

RF ENERGY HARVESTING USING ENHANCED DESIGN OF FSPA

Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering

By

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SCHOOL OF ELECTRICAL AND ELECTRONICS ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)
Accredited with Grade “A” by NAAC

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MARCH – 2021.



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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **PENUGONDA MOWNIKA** (37130368) and **SHAIK HADASA** (37130368) who carried out the project entitled "**RF ENERGY HARVESTING USING ENHANCED DESIGN OF FSPA**" under our supervision from December 2020 to March 2021.

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DECLARATION

We **PENUGONDA MOWNIKA** (37130311) and **SHAIK HADASA**(37130368) hereby declare that the Project Report entitled “**RF ENERGY HARVESTING USING ENHANCED DESIGN OF FSPA**” done by us under the guidance of **Dr.G.D.ANBARASI JEBASELVI ,M.E., Ph.D., Associate Professor** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering Degree in **Electronics and Communication Engineering**.

1.)

2.)

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We are pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

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ABSTRACT

RF energy harvesting using antenna design. In that the radiation of electrons from AC to DC using the High frequency simulation software.

This deals with the suitable antennas for energy harvesting. A new folded shorted patch antenna for new application that is RF energy harvesting will bring forward and sketched. A new folded shorted patch antenna structure will joint the folded patch line and has two pairs of slotted embedded system into its neutral plane. Profile and cost are very less but ease to fabricate the folded shorted patch antenna (FSPA) will developed. Using high frequency simulator software, the new antenna performance was designed and simulated. An impedance bandwidth of 2.48% from 839 to 860MHz at the center frequency of 848 Mhz is simulated, due to utilization of abundant RF energy. The resonance frequency of the unique parts of the antenna such as the antenna and rectifier circuit is 2.45Ghz. The patch antenna was then produced and tested using Network Analyzer. In order to achieve for Direct Current output voltage-buffer; an input power level of 10 dBm was used to the patch antenna. It also shows the good stability towards gain and there is a radiation pattern in the omnidirection. The best value of load resistance to harvest maximum output Direct current as power was obtained through CST simulation. Finally, the received Radio Frequency power, the values of output Direct Current voltage and power were studied.

CHAPTER 1

INTRODUCTION

Energy reaping is an interaction wherein energy from the climate can be changed over into usable energy that can be utilized for a low force hardware. Lamentably, contrasted and the force that can be given to regular batteries, electric waves bring less energy. In a RF power collecting framework, the procured radio wire is a significant factor since it is liable for catching energy from the radiation source. Legitimate receiving wire configuration is significant on the grounds that the reception apparatus attributes, (for example, advantage, radiation design and grouped impedance) influence the potential for reaping. As of late, the sending of smaller receiving wires to remote nerve networks has pulled in expanding interest. The reception apparatus is a significant element of the RF power collecting system, which can expand the most extreme force and eliminate the brilliant RF ability to meet lawful necessities. The intention is to plan a receiving wire that can create most extreme DC yield power. The test here is to discover the energy produced by low energy utilization.

1.1 ANTENNA:



Figure no : 1.1 : ANTENNA

An **antenna** is the network which is usually passes through the metal conductors and the propagation is done between space and current of radio waves, there by used in transmission or receiving the signals.

some amount of the conductors passes current to the antenna elements, and that antenna reflects radiated energy from the current electromagnetic waves. In receiver side, an antenna intercept the power of an electromagnetic wave in order to manufacture a small amount of current at its terminals, and that terminal is put in to a receiver to be boosted. Antennas are crucial bits of all wireless equipment.

An antenna is connected to the transmitter and on receiver array elements to be mapped out of all horizontal electromagnetic waves in a specified direction. It may include the elements which are not serving the electromagnetic waves into the beams. The electromagnetic field sustains the signals through the air at the light speed with no loss of the transmission. The antenna is having an omnidirectional antenna, gives an example of automobile's antenna. It divides the radiation energy which is equally in the directional manner, in which the energy is propagating through more of 1 directional. It completes the uniform stability of omnidirectional antenna is not possible physically.

PARAMETERS IN ANTENNA

An antenna conducts the radiation of the radiated electrons in the conductors transmitting side of the electromagnetic waves in the form of energy in the space receiver of the collected radio energy through space.

1.1.1 GAIN OF POWER

Simply **gain** is a which measures the antenna ability to give direct power input into the radiating energy in specified direction. It is also sometimes gives us an intensity of the radiation pattern of the peak radiation. The assumption of the density of a power is to reflect back the radiated power by the isotropic antenna to give almost equal stability in some directions and it is found to be dividing the power radiation through sphere area as $4\pi R^2$. This antenna is responsible for directing the measurement of efficiency of 100%. An antenna's efficiency Σ antenna and directivity D :

$$G = \Sigma \text{ antenna } .D$$

1.1.2 EFFICIENCY

The **ability** of Σ antenna is an antenna that the power radiated is P_0 which is divided by the power input at the feed point

$$\Sigma \text{ antenna} = P_0/P_{in}$$

A transmitting antenna supplies power by feed line, a line which connects the antenna to a electromagnetic transmitter. The P_{in} to the antenna gives the power input with typically the supplied terminals of antenna to the feed line of the radiated power. So, antenna is having lossless power which include power loss due to some heat in the line of feed and reflects back to the mismatch of the impedance.

The theorem which gives the reciprocity by having the properties of the antenna such as the ability of efficiency, gain power, directivity are same in receiving the used antenna from transmitter side.

1.1.3 DIRECTIVITY

The directivity of an antenna is persistent by its pattern, it allocates in 3 dimensional directions with the radiation. The direction is to increase or decrease the antenna to their extent, which moves radiated power to greater existence. The spherical directions of the spherical coordinates where the θ is the angle between the projected line of the given plane.

1.1.4 PATH LOSS

Path loss basically contains the loss caused by the physical phenomenon of the electromagnetic waves of the expansion in the space free manner. The propagation loss gives us the basic idea to not to do transparent form of the electromagnetic waves through some medium.

$$PL = P_t/P_r$$

1.1.5 RETURN LOSS

The losses may change with the help of the return loss when testing the simulation of the antenna. And it is then compared with the suitable form of the stimulated simulation of the matched impedance of the maximum power to be transformed or transferred.

The return loss is defined by the power incident to the power reflected in some medium of vacuum from the source of the antenna.

The mathematical formulae is

$$R = 10\log_{10}(P_i/P_r)$$

CHAPTER 2

LITERATURE SURVEY

2.1 Antenna design for RF energy harvesting in sensor networks

In this article, another FSPA will be proposed and intended for use in another system gathering RF outside force. The new FSPA construction will meet the prerequisites of the collapsing bowing line and the two spaces inserted in its ground plane. A more modest structure factor, lower cost, and simplicity of planning a collapsed fix receiving wire (FSPA) will be presented. It is prescribed to utilize PC reproduction innovation (CST) for development and activity of the receiving.

2.2 Design of an Enhanced RF Energy Harvesting System

In this article, the way toward creating energy collecting gadgets is proposed. This plan can charge low power utilization sensors by introducing encompassing (RF) radio waves. The innovation incorporates the utilisation of a high-thickness monopole reception apparatus exhibit and motions toward expand the RF power got by the receiving energy. Moreover, a lab for the proposed RF power gathering system has been constructed and tried in the research center.

2.3 Radio frequency energy harvesting for autonomous systems

Ivan K. Ivanov

Radio Frequency Energy Harvesting (RFEH) is an innovation that empowers electrical energy to be moved from a solitary wellspring of energy to different gadgets. The principle parts of this innovation are links and fix circuits that convert radio recurrence signals into direct current. Gadgets utilising radio recurrence (RF) can be coordinated into remote

telemetry frameworks, and can be utilized for telephone charging. Notwithstanding free frameworks, for example, WSN and RFID, the billions of portable hardware markets from GSM cells to MP3 players may likewise become appealing applications for RF energy reaping if energy prerequisites are met.

2.4 METHOD DESIGNING

The analysis of the designing method gives us a simple formula to formulate the structural procedure for explaining a rectangular antenna patched with the microstrip.

This procedure will find the capacity of 3 essential parts to be parameterized for designing an antenna is operated frequency f , the constant ϵ_r and the dielectric height is h .

2.5 THE MICROSTRIP PATCH ANTENNA CALCULATION

PROCESSDESIGN EQUATION:

Calculation process of the antenna patched microstrip

Step 1: Width calculation (W) -

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

Step 2: Dielectric constant calculation is effective and depends on the height and dielectric constants to be calculated.

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

Step 3: Length capacity of the effective calculation

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

Step 4: ΔL is the length extension to be calculated.

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

Step 5: Length of the patch calculation.

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

The following parameters are used in antenna are

f_0 is the frequency of resonance

W is the patch width

l is the distance of the Patch

h is the diameter

ϵ_r is the relative Permittivity of the dielectric element

c is the Speed of light: 3×10^8

2.6 ADVANTAGES AND DISADVANTAGES :

The merits of microstrip patch antennas are:

- (1) The planar is a shaped surface
- (2) Profile is very less
- (3) Radar cross section is lesser
- (4) Printed technology to be implemented
- (5) Circuit elements are integrated.
- (6) Dual polarized operations be structured.
- (7) Multi-frequency operates in the plotted manner.

These merits make microstrip patch antennas more acceptable for the crafts to be done in air, space or in missiles. And they do not involve the dynamics of the motion vehicles.

Their profiles gives a comparison with arrays of microstrip of the patch antenna of the planar structure to be in the wing shape manner. The listed particulates that the microstrip antenna become the good antenna to design a wireless communication.

2.6.1 DISADVANTAGES OF MICROSTRIP PATCH ANTENNAS

There are several demerits involves in microstrip patch antennas.

(1) The microstrip antenna gives the bandwidth less than 5%. There are various bandwidth widening methods to develop the narrow impedance. The bandwidth has achieved above 55%. This is true that the bandwidth is achieved using the volume increment.

(2) Due to the small separation between the radiating patch and its ground plane, the microstrip antenna can handle relatively low RF power. The average power considered safe is a few tens of watts.

(3) While a single patch element generally incurs very little loss because it is only about one-half wave long, microstrip arrays generally have larger ohmic loss than arrays of other types of antennas of equivalent aperture size. This ohmic loss occurs in the dielectric element and the metal conductor of the microstrip feed line network and power dividing circuit.

CHAPTER 3

EXISTING AND PROPOSED SYSTEM

3.1 EXISTING SYSTEM:

The work and development can charge little power sensors by getting the encompassing radio waves, and this plan is valuable for some wireless applications.

3.2 PROPOSED SYSTEM

- Collecting energy or biting energy in the environment is probably the most ideal approaches to expand the existence of a remote organization by supplanting the battery.
- Frequency necessities are predictable with past work. Be that as it may, to decrease the size of the radio wire, another FSPA reception apparatus was planned.
- The proposed new antenna intended to work at 850 Mhz. Hence, to accomplish the necessities determination, further examination and improvement should be thought of.

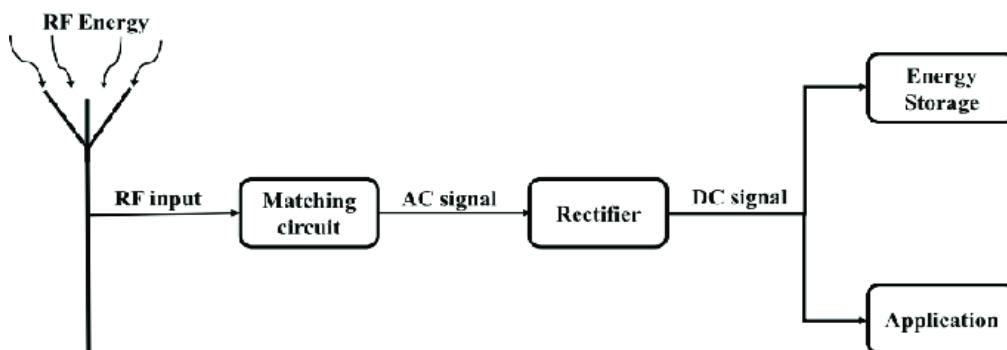


Figure no : 3.1 : Block diagram of RF ENERGY HARVESTING

3.3 WORK FLOW WITH HARDWARE AND SOFTWARE REQUIREMENTS

- The software used to reap RF power is “high recurrence structure exciter” (or) “re-enactment innovation”.
- EM reproduction can be delegated an elite capacity.
- HFSS (or) CST applications should meet the most elevated necessities as far as CPU, RAM, and illustrations information to accomplish ideal execution.

- It is likewise important to guarantee that the work environment or worker has adequate limit and cooling.

3.4 SIMULATION TOOL

Simulation tool gives the ansys hfss 3d electromagnetic radiation software in designing a very high frequency products through electronic media. The components which filters the unwanted signals through the media of the arrays , Radio frequencies, connectors in the printed circuits of the common engineering techniques. The system which specify the design of the established manner to develop the things which are related to the antenna designing of the digitalized devices.

This recruits the flexible solvation of an builtin functions to give support to the performed em problems in all 3D unparalleled radiations. It is very well known that this will helps in sorting the technique which are focused and stable to be developed with the standard positioning manner. A complete task to be completed with in the advanced product of the simulated content by virtue of the accelerating sophisticated solvating solvers to this technology.

The overall set of the configuration to be performed in the simulated software is to set the address of the electromagnetic spectrum of the scale to be passive form integrated circuit components for large scale industrial EM analysis. The antenna is having a reliable simulation to perform the suitable stability of the gain to be in part of the mesh to be sorted. This will helps us in forming an accurate solution to multiple simulators to generate the mesh.

The primary use of the ansys hfss is that which will helps in requiring R & D prototype by increasing or decreasing an antenna designing time to boosts the signals to be applied on the specific reliability antenna and the performance is based on the beat of the conflicts and the displayed antenna is kept in such a virtual prototype.

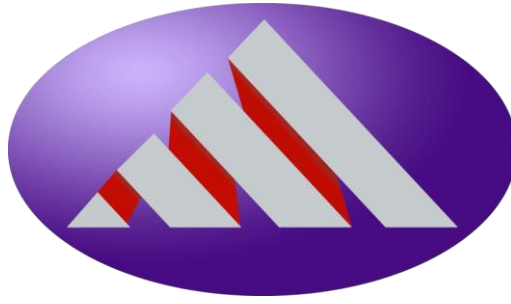


Figure no : 3.2 ANSYS HFSS 15.0 64 BIT

3.5 ANSOFT MODE

There are several panels to be taken in part of ansof hfss window

3.5.1 MANAGERAL PROJECT – This project suggests the tree to be designed in the list of the project to be in structured manner.



Figure no : 3.3: project manager

3.5.2 A Manager Messages- It allows the visibility of the error to occur before the simulation begin .

3.1.1 A Window Property- This property helps in capturing and allowing the parameters to be modeled or attributed.

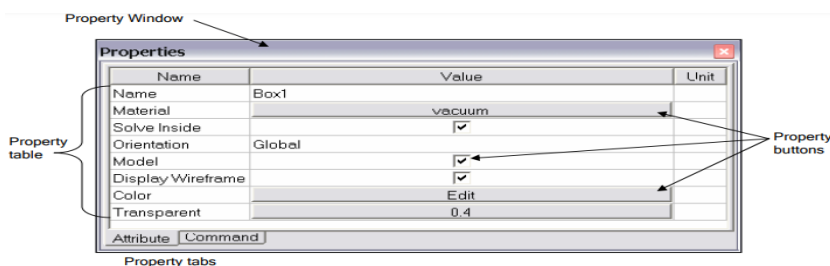


Figure no : 3.4 : property window

3.1.2 A Window Progression –The window progress capture the object in the solution progress.

3.1.3 A 3D Window Model- This model contains the window which specify the particular model tree for designing and it should be in activation mode.

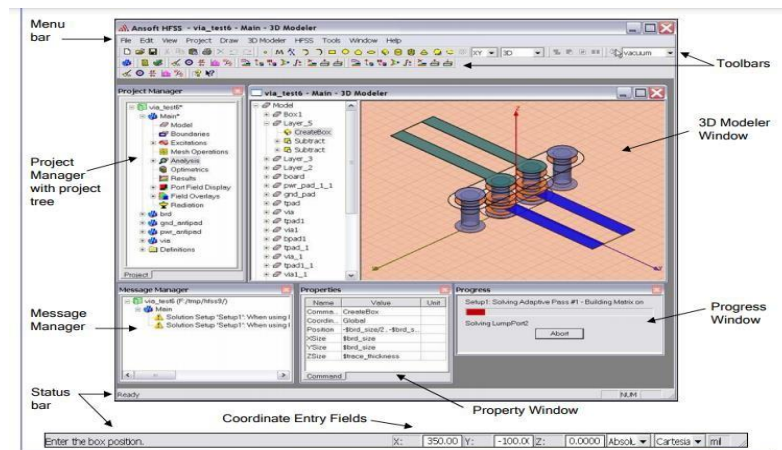


Figure no : 3.5 : 3D Modeler Window

3.2 ANSOFT 3D MODELER

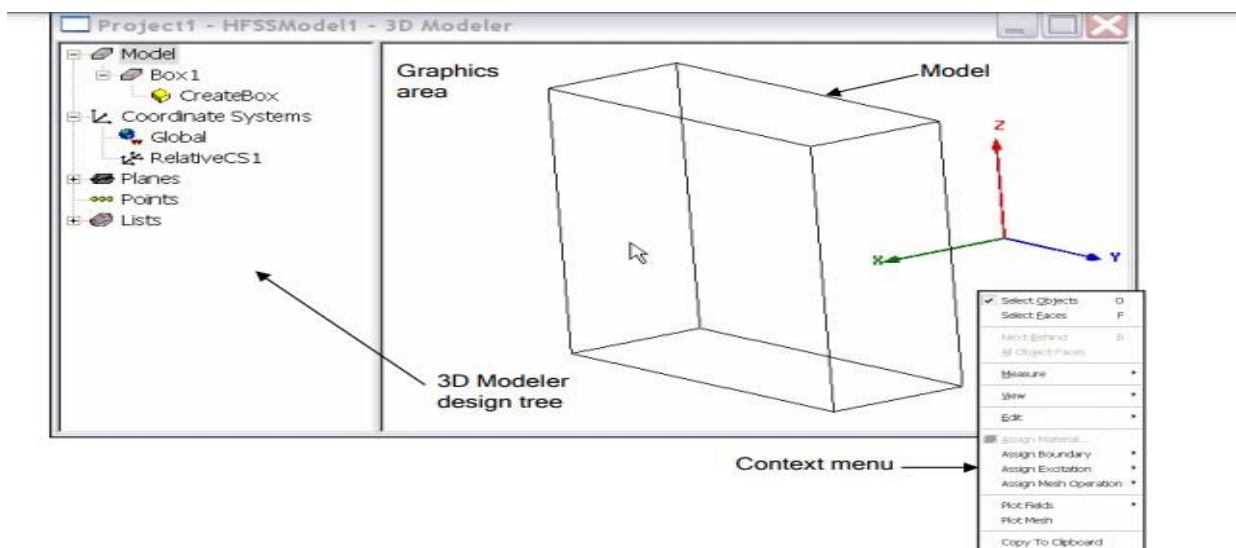


Figure no : 3.6 : ansoft 3D modeler

3.3 DESIGNING A WINDOW

Each and every design is having a project with multiple designing techniques with the help of this ansoft HFSS software and is captured with the help of the design window.

The title bar is redrawn by dragging through a corner or border with the help of the title bar. This will give the establishes design openings and the icons is sometimes detected or not detected. They resize some important open documents.

There is a chance to materialize the bottom parts of the ansoft hfss software to arrange the items in menu or a title bar.

The symbols which give the icons to dispose and select menu items from windows and also sometimes it gets cascaded with the help of the vertical or horizontal sizes.

The icons are detected but it depends on the suitability of the simulation software of the particular development of the document.

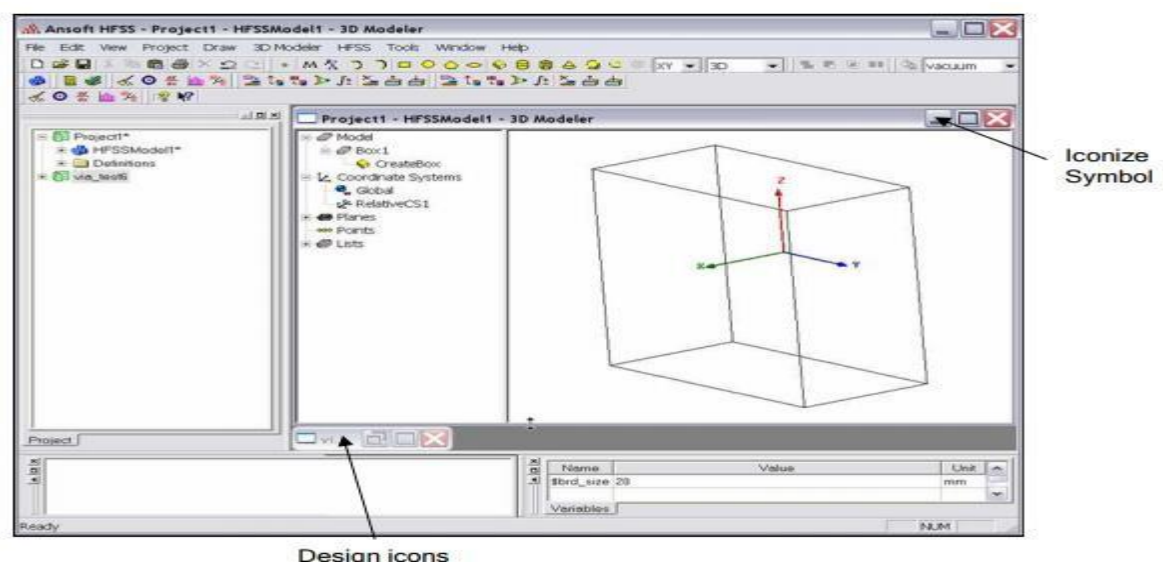


Figure no : 3.7 Ansoft HFSS window

3.3 TOOL BUTTONS

The buttons which gives a toolbar as a time saving approach which are used frequently. The availability of the toolbar buttons helps in capturing and displayed in the initial screen of the window. It was probably suitable for the personalized the toolbars in the way. They are not arranging the software with the displayed selection directly through the related type of the antenna.

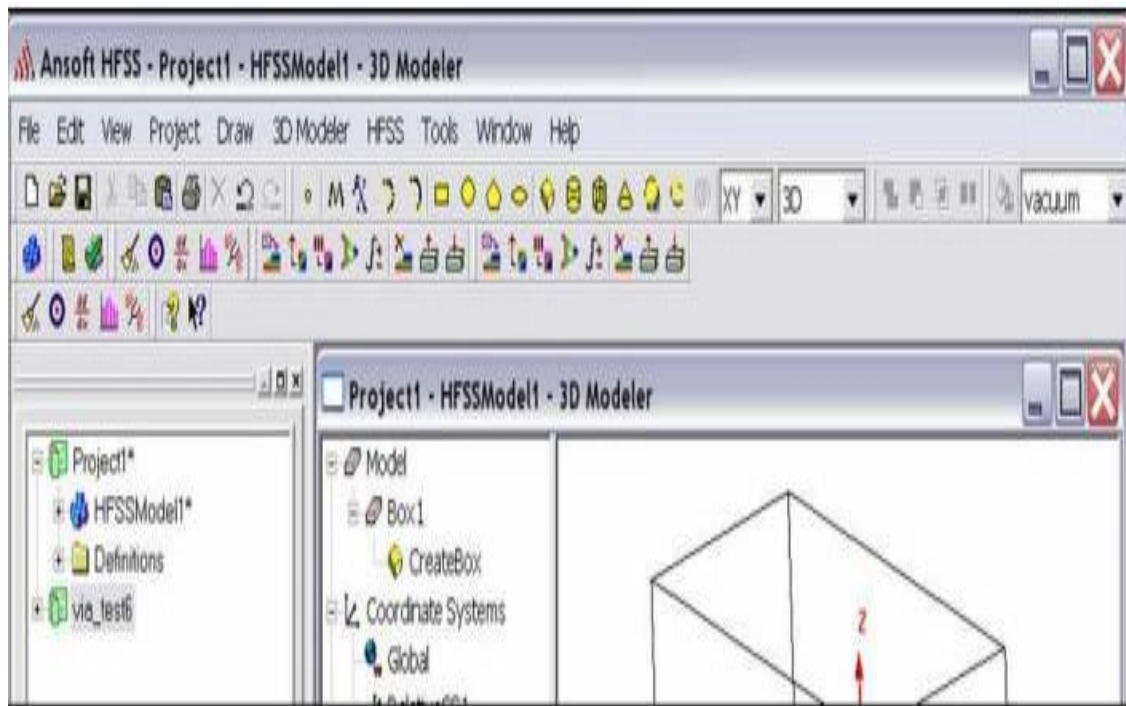


Figure no : 3.8 Toolbars

3.4 Ansoft HFSS WORK STATION

The Ansoft HFSS work station supplies an inbuilt interface for growing the device model, which creates and develops and important steps to be followed:

1. The generation of the parametric model gives the implementation of the geometrical boundaries and excitations.
2. This setup follows the solution and frequency sweep analysis setup.
3. The plotted field gives the resultant of 2D communication.
4. The loop process solve the solution automatically.

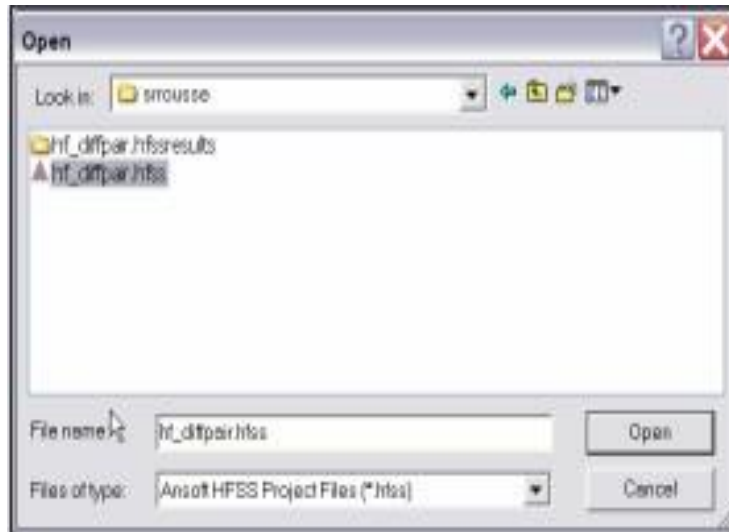


Figure no : 3.10 Window to Open Project

3.6 SOLUTION SET TYPE

The report tells us that the solution setup is determining the result to how the radiation are done in the solution type have the convergence of the antenna. There is some suitable forms of the solution set type of antenna are available:

3.11.1. Modal Driven – The matrix which helps in modal based solutions to be parameterized manner to convey the information in the modal based S – parameter of the incident and reflection of the mode of waveguide.

3.11.2. Terminal Driven – The matrix which helps in calculating the terminal based parameter to form a multiconductor port line. It establishes the voltage and current in the terminal side.

3.11.3. Mode of Eigen – The resonances of the structure determines the availability of solving certain problems in the resonant frequency of the fields at some antenna's.

The solution setup types:

1. Choose one of the following:
 1. Modal Driven
 2. Terminal Driven
 3. Mode of eigen

2. Press the OK button



Figure no : 3.11 solution type window

3.7 CREATION OF THE PARAMETRIC MODEL

This model develops the use of flexibility and the power is unique in all the abilities of the parametric designs. There is minimum editing of full complexed macros history. The main purpose of this model is to provide the summary of the 3D modeling capacity. By knowing some basic concepts there is outline manner which will be able to take merits of the features offered to set a 3D parametric modeler.

Summary of the pictures which gives a brief idea on the modeler window.

3D Modeler Tree Design – The object dependency and attributes follows the capability of the user interface to face the challenges and gives the essential parts of the 3D design tree. This tree shows how they access the structured components to the attributes and objects of the interface.

3.7.1 Context Menu – These menus are flexibly accessing techniques used to command the frequently used current context of the menu. They provide some contents to be done with the drastical change in the availability of the interface by clicking with the menu of the selected right mouse bit of the button.

3.7.2 Graphics – There is a interaction between the elements to be structured in a very well designed manner with the help of the area of graphics designing.

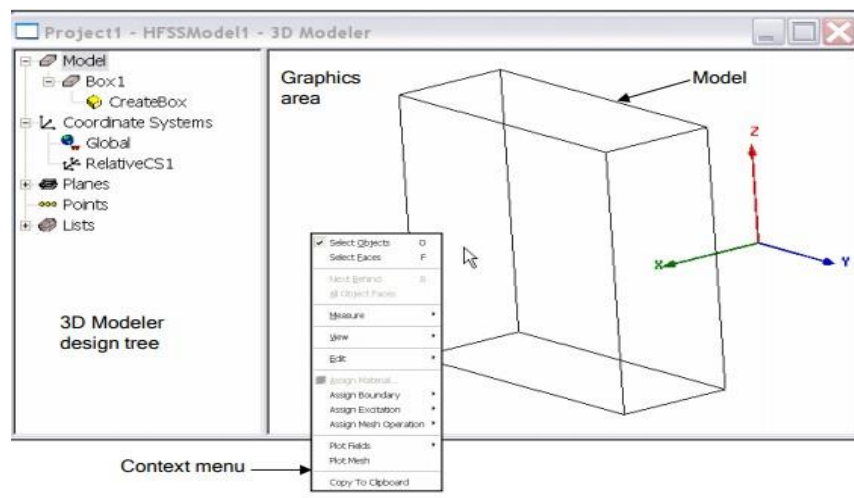


Figure no : 3.12 Graphics Area

With the help of 2 additional bits of the interface collaboration is done in the modeler of antenna design

3.7.3 Window Property – This window is used in visible or in a viewed manner to modify the attributes and objects with dimensions.

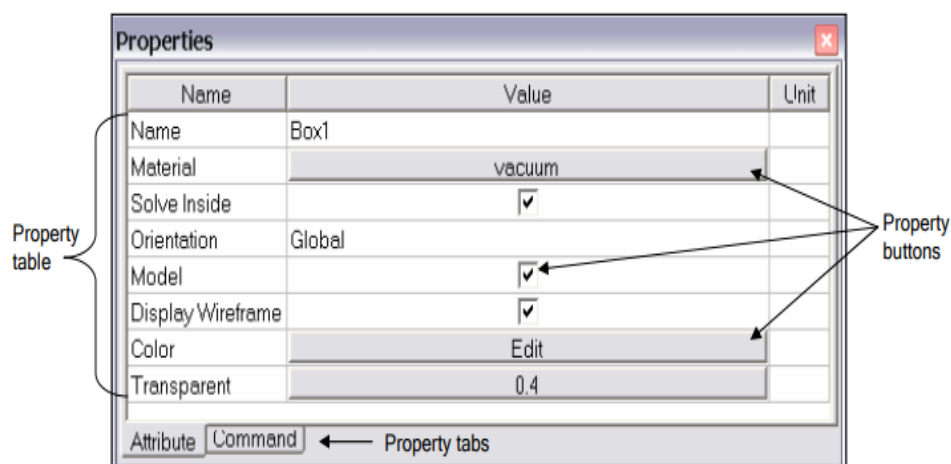


Figure no : 3.13 Property window

3.7.4 Entry Coordinate – The Entry Coordinate on the Ansoft Status Coordinate Entry of HFSS Desktop Window displays the Coordinate Entry fields that can be used to define points or offsets during the creation of structural objects

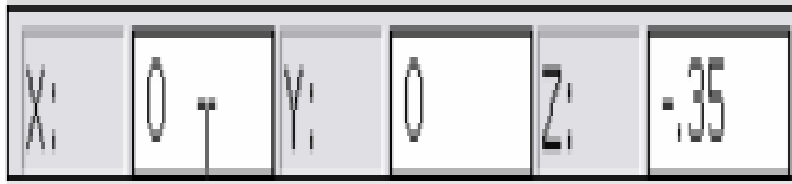


Figure no : 3.14 Entry coordinate

3.7.5 ACTIVATION CURSOR

The activation cursor helps in referring different types of the object creation which is applicable to allow the drastical change in the graphical area in current position. There is an object creation creation which displayed the entry cocoordination of the ansoft HFSS software.

If the object is not developed or created the activation cursor remains unchanged and it will set to dynamic sections of selection. The overall summary of the object selection is having more and more detailed manner.

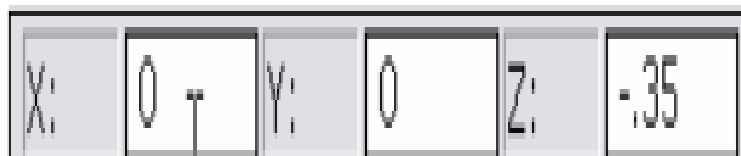


Figure no : 3.15 Active cursor

3.7.6 GRID PLANE

The designed grid primitives having a plane in the reduced creation of objects. The plane do not have the user to limit the tow dimensional coordinates but instead of involving some other phenominal guide to simplify the structure privileged in primitive manner. This constituted by the active group to active grid of the reviwing planes. They determined the creation of the unique structure with unique creation and viewing manner

3.8 Create and visualization of simple structure

Create a 3D designing objects which is accomplished by participated the following steps:

1. Setup a plane of grid.

2. The object base shape is created.

3. Height must be setup.

3.8.1 CREATING A BOX

This box contain the demonstrated steps by creating a box. These steps allows the hfss software design to perform the created projects. The 3 points establish the box to be created with the 2 forms of the rectangular base and the 3rd setup should be the height of the box.

1: The starting point of the rectangular base point is determined

2: The magnitude of the box is determined

3: Box height should be measured.

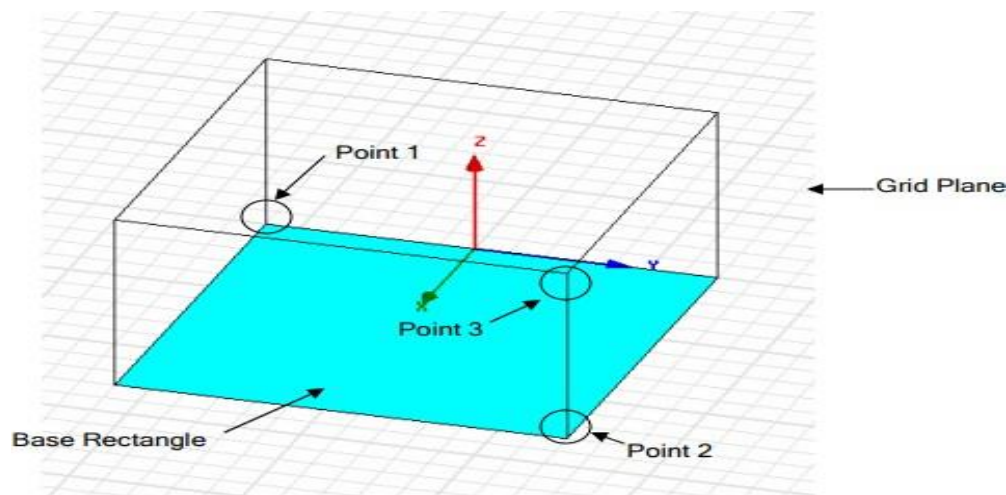
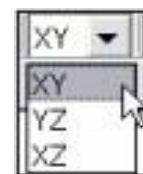


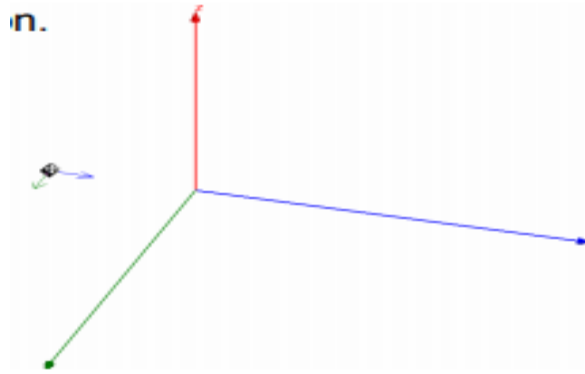
Figure no : 3.16 simple structure

1. 3D Modeler > Grid Plane > XY ,Click the item.

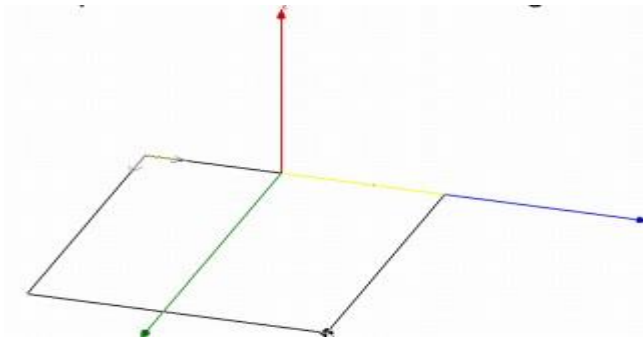
2. With help of mouse implement the shape of the base



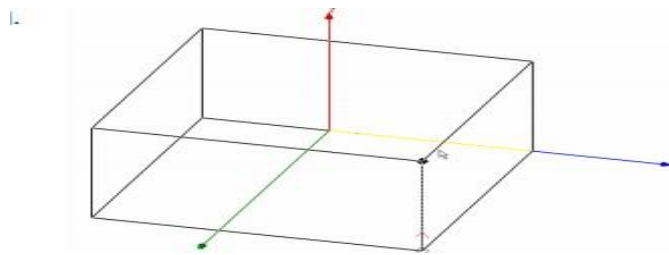
1. The initial point to be substituted by positioning and clicking the left button of the active cursor.



2. The base rectangle helps in forming the left button to be placed in the active cursor.



3. Arranging the cursor by setting up the height and click on the left button.



3.9 PROPERTIES OF OBJECT

This property appears with the help of completion of the structure sketching and the developed object. The maintenance of the position and magnitude of the object be modified. This method always allows the objects by selecting the estimated values with the corresponding correcting values in the dialog box.

This property dialog allows the equation to accept the summary by entering into the object property for more detailed manner.

Each and every object having 2 types of properties

1. Command property is the primitive command used to define the structure
2. Attribute property describe the solving and capturing properties.

3.9.1 COMMAND WINDOW

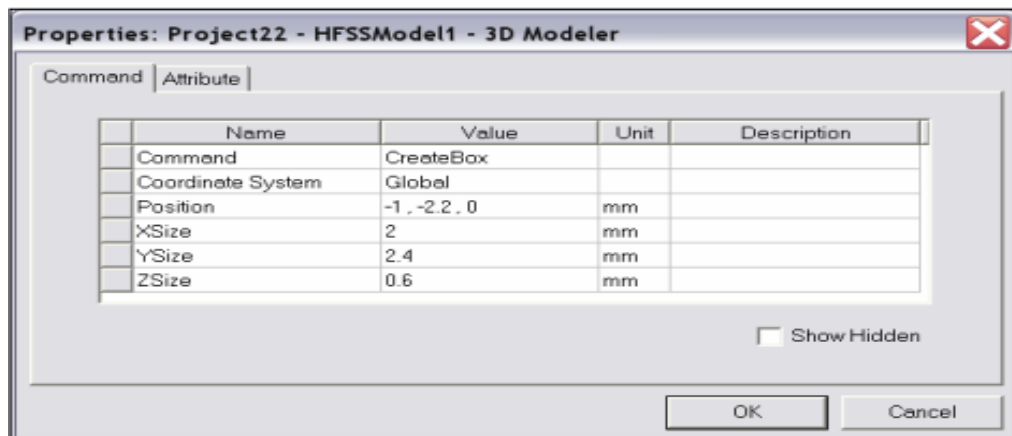


Figure no : 3.17 Command Window

3.9.2 ATTRIBUTES WINDOW

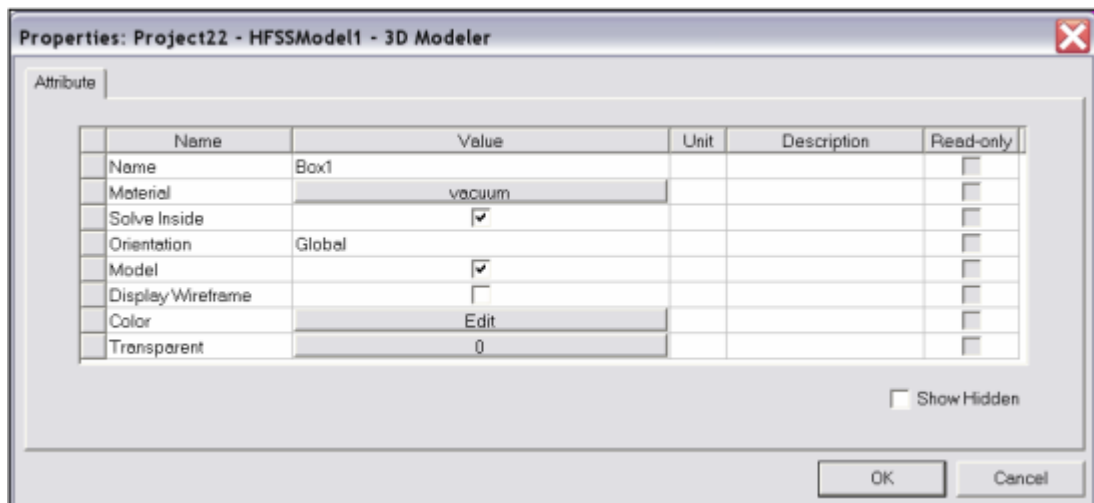


Figure no : 3.18 Attributes Window

3.10 CREATING A SUBSTRATE

Element or dielectric medium is a case metallic sheet antenna is plays the main role in fabricating the entire microstrip antenna functioning. This substrate in microstrip antennas is a principle usefull in supporting the antenna designing through mechanism. This will helps in the formation of the substrate to be dielectric in nature and perform the circuit to be affected by electrical material. It satisfy the requirements of the mechanisms to meet their antenna needs. Correctness is must on the basis of cost, efficiency and size. Substrate are needed for improving stability gain of the electrical and mechanical continuous layer in an insulating material. Used to decrease the size of the antenna and can help to develop the varying time of the stimulated antenna.

This property appears with the help of completion of the structure sketching and the developed object. The maintainance of the position and magnitude of the object be modified. This method always allows the objects by selecting the estimated values with the corresponding correcting values in the dialog box.

This property dialog allows the equation to accept the summary by entering into the object property for more detailed manner.

The designed grid primitives having a plane in the reduced creation of objects. The plane do not have the user to limit the tow dimensional coordinates but instead of involving some other phenominal guide to simplify the structure privileged in primitive manner. This constituted by the active group to active grid of the reviwing planes.They determined the creation of the unique structure with unique creation and viewing manner.

This model develops the use of flexibility and the power is unique in all the abilities of the parametric designs. There is minimum editing of full complexed macros history. The main purpose of this model is to provide the summary of the 3D modeling capacity. By knowning some basic concepts there is outline manner which will be able to take merits of the features offered to set a 3D parametric modeler.

FR4 Epoxy substrate

Position :0,0,0 X size:16 Y size:18 Z size: 1.6

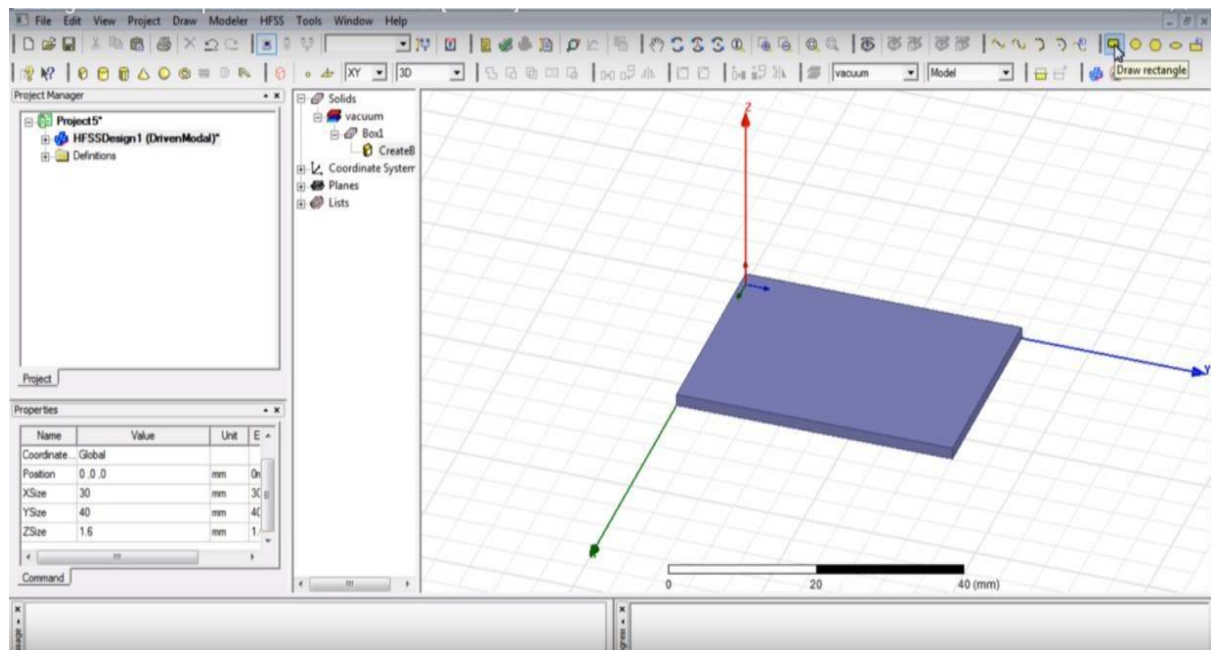


Figure No:3.19. FR4 Epoxy substrate

3.11 GROUND PLANE

The plane which is electrically surface connected to the neutral point of the conducting surface. These are having a unique quality to be separated by the area of the electrically charged poles having a dipole moment of the unique meanings. The neutral point compares the theory with the help of antenna such as the Earth's wavelength which connects the transmission neutral wire and serves the radiating energy through electromagnetic wave. In the circuits the plane acts as a neutral plane having larger area to cover the power supply in the unique components

3.12 PATCHED ANTENNA

It is a type of antenna which is having a very less profile simulated on the flat mounted surface of the patch antenna. The components has the suitable radiated power in the situation to be developed in a planar rectangular sheet to be patched on the metal surface called the plane ground of the large sheet.

The length of the resonant antenna has the line which transmits the shorter wavelength for the microstrip to be executed. The antenna helps in maintaining the simulated power possible at the frequencies at which the patches the small values conveniently. The wide use of the portable form of the devices helps in forming the fabrication work in the circuit boards to be printed. There are multiple patches to be with the same substrate conveniently of making the gain value high.

The operation makes the antenna used in the phones to be shorted in one part of the antenna. The neutral point to be placed in the suitable form of the partly etched antenna designing. The printed model varies in order to be very versatile antenna for the dual operation.

- **Position:3.5,5,1.6 Axis: z X size :9 Y size: 12**

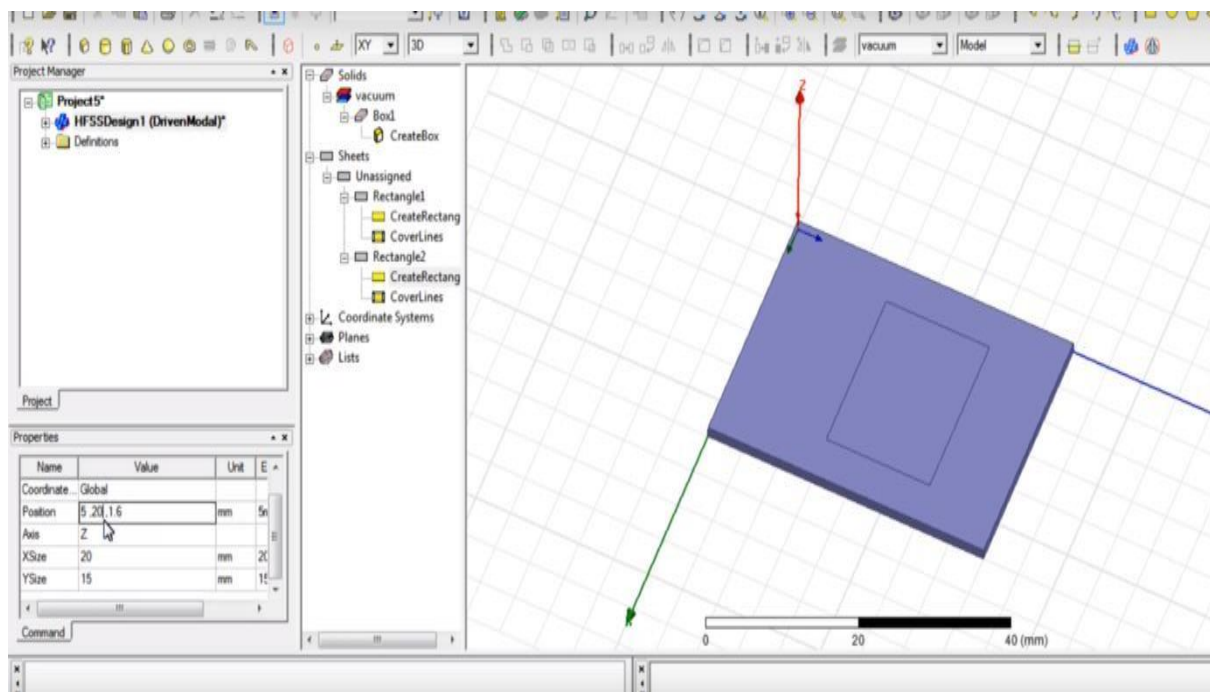


Figure no : 3.20 patch antenna

3.13 LINE OF FEED

The antenna is capable of transmitting the line of feed to be considered as the electromagnetic radiation of the signal to be travelled by the radiation of electrons. These feeder line feeds the capacity of how much the power of electrons is feed into the signaling technique.

The radio frequency which helps in finding the transmission side of the radiation in the electromagnetic waves. The conversion of the voltages to be satisfied with the help of involving in the receiver. This capacity carry signals in the specialized manner with the type of cabled nature of the transmission. The epoxy material is laminated with the help of the NEMA glass graded designation. It is composed of dielectric constant material woven fiber glass with epoxy self extinguishing. It is a suitable material for antenna such as dielectric constant and loss tangent. S11 is the return loss parameter. It is V like structure. It is used to determined the power of the signal returned by a transmission line. It represents how much power is reflected from antenna.

Position: 7,0,1.6 Axis: z Xsize: 2 Y size: 5

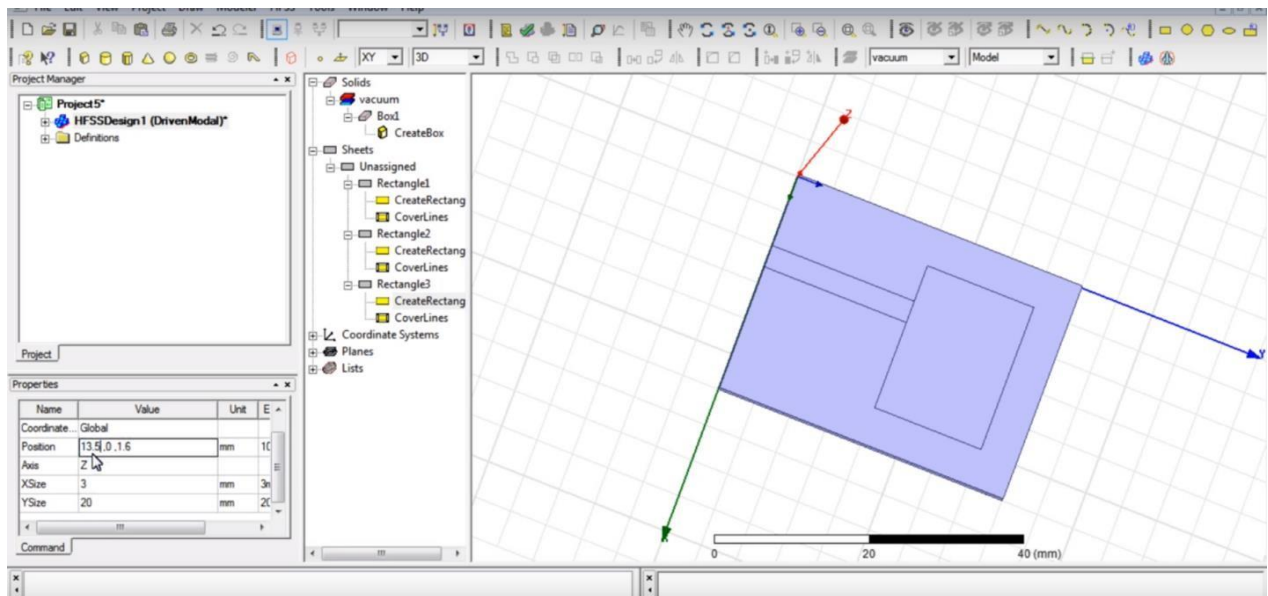
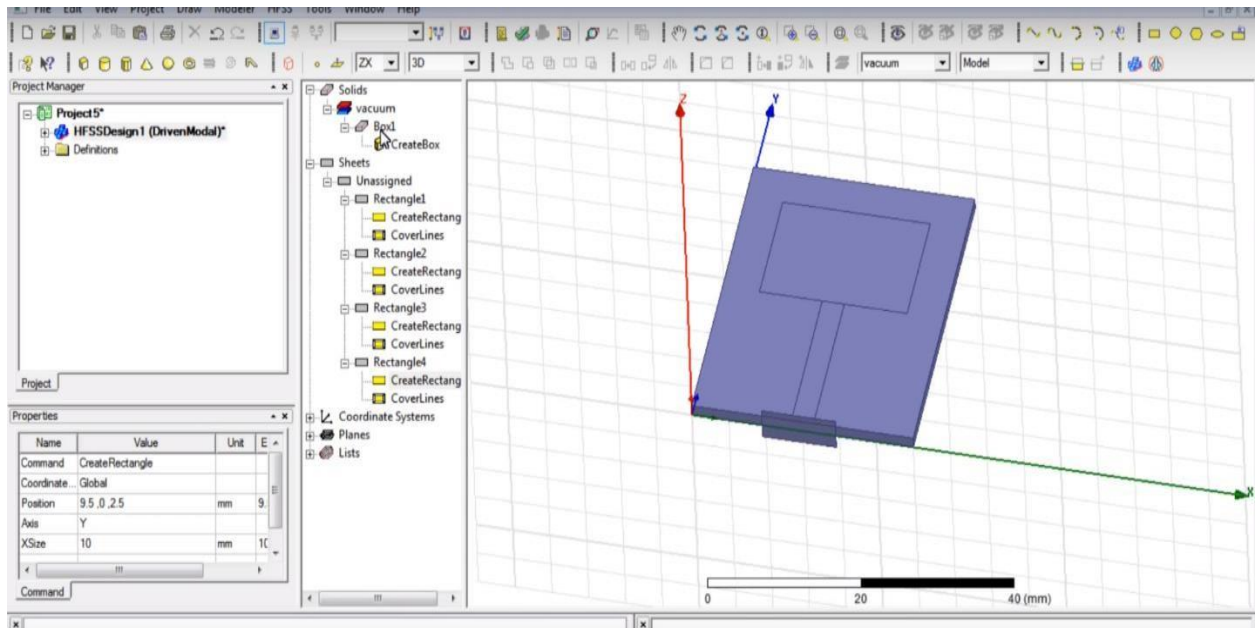


Figure no : 3.21 **Feed line**

3.14 PORT

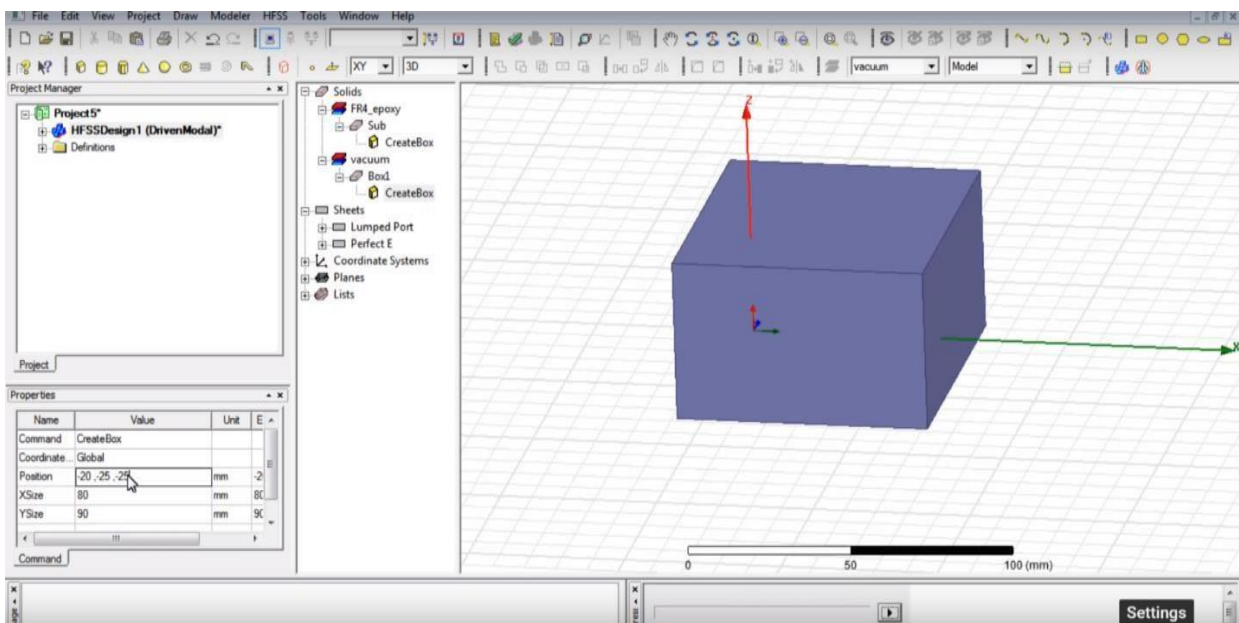
The port which is basically a term for transmitting the signals under some condition. For some conditions the operation of LTE mode is in the direction downwards to be independent the assumed channel of the separated antenna of the logical port to be establishes.

Position: 7,0,1.6 Axis: y X size: 2 Z size:-1.6



3.15 BOUNDARY

Position: -3.4,-3.4,-3.4 X size: 22.8 Y size: 25.8 Z size: 8.4



3.16 ANTENNA DESIGN MODEL

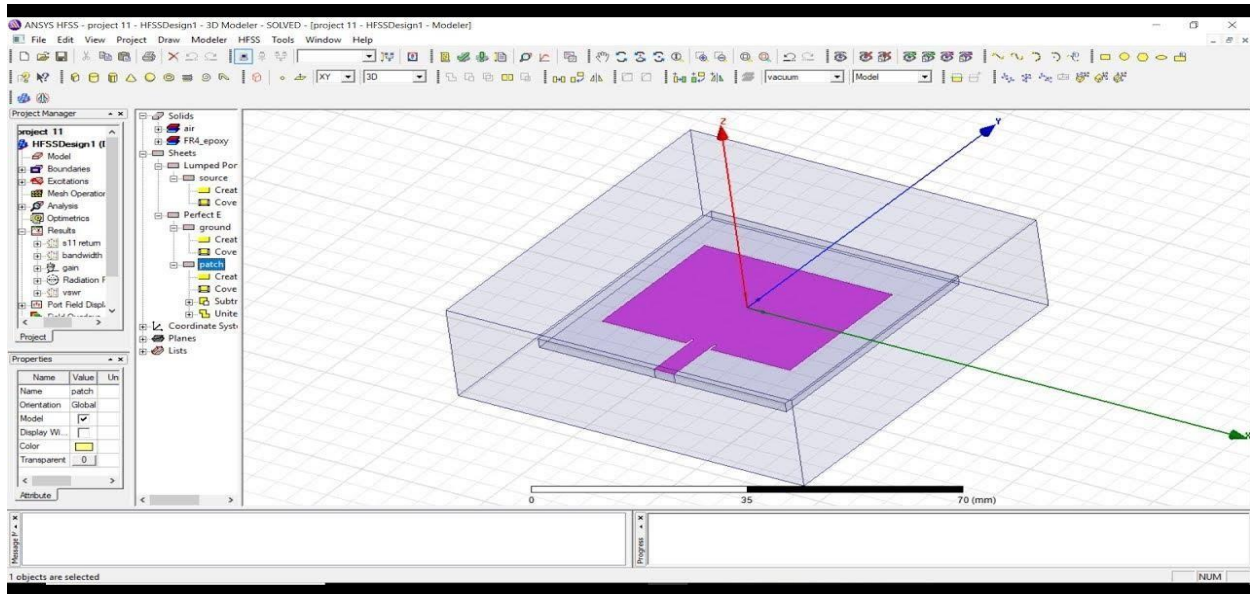


Figure no 3.24 Antenna design model

3.17 RESULTS OBSERVED FR4 EPOXY SUBSTRATE:

- The epoxy material is laminated with the help of the NEMA glass graded designation.
- It is composed of dielectric constant material woven fiber glass with epoxy self extinguishing.
- It is a suitable material for antenna such as dielectric constant and loss tangent.

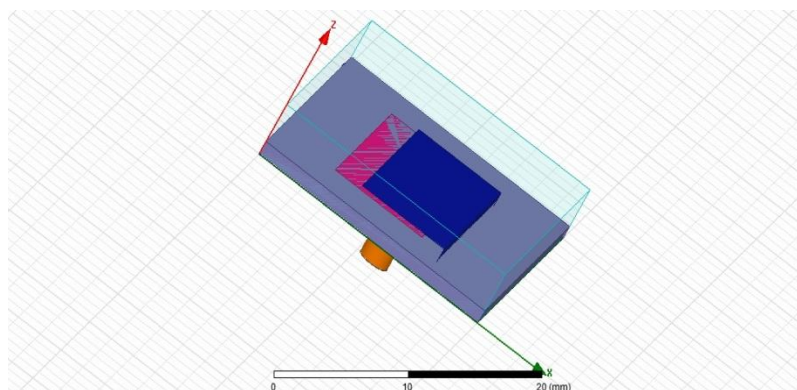


Figure no 3.25: FR4 epoxy substrate

3.17.1 S11 PARAMETER

S11 is the return loss parameter. It is V like structure. It is used to determined the power of the signal returned by a transmission line. It represents how much power is reflected from antenna.

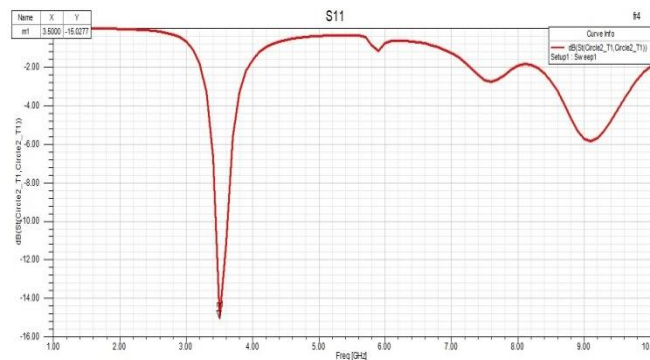


Figure no: 3.26 s11 parameter

NAME	X	Y
m1	4.6000	-13.9731

Table no: 3.1 s11 parameter

3.1.1 VSWR PARAMETER

VSWR is nothing but voltage standing wave ratio. It is a measure of how efficiently the ability of the radio frequency power is transmitted from a power source, through a transmission line into a load.

The value of VSWR parameter is **1.96 dB**.

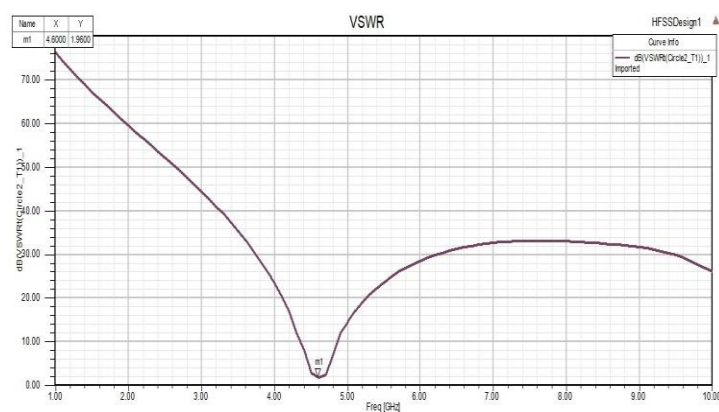


Figure no: 3.27 vswr parameter

NAM E	X	Y
m1	4.6000	1.9600

Table no: 3.2 vswr parameter

3.1.2 GAIN PARAMETER

- The measurement of gain is calculated by the contrast of transmitted power in a specific direction to the transmitted power by ideal antenna.
- The transmitting antenna is having a gain of 3dB means that there is a power which receive the higher with lossless antenna with the same power input to that specific antenna

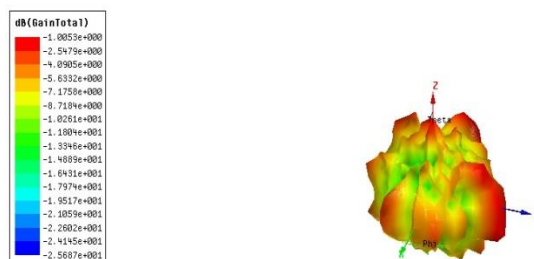


Figure no : 3.28 Gain Parameter

3.1.3 RADIATION PATTERN

- Radiation pattern defines that the directional dependent on the antenna strength using electromagnetic waves.
- Measurement and simulation pattern of the FSPA at 867MHz, 915MHz, 953MHz.

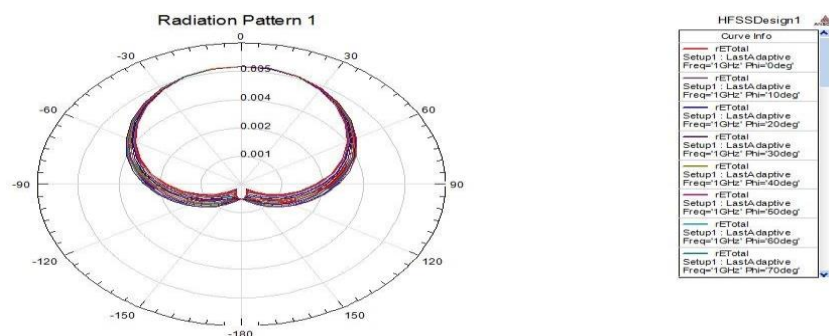


Figure no 3.29 radiation pattern

3D POLAR PLOT:



Figure no 3.30: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive

ROGER SUBSTRATE:

- It is also a laminated material that are used to make circuit boards.
- Most circuit boards are made up of materials known as FR4.
- They are more expensive than fiber glass, but are less lossy at high frequencies.

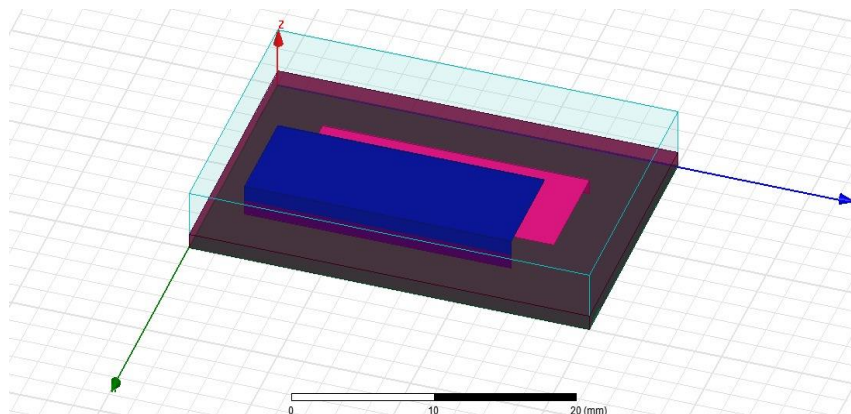


Figure no 3.31: Roger substrate

S11 PARAMETER:

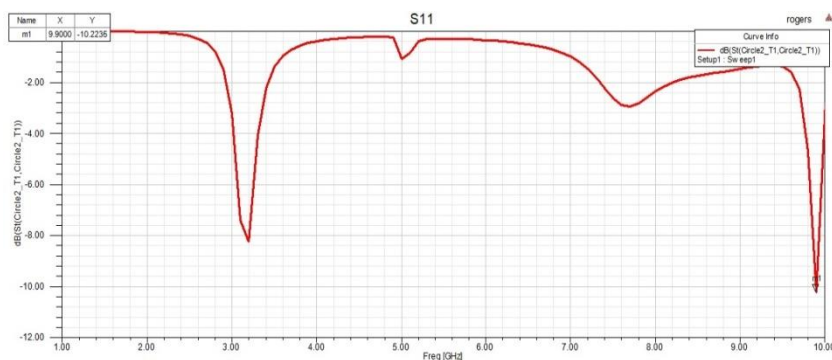


Figure no 3.32: s11 parameter

- Value of s11 parameter is -10.2235db at 9.9GHZ.

VSWR PARAMETER:

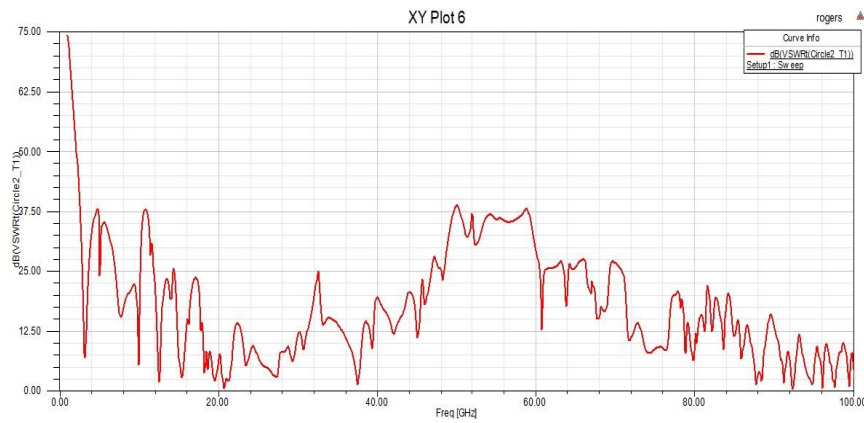


Figure no 3.33: vswr parameter

- Value of VSWR parameter is 1.96 db at 4.6GHZ.

GAIN:



Figure no 3.34: Gain

- Gain** is observed when energy harvesting. If the frequency is from 0 GHZ to 4GHZ the gain is Negative. When it ranges upto 100GHz it may be Positive.

RADIATION PATTERN :

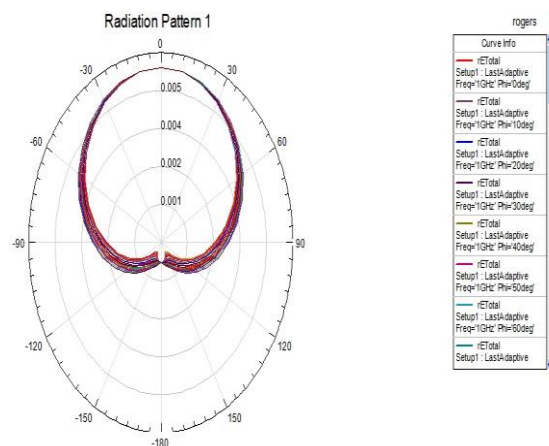


Figure no 3.35: Radiation pattern

- This radiation pattern is in circular form so by this we can say that achieved CIRCULAR RADIATION EFFECT.

3D POLAR PLOT:



Figure no 3.36: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive

SILICON SUBSTRATE:

- It is a semiconductor with a very special property.
- It conducts electricity under some conditions and acts as an insulator.
- It is even the most similar element in the Earth's crust.

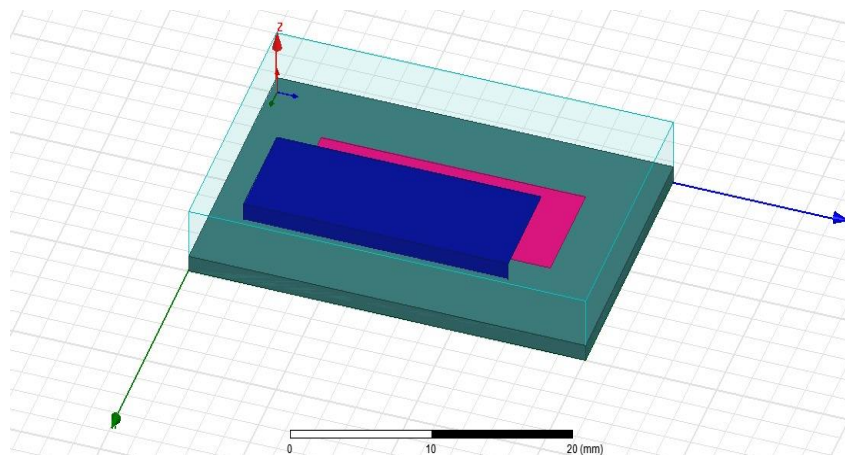


Figure no 3.37: Silicon substrate

S11 PARAMETER:

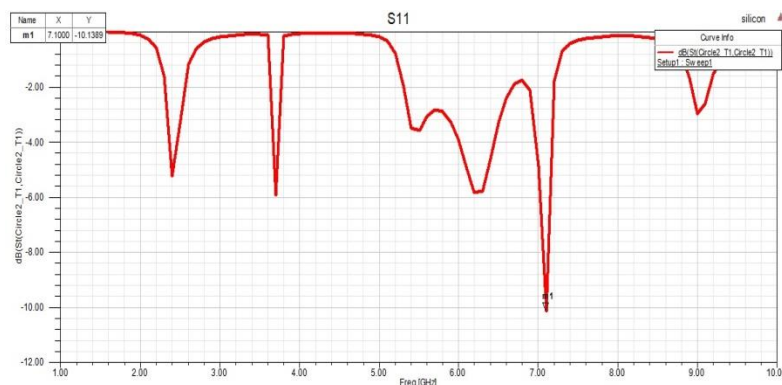


Figure no 3.38: s11 parameter

- Value of s11 parameter is -10.1389db at 7.1GHZ.

VSWR PARAMETER:

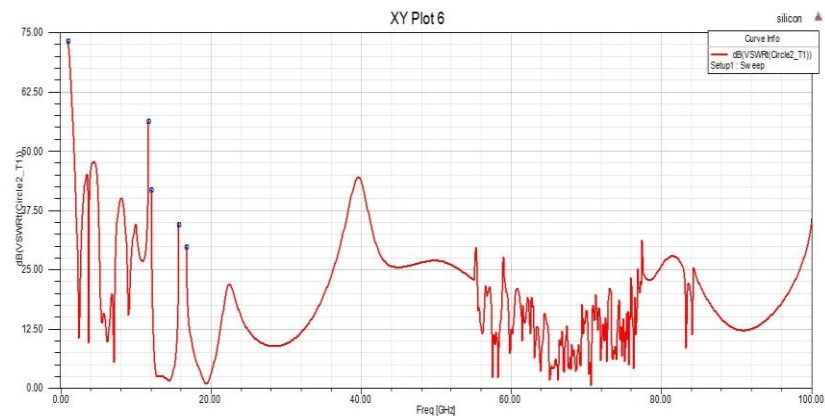


Figure no 3.39: vswr parameter

- Value of VSWR parameter is 1.96 db at 4.6GHZ.

GAIN:

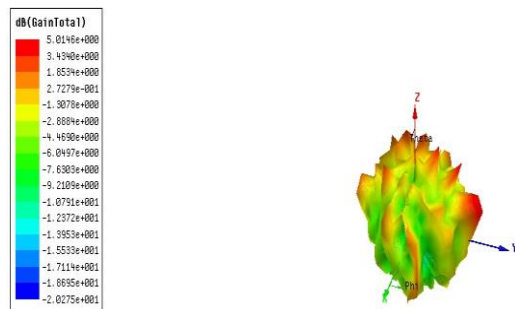


Figure no 3.40: Gain

- **Gain** is observed when energy harvesting. If the frequency is from 0 GHZ to 4GHZ the gain is Negative. When it ranges upto 100GHz it may be Positive.

RADIATION PATTERN :

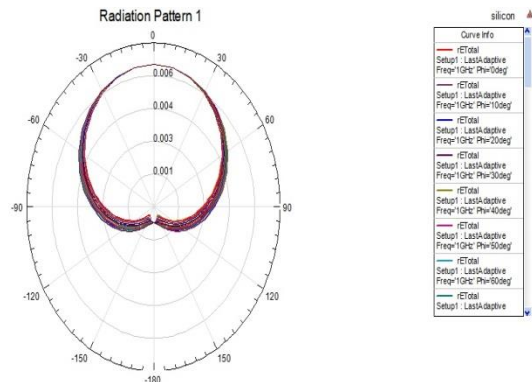


Figure no 3.41: Radiation pattern

- This radiation pattern is in circular form so by this we can say that achieved CIRCULAR RADIATION EFFECT.

3D POLAR PLOT:



Figure no 3.42: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive

TEXTILE SUBSTRATE:

- It is a substance which upon an enzyme reacts nothing but surface treatment.

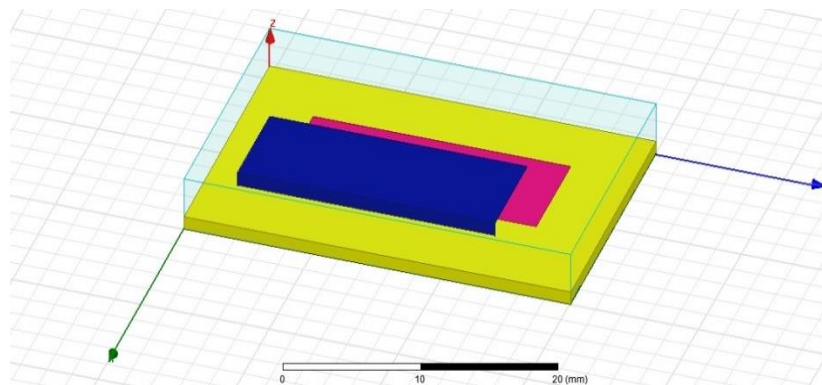


Figure no 3.43: Textile substrate

S11 PARAMETER:

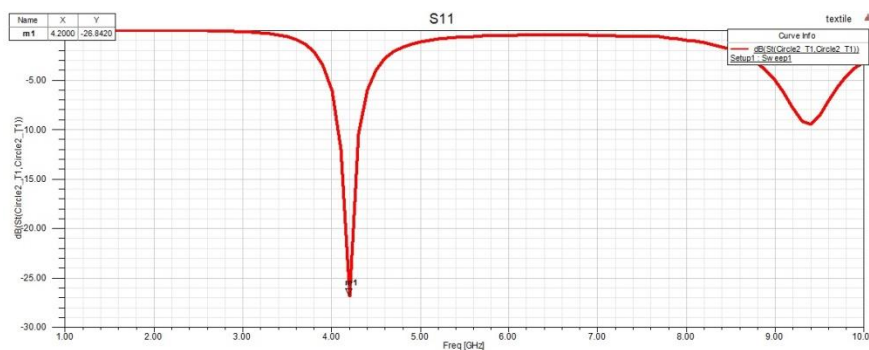


Figure no 3.44: s11 parameter

- Value of s11 parameter is -26.8420db at 4.2GHZ.

VSWR PARAMETER:

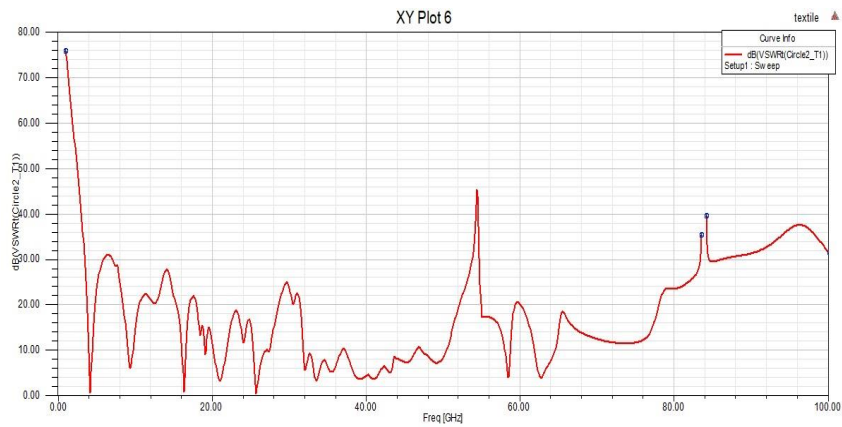


Figure no 3.45: vswr parameter

- Value of VSWR parameter is 1.96 db at 4.6GHZ

GAIN:



Figure no 3.46: Gain

- Gain** is observed when energy harvesting. If the frequency is from 0 GHZ to 4GHZ the gain is Negative. When it ranges upto 100GHz it may be Positive.

RADIATION PATTERN :

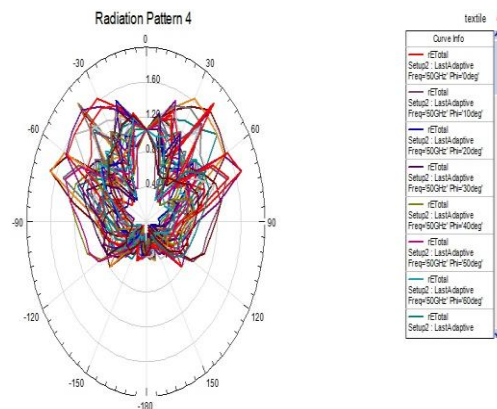


Figure no 3.47: Radiation pattern

3D POLAR PLOT:

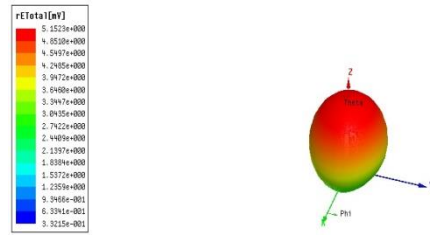


Figure no 3.48: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive.

TABLE.3.3. Optimized parameter values of proposed antenna

S.NO	TYPES OF SUBSTRATES USED	TYPES OF PARAMETERS	SIMULATED VALUES OF PROPOSED ANTENNA	EXISTING VALUES
1	FR4 EPOXY SUBSTRATE	S11	-15.0277dB	-19.27dB
		VSWR	1.96	2.5
		GAIN	-1.0053dB	5.4887dB
		RADIATION PATTERN	0.005	0.025
		3D POLAR PLOT	5.3713mV	8.5374mV
2	ROGERS SUBSTRATE	S11	-10.2235dB	-17.27dB
		VSWR	1.96	2.5
		GAIN	4.6961dB	7.4887dB
		RADIATION PATTERN	0.005	0.025
		3D POLAR PLOT	5.5277mV	8.5174mV
3	SILICON SUBSTRATE	S11	-10.1389dB	-16.27dB
		VSWR	1.96	2.5
		GAIN	5.0146dB	8.4887dB
		RADIATION PATTERN	0.006	0.005
		3D POLAR PLOT	6.0849mV	9.5374mV
4	TEXTILE SUBSTRATE	S11	-26.8420dB	-26.27dB
		VSWR	1.96	2.5
		GAIN	7.7779dB	9.4887dB
		RADIATION PATTERN	1.60	1
		3D POLAR PLOT	5.1523mV	9.5374mV

CONCLUSION:

RF power reaping radio wire to find GSM-900 band signals. With the quick improvement of correspondence innovation and the far reaching acknowledgment of little gadgets, it has incredible incentive in the field of versatile correspondence. Consequently, the reception apparatus will be utilized as a beneficiary for GSM-900 band signal catch in light of the fact that the receiving signal proposed in this article is more conservative than some other pre-bundled collapsing patch radio wire. The receiving wire can be associated with a RF-DC converter circuit to gather RF power at frequencies from 860 MHz to 960 MHz in future applications. It very well may be inferred that the outcomes delivered are appropriate to meet the necessary methodology.

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- [4] Z. W. Sim, R. Shuttleworth, M. J. Alexander, and B. D. Grieve, "Compact Patch Antenna Design for Outdoor RF Energy Harvesting in Wireless Sensor

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by Ww Qq

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RF ENERGY HARVESTING USING ENHANCED DESIGN OF FSPA

6 Submitted in partial fulfillment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering

By

PENUGONDA MOWNIKA - Reg No.37130311

SHAIK HADASA – Reg No.37130368



7 **DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**
SCHOOL OF ELECTRICAL AND ELECTRONICS ¹ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with Grade "A" by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

MARCH – 2021.



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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **PENUGONDA MOWNIKA** (Register No.37130368) and **SHAIK HADASA** (Register No.37130368) who carried out the project entitled "**RF ENERGY HARVESTING USING ENHANCED DESIGN OF FSPA**" under our ¹supervision from December 2020 to March 2021.

Internal Guide

DR.G.D.ANBARASI JEBASELVI, M.E., Ph.D,
Associate Professor

Head of the Department

Dr.T.RAVI, M.E., Ph.D

Submitted for Viva voce Examination held on _____

Internal Examiner

External Examiner

DECLARATION

7 We **PENUGONDA MOWNIKA** (Reg. No. 37130311) and **SHAIK HADASA** (Reg. No.37130368) hereby declare that the Project Report entitled “**RF ENERGY HARVESTING USING ENHANCED DESIGN OF FSPA**” **1** done by us under the guidance of **Dr.G.D.ANBARASI JEBASELVI ,M.E., Ph.D., Associate Professor** **1** is submitted in partial fulfilment of therequirements for the award of Bachelor of Engineering Degree in **Electronics and Communication Engineering**.

1.

2.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey my thanks to **Dr.N.M.NANDITHA, M.E.,Ph.D., Dean, School of Electrical and Electronics Engineering** and **Dr.T.RAVI, M.E.,Ph.D., Head of the Department, Dept. of Electronics and Communication Engineering** for providing me necessary support and details at the right time during the progressive reviews.

We would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. G. D.ANBARASI JEBASELVI ,M.E.,Ph.D** for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

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¹¹ We would also like to express our whole hearted thanks to our beloved **PARENTS** for their constant support and blessings without whom the project would not be a successful one and finally we would like to thank the **ALMIGHTY** for his blessings throughout the completion of our course.

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ABSTRACT

RF energy harvesting using antenna design. In that the radiation of electrons from AC to DC using the High frequency simulation software.

This deals with the suitable antennas for energy harvesting. A new folded shorted patch antenna for new application that is RF energy harvesting will bring forward and sketched. A new folded shorted patch antenna structure will joint the folded patch line and has two pairs of slotted embedded system into its neutral plane. Profile and cost are very less but ease to fabricate the folded shorted patch antenna (FSPA) will developed. Using high frequency simulator software, the new antenna performance was designed and simulated. An impedance bandwidth of 2.48% from 839 to 860MHz at the center frequency of 848 Mhz is simulated, due to utilization of abundant RF energy. The resonance frequency of the unique parts of the antenna such as the antenna and rectifier circuit is 2.45Ghz. The patch antenna was then produced and tested using Network Analyzer. In order to achieve for Direct Current output voltage-buffer; an input power level of 10 dBm was used to the patch antenna. It also shows the good stability towards gain and there is a radiation pattern in the omnidirection. The best value of load resistance to harvest maximum output Direct current as power was obtained through CST simulation. Finally, the received Radio Frequency power, the values of output Direct Current voltage and power were studied.

CHAPTER 1

INTRODUCTION

Energy reaping is an interaction wherein energy from the climate can be changed over into usable energy that can be utilized for a low force hardware. Lamentably, contrasted and the force that can be given to regular batteries, electric waves bring less energy. In a RF power collecting framework, the procured radio wire is a significant factor since it is liable for catching energy from the radiation source. Legitimate receiving wire configuration is significant on the grounds that the reception apparatus attributes, (for example, advantage, radiation design and grouped impedance) influence the potential for reaping. As of late, the sending of smaller receiving wires to remote nerve networks has pulled in expanding interest. The reception apparatus is a significant element of the RF power collecting system, which can expand the most extreme force and eliminate the brilliant RF ability to meet lawful necessities. The intention is to plan a receiving wire that can create most extreme DC yield power. The test here is to discover the energy produced by low energy utilization.

1.1 ANTENNA:



Figure no : 1.1 : ANTENNA

An **antenna** is the network which is usually passes through the metal conductors and the propagation is done between space and current of radio waves, there by used in transmission or receiving the signals.

some amount of the conductors passes ⁵ current to the antenna elements, and that antenna reflects radiated energy from the current electromagnetic waves. In receiver side, an antenna intercept the power of an electromagnetic wave in order to manufacture ¹² a small amount of current at its terminals, and that terminal is put in to a receiver to be boosted. Antennas are crucial bits of all wireless equipment.

An antenna is connected to the transmitter and on receiver array elements to be mapped out of all horizontal electromagnetic waves in a specified direction. It may include the elements which are not serving the electromagnetic waves into the beams. The electromagnetic field sustains the signals through the air at the light speed with no loss of the transmission. The antenna is having an omnidirectional antenna, gives an example of automobile's antenna. It divides the radiation energy which is equally in the directional manner, in which the energy is propagating through more of 1 directional. It completes the uniform stability of omnidirectional antenna is not possible physically.

PARAMETERS IN ANTENNA

An antenna conducts the radiation of the radiated electrons in the conductors transmitting side of the electromagnetic waves in the form of energy in the space receiver of the collected radio energy through space.

1.1.1 GAIN OF POWER

Simply **gain** is a which measures the antenna ability to give direct power input into the radiating energy in specified direction. It is also sometimes ¹⁷ gives us an intensity of the radiation pattern of the peak radiation. The assumption of the density of a power is to reflect back the radiated power by the isotropic antenna to give almost equal stability in some directions and it is found to be dividing the power radiation through sphere area as $4\pi R^2$. This antenna is responsible for directing the measurement of efficiency of 100%. An antenna's efficiency Σ antenna and directivity D :

$$G = \Sigma_{\text{antenna}} \cdot D$$

1.1.2 EFFICIENCY

The **ability** of Σ antenna is an antenna that the power radiated is P_0 which is divided by the power input at the feed point

$$\Sigma \text{ antenna} = P_0/P_{in}$$

A transmitting antenna supplies power by feed line, a line which connects the antenna to a electromagnetic transmitter. The P_{in} to the antenna gives the power input with typically the supplied terminals of antenna to the feed line of the radiated power. So, antenna is having lossless power which include power loss due to some heat in the line of feed and reflects back to the mismatch of the impedance.

The theorem which gives the reciprocity by having the properties of the antenna such as the ability of efficiency, gain power, directivity are same in receiving the used antenna from transmitter side.

1.1.3 DIRECTIVITY

The directivity of an antenna is persistent by its pattern, it allocates in 3 dimensional directions with the radiation. The direction is to increase or decrease the antenna to their extent, which moves radiated power to greater existence. The spherical directions of the spherical coordinates where the θ is the angle between the projected line of the given plane.

1.1.4 PATH LOSS

Path loss basically contains the loss caused by the physical phenomenon of the electromagnetic waves of the expansion in the space free manner. The propagation loss gives us the basic idea to not to do transparent form of the electromagnetic waves through some medium.

$$PL = P_t/P_r$$

1.1.5 RETURN LOSS

The losses may change with the help of the return loss when testing the simulation of the antenna. And it is then compared with the suitable form of the stimulated simulation of the matched impedance of the maximum power to be transformed or transferred.

The return loss is defined by the power incident to the power reflected in some medium of vacuum from the source of the antenna.

The mathematical formulae is

$$R = 10\log_{10}(P_i/P_r)$$

CHAPTER 2

LITERATURE SURVEY

¹⁴ 2.1 Antenna design for RF energy harvesting in sensor networks

In this article, another FSPA will be proposed and intended for use in another system gathering RF outside force. The new FSPA construction will meet the prerequisites of the collapsing bowing line and the two spaces inserted in its ground plane. A more modest structure factor, lower cost, and simplicity of planning a collapsed fix receiving wire (FSPA) will be presented. It is prescribed to utilize PC reproduction innovation (CST) for development and activity of the receiving.

¹⁵ 2.2 Design of an Enhanced RF Energy Harvesting System

In this article, the way toward creating energy collecting gadgets is proposed. This plan can charge low power utilization sensors by introducing encompassing (RF) radio waves. The innovation incorporates the utilisation of a high-thickness monopole reception apparatus exhibit and motions toward expand the RF power got by the receiving energy. Moreover, a lab for the proposed RF power gathering system has been constructed and tried in the research center.

2.3 Radio frequency energy harvesting for autonomous systems

Ivan K. Ivanov

Radio Frequency Energy Harvesting (RFEH) is an innovation that empowers electrical energy to be moved from a solitary wellspring of energy to different gadgets. The principle parts of this innovation are links and fix circuits that convert radio recurrence signals into direct current. Gadgets utilising radio recurrence (RF) can be coordinated into remote sensor organizations (WSN), radio recurrence ID

telemetry frameworks, and can be utilized for telephone charging. Notwithstanding free frameworks, for example, WSN and RFID, the billions of portable hardware markets from GSM cells to MP3 players may likewise become appealing applications for RF energy reaping if energy prerequisites are met.

2.4 METHOD DESIGNING

The analysis of the designing method gives us a simple formula to formulate the structural procedure for explaining a rectangular antenna patched with the microstrip.

This procedure will find the capacity of 3 essential parts to be parameterized for designing an antenna is operated frequency f , the constant σ_r and the dielectric height is h .

2.5 THE MICROSTRIP PATCH ANTENNA CALCULATION PROCESS

DESIGN EQUATION:

Calculation process of the antenna patched microstrip

Step 1: Width calculation (W) -

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

Step 2: Dielectric constant calculation is effective and depends on the height and dielectric constants to be calculated.

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

Step 3: Length capacity of the effective calculation

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

Step 4: ΔL is the length extension to be calculated.

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

Step 5: Length of the patch calculation.

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

The following parameters are used in antenna are

f_0 is the frequency of resonance

¹⁹ W is the patch width

l is the distance of the ⁹ Patch

h is the diameter

ϵ_r is the relative Permittivity of the dielectric element

c is the Speed of light: 3×10^8

⁸ **2.6 ADVANTAGES AND DISADVANTAGES :**

The merits of microstrip patch antennas are:

- (1) The planar is a shaped surface
- (2) Profile is very less
- (3) Radar cross section is lesser
- (4) Printed technology to be implemented
- (5) Circuit elements are integrated.
- (6) Dual polarized operations be structured.
- (7) Multi-frequency operates in the plotted manner.

These merits make microstrip patch antennas more acceptable for the crafts to be done in air, space or in missiles. And they do not involve the dynamics of the motion vehicles.

Their profiles gives a comparison with arrays of microstrip of the patch antenna of the planar structure to be in the wing shape manner. The listed particulates that the microstrip antenna become the good antenna to design a wireless communication.

2.6.1 ²DISADVANTAGES OF MICROSTRIP PATCH ANTENNAS

There are several demerits involves in microstrip patch antennas.

(1) The microstrip antenna gives the bandwidth ⁸less than 5%. There are various bandwidth widening methods to develop the narrow impedance. The bandwidth has achieved above 55%. This is ⁸true that the bandwidth is achieved using the volume increment.

²(2) Due to the small separation between the radiating patch and its ground plane, the microstrip antenna can handle relatively low RF power. The average power considered safe is a few tens of watts.

(3) While a single patch element generally incurs very little loss because it is only about one-half wave long, microstrip arrays generally have larger ohmic loss than arrays of other types of antennas of equivalent aperture size. This ohmic loss occurs in the dielectric element and the metal conductor of the microstrip feed line network and power dividing circuit.

EXISTING AND PROPOSED SYSTEM

3.1 EXISTING SYSTEM:

The work and development can charge little power sensors by getting the encompassing radio waves, and this plan is valuable for some wireless applications.

3.2 PROPOSED SYSTEM

- Collecting energy or biting energy in the environment is probably the most ideal approaches to expand the existence of a remote organization by supplanting the battery.
- Frequency necessities are predictable with past work. Be that as it may, to decrease the size of the radio wire, another FSPA reception apparatus was planned.
- The proposed new antenna intended to work at 850 Mhz. Hence, to accomplish the necessities determination, further examination and improvement should be thought of.

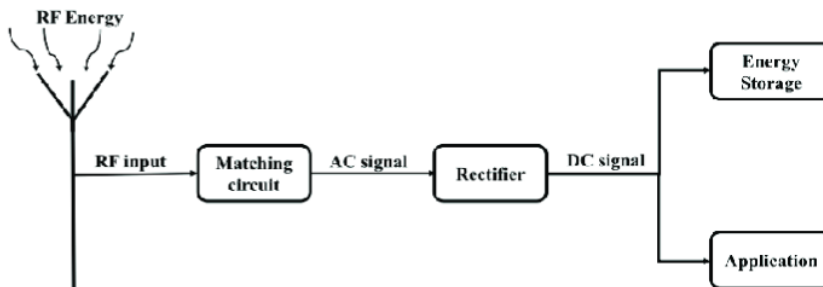


Figure no : 3.1 : Block diagram of RF ENERGY HARVESTING

3.3 WORK FLOW WITH HARDWARE AND SOFTWARE REQUIREMENTS

- The software used to reap RF power is “high recurrence structure exciter” (or) “re-enactment innovation”.
- EM reproduction can be delegated an elite capacity.
- HFSS (or) CST applications should meet the most elevated necessities as far as

CPU, RAM, and illustrations information to accomplish ideal execution.

- It is likewise important to guarantee that the work environment or worker has adequate limit and cooling.

3.4 SIMULATION TOOL

Simulation tool gives the ansys hfss 3d electromagnetic radiation software in designing a very high frequency products through electronic media. The components which filters the unwanted signals through the media of the arrays , Radio frequencies, connectors in the printed circuits of the common engineering techniques. The system which specify the design of the established manner to develop the things which are related to the antenna designing of the digitalized devices.

This recruits the flexible solvation of an builtin functions to give support to the performed em problems in all 3D unparalleled radiations. It is very well known that this will helps in sorting the technique which are focused and stable to be developed with the standard positioning manner. A complete task to be completed with in the advanced product of the simulated content by virtue of the accelerating sophisticated solvating solvers to this technology.

The overall set of the configuration to be performed in the simulated software is to set the address of the electromagnetic spectrum of the scale to be passive form integrated circuit components for large scale industrial EM analysis. The antenna is having a reliable simulation to perform the suitable stability of the gain to be in part of the mesh to be sorted. This will helps us in forming an accurate solution to multiple simulators to generate the mesh.

The primary use of the ansys hfss is that which will helps in requiring R & D prototype by increasing or decreasing an antenna designing time to boosts the signals to be applied on the specific reliability antenna and the performance is based on the beat of the conflicts and the displayed antenna is kept in such a virtual prototype.

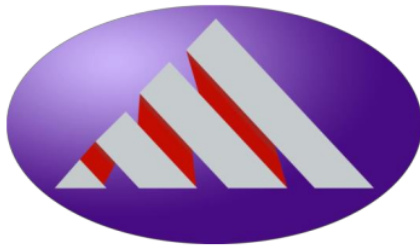


Figure no : 3.2 ANSYS HFSS 15.0 64 BIT

3.5 ANSOFT MODE

There are several panels to be taken in part of ansoft hfss window

3.5.1 MANAGERAL PROJECT – This project suggests the tree to be designed in the list of the project to be in structured manner.



Figure no : 3.3: project manager

3.5.2 A Manager Messages- It allows the visibility of the error to occur before the simulation begin .

3.1.1 A Window Property- This property helps in capturing and allowing the parameters to be modeled or attributed.

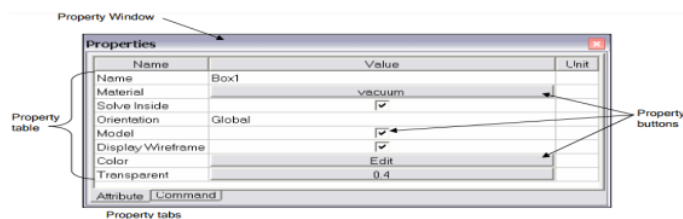


Figure no : 3.4 : property window

3.1.2 A Window Progression –The window progress capture the object in the solution progress.

3.1.3 A 3D Window Model- This model contains the window which specify the particular model tree for designing and it should be in activation mode.

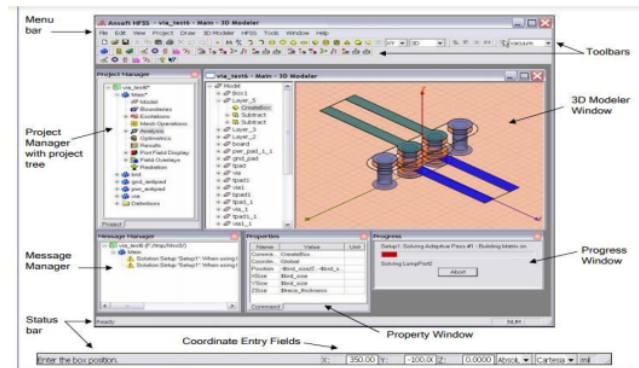


Figure no : 3.5 : 3D Modeler Window

3.2 ANSOFT 3D MODELER

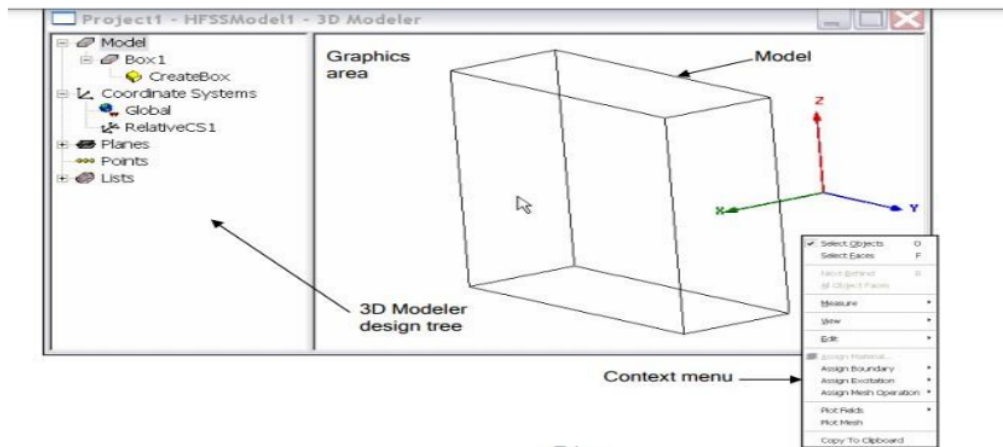


Figure no : 3.6 : ansoft 3D modeler

3.3 DESIGNING A WINDOW

Each and every design is having a project with multiple designing techniques with the help of this ansoft HFSS software and is captured with the help of the design window.

The title bar is redrawn by dragging through a corner or border with the help of the title bar. This will give the established design openings and the icons is sometimes detected or not detected. They resize some important open documents.

There is a chance to materialize the bottom parts of the ansoft hfss software to arrange the items in menu or a title bar.

The symbols which give the icons to dispose and select menu items from windows and also sometimes it gets cascaded with the help of the vertical or horizontal sizes.

The icons are detected but it depends on the suitability of the simulation software of the particular development of the document.

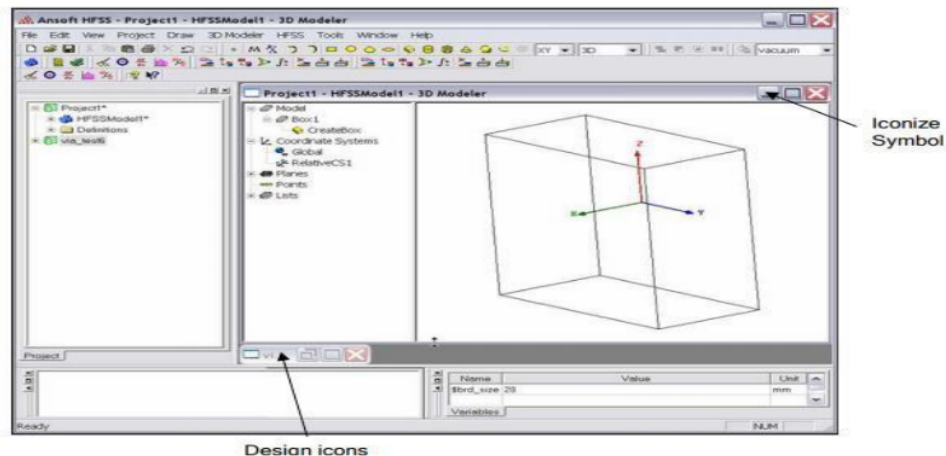


Figure no : 3.7 Ansoft HFSS window

3.3 TOOL BUTTONS

The buttons which gives a toolbar as a time saving approach which are used frequently. The availability of the toolbar buttons helps in capturing and displayed in the initial screen of the window. It was probably suitable for the personalized the toolbars in the way. They are not arranging the software with the displayed selection directly through the related type of the antenna.

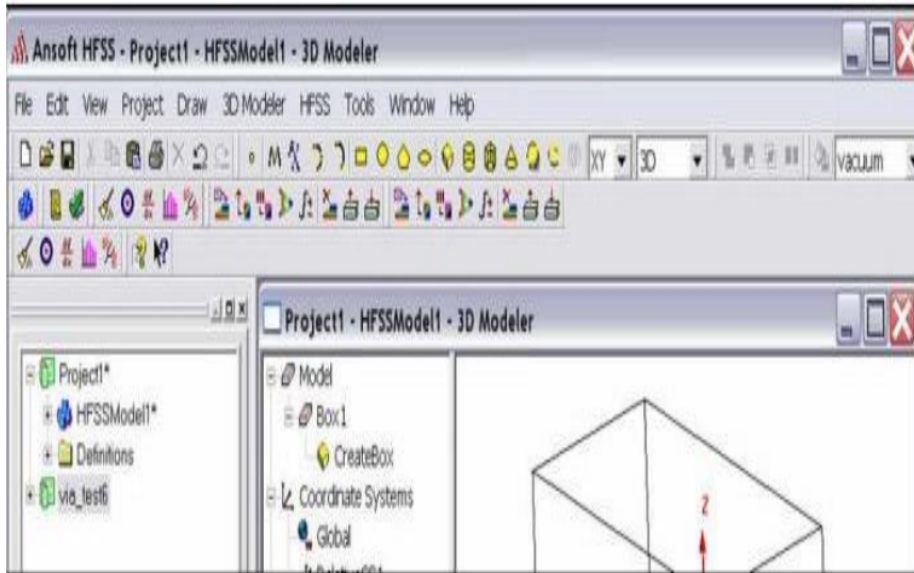


Figure no : 3.8 Toolbars

3.4 Ansoft HFSS WORK STATION

The Ansoft HFSS work station supplies an inbuilt interface for growing the device model, which creates and develops and important steps to be followed:

1. The generation of the parametric model gives the implementation of the geometrical boundaries and excitations.
2. This setup follows the solution and frequency sweep analysis setup.
3. The plotted field gives the resultant of 2D communication.
4. The loop process solve the solution automatically.

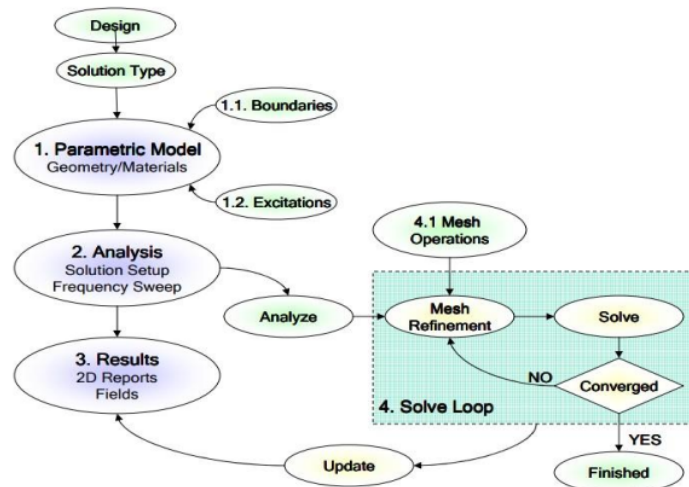


Figure no : 3.9 Creating Design Steps

3.5 Opening a project

The existing project determines how to open a project

3.5.1 Opening a New project :

1. Select the items as File menu > New in the ansoft hfss.
2. Select Project > Insert HFSSDesign.

3.5.2 Opening an Existing HFSS project :

1. To select a project, use the Opendialog.
2. Click open to get project.

3.5.3 Opening Project from Explorer

To extract the ³project directly from the explorer using Microsoft windows..

To open a project from Windows Explorer, do one of the following: e following:

1. Right-select the name to get the project on the explorer.
2. Double-select the menu to get the project.

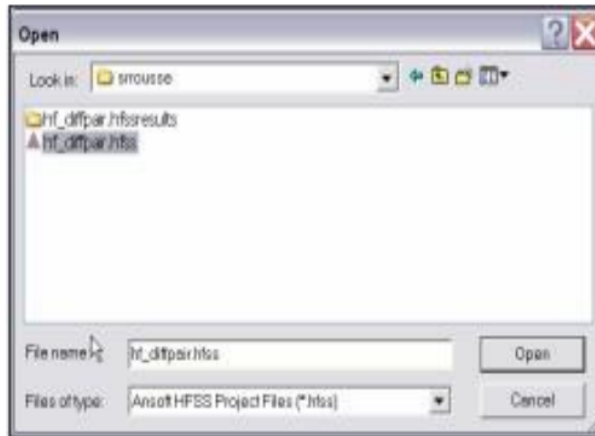


Figure no : 3.10 Window to Open Project

3.6 SOLUTION SET TYPE

The report tells us that the solution setup is determining the result to how the radiation are done in the solution type have the convergence of the antenna. There is some suitable forms of the solution set type of antenna are available:

3.11.1. Modal Driven – The matrix which helps in modal based solutions to be parameterized manner to convey the information in the modal based S – parameter of the incident and reflection of the mode of waveguide.

3.11.2. Terminal Driven – The matrix which helps in calculating the terminal based parameter to form a multiconductor port line. It establishes the voltage and current in the terminal side.

3.11.3. Mode of Eigen – The resonances of the structure determines the availability of solving certain problems in the resonant frequency of the fields at some antenna's.

The solution setup types:

1. Choose one of the following:
 1. Modal Driven
 2. Terminal Driven
 3. Mode of eigen

2. Press the OK button

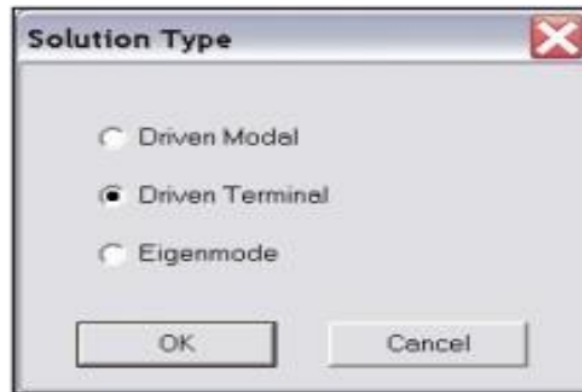


Figure no : 3.11 solution type window

3.7 CREATION OF THE PARAMETRIC MODEL

This model develops the use of flexibility and the power is unique in all the abilities of the parametric designs. There is minimum editing of full complexed macros ³ history. The main purpose of this model is to provide the summary of the 3D modeling capacity. By knowing some basic concepts there is outline manner which will be able to take merits of the features offered to set a 3D parametric modeler.

Summary of the pictures which gives a brief idea on the modeler window.

3D Modeler Tree Design – The object dependency and attributes follows the capability of the user interface to face the challenges and gives the essential parts of the 3D design tree. This tree shows how they access the structured components to the attributes and objects of the interface.

3.7.1 Context Menu – These menus are flexibly accessing techniques used to command the frequently used current context of the menu. They provide some contents to be done with the drastical change in the availability of the interface by clicking with the menu of the selected right mouse bit of the button.

3.7.2 Graphics – There is a interaction between the elements to be structured in a very well designed manner with the help of the area of graphics designing.

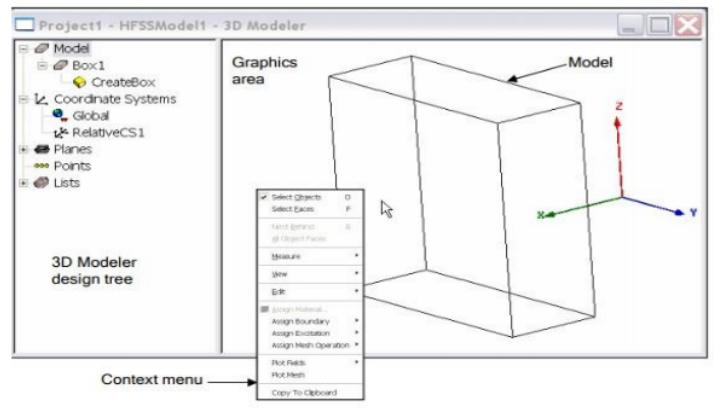


Figure no : 3.12 Graphics Area

With the help of 2 additional bits of the interface collaboration is done in the modeler of antenna design

3.7.3 Window Property – This window is used in visible or in a viewed manner to modify the attributes and objects with dimensions.

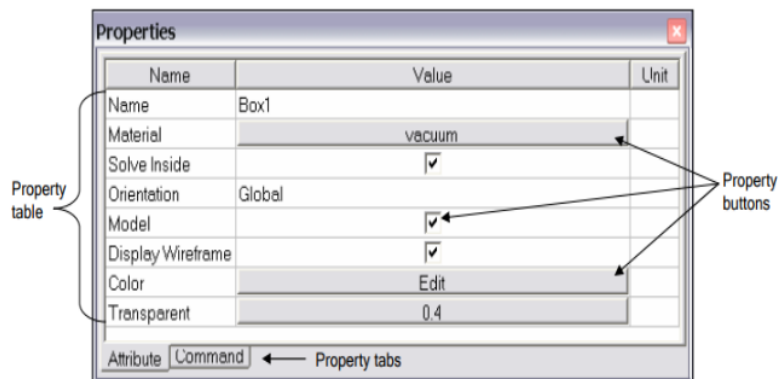


Figure no : 3.13 Property window

3.7.4 Entry Coordinate – The Entry Coordinate on the Ansoft Status Coordinate Entry of HFSS Desktop Window displays the Coordinate Entry fields that can be used to define points or offsets during the creation of structural objects

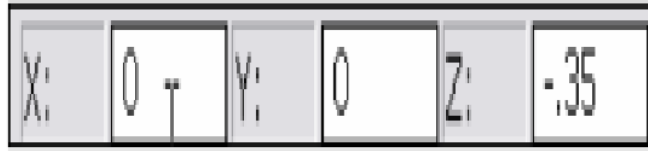


Figure no : 3.14 Entry coordinate

3.7.5 ACTIVATION CURSOR

The activation cursor helps in referring different types of the object creation which is applicable to allow the drastical change in the graphical area in current position. There is an object creation creation which displayed the entry cocoordination of the ansoft HFSS software.

If the object is not developed or created the activation cursor remains unchanged and it will set to dynamic sections of selection. The overall summary of the object selection is having more and more detailed manner.



Figure no : 3.15 Active cursor

3.7.6 GRID PLANE

The designed grid primitives having a plane in the reduced creation of objects. The plane do not have the user to limit the tow dimensional coordinates but instead of involving some other phenominal guide to simplify the structure privileged in primitive manner. This constituted by the active group to active grid of the reviwing planes. They determined the creation of the unique structure with unique creation and viewing manner

3.8 Create and visualization of simple structure

Create a 3D designing objects which is accomplished by participated the following steps:

1. Setup a plane of grid.

2. The object base shape is created.
3. Height must be setup.

3.8.1 CREATING A BOX

This box contain the demonstrated steps by creating a box. These steps allows the hfss software design to perform the created projects. The 3 points establish the box to be created with the 2 forms of the rectangular base and the 3rd setup should be the height of the box.

- 1: The starting point of the rectangular base point is determined
- 2: The magnitude of the box is determined
- 3: Box height should be measured.

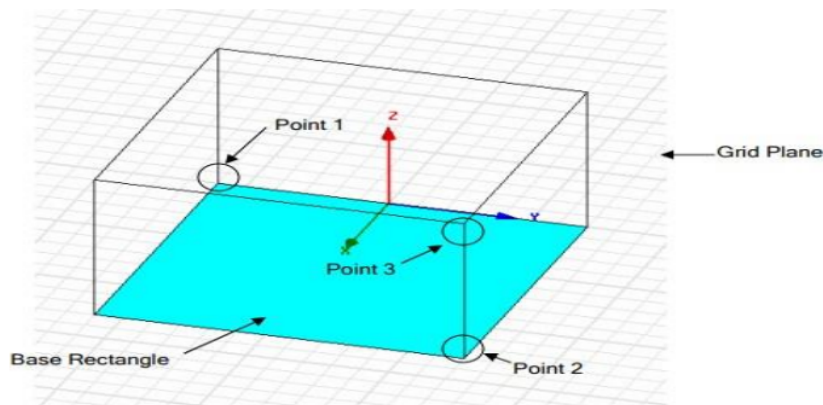
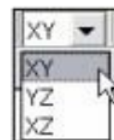
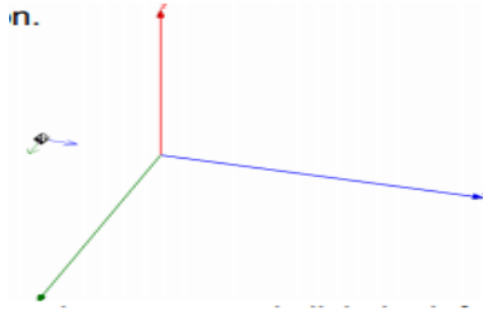


Figure no : 3.16 simple structure

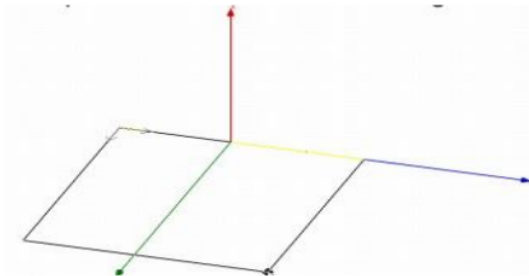
1. 3D Modeler > Grid Plane > XY ,Click the item.
2. With help of mouse implement the shape of the base



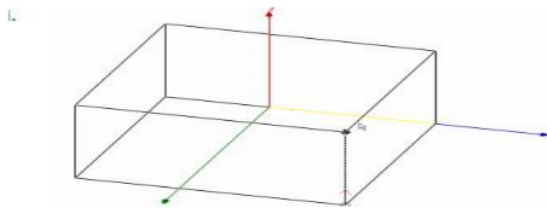
1. The initial point to be substituted by positioning and clicking the left button of the active cursor.



2. The base rectangle helps in forming the left button to be placed in the active cursor.



3. Arranging the cursor by setting up the height and click on the left button.



3.9 PROPERTIES OF OBJECT

This property appears with the help of completion of the structure sketching and the developed object. The maintenance of the position and magnitude of the object be modified. This method always allows the objects by selecting the estimated values with the corresponding correcting values in the dialog box.

This property dialog allows the equation to accept the summary by entering into the object property for more detailed manner.

Each and every object having 2 types of properties

1. Command property is the primitive command used to define the structure
2. Attribute property describe the solving and capturing properties.

3.9.1 COMMAND WINDOW

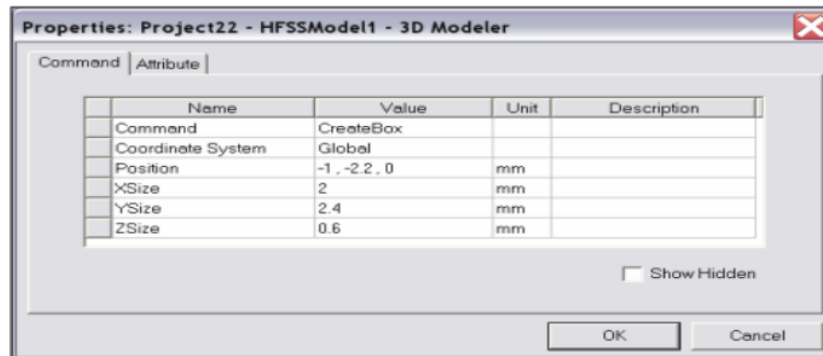


Figure no : 3.17 Command Window

3.9.2 ATTRIBUTES WINDOW

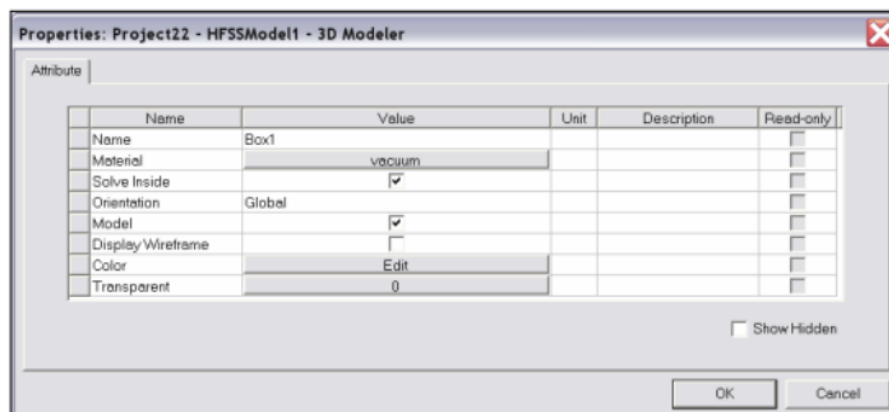


Figure no : 3.18 Attributes Window

3.10 CREATING A SUBSTRATE

Element or dielectric medium is a case metallic sheet antenna is plays the main role in fabricating the entire microstrip antenna functioning. This substrate in microstrip antennas is a principle usefull in supporting the antenna designing through mechanism. This will helps in the formation of the substrate to be dielectric in nature and perform the circuit to be affected by electrical material. It satisfy the requirements of the mechanisms to meet their antenna needs. Correctness is must on the basis of cost, efficiency and size. Substrate are needed for improving stability gain of the electrical and mechanical continuous layer in an insulating material. Used to decrease the size of the antenna and can help to develop the varying time of the stimulated antenna.

This property appears with the help of completion of the structure sketching and the developed object. The maintainance of the position and magnitude of the object be modified. This method always allows the objects by selecting the estimated values with the corresponding correcting values in the dialog box.

This property dialog allows the equation to accept the summary by entering into the object property for more detailed manner.

The designed grid primitives having a plane in the reduced creation of objects. The plane do not have the user to limit the tow dimensional coordinates but instead of involving some other phenominal guide to simplify the structure privileged in primitive manner. This constituted by the active group to active grid of the reviwing planes.They determined the creation of the unique structure with unique creation and viewing manner.

This model develops the use of flexibility and the power is unique in all the abilities of the parametric designs. There is minimum editing of full complexed macros ³ history. The main purpose of this model is to provide the summary of the 3D modeling capacity. By knowing some basic concepts there is outline manner which will be able to take merits of the features offered to set a 3D parametric modeler.

FR4 Epoxy substrate

Position :0,0,0 X size:16 Y size:18 Z size: 1.6

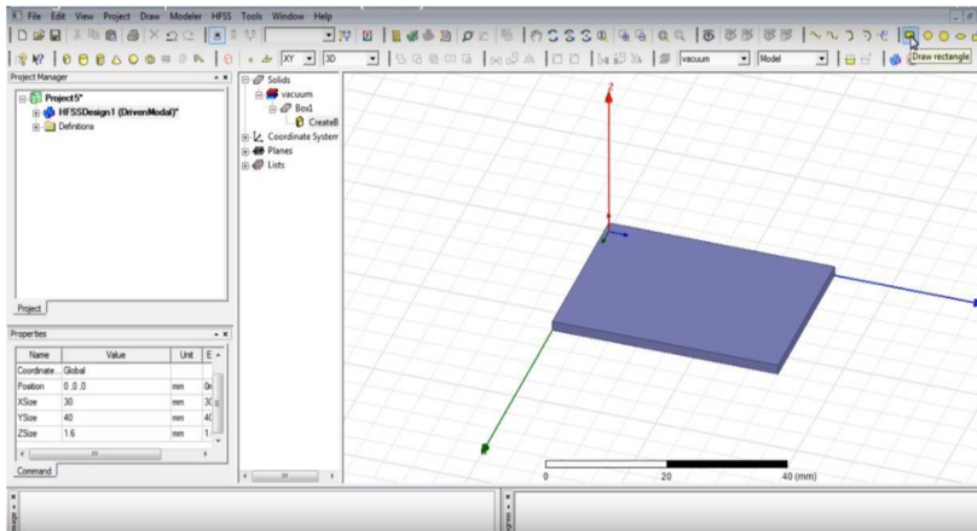


Figure No:3.19. FR4 Epoxy substrate

3.11 GROUND PLANE

The plane which is electrically surface connected to the neutral point of the conducting surface. These are having a unique quality to be separated by the area of the electrically charged poles having a dipole moment of the unique meanings. The neutral point compares the theory with the help of antenna such as the Earth's wavelength which connects the transmission neutral wire and serves the radiating energy through electromagnetic wave. In the circuits the plane acts as a neutral plane having larger area to cover the power supply in the unique components

3.12 PATCHED ANTENNA

It is a type of antenna which is having a very less profile simulated on the flat mounted surface of the patch antenna. The components has the suitable radiated power in the situation to be developed in a planar rectangular sheet to be patched on the metal surface called the plane ground of the large sheet.

The length of the resonant antenna has the line which transmits the shorter wavelength for the microstrip to be executed. The antenna helps in maintaining the simulated power possible at the frequencies at which the patches the small values conveniently. The wide use of the portable form of the devices helps in forming the fabrication work in the circuit boards to be printed. There are multiple patches to be with the same substrate conveniently of making the gain value high.

The operation makes the antenna used in the phones to be shorted in one part of the antenna. The neutral point to be placed in the suitable form of the partly etched antenna designing. The printed model varies in order to be very versatile antenna for the dual operation.

- **Position:3.5,5,1.6 Axis: z X size :9 Y size: 12**

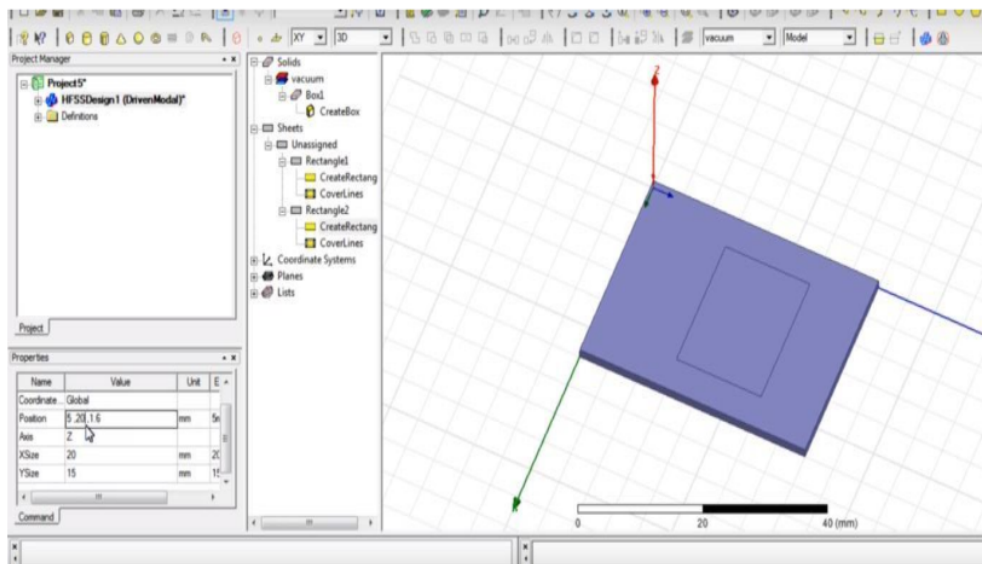


Figure no : 3.20 patch antenna

3.13 LINE OF FEED

The antenna is capable of transmitting the line of feed to be considered as the electromagnetic radiation of the signal to be travelled by the radiation of electrons. These feeder line feeds the capacity of how much the power of electrons is feed into the signaling technique.

The radio frequency which helps in finding the transmission side of the radiation in the electromagnetic waves. The conversion of the voltages to be satisfied with the help of involving in the receiver. This capacity carry signals in the specialized manner with the type of cabled nature of the transmission. The epoxy material is laminated with the help of the NEMA glass graded designation. It is composed of dielectric constant material woven fiber glass with epoxy self extinguishing. It is a suitable material for antenna such as dielectric constant and loss tangent. S11 is the return loss parameter. It is V like structure. It is used to determined the power of the signal returned by a transmission line. It represents how much power is reflected from antenna.

Position: 7,0,1.6 Axis: z Xsize: 2 Y size: 5

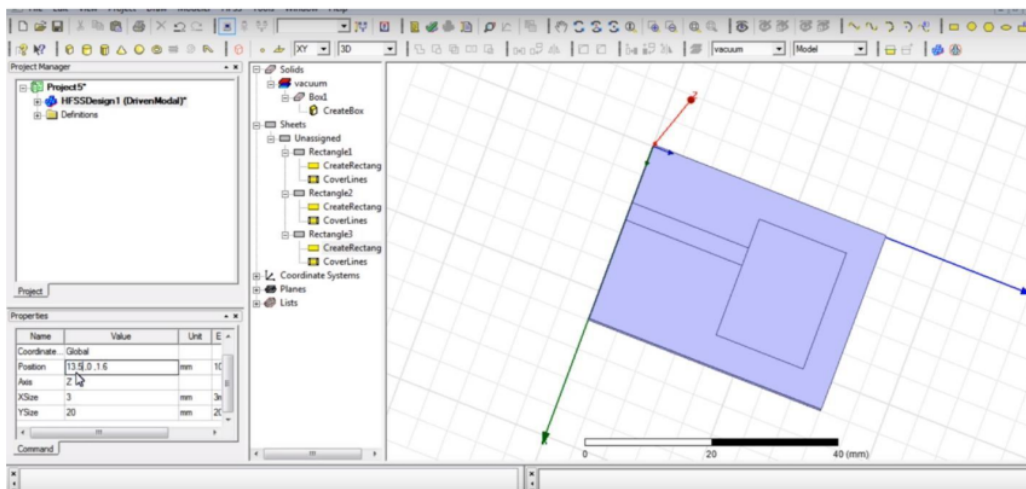


Figure no : 3.21 **Feed line**

3.14 PORT

The port which is basically a term for transmitting the signals under some condition. For some conditions the operation of LTE mode is in the direction downwards to be independent the assumed channel of the separated antenna of the logical port to be establishes.

Position: 7,0,1.6

Axis: y

X size: 2

Z size:-1.6

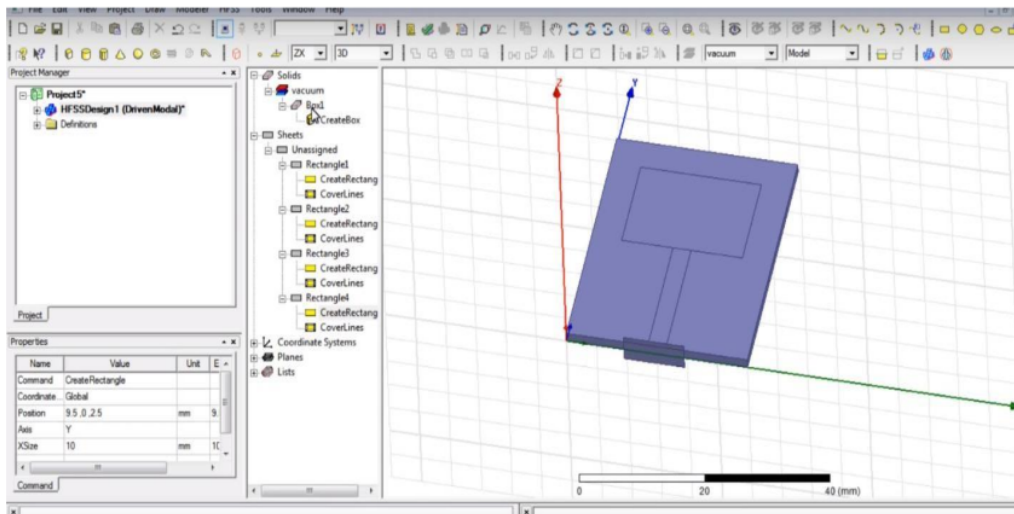


Figure no : 3.22 port antenna

3.15 BOUNDARY

Position: -3.4,-3.4,-3.4 X size: 22.8 Y size: 25.8 Z size: 8.4

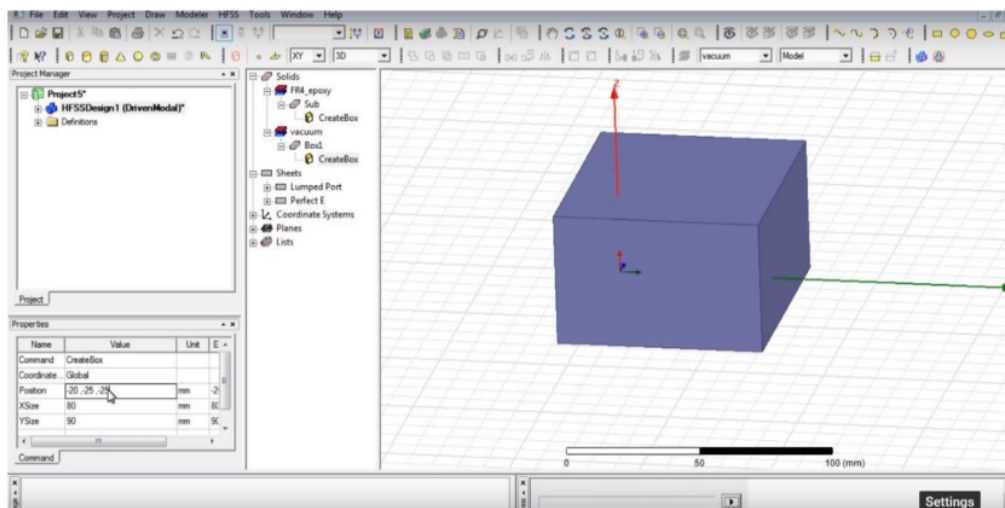


Figure no : 3.23 Boundary

3.16 ANTENNA DESIGN MODEL

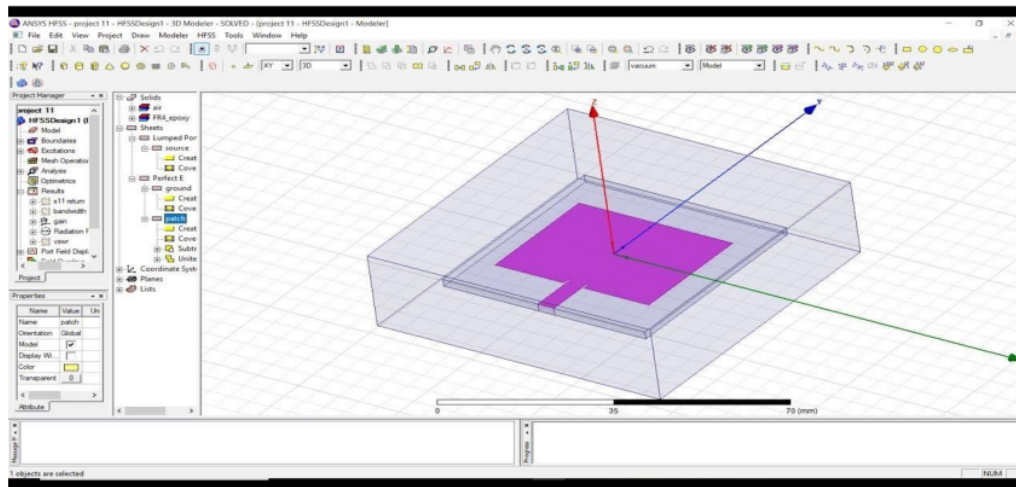


Figure no 3.24 Antenna design model

3.17 RESULTS OBSERVED FR4 EPOXY SUBSTRATE:

- The epoxy material is laminated with the help of the NEMA glass graded designation.
- It is composed of dielectric constant material woven fiber glass with epoxy self extinguishing.
- It is a suitable material for antenna such as dielectric constant and loss tangent.

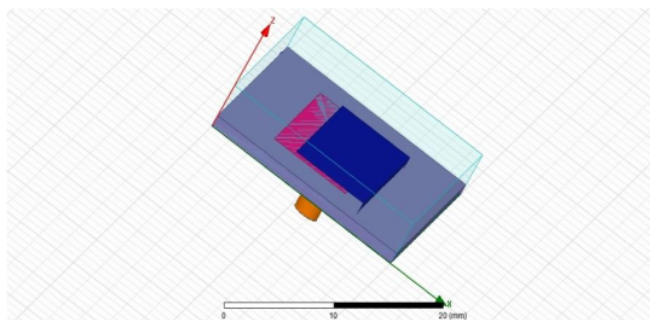


Figure no 3.25: FR4 epoxy substrate

3.17.1 S11 PARAMETER

S11 is the return loss parameter. It is V like structure. It is used to determine the power of the signal returned by a transmission line. It represents how much power is reflected from antenna.

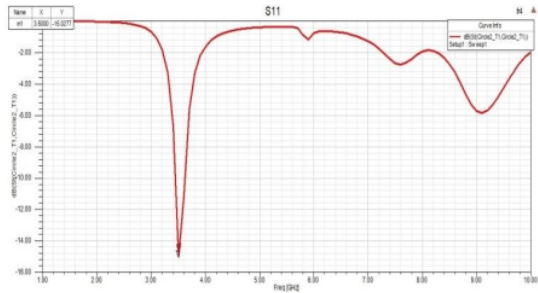


Figure no: 3.26 s11 parameter

NAME	X	Y
m1	4.6000	-13.9731

Table no: 3.1 s11 parameter

3.1.1 VSWR PARAMETER

VSWR is nothing but voltage standing wave ratio. It is a measure of how efficiently the ability of the radio frequency power is transmitted from a power source, through a transmission line into a load.

The value of VSWR parameter is **1.96 dB**.

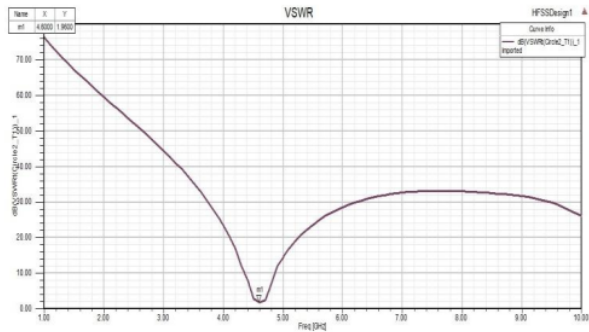


Figure no: 3.27 vswr parameter

NAME	X	Y
m1	4.6000	1.9600

Table no: 3.2 vswr parameter

3.1.2 GAIN PARAMETER

- The measurement of gain is calculated by the contrast of transmitted power in a specific direction to the transmitted power by ideal antenna.
- The transmitting antenna is having a gain of 3dB means that there is a power which receive the higher with lossless antenna with the same power input to that specific antenna

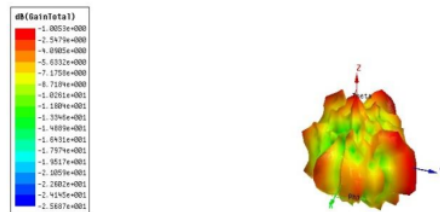


Figure no : 3.28 Gain Parameter

3.1.3 RADIATION PATTERN

- Radiation pattern defines that the directional dependent on the antenna strength using electromagnetic waves.
- Measurement and simulation pattern of the FSPA at 867MHz, 915MHz, 953MHz.

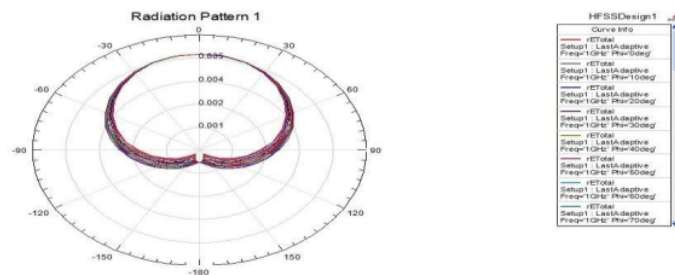


Figure no 3.29 radiation pattern

3D POLAR PLOT:



Figure no 3.30: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive

ROGER SUBSTRATE:

- It is also a laminated material that are used to make circuit boards.
- Most circuit boards are made up of materials known as FR4.
- They are more expensive than fiber glass, but are less lossy at high frequencies.

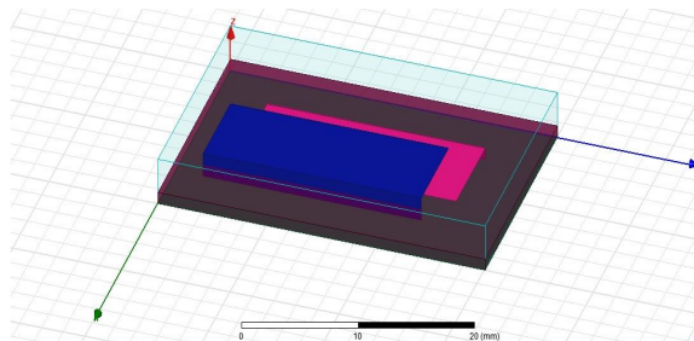


Figure no 3.31: Roger substrate

S11 PARAMETER:

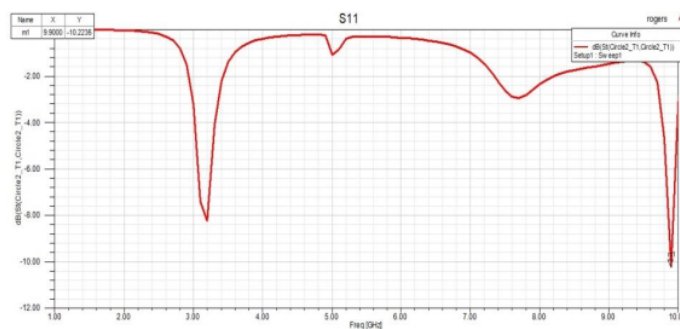


Figure no 3.32: s11 parameter

- Value of s11 parameter is -10.2235db at 9.9GHZ.

VSWR PARAMETER:

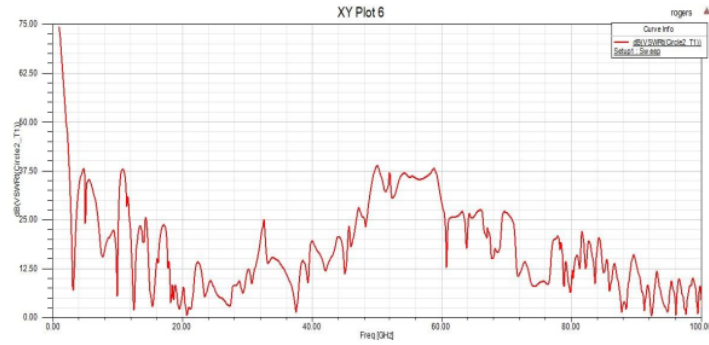


Figure no 3.33: vswr parameter

- Value of VSWR parameter is 1.96 db at 4.6GHZ.

GAIN:



Figure no 3.34: Gain

- Gain** is observed when energy harvesting. If the frequency is from 0 GHZ to 4GHZ the gain is Negative. When it ranges upto 100GHz it may be Positive.

RADIATION PATTERN :

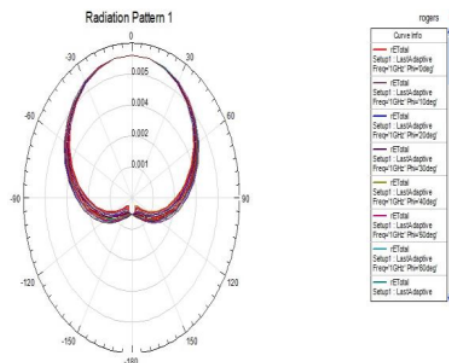


Figure no 3.35: Radiation pattern

- This radiation pattern is in circular form so by this we can say that achieved CIRCULAR RADIATION EFFECT.

3D POLAR PLOT:



Figure no 3.36: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive

SILICON SUBSTRATE:

- It is a semiconductor with a very special property.
- It conducts electricity under some conditions and acts as a insulator.
- It is even the most similar element in the Earth's crust.

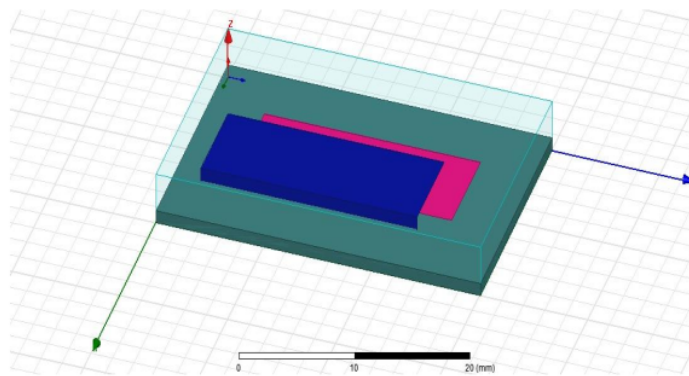


Figure no 3.37: Silicon substrate

S11 PARAMETER:

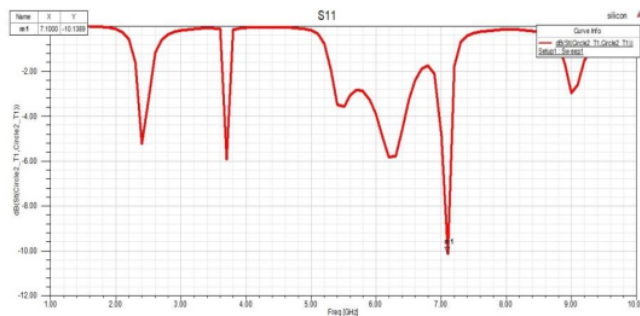


Figure no 3.38: s11 parameter

- Value of s11 parameter is -10.1389db at 7.1GHZ.

VSWR PARAMETER:

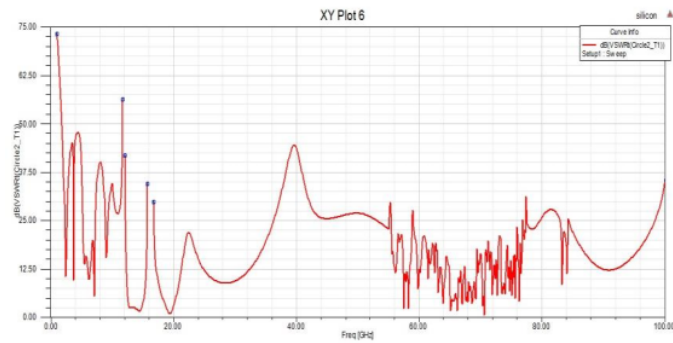


Figure no 3.39: vswr parameter

- Value of VSWR parameter is 1.96 db at 4.6GHz.

GAIN:

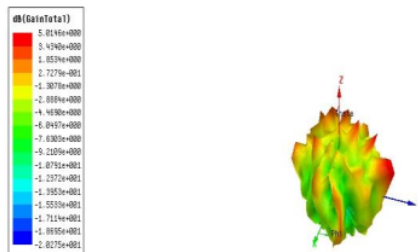


Figure no 3.40: Gain

- Gain** is observed when energy harvesting. If the frequency is from 0 GHz to 4GHz the gain is Negative. When it ranges upto 100GHz it may be Positive.

RADIATION PATTERN :

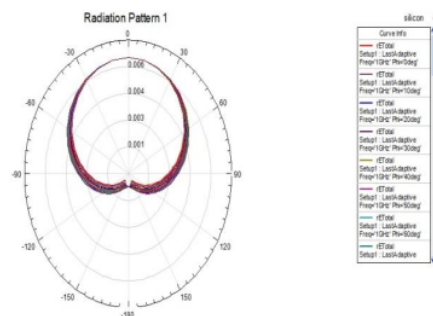


Figure no 3.41: Radiation pattern

- This radiation pattern is in circular form so by this we can say that achieved CIRCULAR RADIATION EFFECT.

3D POLAR PLOT:



Figure no 3.42: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive

TEXTILE SUBSTRATE:

- It is a substance which upon an enzyme reacts nothing but surface treatment.

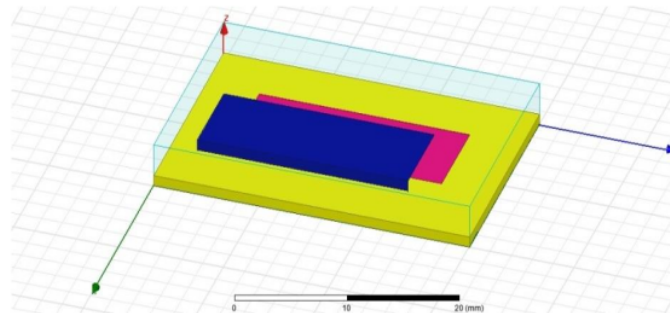


Figure no 3.43: Textile substrate

S11 PARAMETER:

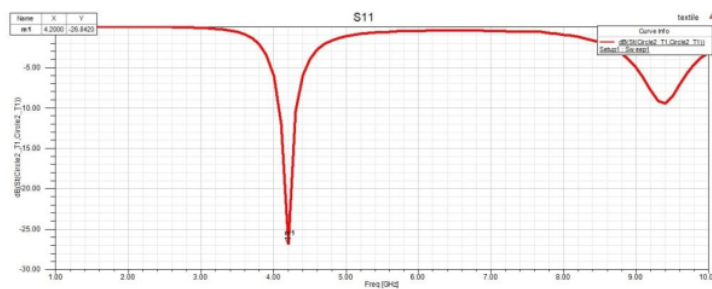


Figure no 3.44: s11 parameter

- Value of s11 parameter is -26.8420db at 4.2GHZ.

VSWR PARAMETER:

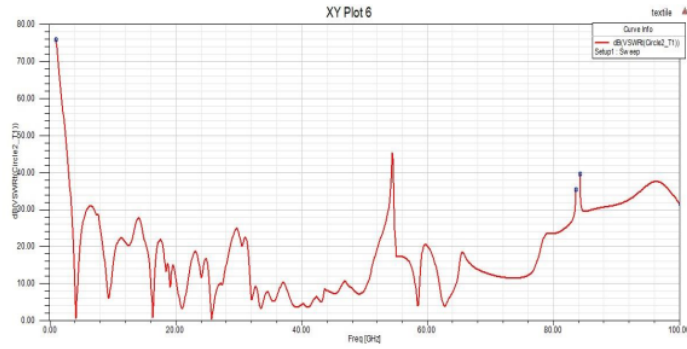


Figure no 3.45: vswr parameter

- Value of VSWR parameter is 1.96 db at 4.6GHz

GAIN:

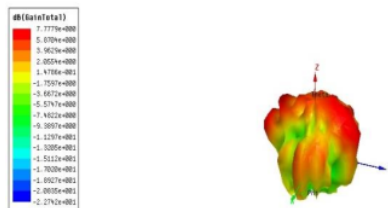


Figure no 3.46: Gain

- **Gain** is observed when energy harvesting. If the frequency is from 0 GHz to 4GHz the gain is Negative. When it ranges upto 100GHz it may be Positive.

RADIATION PATTERN :

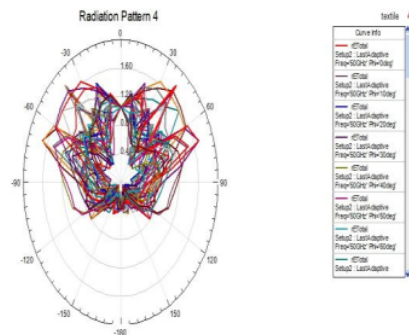


Figure no 3.47: Radiation pattern

3D POLAR PLOT:

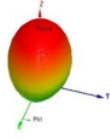
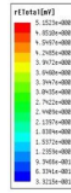


Figure no 3.48: 3D polar plot

- This 3d polar plot is having the 0 to 100GHz is taken as positive.

TABLE.3.3. Optimized parameter values of proposed antenna

S.NO	TYPES OF SUBSTRATES USED	TYPES OF PARAMETERS	SIMULATED VALUES OF PROPOSED ANTENNA	EXISTING VALUES
1	FR4 EPOXY SUBSTRATE	S11	-15.0277dB	-19.27dB
		VSWR	1.96	2.5
		GAIN	-1.0053dB	5.4887dB
		RADIATION PATTERN	0.005	0.025
		3D POLAR PLOT	5.3713mV	8.5374mV
2	ROGERS SUBSTRATE	S11	-10.2235dB	-17.27dB
		VSWR	1.96	2.5
		GAIN	4.6961dB	7.4887dB
		RADIATION PATTERN	0.005	0.025
		3D POLAR PLOT	5.5277mV	8.5174mV
3	SILICON SUBSTRATE	S11	-10.1389dB	-16.27dB
		VSWR	1.96	2.5
		GAIN	5.0146dB	8.4887dB
		RADIATION PATTERN	0.006	0.005
		3D POLAR PLOT	6.0849mV	9.5374mV
4	TEXTILE SUBSTRATE	S11	-26.8420dB	-26.27dB
		VSWR	1.96	2.5
		GAIN	7.7779dB	9.4887dB
		RADIATION PATTERN	1.60	1
		3D POLAR PLOT	5.1523mV	9.5374mV

CONCLUSION:

RF power reaping radio wire to find GSM-900 band signals. With the quick improvement of correspondence innovation and the far reaching acknowledgment of little gadgets, it has incredible incentive in the field of versatile correspondence. Consequently, the reception apparatus will be utilized as a beneficiary for GSM-900 band signal catch in light of the fact that the receiving signal proposed in this article is more conservative than some other pre-bundled collapsing patch radio wire. The receiving wire can be associated with a RF-DC converter circuit to gather RF power at frequencies from 860 MHz to 960 MHz in future applications. It very well may be inferred that the outcomes delivered are appropriate to meet the necessary methodology.

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