ANALYSIS AND DESIGN OF A MULTI-BAND MICROSTRIP PATCH ANTENNA

This Thesis submitted in partial fulfillment of the requirements for the Award of Degree of
Bachelor of Science in Electrical and Electronic Engineering

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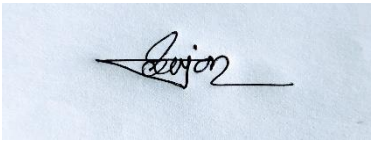
December 2018

Certification

This is to certify that this project and thesis entitled "**ANALYSIS AND DESIGN OF A MULTI-BAND MICROSTRIP PATCH ANTENNA**" is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on December 2018.

Signature of the candidates



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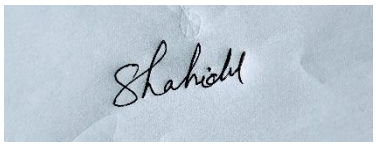

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Dedicated to

Our Parents

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List of Abbreviations

WLAN	Wireless Local Area Network
VSWR	Voltage Standing Wave Ratio
CST	Computer Simulation Technology
RL	Return Loss
BW	Bandwidth
EMC	Electromagnetic Compatibility
RHC	Right-Hand-Circular
LHC	Left-Hand-Circular
RF	Radio Frequency
FEM	Finite Element Method
HFSS	High Frequency Structure Simulator
RFIC	Radio Frequency Integrated Circuits
MMIC	Monolithic Microwave Integrated Circuit
MW	Micro Wave
LAN	Local Area Network
UHF	Ultra High Frequency
LEO	Low Earth Orbit
MEO	Medium Earth Orbit
HEO	Highly Elliptical Orbit
GEO	Geostationary Earth Orbit
GPS	Global Positioning System
DTH	Direct To Home
PSO	Particle Swarm Optimization

List of Symbols

λ	Wavelength
L	Resonant length
ϵr	Dielectric constant
C	Speed of light
f	Frequency
ΔL	Length extension
$\varepsilon f f$	Effective dielectric constant
dB	Decibels
F_H	Higher frequency
F_L	Lower frequency
W	Width of patch
L	Length of patch
h	Height of substrate
t	Thickness of substrate
xf	Feed location
ri	Inner radius
ro	Outer radius

ACKNOWLEDGEMENT

First of all, we give thanks to Allah or God. Then we would like to take this opportunity to express our appreciation and gratitude to our project and thesis supervisor **Mr. Md. Mahmudur Rahman, Assistant Professor** of **Department of EEE** for being dedicated in supporting, motivating and guiding us through this project. This project can't be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.

We also want to convey our thankfulness to **Dr. Md. Shahid Ullah, Professor and Chairperson** of the **Department of EEE** for his help, support and constant encouragement.

Apart from that, we would like to thank our entire friends for sharing knowledge; information and helping us in making this project a success. Also thanks for lending us some tools and equipment.

To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

ABSTRACT

Wireless communication has been developed widely and rapidly in the modern world specifically during the last two decades. The future development of the particular communication devices will aim to afford image, speech and data communications at any time, and anywhere around the world. Communication between humans was main by sound through tone of voice. With the desire for a bit more distance communication came, devices for example drums, then visual methods for example signal flags and smoke cigarettes signals were used. These types of optical communication devices, obviously, utilized the light part of the electromagnetic spectrum, outdoors visible region, has been useful for communication, through the utilization of radio.

The thesis provides a detailed study of how to design and fabricate a Probe-fed Rectangular Microstrip Patch antenna using CST software and study the effect of antenna dimensions length (L), and substrate parameters comparative Dielectric constant (ϵr), substrate thickness (t) on the Radiation parameters of Bandwidth and Beam-width.

Chapter 1

Introduction

1.1 Introduction

An antenna is mostly a device that is which is used to convert guided electromagnetic waves into electrical signals and additionally vice versa (i.e. either in transmitting option or in receiving option of operation). Antenna is normally frequency dependent devices. Each antenna is made for a certain frequency band and close to this band, antenna castoffs all the signal. Therefore we can say antenna is mostly a band pass filter and additionally transducer.

Antennas are crucial part in communication units therefore understanding their requisites are significant. With typically the advances in telecommunication, the requirement for compact antenna has increased significantly. In mobile communication, the requirement for smaller antennas can be quite large, so significant developments are finished to design compact, bare minimum weight, low profile antennas for the purpose of both academic and economic communities of telecommunication. The technologist focused towards the design of micro strip patch antennas. Many variations in designing are potential with micro strip antenna. This chapter permits the brief introduction and back ground about antenna, wireless communication and different wireless standards of wireless network communication. The properties of this transmitting and receiving antennas are actually fully represented by Maxwell's equations. From definition, and antenna can be described as device used to turn an RF signal, traveling even on a conductor, into an electromagnetic wave in free space. Antennas demonstrated a home known as reciprocity, so considering an antenna will remain an identical characteristics regardless in case it is transmitting or receiving. Virtually all antennas are resonant items, which operate efficiently during a relatively narrow frequency ring. When a signal might be fed into an antenna, the antenna will emit radiation distributed in space in any certain way. A graphical representation of this relative distribution of typically the radiated power in space is considered a radiation pattern.

1.2 Problem Statement

Make use of conventional microstrip antennas is limited because of the poor gain, low bandwidth plus polarization purity. There has been a lot of research prior to now decade in this vicinity. Our work was primarily focused entirely on multi band and multi-ply frequency operation of microstrip replacement patch antennas. Multi frequency operation of antenna has become a necessity for many uses in recent WLAN connecting, Radar communication and satellite communication.

1.3 Objective of the Thesis

The objectives of the thesis is to design and fabricate multi frequency and multi polarized microstrip patch antenna with probe-fed. This design provides an in-depth explanation of antenna pattern measurement techniques used to determine the performance of multi polarized antennas and of some antenna characteristics that are unique to antennas used in a polarization diversity scheme. The performance comparison is constructed on radiation pattern, bandwidth, return loss, VSWR and gain.

1.4 Scope

In our design we try to cover total two band these are S-Band (2 – 4) GHz and C-Band (4 – 8) GHz. But we can cover S-Band fully and C-Band up to 5.6 GHz. In this thesis the scope to get one more S-Parameter notch between 5.6 GHz to 8 GHz.

1.5 Research Methodology

At first we install CST software for designing an antenna. But we didn't understood how to design an antenna in CST. Then the help of our supervisor and internet we learned some technique about design antenna in CST. We collect some thesis paper from internet and our supervisor and then start to design many shape of microstrip patch antenna. Many principle theories are the main reference for our microstrip patch antenna design. In the beginning of design we designed some basic structure like line feed rectangular patch antenna, probe-fed

patch antenna and the different shape of patch like circle, rectangular, triangle etc. After completing some design then we start our final structure for our design.

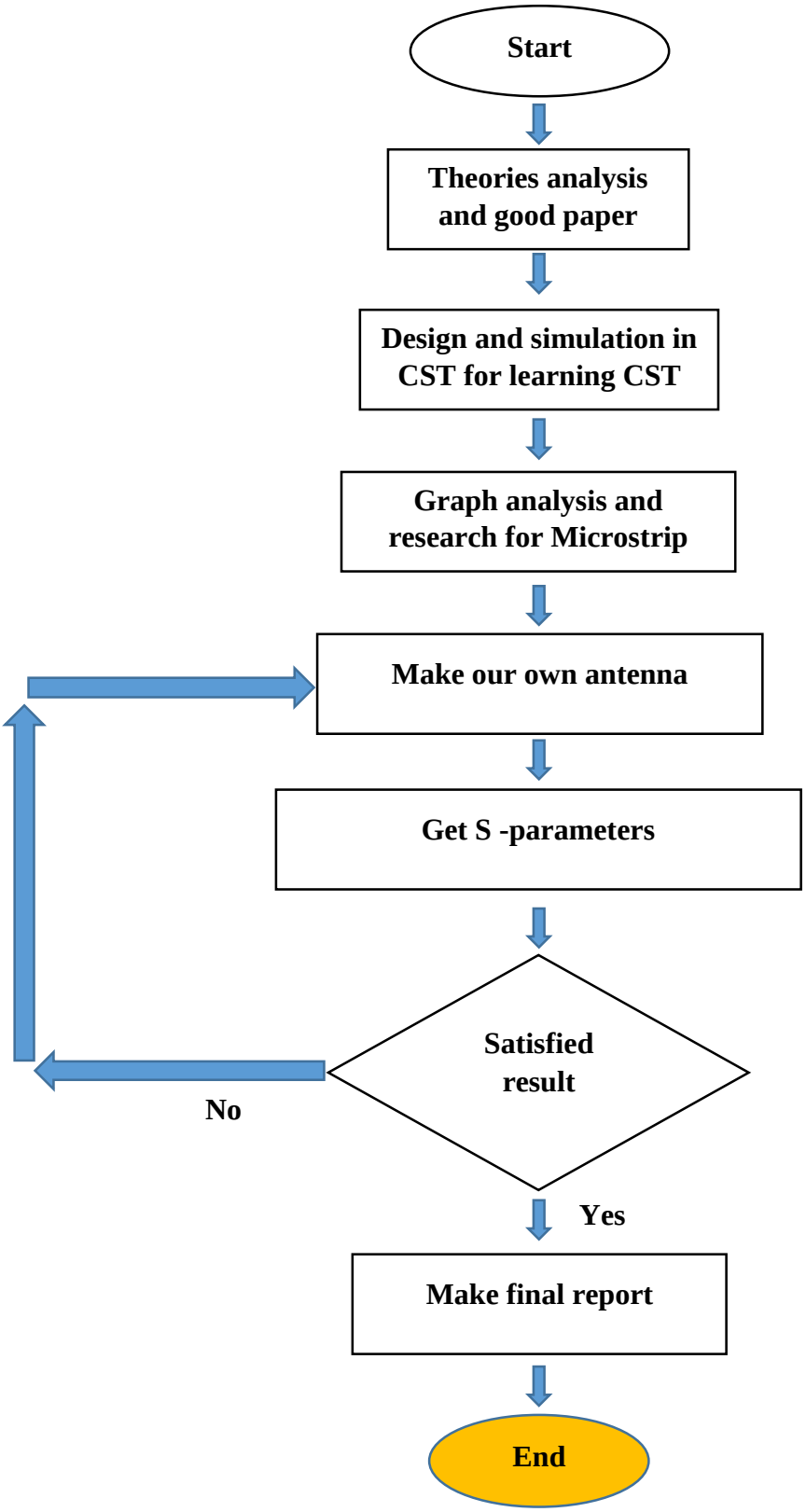

Figure 1.1: Flow Chart of Research Methodology

1.6 Thesis Outline

In this paper at first chapter will cover the introduction and the basic antenna parameter and the general types of antenna in short description.

In the second chapter we cover the theory of microstrip patch antenna and the types of microstrip patch antenna and the feeding technique in details.

In the third and fourth chapter we shown the basic tutorial of using a CST software to design a microstrip patch antenna and the applications of our proposed antenna.

In chapter 5 we shown the full process of design a coaxial feed microstrip patch antenna and also shown the simulation of S-Parameter, VSWR, Radiation Pattern, Gain etc.

In conclusion chapter, have shown the future scope and limitation of this research.

1.7 Antenna Theory

What is the beginning of the antenna? We happen to be ruling out such premature devices as compasses, because while they using intellect receive a magnetic field, it is not an electromagnetic field. Ben Franklin's kite play with it wasn't quite an antenna, mainly because that captured lightning give off, which is a direct current path when the energy is not transferred independent of the medium it travels. The human eye of course receives huge frequency electromagnetic waves (light, into the layman). Strictly the eye is usually classified as an antenna; however the way it can't transmit waves, the chances of a sensor, so I'll omit that in the process.

The earliest experiments that elaborate a coupling of electricity plus magnetism and showed your decisive relationship was this done by Faraday in the region of the 1830s. He skated a magnetic within the coils of a wire along with a galvanometer. In switching the magnet, he was in effect creating a time-varying magnets field, which as an effect (from Maxwell's Equations), needs to have had a time-varying electronic field. The coil represented for a loop antenna and got the electromagnetic radiation, that's received (detected) by the galvanometer - the repair of an antenna. Remarkably, the concept of electromagnetic waves hadn't even been thought up after all this.

1.8 Antenna Parameters

1.8.1 Length

The size of the rectangular patch antenna, typically the resonant length, it determines the resonant frequency as well as λ/2 for a rectangle-shaped patch in its significant mode. The length is calculated as

$\lambda = 0, \quad \lambda/\sqrt{\varepsilon r} \approx L.$

λ – Wave length of free space

L – Resonant length

ϵr – Dielectric constant

1.8.2 Width

As we know that the dimensions of the patch antenna effects in the results as the main part, especially length (L) and the width (W) [10]

$$W = \frac{C}{2fo\sqrt{\frac{(\epsilon r + 1)}{2}}}$$

C = speed of light

ϵr = the resonant frequency which is equal to 1 GHz

1.8.3 Length Extension (ΔL)

The calculation belonging to the extension of the length is written by a very popular relation in the normalized extension of the space is. [10]:

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

H = height

W = width of patch

$\varepsilon ff =$ Effective dielectric constant

1.8.4 Input Impedance

Antenna impedance relays the voltage to the present at the input to your antenna. This is enormously significant as we will have. Let's say an antenna carries with it an impedance of 50 ohms. Therefore if a sinusoidal voltage is applied along at the antenna terminals with an amplitude of just one Volt, then the current has an amplitude of 1/50 = 0. 02 Amps. Meanwhile the impedance is actually a real number, the voltage is in-phase together with the current. If the antenna occupies impedance from 50 ohms, then there's a simple mismatch and an impedance identical circuit is mandatory. [4]

1.8.5 Return Loss

Return loss is actually a significant parameter when leading an antenna. It relates to impedance consistent and maximum transfer of power way of thinking. It is also measure of the potency of an antenna to deliver power with the source to the antenna. The return loss (RL) is defined by ratio of the incident power of your antenna Pin to the capability reflected back from the antenna of your source Pref. The mathematical entrance is:

$$RL = 10\ log \frac{Pin}{Pref}\ (dB)$$

For decent power transfer, the ratio P_{in}/P_{ref} shall be high. If we have low RL there is a risk that there will occur upended wave phenomena's (resonances) and it will end up in a frequency ripple of improvement etc. In most practical circuits a RL value of -10 dB is sufficient for antenna.

1.8.6 Bandwidth

Bandwidth is another important antenna parameter. Bandwidth entitles the range of frequencies over which the antenna can accurately radiate or receive energy. Often, the desired bandwidth are one of the determining parameters used to decide upon an antenna. For occurrence, many antenna types have very narrow bandwidth and cannot be cast-off for wideband operation. The lower and upper frequencies compatible to the wanted VSWR set the frequency band over which the antenna meets the VSWR specification. A VSWR specification generally adopted is a 2:1 VSWR, which means that the range of frequencies over which the VSWR is less than 2 is chosen as the bandwidth of operation.

$$BW = 100\ \text{x}\ \frac{\text{FH}-\text{FL}}{\text{Fc}}$$

Where FH is a most extreme recurrence in a band, FL is the base recurrence in the band and Fc is an inside recurrence in a band. As such, data transfer capacity is steady unmistakable to recurrence. On the off chance that transfer speed gave off an impression of being communicated in supreme frameworks of recurrence, it is distinctive relying on the guts recurrence. Diverse sorts with reception apparatuses have distinctive data transfer capacity zone.

1.8.7 Radiation Pattern

Radiation pattern is distinct as "the three-dimensional distribution of a magnitude that describes the electromagnetic field generated by antenna" (IEEE, 1993). Radiation pattern can be a two- or three-dimensional spatial distribution of power flux density, radiation intensity, field forte, directivity, phase or polarization. Radiation pattern is a function of the observer's position along a path or apparent of constant radius (Balanis, 1997) and goes to through a direction at which extreme radiation occurs.

Inside the logarithmic polar coordinate method the concentric grid traces are spaced periodically in line with the logarithmic of the voltage inside the signal. Different values works extremely well for the logarithmic continual of periodicity, and this choice will have an impact on the appearance of the particular plotted patterns. Generally the 0 dB reference for your outer edge of the chart is employed. With this type regarding grid, lobes that are 25 or 40 dB below the key lobe are still distinguishable. The separating between focuses at 0 dB and at - 3 dB is more prominent than the dispersing between - 20 dB and - 23 dB, which is more noteworthy than the dividing between - 20 dB and - 23 dB, which is more noteworthy than the dispersing between - 50 dB and - 53 dB the separating therefore compares to the overall centrality of such changes in reception apparatus execution.

The radiation design is a gathering design too, since it likewise portrays the getting properties of the radio wire. For the most part, the round directions framework is utilized to imagine the radiation design.

A two-dimensional example can be a component of the height point, θ, at steady azimuth edge, φ, or an element of φ at consistent θ-esteem.The spherical coordinate scheme is shown in figure:

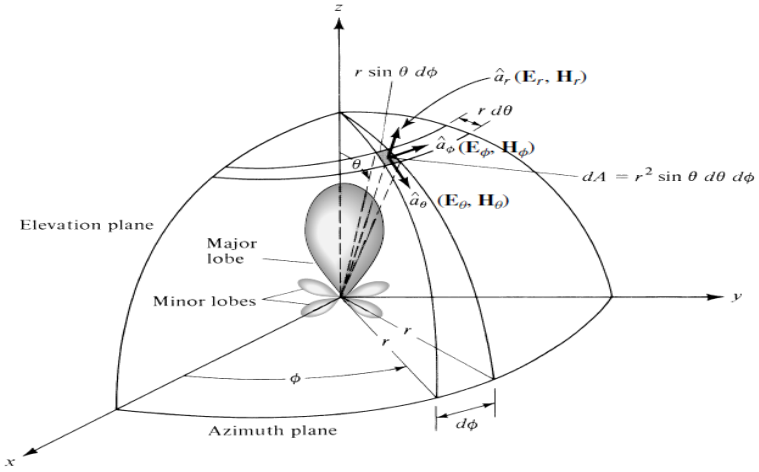

Figure 1.2: Coordinate system for antenna analysis

Radiation pattern contain power flux density, radiation intensity, field strength, directivity, phase or polarization

- Amplitude Field pattern
- Amplitude Power Pattern

Regularly the field and power design balanced out to the greatest esteem, passive settled field and power designs. The example is generally plotted on a logarithm scale (dB). The scale is attractive a logarithm scale can complement in more subtleties those parts of the example of low benchmarks. Field pattern classically characterizes a plot of the magnitude of the electric or magnetic field as a function of the angular space.

- Power pattern naturally represents a plot of the square of the magnitude of the electric or magnetic field as a function of the angular space.
- Power pattern (in dB) signifies the magnitude of the electric or magnetic field, in decibels, as a function of the angular space.

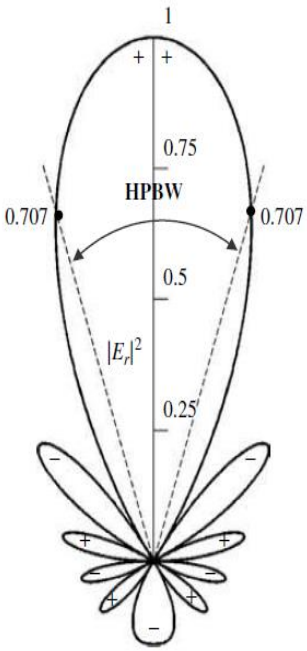

Fig1.3: Field Pattern Linear Scale (In linear scale)

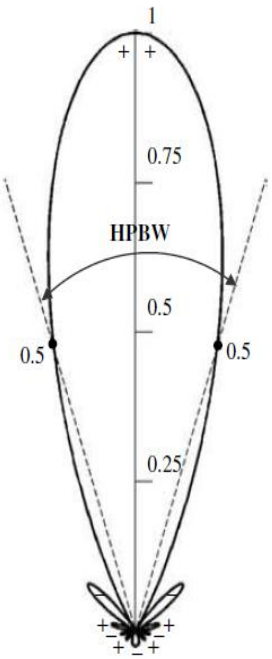

Fig1.4: Field Pattern (Power in DB)

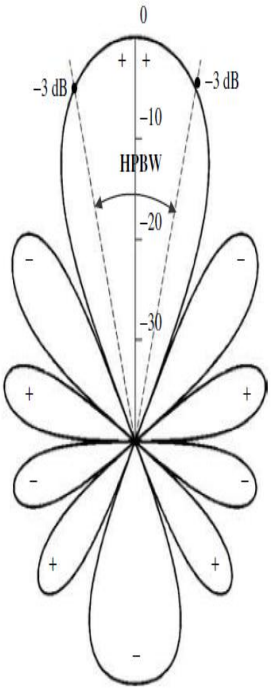

Fig1.5: Power

To show this, the two-dimensional normalized arena pattern (plotted in linear scale), electricity pattern (plotted in linear scale), and power pattern (plotted for a logarithmic dB scale) on the 10-element linear antenna choice of isotropic sources, with your spacing of d = 0. 25 λ regarding the elements, are shown around figure In the accompanying and resulting designs, the in addition to (+) in addition to less (-) signs while in the projections demonstrate the overall polarization of your adequacy of the plentifulness with respect to the different flaps, which changes (exchanges) just like the nulls are crossed. To uncover the points where the sample achieves its half-power (-3 dB points), in accordance with the maximum value of your pattern, you set the additional value of the.

A. field pattern at 0.707 value of its maximum, as shown in figure 1.3.

B. power pattern (in a linear scale) at its 0.5 value of its maximum, as shown in figure 1.4

C. power pattern (in dB) at -3 dB value of its maximum, as shown in figure 1.5. [1]

1.8.8 Directivity

Directivity is a central recieving wire parameter. It is a proportion of how 'directional' a radio wire's radiation design is. A recieving wire that transmits likewise every which way would have effectively zero directionality, and the directivity of this sort of radio wire would be 1 (or 0 dB). Scientifically the equation is directivity is [5] -

$$D = \frac{1}{\left(\frac{1}{4}\right)\int_0^{2\pi}\int_0^{\pi}(F(\theta,\emptyset))^2 \sin\theta \, d\theta \, d\emptyset}$$

This equation for directivity might look complex, but the numerator is the maximum value of F, and the denominator just indicates the “average power radiated over all directions”. This equation then is just a quantity of the peak value of radiated power divided by the average, which gives the directivity of the antenna.

1.8.9 Gain

Communications and electromagnetic compatibility (EMC) ask for precise estimation of antenna gain, which is the best execution parameter of a radio wire. At times, it is beyond the realm of imagination to expect to gauge or figure the gain of a recieving wire. Numerous basic

equations are accessible for estimating gain. The shaft widths and directivity of a generally extensive planar cluster or gap radio wires are associated by different understood rough conditions.This is the common radar prerequisite to undertake a narrow beam in one plane including a shaped beam in a further. The paper presents a super easy formula of gain diagnosis, which is verified to get shaped beam antenna. To illustrate, experimental results of all five hog horn antennas, which have been designed by sectorial horn, broadening in just one plane, with parabolic pump, are published and compared to the simple formula with gain assessment.

Gain is just not a quantity that is well-defined in terms of a physical measure for example the watt or the Ohm, nevertheless it is dimensionless ratio. Gain is assumed in reference to a standard antenna. Both the most common reference antennas include the isotropic antenna and resonant half-wave dipole antenna. Your isotropic antenna radiates correspondingly effectively in wholly directions. [6]

1.8.10 Beamwidth

A radio wire's beamwidth is typically comprehended to mean the half-control beamwidth. The pinnacle radiation control is start and the focuses on either side of the pinnacle which speak to a large portion of the intensity of the pinnacle power are to be found. The precise separation between the half power focuses is all around characterized as the beamwidth. A large portion of the power communicated in decibels is - 3 dB, so the half power beamwidth is in some cases alluded to as the 3dB beamwidth. Both level and vertical bar widths are commonly estimated. Assuming that most of the radiated power is not divided into side lobes, then the directive gain is inversely proportional to the beamwidth: as the beamwidth falls, the directive gain surges.

1.8.11 Sidelobes

Throughout antenna engineering, side lobes or sidelobes include the lobes (local maxima) in the far field radiation pattern which have been not the main lobe. Beams example of furthermost radio wires exhibits an example of "flaps" in a few points, headings the place that the emanated flag quality course a greatest, isolated by basically "nulls", edges at this transmitted flag quality is classified to zero. In a directional reception apparatus that fair-minded is to discharge the radio waves in a single course, the flap toward that path conveys a better field quality as contradicted than others; this is your "fundamental projection".

The different projections are classified "side flaps", and regularly speak to unwanted radiation all through undesired bearings. The side projection inside inverse bearing (180°) through the principle flap is known as a corner projection. In transmitting reception apparatuses, extraordinary side flap radiation squanders vitality and might make impedance different other hardware. Classified data could be grabbed by unexpected collectors. In receiving antennas, side lobes may pick-up interfering signals, and improve the noise level in your receiver. [7]

1.8.12 Nulls

Within the antenna radiation pattern, a null is a zone that the effective radiated power is to begin with. An invalid regularly consolidates a thin directivity point applicable to that of the key pillars. Consequently, the null is advantageous for several purposes, like suppression of interfacing signal within a given direction.

1.8.13 Polarization

An antenna is a transducer that variations radio frequency electric current to electromagnetic waves that are formerly radiated into space. The electric field or "E" plane accomplishes the polarization or orientation of the radio wave. In general, most antennas radiate either linear or circular polarization.

A straight captivated recieving wire emanates only in one plane containing the bearing of engendering. In a roundabout enraptured recieving wire, the plane of polarization pivots around building one complete transformation all through one time of the wave. On the off chance that the pivot is clockwise looking toward engendering, the sense is called right-hand-roundabout (RHC). In the event that the turn is counterclockwise, the rationale is called left-hand-roundabout (LHC) [7].An antenna is supposed to be vertically polarized (linear) when its electric field is perpendicular to the Earth's surface. An instance of a vertical antenna is a broadcast tower for AM radio or the "whip" antenna on an automobile.

Horizontally polarized (linear) antennas have their electric field parallel to the Earth's surface. Television transmissions in the USA use horizontal polarization.

A round captivated wave emanates vitality in both the flat and vertical planes and all planes in the middle. The distinction, assuming any, between the most extreme and the base crests as the

radio wire is turned through all points, is known as the hub proportion or ellipticity and is typically indicated in decibels (dB). In the event that the hub proportion is close to 0 dB, the receiving wire should be roundabout energized. On the off chance that the pivotal proportion is more noteworthy than 1-2 dB, the polarization is every now and again alluded to as circular. [8]

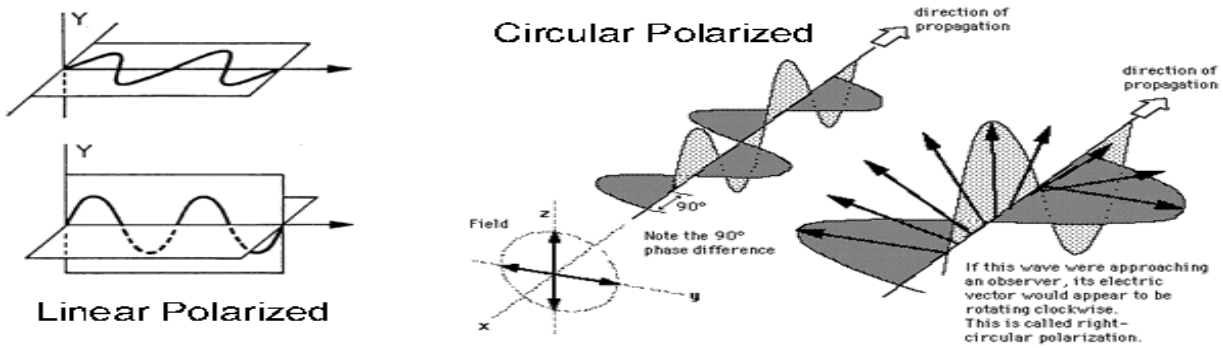

Figure 1.6: Antenna Polarization

1.8.14 Wavelengths

In view of the standard definition, "The separation between 2 back to back greatest focuses (peaks) or even between two progressive least focuses (troughs) is known as the wavelengths."

Only, the separation between 2 moment positive pinnacles or even two quick negative highs is nothing worth mentioning however along that wave. It could be named as the wavelengths. The following figure demonstrates an ordinary waveform. The wavelength and adequacy are spoken to inside the figure. The higher the genuine recurrence, the lesser would be the wavelength and the other way around. Numerical articulation - The recipe for wavelength is,

$$\lambda = C/f$$

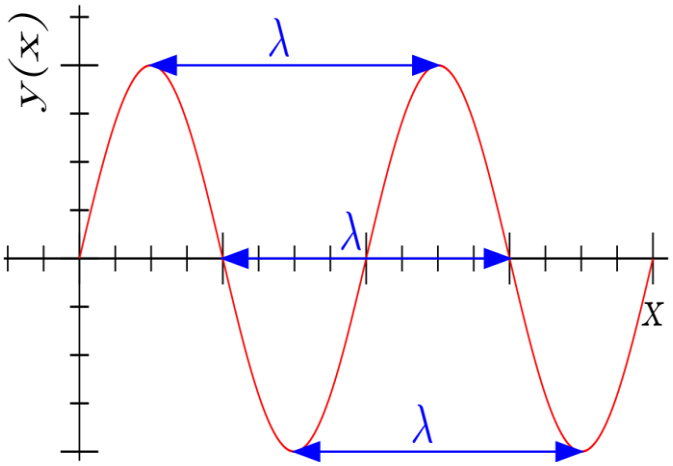

Figure 1.7: Wavelengths

Where λ is certainly the wavelength, C is that speed of light (3*10^8 ms-1), f is unquestionably the recurrence. The wavelengths λ is expressed with the units of length which incorporates meters, feet or in. The ordinarily castoff words is meters.

1.9 Types of Antenna

1.9.1 Log Periodic Antennas

- Bow Tie Antennas
- Log-Periodic Dipole Array

1.9.1(a) Bow Tie Antenna

Most of bow tie antennas are a derivative of the biconical antenna. The biconical antenna is an omnidirectional wide antenna. Its size determines its lowest frequency response, as it acts like a high pass filter. As frequency goes higher, away from the design frequency, the pattern of the antenna distorts and spreads.

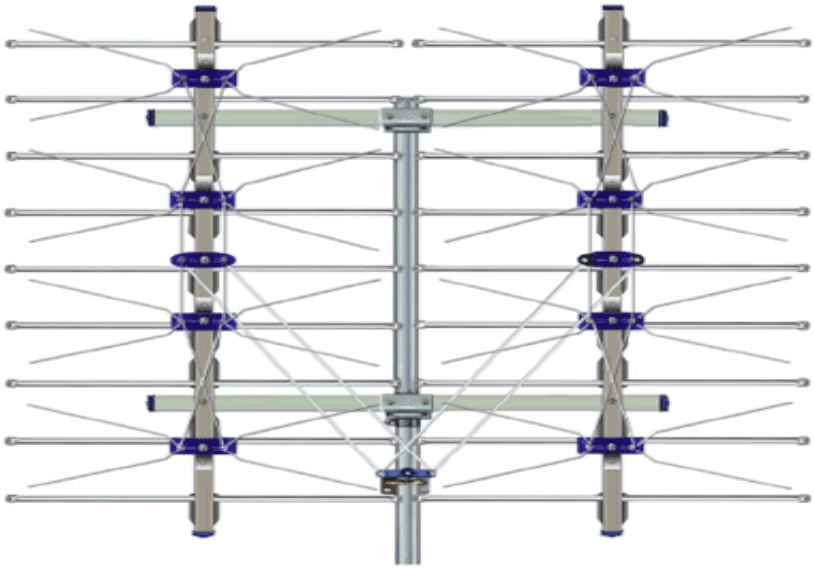

Figure 1.8: Bow Tie Antenna

1.9.2 Wire Antennas

- Short Dipole Antenna
- Dipole Antenna
- Monopole Antenna
- Loop Antenna

1.9.2(a) Short Dipole and Dipole Antenna

The short dipole antenna is one that is short when compared to a wavelength at the operating frequency. Typically a short dipole antenna is taken to be one that is less than of a wavelength long.

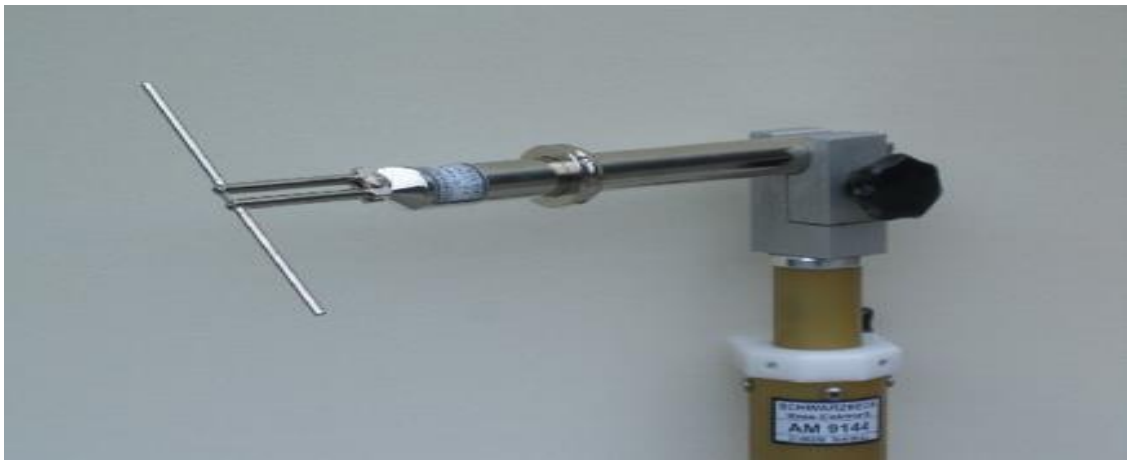

Figure 1.9: Short dipole antenna

A dipole antenna is a straight electrical conductor measuring ½ wavelength from end to end and connected at the center to a radio-frequency (RF) feed line.

Figure 1.10: Dipole antenna

1.9.3 Travelling Wave Antennas

- Helical Antennas
- Yagi-Uda Antennas

1.9.3(a) Helical Antennas

Helical radio wire or possibly helix recieving wire is the reception apparatus that the directing wire is wound fit as a fiddle and connected with the ground plate that has a feeder line. It would be the least complex recieving wire, which conveys circularly captivated waves.

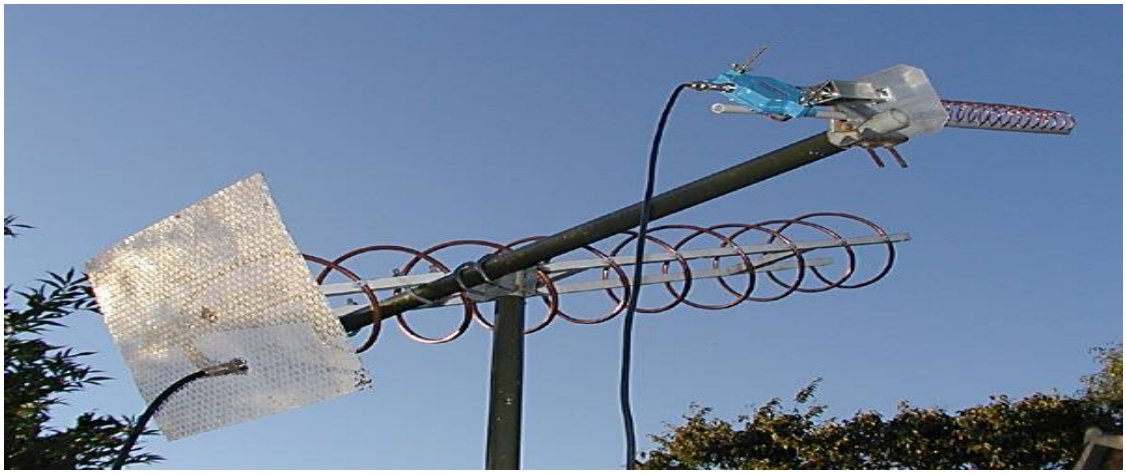

Figure 1.11: Helical Antenna

1.9.3(b) Yagi-Uda Antennas

A Yagi-Uda antenna, commonly known as a Yagi antenna, is a directional antenna consisting of multiple parallel elements in a line, usually half-wave dipoles made of metal rods

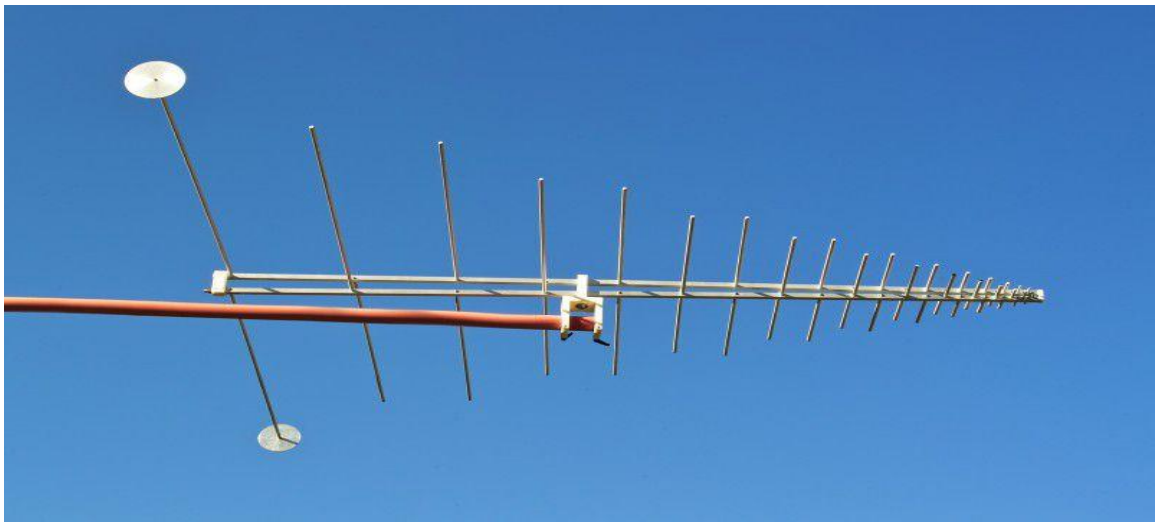

Figure 1.12: Yagi-Uda Antenna

1.9.4 Microwave Antennas

- Rectangular Micro strip Antennas
- Planner Inverted-F Antennas

1.9.4(a) Rectangular Micro strip Antennas

In telecommunication, a microstrip antenna usually means an antenna fabricated using microstrip techniques on a printed circuit board. It is a kind of Internal Antenna.

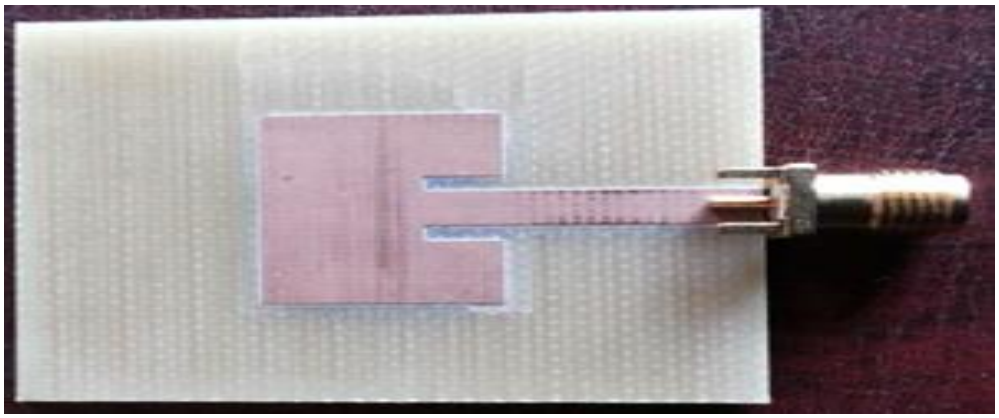

Figure 1.13: Rectangular Microstrip Antennas

1.9.2(b) Planner Inverted-F Antennas

An inverted-F antenna is a type of antenna used in wireless communication. It consists of a monopole antenna running parallel to a ground plane and grounded at one end.

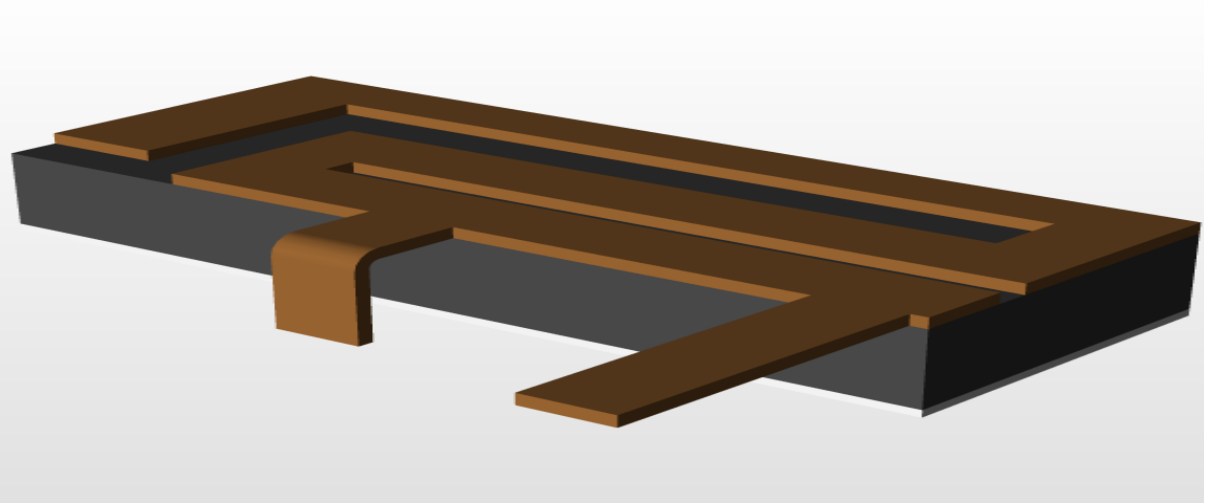

Figure1.14: Planner Inverted-F Antenna

1.10 Summary of the Chapter

The conclusion of this chapter is about the objective, the research methodology, scope and also described on parameter and basic types of antenna.

Chapter - 2

MICROSTRIP PATCH ANTENNA

2.1 Introduction

Generally microstrip element contain associated with an area of metallization support above the soil plane, named as microstrip plot. The subordinate element is termed substrate material which can be found between the patch and the ground plane. The microstrip antenna might be fabricated with low charge lithographic technique or by simply monolithic integrated circuit strategy. Utilizing solid coordinated circuit system you can manufacture stage shifters, intensifiers and furthermore other vital gadgets, for the comparative substrate by customized technique. In greater part in the cases the execution attributes in the reception apparatus will give guideline picture with respect to microstrip radio wire alternatives, strategies for investigation and a couple of sustaining method.

2.2 Types of Patch Antenna

Microstrip antennas are actually printed circuit antennas for ones transmission and reception from electromagnetic energy.

In 1953, Deschamps proposed the very idea of Microstrip antennas. The perception of microstrip antennas isn't active until the fast 1970's, when there was a need for low profile antennas at the developing new generation missiles.

In 1970 Byron spoke to a leading strip radiator disconnected by a ground plane by some dielectric substrate. A strip radiator having measure of a few wavelengths and about half wavelength width was government at intermittent interims following the transmitting edges. This is the in any case announced radio wire cluster in the open writing.

In 1974 Munson exhibited new class of microstrip wraparound reception apparatus worthy for rockets utilizing microstrip radiator also microstrip feed systems at the alike substrate. This moderate profile microstrip cluster most recent about 90% effectiveness also almost

omnidirectional dealing with. After these receiving wire an inventive scientific strategy, called pit display, for the review of microstrip reception apparatuses. Amid this model the upper fix and furthermore segment of the yard plane situated beneath everything, is joined by a decent attractive divider underneath the edge inside the fix. The substrate currently executes as the dielectric resonator. The radio wire parameters for unique fix geometries using clueless feed focuses are typically determined utilizing this procedure. The impacts of radiation together with different misfortunes are acquainted identifying with either a vitally substrate hardship digression. Tuan Q. Tran presented a multimode antenna design using one substrate layer. It kept of concentric circular pads generating TM11, TM21 and TM31 processes and separated by concentric slots as long as isolation between the processes. The antenna can double to generate limited gleam scan performance, circular polarization, and multiple phase centers giving a solution for multifunctional communication app. The amplitude and phase for the feed points can be systematized when using the signal processing techniques.

Surabhi Dwivedi created relationship of directivity while utilizing the dispersing stature of copper framework layer over the fix, named as haphazardly structure. Various plans and models of randome structure are hypothetically fathomed and assessed applying limited component technique (FEM) based Excessive Frequency Structure Simulator (HFSS) programming program. Furthermore, it is pass on forward to execution associated with metamaterial idea for radome structure.

Tahsin ferdous exhibited a type of near investigation of rectangular and roundabout fix reception apparatuses on a X band alongside the thunderous recurrence is resolved at 10GHz. What's more, CST Microwave Studio is required as programming for this correlation. [9]

2.3 Common Shape of Patch Antenna

As an approach to improve investigation and viability count, the fix is regularly square, rectangular, roundabout, triangular and circular or different sorts of normal shape as appeared in figure for only a rectangular fix the length L on the fix is generally

0. 3333λ0 < L < 0. 5λ0, where λ0 would be the free-space wavelength. The fix is chosen for being slim such of which t << λ0 (where t would be the fix thickness). The stature h on the dielectric substrate is normally 0. 003λ0 ≤ they would ≤ 0. 05λ0.

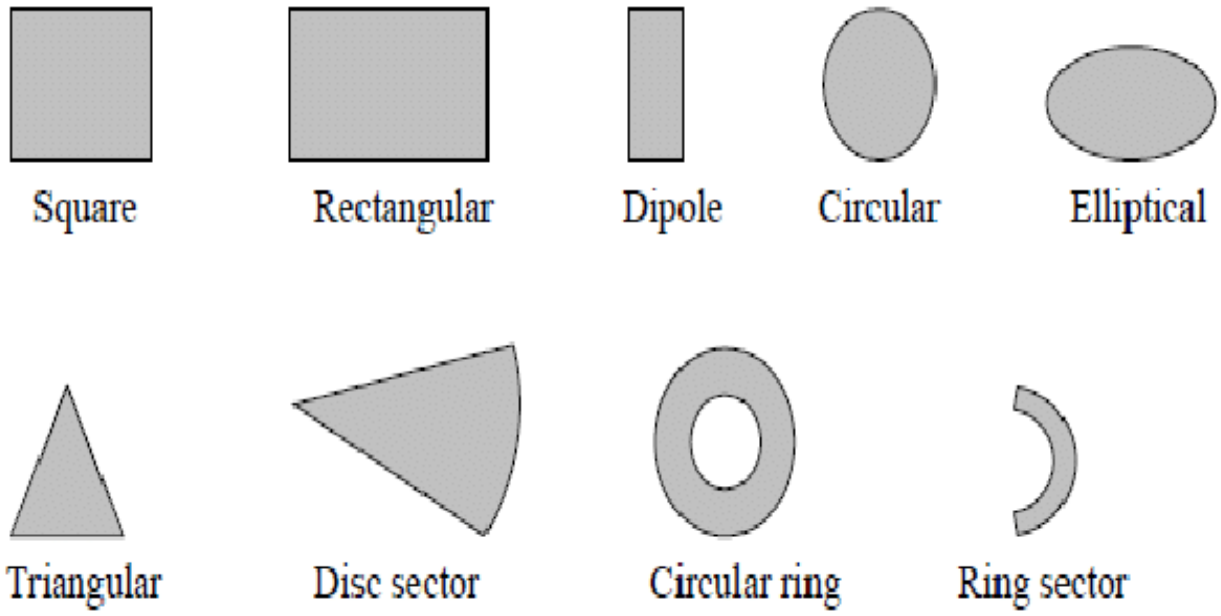

Figure 2.1: Common shape of microstrip patch elements

2.4 Advantages and Disadvantages

Microstrip antenna has a number of advantages compared to conventional microwave antennas. These antennas are cast-off in many applications over the wide frequency range from 100MHz to 50GHz.

Some of the principle advantages of these antennas are [10]:

- Low weight, low cost, low profile and conformal.
- Easy to fabricate and can be integrated with other microstrip components in monolithic application alike to RFIC and MMIC.
- The antenna can be simply straddling on missiles, rockets and satellite without major alterations.
- The antenna has low scattering cross section
- Dual frequency antenna can be easily made.
- Mechanically vigorous when mounted on unwavering surfaces.

Microstrip patch antenna struggle from more draw back as compared to conventional antennas. Some of their major disadvantages talk over by Garg et al are given below:

- Narrow bandwidth

- Low efficiency
- Low gain
- Low power handling capacity
- Extraneous radiation from feeds and junctions.
- Poor end fire radiator excluding tapered slot antennas
- Surface wave excitation

2.5 Feed Technique

Microstrip fix reception apparatuses could be encouraged by a variety of strategies. These strategies could be arranged into two classifications reaching just as non-reaching. In the connecting with system, the RF control is bolstered directly to the emanating patch using an interfacing component like a microstrip line. In the real non-reaching framework, electromagnetic field coupling is performed to exchange control between your microstrip line and the real emanating patch. Sustaining system is coordinated through the factor of productive power exchange between your radiation structure, bolstering structure and their impedance coordinating. [10]

2.5.1 Microstrip Line Feed

It is a feeding technique, in which the microstrip patch is directly connected with the conducting microstrip feed line. The dimensions of the feed line are dissimilar than microstrip patch. It is easy to fabricate and match. However as the thickness of the dielectric substrate increases, surface waves and spurious feed radiation also increases, which obstructs the bandwidth of the antenna. This type of feeding technique results in unwanted cross polarization effects.

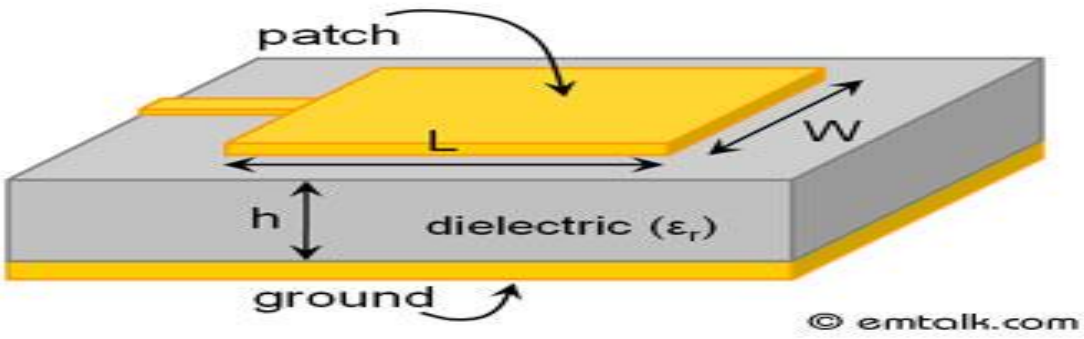

Figure 2.2: Microstrip Line Feed

2.5.2 Coaxial Feed

The specific Coaxial feed or Probe feed is likely the most widely recognized system helpful for nourishing microstrip fix radio wires. As observed from number the inward channel with the coaxial connector through the dielectric which is bound to the transmitting spot, though the external conveyor is connected to the ground plane.

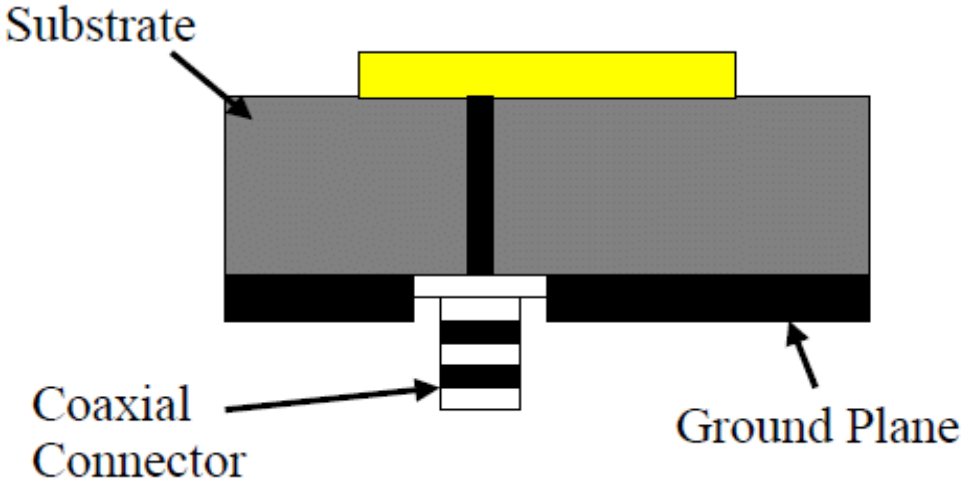

Figure 2.3: Coaxial feed Microstrip Patch Antenna

The advantage of this kind of bolstering structure is the means by which the feed can be situated at any favored position inside the fix and find impedance coordinating. This feed technique is easy to manufacture and offers low misleading radiation results. Notwithstanding, its significant hindrance is it manages limited data transmission and it is hard to show since an opening should be penetrated into the substrate. Furthermore for thicker substrates, the genuine expanded test length can make the information impedance significantly more inductive, prompting organizing issues. By utilizing a thick dielectric substrate to enhance the transfer speed, the microstrip line feed and furthermore the coaxial feed endure the radiation and coordinating issue.

2.5.3 Aperture Coupled Feed

This feed is having two substrates, which are different from each other and are separated by a ground plane. In this method, the microstrip patch and feed line are coupled through a slot in the ground plane. Minimization in interference and pure polarization are the advantages of aperture coupled feeding method. The aperture coupled feed is as shown in figure:

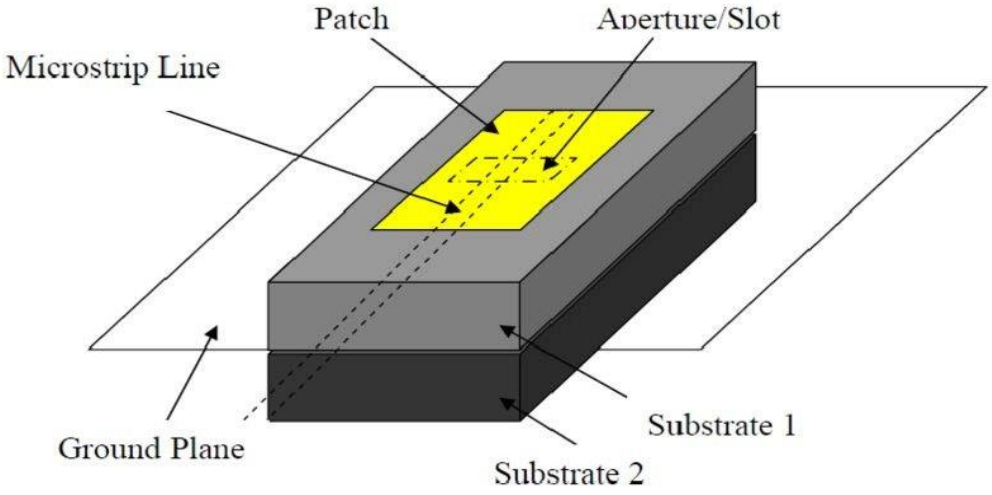

Fig 2.4: Microstrip Aperture-Coupled Feed

2.5.4 Proximity Coupled Feed

This technique employs ground plane among two substrates. A slot will be placed on a lawn plane and feed line will probably be placed on lower substrate. This will be electromagnetically connected to patch around the upper substrate through the bottom plane slot. One should take value substrate parameters and they should choose in a fashion that feed optimization and self-sufficient radiation operative can are present. The coupling slot needs to be nearly cantered so your patch magnetic field will probably be maximum.

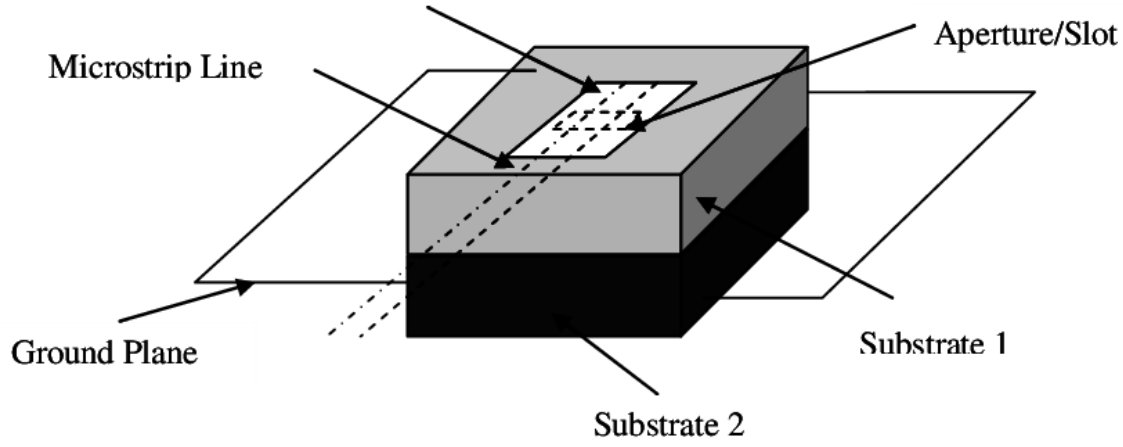

Fig 2.5: Microstrip Proximity Coupled Feed

The benefit of this feed technique is it eliminates spurious feed radiation and delivers high bandwidth of about 13%, because of increase in the electrical thickens from the microstrip

patch antenna. This particular scheme also provides options between two different dielectric press, one for the patch and something for the feed line to optimize the person performances.

2.6 Summary of the Chapter

The conclusion of this chapter is described on the topic of basic Microstrip Patch Antenna and feeding techniques.

Chapter - 3

CST STUDIO SUITE DESIGN TUTORIAL

3.1 Introduction

In this chapter we showing the full using of CST STUDIO SUITE having the design of coaxial feed technique micrsostrip patch antenna.

3.2 Design Tutorial

Step 1:

Open the CST Software and go to the new template.

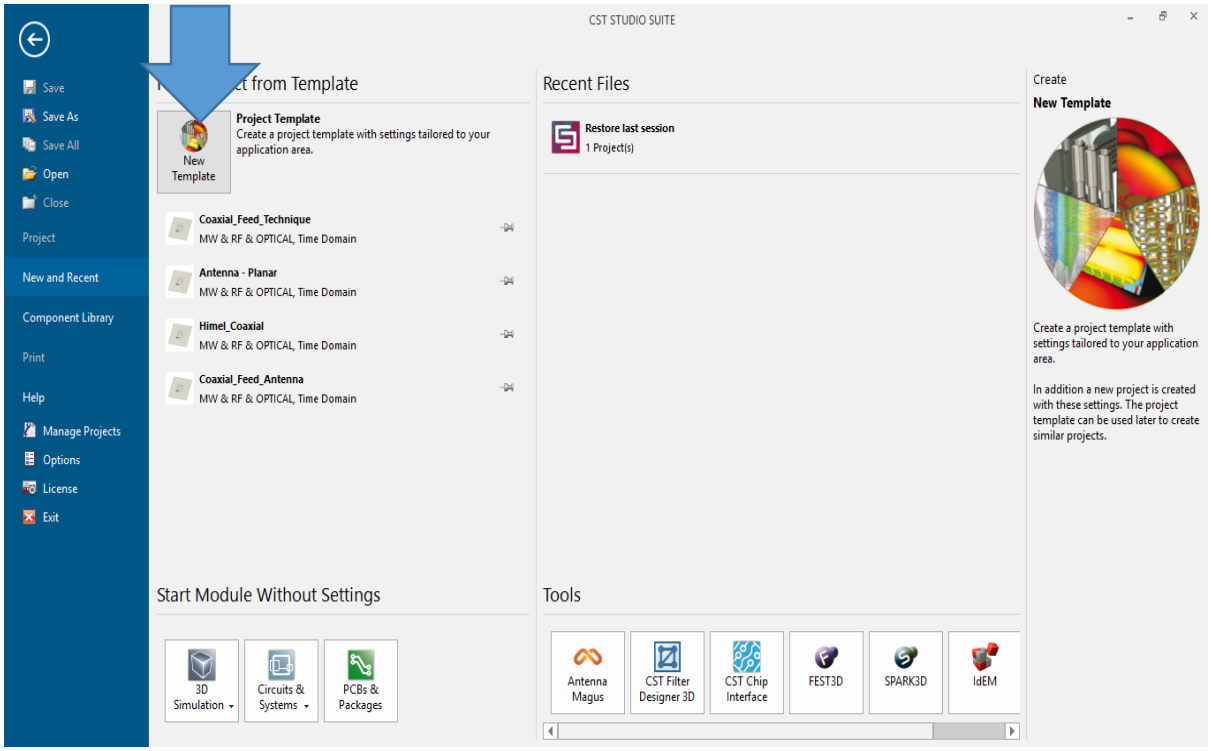

Figure 3.1: CST STUDIO SUITE.

Step 2:

After completing the first step then show a new window like this. Here the some options and select the MW & RF & Optical then select Antennas and click the Next Button.

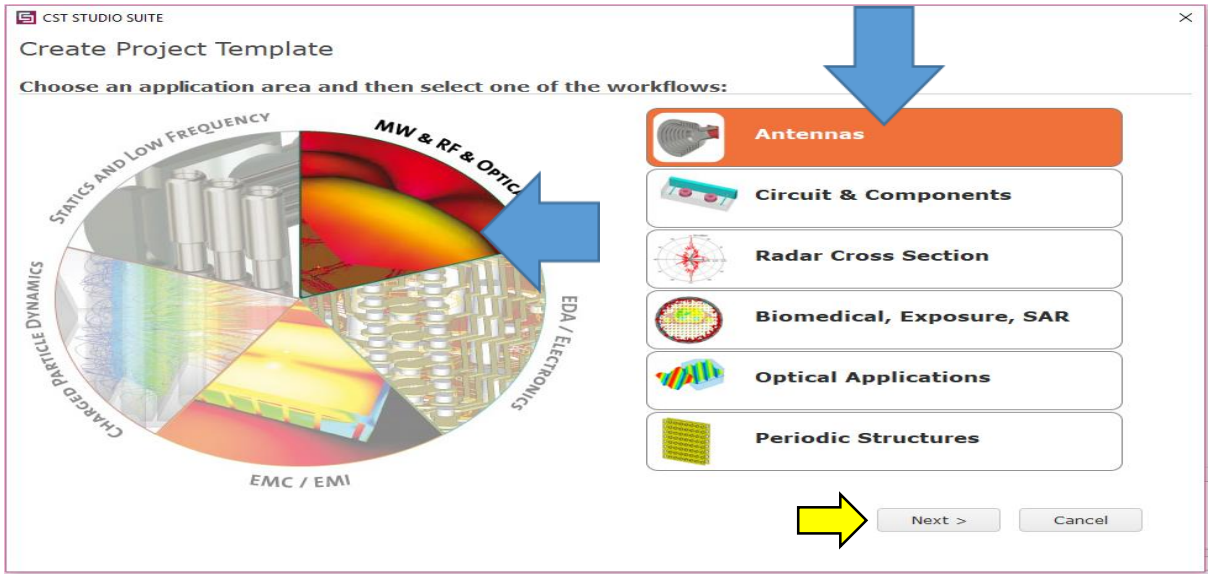

Figure 3.2: Choose an application area.

Step 3

In this step select planar (Patch, Slot, etc.) then click next button.

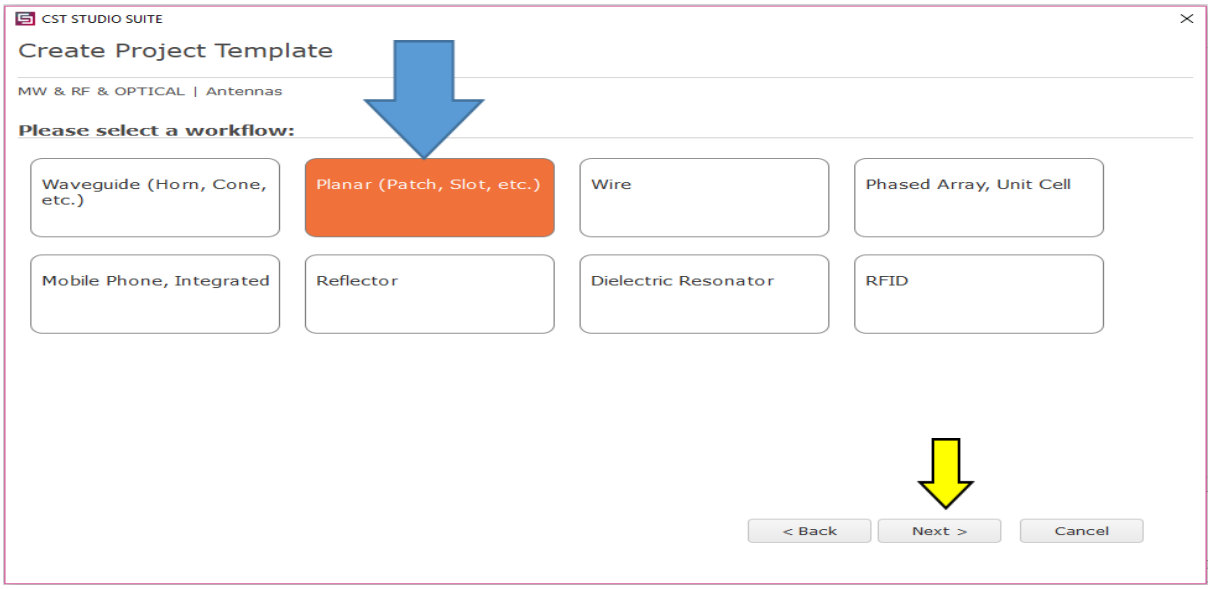

Figure 3.3: Select a workflow.

Step 4

In this step select the Time Domain and then click the Next.

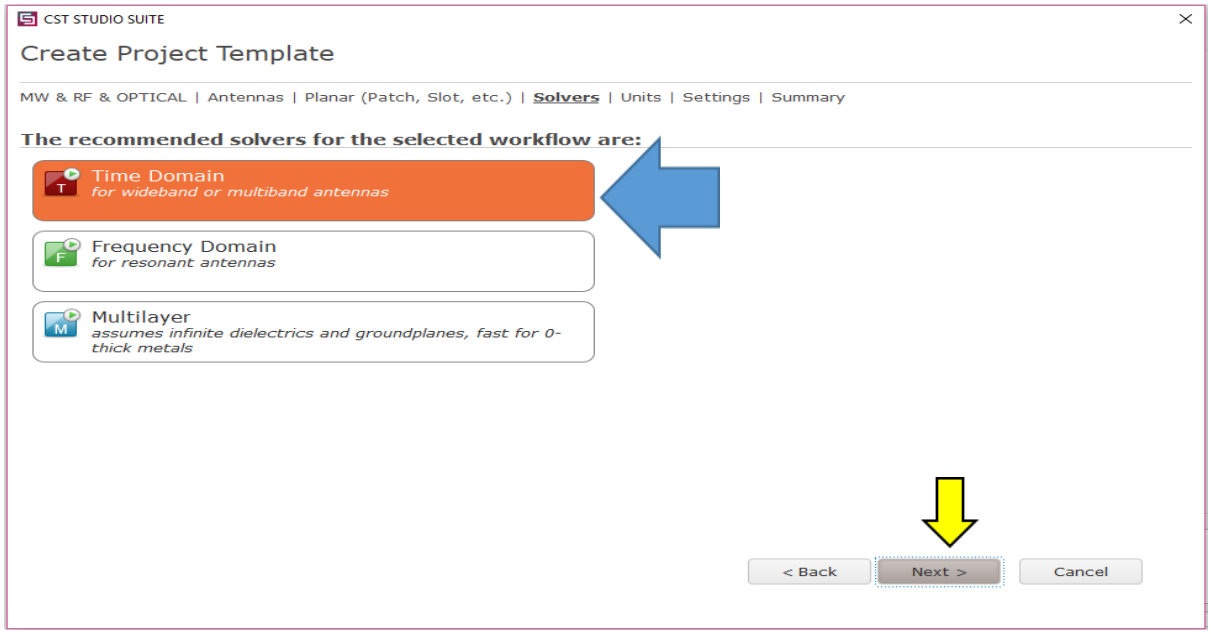

Figure 3.4: The Recommended solvers for the selected workflow.

Step 5

In this step select the default unit form and click the Next.

Figure 3.5: Units Selection window.

Step 6

In this step select the frequency range from minimum frequency to maximum frequency and put the center frequency that we select for our design. In monitors select all the points (E-field, H-field, Fairfield etc.)

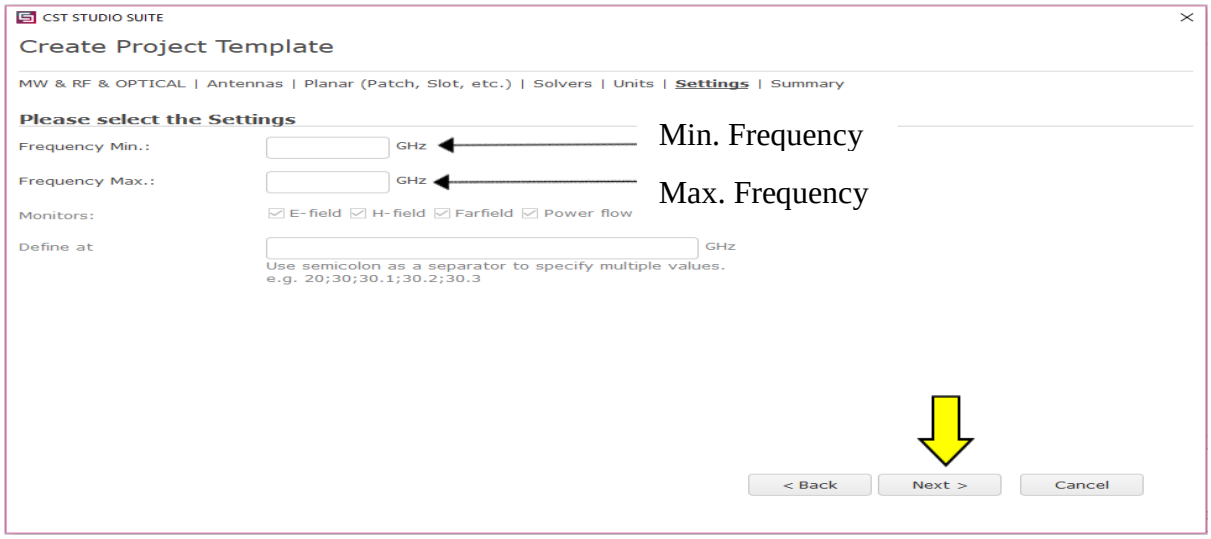

Figure 3.6: Frequency selection window.

Step 7

In this step select your project file name and click finish button.

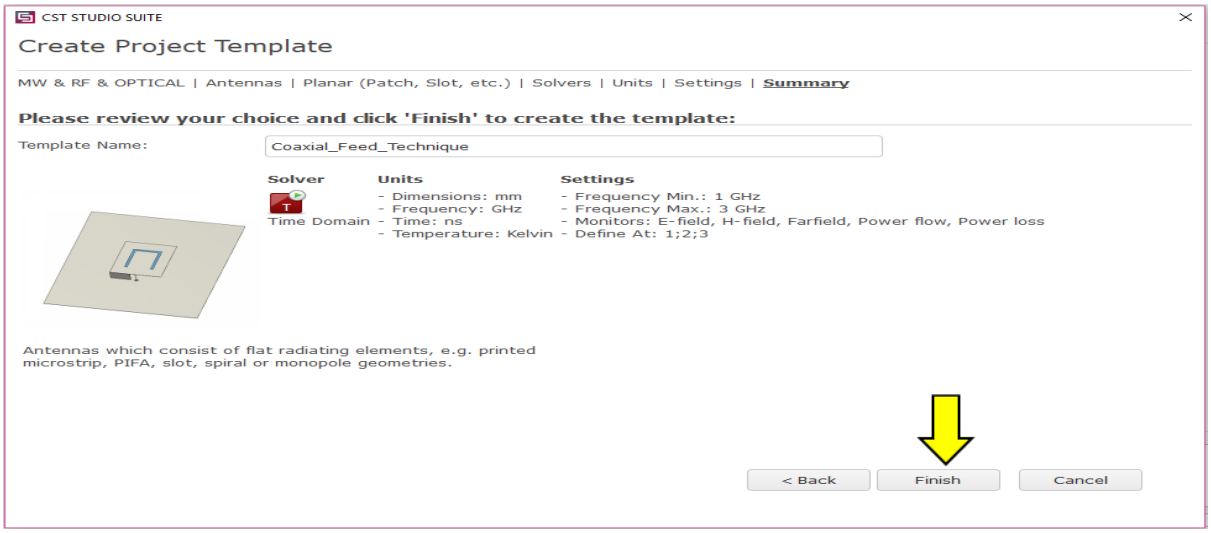

Figure 3.7: File / Project name selection window.

Step 8

This is the final step to ready your work space. Now you can design your antenna.

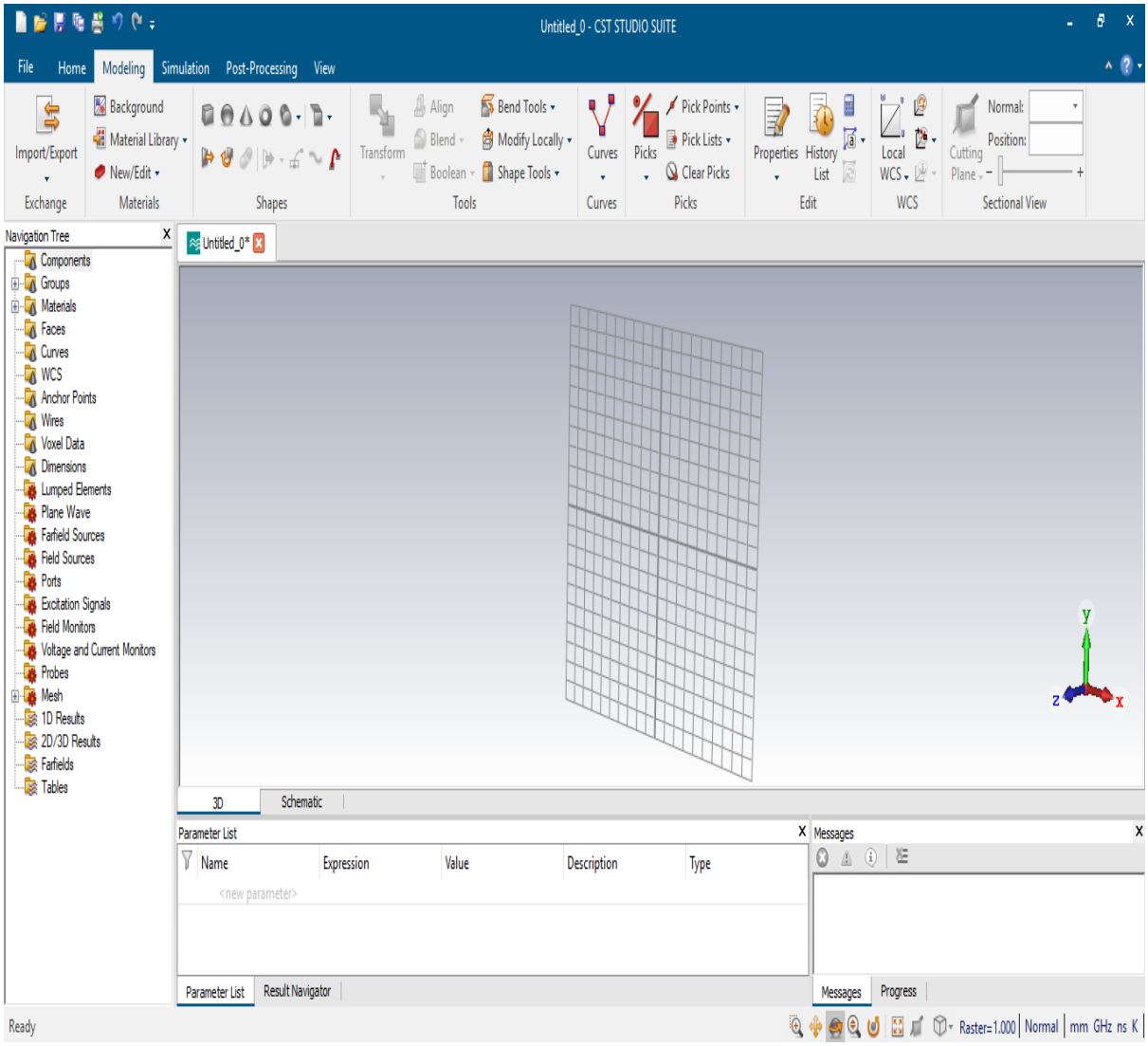

Figure 3.8: Work space window.

3.3 Summary of the Chapter

In this chapter showing the full tutorial of CST software using starting process step by step.

Chapter - 4

APPLICATIONS

4.1 WLAN

4.1.1 Introduction

A wireless local area network (WLAN) is a wireless distribution technique for two or more devices that use high-frequency radio waves and often include an access point to the Internet. A WLAN allows users to move around the coverage area, often a home or small office, while maintaining a network connection. An invisible local area network (WLAN) is actually a local area network (LAN) will not rely on wired Ethernet relationships. A WLAN can regularly be either a recompense to the current wired system or another to shoeless running. WLANs have information exchange speeds cover anything from 1 to 54Mbps, by utilizing some maker's membership mystery 108Mbps arrangements. The 802. 11n standard can achieve 300 with the goal that you can 600Mbps. Since the handheld flag is communicated henceforth everyone adjacent can advance it, a few security safety measures are fundamental to guarantee just qualified clients can get to an individual's WLAN. A WLAN flag is frequently communicated to cover a spot running in size beginning from a little office to a significant grounds. Most ordinarily, a WLAN passage manages access with a span of 65 so you can 300 feet.A WLAN is usually demand a local area wireless network (LAWN).

4.1.2 History of WLAN

Within the primary 1990s, WLANs were very costly and were only utilized when wired connections had been intentionally impossible. By the actual late 1990s, most WLAN options and trademarked protocols had been replaced by IEEE 802. 11 standards in a variety of versions (versions "a" via "n"). WLAN prices also started to decrease significantly.

WLAN shouldn't be disorganized with the Wi-Fi Alliance's Wi-Fi brand. Wi-Fi is not the technical term, but is referred to as a superset of the actual IEEE 802. 11 standard and it is

sometimes used interchangeably with this standard. Nevertheless, not each and every Wi-Fi device actually gets Wi-Fi Alliance certification, although Wi-Fi can be used by more than seven hundred million people through regarding 750, 000 Internet link hot spots.

4.1.3 Types of WLAN

4.1.3(a) Private Home or Small Business WLAN

For the most part, a home or business WLAN utilizes two or three passages to communicate a sign around a 100-so as to 200-foot sweep. You can get hardware for introducing a house WLAN in numerous stores.

With couple of exemptions, equipment with this class buys in to the genuine 802. 11a, b, or g norms (additionally alluded to as Wi-Fi); some home and work environment WLANs currently pursue towards the new 802. 11n normal. Likewise, due to security fears, many home and office WLANs adhere to the Wi-Fi Protected Entry 2 (WPA2) standard.

4.1.3(b) Enterprise Class WLAN

A venture class WLAN utilizes a substantial number of individual passageways to help communicate the flag into a wide zone. The passageways have a larger number of structures than home or possibly little office WLAN mechanical assembly, for example, better wellbeing measures, confirmation, remote administration, and devices that can help partake with existing networks. These passages utilize a bigger inclusion zone in examination with home or little organization hardware, and are made to cooperate to cover an a lot more extensive region. This gear can see towards 802. 11a, b, gary the contraption fellow, or n standard, so they can security-refining models, such observing that 802. 1x and WPA2.

4.1.4 WLAN Standards

WLAN standard	Advantages	Disadvantages
802.11a	• Speedier data transfer rates. (up to 54Mbps) • Supports far more synchronized connections • Less subject to interference.	• Short vary (60-100 feet) • Less qualified to penetrate physical barriers.
802.11b	• Better with penetrating physical barriers • Longest array (70-150 feet) • Hardware is normally less expensive.	• Slower files transfer rates (up for you to 11Mbps) • Doesn't support numerous simultaneous connections • More vulnerable to interference.
802.11g	• Faster data files transfer rates (up towards 54Mbps) • Better range as opposed to 802. 11b (65-120 feet).	• More vulnerable to interference.
802.11n	The actual 802. 11n standard was recently ratified through the Institute of Electrical as well as Electronics Engineers (IEEE), when compared with the previous three requirements. Though specifications may alter, it is expected to permit data transfer rates as much as 600Mbps, and may provide larger ranges.	

[12]

4.1.5 Applications of WLAN Communications

Remote LANs have a few applications, all things considered. They are oftentimes useful to enhance a wired hover, not to totally swap them. The accompanying portrays a great deal of the applications that are made conceivable through the power notwithstanding suppleness of remote LAN mechanical.

Human services

Wellbeing experts and attendants arranged having PCs or PDAs have quicker approaching patient information. Furthermore, in a crisis circumstance they will speak with different offices in the clinic by utilizing WLAN as an approach to give speedy diagnostics. It is a region where WLAN has just been decently generally utilized. As much of the time, WLAN is useful to improve an officially later wired system.

Leading Everyday Business

Maintaining a business, individuals can work innovatively alongside clients or providers inside gathering rooms - you don't need to leave the space to keep an eye on if imperative messages have arrived or print substantial records. In its place you can send them from one PC to an alternate. Senior officials in gatherings could settle on speedier choices since they gain admittance to constant data.

System Managers in more established Buildings

Systems administration administrators in more seasoned homes, for example, schools, eating foundations, and stockrooms, discover WLANs as most savvy substructure decision. When constructing an alternate system or expanding any old in-house organize, hardly any links require be drawn through the divider surfaces and roofs.

System Managers in Dynamic Environments

Framework administrators in unique conditions minimalize the cost of moves, arrange expansions, and different changes by wiping out the cost of cabling and establishment. The portable scene related with WLAN permits the building and testing of the new system before moving to mission-basic environment.

4.2 Radar

4.2.1 Introduction

RADAR represents Radio Detection and which range System. It is mostly an electromagnetic system utilized to detect the location and distance of your object from the level wherever the RADAR is put. It works by radiating vitality into space and examining the echo or reflected signal from your objects. It operates inside the UHF and microwave array. The RADAR system mostly is made up of transmitter which produces an electromagnetic signal which can be radiated into space simply by an antenna. When this kind of signal strikes anything, it gets reflected or re-radiated in lots of directions. This reflected or indicate signal is received from the radar antenna which delivers it for the receiver, where it is processed to determine the geographical statistics of the thing. The range is dependent on the calculating the time taken from the signal to travel from your RADAR to the targeted and back. The target's place is slow in perspective, from the direction regarding maximum amplitude echo sign, the antenna points to be able to. To measure range and also location of moving things, Doppler Effect is cast-off.

4.2.2 Types of Radar

There are a wide range of kinds of Radar.

Bistatic Radar

Bistatic radar is extremely a radar framework that incorporates of the transmitter and a beneficiary which are isolated by a separation that is equivalent to the separation from the normal target. A radar in that the transmitter and the collector are arranged at a similar place is really an ascetic radar. Most long range surface-to-air just as aerial rockets utilize utilizing bistatic radar.

Nonstop Wave Radar

A nonstop wave radar is a kind of radar where a recognized constant recurrence consistent state radio vitality is transmitted after which it got from one of the articles that mirror your waves. A constant wave radar utilizations Doppler innovation so this implies the radar will dependably be invulnerable to any method for impedance by extensive items which have been stationary or moderate exchanging.

Doppler radar

A Doppler radar is generally a prevalent type of radar that utilizes the work of Doppler Effect to make speed information around an article for a given separation. This is achieved by methods for sending electromagnetic signs towards an objective at that point investigating how the objective movement has influenced the recurrence on the returned flag. This variety has the ability to extend incredibly precise estimations on the spiral part of an objective's speed relating to the radar. Doppler radars have applications in an assortment of businesses including flight, meteorology, medicinal services and there are others.

Monopulse Radar

A monopulse radar can be a radar framework that relates the got flag from your single radar beat against itself having a point of contrasting the flag as saw in numerous polarizations or rules. The most widely recognized sort of monopulse radar is the specific release of cone shaped translating radar which thinks about the specific come back from two rules to specifically quantify the situating of the objective. You should take note of that most with the radars that were structured thinking about that the 1960s are monopulse radars.

Inactive Radar

Any inactive radar framework is a type of radar that is worked to identify and follow things by agreement reflections from non-helpful explanations behind light in the environment. These sources incorporate explicit things like correspondences signs and business transmissions. Aloof radar might be classified in the indistinguishable class of radar since bistatic radar.

Instrumentation Radar

Instrumentation radars will be radars that can test rockets, rockets, and air ships together with rockets on government together with private test ranges. They have a fluctuation of material including space, position, and time both amid the constant and amid the post preparing examination.

Climate Radars

Climate condition radars are radar frameworks that happen to be utilized for climate acknowledging and recognition. This radar utilizes radio waves combined with level or roundabout polarization. The recurrence scope of climate radar shifts as per an execution participation among precipitation refection and weakening coming about because of environmental water vapor. Some climate radars are made to utilize Doppler moves so you can quantify the speed with wind and double polarization to commend precipitation types.

Mapping Radar

Mapping radars will in general be pushed off to check a sizable topographical district for area and remote detecting programs. In view of their usage of engineered opening radar, they're constrained to generally static things. There are some particular radar frameworks that may detect people behind dividers in light of the intelligent attributes of people which are more fluctuated than those found in development supplies.

Navigational Radars

Navigational radars are usually simply like inquiry radars. Nonetheless, they accompany significantly shorter wavelengths that can deal with reflecting from the planet and from stones. They're generally open on business transports alongside other long separation business air ships. There are various navigational radars that comprise of marine radars ordinarily introduced on boats for crash prevention and navigational purposes.

4.2.3 Major Parts of Radar

There are many key parts of Radar.

I. **Transmitter**: It can unquestionably be a power intensifier like another Klystron, Traveling Wave Tube or potentially a power Oscillator like another Magnetron. The flag is first created by utilizing a waveform generator and after that enhanced inside power intensifier.

ii. **Waveguides**: The waveguides are sign lines for transmission in the RADAR signals.

iii. **Recieving wire**: The radio wire push off is generally an illustrative reflector, planar exhibits just as electronically directed staged clusters.

iv. **Duplexer**: A duplexer enables the recieving wire to get utilized as a transmitter or potentially a collector. It can absolutely be a vaporous gadget that would build up a short out at the contribution on the beneficiary when transmitter must be utilized.

v. **Beneficiary**: It may be too heterodyne recipient or some other collector which contains of a processor to process your flag and recognize the thought.

vi. Edge Decision: The yield in the collector is contrasted which has a limit with recognize your reality of any subject. On the off chance that the yield can be beneath any limit.

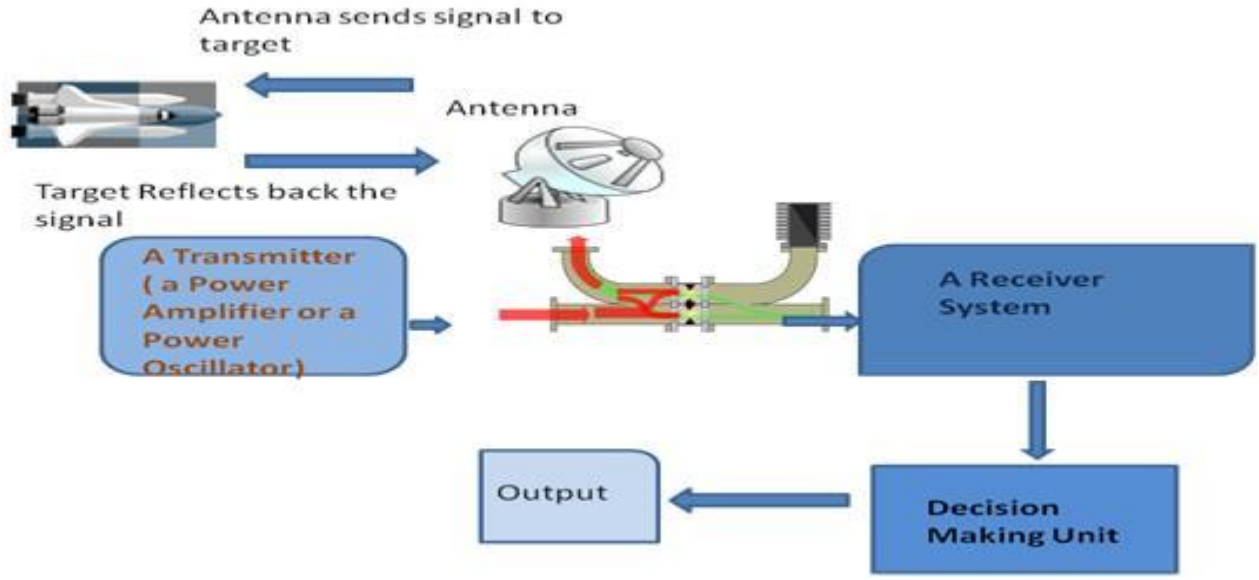

Figure 4.1: A Radar System

4.2.4 Applications of Radar Communications

Military Applications:

The specific RADAR has 3 enter applications in Military:

i. i.In air barrier it truly is utilized for target determination, target acknowledgment and firearm control (coordinating the weapon for the followed targets).
ii. In rocket framework to control the weapon.
iii. Discovering foe areas in guide.

Aviation authority:

The specific RADAR has 3 enter applications in Air Traffic control:

i. To control air focused on traffic close air terminals. The Air Surveillance RADAR will be pushed off to recognize and furthermore show the air ship's situation inside the air terminal terminals.

ii. ii. To control the air ship to landscape in terrible climate making utilization of Accuracy Approach RADAR.

iii. To examine the global air terminal surface for air ship and furthermore ground vehicle positions.

Remote Sensing:

RADAR can be used for watching climate or maybe watching earthbound positions and furthermore observing ocean ice to make certain smooth course for travels.

Ground Traffic Control:

RADAR can likewise be utilized by traffic police to know speed of the engine vehicle, controlling the development of vehicles by furnishing sees about nearness with different vehicles or pretty much every different impediments behind them.

Space:

RADAR has 3 key applications:

i. To manage the room vehicle for safe getting on moon

ii. To see the planetary frameworks

iii. To distinguish and screen satellites

iv. To monitor the meteors

4.3 Satellite

4.3.1 Introduction

Normally terms, a satellite might be a littler item that pivots around a superior article in space. Counting, moon is an all-normal satellite of earth. We realize that Communication takes a gander at the trade (sharing) of data between a few items, through any low to medium or channel. In numerous different words, it is only sending, accepting and refinement of data. On the off chance that the correspondence meets up between any two earth stations from a satellite, at that point it is as satellite correspondence. Amid this correspondence, electromagnetic waves happen to be given off a role as transporter information. These signs convey the web, for example, voice, mp3, video or any numerous other information between ground together with

space and the other way around. Soviet Joining had propelled the worldwide first fake satellite titled, Sputnik 1 of every 1957. Near following 18 years, India likewise propelled the phony satellite named, Aryabhata amid 1975.

4.3.2 Types of Satellite

Satellites can be arranged by their capacity since they are propelled into space to complete a correct activity. The satellite must be planned explicitly to satisfy its job. There are nine distinct kinds of satellites

i. Communications Satellite

ii. Remote Sensing Satellite

iii. Navigation Satellite

iv. Geocentric Orbit type satellites - LEO, MEO, HEO

v. Global Positioning System (GPS)

vi. Geostationary Satellites (GEOs)

vii. Drone Satellite

viii. Ground Satellite

ix. Polar Satellite

x. Nano Satellites, CubeSats and SmallSats

4.3.3 Satellite Working Principle

A satellite is typically a body that moves around another body inside a particular way. A correspondence satellite is it will dependably be a microwave repeater area in space. It is normally helpful in media communications, radio and TV related to web applications. A repeater is normally a circuit, which rises the viability of the got flag at that point transmits it.

Be that as it may, this repeater attempts to be a transponder. That implies, it changes the recurrence band on the transmitted flag from this got one. The utilizing figure represents this guideline obviously.

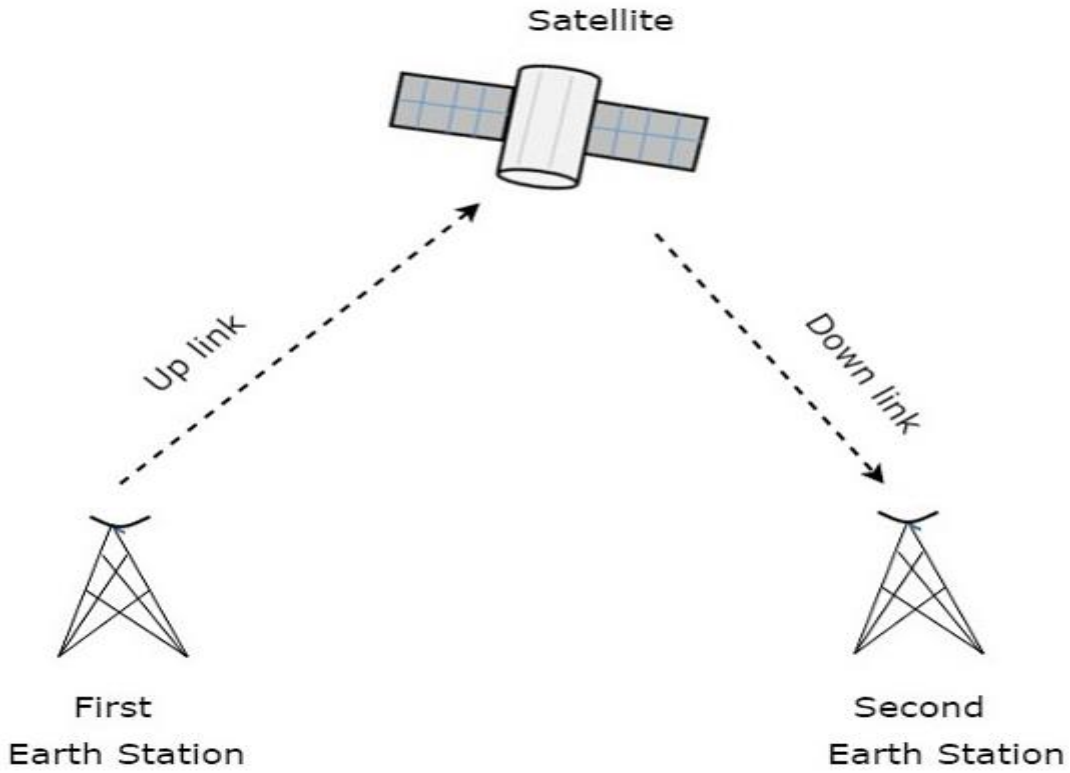

Figure 4.2: Satellite to Earth station data transmitter and receiver system.

The particular transmission of signal coming from first earth station to be able to satellite finished a channel is named as uplink. Similarly, the transmission of sign from satellite to second earth station by way of a channel is called since downlink. Uplink frequency could be the frequency at which, the initial earth station is speaking with satellite. The satellite transponder adjustments this signal into one more frequency and sends it as a result of the second earth stop. This frequency is referred to as as Downlink frequency. Inside comparable way, second earth station also can communicate with the initial one. The process regarding satellite communication begins with an earth station. The following, an installation is built to transmit and receive signals from your satellite in an orbit across the earth. Earth stations send the data to satellites by means of high powered, high regularity (GHz range) signals. The particular satellites receive and re-transmit the signals returning to earth where they are usually

received by other world stations in the exposure section of the satellite. Satellite's footprint could be the area which receives a sign of useful strength from your satellite. [13]

4.3.4 Application of Satellite Communications

Satellite correspondence assumes a dynamic job in our regular day to day existence. Following are the projects of satellite correspondence

a. Radio broadcasting and manner of speaking interchanges
b. TV broadcasting for instance Direct To Home (DTH)
c. Internet applications, for example, giving Web association with information exchange, GPS NAVIGATION applications, Internet surfing, etc.
d. Military applications just as routes
e. Remote acknowledging applications
f. Weather circumstance checking and Forecasting.

4.3.5 Advantages and Disadvantages

On this area, let us look at the favorable circumstances and drawbacks of satellite correspondence

Following are some incredible advantages of utilizing satellite correspondence:

a. Area of inclusion will be additional than that in regards to earthly frameworks
b. Each corner of the earth might be secured
c. Transmission cost is free of protection inclusion zone
d. More transfer speed and furthermore communicating chances

Following are some incredible drawbacks of utilizing satellite correspondence:

i. Launching of satellites into circles is normally an expensive procedure.
ii. Broadcast postponement of satellite frameworks is in overabundance of that of customary earthbound projects.
iii. Difficult to give fixing activities if any issue happens in a satellite television on pc framework.

iv. Free living space misfortune is more

v. There can be blockage of frequencies.

4.4 Summary of the Chapter

In this chapter discussed about applications in detail for our final antenna design. Here also discussed also the advantages and disadvantages of these each applications WLAN, Radar and Satellite communication.

Chapter – 5

ANTENNA DESIGNING AND SIMULATIONS

5.1 Introduction

In this thesis we have designed a multiband multiple I-shape microstrip patch antenna which produces multi band of frequencies resonating at 2.8 GHz, 4.2 GHz and 5.6 GHz which can be used for WLAN, Radar and satellite applications. This antenna is specifically WLAN communication systems.

5.2 Design of Single Band Rectangular Microstrip Patch Antenna with Coaxial Feed

Step 1

Parameter	Dimensions (mm)
Width (W)	68
Length (L)	52.76
Substrate height (h)	4
Thickness of Patch (t)	0.02
Feed location (xf)	13
Inner Radius (ri)	0.5
Outer Radius (ro)	1.5

Table 1: Parameter list for 2.5 GHz microstrip patch antenna.

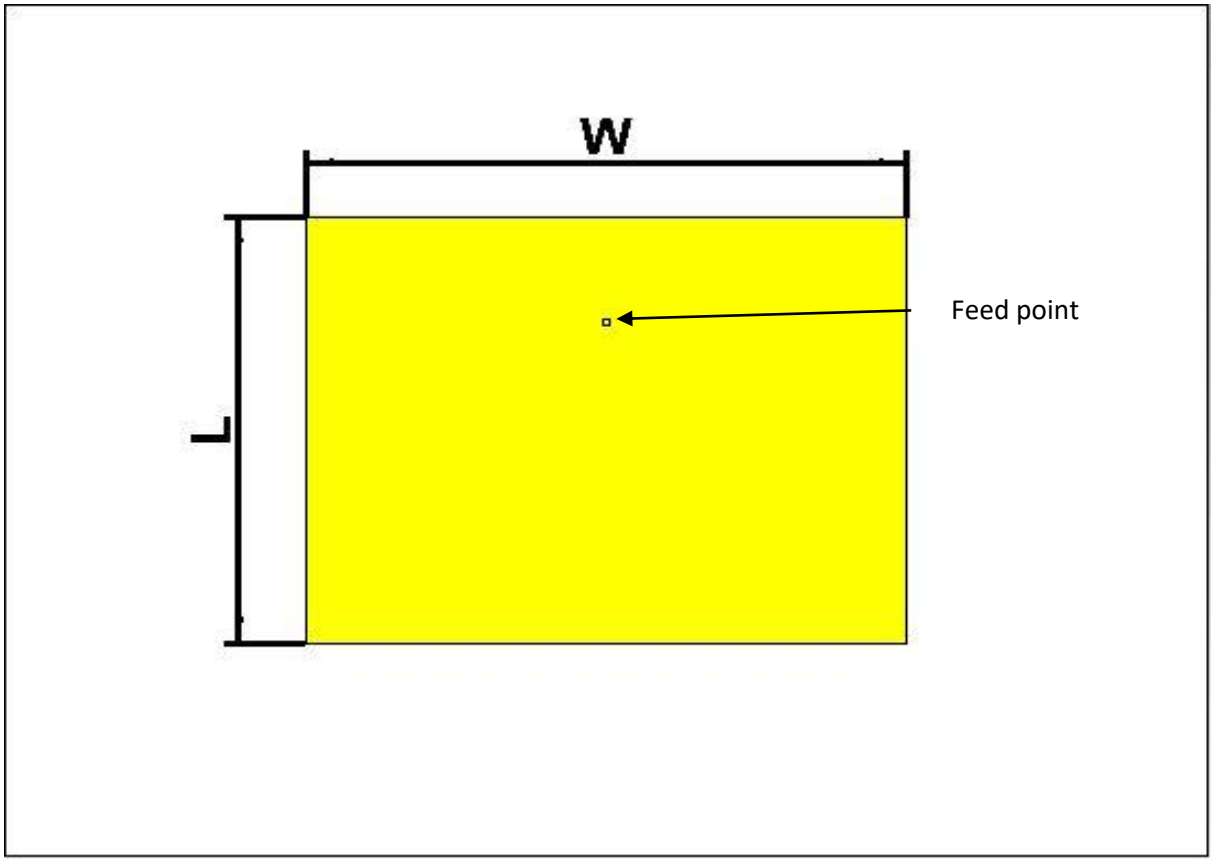

Figure 5.1: Designed structure of design 1

The design of single band antenna has been shown in figure 5.1. The antenna was designed on a air substrate having relative permittivity ϵr = 1.00059. The simulation software was CST (Computer Simulation Technology) is used to optimize the dimension of this antenna on the basis of best performance. For this frequency (2.5 GHz) we got return loss = -27.37 dB.

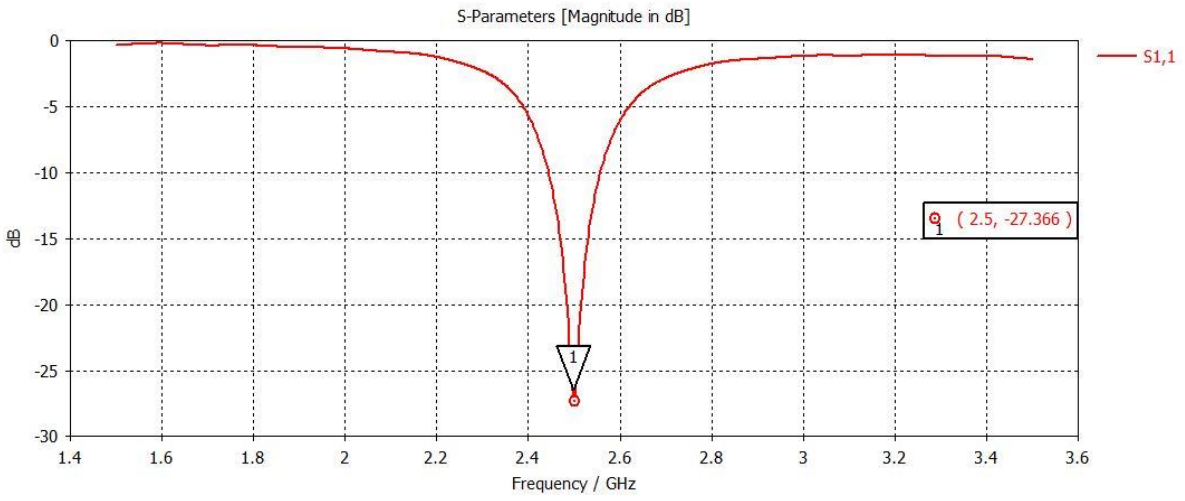

Figure 5.2: S-Parameter for this design 1

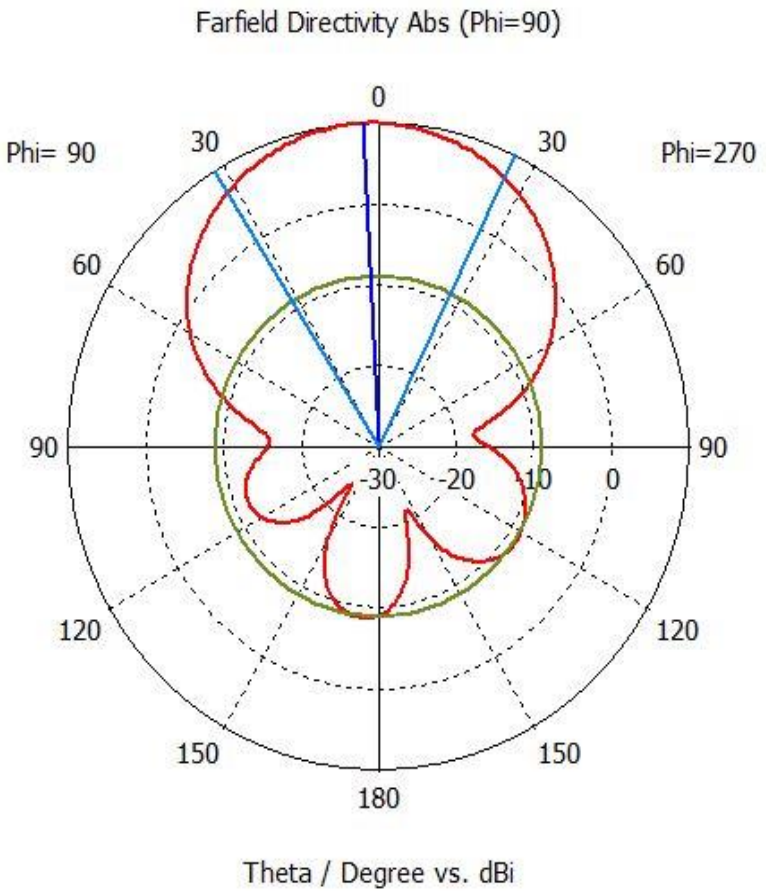

Figure 5.3: Radiation pattern of this antenna at 2.5 GHz.

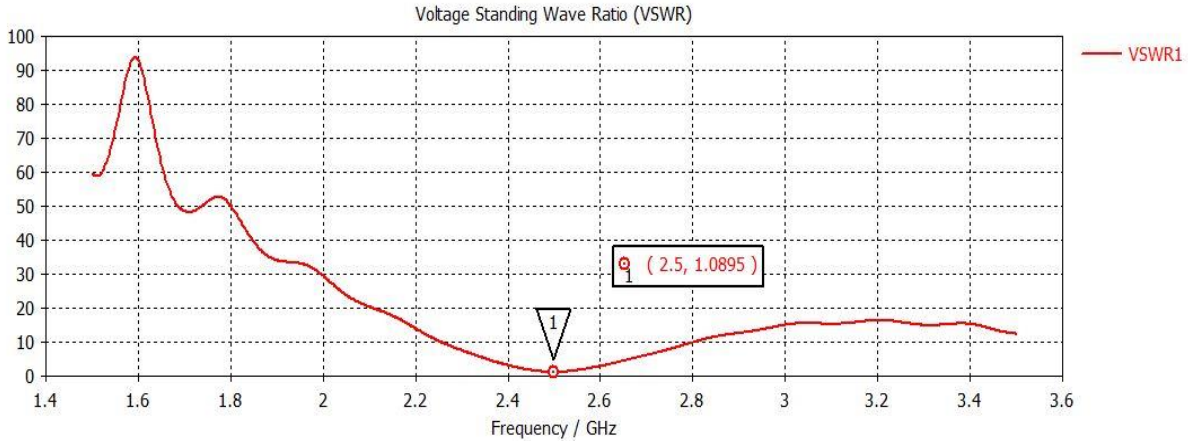

Figure 5.4: VSWR for 2.5 GHz antenna

5.3 Design of Dual Band Rectangular Microstrip Patch Antenna with Coaxial Feed

Step 2

Parameter	Dimensions (mm)
Width (W)	70
Length (L)	75
Substrate height (h)	4
Thickness of Patch (t)	0.02
Feed location (xf)	13
Inner Radius (ri)	0.5
Outer Radius (ro)	1.5
Slot width (A)	70
Length of Slot legs 1 (B)	31
Length of Slot legs 2 (C)	28
Width of slot central part (D)	6

Table 2: Parameter list of U-Shape microstrip patch antenna.

The design of dual band antenna has been shown in figure 5.5. The antenna was designed on an air substrate having relative permittivity ϵr = 1.00059. The simulation software was CST (Computer Simulation Technology) is used to optimize the dimension of this antenna on the basis of best performance. This antenna which produce dual band of frequencies resonating at 2.2 GHz with return loss -20.667 dB and 2.9 GHz with return loss -21.637 dB.

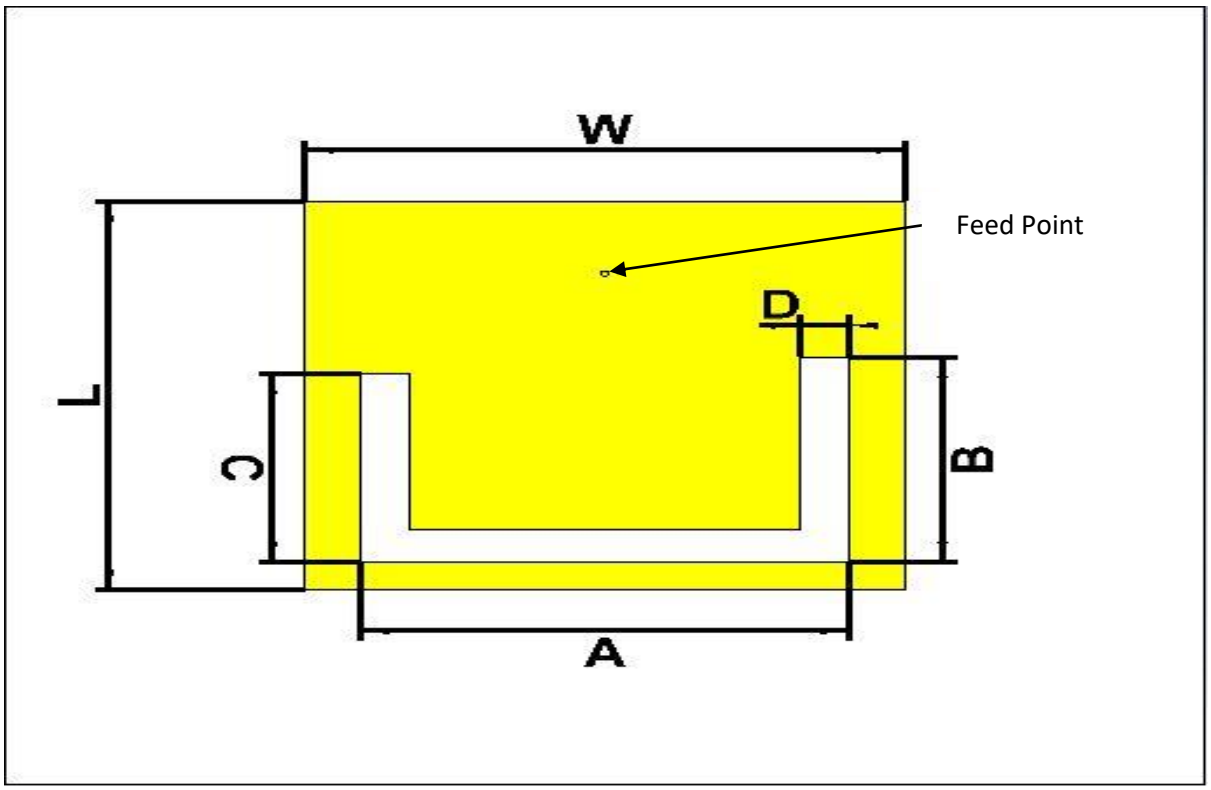

Figure 5.5: Designed structure of U- Shape microstrip patch antenna.

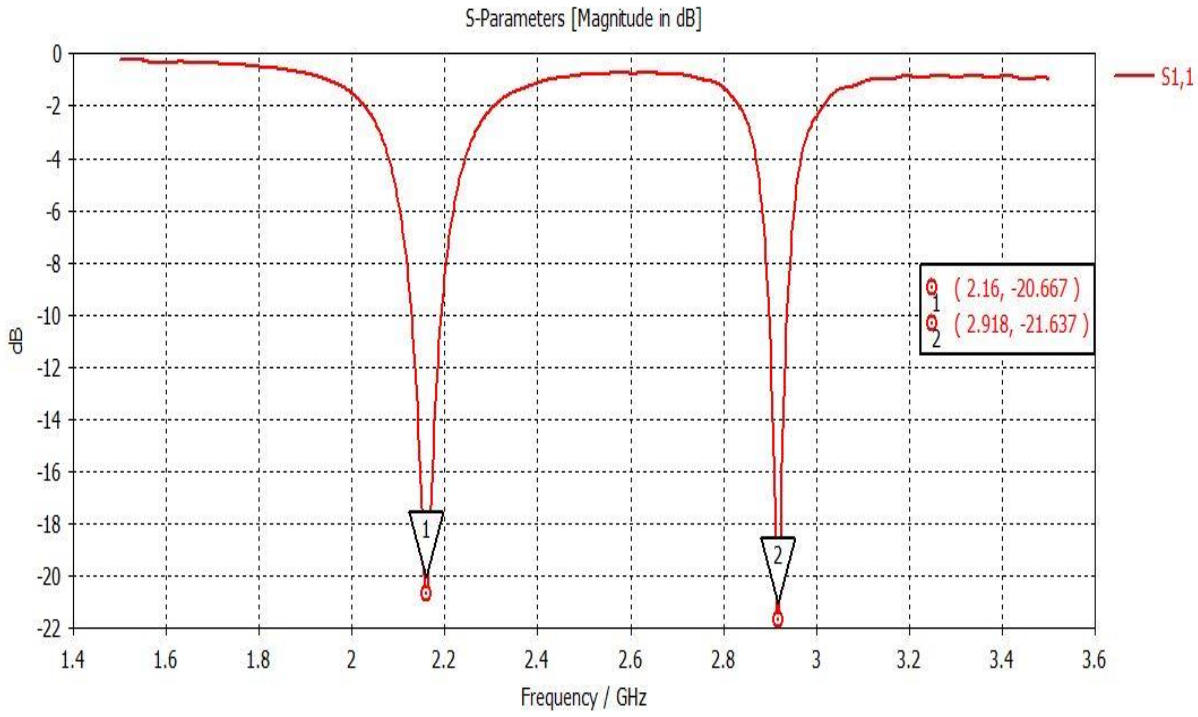

Figure 5.6: S-Parameter for this design 2

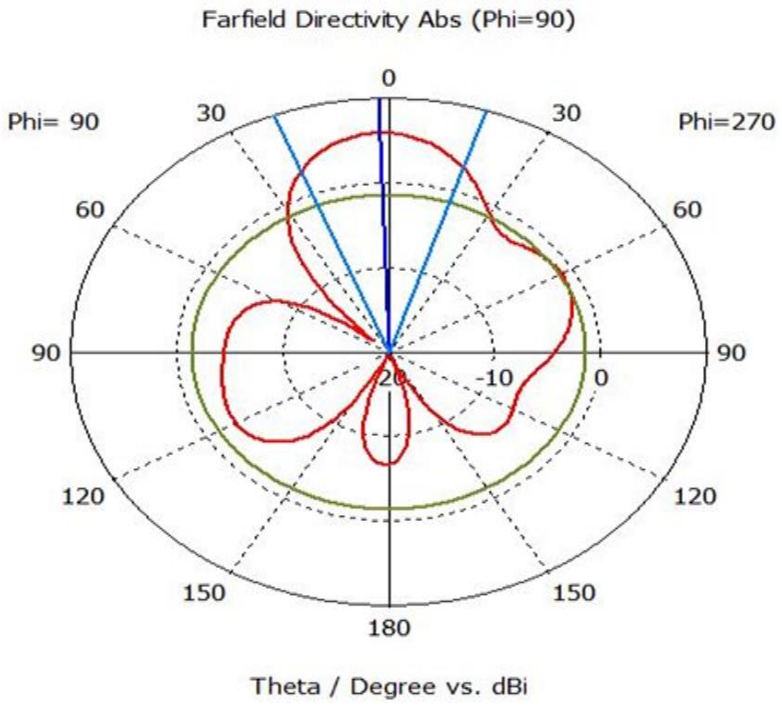

Figure 5.7: Radiation pattern for design 2

5.4 Final Design of Multi Band Multiple I-Shape Rectangular Microstrip Patch Antenna with Coaxial Feed

Parameter	Dimensions (mm)
Width (W)	72
Length (L)	45
Substrate height (h)	4
Thickness of Patch (t)	0.02
Feed location (xf)	13
Inner Radius (ri)	0.5
Outer Radius (ro)	1.5
Width of Slot 1 (A)	50
Length of Slot 1 (B)	9
Length of Slot 2 (C)	29.5
Width of Slot 2 (D)	8

Length of Slot 3 (E)	26.5
Width of slot 3 (F)	8
Width of Slot 4 (G)	40
Length of Slot 4 (H)	6

Table 3: Parameter list of multiple I-Shape microstrip patch antenna with dimension in mm

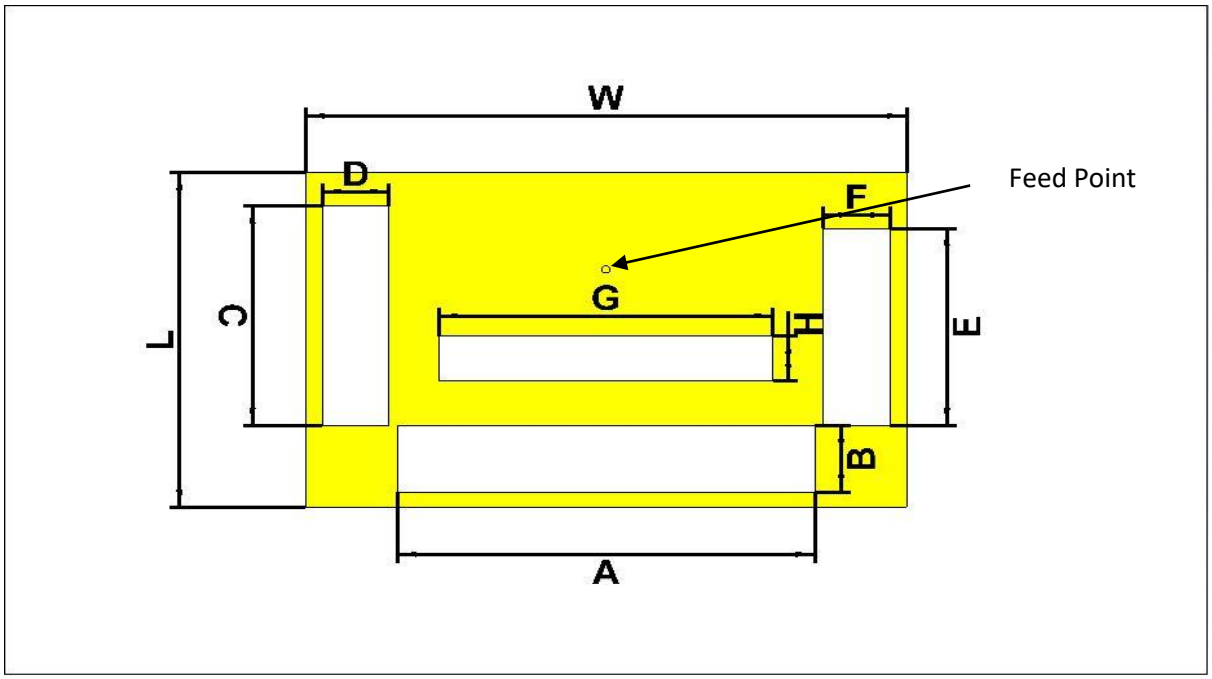

Figure 5.8: Designed structure of Multiple I-Shape microstrip patch antenna.

The design of multi band antenna has been shown in figure 5.8. The antenna was designed on an air substrate and patch slots also in air substrate having relative permittivity ϵr = 1.00059. This antenna which produce multi band of frequencies resonating at 2.8 GHz with return loss -28.133 dB, 4.2 GHz with return loss -32.045 dB and 5.6 GHz with return loss -29.854 dB.

5.4.1 S-Parameter

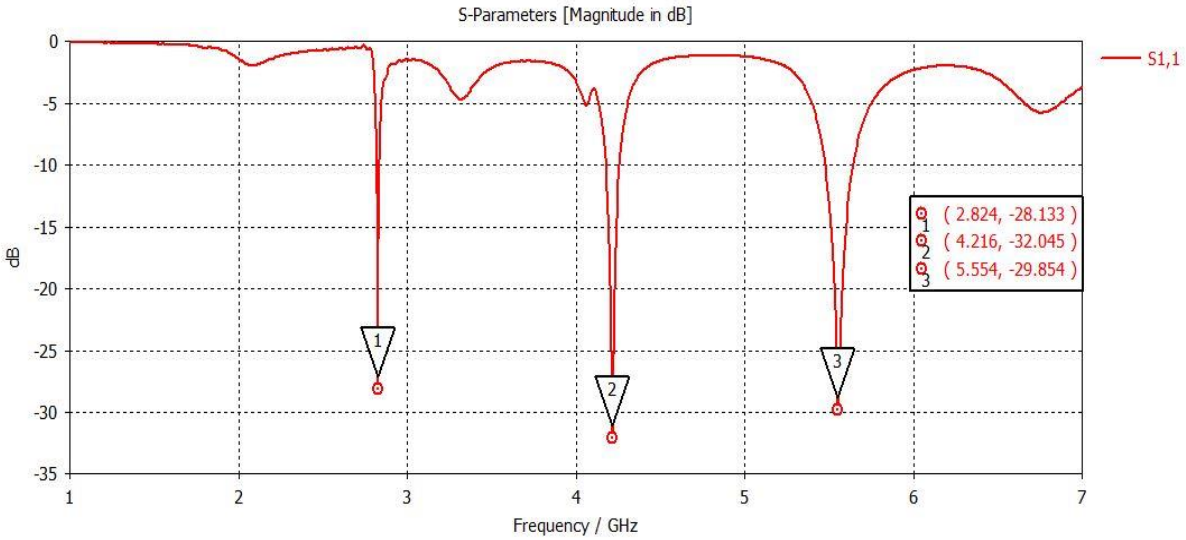

Figure 5.9: S-Parameter for final design

5.4.2 Radiation Pattern

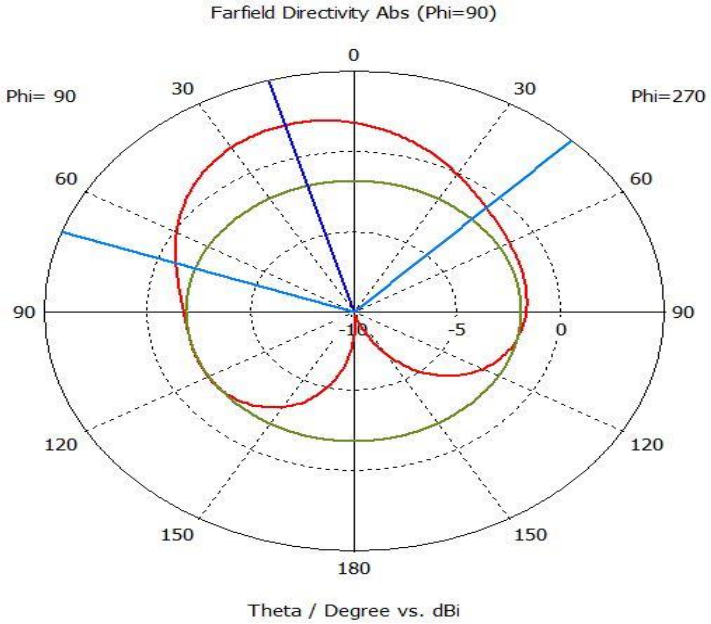

Figure 5.10(a): Radiation pattern for final design at 2.8 GHz

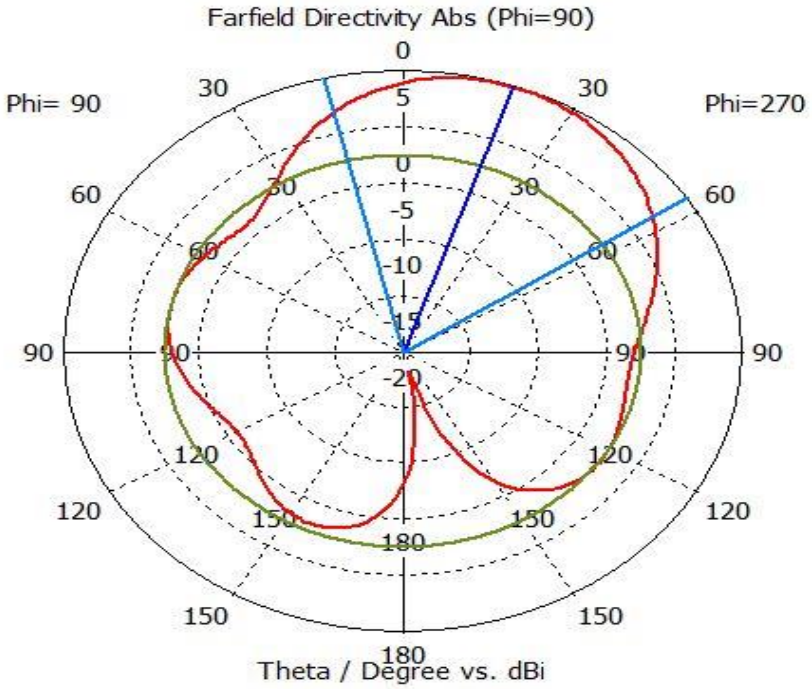

Figure 5.10(b): Radiation pattern for final design at 4.2 GHz

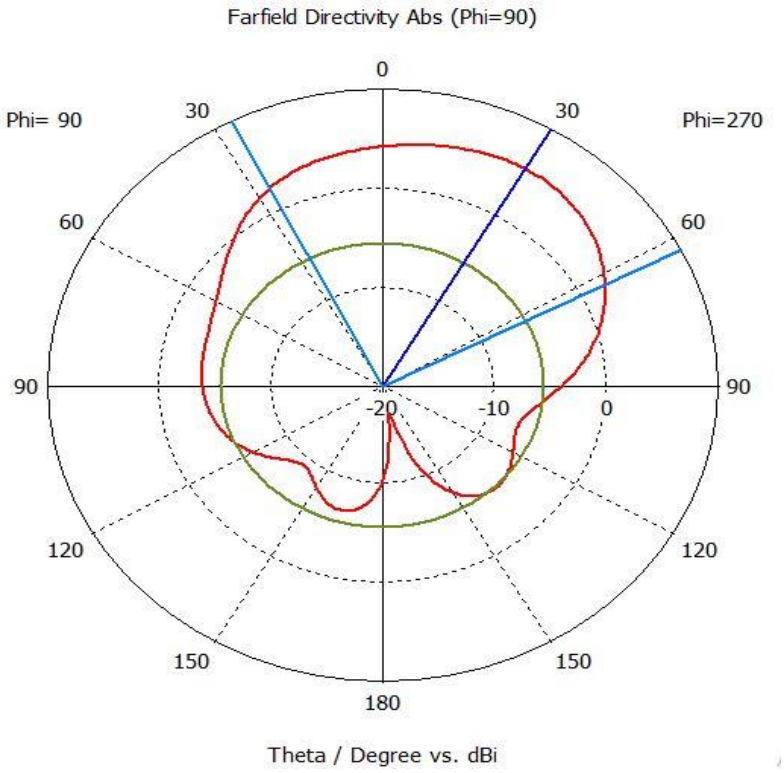

Figure 5.10(c): Radiation pattern for final design at 5.5 GHz

5.4.3 VSWR

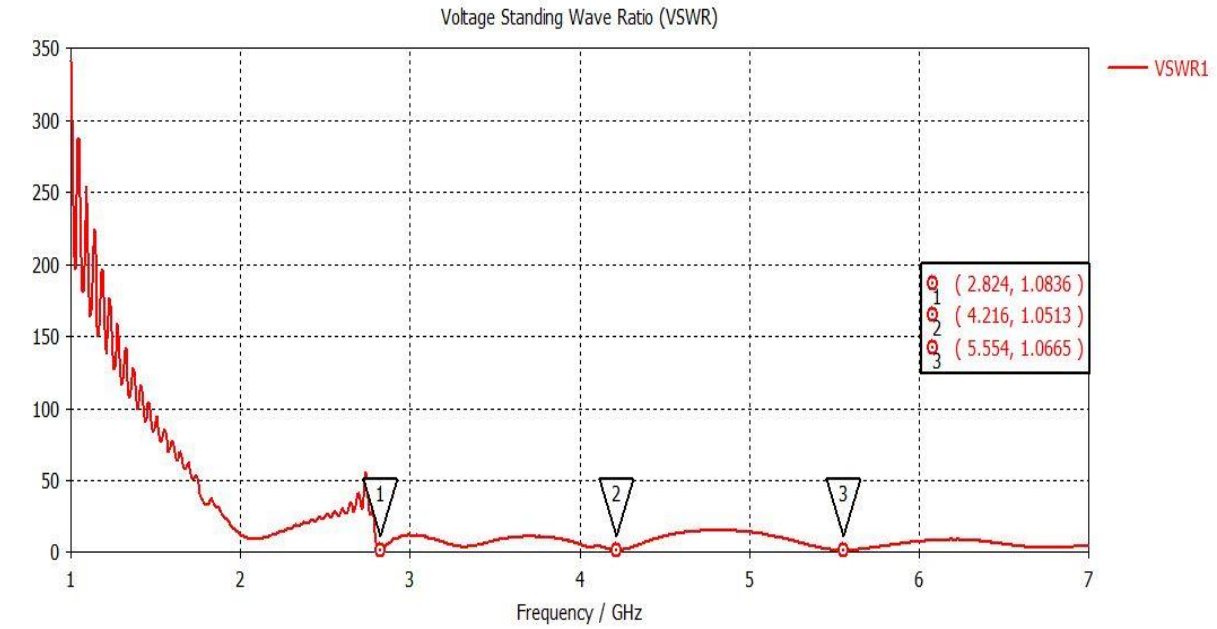

Figure 5.11: VSWR (Voltage Standing Wave Ratio)

5.4.4 Y-Parameter & Z-Parameter

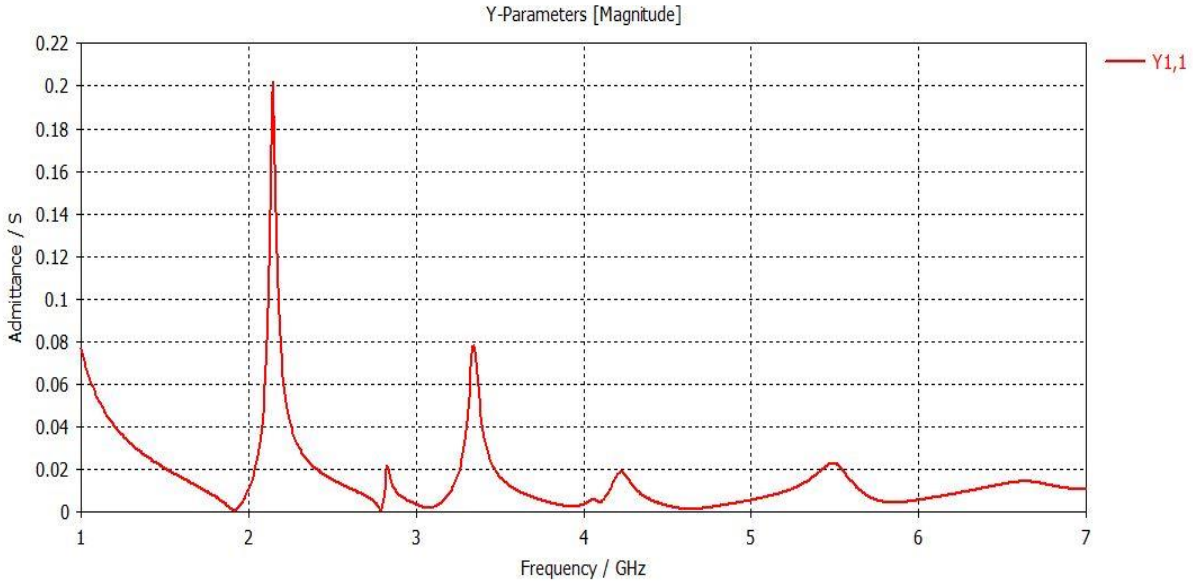

Figure 5.12(a): Y- Parameter

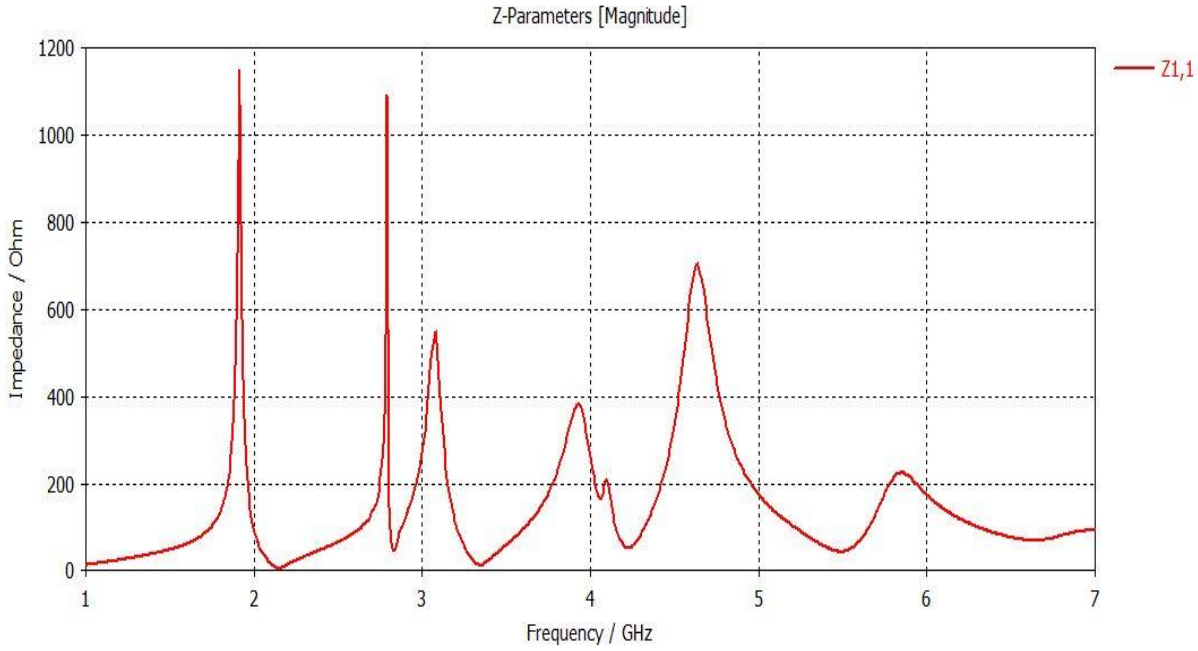

Figure 5.12(b): Z – Parameter

5.4.5 3D Plot of this Antenna Gain

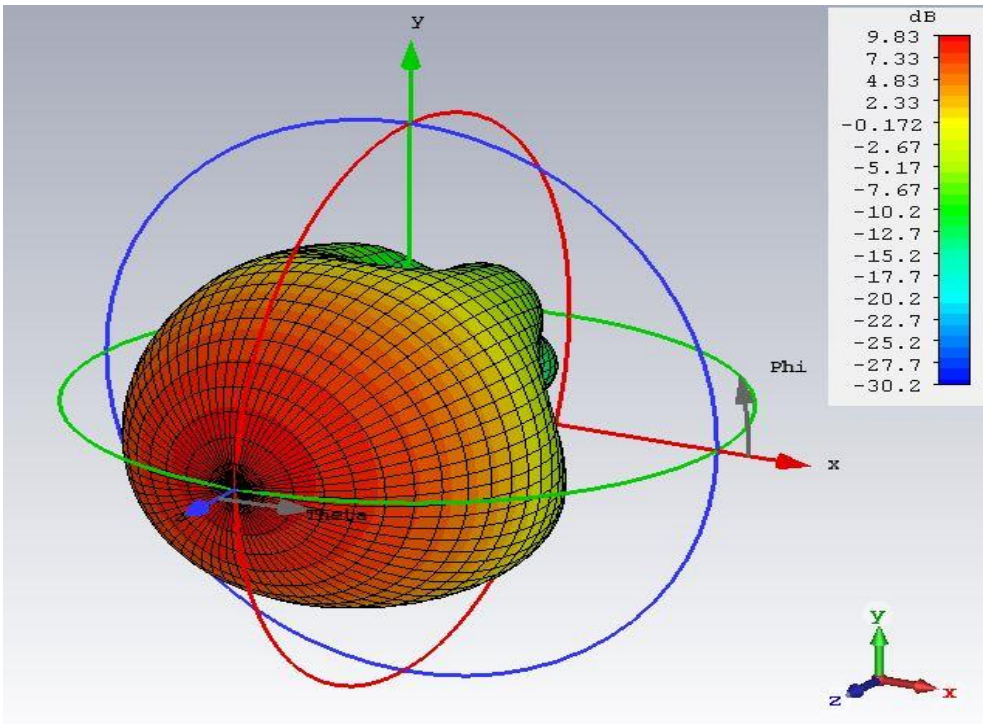

Figure 5.13(a): The Simulated 3D Pattern of the Gain at 2.8 GHz

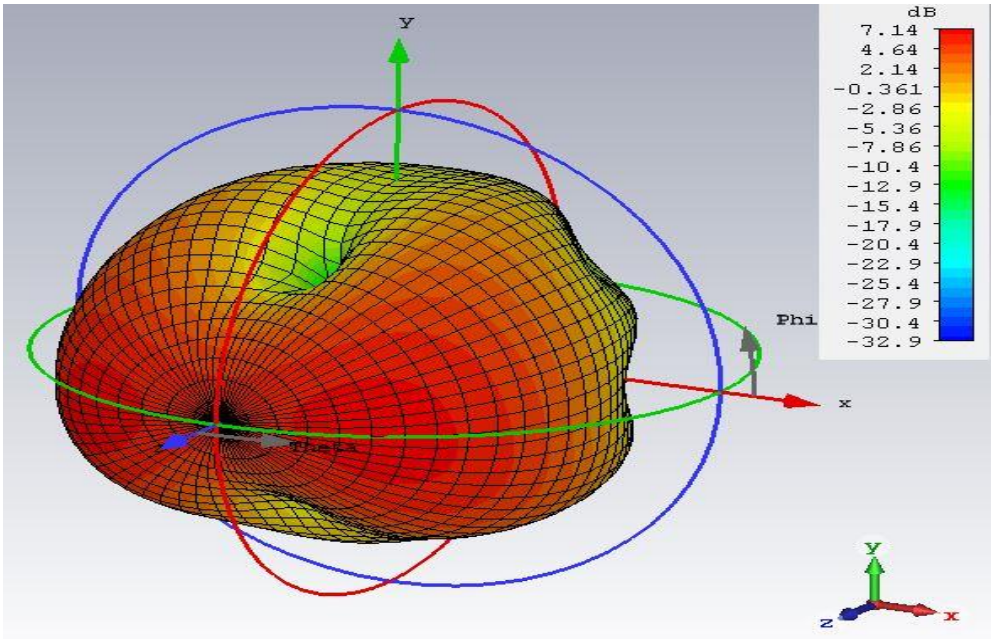

Figure 5.13(b): The Simulated 3D Pattern of the Gain at 4.2 GHz

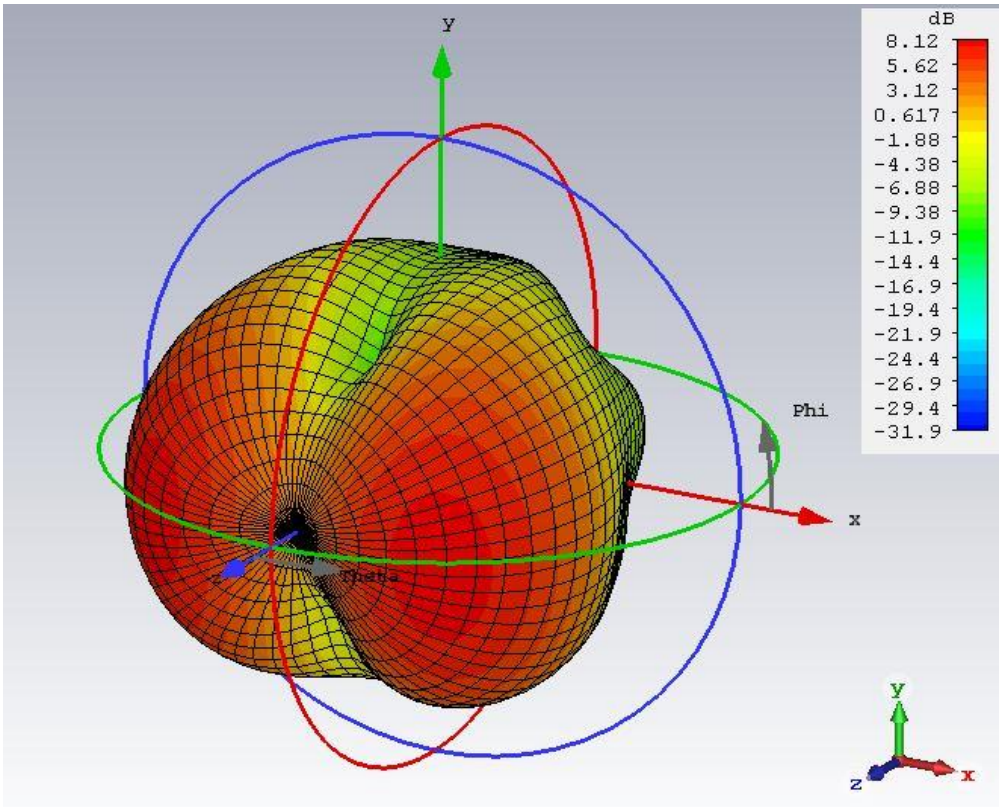

Figure 5.13(c): The Simulated 3D Pattern of the Gain at 5.6 GHz

5.5 Summary of the Chapter

In this chapter shown the designing part and simulation output. The desired S-Parameter shown in the figure 5.9. Here also shown the radiation pattern, VSWR, output gain etc.

Chapter – 6

CONCLUSIONS

6.1 Conclusion

The design of multiple I-Shape patch (Probe-Fed) antenna has been completed using CST software. The overall working was understood. The major parameters (such as Return Loss curves, Radiation Patterns, Gain and Beam width) that affect design and applications were studied and their implications understood. Multi band and multi polarization were successfully incorporated into a single patch. The effect of varying the slot length and slot width were studied under great details with the help of experimental results. Manufacturing it is very easy and fabrication cost is very low, so communication system will develop drastically.

In this study, a design and analysis of simple Probe fed microstrip patch antenna for global WLAN, Radar and some satellite communication applications has been achieved. The proposed antenna was designed to operate at 2.8 GHz, 4.2 GHz and 5.6 GHz for those applications. Good results were obtained due to proper impedance matching at the optimized feed point on the design the Voltage standing wave ratio (VSWR) is respectively 1.0836, 1.0513 and 1.0665 were obtained. It can also be noticed that acceptable broadside radiation patterns were obtained at the resonating frequency, where gain of respectively 7.14 dB, 9.83 dB and 8.12 dB where investigated for the design.

6.2 Limitations of the Work

The substrate thickness should be expanded so as to secure high gain and transmission capacity. So microstrip fix radio wires as a rule are tormented by low gain just as data transmission. By expanding the real substrate thickness produces territory wave misfortune and outer radiation. In our design we get two band frequency these are S-Band (2 – 4) GHz and C-Band (4 – 8) GHz. But we covered S-Band fully and C-Band up to 5.6 GHz.

6.3 Future Scopes of the Work

A more efficient antenna design can be developed by considering other prospects like current distribution and radiation pattern of the antenna. The investigation has been limited mostly theoretical studies and simulations due to lack of fabrication facilities. Detailed experimental studies can be taken up at a later stages to fabricate the antenna. Before going for fabrication we can optimize the parameters of antenna by using soft computing techniques known as Particle Swarm Optimization (PSO).

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