CHAPTER 1

INTRODUCTION

1.1 ANTENNA BASICS

Antenna is an electrical device which coverts electrical power into radio waves, and vice versa.

Transmitter - Radiates electromagnetic energy into space

Receiver - Collects electromagnetic energy from space

Antennas are very important component of communication systems. By definition, an antenna is device used to transform a RF signal, travelling on a conductor, into an electromagnetic wave in a free space. Antenna demonstrate a property known as reciprocity, which means that an antenna will maintain the same characteristic regardless if it is transmitting or receiving. Most antennas are resonant devices, which operate efficiently over a relatively narrow frequency band. An antenna must be turned to the same frequency band of radio system to which it is connected, otherwise the reception and transmission will be impaired. When a signal fed into antenna, the antenna will radiation distributed in space in a certain way.

1.2 ANTENNA PARAMETERS

The choice of a particular antenna depends on a factors such as gain, radiation pattern, polarization bandwidth resonant frequency and impedance. The antenna parameters such as gain resonant frequency impedance etc., defines the performance of the antenna.

1.2.1 RETURN LOSS

The return loss is another way of expressing mismatch. It is a logarithmic ratio measured in dB that compares the power reflected by the antenna to the power that is fed into the antenna from the transmission line. The relationship between SWR and return loss is the following:

$$\text{Return Loss (in dB)} = 20\log10\text{SWR} \qquad \text{-----------} (1)$$

1.2.2 GAIN

The gain of an antenna in a given direction is the amount of energy radiated in that direction compared to the energy an isotropic antenna would radiate in the same direction when driven with the same input power. Usually we are only interested in the maximum gain, which is the gain in the direction in which the antenna is radiating most of the power. An antenna gain of 3 dB compared to an isotropic antenna would be written as 3 dBi. The resonant half-wave dipole can be a useful standard for comparing to other antennas at one frequency or over a very narrow band of frequencies. To compare the dipole to an antenna over a range of frequencies requires a number of dipoles of different lengths. An antenna gain of 3 dB compared to a dipole antenna would be written as 3 dBd.

$$\text{dBi} = \text{dBd} + 2.15 \text{ dB} \qquad \text{----------}(2)$$

where,

dB_i- decibel referenced to an isotropic antenna

dB_d- decibel referenced to a half wavelength dipole

1.2.3 DIRECTIVITY

Directivity is the ability of an antenna to focus energy in a particular direction when transmitting, or to receive energy better from a particular direction when receiving. In a static situation, it is possible to use the antenna directivity to concentrate the radiation beam in the wanted direction. However in a dynamic system where the transceiver is not fixed, the antenna should radiate equally in all directions, and this is known as an Omni-directional antenna.

1.2.4 RESONANT FREQUENCY

Signals of different frequencies reach the antenna simultaneously and for it to be of any importance, it should be able to select only one frequency of interest at a time. That frequency is called resonant frequency and it is achieved by the use of turned circuit at the receiver or transmitter. Antennas are only effective for a range of frequencies over which they can operate and this is determined by their physical length

1.2.5 IMPEDANCE

The input impedance of an antenna determines the amount of energy it can transmit or receive. Maximum power transfer will occur when the antenna is matched to the receiver or transmitter as in accordance with the maximum power transfer theorem. Most of all, an antenna is connected to the load by a feeder (usually a coaxial cable) which is unbalanced. In consequence, the cable radiates and this affects the efficiency of energy transfer to or from antenna.

1.2.6 BANDWIDTH

The bandwidth of an antenna is the range of frequencies for which it is effective. Several techniques can be used to improve the bandwidth of an antenna. Tapering antenna elements is one of these techniques and it is the essential application in the log-periodic dipole antenna.

1.2.7 RADIATION PATTERN

The radiation pattern of an antenna is the most important requirement since it determines the direction in which the signal is transmitted or received. It is specified by the beam width and side lobe level in the plane (vertical or horizontal) it is being measured. In most cases, the radiation pattern is determined in the far field region. Radiation properties include power flux density, radiation intensity, field strength, directivity phase or polarization.

1.2.8 VSWR

Standing wave ratio (SWR) is the ratio of amplitude of a partial standing wave at an antinodes (maximum) to the amplitude at an adjacent node (minimum), in an electrical transmission line. The SWR is usually defined as a voltage ratio called the VSWR, for Voltage Standing Wave Ratio.

1.2.9 POLARIZATION

Polarization is defined as the orientation of the electric field of an electromagnetic wave. Polarization is in general described by an ellipse. Two special cases of elliptical polarization are linear polarization and circular polarization. The initial polarization of a radio wave is determined by the antenna.

1.3 HISTORY OF UWB

In now day's the wireless system has become a part of human life. Most of the electrical and electronics equipment around are using the wireless system. An antenna is an essential element of the wireless system. Antenna is an electrical device which transmits the electromagnetic waves into the space by converting the electric power given at the input into the radio waves and at the receiver side the antenna intercepts these radio waves and converts them back into the electrical power. There are so many systems that uses antenna such as remote controlled television, cellular phones, satellite communications, spacecraft, radars, wireless phones and wireless computer networks. Day by day new wireless devices are introducing which increasing demands of compact antennas. Increase in the satellite communication and use of antennas in the aircraft and spacecraft has also increased the demands a low profile antenna that can provide a reliable communication.

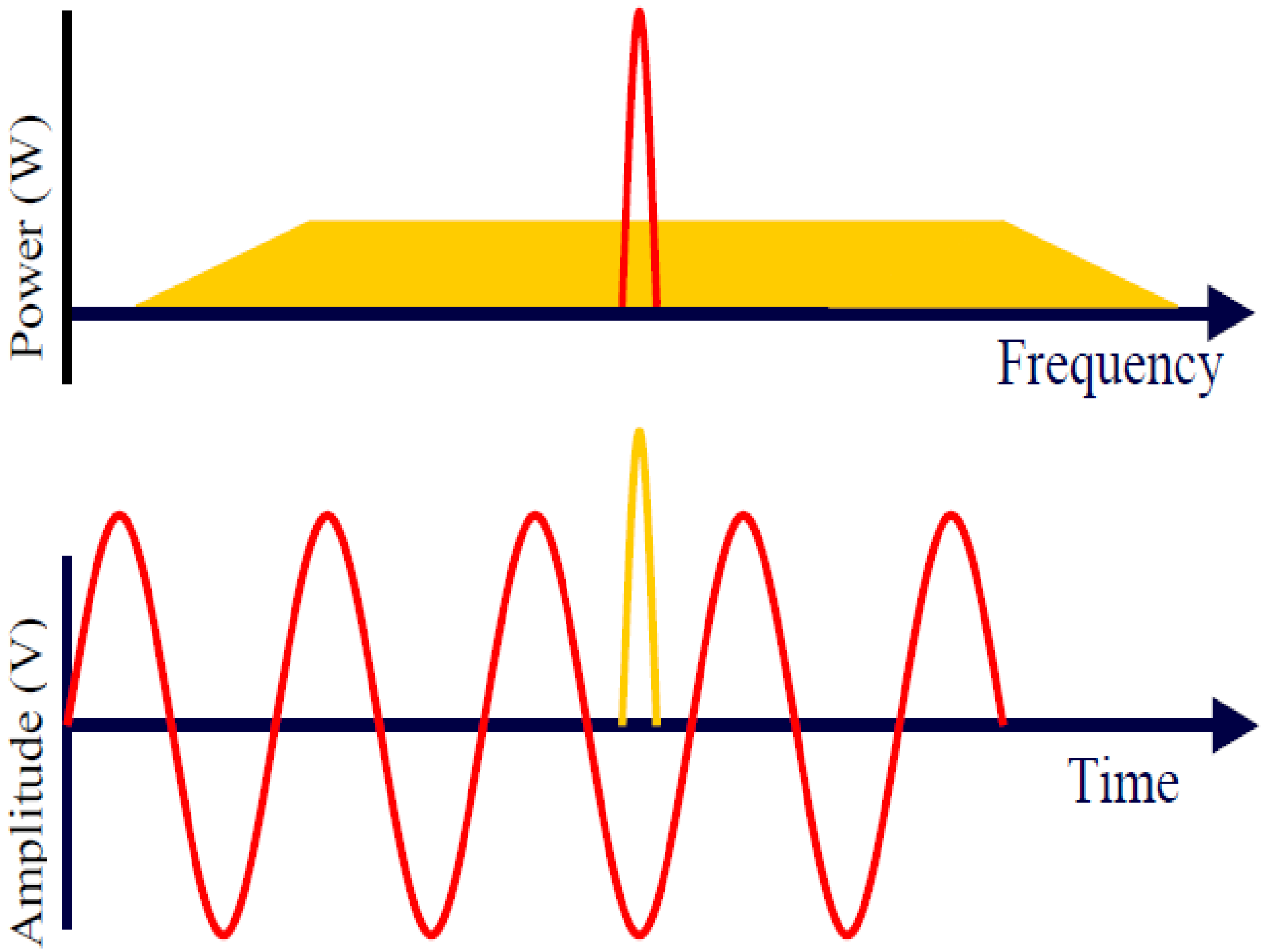

Figure 1.1 Equivalence of a pulse based waveform compressed in time to a signal of very wide bandwidth in the frequency domain.

Figure 1.1 illustrates the equivalence of a narrowband pulse in the time domain to a signal of very wide bandwidth in the frequency domain. Also, it shows the equivalence of sinusoidal signal (essentially expanded in time) to a very narrow pulse in the frequency domain.

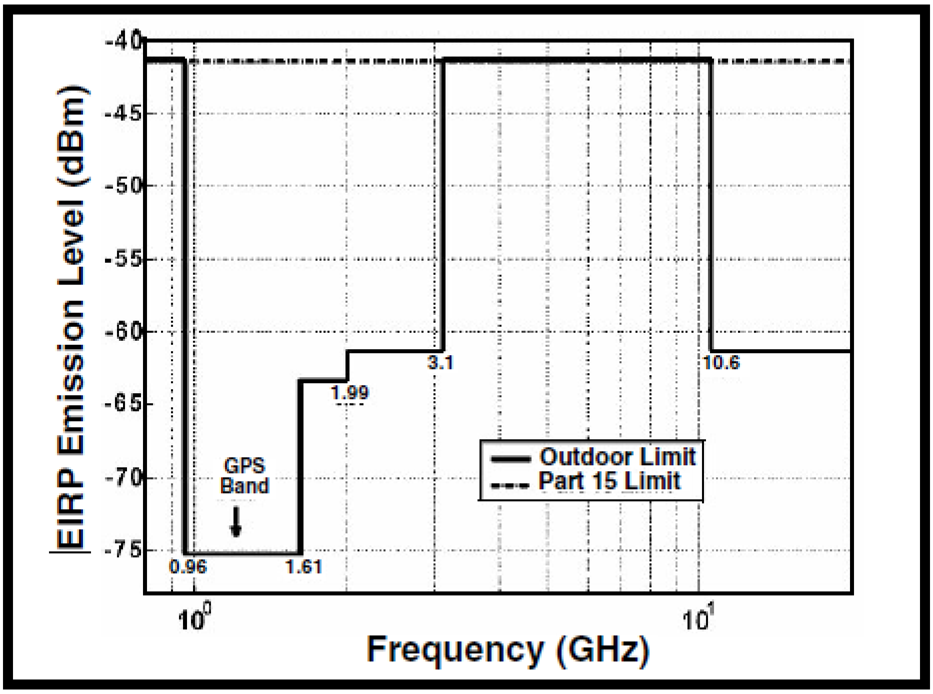

Figure 1.2 Mask of an UWB communications system.

In February 2004, the FCC allocated the 3.1-10.6 GHz spectrum for unlicensed use as shown in figure 1.2. This enabled the use and marketing of products which incorporate UWB technology. Since the allocation of the UWB frequency band, a great deal of interest has generated in industry. The UWB spectral mask was defined to allow a spectral density of -41.3 dBm/MHz throughout the UWB frequency band. Operation at such a wide bandwidth entails lower power that enables peaceful coexistence with narrow band systems. These specifications presented a myriad of opportunities and challenges to designers in a wide variety of fields including RF and circuit design, system design and antenna design.

Ultra Wideband is defined as any communication technology that occupies greater than 500 MHz of bandwidth, or greater than 25% of the operating centre frequency. Most narrowband systems occupy less than 10% of the centre frequency bandwidth, and are transmitted at far greater power levels. For example, if a radio system is to use the entire UWB spectrum from 3.1-10.6

GHz, and center about almost any frequency within that band, the bandwidth used would have to be greater than 100% of the centre frequency in order to span the entire UWB frequency range. By contrast, the 802.11b radio system centres about 2.4 GHz with an operating bandwidth of 80 MHz . This communication system occupies a bandwidth of only 1% of the center frequency.

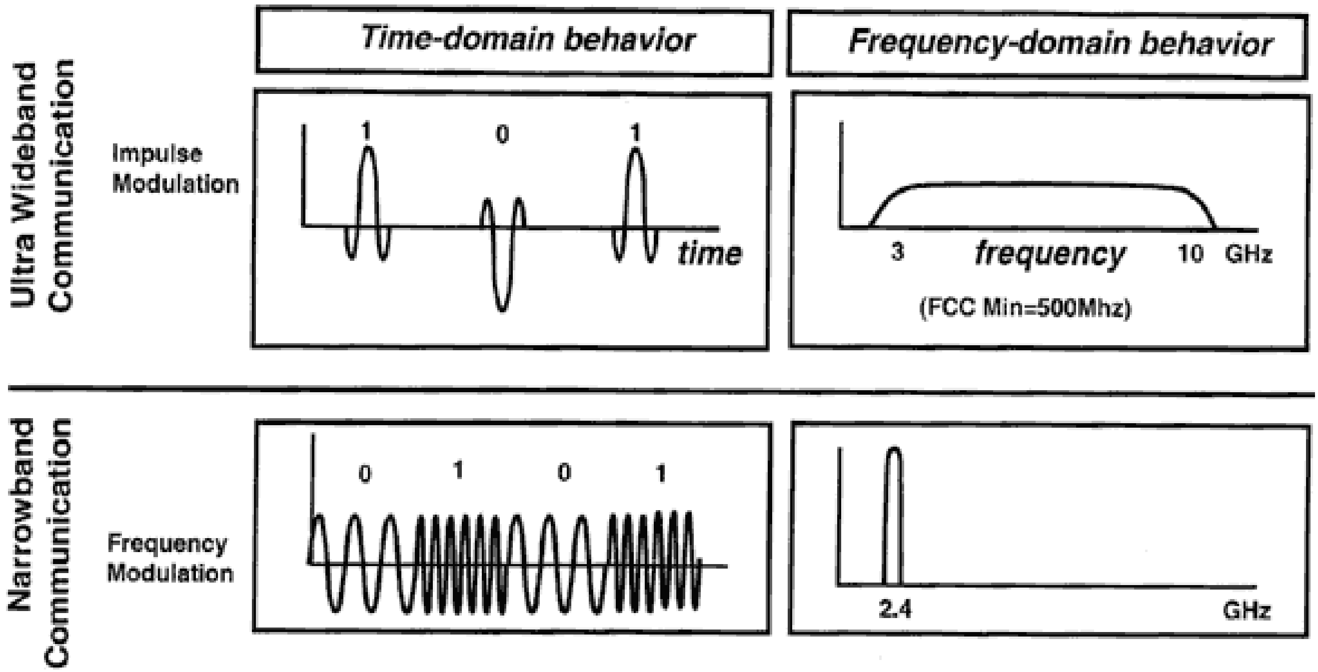

Figure 1.3 Impulse and frequency modulation

While Ultra Wideband technology may represent a revolutionary approach to wireless communication at present, it certainly is not a new concept. The first UWB radio, by definition, was the pulse-based Spark Gap radio, developed by Guglielmo Marconi. This radio system was used for several decades to transmit Morse code through the airwaves. However, Spark Gap radios were forbidden in most applications due to their strong emissions and interference to narrowband (continuous wave) radio systems.

By the early 1960's, increased interest in time domain electromagnetics by MIT's Lincoln Laboratory and Sperry Research Centre surged the development of the sampling oscilloscope by Hewlett-Packard in 1962. This enabled the analysis of the impulse response of microwave networks, and catalysed methods for sub nano second pulse generation. A significant research effort also was conducted by antenna designers, including Rumsey and Dyson who were developing logarithmic spiral antennas, and Ross, who applied impulse measurement techniques to the design of wideband, radiating antenna elements. With these antenna advances, the potential for using impulse based transmission for radar and communications became clear. [15]

Through the late 1980's, UWB technology was referred to as baseband, carrier-free or impulse technology, as the term "ultra wideband" was not used until 1989 by the U.S. Department of Defence. Until the recent FCC allocation of the UWB spectrum for unlicensed use, all UWB applications were permissible only under a special license. For the nearly 40 year period from 1960-1999, over 200 papers were published in accredited IEEE journals, and more than 100 patents were issued on topics related to ultra wideband technology. The interest seems to be growing exponentially now, precipitated by the FCC allocation in 2002 of the UWB spectrum, with several researchers exploring RF design, circuit design, system design and antenna design, all related to UWB applications. Several business ventures have started with the hope of creating the first marketable UWB chipset, enabling revolutionary high-speed, short range data transfers and higher quality of services to the user. [15]

CHAPTER 2

LITERATURE SURVEY

Y.M. Dubey and et.al [6], proposed that UWB is an emerging technology and has numerous applications in different fields in this digital era. As we know that the range of UWB exist are 3.1GHz-10.6 GHz but some narrow band applications also exist in this range and causes interference to Ultra Wideband applications. In this existing work a novel UWB antenna is integrated with W shape notch to reduce interference which mainly occurs at 5 GHz due to WLAN (IEEE 802.11a) and it also cover U-NII band (5.15-5.85 GHz). The antenna is designed using FR-4 substrate, size of proposed antenna is 25x20 mm2 which makes it very compact and thickness is 1.6mm and fed through micro strip line to achieve better impedance matching. The range of antenna is 3.4GHz to 11 GHz and return loss of 36 dB at resonant frequency is 4.4 GHz observed for the antenna and achieve VSWR<2. The proposed antenna is well suited for the wireless USB.

Fawzy Ibrahim and et.al [8], derived transformation equations are to design single band antennas for Millimeter Wave (MMW) applications. The design utilizes the approach adopted for MMW antenna design based on an integrated Dielectric Resonator Antenna (DRA) in a Si-based technology platform for 77 GHz MMW applications. The obtained optimized antenna by DRA is used as a reference and the existing transformation is applied to calculate the new antenna design parameters that satisfy its given specification without changing the geometry. Four Antennas are demonstrated by using this transformation. The desired frequencies are: 35, 60, 94 and 120 GHz all lie in the MMW band to be utilized in several applications.

Faraz Ahmed and et.al [7], proposed an ultra-wideband antipodal Vivaldi antenna among end fire radiation patterns function at UWB (3.1 GHz to 10.6 GHz) frequency range for radar and microwave imaging application is proposed. It presents the design of two different types of antipodal Vivaldi antennas, a conventional and a modified antipodal Vivaldi antenna. It presents a parametric analysis of each antenna. While designing the antennas, originally a conventional antipodal Vivaldi antenna is presented for a wide impedance bandwidth performance assessment. Furthermore, the Vivaldi antenna is modified by incorporating corrugations on the edges which resulting in gain significantly along with increased directivity in low frequency band. In addition, the modified antenna offers high gain and flat gain in the operating UWB band. The design and optimization process is carried out using the CST simulation software for parameters performance assessment of return loss, radiation pattern, directivity and input impedance. Prototypes of the two different proposed antennas are fabricated and tested for its return loss and directional pattern.

Harsha Vardhini and et.al [12], had designed based on different frequency bands used in mobile and wireless communications have driven the demand of antenna that can operate in multiband frequencies. As there is an increase in demand of portable hand held devices, there is a need for small antennas too. This work describes the design of a Multi-Band antenna, for use on portable communications devices, which provides an embedded solution for multiband applications. Microstrip multiband antenna for mobile communication is designed and simulated using CST Microwave studio software.

Kiruthika and et.al [18], presented a Microstrip Patch antenna for radar application. There is a variety of shapes available for Microstrip patch antenna. In this paper, conventional shapes like Rectangular, Triangular and Circular

Microstrip patch antenna are designed and analyzed. The antenna is designed to resonate at X-band frequency. The X-band frequency range lies between 8 to 12 Gigahertz and are widely used in radar applications. The substrate used by the antenna is the low cost FR4 (Flame Retardant) Epoxy. The Ansoft HFSS (High Frequency Structural Simulator) Version 12 software is used to analyze the results of different shapes of Microstrip patch antenna.

Kumar Mohita and et.al [20], compared the features of three dissimilar feeding methods namely co-axial probe, microstrip line and co-planer feeding for a thermally stable resonator antenna (TSRA). First, nanoparticles have been developed by using proper synthesis process and then mixed in accordance with their temperature coefficients such as to achieve thermal stability. The Nicholson-Ross-Weir conversion method has been used for the determination of microwave dielectric constant (εr) and permeability (μr). Further, a thermal stable cuboid shaped resonator antenna was developed by using this composition. Three different feeding techniques are used and their corresponding resultant characteristics are compared for this developed antenna.

Y. X. Liu and et.al [21], proposed the lamination of surface modified printed circuitboard (PCB) substrate, FR-4â, from argon plasma pretreatment and UV-induced graft copolymerization with glycidyl methacrylate (GMA), to copper foil was carried out at elevated temperature and in the presence of an epoxy adhesive. The structure and chemical composition of the graft copolymerized surfaces and interfaces of the glass fiber-reinforced and epoxy-based FR- 4 substrates were studied by X-ray photoelectron spectroscopy (XPS). The effects of the plasma pretreatment time, the UV illumination time, as well as the curing temperature, on the adhesion strength between the FR-4 substrate and copper were investigated. The assemblies involving GMA graft copolymerized FR-4, or the FR-4-GMA/epoxy resin/Cu assemblies, exhibited a significantly higher interfacial adhesion strength and reliability, in comparison to those assemblies in which only epoxy adhesive alone was used. The enhanced adhesion in the assemblies involving GMA graft copolymerized substrate arises from the fact that the covalently tethered GMA graft chains on the FR-4 surface can become covalently incorporated into the epoxy resin, resulting in the toughening of the epoxy matrix and increased interaction with copper.

Manjunath and et.al [23], designed circular microstrip patch antenna with sandwiching the substrate for bandwidth enhancement. The antenna is designed at 2.7GHz (S-band) using High Frequency Structural Simulator. The circular patch antenna is designed on two different substrates, FR4 epoxy and RT Duroid 588 and fabricated on the three layer FR4-epoxy substrate. The effect of dielectric constant, substrate stacking on the performance of an antenna system is compared and results from the simulator are analysed. The result analysis shows that the bandwidth of this antenna has increased 2.5 times with three layer stacking at 10 dB return loss and directive gain of 4.7dBi. The work can be enhanced in the future using meta materials to reduce the antenna weight and to increase the bandwidth of operation.

Harold Hoff and et.al [11], deals with the use of ultra-wideband technology (restricted to impulse radio UWB) for military purpose related to radar, telecommunication or localisation. After defining what a UWB signal is, its physical features are described, as well as a few constraints relevant with the future systems. From this, some particular military applications are inferred and depicted thanks to the current work carried out at CELAR. Keeping in mind these potential applications, operational missions are presented, for which UWB technology may bring advantages. Finally, some prospects concerning studies at the DGA are considered.

Gamal and et.al [9], presents an overview of the ultra wideband (UWB) technology for wireless communications systems. Following a brief review of the UWB basic principles, the characteristics of application specific UWB wireless systems will be described. Design principles and challenges of UWB wireless systems, with an emphasis on monolithic implementations will be discussed. Trade-offs between performance, power consumption, and technology choices are addressed. Examples of state-of-the-art UWB circuits and systems are presented.

Anurag Garg and et.al [2], proposed compact ultra-wideband (UWB) antenna with dual band notch. The dual band notched antenna is designed on FR4 substrate having dielectric constant 4.4, and height 1.6 mm. It works on frequency 3.1 GHz to 12 GHz and VSWR< 2. Frequencies from 4.7 GHz to 6.8 GHz and from 8.3 GHz to 9.6 GHz are band notched. Radiation patterns with the frequency of 4.7 GHz, 6.8 GHz, 8.3 GHz and 9.6 GHz of antenna are investigated. CST Microwave Studio has been used as simulation tool for design.

Long Zhang and et.al [22], presents a novel ultra-wide-band tightly coupled dipole reflectarray (TCDR) antenna. This reflectarray antenna consists of a wideband feed and a wideband reflecting surface. The feed is a log-periodic dipole array antenna. The reflecting surface consists of 26_11 unit cells. Each cell is composed of a tightly coupled dipole and a delay line. The minimum distance between adjacent cells is 8 mm, which is about 1/10 wavelength at the lowest operating frequency. By combining the advantages of reflectarray antennas and those of tightly coupled array antennas, the proposed TCDR antenna achieves ultra-wide bandwidth with reduced complexity and fabrication cost. A method to minimize the phase errors of the wideband reflectarray is also developed and the concept of equivalent distance delay is introduced to design the unit cell elements. To verify the design concept, a prototype operating from 3.4 to 10.6 GHz is simulated and fabricated. Good agreement between simulated and measured results is observed. Within the designed frequency band, the radiation pattern of the TCDR antenna is stable and the main beam of the antenna is not distorted or split. The side lobe levels of the radiation patterns are below -11.7 dB in the entire operating band.

Arif Khany and et.al [3], an antenna is a key component of microwave imaging. In this paper, a study of Multiple Ring Slots Ultra-WideBand (MRS-UWB) patch antenna is presented for breast cancer detection. The proposed antenna design is capable to detect the breast tumor with the improved characteristics compared to the other available designs in the literature. The proposed antenna with the ring slots is designed on FR-4 substrate and is fed through a microstrip line by optimizing the width and the position of the feed along with the width of the partial ground structure. According to -10dB bandwidth criteria, the proposed antenna offers promising performance of UWB design ranging from 2-12 GHz. From the results, it is shown that the maximum Return Loss (RL) occurred at 4.3 GHz, 5.8GHz, 8 GHz and 11.6 GHz. For the entire UWB range, the VSWR< 2 that is one of the desired characteristic of an efficient design. It is worth noting that our proposed design is of low cost and easy to fabricate that makes it a favorable choice for medical applications.

Jingchao Tang and et.al [14], proposed an antenna to improve the resolution of biological imaging, a water immersed (the antenna is placed in the pure water) ultra-wide band (UWB) microstrip antenna. The aim of this paper is to determine the suitable wavelength of the interrogating radiation in the medium and to reduce the big reflection of the incident energy at the interface between the target and the medium surrounding the target. In this way, the frequency of 2.45 GHz is selected due to the compromise between spatial resolution and loss of signal, and the medium is chosen as water because of its relative permittivity close to the biological tissues. The design of the linear gradient impedance-matched patch antenna is proposed to match the antenna and the coaxial transmission line of 50 ohms. The simulation results are presented that the fixed percentage bandwidth of this antenna is about 0.923 (1.75 ~ 4.8 GHz) and the 3 dB gain degree range is from -30° to 30° except the null at the center from -6° to 6°, which are both good enough to satisfy the requirements for biological imaging system.

Artur Zolich and et.al [4], several different methods can be used to determine the 3-dimensional position of an object. A common solution is use of Global Navigation Satellite System (GNSS). However, for some operation the specific characteristics of GNSS can be challenging, e.g. time-to-fix on GPS RTK or unavailability of GNSS signals. When considering operations within limited range (a few hundreds of meters) another solution based on Ultra-wideband Real Time Location Systems (UWB RTLS). In this paper authors have tested a set-up of a tag and five anchors in order to determine if such solution can be used in local operations of Unmanned Aerial Vehicles (e.g. landing). Experimental data are analyzed and compared against GPS RTK measurements.

CHAPTER 3

METHODOLOGY

3.1 EXISTING MODEL

The existing miniaturized antenna is designed on FR4 substrate with dielectric constant (εr) 4.4, thickness 1.6 mm, and loss tangent 0.02, overall size 25x20 mm2, and height (h) 1.6mm. The antenna consists of hexagonal patch. Primarily, the base of the antenna is designed using formula for simple patch antenna design, after that the parameters are optimized to get UWB characteristics. The proposed antenna is integrated with band notch characteristics to filter band at GHz to get interference free short distance communication

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A UWB antenna with Fixed U-NII band (5.15-5.85GHz) band notched characteristics has been presented by using W slot on the patch. The parameter of hexagon W slot antenna is simulated using High frequency HFSS software. The W Slot antenna is compact one which can easily be integrate with portable devices like USB. The controlled band notched characteristics is achieved by varying the parameters of the proposed W slot. The proposed antenna is expected to be an excellent for UWB short distance applications with band notched characteristics at Fixed 5GHz WLAN IEEE(802.11a) and U-NII band (5.15-5.85GHz) .

3.2 PROPOSED MODEL

The proposed miniaturized UWB rectangular patch antenna is shown in Fig. 1. The antenna is designed on FR4 substrate with dielectric constant (εr) 4.4, thickness 1.6 mm, overall size 20x15 mm^2, and height (h) 1.6mm.The antenna consists of rectangular patch. Primarily, the base of the antenna is designed using formula for simple patch antenna design, after that the parameters are optimized to get UWB characteristics.

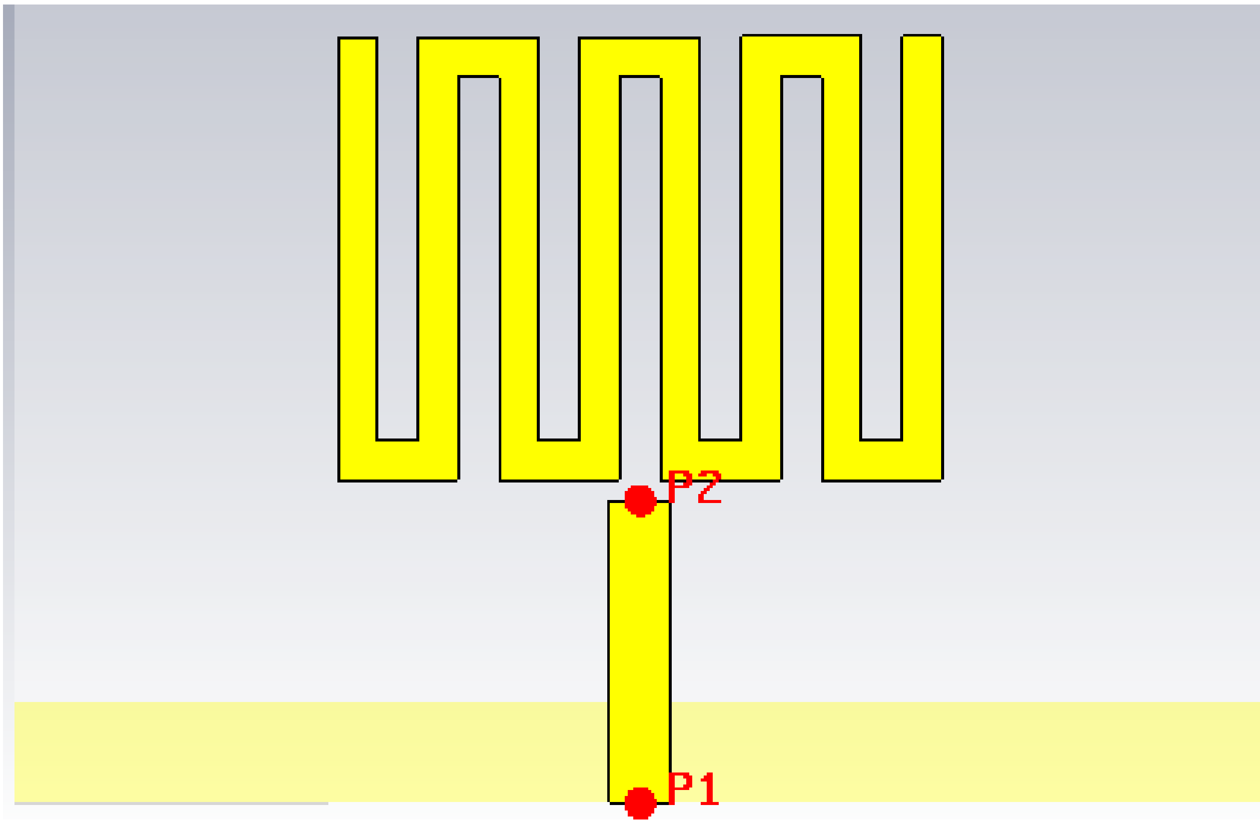

Figure 3.1 Geometry of proposed UWB antenna

A novel shape is being cut on rectangular patch of length 'L' and width 'W'. The optimized parameter of proposed antenna is given in following table1. By varying the slot parameters, the notch band can be achieved effectively by introducing novel shape slot.

3.2.1 DESIGN OF GROUND

The basic microstrip antenna element is comprised of metal patch mounted over a large ground plane. Here the material used for ground plane is copper annealed. The specifications of copper annealed are listed below:

Density	8930[kg/m^3]
Permeability	1
Electrical conductivity	5.8e+007[S/m]
Thermal conductivity	401[W/K/m]

Table 3.2.1 Specifications of ground plane

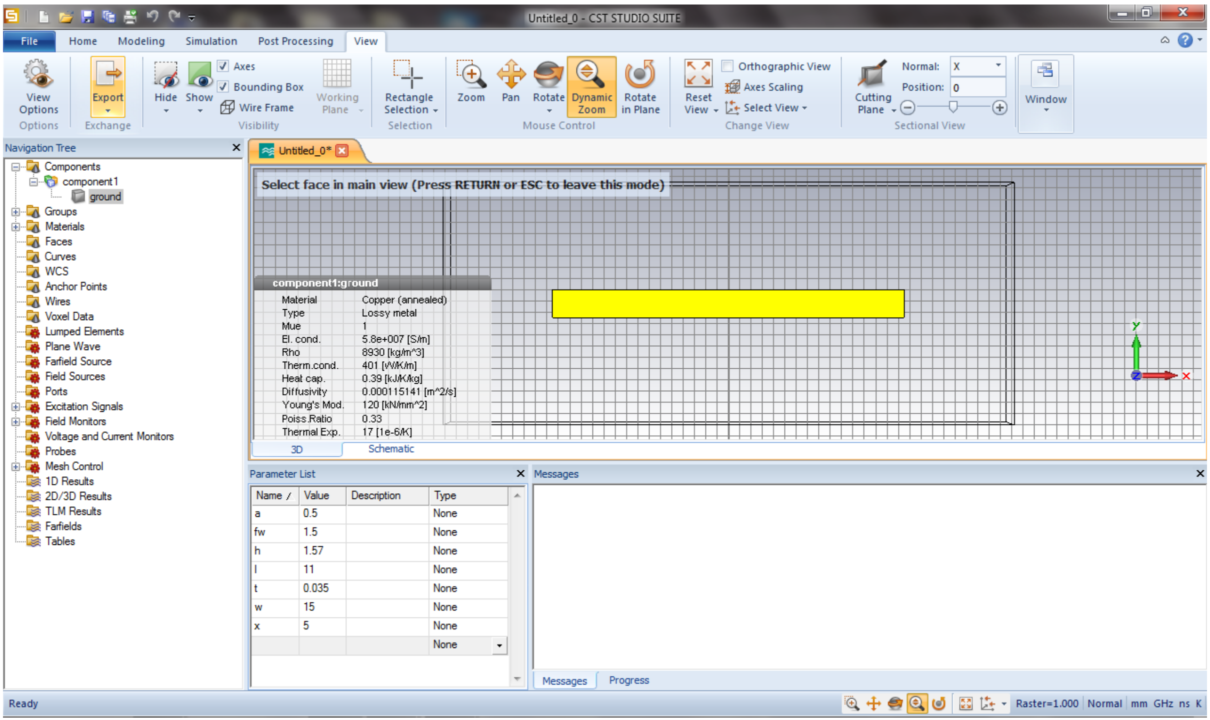

Figure 3.2 Design of ground in CST

3.2.2 DESIGN OF SUBSTRATE

The dielectric sheet is usually called the substrate. In order to choose a substrate we have to consider its various features like the dielectric constant, the dielectric loss tangent, the cost of the material, the dimensional stability with time, the surface adhesion properties for the conductor coatings, the manufacturability (ease of cutting, drilling and shaping). A wide variety of substrate materials have been found to exist with mechanical, thermal and electrical properties which are attractive for use in both planar and conformal antenna configurations.

In this FR4 lossy is used as dielectric material. FR4 is an emerging dielectric material that has gained attention in recent few years as a potential high performance microwave flexible substrate and packaging material. Specifications of FR4 lossy are listed below:

Dielectric constant	4.3
Permeability	1
Electrical conductivity	0.025
Thermal conductivity	0.3
Operating frequency	3.1 to 10.6 GHz

Table 3.2.2 Specifications of substrate

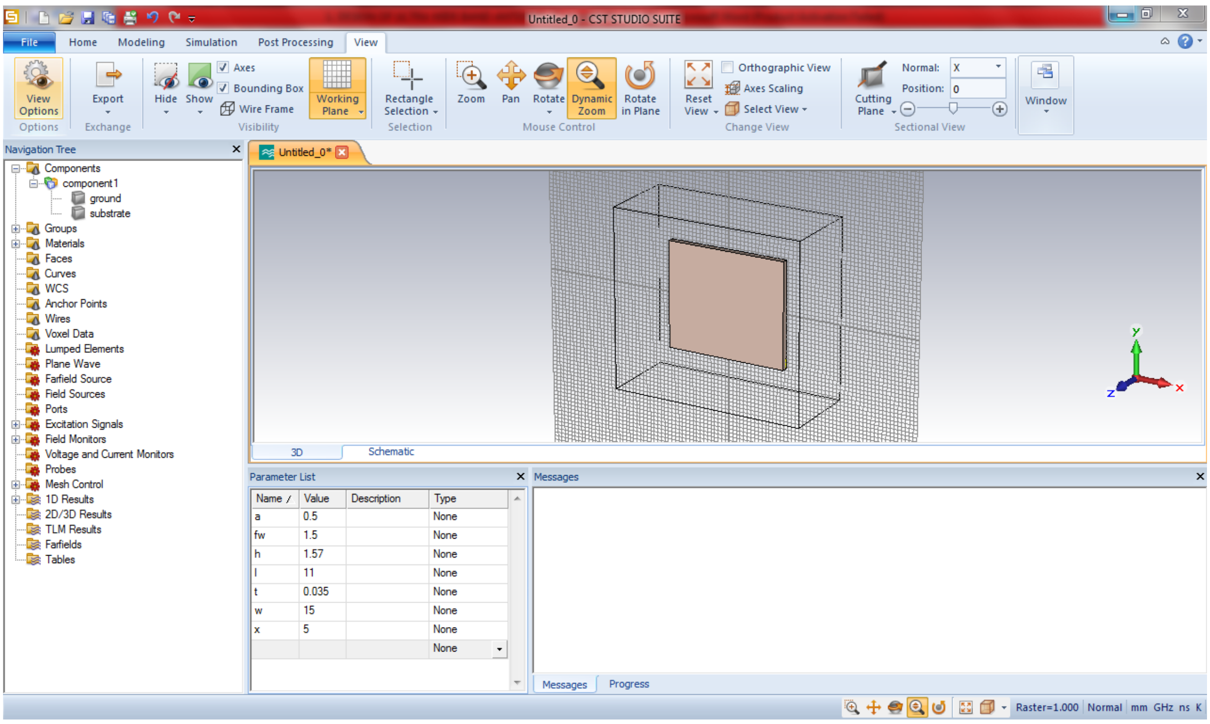

Figure 3.3 Design of substrate in CST

3.2.3 DESIGN OF PATCH

The patch is a very thin flat metallic region having different shapes and the ground plane is usually of same metal. A feed line supplies the RF power to the patch element. The patch is usually made of high conductivity material. Here copper annealed material is used for patch element.

Density	8930[kg/m^3]
Permeability	1
Electrical conductivity	5.8e+007[S/m]
Thermal conductivity	401[W/K/m]

Table 3.2.3 Specifications of patch

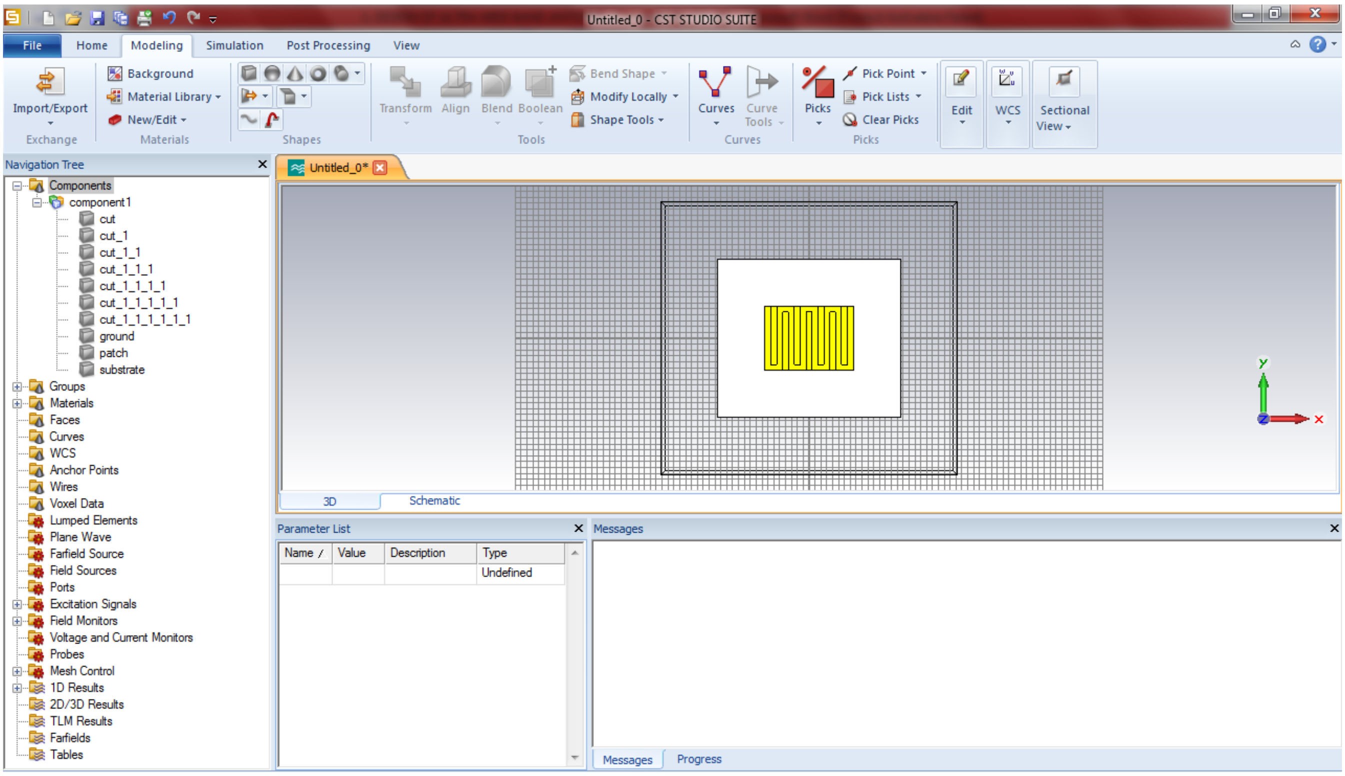

Figure 3.4 Design of patch in CST

3.2.4 DESIGN OF FEED

Microstrip line feed is one of the easier methods to fabricate as it is a just conducting strip connecting to the patch and therefore can be consider as extension of patch. It is simple to model and easy to match by controlling the inset position. A feed line supplies the RF power to the patch element. The same copper annealed is used for feed.

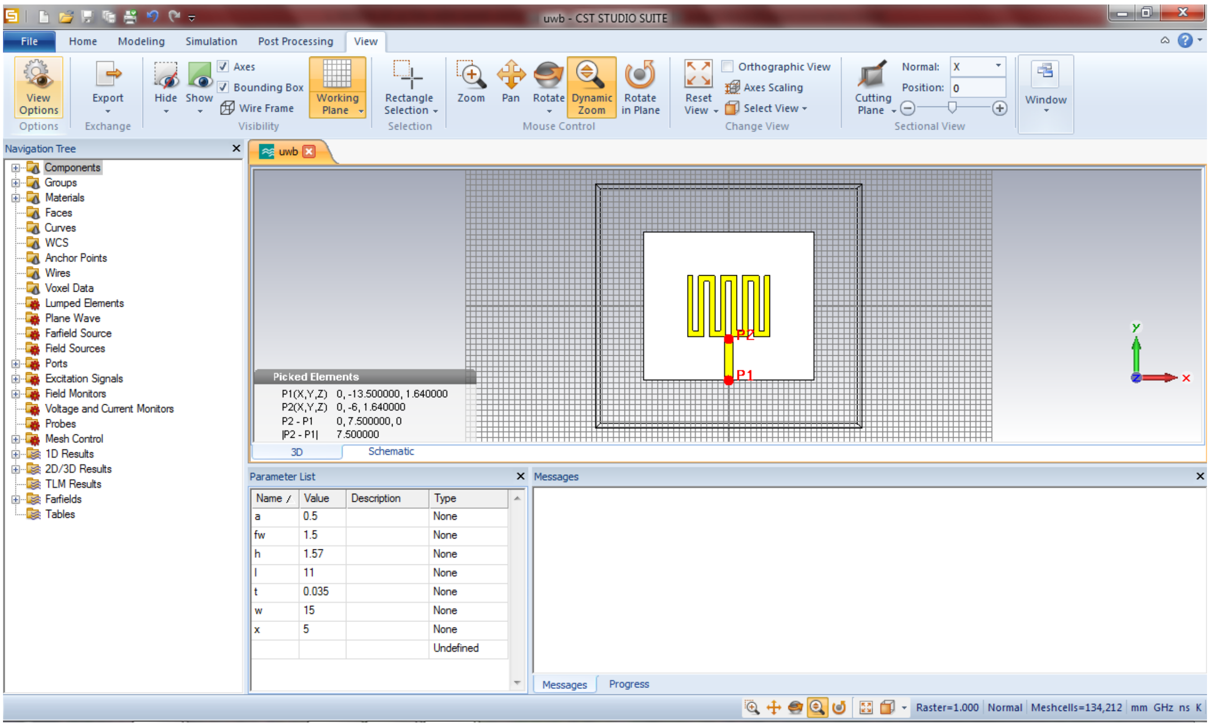

Figure 3.5 Design of feed in CST

3.3 DESIGN EQUATIONS

Width of Rectangular Patch is calculated using equation

$$W = \frac{c_0}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \qquad \text{---------- (3)}$$

where,

W - Width of the patch

c_0-Speed of light

ε_r-substrate dielectric constant

f_r- Frequency of Resonance

Length Rectangular Patch is calculated using equation

Effective dielectric constant ε_{reff}

$$\epsilon_{reff} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2}\left(1 + \frac{12h}{W}\right)^{-\frac{1}{2}}$$

---------- (4)

Fringing effect of patch ΔL

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

---------- (5)

Effective length L_{eff}

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

---------- (6)

Rectangular Patch length L

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

---------- (7)

where

ε_r-substrate dielectric constant h- Thickness of substrate material

f_r- Frequency of Resonance

3.4 VALUES OF CALCULATED SPECIFICATIONS

SPECIFICATION	DIMENSIONS
Width of the ground/substrate	31mm
Length of the ground	2.5mm
Thickness of the ground/patch	0.035mm
Thickness of the substrate	1.57mm
Width of the patch	15mm
Length of the patch	11mm
Substrate material	FR-4
Ground/patch material	Copper
Thickness of slot	0.035
Width of slot	1.5
Length of slot	7.5
Slot implementation	Patch
Substrate material	Copper

Table 3.4 Variable values of proposed UWB antenna

The above mentioned specifications are used to carry out the proposed model design of UWB antenna.

CHAPTER 4

EXPERIMENTAL RESULTS

4.1 ANTENNA SIMULATION

Here in this work for high frequency simulation, CST microwave studio have been used a transient solver with an optimizer. CST microwave studio is a specialized tool for fast and accurate three dimensional electromagnetic simulations of high frequency problems. It possesses key features like compatibility, automatic macro recording, automatic multi-dimensional parameter sweeps and optimizers, electrostatics and magneto static solvers.

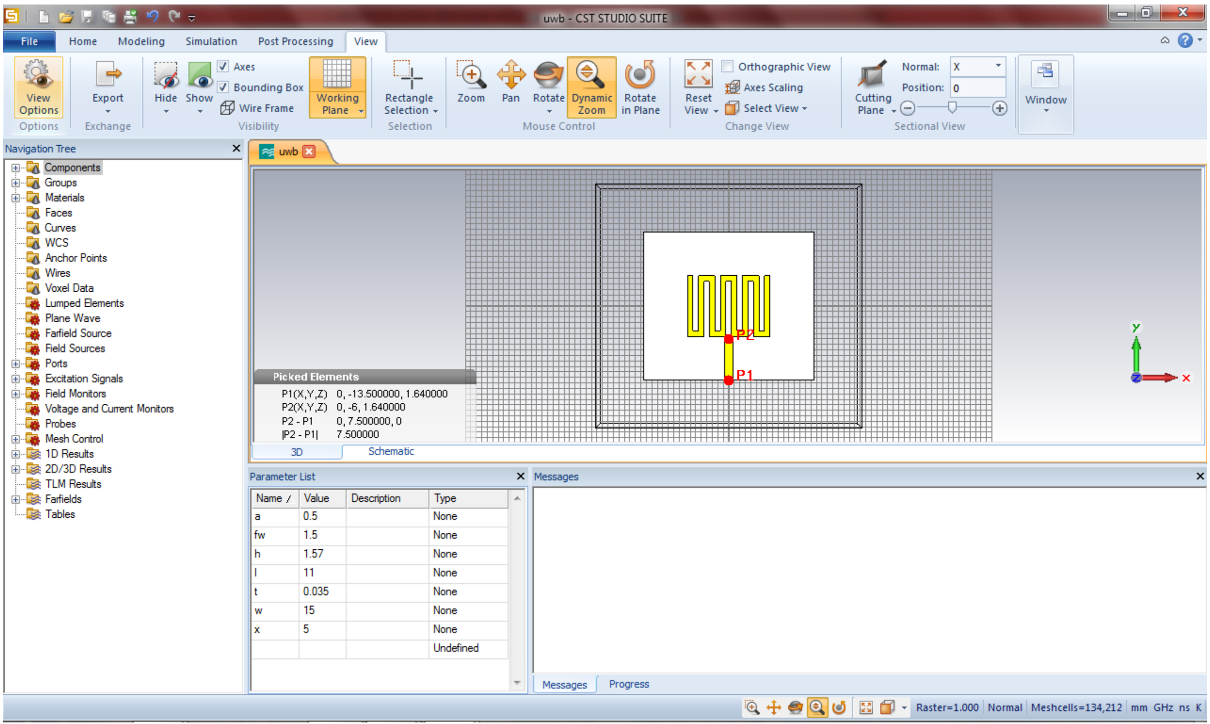

Figure 4.1 Simulation using CST

The main result of interest of an antenna is farfield distribution at given frequency. A farfield monitor at one of the resonance frequencies allows the visualization of the farfield after the simulation. In this work, farfield pattern plots are obtained from the CST Microwave studio software.

4.2 RETURN LOSS

The variation of S11 with frequency for UWB rectangular antenna characteristics is shown in the figure 4.2. Simple patch as well as w slot on radiating patch fulfilling UWB condition and giving stable band throughout. The Plot of return loss is shown in figure 4.2 illustrating band range.

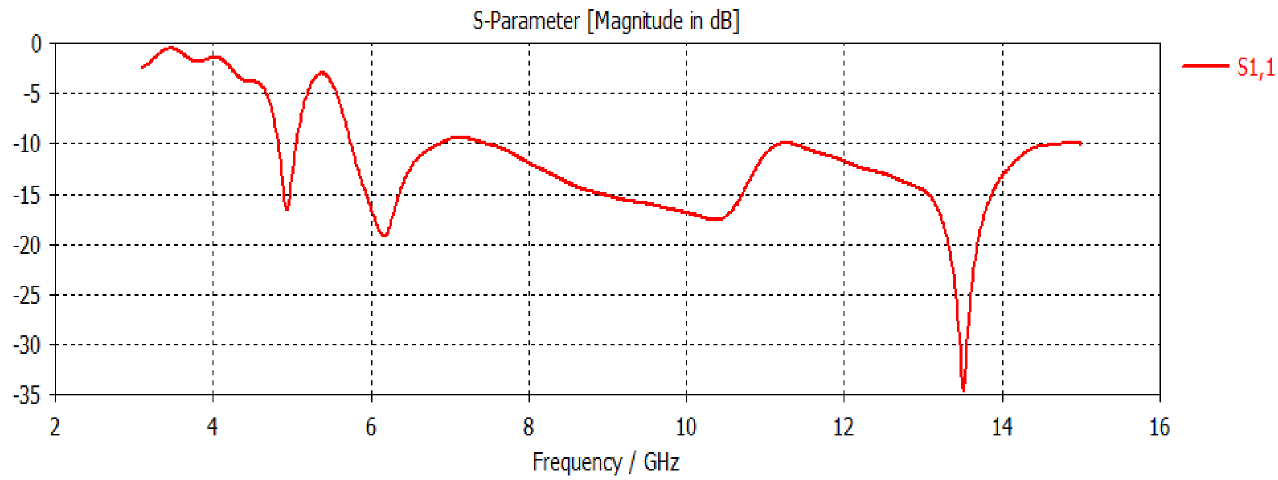

Figure 4.2 Return loss

4.3 VSWR

The variation of VSWR with frequency for UWB hexagonal antenna with from fixed U-NII band 5.15GHz to 5.85GHz band notched characteristics is shown in the Fig. 4.3. The VSWR value at the notched bands is more and for the remaining band the value is less than 2 (VSWR < 2).

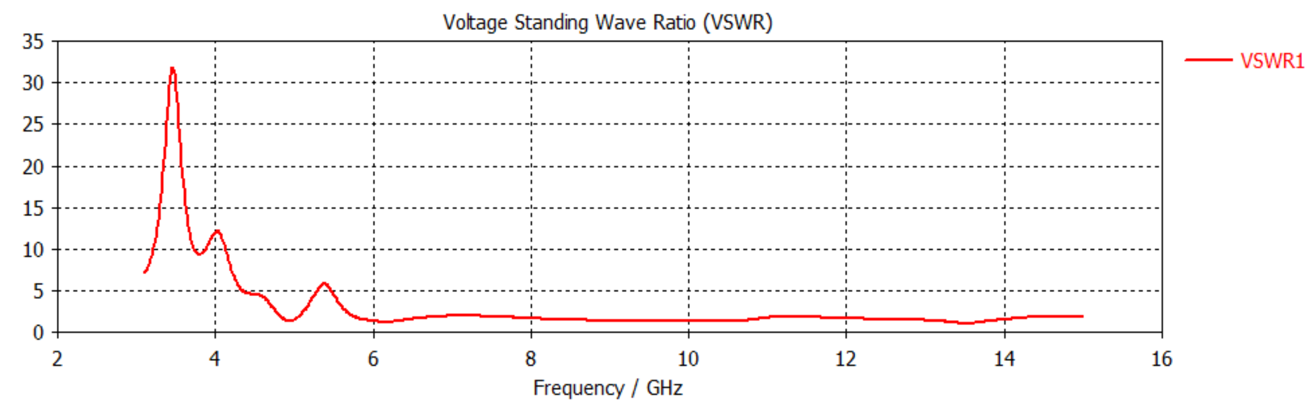

Figure 4.3 VSWR

4.4 RADIATION PATTERN

4.4.1 DIRECTIVITY

Directivity of an antenna is defined as the ratio of the radiation intensity in a given direction from the antenna to the radiation intensity averaged over all directions. The radiation intensity is given by the total power radiated by the antenna divided by 4π.

The same definition is presented in CST Microwave studio. If the direction is not specified the direction of maximum radiation intensity is implied. The directivity is defined with respect to an isotropic source and hence has the unit dBi. An isotropic source radiates an equal amount of power in every direction.

4.4.2 GAIN

Antenna gain is related to input or accepted power of the antenna structure. Absolute gain of an antenna in a given direction is defined as the ratio of the radiation intensity, in a given direction to the radiation intensity that could be obtained if the power accepted by the antenna were radiated isotropically.

Gain is not a quality which can be defined in terms of a physical quality such as the Watt or the Ohm, but it is a dimensionless ratio. Gain is given in reference to a standard antenna.

Antenna gain is expressed in decibels. The CST Microwave Studio utilises the same definition to obtain antenna gain. In case of loss free antenna having no conductor losses, the gain is equal to directivity. Antenna gain considers dielectric and conductor losses and doesn’t consider mismatch losses.

4.5 OUTPUT FREQUENCIES

Far field f=4.917

Gain

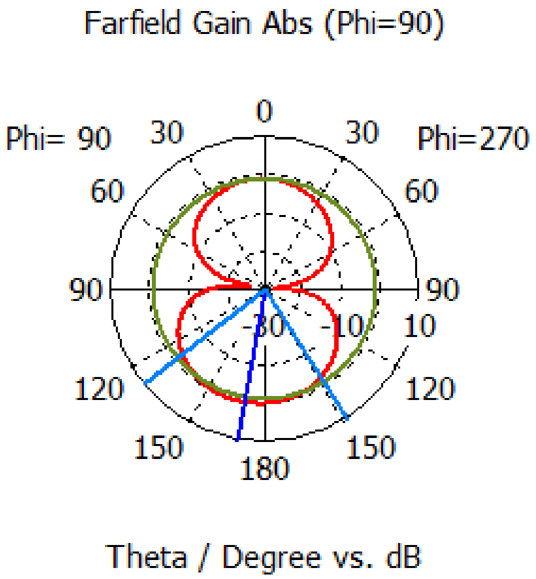

Figure 4.4 Far field gain at 4.917GHz

Frequency=4.917

Main lobe magnitude=-0.0625dB

Main lobe direction=-169.0deg.

Angular width (3 dB)=84.3deg.

Side lobe level=-1.2dB

Directivity

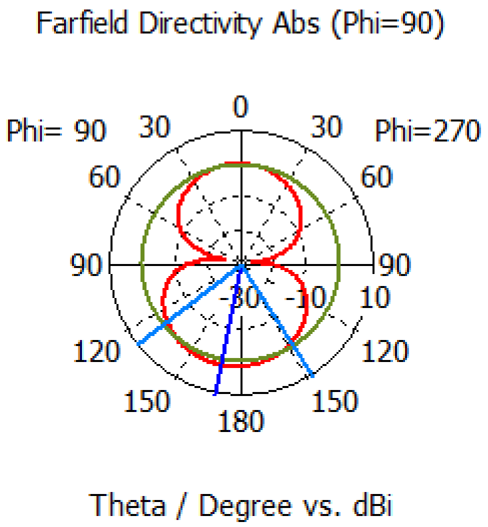

Figure 4.5 Far field directivity at 4.917GHz

Frequency=4.917

Main lobe magnitude=1.12dBi

Main lobe direction=169.0deg.

Angular width (3 dB)=84.3deg.

Side lobe level=-1.2dB

Gain in 3 Dimension

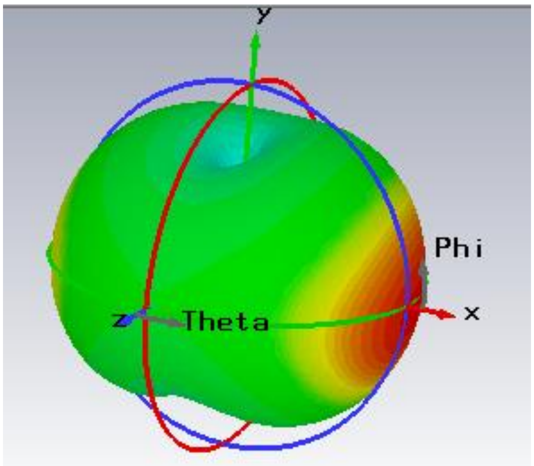

Figure 4.6 Far field gain at 4.917GHz in 3Dimension

Far field f=6.1009

Gain

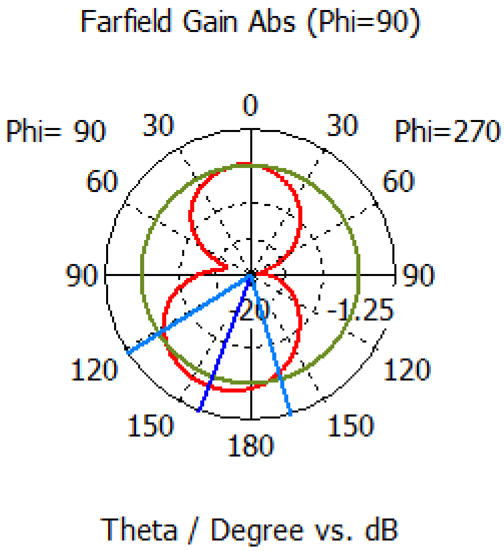

Figure 4.7 Far field gain at 6.1009GHz

Frequency=6.1009

Main lobe magnitude=0.387dB

Main lobe direction=159.0deg.

Angular width (3 dB)=73.8deg.

Side lobe level=-1.6dB

Directivity

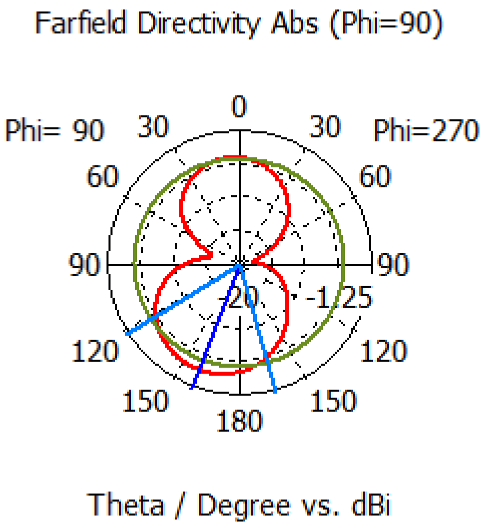

Figure 4.8 Far field directivity at 6.1009GHz

Frequency=6.1009

Main lobe magnitude=1.45dBi

Main lobe direction=159.0deg.

Angular width (3 dB)=73.8deg.

Side lobe level=-1.6dB

Gain in 3 Dimension

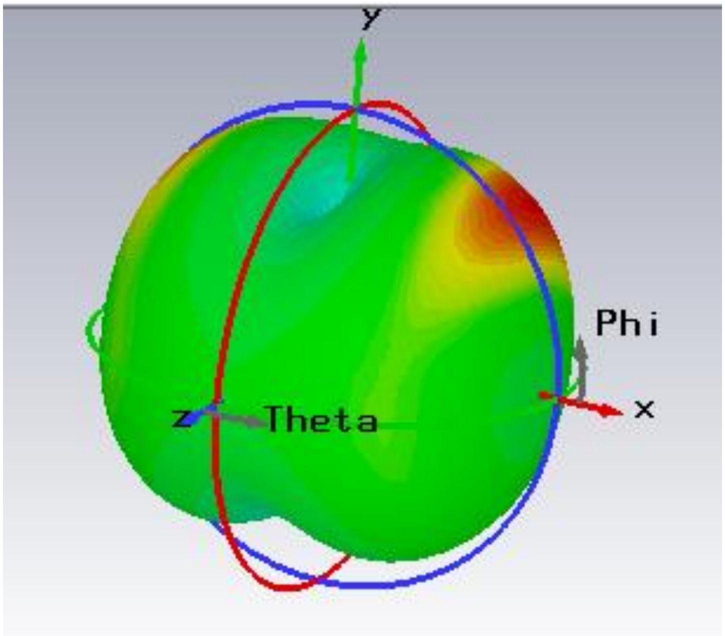

Figure 4.9 Far field gain at 6.1009GHz in 3Dimension

Far field f=10.407

Gain

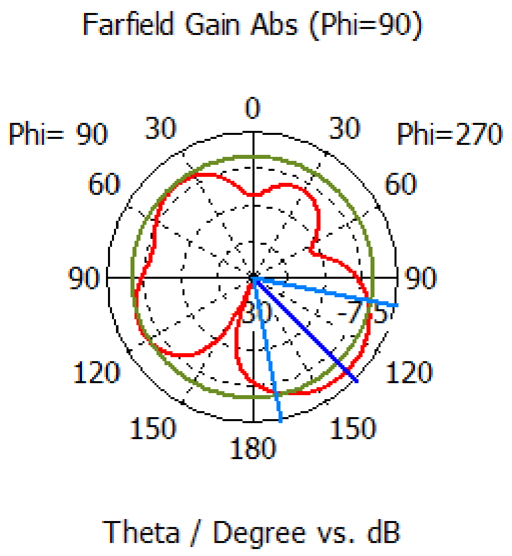

Figure 4.10 Far field gain at 10.407GHz

Frequency=10.407

Main lobe magnitude=-2.86dB

Main lobe direction=135.0deg.

Angular width (3 dB)=68.9deg.

Side lobe level=-2.0dB

Directivity

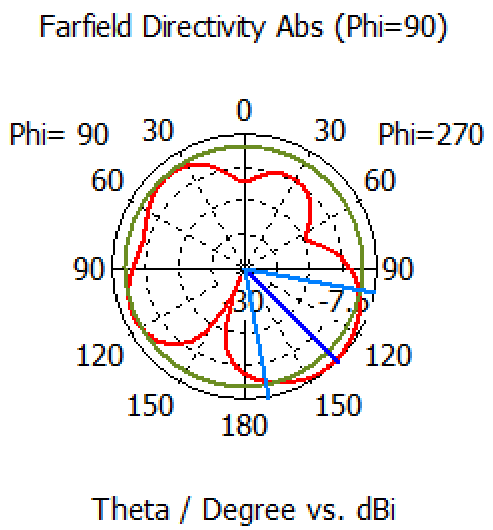

Figure 4.11 Far field directivity at 10.407GHz

Frequency=10.407

Main lobe magnitude=-0.778dBi

Main lobe direction=135.0deg.

Angular width (3 dB)=68.9deg.

Side lobe level=-2.0dB

Gain in 3 Dimension

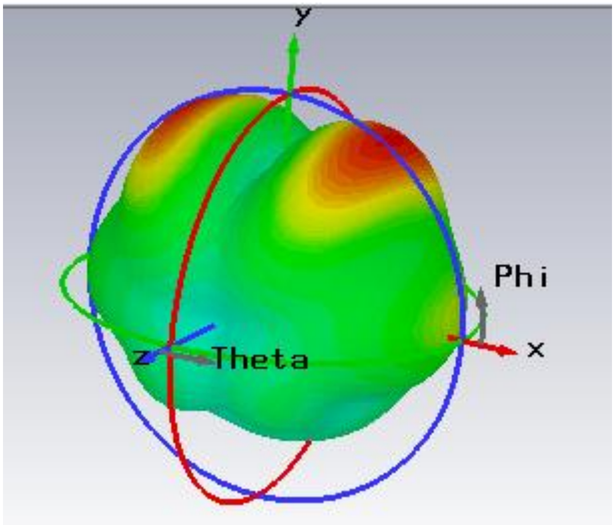

Figure 4.12 Far field gain at 10.407GHz in 3Dimension

Far field f=13.476

Gain

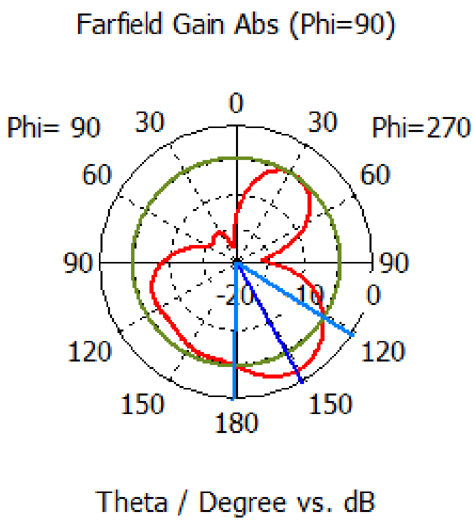

Figure 4.13 Far field gain at 13.476GHz

Frequency=13.476

Main lobe magnitude=-1.96dB

Main lobe direction=151.0deg.

Angular width (3 dB)=59.0deg.

Side lobe level=-2.7dB

Directivity

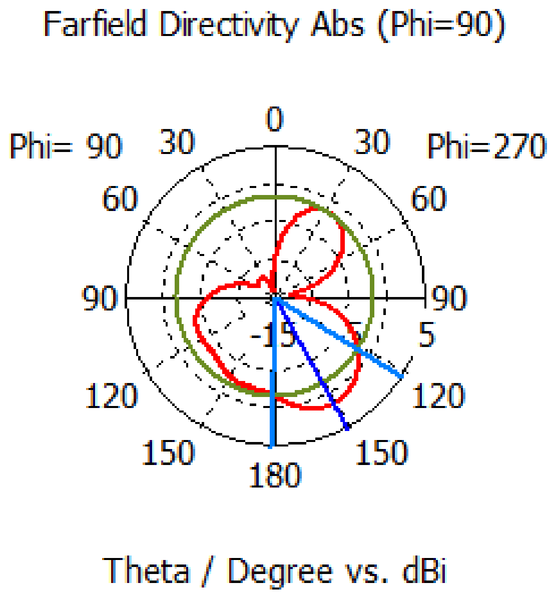

Figure 4.14 Far field directivity at 13.476GHz

Frequency=13.476

Main lobe magnitude=1.1dBi

Main lobe direction=151.0deg.

Angular width (3 dB)=59.7deg.

Side lobe level=-2.8dB

Gain in 3 Dimension

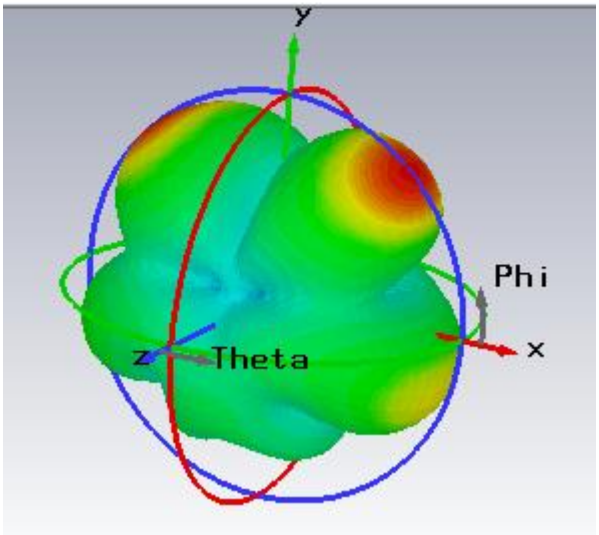

Figure 4.15 Far field gain at 13.476GHz in 3Dimension

4.6 Fabricated Antenna

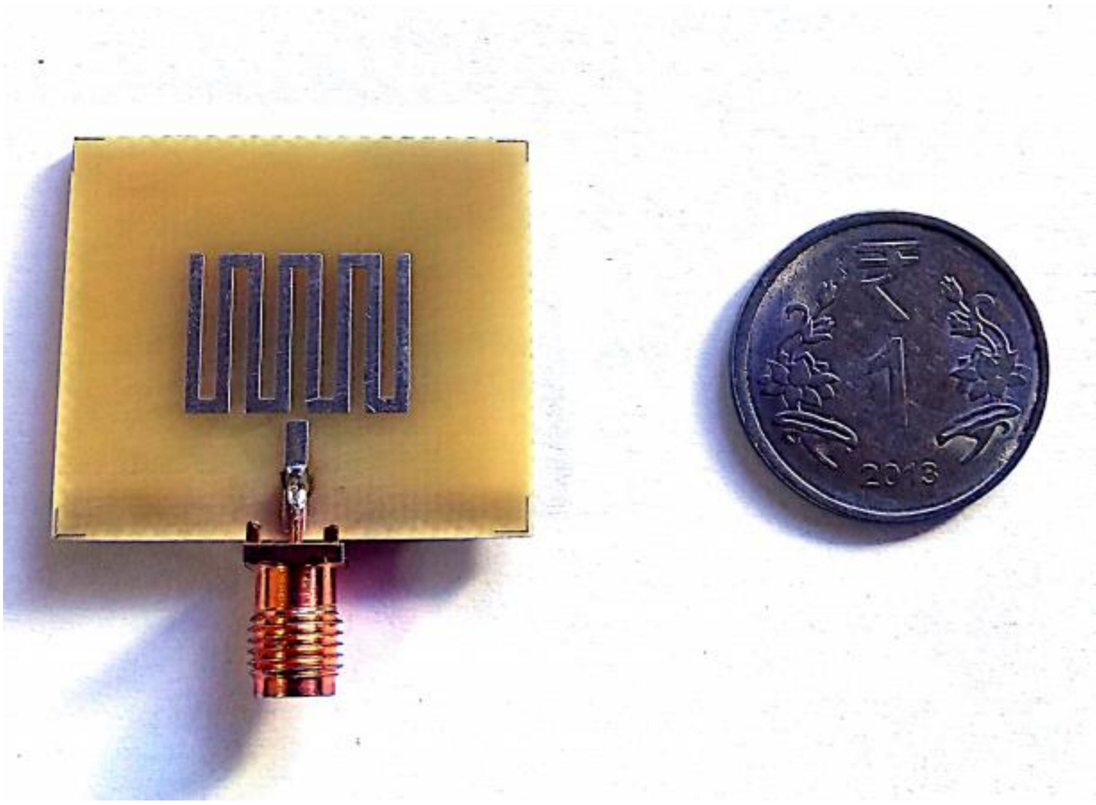

Figure 4.16 Fabricated Antenna of proposed model

CHAPTER 5

CONCLUSION

Ultra wide antenna technology has been an important area of research ever since the FCC declaration of ultra wide band frequency band in 2002. Ultra wide band antenna is essential component in the UWB system. Interference is a serious problem of UWB antenna with the existing narrow band systems. A UWB antenna with Fixed band (3.1 to10.6GHz).This characteristics of antenna has been presented by using rectangular slot on the patch. The parameter of rectangular patch UWB antenna is simulated using CST 2014 software. The rectangular UWB antenna is compact one which can easily be integrate with portable device like USB. These characteristics is achieved by varying the parameters of the proposed rectangular slot. The proposed antenna is expected to be an excellent for UWB short distance applications like military, satellite, cognitive radio etc.

5.1 FUTURE SCOPE

For the WPAN applications UWB antenna with small size is required. In near future researchers would be more engaged to find new techniques to reduce the size of UWB microstrip antenna. Ultra wideband cause interference with coexisting systems like Wi- Max (Worldwide Interoperability for Microwave Access) having operating range of 3.3GHz - 3.7GHz, ITU (international telecommunication union) with operating range of 8.025 GHz - 8.4 GHz etc. UWB antenna with dual band notch and/or triple band notch can be an objective for future work.

Fabrication of prototype antenna will be carried out in future and measured results will be compared with simulated results.

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