

DESIGN AND ANALYSIS OF COMPACT UWB ANTENNA

*Project report submitted in partial fulfillment of the requirements for the degree
of*

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

Abhinav Sharma (161060)

Archit Sugha (161102)

UNDER THE GUIDANCE OF

Dr. Naveen Jaglan



**JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY,
WAKNAGHAT**

May 2020

TABLE OF CONTENTS

LIST OF FIGURES.....	5
LIST OF SYMBOLS	6
ACKNOWLEDGEMENT.....	7
DECLARATION	8
ABSTRACT.....	9
CHAPTER 1 INTRODUCTION	10
1.1 Overview.....	10
1.2 Basic antenna parameters	11
1.2.1 Reflection coefficient	11
1.2.3 Impedance Matching	12
1.2.5 Bandwidth	13
1.2.6 Percentage Bandwidth	14
1.2.8 Directivity	14
1.2.8 Aperture Efficiency	15
1.2.9 Gain.....	15
1.3 Types of antennas.....	18
1.3.1 Microstrip patch antenna	18
1.3.1.1 Construction & Working of Micro strip Antennas	18
1.3.1.2 Radiation Pattern	19
1.3.1.3 Advantages.....	19
1.3.1.4 Disadvantages.....	19
1.3.1.5 Applications	19
1.3.2 Horn Antenna	19
1.3.2.1 Construction & Working of Horn Antenna	20
1.3.2.2 Radiation Pattern	22

1.3.3.3 Advantages.....	22
1.3.3.4 Disadvantages.....	22
1.3.3.5 Applications	22
CHAPTER 2 MICROSTRIP ANTENNA	23
2.1 Introduction	23
2.1.1 Advantages and Disadvantages of Patch Antennas	24
2.2 Feeding techniques of micro strip antenna.....	25
2.2.1 Co-axial feeding	25
2.2.1.1 Advantages	25
2.2.1.2 Disadvantages.....	26
2.2.2 Line Feeding.....	26
2.2.3 Aperture Coupled Feeding.....	27
2.2.4 Proximity Coupled Feed.....	28
2.3 DIFFERENT METHODS OF ANALYSIS	29
2.3.1 Transmission Line model	30
2.3. Cavity model	30
2.3.3 Full Wave Analysis	31
2.3.4 Finite Difference Time Domain.....	31
2.3 Designed Rectangular coaxial microstrip patch antenna	33
2.3.1 Tool used – High Frequency Structure Simulator (HFSS)	33
2.3.2 Layout of Rectangular coaxial microstrip patch antenna.....	33
2.3.3 Result	35
2.3.3.1 Return Loss	35
2.3.3.1 Radiation pattern	36
CHAPTER 3 UWB ANTENNA.....	37
3.1 Overview.....	37

3.1.2 UWB Characteristics	39
3.1.3 UWB Applications	39
3.1.4 Directionality of UWB antenna	40
3.1.5 How UWB Works?.....	40
3.2 Designed UWB Antenna	41
3.2. 1 Layout of UWB Antenna.....	41
3.3.3.1 Return Loss	42
3.3.3.1 Radiation pattern	43
3.3.3.2 Surface current distribution.....	44
CHAPTER-4 Compact UWB MIMO Antenna.....	46
4.1 Introduction.....	46
4.2 History	46
4.3 Standards and commercialization	47
4.5 Forms	47
4.6 Applications	48
4.7 Designed Compact UWB MIMO Antenna	49
4.8 Results.....	50
4.8.1 Return loss.....	50
4.8.2 Mutual Coupling.....	50
4.8.3 Radiation pattern	51
4.8.4 Surface Current Distribution.....	54
CHAPTER 5 CONCLUSION AND FUTURE WORK	56
REFERENCES.....	57

LIST OF FIGURES

Figure 1: Radiation Pattern[6]	17
Figure 2: Lobe Formation[7].	17
Figure 3: Microstrip Antenna [9].....	19
Figure 4: Horn Antenna[11]	20
Figure 5:Different types of horn antenna[12]	21
Figure 6: Radiation pattern of horn antenna[13]	22
Figure 7: Shape of micro strip antenna [15].....	23
Figure 8: Co-axial feeding[19]	26
Figure 9:Line feeding[20].....	27
Figure 10:Aperture feeding technique[21].....	28
Figure 11: Proximity coupled feed[22].....	29
Figure 12: Layout of Rectangular coaxial microstrip patch ante.....	34
Figure 13:Return loss	35
Figure 14:Radiation pattern	36
Figure 15: UWB Antenna [24]	37
Figure 16: Layout of UWB Antenna	41
Figure 17: Return Loss	42
Figure 18: Radiation pattern (a)3.5GHz (b)6.8GHz and (c) 9.5GHz	43
Figure 19: Surface current distribution at (a)3.5GHz and (b)6.8GHz	44
Figure 22: Return loss of UWB MIMO antenna	50
Figure 23: Mutual coupling of UWB MIMO antenna.....	51
Figure 24: Radiation pattern at f=3.5 GHz (a) 0 deg (b) 90 deg.....	52
Figure 25: Radiation pattern at f=5.5 GHz (c) 0 deg (d) 90 deg.....	53
Figure 27: Surface Current Distribution at (a) 3.5 GHz (b) 5.5 GHz (c) 6.6 GHz.....	55

LIST OF SYMBOLS

f_0	Frequency
ϵ_r	Dielectric constant
λ_0	Free space Wavelength
h	Height
ϵ_{eff}	Effective dielectric constant
ΔL	Effective Length
D	Directivity
G	Gain
W	Width of substrate
L	Length of substrate
F_1	Length of feed line
r	Radius of patch

ACKNOWLEDGEMENT

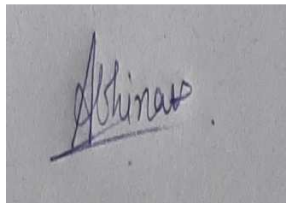
We would like to thank Prof. Dr. M.J. Nigam of Dept. Electronics and Communication, for providing us the opportunity of working on a project.

We are highly indebted to Dr. Naveen Jaglan and Ms. Ekta Thakur for motivating and enlightening us for our project work. We thank you for being a constant support throughout, without whose valuable guidance and insights, this project would not be a complete one. We offer you our sincere gratitude to you for instructing and directing us through thick and thin.

We would also like to acknowledge Mr. Mohan Sharma and Mr. Ajay Singh for helping us in the labs. Thank you for being there and helping us in and out.

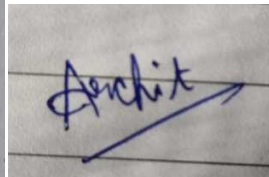
DECLARATION

We hereby declare that the work reported in the B.Tech Project Report entitled **“Design and analysis of compact UWB antenna”** submitted at **Jaypee University of Information Technology, Wagnaghat, India** is an authentic record of our work carried out under the supervision of **Dr. Naveen Jaglan** . We have not submitted this work elsewhere for any other degree or diploma.



ABHINAV SHARMA

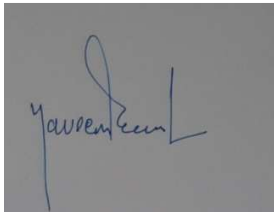
161060



ARCHIT SUGHA

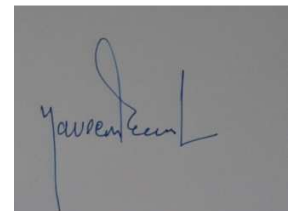
161102

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.



Dr. Naveen Jaglan

Date:23th May 2019



Head of the Department/ Project Coordinator

ABSTRACT

In time where everything is getting simplified where the radio spectrum is finite, but wireless communication is increasing rapidly so therefore there is need for the new technology that can open new pathway for the wireless communication. Ultra wideband (UWB) could be possible solution for this problem.

Basically UWB technology is based upon the use of the narrow pulse in the order of the nanoseconds, which cover a very wide bandwidth in the frequency domain .The primary objective to learn UWB antenna to get a plus point over the other antenna. Before working on UWB technology we have designed microstrip antenna at 2.4 GHz which is often used in the Bluetooth application.

CHAPTER 1 INTRODUCTION

1.1 Overview

An antenna is essentially a radio building, where Antenna act as the boundary between radio waves engendering through the house & electrical flows occupation metal conducts utilize with a sender or beneficiary. In sending of the sender gives an electrical flow to the receiving wire's sending area and the thusly the receiving space transmits the strength from this like a attractive power rushes of radio wire. In gathering of the Antenna blocks some of the office of the radio outflow in order to give the electrical movement at its edges, that is applied to a collector is increased. Reception apparatuses are fundamental components of every radiowave instrumentation.

Antenna assume significant job in the branch of remote interchanges. Some of them are Dipole antennas, Horn Antennas, Patch Antenna [1]. Every radio wire is acceptable in their own functions. It can be said that reception apparatuses are used nearly everywhere [2].

An antenna is the collection of conductors, electrically aligned with the sender or receiver. Receiving instruments are regularly proposed to send and get the waves out and out even headings similarly or specially an exceedingly explicit way essentially they could be grasp not associated with the transmitter, and illustrative reflectors or parasitic parts, that provide to guide waves into the light emission radiation design [3]

1.2 Basic antenna parameters

The basic parameters are examined here provides us with the basic knowledge about the concept of antennas . The remote correspondence is executes in form of waves.

Here are some basic parameters –

- Reflection coefficient
- Impedance matching
- Principal Patterns
- VSWR & reflected power
- Bandwidth
- Percentage bandwidth
- Radiation intensity
- Directivity
- Aperture Efficiency
- Gain
- Radiation Pattern

1.2.1 Reflection coefficient

It is the measure of intensity that is reflected because of well the coordinating between the transmitter and radio wire has occurred. The reflection coefficient is described as :

$$|\Gamma| = \frac{V_0}{V_{in}} = \frac{Z_L - Z_0}{Z_L + Z_0} \square$$

$|\Gamma|$ = Magnitude of reflection coefficient, V_0 = Reflected voltage, V_{in} = Incident voltage, Z_L and Z_0 are the load and characteristic impedance[4]

1.2.2 Principal Patterns

For a directly captivated antenna, implementation is often portrayed as its key E-and H-plane examples. The E-plane is describes the plane containing the electric field vector and the H-plane describes the plane containing the attractive field vector and the banner of highest radiation".

1.2.3 Impedance Matching

As indicated by the quality definition, the rough cost of electric opposition of a transmitter, when rises to the surmised cost of the electric obstruction of a collector or the reverse way around, it's named as electric opposition coordinating.

Impedance coordinating is basic between the reception apparatus and furthermore the electronic gear. The electrical opposition of the recieving wire, the conveyor, and furthermore the electronic hardware should coordinate so most force move happens between the radio wire and furthermore the collector or the receiver.

Requirement of Matching:-

Full gadget is something, which supplies higher yield in a sure thin area of frequencies. Reception apparatuses can be unit such full gadgets whom are electrical obstruction whenever coordinated, conveys a much better yield.

The force transmitted by a reception apparatus, will be adequately emanated, if the recieving wire impedance coordinates .

In a beneficiary radio wire, reception apparatus' yield impedance must agree along with information impedance of the receiver speaker circuitary. For a sender recieving wire, radio wire's information impedance should coordinate with transmitter intensifier's yield impedance, alongside the line's impedance. The unit of impedance is Ohms.

1.2.4 VSWR & Reflected Power

As per quality meaning, quantitative connection of the most voltage to the base voltage in a very undulation is comprehended as voltage undulation quantitative connection. The return loss is determined utilizing :

$$RL = -20 \log(\Gamma)$$

In the event that the electric opposition of the receiving wire, the channel and furthermore the electronic hardware don't coordinate with each other, at that point the office won't be emanated successfully. Rather, some of the office is reflected back.

The main specifications are –

- VSWR represents Voltage Standing Wave Ratio.
- The higher value denotes higher estimation of VSWR
- Perfect estimation of VSWR ought to be 1:1 for the best result
- Reflected force is force squandered from the front force. Reflected energy and VSWR demonstrate something very similar.

1.2.5 Bandwidth

A area of frequencies in a frequency range, indicated to a specific correspondence, is said to be as data transfer capacity. The sign once is transmitted or gotten, and done over an assortment of frequencies. Data transfer capacity is the difference between the higher and lower frequencies over which a sign is transmitted.

The transmission capacity is assigned only one time, can't be used by someone else. The entire range can be separated into transmission capacities to apportion to various sending units . The data transfer capacity, can also be called as Absolute Bandwidth.

1.2.6 Percentage Bandwidth

The proportion of absolute data sending to the middle recurrence of that transfer speed is referred as rate transfer speed. The specific recurrence inside a waveband at that the sign quality is most is named as resounding recurrence. It's moreover alluded to as focus recurrence (f_c) of the band. The higher and lower are meant as f_H and f_L individually.

Supreme transmission capacity is $f_H - f_L$.

More extensive data transfer capacity is, partial transmission capacity or rate data transfer capacity must be determined. The Percentage data transfer capacity is determined to know how much recurrence variety either a part or a framework can deal with.

$$\text{Rate Bandwidth} = ((f_H - f_L))/f_c \times 100$$

The higher the rate data transfer capacity, the more extensive will be the sending capacity of the channel.

1.2.7 Radiation Intensity

It is characterized as the force per unit strong edge. Radiation sent from radio wire that is a great deal of exceptional an unmistakable way, shows the most extreme power of that reception apparatus. The discharge of radiation to a most potential degree is nothing anyway the radiation force. It is acquired by duplicating the force transmitted with the square of the spiral separation.

1.2.8 Directivity

The proportion of most extreme radiation force of the matter radio wire to the radiation force of a receiving wire, emanating a similar all out force is called as the directivity. It transmits power, however the heading wherein it emanates

matters a lot. The receiving wire, whose presentation is being watched, is named as subject reception apparatus. Its radiation force is gathered an extremely unequivocal way though it's transmission or getting. Consequently, the receiving wire is asserted to possess its outspread asymmetry there unequivocal way The, is named as directivity. If that specific heading hasn't determined, at that point the course where most extreme force is watched, can be taken as the directivity of that radio wire.

The share of the radiation valor in a path to the radiation force found the center value. Scientifically directivity can be communicated as

$$D = U/U_0 = 4\pi U/P_{\text{rad}}$$

The directivity is given as:

$$D_{\text{max}} = U_{\text{max}}/U_0 = (4\pi U_{\text{max}})/P_{\text{rad}}$$

D = Directivity (dimensionless)

1.2.8 Aperture Efficiency

It, is the proportion of the viable emanating zone (or compelling region) to the corporal territory gap.

An antenna features a gap through that capacity is sent. This radiation must be viable along with the least misfortunes. The corporeal space of the gap should be taken into thought, in verity that the adequacy of the radiation relies on the universe of the gap, truly on the reception apparatus

1.2.9 Gain

Addition of it is the fraction of the radiation force in a assistance to the radiation might that is acquired if the force concede by the radio wire were sent .

Directivity D it is alluded as Power Gain.

$$\text{Force Gain} = E_{\text{antenna.D}}$$

The addition of a radio wire is characterized as the part of the bulk, in a assistance to the radiation bulk that outputs if the bulk took care of to the receiving wire were sent.

$$\text{Gain} = (\text{radiation intensity}) / (\text{all out information power}) = (4\pi r U) / P_{\text{in}}$$

The radiation force comparing to the sent transmitted force is so called as force from the generator, to the radio wire partitioned by 4π .

1.2.10 Radiation pattern

Graphical record results in the capacity given by a reception apparatus as a work bearing long away from the receiving wire. This bulk variety as a work of the appearance edge is resolved inside the antenna's way field. The radiation example can be vigor designs. The field designs are plotted as a module of electric and striking fields, plotted on log scale. The force designs are plot as a component of square of the extent of electric and attractive fields. The rays design is a 3-D figure and strut to in round tips (r, θ, Φ) expecting its cause at the focal point of circular arrange system[5]

2D RADIATION PATTERN

Two-dimensional example is acquired from 3-D by breaking it into even and vertical planes. These ensuing samples region unit alluded to as Horizontal example and Vertical example severally.

LOBE FORMATION

In the delineation of example, we routinely happen upon totally various shapes, that demonstrate the first and minor rays zones, by that the emission intensity of the radio wire is thought. Here, the waves design has principle projection, side flaps and flipside projection.

- The significant piece of emanated turf which captures a bigger zone, is fundamental projection & significant flap. Here, greatest emanated vitality is found. The bearing of the flap displays the directivity.

- Different pieces of example where the rays is appropriated one side are known as side flips or trivial projections. The vigor is squandered here.
- The other flip, inverse to bearing of primary projection. It is known as sponsor flip, which is additionally a negligible protrusion A lot of vitality is squandered

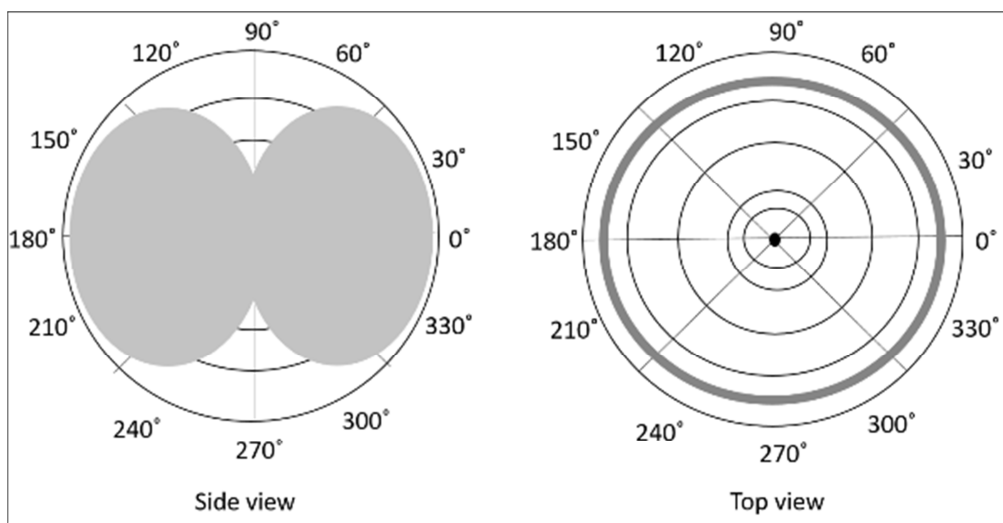


Figure 1: Radiation Pattern[6]

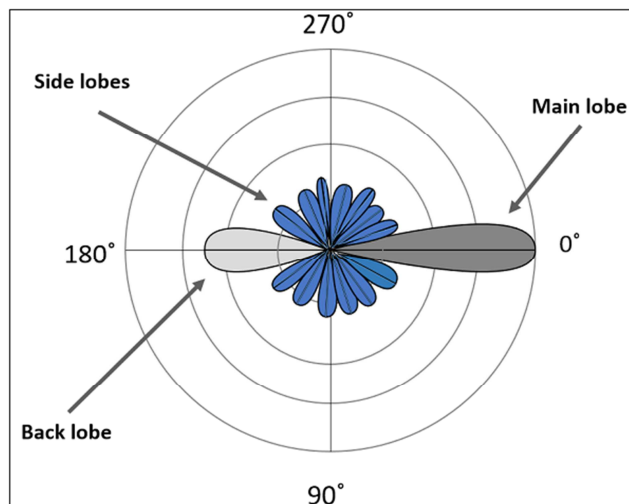


Figure 2: Lobe Formation[7].

1.3 Types of antennas

1.3.1 Microstrip patch antenna

Smaller scale strip radio wires square measure low-profile receiving wires [8]. A metal fix is fixed at a floor level with a dielectric stuff transitional establishes a little strip antenna. These square measure awfully squat extent receiving wires having low rays. The fix radio wires are utilized at frequencies on top of 100MHz.

1.3.1.1 Structure of Micro strip Antennas

Smaller scale sliver reception apparatus comprises of an extremely lean aluminiferous slip put on a opinion flat surface with a dielectric material moderate. The untying part square measure is the strategy for photograph drawing on the dielectric material . As a rule, the fix or smaller scale shred is picked to be tetragon, roundabout or box in structure for the lodging of study and invent ensuing picture.

The span of the metal fix is $\lambda/2$. At point when the reception apparatus is energized, the waves created inside the dielectric experience reflection and the vitality emanated from the limits of the metal fix, which is extremely low.

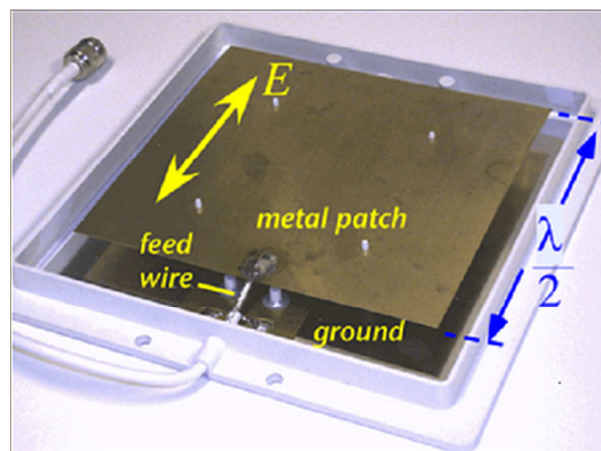


Figure 3: Microstrip Antenna [9]

1.3.1.2 Radiation Pattern

The rays example of micro strip & fix radio wire is wide, comprises of low emission force & tight recurrence data transmission and has less significant directivity. For noteworthy directivity, an exhibit is shaped by utilizing these fixed antennas.

1.3.1.3 Advantages

- Less weight
- Cheap
- Easily Installed

1.3.1.4 Disadvantages

- Poor radiation
- Narrow frequency bandwidth

1.3.1.5 Applications

- Space craft
- Radar

1.3.2 Horn Antenna

Vitality of the shaft when gradually change into rays, the misfortunes are diminished & the centering of the pole gets better. It might be well thought-out as a blurred out beckon run by which the directivity is superior & the bending is decreased. The beyond picture shows a horn recieving wire. There are a few horn arrangements out of which, three setups are most normally utilized.

1.3.2.1 Construction & Working of Horn Antenna

To pick up the heat intensity & spiral asymmetry of the shaft, the beckon direct be supposed to be given stretched out opening to make the unexpected partition of the wave into a progressive change. In a specific order all the vitality inside the forward heading gets transmitted. This might be named as Flaring. Presently, this power be finished use a horn reception apparatus. The equipped repetition scope of a horn reception apparatus is around 300MHz to 30GHz[10].

The vitality of the shaft when gradually change into rays, misfortunes are decreased & the centering of the level better. It might be painstaking as a blurred out wave manage, whose directivity is superior and the bending is diminished. The on top of picture shows the sculpt of a horn radio wire. There are a few horn arrangements out of which, three setups are most normally utilized.

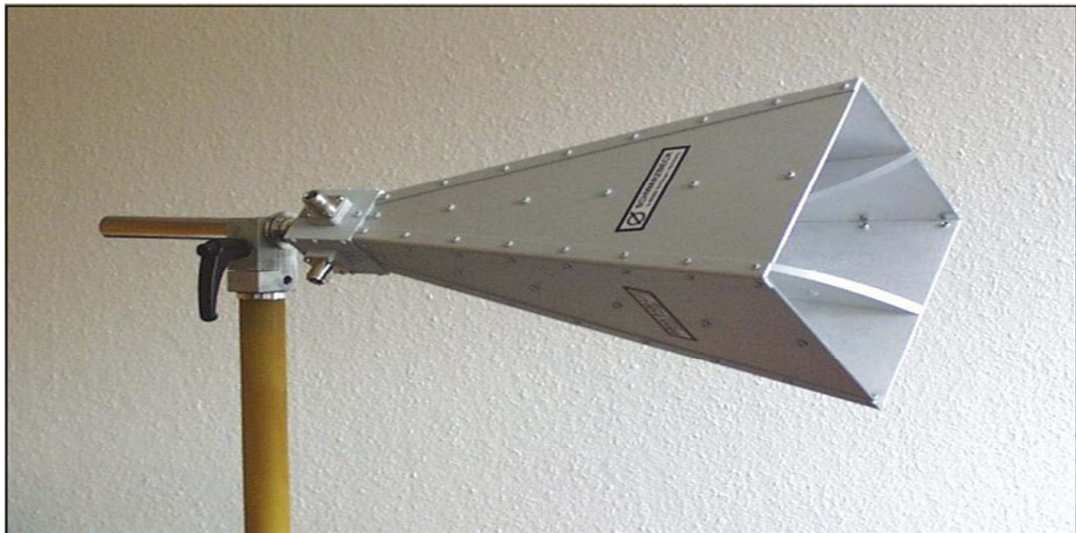


Figure 4: Horn Antenna[11]

SECTORAL HORN

This sort of horn reception apparatus, booms out in just a solo itinerary. Flaring in the direction of Electric vector deliver the parted E-plane horn. Likewise, repeating towards Magnetic vector, achieves the pectoral H-plane horn.

PYRAMIDICAL HORN

Here horn receiving wire has flaring on the two sides. On off chance that it is done on both the E and H divider of a box waveguide, at that point horn receiving wire is received. This radio wire acquires status of a shortened triangle

CONICAL HORN

Here graphical record could be a globular beckon frontage. The wave transmits from gap, limiting the optical wonder of impression. The flaring uses the bar centered. The transmitted bar has towering directionality.

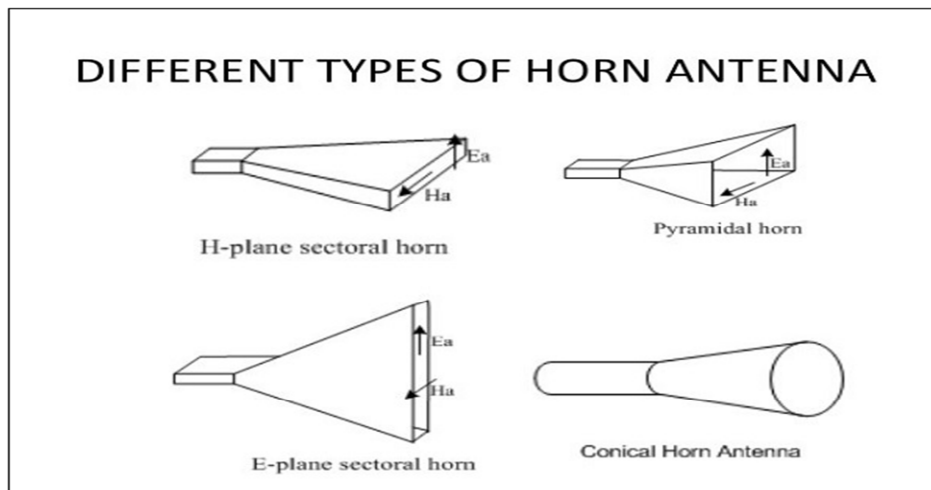


Figure 5: Different types of horn antenna [12]

At the point when the breakers of a roughly wave direct are blurred, it is branded as a funnel twisted horn. This is a consistent conclusion of a roughly wave direct.

1.3.2.2 Radiation Pattern

Graphical record of a radio wire could be a Spherical beckon obverse The wave transmits from the gap, limiting the optical wonder of impression. The blurring keeps the bar centered & transmitted bar has sky-scraping directionality.

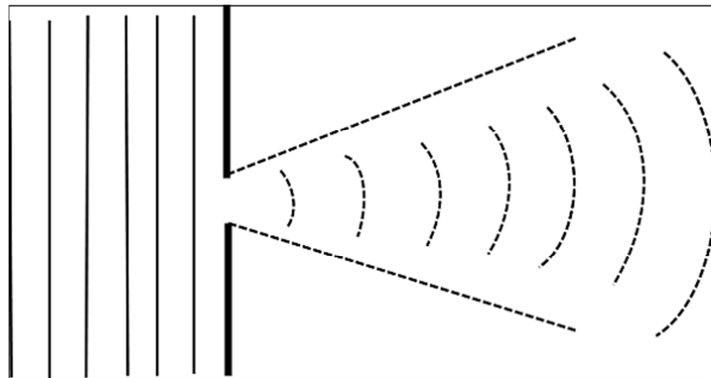


Figure 6: Radiation pattern of horn antenna[13]

1.3.3.3 Advantages

- Negligible lobes formation
- Perfect matching
- Superior directivity
- Narrow grin measurement
- Standing effect is shuned

1.3.3.4 Disadvantages

- Delievers less directivity
- Angles should not be too small

1.3.3.5 Applications

- Used for exorbitant study
- Used in microwave uses

CHAPTER 2 MICROSTRIP ANTENNA

2.1 Introduction

In a the majority indispensable structure a microstrip receiving line includes two meager tinny part one ascending patch and second as position level surface and a substrate pressed between them. The sender fix set on the material and utilized in form of emanating component. Opposite side of the matter there is a conductive deposit utilized as floor flat. Copper and gold is utilized habitually as the layer. Basic shapes are utilized to structure a fix since patch indispensable shape are anything but difficult in investigation by the accessible hypothetical model & anything but complicated to foresee the staging. Tetragon, curved, round are some fundamental shapes[14]

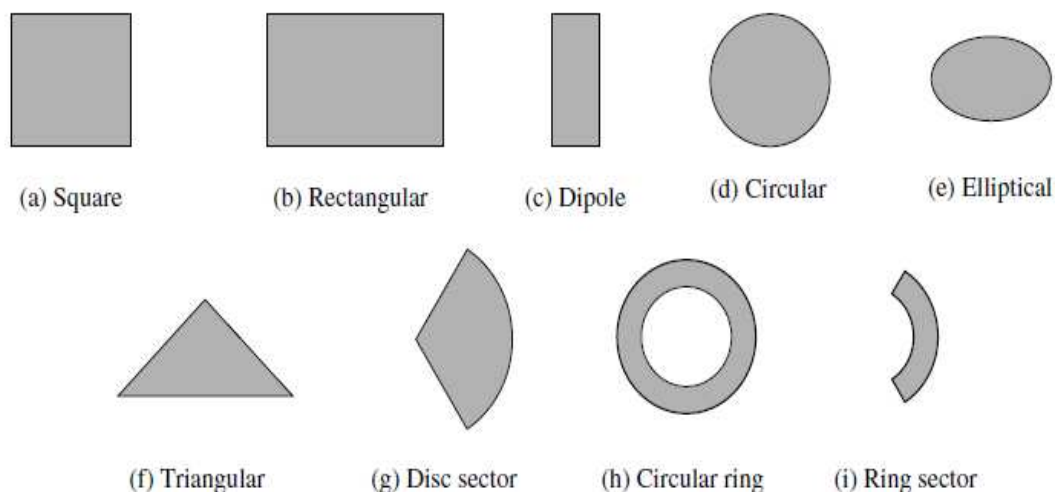


Figure 7: Shape of micro strip antenna [15]

Roundabout, box shaped and dipole are repeatedly utilize shapes for exploration and manufacture. The stature of substrate assumes a momentous job in treatment machinery behavior by and large Microstrip radio wire experiences restricted recurrence data transmission. Anyway some application where limited transfer speed is indispensable, frameworks, they are valuable. Data transmission of microstrip reception apparatus is uncomplicatedly next of kin to stature of substrate. Principle methods two improve the transmission aptitude; one circuit

assumption and subsequent back up. A receiving wire trademark relying upto the radio wire constituent be impacted by the line and response tackle blend. By and large the info damage of microstrip reception apparatus can be unpredictable & trademark obstruction of the line .

This bring on the subject of obstruction perplexing and cause a bad design on transmission line brings about squat obstruction transfer speed. Loom to hammer this concern is exploitation coordinating 12 system in the midst of receiving wire and line. [16].

2.1.1 Advantages and Disadvantages of Patch Antennas

Microstrip fix receiving wires are growing in prominence for exercise in far-flung application because of their spot of protection configuration A portion of their chief favorable circumstances are given underneath :

- Less burden and volume.
- Low shape setup that is used be handily ended to have surface.
- Cheap, can be untrue in enormous volume.
- Ropes unswerving just as encircling polarization.
- Successfully coordinated microwave incorporated circuits
- Competent of multiple reappearance activities
- Involuntarily strong

They fix receiving wires practice the poorly possessions of a range of burdens when used with established reception apparatuses. A portion of noteworthy stuff are given beneath:

- Slender data shift competence
- Stumpy usefulness
- Squat Gain

- Irrelevant emission from feeds
- Meager conclusion blaze stove aside from tightened space receiving wires
- Low power dealing with limit.

2.2 Feeding techniques of micro strip antenna

The four most famous taking care of strategies utilized in the microstrip fix radio wire are co-pivotal feed and line feed , gap coupled feed and backhanded coupling taking care of which are clarified below[17]:-

2.2.1 Co-axial feeding

The co-hub feed is one of the nearly all broadly renowned measures put into action for taking care of microstrip reception apparatuses. From the time when appeared in the beneath figure the internal conduits off the co-pivotal connector reach out through dielectric in center and is secured waves fix and the side-line channel is associated with the most summary position flat. The a good number momentous preferred position of the co-hub taking care of plan is that the taking care of can be set anyplace in the transmitting space so as to get hold of the obstruction coordinate of the reception apparatus.

This taking care of strategy is generally simple to be manufactured and has the low fake radiation impacts. Indeed, even this taking care of methods has hindrances restrictes facts communication & rigid to be sculpt given that the notch is to be uninterested into the material radio wire. For the big matter ,the delayed tests extent makes the obstruction increasingly broad ,bringing up many issues .The utilization of solid substrate increment the diffusion capacity of the micro strip fix radio wire .Same as line taking care of the co-hub taking care of methods experiences the misleading feed and the radiation coordinating problem[18].

2.2.1.1 Advantages

- Trouble-free engineering

- Straightforward to counterpart radiation pattern
- Squat forged radiations

2.2.1.2 Disadvantages

- Difficult to model because of the solid material
- Acquire the natural deforms that engender elevated sort.

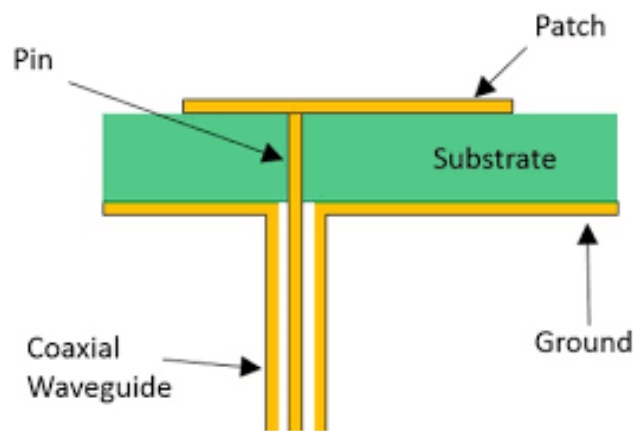


Figure 8: Co-axial feeding[19]

2.2.2 Line Feeding

In this taking care of manner, a directing ribbon is allied with the to the periphery of the microstrip join receiving wire as observed in beneath graph. The directing piece of the reception apparatus is narrow in distance across when referred with the glue of the radio wire. This sort of taking care of itinerary of accomplishment has the favorable taking care of can be dented on a analogous material to bestow a smooth constitution of the receiving wire. The score can be consolidate into secure so as to get your hands on the great loss coordinate lacking condition for any added coordinating gears. This is proficient by appropriately calculating the inset point of the radio wire.

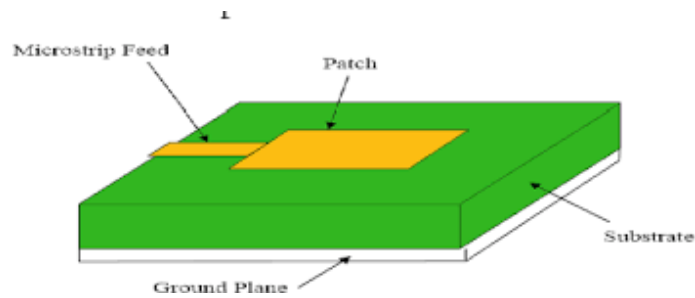


Figure 9:Line feeding[20]

2.2.3 Aperture Coupled Feeding

Line taking care of is a simple taking care of method when contrasted with other taking care of strategies, given that it uses the straightforwardness of create and straightforwardness in signifying. Be that as it may, the girth of the dielectric matter increments and facade influence and deceptive feed energy in addition builds which destroys the data transfer competence of the microstrip treatment kit. This brand of the taking care of strategy brings about unwanted cross polarization impacts in the microstrip receiving wire [9].

In the opening coupling taking care of as appeared in the figure the emanate microstrip fix module is engraved on the peak point of the microstrip data lines line substrate and the microstrip feed line is dented on the support of the feed substrate in the request to dig up the gap mixture of treatment kit. The depth and fixes of these two things of the radio wire may in this way be selected without restraint to increase the unmistakable the fundamentals of waves and hardware of the response gear.

The coupling notch is generally focused underneath the stick of the response gear, prompt poorer output as of sameness. The quantify of the output from the nourish streak to the fix is defined by the silhouette and volume and vicinity of the channel. Seeing as the position seaplane cut off the stick of the receiving wire and the feed line false radiation partial.

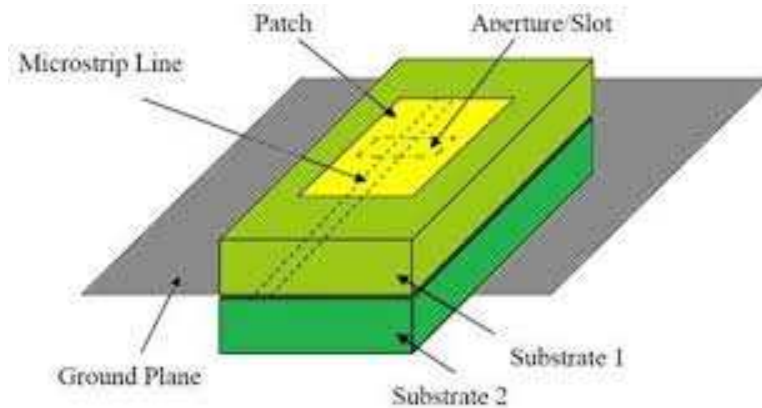


Figure 10:Aperture feeding technique[21]

The opening coupled taking care of a material is made to work for the pedestal and a bulky and the squat dependable stuff is put into action for top materials to rationalize the energy from the glue of broadcasting rope. This kind of taking care of method can give the extremely high data transmission of about 21% of the radiation design. The shock of false rays is not as much of when differenced through additional taking care of methods [10] . The hassle of this method is that it is rigid to assemble since of an assortment of layer, which equally expand the response gear thickness and increment the misfortunes.

2.2.4 Proximity Coupled Feed

Here taking care of method which is the same call as the electromagnetic combination sketch. Method is appear in the beneath outline we can see that the two substances are applied with the conclusion aim that the nosh procession of reception apparatuses is sandwiched between the two and the emanating piece is resting on the highest point of the upper zone. The principle preferred position of the propinquity provide for method is with the intention of it dispense with the fake feed radiation design and the gives high data transfer capacity for the reason that of the expansion in the electrical depth of the micro strip fix radio wire. This arrangement in addition give the result among two typical dielectric medium of the radio wire, solitary on behalf of join and individual for nosh streak to advance the entity exhibitions reaction tools.

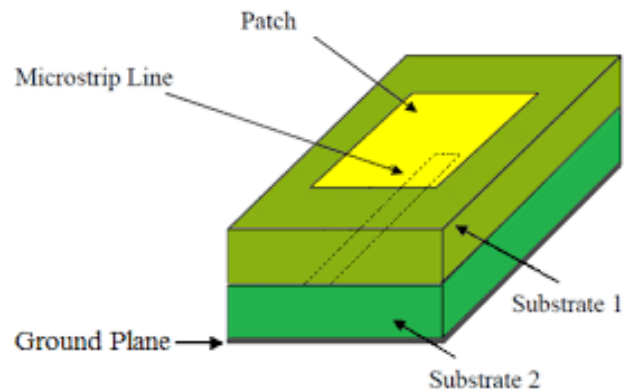


Figure 11: Proximity coupled feed[22]

2.3 DIFFERENT METHODS OF ANALYSIS

- Transmission Line model
- Cavity Model
- Full Wave Analysis
- Finite Difference Time Domain Model

The most mainstream kit on behalf of the inspection of Microstrip fix receiving wires are the broadcast procession sculpt, pit mold, and full beckon replica. The spread column model is the smallest amount multifaceted of all and it give enormous corporal considerate even if it is a smaller amount clear-cut. The hollow representation is increasingly exact and gives great physical understanding yet is wits boggling in nature. The jam-packed gesture model are incredibly precise, flexible and can pleasure lone mechanism, imperfect with nonstop cluster, stack gears, subjective mold works and blend.

2.3.1 Transmission Line model

This replica speak to the microstrip greeting apparatus by two places of distance across W and stature h , inaccessible by a show row of extent L . It is on the whole a nonhomogeneous procession of two , generally the substrate and air.

A large portion of the exciting ground position dwell in the matter and parts of certain outline in space. Therefore, this spread line can't encourage unadulterated slanting electric-attractive (TEM) method of transmission, since the stage speeds would be diverse conspicuous every single one roughly and the substrate. To a certain extent, the principal scheme of engendering can be the partially TEM mode, accordingly, a practicable steady should be acquired thus seeing that to signify the adjoining and the beckon proliferation in the streak.

2.3. Cavity model

In spite of the information the diffusion column copy talk on the subject of in the earlier period sector but thorny to employ, have several built-in weakness. In meticulous, it is ready to lend a hand for patch of preparation and it sees ground assortment next to the derive ends. These inconveniences overwhelmed by make the most of the hole model. The surrounded by locale of the material is confirmed as a crater partial by exciting separator on the apex and pedestal. The motive for this supposition is the complementary perception for slender parts.

- In view of the fact that the it is slim, the turf contained by borough don't shift much.
- The exciting turf is z coordinated just, & attractive turf has just the oblique parts H_x & H_y borough imperfect by the fix. This acuity have room for the stimulating dividers at the summit and the pedestal.

2.3.3 Full Wave Analysis

Complete signal strategy have gotten expanding consideration because of their meticulousness and higher precision. This depends on Sommerfeld type essential condition and arrangement of Maxwell condition in time space. Unmistakable numerical techniques remember fundamental condition examination for otherworldly area, basic condition investigation in space and the limited distinction time area (FDTD) approach [44]. The strategies dependent on essential condition make one significant presumption: The pact is thusly increasingly precise when they are a few frequency long. The FDTD procedure is increasingly proficient for limited estimated receiving wire. Different significant highlights of Full Wave Analysis are:

- Predicts the qualities of Microstrip radio wires at higher frequencies.
- It diminished the request for the coefficient framework and calculations too.
- Versatile as it is utilized for a wide range of radio wire structures.
- It gives more exactness than some other technique.
- Completeness, as it incorporates the impacts of a wide range of misfortunes.
- These are numerically concentrated, thusly requires cautious programming to diminish calculation cost.

2.3.4 Finite Difference Time Domain

FDTD is the most reasonable numerical examination strategies for printed receiving wires. FDTD is seen as adaptable on the grounds that any implanted semiconductor gadget in the reception apparatus can be remembered for the examination at the gadget field cooperation level. This prompts an exact investigation of dynamic reception apparatuses. Maxwell's conditions are understood as such in FDTD, without investigative pre-handling not at all like the other numerical strategies. Along these lines, practically any reception apparatus geometry can be examined. In any case, this procedure is numerically

escalated, and consequently require cautious programming to diminish calculation cost.

The FDTD practice has a position in the broad rank of milieu support disparity statistical indicative of stratagem (limited distinction techniques). Maxwell's state of affairs are disgrace employ crucial distinction rough calculation to the subsistence curtailed contributory. The ensuing restricted contrast environment are unraveled tools in a soar mode: the electric field vector slice in a size of scope are fathomed; at that summit the striking field vector division in the comparable spatial volume are explained at the following moment in time; and the course of action is rework over and over again pending the ultimate momentary or unswerving circumstances electromagnetic turf ways is utterly urban. Some of significant highlights are:

- FDTD is a well known numerical technique, on account of generally simple usage.
- No diagnostic pre-handling and demonstrating is required.
- Applied to all states of geometries.
- Uses retaining limit conditions to reenact unbounded computational space.
- FDTD has a place with lattice based differential numerical displaying strategies.
- Time and space steps must fulfill CFL condition
- To make computational area limited we use ABCs and uncommon retaining materials like PML, which are utilized to actualize engrossing limit conditions.
- E and H fields are time-ventured or refreshed bringing about a walking in-time process

2.3 Designed Rectangular coaxial microstrip patch antenna

2.3.1 Tool used – High Frequency Structure Simulator (HFSS)

It is reenactment indoctrination for development and impersonator high-end electronic bits and pieces, like , broadcasting chains, reaction tackle reveal. Microwave ingredients, rapid interlock, strait, connector, IC collection and written course pane. ANSYS HFSS is used to formation of recurrence, swift widget originate in trade off frame, radar, thrust booster assist frameworks satellites, Internet items and other mechanized doodad. It make the most of flexible solutions and an instinctive user interface to give consummate finishing in totaling to philosophical acquaintance into all the issues. From first to last joining, basic and runny essentials , it gives an incredible and inclusive exploration, warranty their tepid and decisive committed reputation. It is unintentional exceptional fractious division line of attack and up to date solvers, which can be accelerate during cream of the crop handing out. The reproduction matching set encompass of an exhaustive pact of solutions to lecture to various dilemmas and extent commencing uninvolved parts to very giant capacity assessment, for example, vehicle outlook for scaffold.

Its dependable line up multitalented vocation alteration lets us center just about the structure as conflicting to advance vigor settle on. This computerization and guarantee exactness break up it from others, which entail instruction booklet patron direct and different retort for pledge the work is levelheaded and defined., the stuff discipline typify the vocation as conflicting to the effort characterizing the physics.[23]

2.3.2 Layout of Rectangular coaxial microstrip patch antenna

A Rectangular coaxial microstrip patch antenna is considered using FR4 substrate with dielectric constant $\epsilon_r=4.4$ and height 1.6 mm.

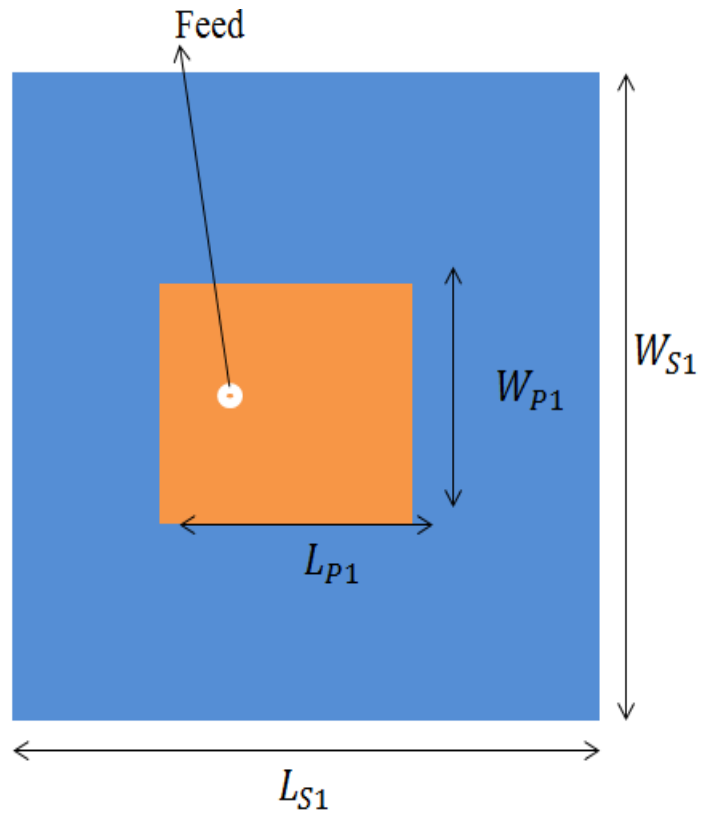


Figure 12: Layout of Rectangular coaxial microstrip patch ante

TABLE 1: Dimensions of microstrip patch antenna

Parameters	Value (mm)
Width of patch(W_{P1})	39.5
Length of patch(L_{P1})	30
Width of substrate (W_{S1})	90
Length of substrate (L_{S1})	100
Feeding point(Y_0)	4.3

2.3.3 Result

2.3.3.1 Return Loss

It is a assess of the replicate vigor as of a send out gesture. Articulated in positive dB's. The superior the assessment the a reduced amount of vigor is echod. The return loss obtained is -26 dB at 2.4 GHz. The range of the tentacle can be said to be those assortment of frequencies in excess of which the revisit failure is superior than -10 dB.

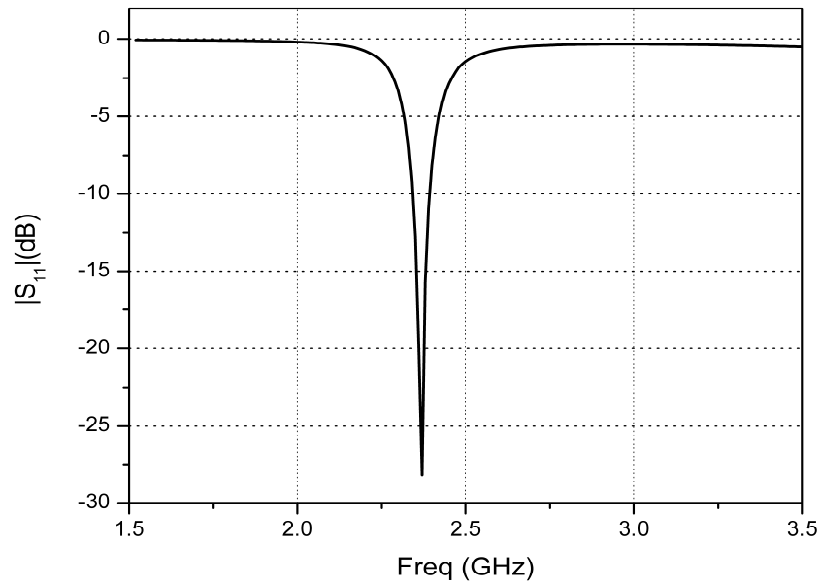


Figure 13:Return loss

2.3.3.1 Radiation pattern

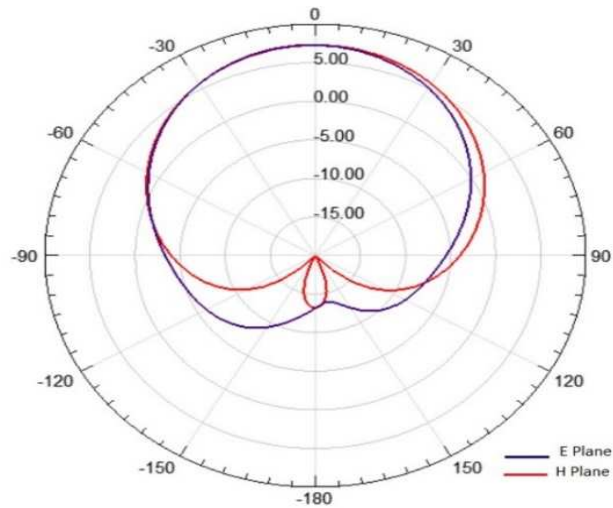


Figure 14: Radiation pattern

2.4 Conclusion

We have designed rectangular co-axial microstrip patch antenna at 2.4GHz which is used in Bluetooth application. The various antenna parameters like return loss, radiation pattern were obtained.

CHAPTER 3 UWB ANTENNA

3.1 Overview

Ultra-wideband (additionally called UWB) is fundamentally a radio innovation which will utilize exceptionally low vitality contribution for short-go, high-data transmission interchanges over a huge bit of radio recurrence range. UWB has old applications in non-agreeable radar imaging. The majority of the application in the objective sensor, accuracy situating of the gadget and the following purposes.

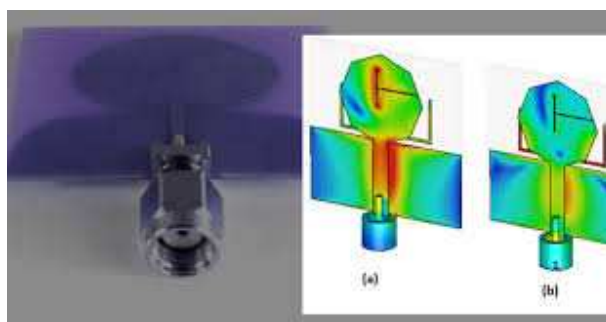


Figure 15: UWB Antenna [24]

UWB antennas has been in effective modern use for a very long time. That is, alike revered communicated bandeau reception apparatus is also "UWB" seeing that, it covers an enormous bandeau for a divisional data measure in over 100% because of a top quality communicate telegraphic thread is completely accomodated recieved thread calculated to pick up private narrowbandeau medium , lucrative divisional data measure is totally exclusively zero. 6-1.9% and just 1 channel are frequently gotten at once.

Be that as it may, countenance issues among antiquated UWB antennas receiving appliances: they are generally "multi-narrowbandeau" recieving threads instead of radio threads enhanced to draw one sound acknowledge past their aggregate operational dossier measure. Part of balance project zone unit a great deal of lenient of reception apparatus variations than remnant. Now for instance, a multi-

bandeau or OFDM reaching is additionally limited inclined to irregularity or elective variances across partner degree receiving thread's operational bandeau no different, a UWB groundwork needs partner degree radio wire furnished for acquiring on entire regularities at indistinguishable time. By doing the work this way radio wire conduct and the presentation ought to be respectably and sure bygone the total bandeau. In a impeccable nature, design and systematizing should be bygone the total bandeau.

Moreover, UWB collecting thread is especially non-dispersive, and have firm part place. One of the probability that wave structure irregularly occurs as a truly unavoidable demeanor, it ought to give to get to speed with itself, anyway typically it's entrancing to transmit comparable waveforms by and large headings. A log-occasional partner degree UWB radio wire is integument of dislodging receiving thread. Tremendous scope components emanate lowering reappearance components while modicum scope components transmit colossal re components. The conclusion is tweet matching, dislodging wave structure. Spare terrible, wave structure can change at totally extraordinary point edges round the radio wire. Recently, a multi-bandeau or OFDM advance is additionally a great deal of open minded of dispersive radio wires. By differentiation, a little part receiving wire, kind of a planate circular dipole will in general emanate an extra conservative, non-dispersive wave, much the same as a "Gaussian W." Since a little segment radio wire not exclusively will in general be non-dispersive, anyway also extra reduced, little segment reception apparatuses square measure most popular in a few applications.

The point of this work is to structure to UWB radio wires. This paper can legitimize key UWB receiving wire thoughts, talk about framework and system worries for UWB reception apparatuses, and blessing essential physical cutoff points to UWB radio wire execution.3.1.1 UWB Antenna concept

A wide sort of receiving wires territory unit fitting to be utilized in ultra-widebandeau pertinences. Some particular territory unit have recorded study UWB radio wires could likewise be delegated correctional or non-correctional, then will any be named each of electrical and alluring receiving wires [25]. This

orders similarly by keeping in mind the evidence that shifted sorts in UWB telegraphic wires will be considered progressively.

3.1.2 UWB Characteristics

UWB antenna disseminates in such way, that does not meddle with standard narrowband, the radio radiation transference inside a similar transmission band. UWB reception apparatus is an innovation utilized for transmitting the enormous transmission capacity (>500MHz); this could in principle and under many right conditions, have the option to impart the range to various clients. In the portable communication Apple propelled the initial three telephones with ultra-wideband abilities in September 2019, to be specific, the iPhone 11, iPhone 11 Pro, and iPhone 11 Pro Max.

3.1.3 UWB Applications

Ultra-wideband qualities square measure appropriate to short-remove applications like PC peripherals, as a result of low outflow levels reasonable by regulative organizations, UWB frameworks will in general be short-run indoor applications as a result of the length of UWB beats, it's simpler specialist high rates; information rate could likewise be changed for shift by conglomerating beat vitality per information bit (with reconciliation or mystery composing techniques). standard symmetrical recurrence division multiplexing (OFDM) innovation might be utilized, subject to least data transmission necessities. High-information rate UWB may alter remote screens, the affordable exchange of information from advanced camcorders, secluded typography of cybernated photographs in distinction to camera while not demand for private personal computer and record moves between PDA handsets and hand held gadgets like transportable media players. UWB is utilized for period area frameworks; its precision capacities and low force make it appropriate for radio-recurrence touchy conditions like medical clinics. Another element of UWB is its short communicated lines.

3.1.4 Directionality of UWB antenna

High increase or directional partner in UWB receiving wire bale strength within petite scrap than an omni-directional radio wire. UWB reception apparatus contains an increase of zero decibel i by elucidation (such radio thread is not truly achievable, at least no more regarding quick example). Indeed, "dB" recommends that decibel comparative with an ideal isotropous reception apparatus. A normal receiving wire contains an addition of concerning a couple of 2 dB. High addition horn or reflector receiving wires could have increases of +10 dB, +20 dB, or maybe a great deal of. Reception apparatus power is encased inside the meaning of radio wire gain, in this way a five hundredth prudent (- 3 decibel) dipole can bear an reinforce of concerning - 1.8 decibel .An ethereal can bear immense addition, slim meadow of peruse & can be similarly monstrous in proportion.

3.1.5 How UWB Works?

The Ultra-wideband remote radios impart many short sign heartbeats over the expansive range. This implies the information is transmitted over the quantity of the recurrence channels on the double, anything over the 500 MHz for instance, a UWB signal is focused at the 5 GHz normally reaches out over the 4 Gigahertz and 6 Gidahertz. The far reaching sign permits , UWB to normally bolster tremendous remote information paces of 480 Mbps up to 1.6 Gbps, at separations unto couple meters(at fast). At longer separations, UWB information rates drop impressively. At the point when it is contrasted with spread range, ultra-band wide range use implies that it doesn't meddle with different transmissions in a similar band, as narrowband and transporter wave transmissions.

3.2 Designed UWB Antenna

3.2.1 Layout of UWB Antenna

A proposed UWB Antenna is described using FR4 substrate with dielectric constant $\epsilon_r=4.4$ and height 1.6 mm. Dimension of the suggested antenna is shown below (table 2).

TABLE2: Dimension of proposed antenna

PARAMETER	UNIT(mm)
W	30
L	34
r	9
f_1	8.3

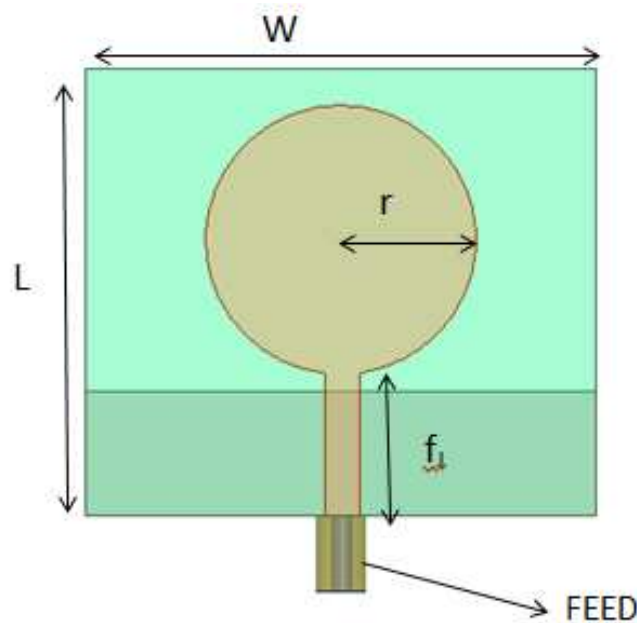


Figure 16: Layout of UWB Antenna

3.3.3 Result

3.3.3.1 Return Loss

Return loss is a proportion of the returned vitality from disseminated sign. Return loss is usually communicated in firm decibel's. Bigger worth, lesser vitality is emulated. The arrival misfortune acquired ultra wide band is - 22.50 dB. . The transmission capacity of the recieving wire can be supposed to be particular scope of frequencies bygone whichever arrival misfortune is more noteworthy than - 10 decibel.

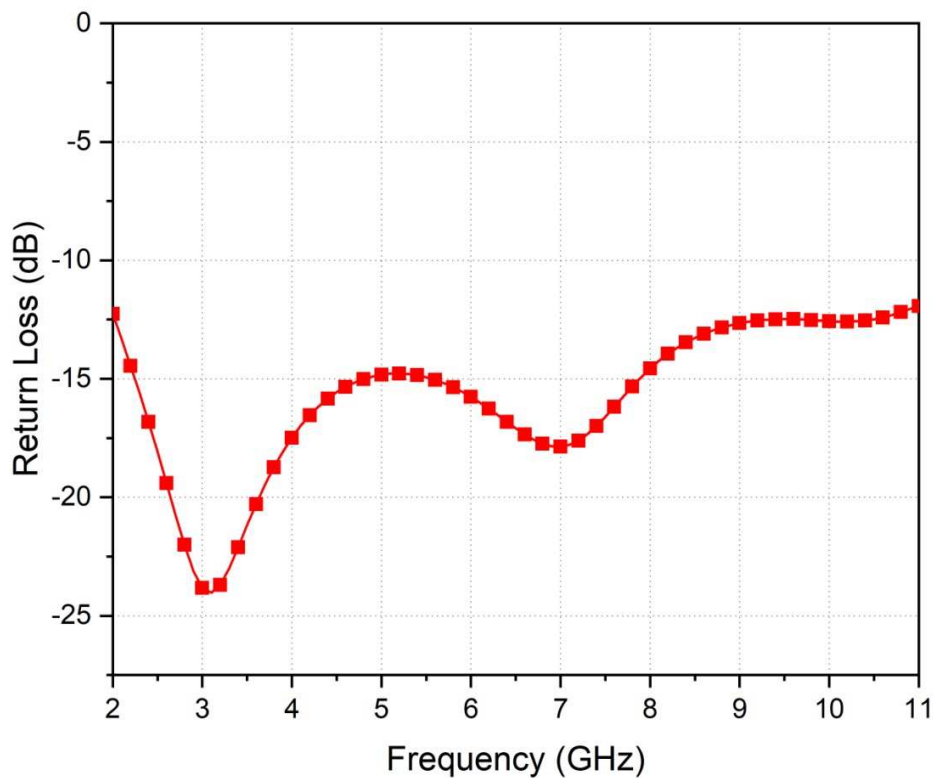


Figure 17: Return Loss

3.3.3.1 Radiation pattern

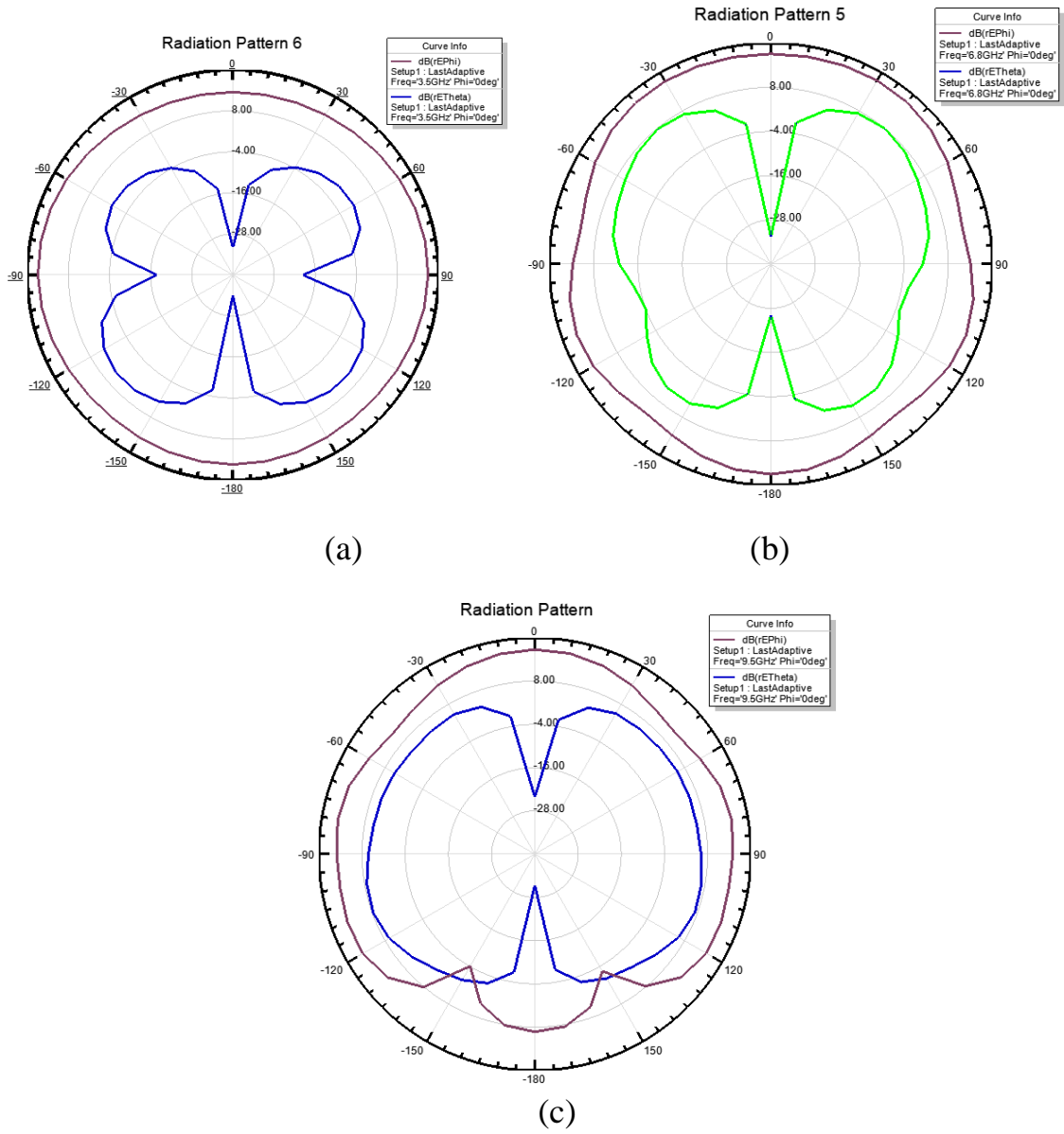


Figure 18: Radiation pattern (a)3.5GHz (b)6.8GHz and (c) 9.5GHz

3.3.3.2 Surface current distribution

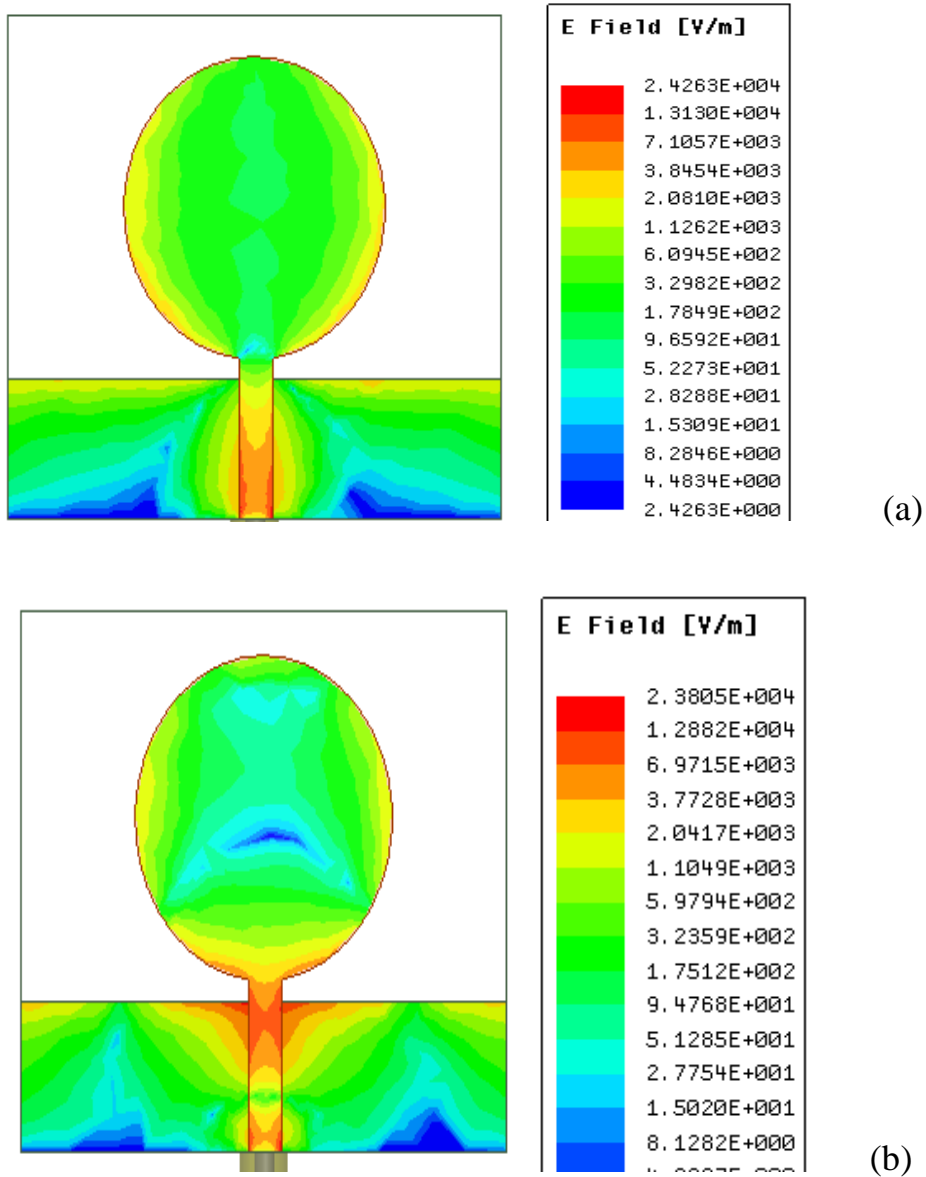


Figure 19: Surface current distribution at (a)3.5GHz and (b)6.8GHz

3.4 Conclusion

We have designed ultra wide bandeau antenna which is worned for ultra wide application such as WiMAX, WLAN and X bandeau satellite transmission. The various antenna parameters like return loss, radiation pattern were obtained.

CHAPTER-4 Compact UWB MIMO Antenna

4.1 Introduction

In radio, different information & plentiful output, or MIMO is system where limit of radio connections can be made identical by taking advantage of separate transference & getting receiving wires to exploiting multipath propagation. MIMO has received necessary elements of isolated coherence guidelines in conjunction with IEEE 802.11n (Wi-Fi), IEEE 802.11a (Wi-Fi), HSPA+ (3G), WiMAX (4G), and Long Term Evolution (4G LTE).

At once, in isolating interpretation "MIMO" suggested in order to use various receiving threads at the transmitter & the receiver. In current day practices, "MIMO" explicitly suggested to functional strategy for dispatching & securing further than one instructional signal at same time bygone analogous radiotelegraphy medium by persecuting multipath procreations. MIMO is essentially not duplicate to dazzling gathering gizmo techniques spawned to promote manifestation of singular instruction signal, for example, beamforming & decent variety.

4.2 History

MIMO is regularly pursued endorse to 1970s analysed citations regarding multi-station computerize transference frameworks & obstruction among lead combines in a linkage assembly. Regardless of the verity they are not occurrence of violence dual zone proliferation to propel numerous statistics brook, a segment where arithmetic practice for handle shared obstruction displayed valuable encroachment. People researching dual punter frameworks operational greater than commonly shuffled straight systems by means of added substance commotion foundation.

Techniques be formed to improve staging of cubicle data lines & sanction increasingly dynamic reappearance reclaim. Space-division numerous entrance (SDMA) utilizes directional or savvy radio chains toward suggest to a parallel

return among regulars during a variety of vicinity inside span of a like stand post.

4.3 Standards and commercialization

MIMO innovations have become normalized intended for far-flung LANs, booth handset scheme, and 4G cell phone organizes & is right now in across the board business use.

The prime 4G cell standard was projected by NDoCoMo in 2004. LTE relies on MIMO-OFDM and remain on mortal fashioned by 3GPP. LTE designate rates of 300 Mbit/s, upload speed of 75 Mbit/s, and character of supervision parameters low idleness. LTE consist of prop up for picocells, and bearer conduits up to 100 MHz wide.

Earliest LTE paperwork was thrust in Oslo and Stockholm by TeliaSonera in 2009.

4.5 Forms

Multi -antenna types

Multi response equipment MIMO modernism has been formed and actualized here:

- SISO/SIMO/MISO are unusual types of MIMO
- Dupliinfo and soloyield is an exceptional situation whilst the recipient have a solitary mast.
- Solo-input and diverse yield is an uncommon situation after the spreader has a solitary mast.
- Soloinput solooutput is a customary broadcasting framework wherever nor spreader nor receiver have numerous reception apparatus.
- Some limitations

- Soloinput solooutput is a customary broadcasting framework wherever nor transmitter nor recipient have numerous reception apparatus.

Multi-user types

- Superior MIMO: 1) Uses complex translate methods, 2) Uses complex precoding methods
 - SDMA speaks to what's more dissection different admittance or super-partition numerous entrance somewhere marvelous stresses with the aim of symmetrical partition, recurrence and time dissection isn't utilized yet non-symmetrical methodologies.
- Co MIMO (CO-MIMO)
- Apply different adjacent pedestal posting to mutually put out/get information en route for/as of clients. Accordingly, adjacent pedestal place don't root intercellular obstruction.

4.6 Applications

Spatial duplication procedures construct the recipients intricate, and in this manner they are regularly joined with perpendicular return division duplication regulation, somewhere concern through by a two way direct are in use heed of effectively.

They are additionally sought after to be make the most of in itinerant broadcasting handset guidelines..

This innovation be capable of be utilized in non far-flung correspondences frameworks. Solitary model is the abode classification, which characterizes a control column correspondences framework with the purpose of utilizes strategies toward pass on numerous signs larger than different supports (stage, impartial and position.

4.7 Designed Compact UWB MIMO Antenna

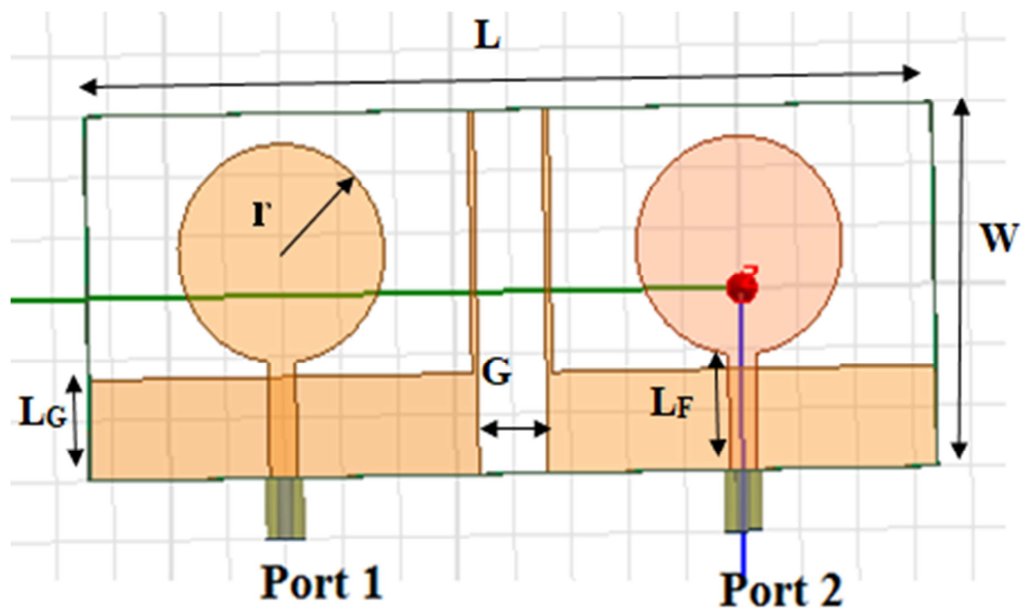


Table 3: Dimensions of UWB MIMO antenna

Parameters	Value (mm)
Radius of circle(r)	9
Feed line (x axis)	2.4
Feed line (y axis)	12
Length of substrate (x axis)	37
Length of substrate (y axis)	30
Radius of inner cylinder	0.7
Height of inner cylinder	5
Radius of outer cylinder	1.7
Height of outer cylinder	5
Radius of circle of feed	1.7

4.8 Results

4.8.1 Return loss

It is the gauge of imitate vitality starting a broadcast sign.,communicated in constructive dB's . Superior worth compared to fewer vitality replicate. Obtained is -33 dB at 2.2 GHz. The second rate is attained at 7 GHz. The bandwith is obtained in ultra wide band region expressing the efficient functioning of the antenna within the desired range.

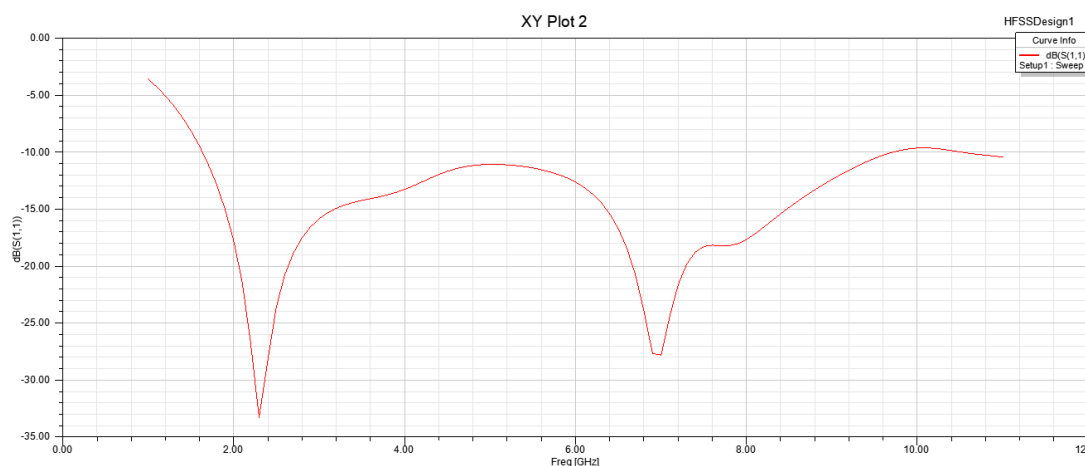


Figure 20: Return loss of UWB MIMO antenna

4.8.2 Mutual Coupling

Radio wire to reception apparatus common coupling portrays vitality consumed by one recieving wire's beneficiary when another close by reception apparatus is working . That is, common coupling in general bothersome of verity that vitality that ought to be transmitted away is consumed by close by reception apparatus .Similarly, vitality that could have been caught by one recieving wire is rather consumed by a close by antenna.Hence shared coupling decreases the radio wire proficiency and execution of recieving wires the transmit & get mode.

Assessment so as to correspondence , reception apparatuses encompass comparable properties in the transmit and get mode, so by understanding coupling misfortune in the transmit mode .

Below peaks are first obtained at 5.5 GHz at the magnitude of -45 dB and secondly obtained at 9 GHz at a magnitude of 42 dB. Here the complete band should be under -15 dB in order to achieve successful coupling

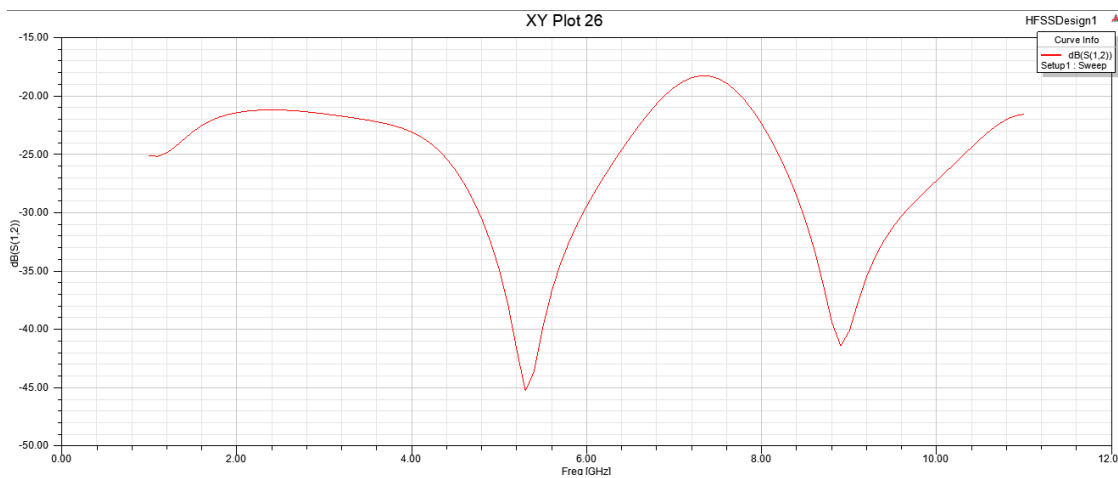
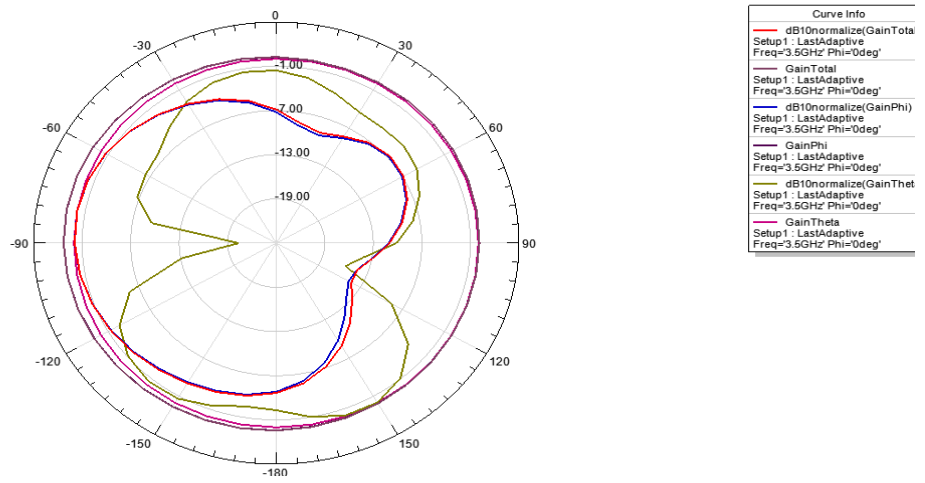


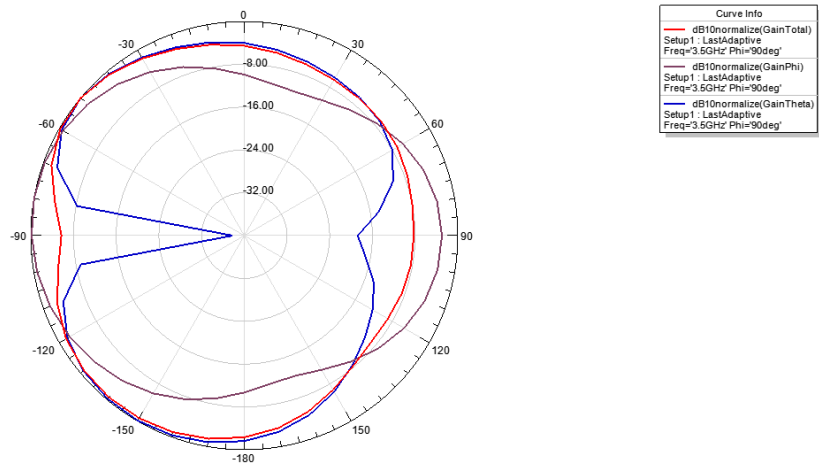
Figure 21: Mutual coupling of UWB MIMO antenna

4.8.3 Radiation pattern

It is the divergence of the might send out via a response tools as an building block of the attitude continually on or after the recieving wire. This strength assortment as a module of the manifestation point in the recieving wire's remote pasture. The red coloured 8 shaped pattern describes the E plane whereas the green coloured represents the H plane where both the planes are perpendicular to each other.

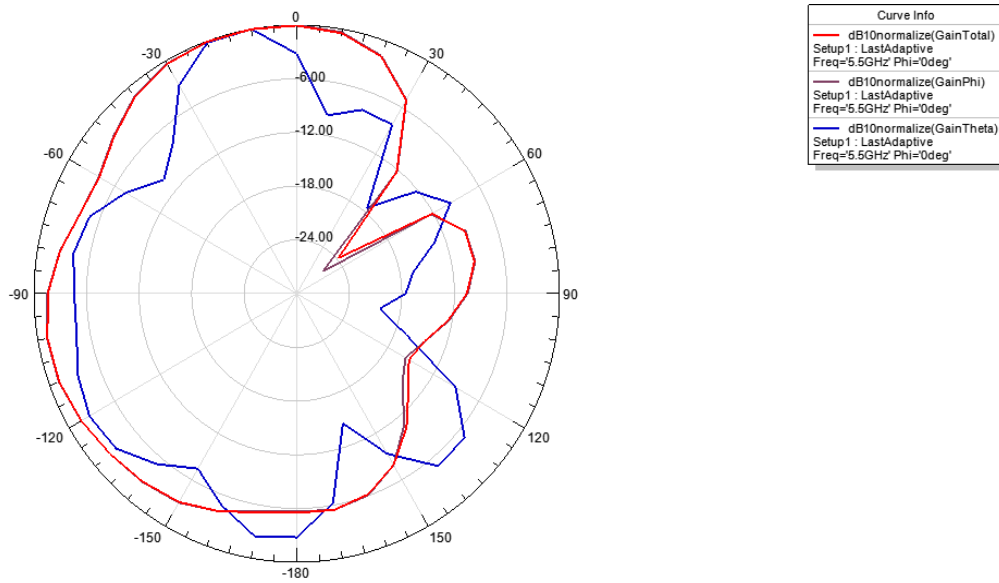


(a)

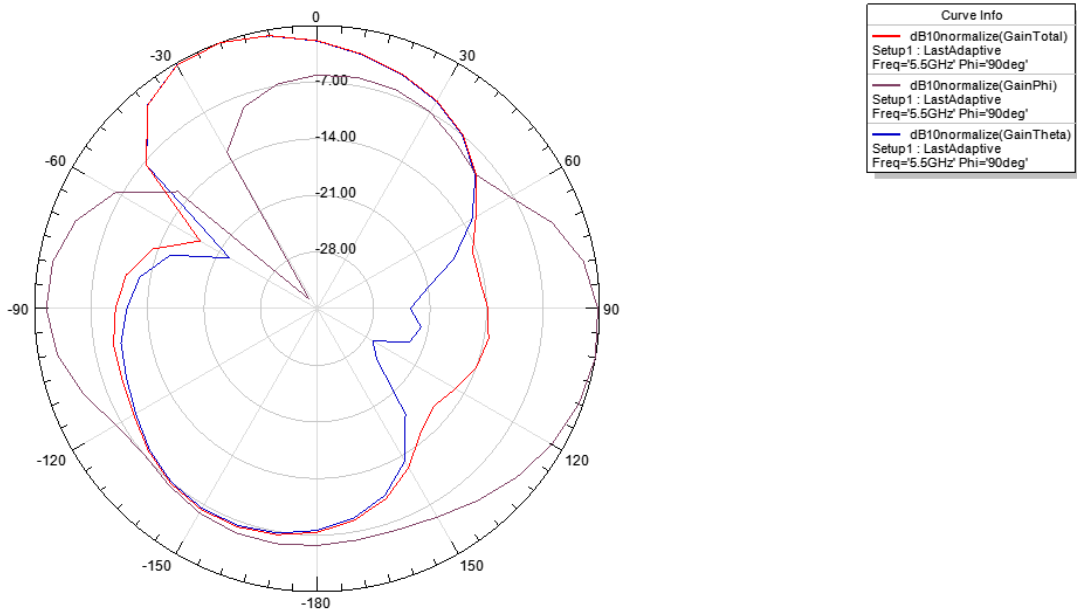


(b)

Figure 22: Radiation pattern at $f=3.5$ GHz (a) 0 deg (b) 90 deg



(c)



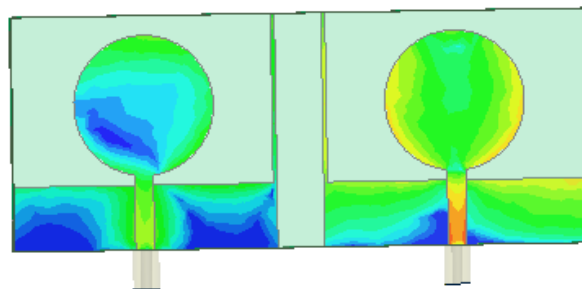
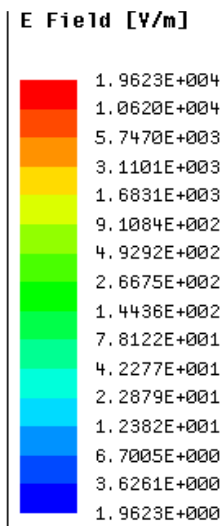
(d)

Figure 23: Radiation pattern at $f=5.5$ GHz (c) 0 deg (d) 90 deg

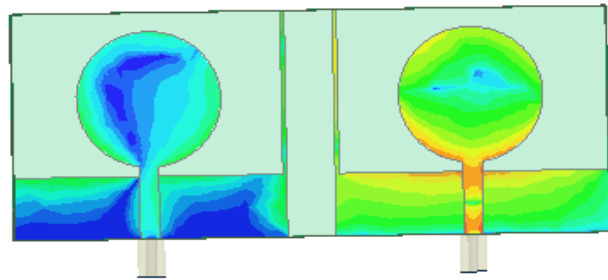
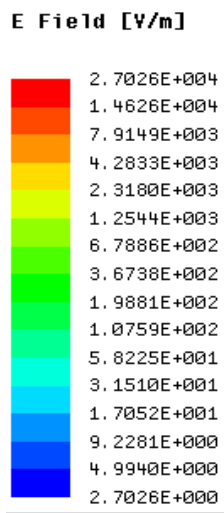
4.8.4 Surface Current Distribution

It is characterized as a component whose greatness is the thrilling flow per cross segment territory in space, its bearing mortal that of the movement of the positive allege now .In SI base units, the electric flow thickness is measure in amperes per square meter.

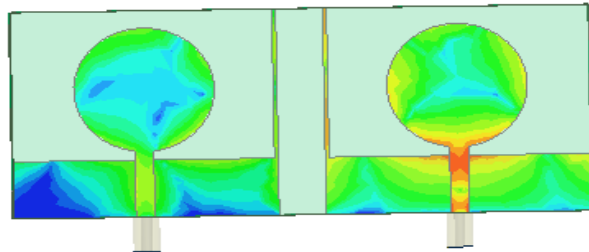
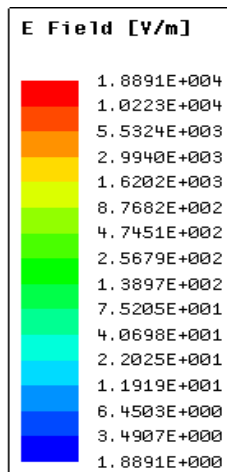
Here the figures down below represent the distribution of currents through the MIMO antenna.The left picture describes the antenna is normal state whereas the right indicates the state of antenna in excited state. In the excited state it can be seen how the current starts spreading through the feed line into the central parts .The outer radius contains more current as compared to the rest the antenna. This represents that from this portion maximum radiation is being released.The red colour represents more current in the region whereas the blue colour represents the least amount of colour present.



(a)



(b)



(c)

Figure 24: Surface Current Distribution at (a) 3.5 GHz (b) 5.5 GHz (c) 6.6 GHz

CHAPTER 5 CONCLUSION

The rectangular microstrip antenna is designed at 2.4GHz for Bluetooth application. The various antenna parameters like return loss, VSWR, directivity, gain, bandwidth and operating frequency are studied for antenna designing. A UWB antenna is designed for UWB application such as WiMAX, WLAN and X band satellite communication.

REFERENCES

- [1] Ramesh Garg, Prakash Bhatira, Inder Bhal, Apisak Ittipiboon, “Microstrip antenna design handbook”, 2nded ,2002
- [2] J. D. Kraus, R. J. Marhefka, “Antenna for all applications” 3rd Ed., McGraw-Hill, 2002.
- [3] C.A. Balanis, “Antenna Theory Analysis and Design”, 3rd Edition New Jersey, John Wiley and Sons, 2005.
- [4] Mingjian Li and Kwai-Man Luk, “A Low-Profile Unidirectional Printed Antenna for Millimeter-Wave Applications”, *IEEE Transaction on Antennas and Propagations*, vol. 62, no. 3, March 2014
- [5] Muhammad Imran Kazim, Matti H.A.J. Herben, and A.B. Smolders, “60-GHz three-dimensional passive electromagnetic deflector achieves wide angular coverage”, *IEEE Antenna and propagation magazine*, vol -58,pp. 47 – 59,12 ,April ,2016
- [6] Nan Guo, Robert C. Qiu, Shaomin S. Mo, and Kazuaki Takahash, “60-GHz Millimeter-Wave Radio: Principle, Technology, and New Results”, *EURASIP Journal on Wireless Communications and Networking*, vol-2,pp. 1-8, 2007
- [7] Gourav Misra, Arun Agarwal, and Kabita Agarwal, “Design and Performance Evaluation of Microstrip Antenna for Ultra-Wideband Applications Using Microstrip Feed” *American Journal of Electrical and Electronic Engineering*, vol- 3,pp. 93-99,2015
- [8] R. N. Tiwari, P. Kumar, and Nitasha Bish, “ Rectangular Microstrip Patch Antenna with Photonic Band Gap Crystal for 60GHz Communications”, *Progress In Electromagnetics Research Symposium Proceeding*, Suzhou, China, vol -5,pp.12–16, Sept. 2011
- [9] K. Shambavi, Zachariah C Alex, and T. Naveen Phani Krishna, “ Design And Analysis Of High Gain Millimeter Wave Microstrip Antenna Array for

wireless applications”, *Journal of Theoretical and Applied Information Technology*, pp. 159-144, 2005 – 2009

[10] K. Praveen Kumar, K. Sanjeeva Rao, T. Sumanth, N. Mohana Rao, R. Anil Kumar, and Y. Harish, “Effect of Feeding Techniques on the Radiation Characteristics of Patch Antenna: Design and Analysis”, *International Journal of Advanced Research in Computer and Communication Engineering*, Vol. 2, pp.1276-1281, February 2013

[11] Nan Guo, Robert C. Qiu, Shaomin S. Mo, and Kazuaki Takahash, “60-GHz Millimeter-Wave Radio: Principle, Technology, and New Results”, *EURASIP Journal on Wireless Communications and Networking*, vol-2, pp. 1-8, 2007

[12] Rajat Arora, Ajay Kumar, Saleem Khan, and Sandeep Ary, “Finite Element Modeling and Design of Rectangular Patch Antenna with Different Feeding Techniques”, *Open Journal of Antennas and Propagation*, vol-1, 11-17, Sept. 2013

[13] Mingjian Li, and Kwai-Man Luk, “A Low-Profile Unidirectional Printed Antenna for Millimeter Wave Applications”, *IEEE Transactions on Antennas and Propagation*, Vol -62, pp. 1232-1237, March 2014

[14] Neha Mishra, and R.K. Mehrotra, “Design Analysis Of Microstrip Patch Antenna For Rectangular And Circular Patches”, *International Journal of Advanced Research in Electronics and Communication Engineering*, Volume 3, Issue 2, February 2014

[15] Gourav Singh Rajput, “Design and analysis of patch antenna using metamaterial for better efficiency”, *International Journal of Advanced Technology & Engineering Research*, Volume 2, pp. 210-216, Nov. 2012

[16] Nasimuddin Nasimuddin, “Microstrip Antennas” Gordana Klaric Felic, and Efstratios Skafidas, Integration of 60-GHz Microstrip Antennas with CMOS Chip, InTech, pp. 491-506, April, 2011

- [17] Rongguo Zhou, Duixian Liu, and Hao Xin, “ A Wideband Circularly Polarized Patch Antenna for 60 GHz Wireless Communications”, *Wireless Engineering and Technology*, vol-3, pp. 3787 - 3789, 23-27, March, 2009
- [18] M A Matin, and A. I. Sayeed, “ A Design Rule for Inset-fed Rectangular Microstrip Patch Antenna”, *WSEAS Transactions on Communication*, vol-9, pp.62-73, January 2010
- [19] Bimal Garg, Rahul Dev Verma, and Ankit Samadhiya, “Design of Rectangular Microstrip Patch Antenna Incorporated with Innovative Metamaterial Structure for Dual band operation and Amelioration in Patch Antenna Parameters with Negative μ and ϵ ”, *International Journal of Engineering and Technology*, vol-3, pp. 205-216, 1, March 2012
- [20] Aditi Sharma, and G. Singh, ” Rectangular Microstirp Patch Antenna Design at THz Frequency for Short Distance Wireless Communication Systems”, *Journal of infrared, millimeter and terahertz waves*, vol-1, pp. 1–7, Jul,2014
- [21] Sunil Singh, Neelesh Agarwal, Navendu Nitin, and A.K. Jaiswa, “Design consideration of Microstrip Patch Antenna”, *International Journal of Electronics and Computer Science Engineering*, vol-2, pp. 306-316
- [22] Liton Chandra Paul, and Nahid Sultan, “Design, Simulation And Performance Analysis of a line feed Rectangular Microstrip Patch Antenna”, *International Journal of Engineering Sciences & Emerging Technologies*, Volume 4, pp: 117-126, Feb. 2013
- [23] B. Sai Sandeep, and S. Sreenath Kashyap, ”Design and Simulation Microstrip Patch Array Antenna for wireless communication at 2.4 GHz”, *International Journal of Scientific & Engineering Research*, Volume 3, November-2012
- [24] Amandeep Bath, Abhishek Thakur, Jitender Sharma, and Basudeo Prasad, “Design of rectangular microstrip patch antenna” ,*International Journal of Electrical & Electronics Engineering* ,Vol. 1, pp.3-6,Jan-Feb 2014.

[25] Gaurav Waliaa, and Kuldip Pahwaa, “The Effect of Variation in Notch Width on Return Loss of Inset-Fed Rectangular Microstrip Patch Antenna for Wi-Fi Application”, *International Journal of Current Engineering and Technology*, Vol.3,pp.83-93, March 2013.

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: ...18/07/2020.....

Type of Document (Tick): PhD Thesis M.Tech Dissertation/ Report B.Tech Project Report Paper

Name: Archit Sugha, Abhinav Sharma Department: ECE Enrolment No: 161102, 161060

Contact No. 9882524329, 9816082800 E-mail: asugha75@gmail.com, sharma023abhinav@gamil.com

Name of the Supervisor: Dr. Naveen Jaglan

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): DESIGN AND ANALYSIS OF COMPACT UWB ANTENNA

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

- Total No. of Pages =60
- Total No. of Preliminary pages =9
- Total No. of pages accommodate bibliography/references = 4



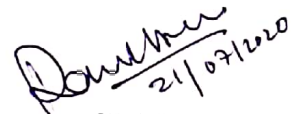
(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found Similarity Index at13.....(%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.



(Signature of Guide/Supervisor)



Signature of HOD

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Excluded	Similarity Index (%)	Abstract & Chapters Details	
Report Generated on	<ul style="list-style-type: none"> All Preliminary Pages Bibliography/ Images/Quotes 14 Words String 		Word Counts	
			Character Counts	
		Submission ID	Page counts	
			File Size	

Checked by
Name & Signature

Librarian

Please send your complete Thesis/Report in (PDF) & DOC (Word File) through your Supervisor/Guide at plagcheck.juit@gmail.com