DESIGN AND ANALYSIS OF MICROSTRIP BAND PASS FILTER

Project Report submitted in partial fulfilment of the requirements for the Degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

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DECLARATION BY THE SCHOLAR

We hereby declare that the work reported in the B-Tech. project entitled **"Design And Analysis of Microstrip Band pass Filter"** submitted at **Jaypee University of Information Technology, Waknaghat, Solan, H.P.** is an authentic record of our work carried out under the supervision of **Dr. Rajiv Kumar**. We have not submitted this work elsewhere for any other degree or diploma.

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Date:

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the B-Tech. project entitled **"Design And Analysis of Microstrip Band pass Filter"**, submitted by **Rishabh Gupta, Varun Singh, Siddharth** at **Jaypee University of Information Technology, Waknaghat, Solan, H.P.** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree or diploma.

(Signature of Supervisor)

Name: Dr. Rajiv Kumar

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Date:

ACKNOWLEDGEMENT

It is our foremost duty to express our deep regards & gratitude to our Project Guide **Dr. Rajiv Kumar,** under whose guidance & supervision we are able to work on the project **"Design And Analysis of Microstrip Band pass Filter".** Any amount of gratitude towards our family and friends can never be enough for the constant support they have provided us with, we are totally indebted to them. At last it is him, to whom we owe everything, as without God's blessings this endeavours of ours would never have been a success.

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ABSTRACT

Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board technology, and is used to convey microwave -frequency signals. It consists of a conducting strip separated from a ground plane by a dielectric layer known as the substrate. Microwave existing as the pattern of metallization on the substrate.

The purpose of the project is to design, simulate, fabricate, and measure or analysis the characteristics of a 'Microstrip Filter' operating at microwave frequency by using Zeland IE3D software.

The project will present the synthesis and design of the appropriate microwave Filter, whose synthesis is done by ZELAND IE3D and then the microstrip will be locally fabricated in the laboratory and later will be analysed with the help of spectrum analyser

CHAPTER 1

INTRODUCTION

Microstrip is a type of electrical transmission line which can be fabricated using printed circuit board [PCB] technology, and is used to convey microwave frequency signals and it consists of a conducting strip separated from a ground plane by a dielectric layer known as the substrate. Filter can be formed from the microstrip.

It is a device that existing as the pattern of metallization on the substrate. Microstrip technology is far cheep than waveguide technology, as well as being far lighter and more compact.

Microstrip transmission line consist of a conductive strip consist of a conductive strip of width (W) and thickness (t) separated by a dielectric layer (a.k.a. the “substrate”) of thickness (h). Microstrip is by far the most popular microwave transmission line, especially for microwave integrated circuits and MMICs. The major advantage of microstrip over strip line is that all active components can be mounted on the top of the board.

A filter is a network that provides perfect transmission for signal with frequencies in certain passband region and infinite attenuation in the stopband regions. Such ideal characteristics cannot be attained, and the goal of filter design is to approximate the ideal requirements to within an acceptable tolerance.

Filters are used whenever there is something to be passed and something to get rid of. A filter is designed to remove something that unwanted and pass on what is wanted. A microwave filter is a two port device that plays an important role of controlling the frequency response at certain point at cross section in a microwave system, letting a band of frequencies pass through while rejecting frequency in other bands.

Its purpose is to allow a range of signal frequencies to pass, but to block others. Conventional filters are constructed from inductors and capacitors, and the circuits so built are described by the lumped element model, which considers each element to be "lumped together" at one place. That model is conceptually simple, but it becomes increasingly unreliable as the frequency of the signal increases, or equivalently as the wavelength decreases. The distributed element model applies at all frequencies, and is used in transmission line theory; many distributed element components are made of short lengths of transmission line. In the distributed view of circuits, the elements are distributed along the length of conductors and are inextricably mixed together.

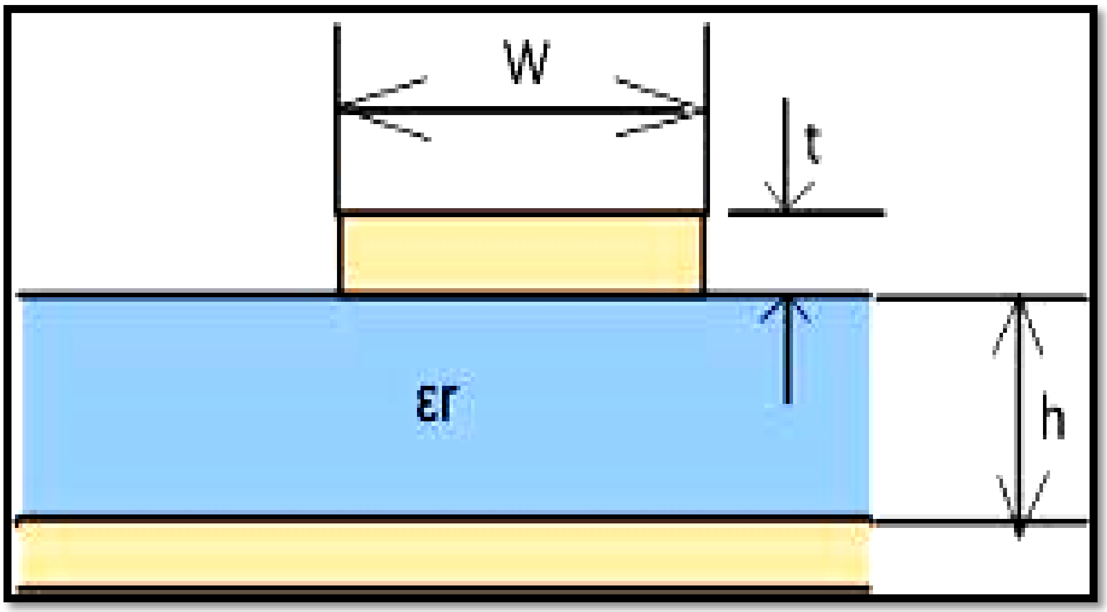


Fig 1.1- Microstrip line.

In modern wireless and mobile communication systems, Radio Frequency (RF) and microwave filter are important and essential components. No doubt, filters are playing an important role in the RF and microwave applications. Filters with smaller size, lighter weight, higher performance, and lower insertion loss are of high demand. Microstrip filters can fulfil the requirements stated above. Besides wireless and mobile communication systems, low-temperature co-fired ceramics (LTCC), high-temperature superconductor (HTS), monolithic microwave integrated circuits (MMIC), micro electro mechanic system (MEMS) and micro machining technology, have driven the rapid development of the new microstrip filter than other microwave and RF filters. Figure 2.1 shows the microstrip filters linkage. Microstrip filters can be designed in various patterns depending on different requirements. Each microstrip filter consists of its individual properties and characteristics. The common microstrip designs that available in market are such as rectangular patch filter, circular patch filter, triangular patch filter and etc.

1.1 **Aim and Objectives.**

Microstrip patch antenna used to send onboard parameters of article to the ground while under operating conditions. The aim of the thesis is to design and fabricate an probe-fed Square Microstrip Patch Antenna and study the effect of antenna dimensions Length (L), and substrate parameters relative Dielectric constant (εr), substrate thickness (t) on the Radiation parameters of Bandwidth and Beam-width.

1.2 Overview of Microstrip Antenna

A microstrip antenna consists of conducting patch on a ground plane separated by dielectric substrate. This concept was undeveloped until the revolution in electronic circuit miniaturization and large-scale integration in 1970. After that many authors have described the radiation from the ground plane by a dielectric substrate for different configurations. The early work of Munson on micro strip antennas for use as a low profile flush mounted antennas on rockets and missiles showed that this was a practical concept for use in many antenna system problems. Various mathematical models were developed for this antenna and its applications were extended to many other fields. The number of papers, articles published in the journals for the last ten years, on these antennas shows the importance gained by them.

The micro strip antennas are the present day antenna designer's choice. Low dielectric constant substrates are generally preferred for maximum radiation. The conducting patch can take any shape but rectangular and circular configurations are the most commonly used configuration. Other configurations are complex to analyze and require heavy numerical computations. A microstrip antenna is characterized by its Length, Width, Input impedance, and Gain and radiation patterns. Various parameters of the microstrip antenna and its design considerations were discussed in the subsequent chapters. The length of the antenna is nearly half wavelength in the dielectric; it is a very critical parameter, which governs the resonant frequency of the antenna. There are no hard and fast rules to find the width of the patch.

1.3 Waves on Microstrip

The mechanisms of transmission and radiation in a microstrip can be understood by considering a point current source (Hertz dipole) located on top of the grounded dielectric substrate (fig. 1.1) This source radiates electromagnetic waves. Depending on the direction toward which waves are transmitted, they fall within three distinct categories, each of which exhibits different behaviors.

1.3.1 Surface Waves

The waves transmitted slightly downward, having elevation angles θ between π/2and π - arcsin (1/√εr), meet the ground plane, which reflects them, and then meet the dielectric-to-air boundary, which also reflects them (total reflection condition). The magnitude of the field amplitudes builds up for some particular incidence angles that leads to the excitation of a discrete set of surface wave modes; which are similar to the modes in metallic waveguide. The fields remain mostly trapped within the dielectric, decaying exponentially above the interface (fig1.2). The vector α, pointing upward, indicates the direction of largest attenuation. The wave propagates horizontally along β, with little absorption in good quality dielectric. With two directions of α and β orthogonal to each other, the wave is a non-uniform plane wave. Surface waves spread out in cylindrical fashion around the excitation point, with field amplitudes decreasing with distance (r), say1/r, more slowly than space waves. The same guiding mechanism provides propagation within optical fibers. Surface waves take up some part of the signal's energy, which does not reach the intended user. The signal's amplitude is thus reduced, contributing to an apparent attenuation or a decrease in antenna efficiency. Additionally, surface waves also introduce spurious coupling between different circuit or antenna elements.

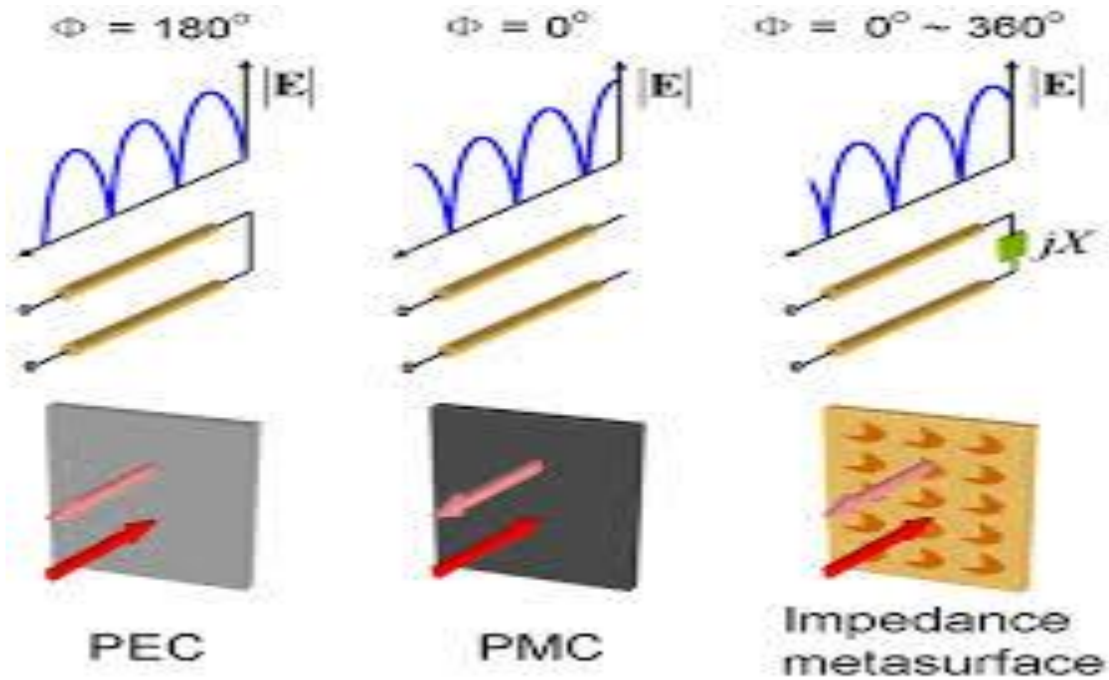


Fig 1.2: Variation of Field with Incidence Angle

This effect severely degrades the performance of microstrip filters because the parasitic interaction reduces the isolation in the stop bands. In large periodic phased arrays, the effect of surface wave coupling becomes particularly obnoxious, and the array can neither transmit nor receive when it is pointed at some particular directions (blind spots). This is due to a resonance phenomenon, when the surface waves excite in synchronism the Floquet modes of the periodic structure. Surface waves reaching the outer boundaries of an open microstrip structure are reflected and diffracted by the edges. The diffracted waves provide an additional contribution to radiation, degrading the antenna pattern by raising the side lobe and the cross polarization levels. Surface wave effects are mostly negative, for circuits and for antennas, so their excitation should be suppressed if possible.

CHAPTER 2

LITERATURE REVIEW

Microstrip antennas are attractive due to their light weight, conformability and low cost. These antennas can be integrated with printed strip-line feed networks and active devices. This is a relatively new area of antenna engineering. The radiation properties of micro strip structures have been known since the mid 1950's. The application of this type of antennas started in early 1970's when conformal antennas were required for missiles. Rectangular and circular micro strip resonant patches have been used extensively in a variety of array configurations. A major contributing factor for recent advances of microstrip antennas is the current revolution in electronic circuit miniaturization brought about by developments in large scale integration. As conventional antennas are often bulky and costly part of an electronic system, micro strip antennas based on photolithographic technology are seen as an engineering breakthrough.

2.1 Feed Techniques

Microstrip patch antennas can be fed by a variety of methods. These methods can be classified into two categories- contacting and non-contacting. In the contacting method, the RF power is fed directly to the radiating patch using a connecting element such as a microstrip line. In the non-contacting scheme, electromagnetic field coupling is done to transfer power between the microstrip line and the radiating patch. The four most popular feed techniques used are the microstrip line, coaxial probe (both contacting schemes), aperture coupling and proximity coupling (both non-contacting schemes).

2.2 Microstrip Line Feed

In this type of feed technique, a conducting strip is connected directly to the edge of the Microstrip patch as shown in Figure 2.3. The conducting strip is smaller in width as compared to the patch and this kind of feed arrangement has the advantage that the feed can be etched on the same substrate to provide a planar structure. The purpose of the inset cut in the patch is to match the impedance of the feed line to the patch without the need for any additional matching element. This is achieved by properly controlling the inset position. Hence this is an easy feeding scheme, since it provides ease of fabrication and simplicity in modeling as well as impedance matching. However as the thickness of the dielectric substrate being used, increases, surface waves and spurious feed radiation also increases, which hampers the bandwidth of the antenna. The feed radiation also leads to undesired cross polarized radiation.

2.3 Methods of Analysis

The preferred models for the analysis of Microstrip patch antennas are the transmission line model, cavity model, and full wave model (which include primarily integral equations/Moment Method). The transmission line model is the simplest of all and it gives good physical insight but it is less accurate. The cavity model is more accurate and gives good physical insight but is complex in nature. The full wave models are extremely accurate, versatile and can treat single elements, finite and infinite arrays, stacked elements, arbitrary shaped elements and coupling. These give less insight as compared to the two models mentioned above and are far more complex in nature.

2.3.1 Transmission Line Model

This model represents the microstrip antenna by two slots of width W and height h, separated by a transmission line of length L. The microstrip is essentially a non- homogeneous line of two dielectrics, typically the substrate and air.

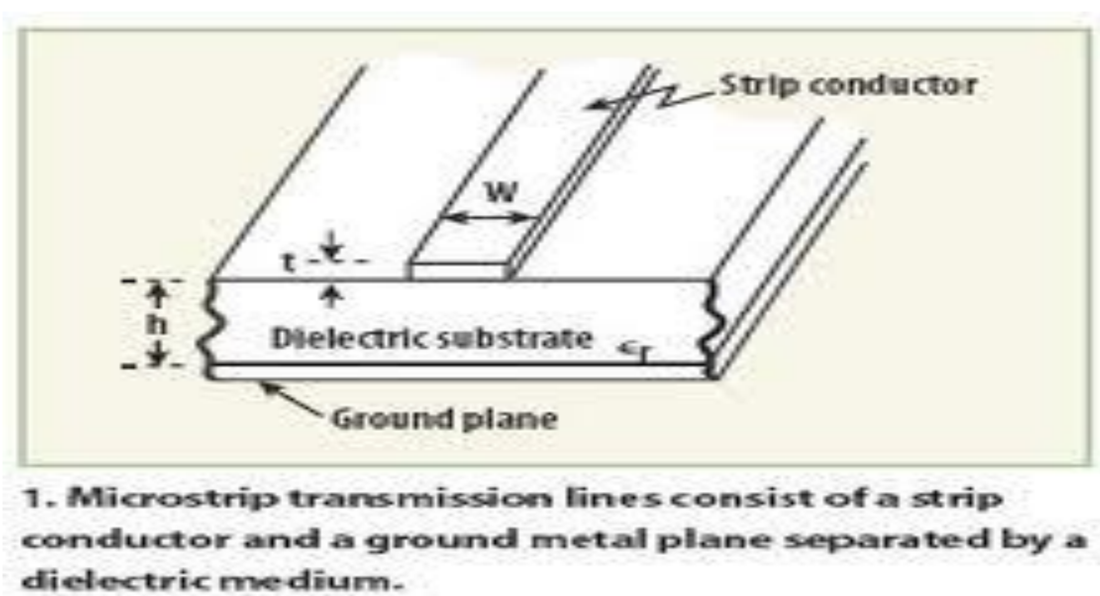


Fig 2.1: Microstrip Transmission Line

Hence, as seen from Figure , most of the electric field lines reside in the substrate and parts of some lines in air. As a result, this transmission line cannot support pure transverse-electric-magnetic (TEM) mode of transmission, since the phase velocities would be different in the air and the substrate. Instead, the dominant mode of propagation would be the quasi-TEM mode. Hence, an effective dielectric constant (εreff) must be obtained in order to account for the fringing and the wave propagation in the line. The value of εreff is slightly less then εr because the fringing fields around the periphery of the patch are not confined in the dielectric substrate but are also spread in the air as shown in Figure2.1.

CHAPTER 3

MICROWAVE FILTER DESIGN PROCEDURE

Our goal is to achieve high accuracy in obtaining the required designed parameters (like the cutoff frequency and return loss) The filters are one of the primary and necessary components of a microwave system. Microstrip line is a good candidate for filter design due to its advantages of low cost , compact size, light weight, planar structure and easy integration with other components on a single board. Conventional filter structures like equal ripple and Butterworth low pass filters are requirement of special fabrication methods. Conventional low frequency techniques for fabrication does not fit at these frequencies due to the very high losses associated. The design and simulation are performed using 3D full wave method of moment based electromagnetic simulator IE3D.

3.1 Filter Design Procedure

The design of filters involves two main steps. The first one is to select an appropriate low pass prototype. The choice of the type of response, including pass band ripple and the number of reactive elements(order of the filter) will depend on the required specifications. The element values of the low pass prototype filters, which are usually normalized to make a source impedance g0=1 and a cutoff frequency Ωc=1.0, are then transformed to the L-C elements for the desired cutoff frequency and the desired source impedance, which is normally 50 ohms for micro strip filters.

3.2 Fabrication Stage

Next, will be the fabrication stage. The simulation results have been sent to supervisor to verify before fabrication process. Substrate Duroid 6006 that used in this filter design is available on the market. The Duroid 6006 used in this project is with single-sided, photo print and UV positive photoresist properties. During fabrication, the filter designs have to be printed on tracing paper first before printed on the board. The size of filter must be 100% exact size of the simulation filter design as the gap for capacitive coupling is extremely sensitive. A 0.01mm mismatch may affect the final result. Hence writer has used several approaches in order to print exact filter design layout on tracing papers. At first, writer has asked some PCB maker in industrial line to fabricate the board for us. Industrial PCB maker has the advance equipment that can help them achieve 0.01 mm accuracy or even more.

3.3 Bends in a Microstrip

In order to build a complete circuit in microstrip, it is often necessary for the path of a strip to turn through a large angle. An abrupt 90° bend in a microstrip will cause a significant portion of the signal on the strip to be reflected back towards its source, with only part of the signal transmitted on around the bend. One means of effecting a low-reflection bend, is to curve the path of the strip in an arc of radius at least 3 times the strip-width.[8] However, a far more common technique, and one which consumes a smaller area of substrate, is to use a mitred bend.

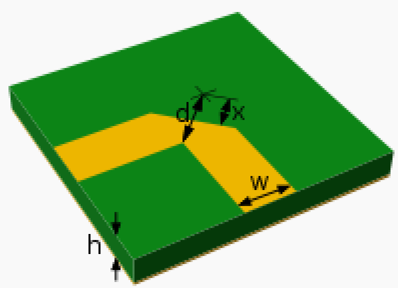


Fig 3.1: Microstrip 90° mitred bend.

To a first approximation, an abrupt un-mitred bend behaves as a shunt capacitance placed between the ground plane and the bend in the strip. Mitring the bend reduces the area of metallization, and so removes the excess capacitance. The percentage mitre is the cut-away fraction of the diagonal between the inner and outer corners of the un-mitred bend.

The optimum mitre for a wide range of microstrip geometries has been determined experimentally by Douville and James. They find that a good fit for the optimum percentage mitre is given by

$$M = 100\frac{x}{d}\% = (52 + 65e^{-\frac{27}{20}\frac{w}{h}})\%$$

subject to $w/h \geq 0.25$ and the with the substrate dielectric constant $\varepsilon_r \leq 25$. This formula is entirely independent of ε_r. The actual range of parameters for which Douville and James present evidence is $0.25 \leq w/h \leq 2.75$ and $2.5 \leq \varepsilon_r \leq 25$. They report a VSWR of better than 1.1 (i.e., a return better than −26 dB) for any percentage mitre within 4% (of the original d) of that given by the formula. At the minimum w/h of 0.25, the percentage mitre is 98.4%, so that the strip is very nearly cut through.For both the curved and mitred bends, the electrical length is somewhat shorter than the physical path-length of the strip.

CHAPTER 4

SOFTWARE IMPLEMENTATION

4.1 Introduction

In this chapter, the procedure for designing a microstrip antenna in IE3D software is explained. And the results obtained from the simulations are demonstrated.

4.2 About IE3D Software

IE3D is an integrated full-wave electromagnetic simulation and optimization package for the analysis and design of 3D and planar microwave circuits.Since its formal introduction in 1993 IEEE International Microwave Symposium (IEEE IMS 1993), the IE3D has been adopted as an industrial standard in planar and 3D electromagnetic simulation.The IE3D has become the most versatile, easy to use, efficient and accurate electromagnetic simulation tool.

4.2.1 MGRID

MGRID is the major layout editor for construction of a structure. It allows a user to create and edit a structure as polygons and vertices. It has full control over the detail shapes and locations of geometry. It also serves as the post processor for current display, pattern calculation, near field calculation and visualization. Starting from IE3D 12, parameter visualization and lumped element extraction are also integrated into MGRID to simplify the use of IE3D.The IE3D has a great advantage over other commercial EM simulation tools no matter whether accuracy, efficiency, capability or capacity is concerned.The circuit is implemented using the IE3D software. The problems with the designing can be estimated, spotted and eliminated with the help of this software without implementing it on the hardware(PCB).

IE3D is the first SCALABLE EM design and verification platform that delivers the modeling accuracy for the combined needs of high-frequency circuit design and signal integrity engineers across multiple design domains. For many companies, there is no longer just one EM problem at hand, but several different ones each presenting a unique bottleneck and delaying overall design closure. IE3D's multi-threaded and distributed simulation architecture and high-design capacity is the most cost-effective EM simulation and modeling solution for component-level and circuit-level applications. IE3D offers the highest simulation capacities and fastest turnaround times for the broadest number of applications making it the best choice for improving your design team productivity and meeting design schedules on time.

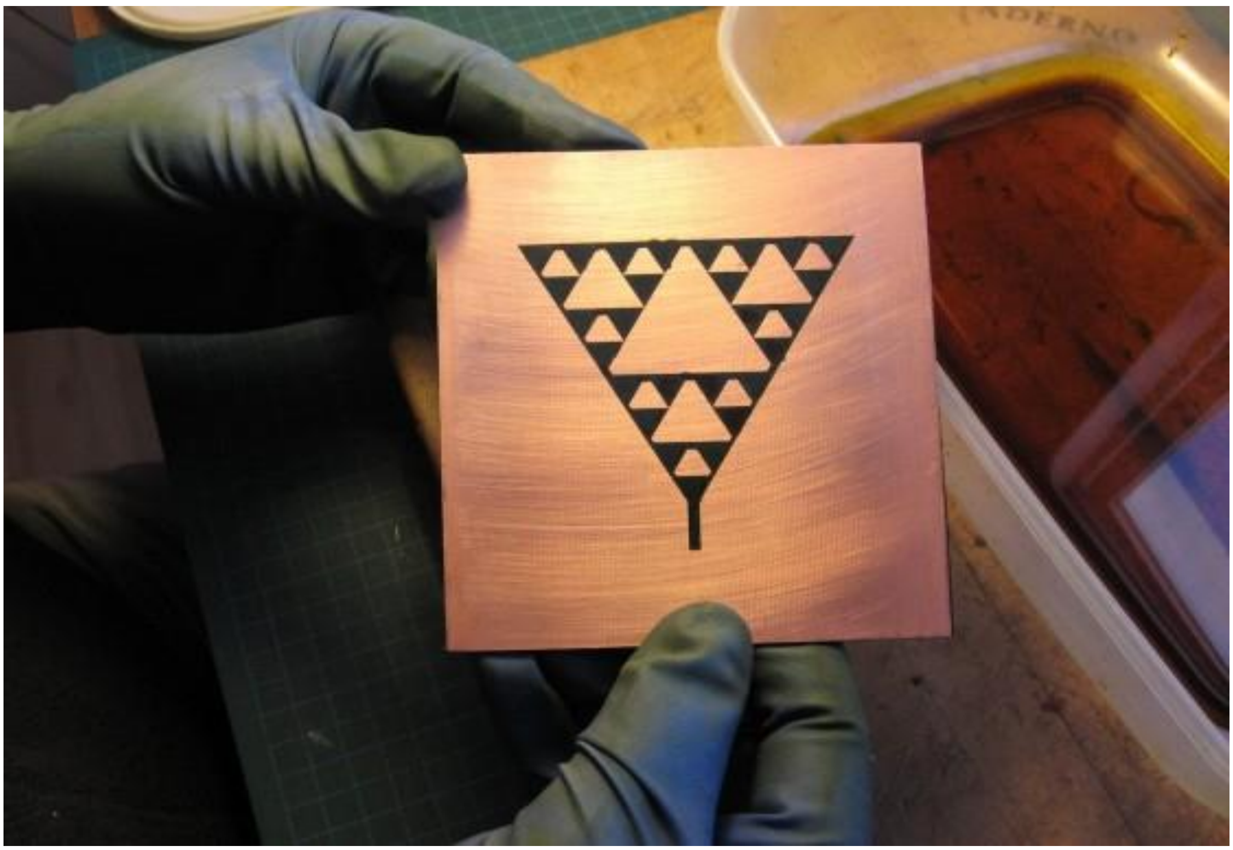
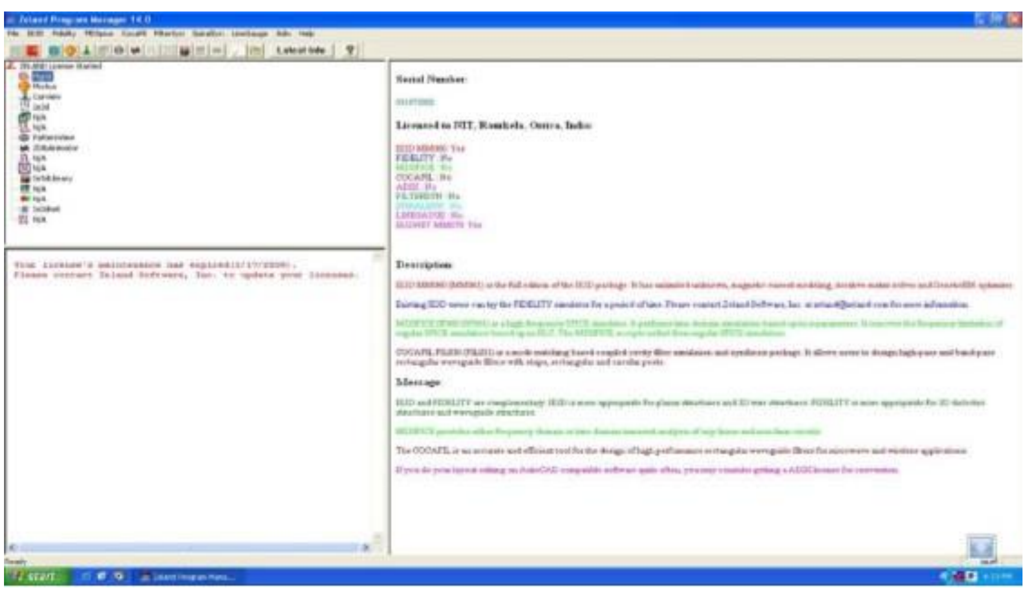


Fig 4.1: fabricated microstrip Filter using IE3D software.

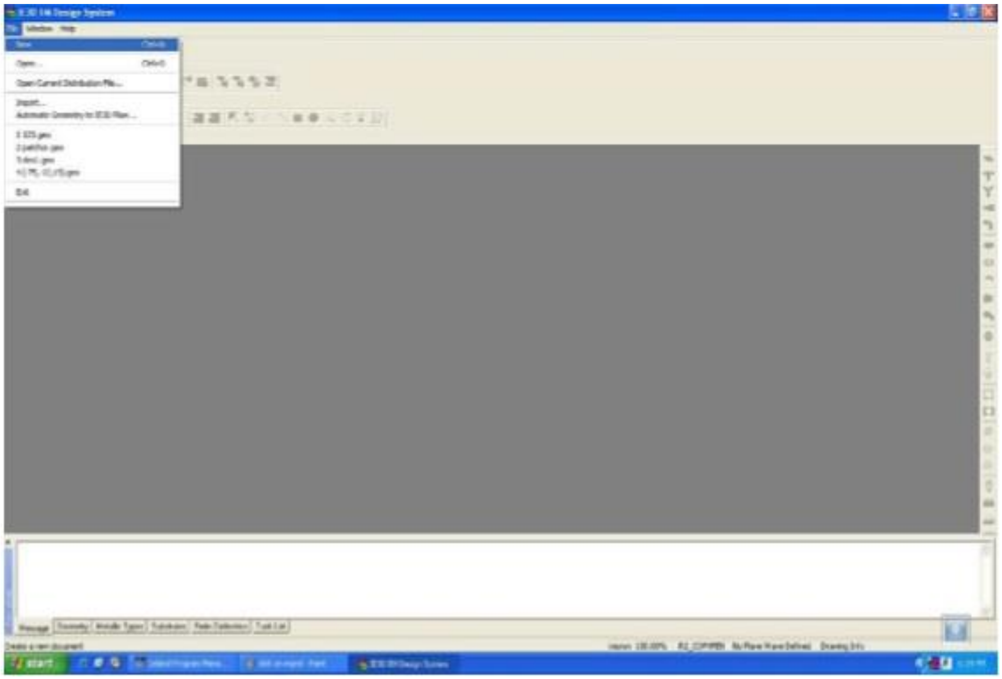
4.3 Simulation in IE3D

Step 1: Start Zeland Program Manager.

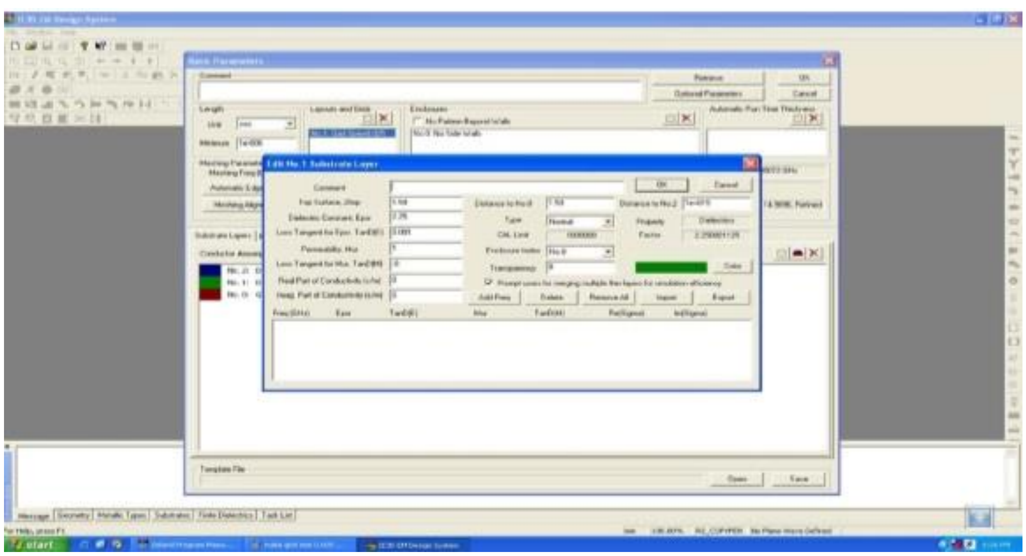
Step 2 : Double click on mgrid.



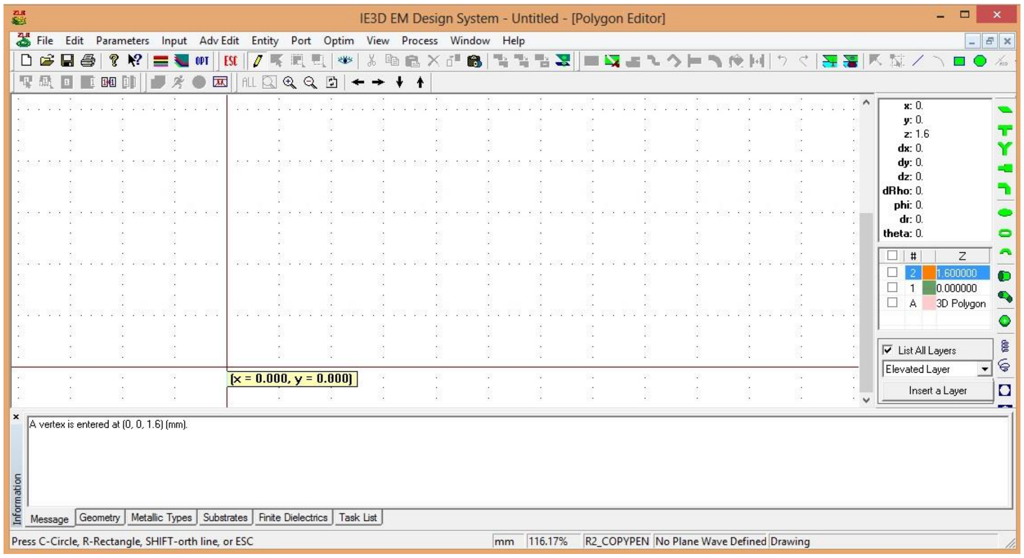
Step 3. Click on File and then Open a New File.



Step 4. Define Substrate Parameters.



Step 5: Define all co-ordinates in a Co-ordinates Screen



Step 6: After entering all coordinates ,click on ‘define port’.Then click to ‘simulate’.

Step 7: Then Enter Frequencies as shown below.

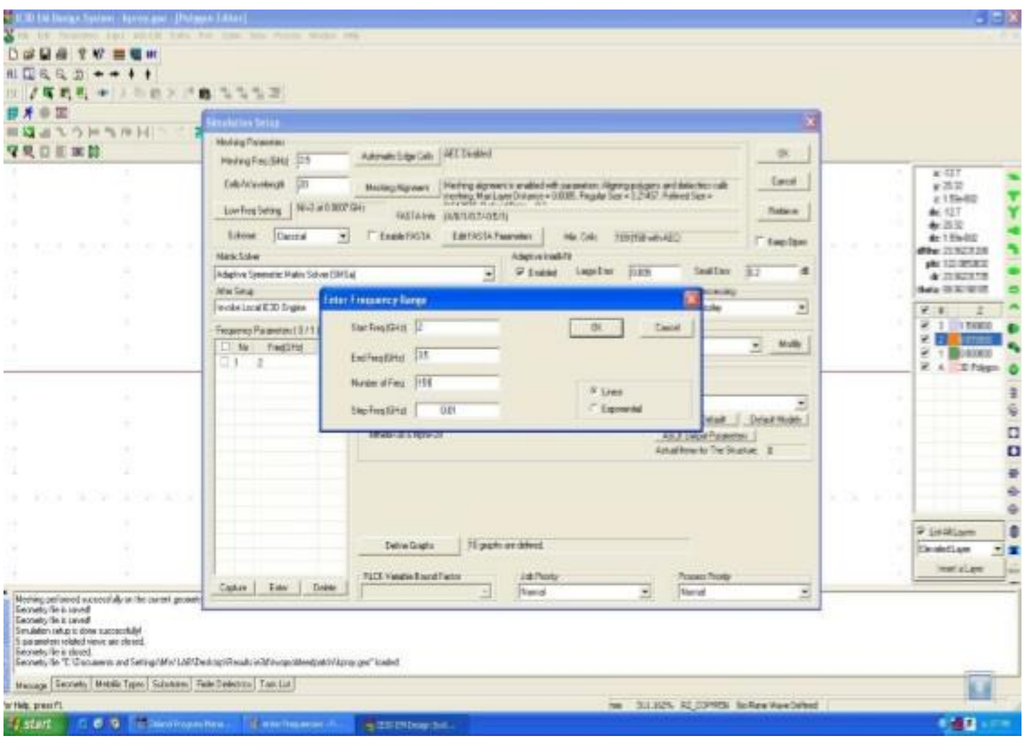


Fig-4.2: Simulation Process using IE3D Software

Step 8.Then Press OK.

Step 9.Simulation Starts and after simulation we get the results.

The IE3D is easy-to-use where it is accurate and efficient in modeling wide range structures such as microstrip circuits and antennas, strip-line circuits, CPW circuits and antennas, coaxial structure with uniform dielectric filling, inverted-F antennas, dipoles and other wire antennas, high speed transmission lines, high speed digital circuit interconnects, high speed digital circuit packaging. However, moment method codes have some rooter disadvantages in modeling 3D dielectric structures, waveguide structures and structures emphasizing near field distribution.

CHAPTER 5
FABRICATION

5.1 FABRICATION PROCESS OF MICROSTRIP CIRCUIT

5.1.1 Introduction

Filter networks are essential building elements in many areas of RF/microwave en- gineering. Such networks are used to select/reject or separate/combine signals at different frequencies in a host of RF/microwave systems and equipment. Although the physical realization of filters at RF/microwave frequencies may vary, the circuit network topology is common to all. At microwave frequencies, voltmeters and ammeters for the direct measurement of voltages and currents do not exist. For this reason, voltage and current, as a mea- sure of the level of electrical excitation of a network, do not play a primary role at microwave frequencies. On the other hand, it is useful to be able to describe the op- eration of a microwave network such as a filter in terms of voltages, currents, and impedances in order to make optimum use of low-frequency network concepts.

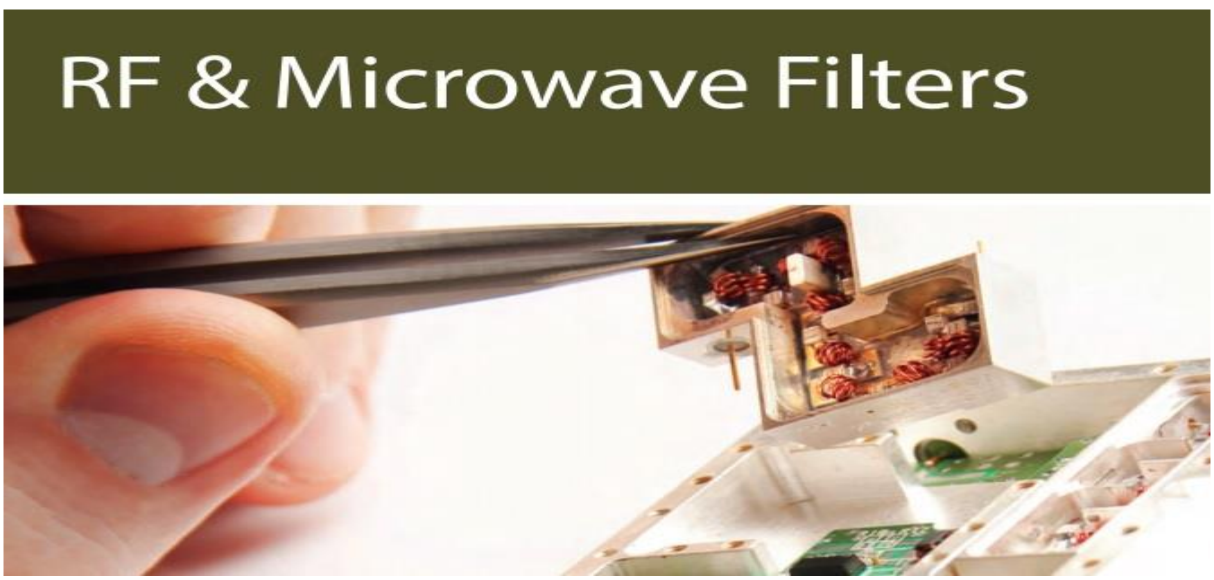


Fig 5.1: RF and Microwave Filters

The design of microstrip antenna is made using IE3D software.The investigation has been limited mostly to theoretical studies and simulations due to lack of fabrication facilities. Detailed experimental studies can be taken up at a later stage to fabricate the antenna. Before going for fabrication we can optimize the parameters of antenna using one of the soft computing techniques known as Particle Swarm Optimization (PSO). Microwave filters are vital component in wireless communication system.The use of microstrip technology in the design of microwave components and and integrated circuits has gained tremendous popularity since last decade.

5.2 Photoresist Material

A photoresist is a light-sensitive material used in several industrial processes, such as photolithography and photoengraving to form a patterned coating on a surface. Photoresists are most commonly used at wavelengths in the ultraviolet spectrum or shorter (<400 nm). For example, diazonaphthoquinone (DNQ) absorbs strongly from approximately 300 nm to 450 nm. The absorption bands can be assigned to n-π* (S_0–S_1) and π-π* (S_1–S_2) transitions in the DNQ molecule. In the deep ultraviolet (DUV) spectrum, the π-π* electronic transition in benzene or carbon double-bond chromophores appears at around 200 nm.

Due to the appearance of more possible absorption transitions involving larger energy differences, the absorption tends to increase with shorter wavelength, or larger photon energy. Photons with energies exceeding the ionization potential of the photoresist (can be as low as 5 eV in condensed solutions) can also release electrons which are capable of additional exposure of the photoresist. From about 5 eV to about 20 eV, photoionization of outer "valence band" electrons is the main absorption mechanism. Above 20 eV, inner electron ionization and Auger transitions become more important. Photon absorption begins to decrease as the X-ray region is approached, as fewer Auger transitions between deep atomic levels are allowed for the higher photon energy. The absorbed energy can drive further reactions and ultimately dissipates as heat. This is associated with the outgassing and contamination from the photoresist.

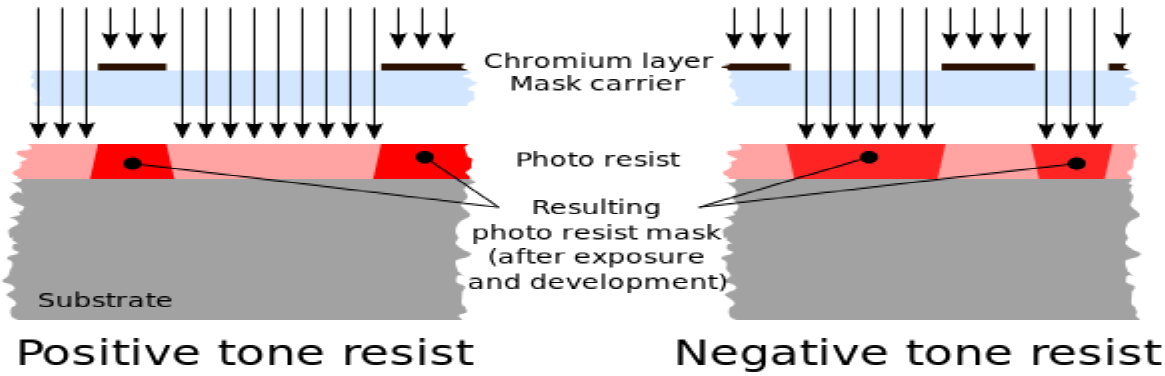


Fig 5.2:Different types of Photo resist

Contrary to past types, current negative photoresists tend to exhibit better adhesion to various substrates such as Si, GaAs, InP and glass, as well as metals, including Au, Cu and Al, compared to positive-tone photoresists. Additionally, the current generation of G, H and I-line negative-tone photoresists exhibit higher temperature resistance over positive resists.One very common negative photoresist is based on epoxy-based polymer. The common product name is SU-8 photoresist, and it was originally invented by IBM, but is now sold by Microchem and Gersteltec. One unique property of SU-8 is that it is very difficult to strip. As such, it is often used in applications where a permanent resist pattern (one that is not strippable, and can even be used in harsh temperature and pressure environments) is needed for a device.

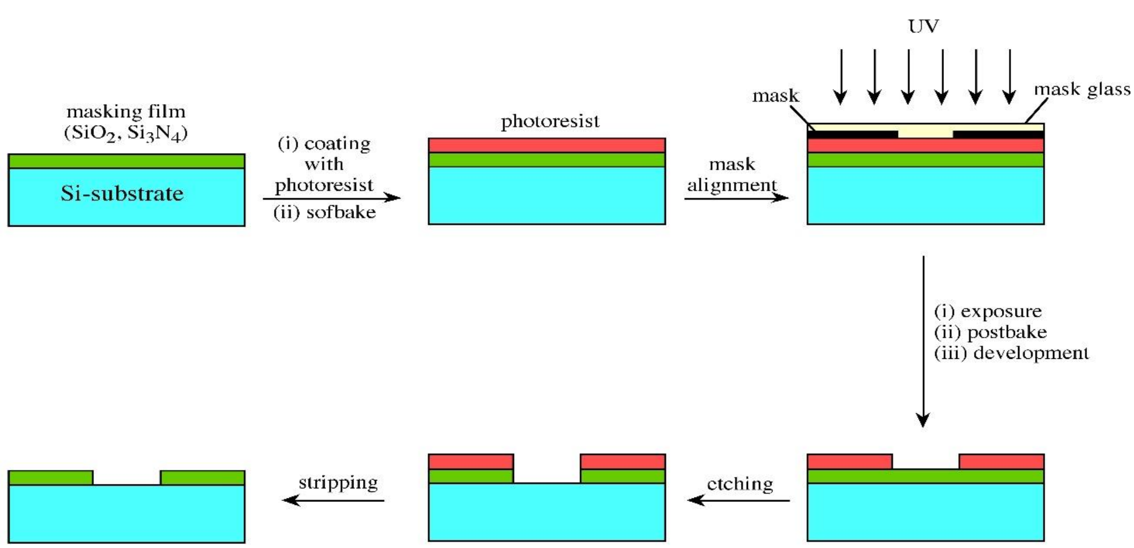


Table 5.1: Etching Process

5.3 Etching Process

Etching is the process of using strong acid or mordant to cut into the unprotected parts of a metal surface to create a design in intaglio in the metal (the original process—in modern manufacturing other chemicals may be used on other types of material). As an intaglio method of printmaking, it is, along with engraving, the most important technique for old master prints, and remains in wide use today. In pure etching, a metal (usually copper, zinc or steel) plate is covered with a waxy ground which is resistant to acid. The artist then scratches off the ground with a pointed etching needle where he or she wants a line to appear in the finished piece, so exposing the bare metal. The échoppe, a tool with a slanted oval section, is also used for "swelling" lines. The plate is then dipped in a bath of acid, technically called the *mordant* (French for "biting") or *etchant*, or has acid washed over it. The acid "bites" into the metal, where it is exposed, leaving behind lines sunk into the plate. The remaining ground is then cleaned off the plate. The plate is inked all over, and then the ink wiped off the surface, leaving only the ink in the etched lines.

The plate is then put through a high-pressure printing press together with a sheet of paper (often moistened to soften it). The paper picks up the ink from the etched lines, making a print. The process can be repeated many times; typically several hundred impressions (copies) could be printed before the plate shows much sign of wear. The work on the plate can also be added to by repeating the whole process; this creates an etching which exists in more than one state.

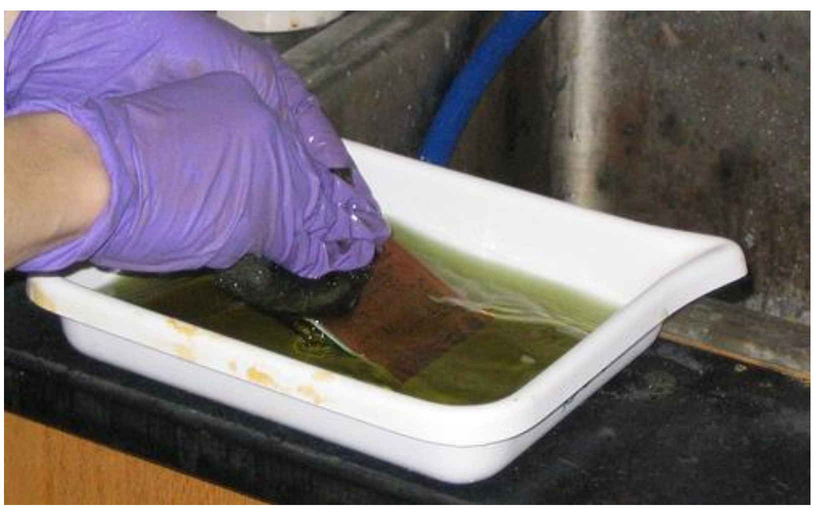


Fig 5.3: Etching Process

5.4 Microstrip Housing (Ground Plane)

The main purposes of the housing or package are to provide mechanical strength, EM shielding, germetiza- tion, and heat sinking in the case of high-power applications. Packaging must protect the circuitry from mois- ture, humidity, dust, salt spray, and other environmental contaminants. In order to protect the circuit, certain methods of sealing can be used: con- ductive epoxy, solder, gasket materi- als, and metallization tape. An MIC mounted into a housing may be looked on as a dielectrically loaded cavity resonator (Fig. 3, left) with the following inner dimensions: a is the width, l is the length, and H is the height of the enclosure.

These dimensions should be selected in a way so that the waveguide modes are below cutoff. The characteristic impedance of a microstrip line may be approximate- ly calculated by assuming that the EM field in the line has a quasi trans- verse-EM (TEM) nature. The characteristic impedance of a microstrip line can be calculated using the Wheeler equations. To minimize conductor loss while simultaneously minimizing the amount of metallic material flanking the dielectric, the conductor thick- ness should be greater than approxi- mately three to five times the skin depth. In a microstrip line, conductor loss- es increase with increasing charac- teristic impedance due to the greater resistance of narrow strips.

CHAPTER 6
TESTING AND MEASUREMENTS

6.1 INTRODUCTION

After the microstrip is locally fabricated in the laboratory , the microstrip is analysed with the help of spectrum analyser.

6.2 Spectrum Analyser

A spectrum analyzer measures the magnitude of an input signal versus frequency within the full frequency range of the instrument. The primary use is to measure the power of the spectrum of known and unknown signals. The input signal a spectrum analyzer measures is electrical, however, spectralcompositions of other signals, such as acoustic pressure waves and optical light waves, can be considered through the use of an appropriate transducer. Optical spectrum analyzers also exist, which use direct optical techniques such as a monochromator to make measurements By analyzing the spectra of electrical signals,dominant frequency, power, distortion, harmonics, bandwidth, and other spectral components of a signal can be observed that are not easily detectable in time domain waveforms. These parameters are useful in the characterization of electronic devices, such as wireless transmitters.

The display of a spectrum analyzer has frequency on the horizontal axis and the amplitude displayed on the vertical axis. To the casual observer, a spectrum analyzer looks like an oscilloscope and, in fact, some lab instruments can function either as an oscilloscope or a spectrum analyzer.

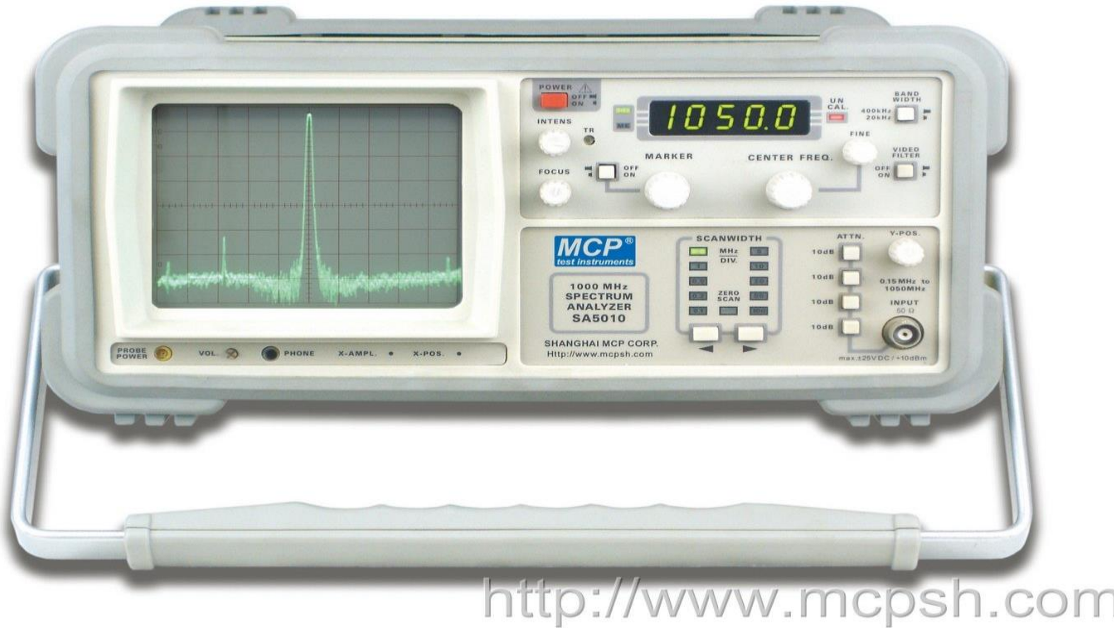


Fig 6.1:- Expected result of CRO

The first spectrum analyzers, in the 1960s, were swept-tuned instruments. Today, there are three basic types of analyzer: the swept-tuned spectrum analyzer, the vector signal analyzer, and the real-time spectrum analyzer.

EXPECTED RESULT

The figure which we describe here is only general.And we

Want the result which is closer to the Ideal graph which is given below .

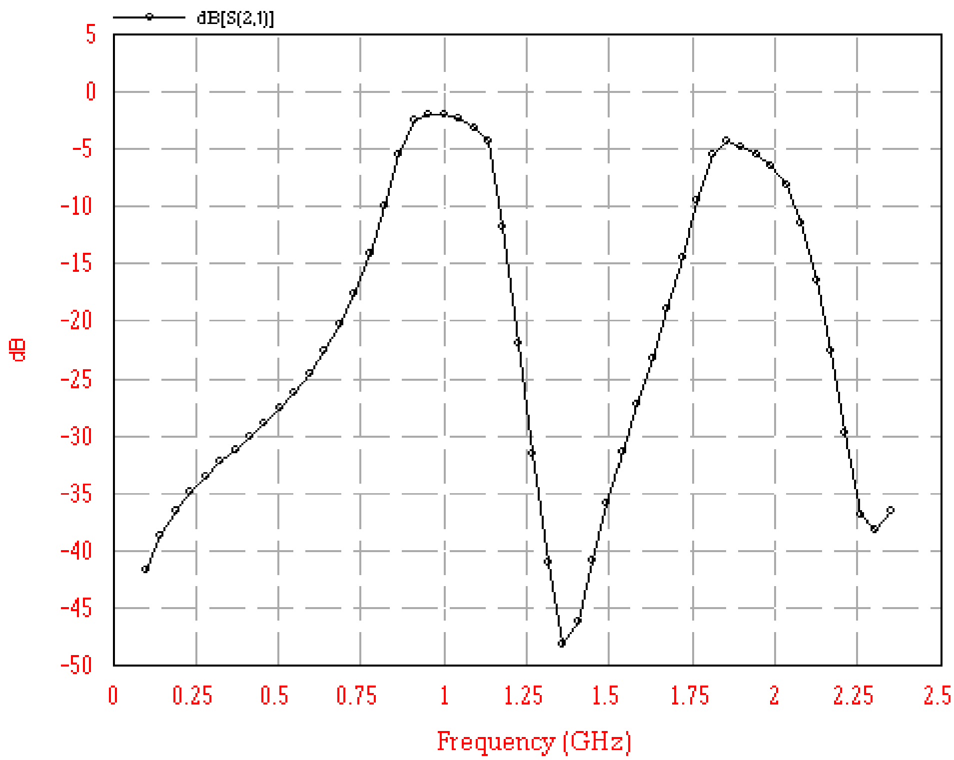


Fig 7.1: (Transmission Coefficient S_{21})

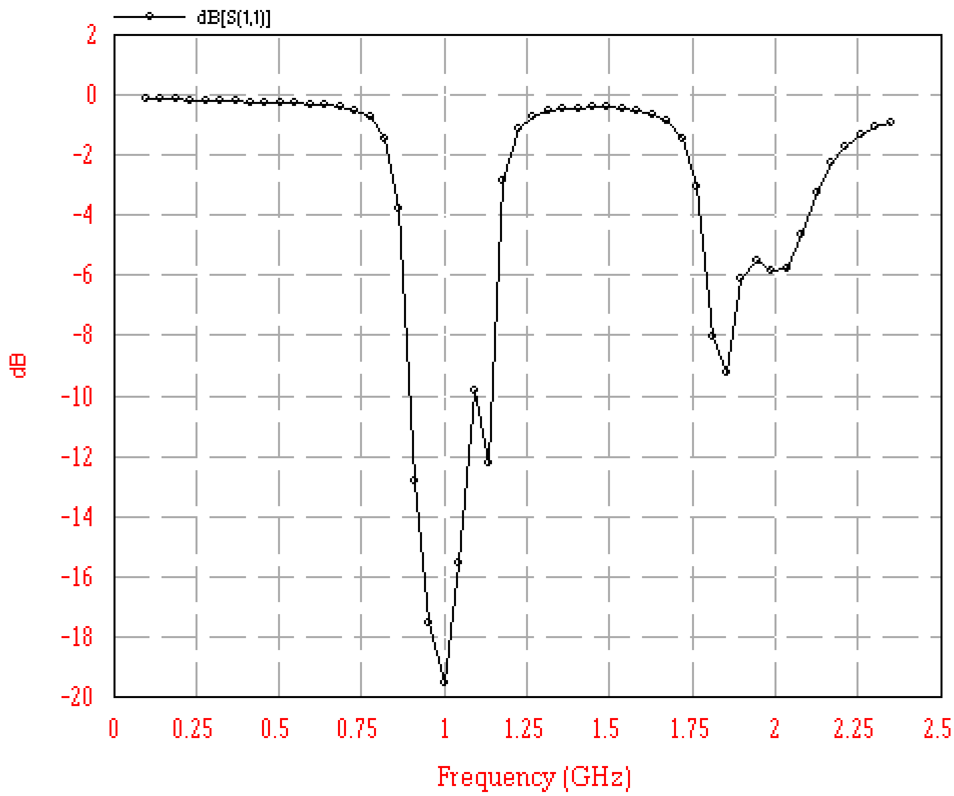


Fig 7.2: (Reflection Coefficient S_{11})

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