DESIGN OF MICROSTRIP PATCH ANTENNA FOR PRACTICAL APPLICATIONS

Project report submitted in partial fulfillment of the requirement for the degree of

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

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UNDER THE GUIDANCE OF

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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

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CONTENTS

DECLARATION

I hereby declare that the work reported in the B-Tech thesis entitled **"DESIGN OF MICROSTRIP PATCH ANTENNA FOR PRACTICAL APPLICATIONS"** submitted at **Jaypee University of Information Technology, Waknaghat, India**, is an authentic record of my work carried out under the supervision of **Dr. Naveen Jaglan.** I have not submitted this work elsewhere for any other degree or diploma.

Name	**Signature**

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Date: 13/05/2019

CERTIFICATE

This is to certify that the project entitled "**DESIGN OF MICROSTRIP PATCH ANTENNA FOR PRACTICAL APPLICATIONS**" submitted by Annie Sharma to the Department of ECE for the fulfilment for the award of **B.Tech** degree from **Jaypee University of Information Technology, Waknaghat, India,** is a record of student's own work carried out under my supervision.

Dr. Naveen Jaglan

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Dated:

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to all those who supported me throughout the entire course of this B. Tech project and without whose guidance it would have been quite a difficult task.

I am highly thankful to **Dr. Naveen Jaglan, Project Supervisor,** for his valuable supervision in this project, whose constant support and motivation encouraged me to do the project efficiently.

I am also thankful to my parents and friends for their support. I gratefully acknowledge each one of them.

Date: 13/05/2019

Annie Sharma (151090)

LIST OF ABBREVIATIONS

- **BER-Bit Error Rate**
- **EBG-Electromagnetic Band Gap Structure**
- **GUI- Graphic User Interface**
- **HFSS- High Frequency Structure Simulator**
- **HSPA-Packet Access**
- **IOT-Internet of Things**
- **ISI-Inter-symbol Interference**
- **LTE-Long Term Evolution**
- **MAI-Multiple Access Interference**
- **MIMO-Multiple Input Multiple Output**
- **MISO- Multiple Input Single Output**
- **QoS-Quality of Servic**
- **RF-Radio Frequency**
- **SIMO- Single Input Multiple Output**
- **SISO- Multiple Input Single Output**
- **SNR-Signal to Noise Ratio**
- **UWB-Ultra Wide Band**
- **VSWR-Voltage Standing Wave Ratio**
- **WIFI-Wireless Fidelity**
- **WPAN-Wireless Personal Area Network**

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Different feeding techniques can be used for microstrip patch antennas and based on power transfer mechanism from feed to patch; they can be differentiated from each other. This report revolves around designing and simulating a microstrip patch antenna by using three feeding techniques namely coaxial feed, quarter wavelength feed and inset feed. The given antenna is excited using these feeds and the given design has been simulated and executed using HFSS. Different parameters of antenna like gain, radiation pattern and bandwidth have been presented in this report. Amongst the three feeding techniques, the coaxial feed gave the best results. Then using the coaxial feed, UWB antenna is designed as there is a need for a large frequency range. The challenges of this UWB antenna are then overcome by designing the UWB-MIMO antenna. The UWB-MIMO antenna helped us overcome the challenges but resulted in large mutual coupling. The designing of the T-shaped UWB-MIMO reduced this mutual coupling and gave best results amongst all.

LITERATURE REVIEW

1. Author: Richa Chandel and Anil Kumar Gautam

Title: Tapered Fed Compact UWB MIMO-Diversity Antenna with Dual Band-Notched Characteristics

A reduced structure of different information different yield (MIMO) Antenna with double strongly dismissed indent groups for compact remote ultra-wideband (UWB) applications is displayed and tentatively explored. The proposed UWB MIMO Antenna has a conservative size of 18 mm × 34 mm. The exhibition of the MIMO Antenna as far as disconnection among the ports, radiation design, proficiency, acknowledged increase, envelope relationship coefficient, mean powerful addition, and all out dynamic reflection coefficient is contemplated.

2. Author: Jianxin Liang and Choo C.Chiau

Title: Study of a Printed Circular Disc Monopole Antenna for UWB Systems

This paper introduces an investigation of a novel monopole radio wire for ultra-wide-band (UWB) applications. Imprinted on a dielectric substrate and encouraged by a 50 microstrip line, a planar round plate monopole has been exhibited to give a ultra -wide 10 dB return misfortune data transfer capacity with agreeable radiation properties. The parameters which influence the presentation of the radio wire in terms of its recurrence space qualities are researched.

3. Author: N. Jaglan, B. Kanaujia, S. Gupta, and S.Srivastava

Title: Triple Band Notched DG-CEBG Structure Baes UWB MIMO/Diversity Antenna

A MIMO/Diversity recieving wire with triple indent attributes is proposed in this article. The proposed reception apparatus has triple scores in the WiMAX band (3.3– 3.6GHz), WLAN band (5– 6 GHz), and X-band satellite correspondence (7.2– 8.4GHz) band. Surrendered Ground Compact Electromagnetic Band Gap (DG-CEBG) is a structure used to achieve band scores. In these structures, decoupling strips and an opened ground plane are utilized to improve the disengagement between two firmly dispersed UWB monopoles.

4. Author: Ekta Thakur, Naveen Jaglan and Samir D. Gupta

Title: A Compact Notched UWB MIMO Antenna with Enhanced Performance

This paper explores the exhibition of minimal triple band-scored Multiple Input Multiple Output (MIMO) receiving wire for Ultra-Wideband (UWB) correspondence. Open-finished quarter wavelength openings are embedded on the radiators. These spaces are utilized to acquire indent groups at WiMAX/C band, WLAN band and the X-band Satellite Communication System that ranges in 3.3– 4.2GHz, 5– 6GHz, and 7.28.6GHz,respectively.

5. **Author: N. Jaglan, S. D. Gupta, B. Kanaujia , S. Srivastava**
Title: Triple Band notched UWB Antenna Design Using Electromagnetic Band Gap Structures
A round monopole reception apparatus for ultra-wideband (UWB) applications with triple band indents is proposed. The proposed reception apparatus rejects overall interoperability for microwave get to WiMAX band (3.3GHz– 3.8GHz), remote neighborhood WLAN band (5.15GHz– 5.825 GHz) and X-Band downlink satellite correspondence band (7.1 GHz– 7.9GHz). The impact of variety of EBG structure parameters on which indented recurrence depends is additionally examined. Manufactured and estimated results are in great concurrence with recreated ones.

6. **Author: L. Wu ,Y. Xia1, and X. Cao**
Title: Compact Quad Band-Notched Monopole Antenna for UWB Systems
A reduced microstrip-sustained UWB radio wire with quad indented band is proposed. The reception apparatus comprises of a rectangular emanating patch with a half circle, a decreased microstrip feed-line, and a semi-curved ground plane. With a couple of L-molded openings, reciprocal co-directional SRR and a couple of C-formed stubs, four scored groups are made to keep impedance from WiMAX/lower WLAN/higher WLAN/X-band. Great radiation examples and stable addition inside the working band have been watched.

7. **Author: F. Yang, and Y. R. Samii**
Title: Microstrip Antennas Integrated With Electromagnetic Band-Gap (EBG) Structures: A Low Mutual Coupling Design for Array Applications
Usage of electromagnetic band-hole (EBG) structures is getting to be appealing in the electromagnetic and receiving wire network. In this paper, a mushroom-like EBG structure is dissected utilizing the limited distinction time-area (FDTD) strategy. Its band-hole highlight of surface-wave concealment is shown by displaying the close field disseminations of the electromagnetic waves. The shared coupling of microstrip radio wires is parametrically examined, including both the E and H coupling headings, diverse substrate thickness, and different dielectric constants.

8. **Author: M. Alam, N. Misran, B. Yatim**
Title: Development of Electromagnetic Band Gap Structure in the perspective of Microstrip Antenna Design
This paper gives an exhaustive audit on different EBG structures, for example, three-, two-and one-dimensional (3D, 2D, and 1D) EBG, mushroom and uni-planar EBG and their progressive headway. Thinking about the related manufacture complexities, usage of via less EBG is an alluring point for microwave engineers. The EBG structures are likewise effectively used in receiving wire clusters for decreasing the common coupling between components of the exhibit. Current difficulties and confinements of the run of the mill microstrip receiving wires and distinctive EBG structures are examined in subtleties with some potential recommendations.

CHAPTER 1

INTRODUCTION TO ANTENNAS

The interfacing between the Electric currents moving in metal conductors and radio waves propagating through space used with in a transmitter and receiver is called an antenna. The electric current is supplied to the antenna terminals using a radio transmitter. The energy from the current is radiated as electromagnetic waves by the antenna. In order to produce an electric current, an antenna takes some of the power of the radio waves which is amplified by applying it to the receiver. In radio equipment's antennas are used an essential components for example radio broadcasting ,broad cast television, cellphones, satellite communications, two - way radio . A radio wave in terms of transverse electro-magnetic field is radiated into the space as energy by time varying fields from antenna. Oscillating currents are created in antennas leading them to move back and forth by incoming radio waves that exert force on the electrons.

A coaxial line or empty pipe is framed by a directing gadget or a transmission line and it is utilized to transport electromagnetic vitality from the transmitting source to the receiving wire, or from the radio wire to the beneficiary. Because of the lossy idea of the transmission line and the receiving wire just as because of reflections there are conduction dielectric misfortunes. Thinking about the inner impedance of the source and dismissing line and reflection misfortunes greatest influence is conveyed to the receiving wire under conjugate coordinating. The voyaging waves alongside the reflected waves structure useful and ruinous impedance designs alluded to as standing waves.

The transmission line could act to a huge degree as a vitality stockpiling component rather than a wave directing or vitality transporting gadget if a radio wire framework isn't appropriately structured. Due the line, receiving wire and the standing waves the misfortunes are unwanted. By selecting low lines, losses due to the lines can be minimized. An antenna is basically a wireless system that needs to be optimized in some directions and suppressed in others.

The antenna serves as a directional device as well as a probing device. The antenna is one of the most important components of the wireless communication system. The requirements and the overall system performance can be improved by a good design of the antenna. Like the eye and eye glasses serve to the humans, the antenna serves to the communication system.

1.1 TYPES OF ANTENNA

1.1.1 WIRE ANTENNAS:

Wire reception apparatuses are for all intents and purposes observed wherever in vehicles, space makes, structures. They can be of various shapes, for example, straight wire, circle and helix. Circle radio wires are not just roundabout they can likewise be rectangular, square and oval. As a result of the effortlessness in development, roundabout circle is generally normal.

Figure1.1: Wire antenna [1]

1.1.2 APERTURE ANTENNAS:

Gap radio wires are valuable for air ship and space create applications as they can be in all respects helpfully flush mounted on the skin of air specialty and space make. A dielectric material is utilized to cover to ensure them from unsafe states of nature.

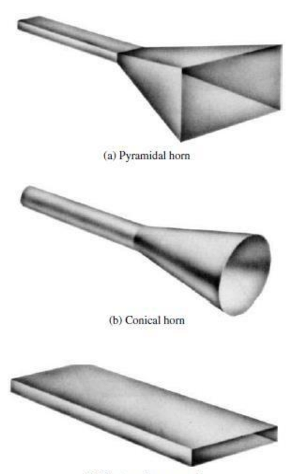


Figure1.2: Aperture antenna [2]

1.1.3 MICROSTRIP ANTENNAS:

In the 1970's primarily, for space bond applications microstrip antennas became very popular. Nowadays these antennas are being used for government and commercial applications. The microstrip antennas consist of a metallic patch on a grounded substrate. Different configurations can be taken from the metallic patch.

Rectangular and circular patches are the most common because of analysis and fabrication, there attractive radiation characteristic especially low cross polarization radiation. Microstrip antennas are low profile, simple and inexpensive to fabricate, mechanically robust when mounted on rigid surfaces, polarization, pattern and impedance. Microstrip antennas can be mounted on the surface of aircrafts, space crafts, satellites, missiles and cars.

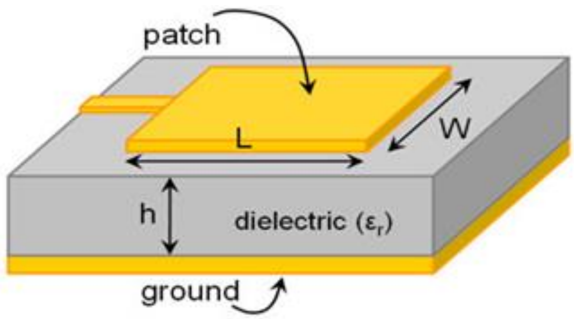


Figure 1.3: Microstrip antenna [3]

1.1.4 ARRAY ANTENNAS:

In an electrical and geometrical course of action (a cluster) it might be conceivable that a total of emanating components will result in the ideal radiation trademark. The radiation from the components is signified give a greatest radiation in a specific course or headings least in others.

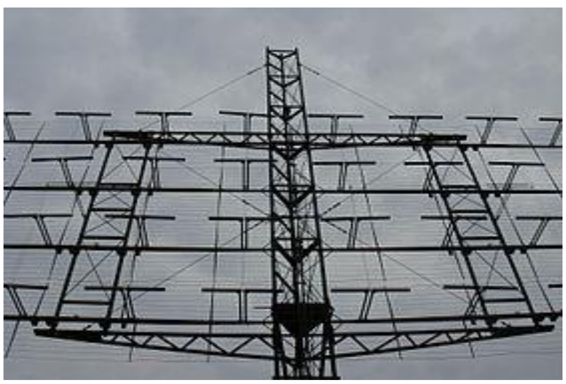


Figure1.4: Array antenna [4]

1.1.5 REFLECTOR ANTENNAS:

These types of antennas have been built with diameters as large as 305m. To achieve the high gain required to transmit or receive signals after millions of miles of travel, such large dimensions are required.

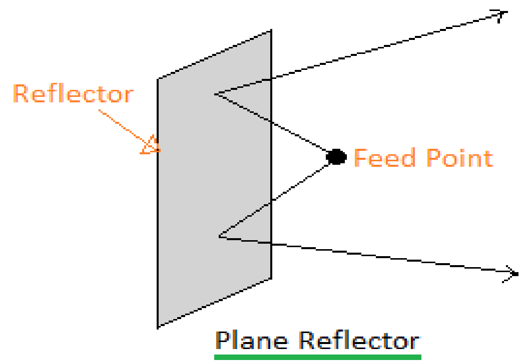


Figure1.5: Reflector Antenna [5]

1.1.6 LENS ANTENNA:

To collimate episode unique vitality to keep it from spreading in undesired ways focal points are principally utilized. We can change different types of disparate vitality into plane waves by appropriately molding the geometrical setup and picking the proper material of the focal point. They have similar utilizations of the allegorical reflectors particularly at higher frequencies. At lower frequencies the measurements and the weight turns out to be exceedingly enormous. According to the material from which they are built, or as indicated by their geometrical shape the focal point receiving wires are ordered.

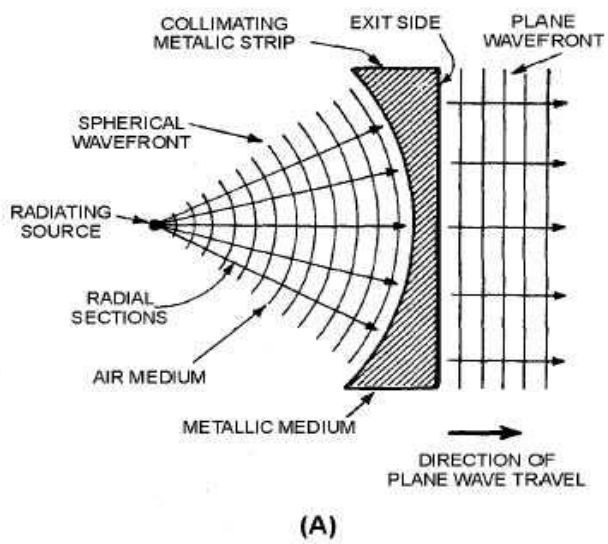


Figure1.6: Lens Antenna [6]

1.1.7 OMNIDIRECTIONAL ANTENNAS:

They transmit and receive radio waves in all horizontal directions equally. A whip antenna also known as vertical antenna which consists of a metal rod is an example of omnidirectional antenna. Many antenna types sends energy upward or downward but have a uniform radiation pattern in horizontal plane. Coupling to the electromagnetic field in the direction of other station is maximized using a “directional antenna”.

Figure1.7: Omnidirectional antenna [7]

1.1.8 HIGH GAIN OR DIRECTIONAL ANTENNAS:

They transmit and receive radio waves in a particular direction. It has 2 conductors extending in opposite directions. Antenna blind cone is the region which cannot be scanned by an antenna because of the limitations of the mount and the radiation pattern of an antenna. It is conical at the vertex with the antenna. Radio waves can be directed into beams by using parasitic elements, parabolic reflectors and horns. The term “aerial” which is associated with antennas is used to designate a wire antenna. Electromagnetic field is joined to the radio receiver or transmitter, electrically by antennas. Signals are carried through air at the speed of light with negligible transmission loss by radio waves which are basically electromagnetic waves.

Figure1.8: Directional antenna [8]

1.1.9 HALF WAVE DIPOLE ANTENNA:

The development of the vertical and dipole radio wires is basic and economical. Most reception apparatuses structures depend on dipole receiving wires. It is a fair segment having equivalent yet inverse voltages .Using a reasonable transmission line, current is connected at its two terminals. Monopole receiving wire is a vertical reception apparatus. This reception apparatus is associated with the inward conductor of the coaxial transmission line. At the ground, the shield of the transmission line is associated. The second conductor of the dipole is taken as ground in this way framing a total circuit. To give a superior ground contact to the earth an establishing structure is given in the monopole receiving wire. The receiving wires that are more mind boggling than the dipole and vertical radio wires are structured so as to expand the increase just as the directivity of the reception apparatus.

Figure1.9: Half wave dipole antenna [9]

1.1.10 FOLDED DIPOLE ANTENNA:

It is another form of the dipole aerial or the dipole antenna that is folded back on it-self. The original dipole elements added in parallel with the half wave conductor so that one end is connected to the other introducing a DC short circuit. The conductor enables the folded dipole. To provide higher feed impedance and larger bandwidth this serves as an advantage in many cases.

Figure1.10: Folded dipole antenna [10]

1.1.11 NON-RESONANT DIPOLE ANTENNA:

A non-resonant dipole is one that can be operated away from its resonant frequency and fed with a high impedance feeder. Thus a non-resonant dipole can operate over a much wider bandwidth.

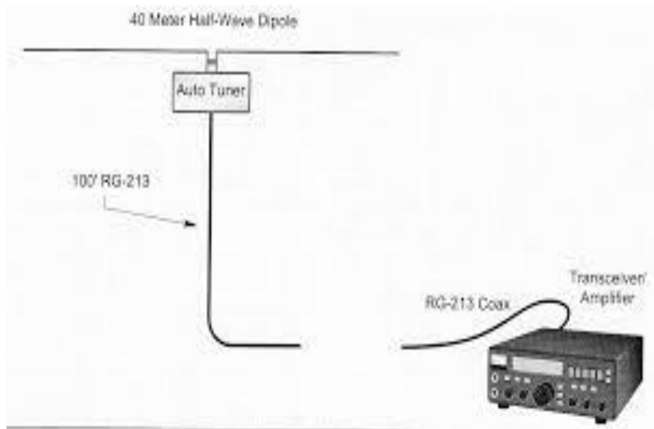


Figure1.11: Non-Resonant Dipole Antenna [11]

1.2 DIFFERENT PARAMETERS OF ANTENNA

1.2.1 INPUT IMPEDANCE:

The impedance of the radio, of the antenna and of the transmission cable connecting them must be the same for efficient transfer of the energy. Transmission lines and transceivers are typically drafted for an impedance of 50ohm. If there is an impedance value other than 50 ohm then there is a mismatch created and an impedance matching circuit is required.

1.2.2 RETURN LOSS:

Due to the discontinuity in a transmission line or optical fiber there is a loss of power in the signal reflected/reflected which is known as the return loss. A mismatch or discontinuity occurs with the terminating load or with a device inserted in the line. The return loss is related to the reflection coefficient and the standing wave ratio. A lower SWR corresponds to an increasing return loss. To measure how well the devices or lines are matched, return loss is calculated. When the return loss is high, the match is good. For a lower insertion loss a high return loss is desirable. It is expressed in decibels (dB).

1.2.3 BANDWIDTH:

A range of frequencies over which an antenna can operate efficiently is known as bandwidth. The number of hertz for which the antenna will exhibit SWR less than 2:1. The percentage of the center frequency of the band can also be described as bandwidth. In absolute units of frequency bandwidth would be different depending on the center frequency. There are different bandwidth limitations for different antennas.

1.2.4 DIRECTIVITY AND GAIN DIRECTIVITY:

The ability of antenna to focus energy in a specific direction while transmitting or to receive energy from a particular direction is called directivity or gain directivity. So as to think the radiation bar in a particular course we use reception apparatus directivity in a static circumstance. At the point when the reception apparatus emanates similarly every which way and the handset isn't fixed in a dynamic framework, it is known as omnidirectional radio wire. A gain is a dimensionless ratio. It gives reference to a standard antenna.

Isotropic antenna and the resonant half wave dipole antenna are the two most common reference antenna. Theoretical antenna pattern are useful and simple and are used to compare real antennas. The amount of energy radiated in that direction compared to energy of an isotropic antenna that would radiate in same direction when driven with same input power is the gain of antenna in given direction.

Directivity=Maximum radiation intensity of subject antenna/Radiation intensity of an isotropic ante nna.

D=ϕ(θ,ϕ)max(from subject antenna)ϕ0(from an isotropic antenna)D=ϕ(θ,ϕ)max(from subject anten na)ϕ0(from an isotropic antenna)

Here

- $\phi(\theta,\phi)_{max}$ϕ(θ,ϕ)max = maximum radiation intensity of antenna.
- ϕ_0ϕ0 =radiation intensity of an antenna with zero losses

$$G=\eta_e D \quad G=\eta eD$$

Here

- **G** = gain of the antenna.
- H_e = antenna’s efficiency.
- **D** = directivity of the antenna.

1.2.5 RADIATION PATTERN:

The relative strength of the radiated field in various directions from the antenna at constant distance is defined by the radiation or antenna pattern. It is also called the reception pattern because it describes the receiving properties of the antenna. The pattern is three dimensional and the pattern measurements are given in rectangular and polar formats. It is difficult to analyze the antenna behavior at different directions. Points are located by projection along a rotating axis to an intersection with one of the several concentric circles in a polar coordinate graph. Linear and logarithmic are the two classes of a polar coordinate system. The concentric circles in a direct arrange framework are similarly separated and graduated. The concentric network lines in the logarithmic polar organize framework are divided intermittently as per the logarithmic of the sign. To build up the total addition of the radio wire, we use gain exchange strategy and radiation design estimations in respect to the isotropic receiving wire. The field patterns that exist close to antenna is known as near field whereas the field pattern at large distances is termed as far field.

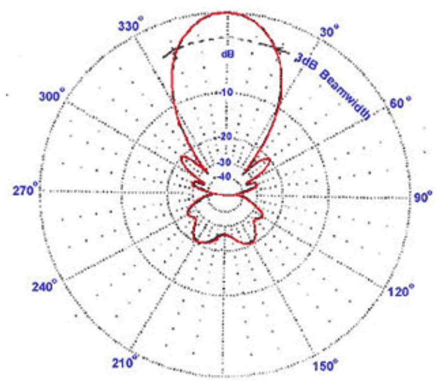


Figure1.12: Radiation Pattern [12]

1.2.6 BEAMWIDTH:

It is defined as the angular distance between the half power points of main lobe is called beam-width. After finding the peak radiation intensity the points on either sides of the peak representing half the power peak intensity are located. The half power bandwidth can also be referred to as 3db bandwidth. We consider both horizontal and vertical beam-width.

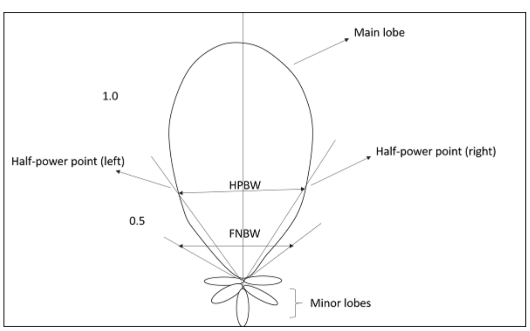


Figure1.13: Beam-width [13]

1.2.7 SIDELOBES:

There is no antenna that is capable of radiating energy in one selected direction whereas some are radiated in other directions. Side lobes are used to refer to the peaks.

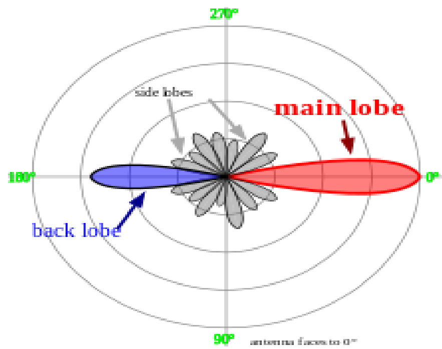


Figure1.14: Side Lobs [14]

1.2.8 POLARIZATION:

Introduction of electric field of an electromagnetic waves is alluded to as polarization. A circle can be utilized to depict polarization. Direct polarization and roundabout polarization are uncommon instances of electrical polarization. A reception apparatus is utilized to decide the underlying polarization of radio waves. The electric field vector remains in a similar plane all the time in straight polarization. The reflections over the transmission way least influence the vertical energized radiation. Vertical polarization is dependably observed in omnidirectional radio wires. Reflections cause varieties in got signal quality with level polarization.

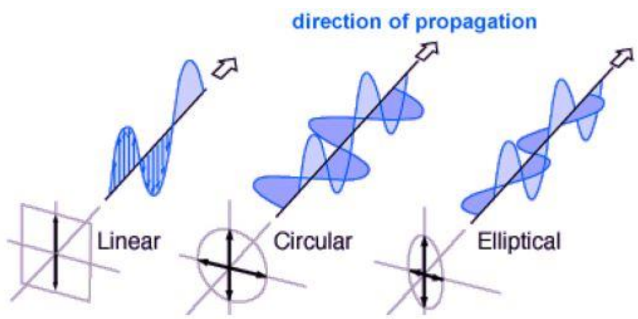


Figure1.15: Polarization [15]

1.2.9 POLARIZATION MISMATCH:

Between transmit and receive antenna both antennas must have the same spatial orientation, the same polarization sense and the same axial ratio in order to transfer maximum power. When the overall polarization is not same there is reduction in power between the two antennas. Due to the reduction in power transfer the overall system efficiency and performance decreases. Physical antenna misalignment will result in polarization mismatch loss when they transmit and receive antennas are both linearly polarized. The circularly polarized antenna and the linearly polarized antenna will vary depending on the axial ratio of the circularly polarized antenna in actual mismatch loss. No attenuation occurs due to coupling mismatch between field and antenna if polarization is coincident.

1.2.10 VSWR

It is an element of the reflection coefficient that alludes to the power reflected from the radio wire. It is constantly positive and genuine number for receiving wires. At the point when the VSWR is little the reception apparatus is said to be better coordinated to the transmission line and more power is conveyed to the receiving wire. The base an incentive for VSWR is 1. No power is reflected from the reception apparatus for this situation. This is the perfect case. In physical significance VSWR is the voltage that is estimated along the transmission line prompting a radio wire. It is the proportion of the pinnacle adequacy of a standing wave to the base of a standing wave.

1.2.11 REFLECTION COEFFICIENT

It is a ratio of the reflected voltage amplitude to that of the forward voltage amplitude. It is determined by its load impedance and impedance towards the source. Impedance discontinuity in the transmission line produces electromagnetic waves; reflection coefficient here calculates how much is reflected back.

$$vswr = \frac{1+|\Gamma|}{1-|\Gamma|}$$

$$\Gamma = \frac{vswr-1}{vswr+1}$$

$$return\ loss(dB) = -20log10(\Gamma)$$

$$mismatch\ loss(dB) = -10log10(1-|\Gamma|^2)$$

1.2.12 E-PLANE AND H-PLANE

They are the reference planes for antennas, linearly polarized waveguides and other microwave devices. The E-plane is the plane that contains the direction of maximum radiation and the electric field vector for a linearly polarized antenna. It determines the orientation or the polarization of the radio wave. The H-plane contains the direction of the radiation and the magnetic field vector.it lies at a right angle to the E-plane.

1.2.13 CO AND CROSS POLARIZATION

These are for the emanating e and h planes and are characterized in circular directions as for the round wave fronts of the proliferating waves. The co pol or the co polarization is toward the e field and the x pol or the cross polarization is toward the h field. The accepting force for a cross pol introduction is least while for the co pol it is most extreme.

1.3 APPLICATIONS OF ANTENNAS

They are used in mobile communication to provide mobile communication services by satellites. They are also used in non-satellite based technologies such as a medical hyperthermia. Antennas are used in integrated phased array systems and radar applications. They are also used in aircraft, spacecraft and missiles.

CHAPTER 2

MICROSTRIP ANTENNA WITH DIFFERENT FEEDING TECHNIQUES

2.1 PRINCIPLE OF ANTENNA

We have gained adequate amount of knowledge and information about the design of antenna and wave propagation. The best procedure is to perform all calculations and try out the antenna for designing the length of the antenna. A cut and try method is used if it doesn't work right. Presently it is conceivable to anticipate the conduct of the reception apparatuses. A few methods are utilized to emanate the sign through space to a beneficiary after a RF signal has been created in a transmitter. This activity is finished by the receiving wire. The transmitting radio wire sends transmitter signal vitality into space. The getting reception apparatus grabs the RF signal from space. RF vitality is transmitted as an electromagnetic field. A voltage is actuated into the receiving wire as the voyaging electromagnetic field lands at the getting radio wire. The RF voltage is actuated into the getting reception apparatus are passed to the recipient and changed over into the transmitted RF data. The reception apparatus framework configuration assumes a significant job in transmitting station. A reception apparatus ought to have the option to emanate productively with the goal that the power provided by the transmitter isn't squandered. The measurements ought to be definite in a proficient transmitting receiving wire. The transmitting frequencies determine the dimensions. For relatively low radio frequencies the receiving antenna dimensions are not critical. This increases the frequency of the signal being received and the design and installation becomes critical.

In sending and receiving information in wireless communication system, antennas play an important role. Antennas are also used in astronomy, medicine, biological tissues, geophysical probing and radio frequency identification systems. Depending upon the geometrical structure, antennas can be classified into wire antennas, microstrip antennas and lens antennas. The basic principle of the antennas has been introduced in this chapter.

In a transmitter after a RF signal has been generated, some method must be used to radiate this signal through space to a receiver. This job is done by the antenna. The transmitting antenna sends the transmitter signal energy into space and the receiving antenna picks up the RF signal from space. A voltage is induced into the antenna, as the travelling Electromagnetic field arrives at the receiving antenna. The RF voltages induced in the receiving antenna are then passed to the receiver and converted back into transmitted RF information. In a transmitting station, the design of the antenna system plays a very important role. So that the power supplied by the transmitter is not wasted the antenna must be able to radiate efficiently. An efficient transmitting antenna should have exact dimensions. The transmitting frequencies determine the dimensions. For relatively low radio frequencies, the dimensions of the receiving antenna are not critical.

2.2 STRUCTURE OF ANTENNA

An antenna is a setup that is made of the three basic components. A ground plane is placed above which the substrate is placed. On top of that the patch is placed. The whole setup is then enclosed in a radiation box to limit the radiations coming out of a patch in the box. The material is chosen accordingly and radiation and boundary is given.

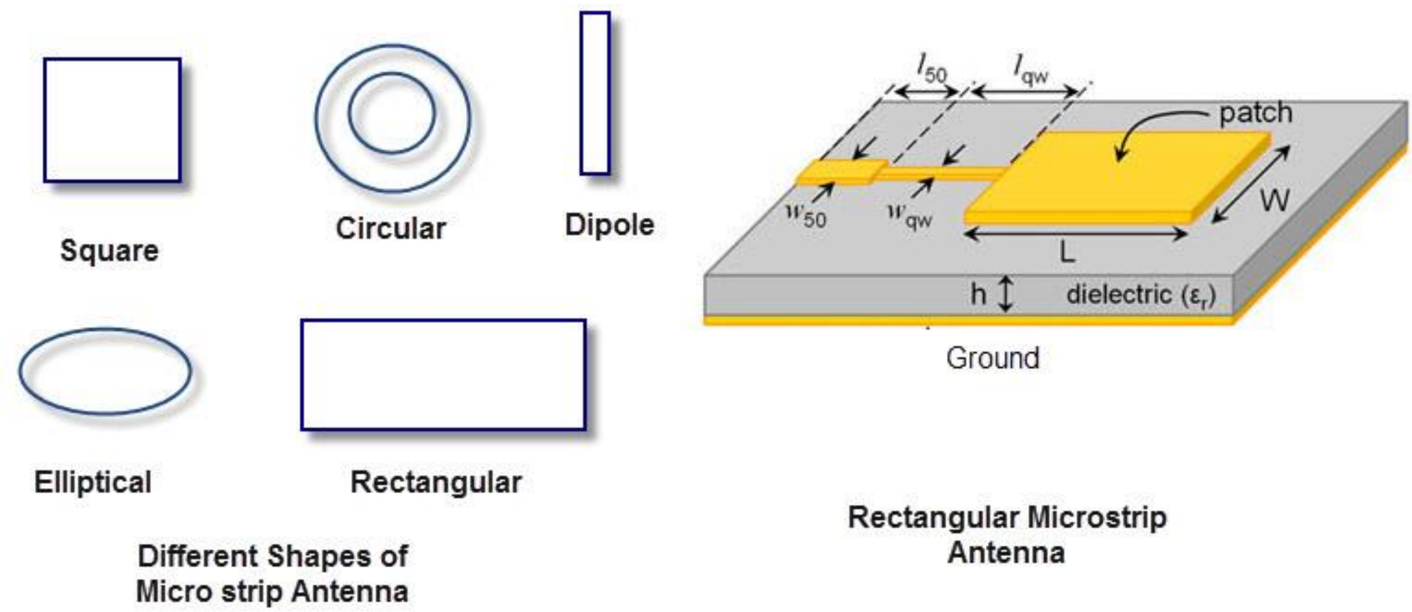


Figure2.2: Structure of Antenna [17]

2.2.1 GROUND PLANE:

A structure of conductive material that improves or either substitutes for the ground is known as a receiving wire counter balance or ground plane. It is associated with or protected from the regular ground. In Monopole radio wire particularly where restrictions of the qualities of the characteristic ground hinder with the best possible capacity, this backings in this capacity of the regular ground. Such a structure resembles a front of a coaxial link that is associated with an arrival association of an uneven transmission line.

2.2.2 SUBSTRATE:

The substrate lies between the ground plane and patch. It plays an important role in designing the bandwidth as well as the size of the antenna. The substrate causes miniaturization as well as broad-banding the antenna. The resonant frequency as well as the bandwidth decreases with increase in dielectric constant and the antenna system becomes narrow band. Bu using low dielectric substrate materials such as FR4 epoxy or Roggers which has dielectric constant equal to 1, we can increase the bandwidth. The bandwidth can also be increased by increasing thickness between patch and ground.

2.2.3 PATCH:

A flat rectangular sheet of metal is mounted over a large sheet of metal called substrate, is known as patch. An antenna radiates through patch therefore it is called the radiating part of antenna. The feed line is connected to the patch. Since patch is the conducting part, a boundary assigned to it is called Perfect E.

2.2.4 FEED AND FEED LINE:

The transmission line or feed line which interfaces the receiving wire to the transmitter or beneficiary is the radio wire lead-in. An uninvolved system normally utilized for impedance coordinating in the middle of the radio wire at a transmitter or recipient is a receiving wire coupling system. All parts associating the receiving wire to a transmitter or collector are known as the radio wire feed. A microwave receiving wire can be bolstered straightforwardly from a waveguide instead of the transmission line. Kinds of feed incorporate coaxial feed, inset feed, quarter wave transformer feed.

2.2.5 RADIATION BOX:

It is a rectangular box that encloses the three components of an antenna namely ground, patch, substrate. To model free space radiation HFSS needs an air box. To emulate free space by truncating infinite free space to finite calculation domain a radiation boundary is used. The material that is used here is AIR and boundary used is Perfect radiation. A radiation box reduces reflections from the outside surfaces and enables maximum absorption. After setting all the components in place an analysis setup is done where the desired frequency is given and thereafter, the design is simulated to check for errors. After successfully simulating the antenna design the desired results are obtained that is a plot between power and frequency.

2.3 MICROSTRIP PATCH ANTENNAS

Microstrip patch antennas are basically are planar resonant cavities that leak from the edges and radiate. To etch the antennas on soft substrates to produce low cost and low profile antennas printed circuit techniques are used. These antennas are often fabricated in sheet metal and mounted on dielectric posts or foam in a variety of ways to eliminate the cost of substrate in etching by manufacturers for mobile communication. The problem of radiation from surface waves excited in a thick dielectric substrate used to increase bandwidth is also eliminated. Microstrip patch antenna basically consists of a radiating patch one side of dielectric substrate and has a ground plane on the other side. The dielectric substrate, the transmitting patch and the feed lines are normally photograph carved. A variety of radio wires can be photograph scratched on the substrate just as the nourishing systems.

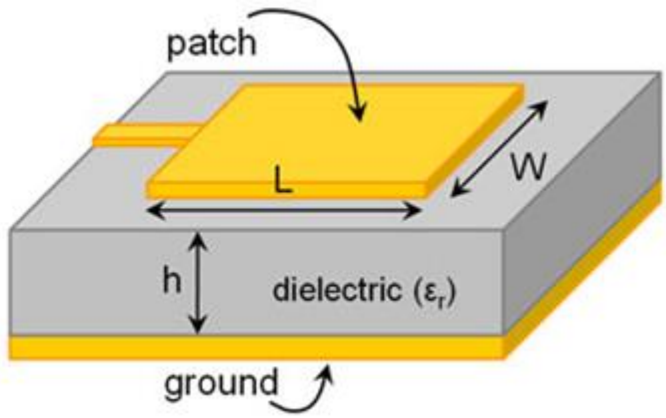


Figure2.1: Microstrip Patch Antenna [16]

2.3.1 ADVANTAGES

They are lightweight and low volume and their low profile configuration makes them easily conformed to host service. Since the fabrication cost is low that can be manufactured in large quantities. Linear and circular polarization is supported by microstrip antennas. Microwave integrated circuits can be easily integrated with the microstrip antennas. Dual as well as triple frequency operations are possible. On mounting them on inflexible surfaces they are stable.

2.3.2 DISADVANTAGES

They have small range of frequency and have low efficiency and low gain. They are poor end fire radiators except tapered slot antennas. Power holding capacity is low. They have very high antenna quality factor.

2.3.3 APPLICATIONS

They are widely being used in wireless applications due to the low profile structure. For embedded antennas in hand held wireless devices like cellular phones and pagers they are extremely capable. Satellite communication uses microstrip patch antenna can be highly advantageous.

2.4 TYPES OF FEED

They can be bolstered by an assortment of techniques. These strategies can be partitioned into two classifications; Contacting and Non Contacting. The RF power can be nourished legitimately to the emanating patch utilizing an associating component, for example, a microstrip line in the Contacting technique. Electromagnetic field coupling is done to exchange control between the microstrip line and the emanating patch in Non Contacting. Microstrip line, coaxial test (both reaching plans), opening coupling and nearness coupling (both non reaching plans) are the four most generally utilized feed strategies.

There are a wide range of sorts of design that can be utilized to nourish microstrip receiving wires. The four most prominent encouraging strategies are microstrip line, coaxial test, gap coupling, closeness coupling. A directing strip more often than not of a lot littler width contrasted with the fix is microstrip feed. It is anything but difficult to create, easy to coordinate by controlling the inset position and somewhat easy to demonstrate. The internal conductor of the coaxial is appended to the radiation fix while the external conductor is associated with the ground plane in coaxial line nourishes. It is anything but difficult to manufacture and coordinate and has low deceptive radiation. Opening coupling is to some degree simpler to display and has moderate misleading radiation. They comprise of two substrate isolated by ground planes

2.4.1 MICROSTRIP LINE FEED:

A conducting strip is connected directly to the edge of the microstrip patch in this type of feed. The width of the conducting strip is smaller as compared to the patch. On the same substrate to provide a planar structure, the feed is etched. This is an advantage of this kind of feed arrangement. When the thickness of the dielectric substrate increases, surface waves and specious feed radiation increases which holds the bandwidth of the antenna. Undesired cross polarized radiation is also an effect of feed radiation.

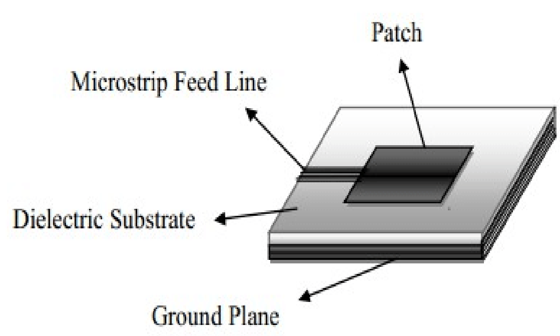


Figure2.3: Microstrip Feed Line [18]

2.4.2 CO-AXIAL FEED:

It is a very common technique used for feeding microstrip patch antennas. In this feed the inner conductor of the coaxial connector extends through the dielectric and is conjoined to the radiating patch and the outer conductor is connected to the ground plane. To enable impedance matching, the feed can be placed at any desired location inside the patch. This is the main advantage of coaxial feed. This method is easy to fabricate and has low specious radiation. It provides small range of frequencies and is difficult to model. This is the major disadvantage of coaxial feed.

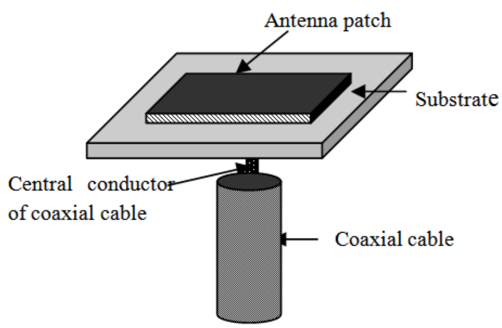


Figure2.4: Coaxial feed [19]

2.4.3 APERTURE COUPLED FEED:

The radiating patch and the microstrip feed line are separated by the ground plane in this type of feed. A slot or an aperture in the ground plane is used for coupling between the feed and the patch. There is lower cross polarization due to symmetry of configuration. The shape, size and location of the aperture is determined by the amount of coupling from the feed line to the patch. The patch and the feed lune are separated by the ground plane, specious radiation is minimized. The bottom substrate is made up of high dielectric material and the top substrate is made up of a low dielectric to optimize the radiation from the patch.

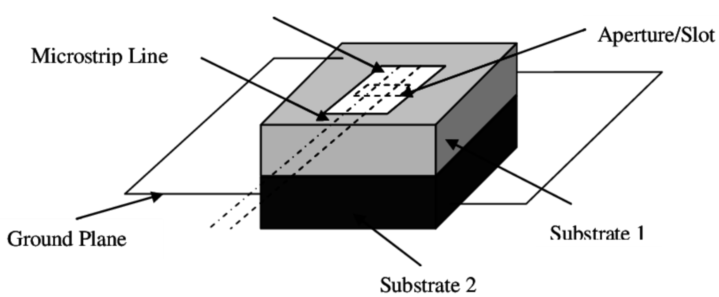


Figure2.5: Aperture Coupled Feed [20]

2.4.4 PROXIMITY COUPLED FEED:

It is also known as the electromagnetic coupling scheme. The feed line is between the two substrates and the radiating patch is on the top of upper substrate. These feeding techniques eliminate specious feed radiation and provide very high bandwidth due to the overall increase in the thickness of the antenna. This is an advantage of the proximity coupled feed. By controlling the length of the feed line and the width-to-line ratio of the patch matching can be achieved.

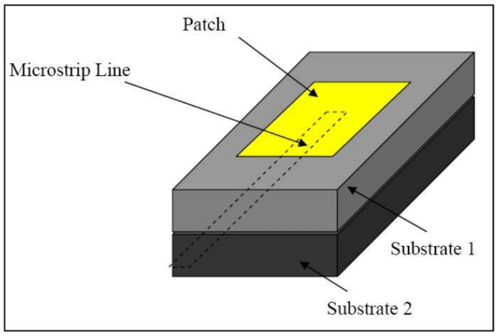


Figure2.6: Proximity Coupled Feed [21]

2.5 SOFTWARE:

ANSYS HFSS (HIGH FREQUENCY STRUCTURE SIMULATOR)

HFSS is the product for structuring and reenacting high recurrence electronic items like radio wires, reception apparatus clusters, RF and microwave segments, channels, connectors, IC bundles, Printed Circuit Boards. HFSS is essentially used to structure high recurrence hardware found in correspondence frameworks, radar frameworks, propelled driver right hand frameworks, satellites, IOT (Internet of Things) and other fast RF and computerized gadgets.

The product utilizes adaptable solvers and an instinctive GUI to give unparalleled program and somewhere inside into every one of the three dimensional EM issues. It is additionally utilized for highest quality level exactness and dependability for taking care of 3D EM difficulties. The HFSS recreation suite contains far reaching set of solvers to address assorted Electromagnetic issues. It gives you a chance to concentrate on the plan as opposed to investing energy deciding and making the best work. HFSS is separated from rest of the EM test systems because of its ensured exactness.

2.5.1 FORMULAS

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

$$\Delta L = 0.412h\frac{(\varepsilon_{eff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{eff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}}$$

$$L = L_{eff} - 2\Delta L$$

$$f_r = \frac{c}{2W\sqrt{(\varepsilon_{r1} + 1)/2}}$$

$$L_g = 6h + L$$

$$W_g = 6h + W$$

2.6 MICROSTRIP PATCH ANTENNA USING COAXIAL FEED

There has been tremendous increase in the trend of wireless communication system. Antennas being one of the most essential design issues in the modern mobile communication systems. A metallic device for radiating or receiving EM waves is known as an antenna. Transducer which converts electrical energy into EM energy at transmitter side and converts EM energy to electrical energy at the receiver side is one of the functions of the antenna. Nowadays, there is rise in demand for compact and low profile antennas. Microstrip antennas are regarded as the best choice due to features such as light weight, simple geometry, compact structure, and compatibility with monolithic integrated circuits.

A rounded cable with a center conductor and a braided or solid metallic shield usually copper or aluminum is called a coaxial cable. The outer shield separates the center conductor by a dielectric which is usually foam, air or a compressed gas such as nitrogen. An outer cable sheath covers the shield. The outer conductor extends up to the patch antenna. The input impedance can be controlled by altering the position of the feed. The coaxial feed introduces an inductance into the feed that needs to be taken into consideration if the height increases. Radiation in undesirable directions can cause radiations in the probe.

Microstrip patch antennas can be fed using coaxial or probe feed which indeed is a very common method. The coaxial connector of the inner conductor extends through the dielectric and is soldered to the radiating patch while the outer conductor is connected to the ground plane. A dielectric constant of 4.4 and the dielectric material of the substrate is FR-4 Epoxy.

Better efficiency and higher bandwidth and a lower quality factor Q is achieved. Fringing field at the patch periphery is increased by the low value of dielectric constant. The patch size is independent of dielectric constant. FR-4 EPOXY and a dielectric constant is used to reduction of patch size. Substrate thickness is the other design parameter. S band range of frequencies is used in height of dielectric substrate of the microstrip patch antenna.

2.6.1 DESIGN

GEOMETRY PARAMETERS:

Parameters for designing:

Parameters	Antenna Parameters	Value
Hs	Height of Substrate	1.6mm
Lg	Length of Ground Plane	38.60mm
Lp	Patch Length	27.4mm
Wg	Width of Ground Plane	46.70mm
Wl	Substrate Length	38.60mm
Ws	Substrate Width	46.70mm
Fr	Resonant Frequency	2.4GHz

Table 2.1: Designing Parameters

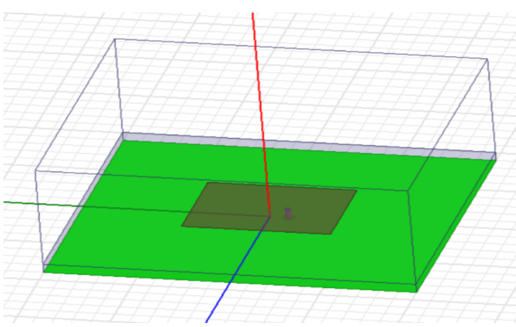


Figure2.7: Microstrip Patch Antenna with coaxial feed

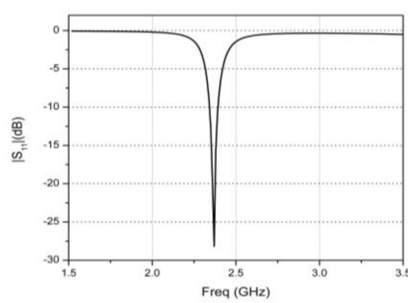


Figure2.8: Simulated Result

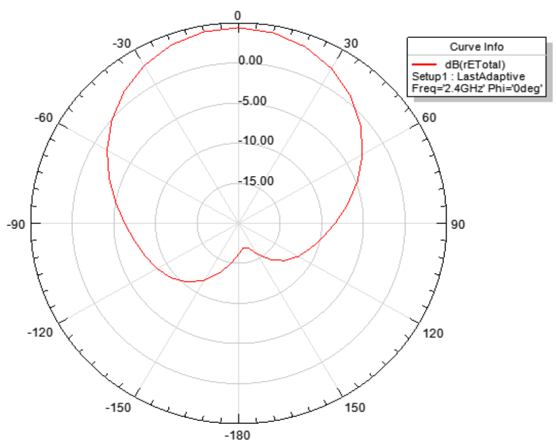


Figure2.9: E-Plane

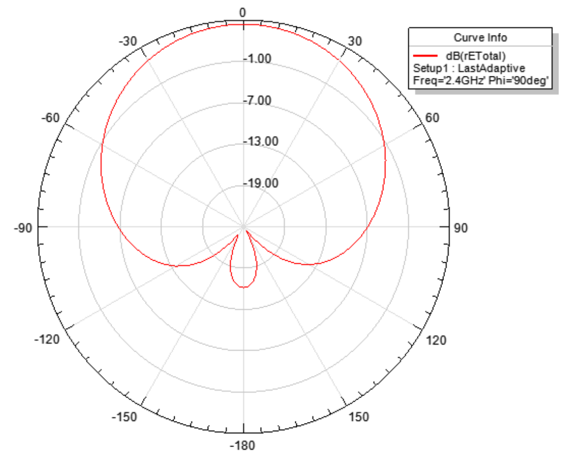


Figure2.10: H-Plane

2.6.2 CONCLUSION

A Microstrip patch antenna has been designed using the coaxial feeding technique using optimized parameters. The Return loss at 2.4 GHz for the proposed antenna came out to be 28dB. High values of return loss results in more power entering into the antenna. Return loss above 10 dB give more benefits, this means that 90% of the power is being delivered to the antenna and only 10% is getting reflected back.

2.6.3 ADVANTAGES

The feed can be put at any area inside the fix so as to coordinate the info impedance. This is the principle advantage. It is anything but difficult to create and amass the receiving wire and also the way toward assembling turns out to be simple.

The structuring of information impedance of an electrical burden or the yield impedance of the comparing signal source to boost the power exchange or limit signal reflection from the heap make impedance coordinating simple. The radio transmitter discharges at frequencies outside its recurrence band make false outflow.

2.6.4 DISADVANTAGES

Due to the low range of frequency and difficulty in modelling as a whole has to be drilled in the substrate and connector protrudes outsides the ground plane making it completely planar for thick substrates is a major drawback. The increased plane makes input impedance more inductive for thicker substrates leading to matching problems. Non-contacting schemes can be used to minimize these problems.

2.7 MICROSTRIP PATCH ANTENNA USING INSET FEED

A method of impedance control with a planar feed configuration is provided by the inset feed microstrip antenna. The input impedance of an inset feed rectangular patch varied as a 4 cos function of the normalized inset depth are shown by the experimental and numerical result. A shifted 2 cos function works well for the inset feed patch was found. The notch width for a given patch and substrate geometry depends upon the parameters of the shifted cosine function. At first substrate material and its thickness is selected to design a microstrip patch antenna. It is easier to design an antenna if the designer has a clear thought about the effect of changing substrate material and its thickness. An important part for designing antennas is selection of appropriate dielectric material and thickness. An inset feed microstrip patch antenna operates at 2.4 GHz. The pattern in design is normal to patch.

2.7.1 DESIGN

GEOMETRY PARAMETERS:

Parameters for designing:

Parameters	Antenna Parameters	Value
Lf	Feedline Length	34.39mm
Lg	Length of Ground plane	76.37mm
Lp	Patch Length	29.22mm
W	Width of Ground plane	58.43mm
Wf	Feedline Width	38.19mm
Wp	Width of Patch	38.19mm
Fr	Resonant Frequency	2.4GHz

Table 2.2: Designing Parameters

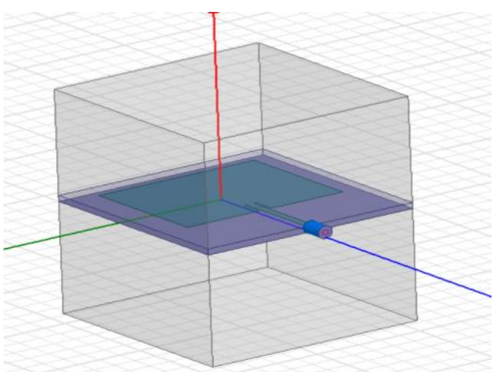


Figure2.11: Microstrip Patch Antenna with Inset Feed

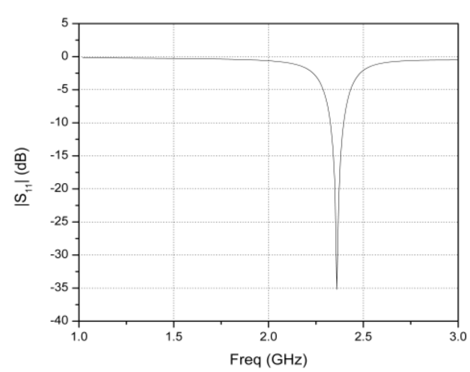


Figure2.12: Simulated result

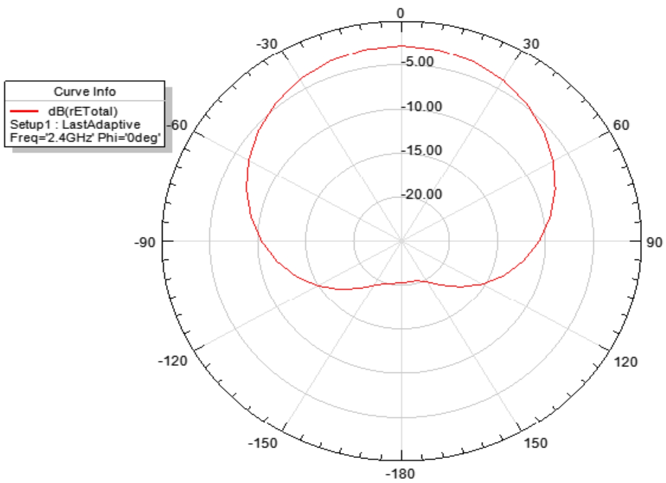


Figure2.13: E-Plane

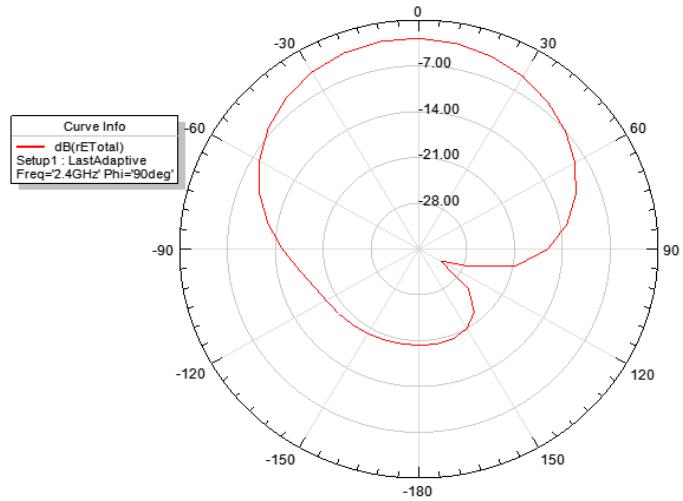


Figure2.14: H-Plane

2.7.2 CONCLUSION

Microstrip patch antenna has been designed using the inset feeding technique using optimized parameters. The Return loss at 2.4 GHz for the proposed antenna is 35dB. High values of return loss results in more power entering into the antenna. Return loss above 10 dB give more benefits, this means that 90% of the power is being delivered to the antenna and only 10% is getting reflected back.

2.7.3 ADVANTAGES

Designing antennas with inset feed is simple. Inset feed allows for planar feeding. Arrays can be easily used with inset feed. In this input match is easy to obtain with inset feed.

2.7.4 DISADVANTAGES

For thicker substrates there is huge line radiation in inset feed. In inset feed fix current and radiation example may indicate mutilation for profound scores.

2.7 MICROSTRIP PATCH ANTENNAS USING QUARTER-WAVELENGTH FEED

As an element importing mobile communication, because of its lower size than the half wave rectangular patch antenna the quarter wave microstrip patch antenna was chosen. Due to its simple realization and its direct contact with the patch, the feeding is made by a coaxial line. The position of the coaxial probe is changed by the conventional method of impedance matching. The band "S" (range of frequencies between 1.54GHz and 5.2 GHz) introduces a simple resonant structure with a long coaxial probe.

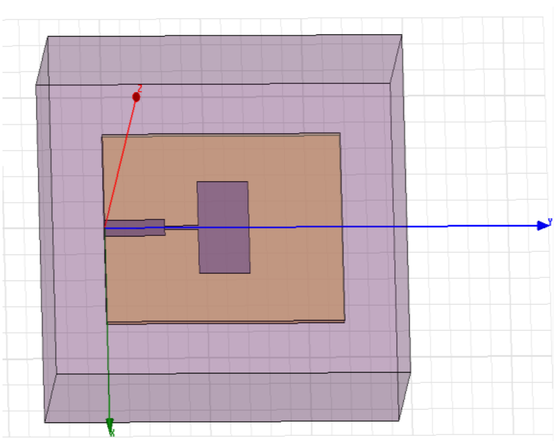
2.8.1 DESIGN

GEOMETRY PARAMETERS:

Parameters for designing:

Parameters	Antenna Parameters	Value
Lf	Feedline Length	4mm
Lg	Length of Ground plane	50mm
Lp	Patch Length	30mm
W	Width of Ground plane	50mm
Wf	Feedline Width	6mm
Wp	Width of Patch	26mm
Fr	Resonant Frequency	2.4GHz

Table 2.3: Designing Parameters



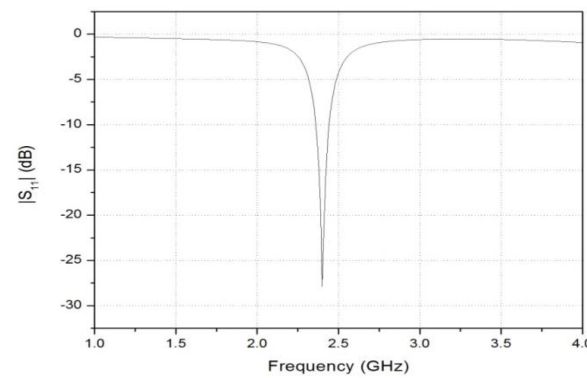
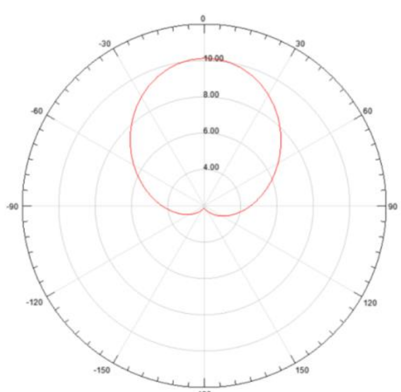


Figure2.15: Microstrip Patch Antenna with quarter wavelength feed

Figure 2.16: Simulated result



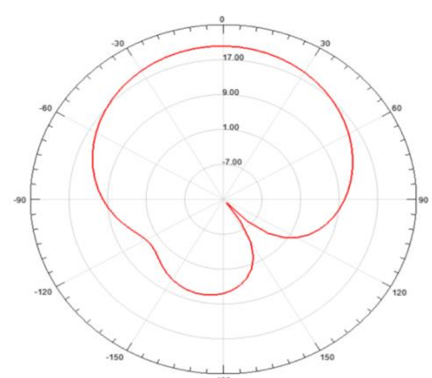


Figure2.17: E-Plane

Figure2.18: H-Plane

2.8.2 CONCLUSION

Microstrip patch antenna has been designed using the quarter-wavelength feeding technique using optimized parameters. The Return loss at 2.4 GHz for the proposed antenna is 27dB. High values of return loss results in more power entering into the antenna. Return loss above 10 dB give more benefits, this means that 90% of the power is being delivered to the antenna and only 10% is getting reflected back.

2.8.3 ADVANTAGES

Antennas with quarter feed are easy to fabricate. They are low cost and low size.

2.8.4 DISADVANTAGES

They have a very low range of frequencies. Conductor and dielectric losses limit the efficiency.

CHAPTER 3

ULTRA-WIDE BAND ANTENNA

UWB is a radio technology that uses a low energy level for high bandwidth communication over a large area of the radio spectrum for a very short range. It transmits in a way that it doesn't interfere with the narrow band and carrier wave transmission in the same frequency band. It transmits information over a large bandwidth, Therefore they are able to share the spectrum with other users. It was known as the Pulse Radio formerly but it is now defined as an antenna transmission for which the emitted signal bandwidth exceeds lesser of 20% or 500GHz of the arithmetic pulse frequency .therefore each transmitted pulse occupies the UWB bandwidth and is accessed under the rules of the UWB spectrum. It has the benefits of relative immunity to multipath fading, unlike carrier based systems that happen due to deep fading and Inter-symbol Interference(ISI).There is need for increasingly wider bandwidth for many modern radar, imaging and communications applications has propelled the search for new technologies. Several emerging lines of research sought to rise to this new challenge, and discussions took place around the world about the different ways of generating special signals to be radiated at a very large frequency range. The Ultra-Wideband (UWB) concept refers to a range of terms such as; impulse, carrier-free, and large bandwidth signals. The UWB systems mark their frequency range from 3.1 to 10.6 GHz. UWB systems transmit streams of extremely short pulses which can be spread through a very broad range of frequencies. These systems carry huge amount of information data and this signal spread makes them robust to interference. Another important feature is security.

3.1 UWB ANTENNAS

This innovation is estimated based on channel limit with respect to a given data transfer capacity and a flagging transmission capacity. Channel limit is the conceivable number of bits every second of data that a framework passes on through connections in a territory. The Shannon-Hartley Theorem expresses the channel limit of appropriately encoded sign is corresponding to the transfer speed of the channel and the logarithm of the SNR-Signal Noise Ratio. Hence when the data transmission increments to the most extreme esteem accessible the channel limit increments proportionately while the expanding the sign power exponentially. Along these lines vast channel limits can be accomplished on a fundamental level without utilizing high request regulations that require a high SNR. The transmitted sign should coordinate the beneficiary sign identifier in transfer speed, signal shape and time .A misfortune could happen because of crisscross in the UWB radio connection. In high information rate UWB beat frameworks Forward Error Correction give channel execution moving toward as far as possible. Errors are fixed by OFDM receivers with the help of low density parity check code and some other outer codes fixing the occasional errors.

3.1.1 DESIGN

- **FORMULAS**:

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi \varepsilon F}\left[\ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{\frac{1}{2}}}$$

$$\text{Where } F = \frac{8.791 \times 10^9}{f_r \sqrt{\varepsilon}}$$

$$Width = \frac{c}{2f_o\sqrt{\frac{\varepsilon_R+1}{2}}}; \quad \varepsilon_{eff} = \frac{\varepsilon_R+1}{2} + \frac{\varepsilon_R-1}{2}\left[\frac{1}{\sqrt{1+12\left(\frac{h}{W}\right)}}\right]$$

$$Length = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}} - 0.824h\left(\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}\right)$$

- **GEOMETRY PARAMETERS:**

Parameters for designing:

Parameters	Antenna Parameters	Value
L	Length of Substrate	50mm
L1	Length of Ground Plane	20mm
R	Radius of Patch	10mm
H	Height	0.3mm
W	Width of Substrate	42mm
W1	Width of Feedline	2.6mm
FR	Resonant Frequency	7.5 GHz

Table 3.1: Designing Parameters

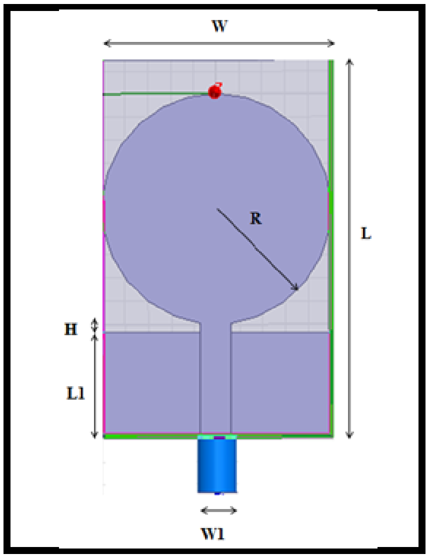


Figure 3.1: UWB Antenna with coaxial feed

- **RETURN LOSS**

The return loss is related to the reflection coefficient and the standing wave ratio. A lower SWR corresponds to an increasing return loss. To measure how well the devices or lines are matched, return loss is calculated. When the return loss is high, the match is good. For a lower insertion loss a high return loss is desirable. It is expressed in decibels (dB).

- **VSWR**

It is an element of the reflection coefficient that alludes to the power reflected from the radio wire. It is constantly positive and genuine number for receiving wires. The base an incentive for VSWR is 1. No power is reflected from the reception apparatus for this situation. This is the perfect case. It is the proportion of the pinnacle adequacy of a standing wave to the base of a standing wave.

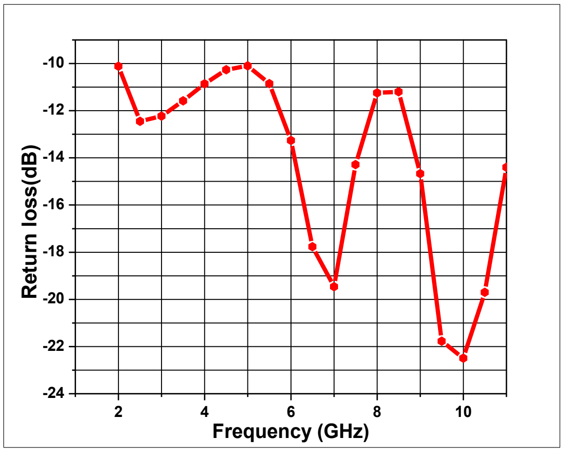


Figure3.2: Return loss (dB)

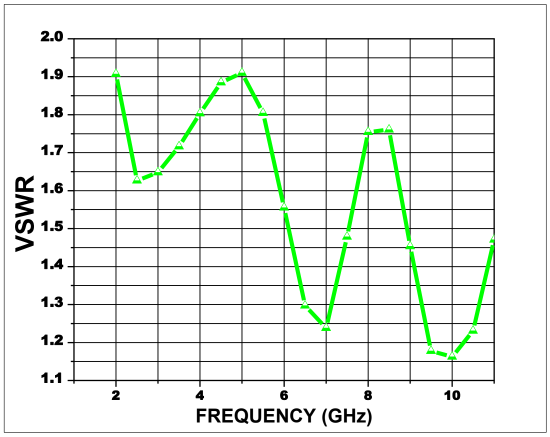


Figure3.3: VSWR

- **E-PLANE AND H-PLANE**

The E-plane is the plane that contains the direction of maximum radiation and the electric field vector for a linearly polarized antenna. It determines the orientation or the polarization of the radio wave. The H-plane contains the direction of the radiation and the magnetic field vector.it lies at a right angle to the E-plane.

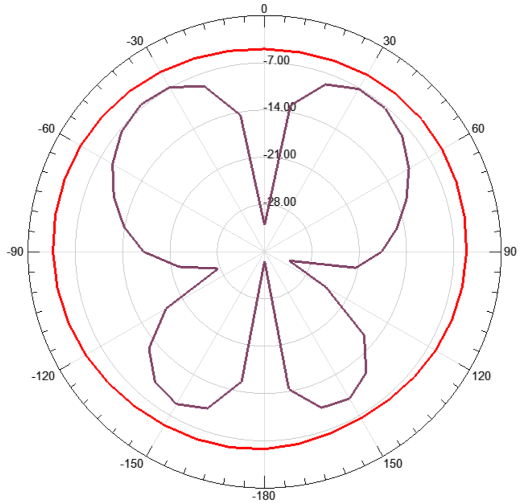


Figure3.4: E-plane

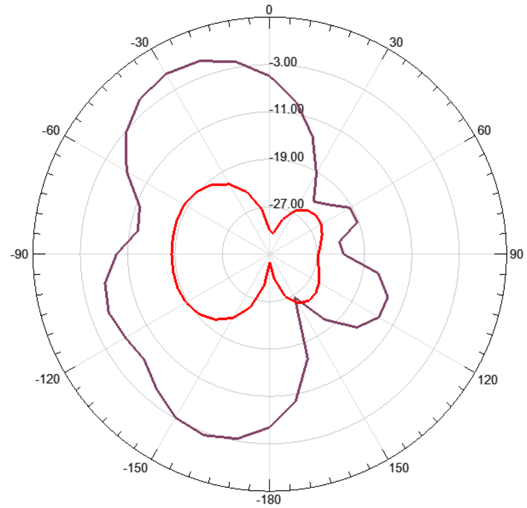


Figure3.5: H-plane

3.1.2 CONCLUSION

UWB antenna has been designed using the coaxial feeding technique using optimized parameters. The Return loss at 7.5 GHz for the proposed antenna is 23dB. High values of return loss results in more power entering into the antenna. Return loss above 10 dB give more benefits, this means that 90% of the power is being delivered to the antenna and only 10% is getting reflected back. This antenna has the capability of supporting multiple resonance distributed across the spectrum. The size of the antenna is reduced and designed with low costs.

3.1.3 ADVANTAGES

It has a large channel capacity and is able to transmit low power. UWB systems are resistant to jamming. They have a coexistence with the current narrow band and wide band radio services. It has a simple transceiver architecture and as the ability to work with low SNR’s. It gives high performance in multipath channels it also avoids licensing fees and offers high performance in noisy environments.These systems enable ultra- low power, smaller form factor and better mean time between failures all at a reduced cost. UWB delivers higher signal strengths in adverse conditions.

3.1.4 DISADVANTAGES

UWB systems are not all about advantages. They are many challenges involved in using these short duration pulses. The challenges faced are:

1. Pulse Short Distortion: Transmission of continuous narrow band signals is much easier than UWB pulses as a narrow band signal remains same throughout the transmission link. The UWB pulses are weak and lower powered and therefore can be easily distorted

2. Channel Estimation: As it is not possible to measure every wireless channel in the field it is important to estimate channel parameters and to use the training sequences such as delays of propagation path and attenuations.

3. High-Frequency Synchronization: The time synchronization between the transmitter and the receiver is must in UWB pairs. However synchronizing and sampling place a major limitation on the design of UWB systems due to the presence of Nano second pulses. The performance of the UWB systems are highly sensitive to timing errors such as jitter and drift due to the presence of strict power limitations and short pulse duration.

4. Multiple Access Interference (MAI): MAI is a limiting factor to the performance of receivers and the Channel capacity. The Low powered UWB pulses are significantly degraded due to the addition of MAI to the unavoidable channel noise and narrowband interference and therefore makes the detection process very difficult

3.1.5 APPLICATIONS

These frameworks are appropriate for short separation applications. They will in general be short range because of low discharge levels allowed by administrative offices. It is anything but difficult to design high information rates because of the term of short heartbeats hence information rate can be traded by accumulating beat vitality per information bit. It empowers remote screens remote printing of computerized pictures from a camera without the need of a PC and the proficient exchange of information from advanced cam recorders. It has low power and precision capabilities that are used for real time location systems as hence it is well suited for radio frequency sensitive environments. UWB also has a feature of short broadcast time. UWB technology has a promise in Doppler processing due to its high resolution object penetrating ability and low average power. It is used in Personal Area Network (PAN’s) have also been proposed.

CHAPTER 4

UWB-MIMO ANTENNA

4.1 MIMO ANTENNA

Wireless communications allows movement while communicating. This is a very attractive feature for the mobile users but a challenge to the engineers. Due to the presence of random signal attenuation and phase distortions from the multipath components this becomes a challenge. The three types of diversity techniques are:

1. Frequency Diversity: information bearing signals are sent by carriers whose frequency gap is greater than the coherence bandwidth of the transmission link.

2. Time Diversity: information bearing signals are sent in time slots that are greater than the coherence time of the transmission link.

3. Space Diversity: at far away distances multiple antennas are employed at the receiver and the transmitter.

Multiple input multiple output (MIMO)/multi antenna systems are the multiple antennas at the transmitter and the receiver in space diversity. They are the capacity boosters for wireless links without penalty in power and bandwidth. In a rich Rayleigh scattering environment the capacity of the channel increases with the minimum of N_R or N_T for a $N_{R*}N_T$ MIMO system linearly. N_R and N_T are the no of transmitters and receivers. The single input single output system which is a single channel communication has N_R =1 and N_T =1. Another case where N_R = 2; and N_T = 1 this is the single input multiple output system a 1*2 SIMO system. This is the receive diversity. Equal gain combining selection combining and maximal ratio combining are the receive diversity techniques that are used to combat the multipath fading concept. Then comes the case where N_T = 2 N_R = 1, this is the multiple input single output system having transmit diversity 2*1 MISO systems. Last is the MIMO case where N_T transmitting antennas N_R receiving antennas are employed having both receiving and transmitting diversities. By increasing the power and transmission bandwidth the data rate can be increased in the SISO system implying the Shannon channel capacity theorem ie:

Frequency spectrum is restricted for use and a valuable resource and just increasing the bandwidth to increase the data rate is not a solution. Since we need highly expensive radio frequency for increasing the data rate we just can increase the transmission power. There are also problems encountered of higher interference with higher power therefore this may be considered as lawful according to the transmission regulations.

From MIMO we have achieved 2 fundamental gains:

Rate gain: this is also known as the multiplexing gain. Different data are sent through parallel channels with the help of a serial to parallel convertor in spatial multiplexing MIMO system. Rate gate is minimum of a parallel MIMO as compared to that of a SISO system.

Diversity gain: same data is sent through all the multiple antennas at the transmitter. There is a possibility that not all the paths are faded. Some of the paths will be working if some of them are completely down. To decode this data accurately the receiver tries to make and efficient use of this in order to give higher link reliability.

4.2 UWB-MIMO ANTENNA

This technology is way to achieve data rates more than 1GB/s for wireless networks and Communication. UWB is applied to short range and mainly indoor communications in environments that are characterized usually by multipath propagation that is dense. In This environment MIMO systems allowed a substantial increase of spectral efficiency by exploiting spatial multiplexing gain and the inherent array gain of the systems.

4.2.1 DESIGN

GEOMETRY PARAMETERS:

Parameters for designing:

Parameters	Antenna Parameters	Value
L	Length of Substrate	33mm
L1	Length of Ground Plane	9mm
L2	Length of Feedline	10mm
LF	Length of Slot 3	22mm
W	Width of Substrate	52mm
W1	Width of Feed	2.6mm
WF1	Length of Slot 1	30mm
WF2	Length of Slot 2	20mm
WL	Width of Slot 3	2mm
WM	Width of Slot 4	18mm
R	Radius of Circular Patch	10mm
FR	Resonant Frequency	7.5GHz

Table 4.1: Designing Parameters

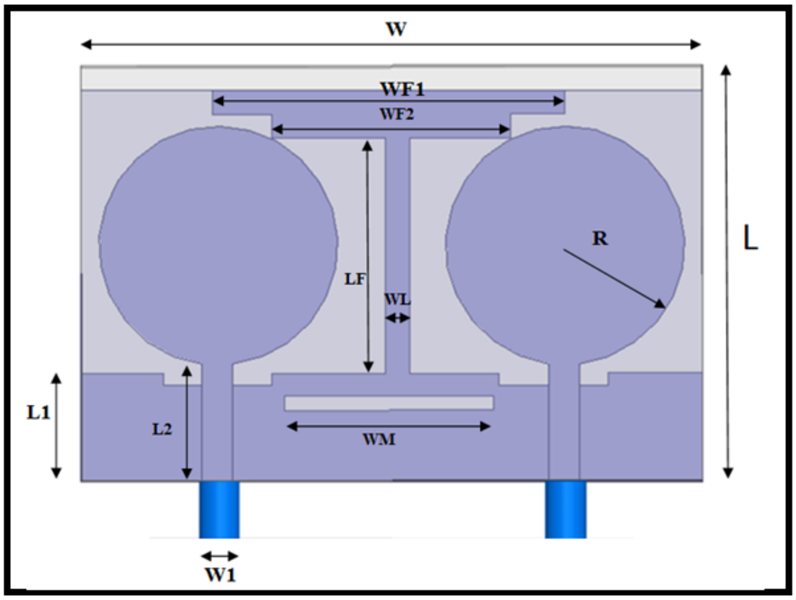


Figure4.1: T-shaped UWB-MIMO antenna

- **RETURN LOSS**

The return loss is related to the reflection coefficient and the standing wave ratio. A lower SWR corresponds to an increasing return loss. To measure how well the devices or lines are matched, return loss is calculated. When the return loss is high, the match is good. For a lower insertion loss a high return loss is desirable. It is expressed in decibels (dB).

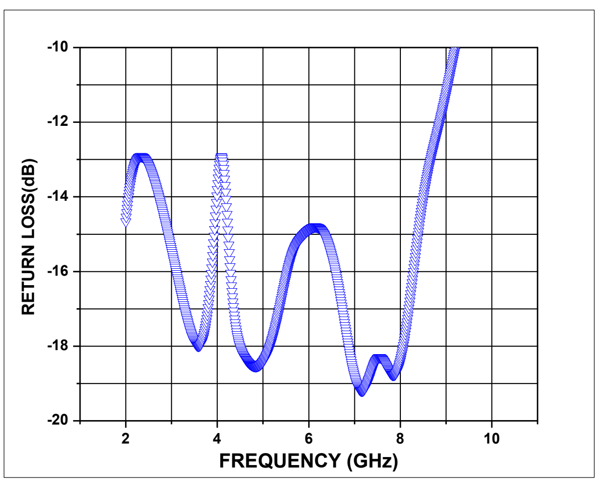


Figure4.2: Return loss (dB)

4.2.2 CONCLUSION

A UWB-MIMO antenna has been designed using optimized parameters. Fig4.2 is the designed antenna using the HFSS software .The Return loss at 7.5 GHz for the proposed antenna is 19 dB. High values of return loss results in more power entering into the antenna. Return loss above 10 dB give more benefits, this means that 90% of the power is being delivered to the antenna and only 10% is getting reflected back. The main focus was to increase the bandwidth and reduce the return loss simultaneously to achieve the maximum output. This antenna is simple, has a compact size and helped us increase the channel capacity.

4.2.3 ADVANTAGES

Higher data rate is achieved with the help of spatial multiplexing techniques and multiple antennas. Therefore higher down link and up link is achieved throughout. It reduces the BER that is present due to advanced signal processing algorithms on the received data. This system minimizes the fading effects with the help of its diversity techniques. Due to multiples antennas and algorithms there is a lower susceptibility of tapping by unauthorized users. It also offers high QoS with increased data rates and spectral efficiency. It has a wide coverage and hence supports large numbers of subscribers.

4.2.4 DISADVANTAGES

The hardware and resource requirements are complex as each antenna requires individual RF units for radio signal processing. There is an increase in the power requirements due to the hardware resources. Battery drains faster due to processing of computationally intensive and complex processing algorithms. These systems cost higher.

4.2.5 APPLICATIONS

This has been proposed in IEEE 802.11n wireless standards. It’s also envisaged in the 5g generation. There is an availability of MIMO based WI-FI and wireless interoperability of microwave access systems. Problems of multipath channel are handled efficiently. They are also used in mobile radio telephone standards, Long Term Evolution (LTE) and High Speed Packet Access (HSPA).

4.3 MUTUAL COUPLING

Mutual coupling arises in MIMO antenna due to surface currents surface waves and free space radiation. It can degrade the convergence of array signal processing algorithms and the signal to interference noise ratio. It can also degrade the angle of arrival Channel estimation carrier frequency offset. The active VSWR can very high due to random phase excitations at antenna ports in MIMO channel.

It can be reduced with the help of the following techniques:

1. Structure Approach: an indirectly connected metallic structure is introduced between the antenna radiators also known as the parasitic element. This ensures the diversion of certain unwanted fields and current and also enhances other characteristics such as efficiency isolation and bandwidth.

2. Slit slot Approach: each slot and slit has its own advantages and disadvantages. Different geometric shapes into the radiation element enhance parameters like wavelength shifting miniaturization and isolation. T shaped slots h shaped slots j and l shaped slots.

3. Coupling and Decoupling structure: EBG structure is the example of a Decoupling structure. It offers high impedance surface to form surface wave frequency band gap. This Decoupling structure is better as compared to all others. Using HFSS we can optimize the performance and dimensions of EBG structure.

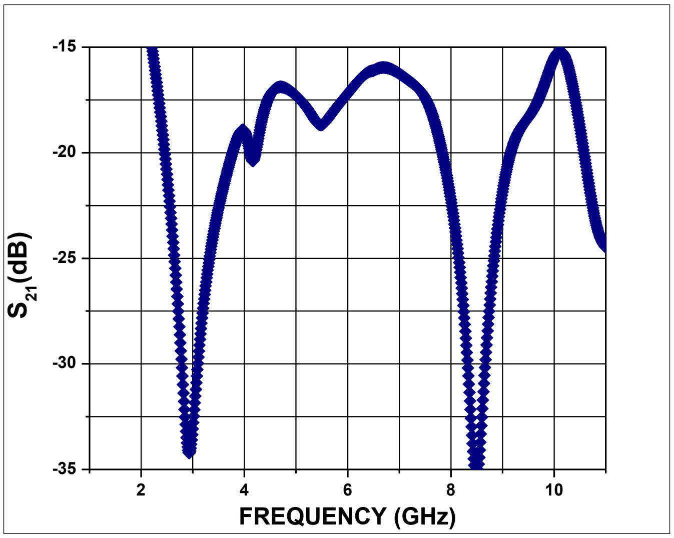


Figure4.3: Mutual coupling

4.3.1 CONCLUSION

A UWB-MIMO antenna has been designed using optimized parameters. Mutual coupling occurs due to the separation existing between elements. This causes undesirable effects on the antenna. There are many techniques to reduce mutual coupling but techniques like introducing EBG's are difficult to fabricate and are cost expensive .therefore we have introduced slots in between the two antennas. These are easy and simple to fabricate. They cause power neutralization and disturb shield current. This reduction in mutual coupling leads to increase in gain of the antenna.

CHAPTER 5

CONCLUSION AND FUTURE WORK

In this report, a microstrip patch antenna has been designed and simulated, using three feeding techniques namely coaxial feed, quarter wavelength feed and inset feed at 2.4 GHz. Different parameters of antenna like return loss, gain, radiation pattern, and bandwidth have been presented in this report. The results showed that amongst the three feeding techniques the coaxial feed gave the best results. The coaxial feeding technique is the most advantageous amongst the three in terms of return loss, bandwidth and efficiency and other antenna parameters. It can be placed at any desired position in patch in order to have a better impedance matching. Using the coaxial feed, UWB antenna was designed and simulated. UWB antenna was taken into consideration as it has the ability of sharing the frequency spectrum and to work with low SNR ratios. Also the probability of intercept and detection is low. But UWB came with drawbacks like multipath fading and less channel capacity. UWB-MIMO antenna improved and increased the channel capacity and the quality of the transmission. It also increased the spectral efficiency, multiplexing and the diversity gain. Therefore UWB-MIMO antenna was designed and gave better results. Last in order to reduce mutual coupling existing in the UWB-MIMO antenna, a decoupling structure was designed. Slots were inserted between the two antennas and this reduced the mutual coupling and giving high values of return loss. There is a scope of enhancing the diversity performance of the UWB-MIMO antenna. The channel capacity for high data rate applications can also be increased by designing a more compact antenna with more optimized parameters.

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