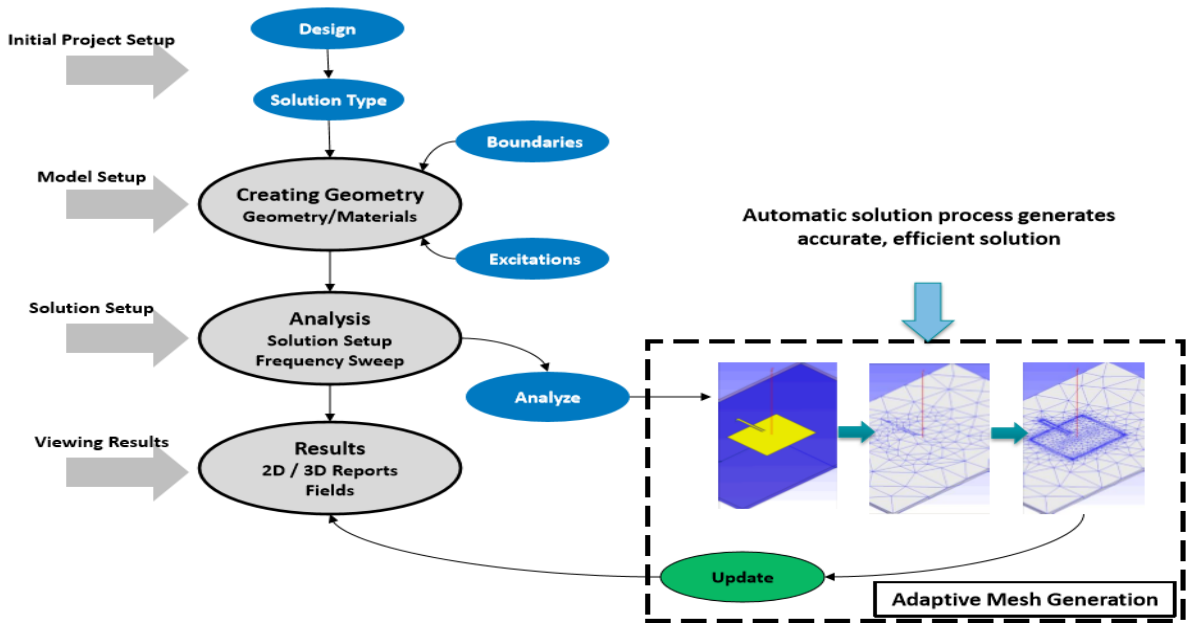
Antenna Design using HFSS

HFSS – Overview of solution process



Workshops

1. Design and analysis of Dipole Antenna at 900 MHz
2. Design and analysis of rectangular patch Antenna using edge feed technique at 10 GHz

WS. 1. Design and analysis of Dipole Antenna at 900 MHz

Aim:

To design and analyse a dipole antenna for 900 MHz.

Objective:

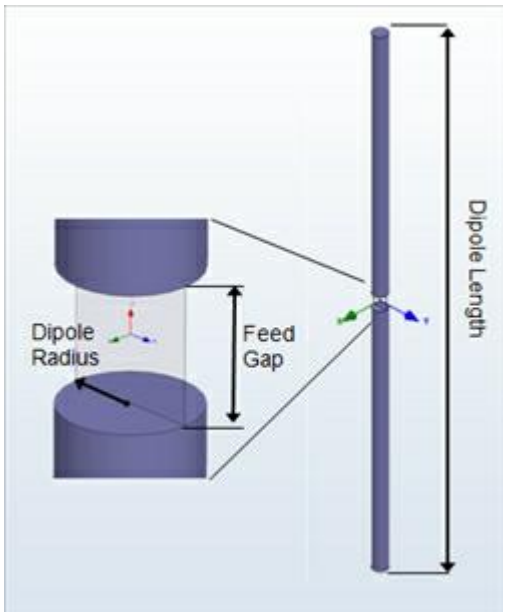
To design dipole antenna and analyse the following antenna parameters

1. Reflection coefficient (S-Parameter)
2. Voltage standing wave ratio (VSWR)
3. Surface current distribution (J Surf)
4. Electric field distribution (E-field)
5. Magnetic field distribution (H-field)
6. 3-D radiation pattern
7. 2-D radiation pattern

Software required:

HFSS

Diagram:



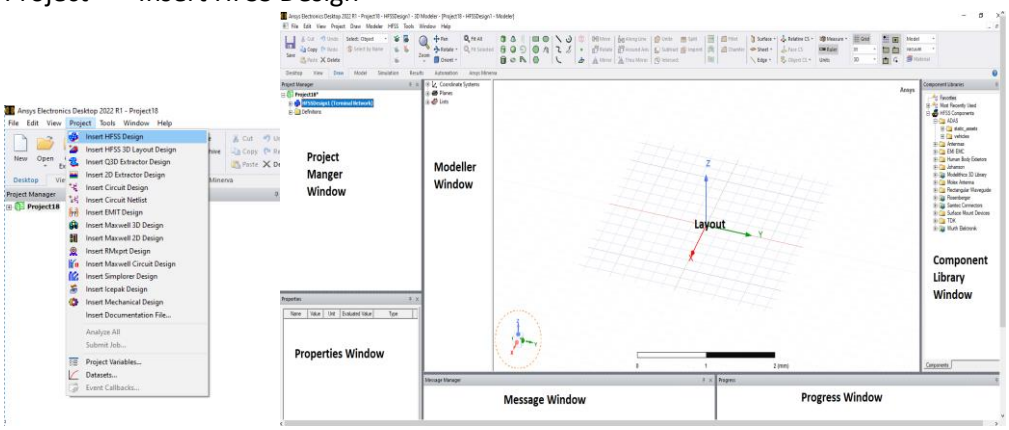
Specifications:

Parameter	Variable	Value
Dipole Length	D_L	14.99cm
Dipole Radius	D_R	0.25cm
Feed Gap	P_G	0.25cm

Procedure:

Step 1: Initial Project Setup

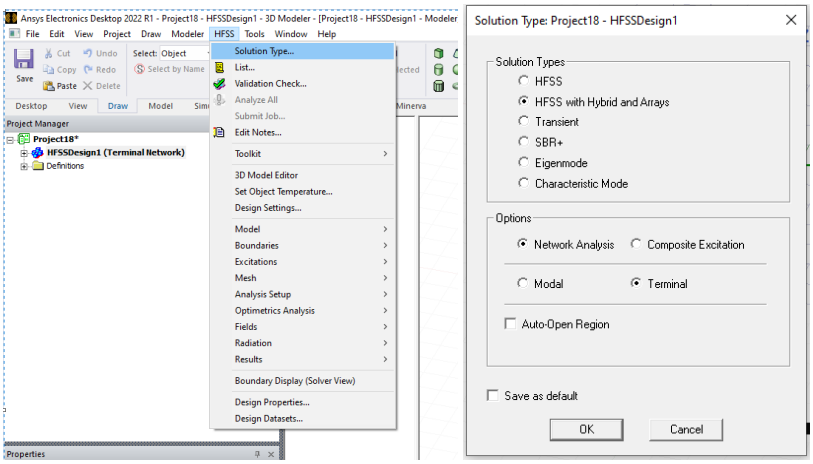
1. **Design**
   Open Ansys Electronics Desktop
   Project ---- Insert HFSS Design



2. **Solution type**
   HFSS ----- Solution type
   Under solution type widow
   Select HFSS with Hybrid and Arrays in solution types

Select Network analysis and Terminal in options

Click Ok



Step 2: Model Setup

1. **Creating Geometry / Material**
   a. **Creation of upper dipole arms**

Draw ----- Cylinder (Randomly cylinder a box on Layout)

To edit box size

Choose Model --- Solids ---- Vacuum ---- cylinder1 ----- Double click on CreateCylinder

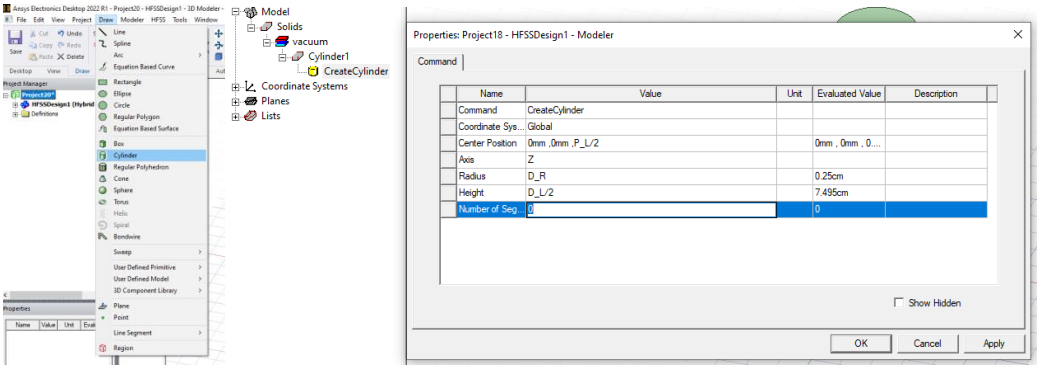
Enter the value

Center Position : 0,0,P_L/2 [(0,0,0.125cm)]

Radius : D_R (0.25cm)

Height : D_L/2 (7.495cm)

Click Ok



Rename Cylinder1 to UpperArm

Double click on Cylinder1 ----- change Cylinder1 to UpperArm under name ---- Click Ok

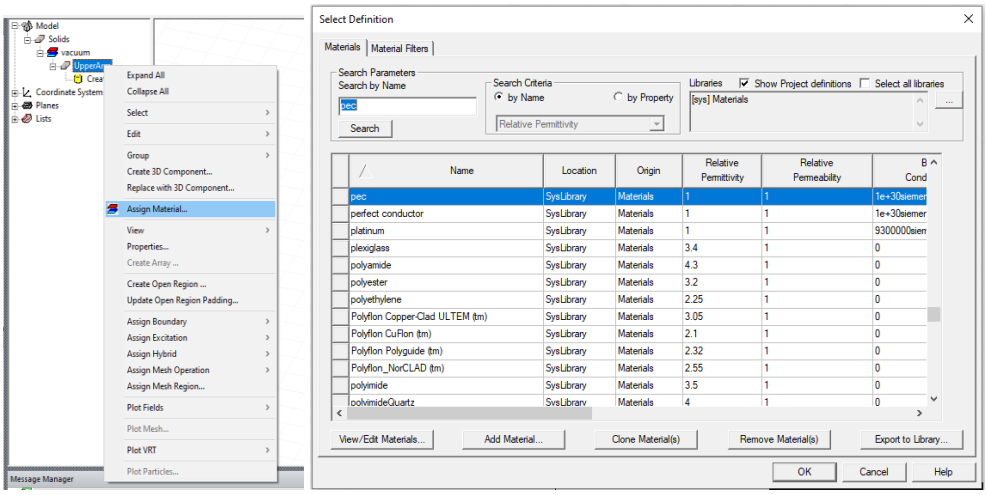
Material Assignment:

Right Click on UpperArm ----- Choose Assign Material

Material Library Window will appear

In Search by name type Copper/PEC and select the material Copper/PEC.

Click Ok.



b. Creation of Lower dipole arm

To create lower arm, we can go in two ways

1. Creation of geometry
2. Duplication of upper arm along axis

We can use any one of the above method,

1. Creation of Geometry

Draw ----- Cylinder (Randomly cylinder a box on Layout)

To edit box size

Choose Model --- Solids ---- Vacuum ---- cylinder1 ----- Double click on CreateCylinder

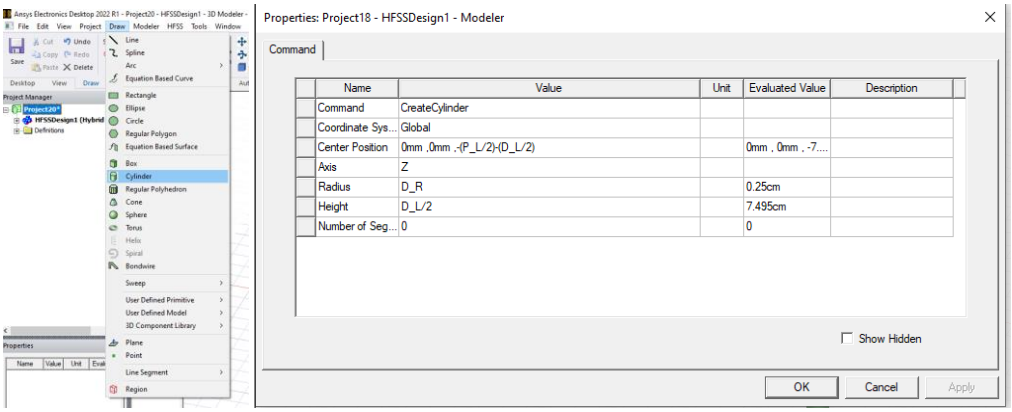
Enter the value

Center Position : 0,0,-(P_L/2)-(D_L/2) [(0,0,-0.125cm-7.495cm)]

Radius : D_R (0.25cm)

Height : D_L/2 (7.495cm)

Click Ok



Rename Cylinder1 to LowerArm

Double click on Cylinder1 ----- change Cylinder1 to LowerArm under name ---- Click Ok

Material Assignment:

Right Click on UpperArm ----- Choose Assign Material

Material Library Window will appear

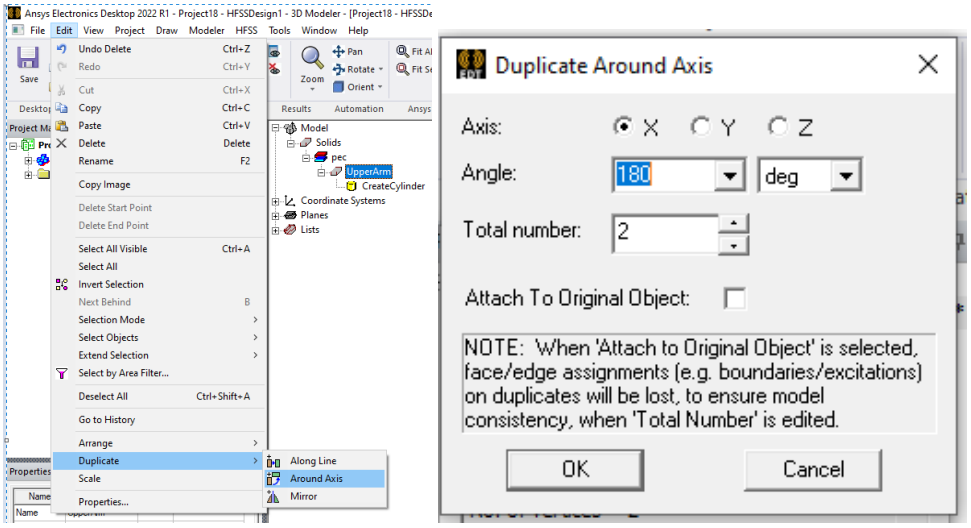
In Search by name type Copper/PEC and select the material Copper/PEC.

Click Ok.

2. Duplication of upper arm along axis

Choose UpperArm ------ Edit in menu bar ------ Duplicate ----- Along Axis
Duplicate Around Axis window will appear
Axis : X
Angle : 180 deg
Total number : 2
Click ok

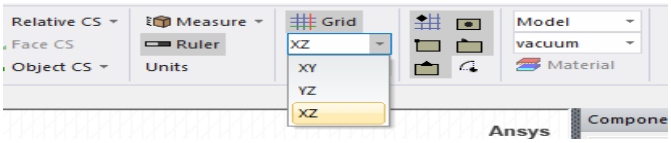
While using duplication we don't need assign material, material property assigned to UpperArm will be assigned automatically.



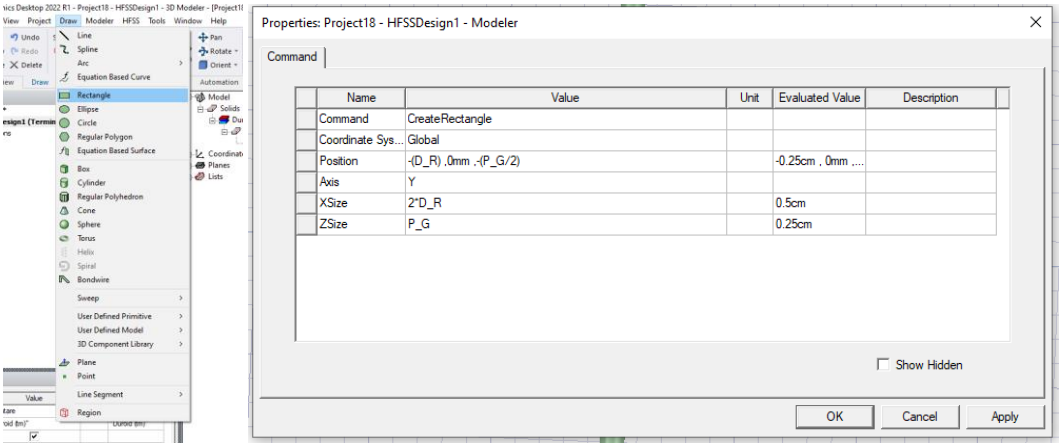
Rename UpperArm_1 to LowerArm
Double click on UpperArm_1 ----- change UpperArm_1 to LowerArm under name ----
Click Ok

c. Creation of Excitation Geometry

Choose XZ plane

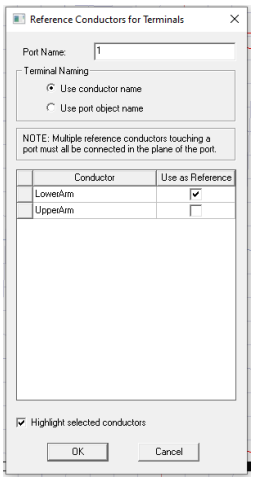


Draw ----- Rectangle (Randomly draw a rectangle on Layout)
To edit rectangle size
Choose Model --- Sheet ---- Unassigned ---- Rectangle1 ----- Double click on CreateRectangle
Enter the value
Position : -(D_R), 0, -(P_G/2) [(-0.25cm, 0cm, -0.25cm)]
Xsize : 2*D_R (0.5cm)
Zsize : P_G (0.25cm)
Click Ok



Rename Rectangle1 to Port

Double click on Rectangle1 ----- change Rectangle1 to Port under name ---- Click Ok



Excitation Assignment:

Right Click on Port ----- Assign Excitation ----- Port ------ Lumped Port

Reference Conductors for terminals window will appear

Check LowerArm option and Click Ok.

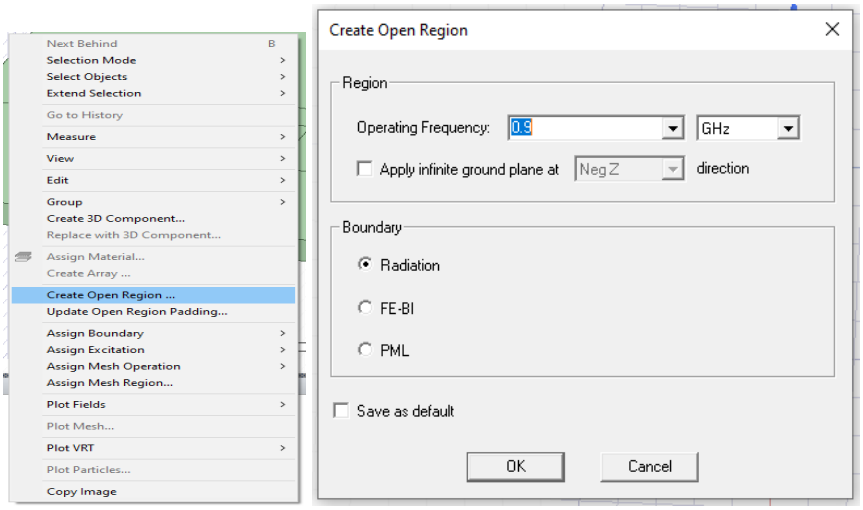
d. Assignment of Open region (Absorbing Boundary Condition)

Right Click on Layout ----- Choose create open region

Create Open Region window will apear

Opearting Frequency : 0.9GHz

Select Radiation in Boundary option.



Step 3 : Solution Setup

In Project Manager Window

Right Click on Analysis ----- Add Solution Setup ----- Advanced

Solution Setup window will appear

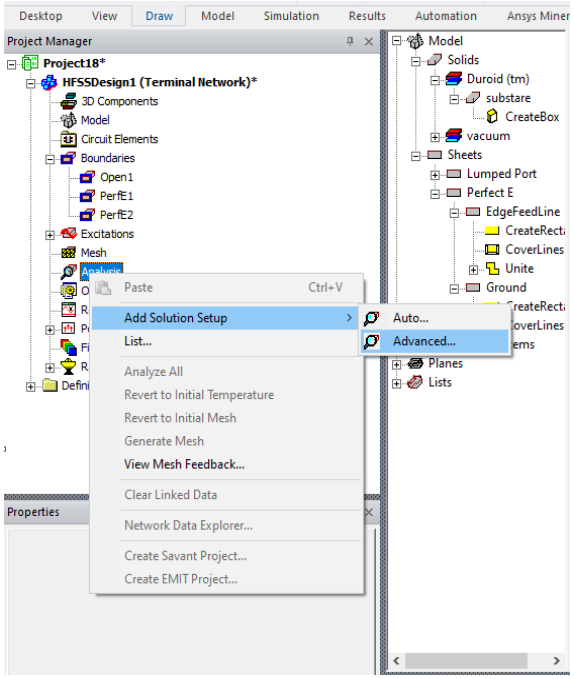
Select Single in Solution Frequency

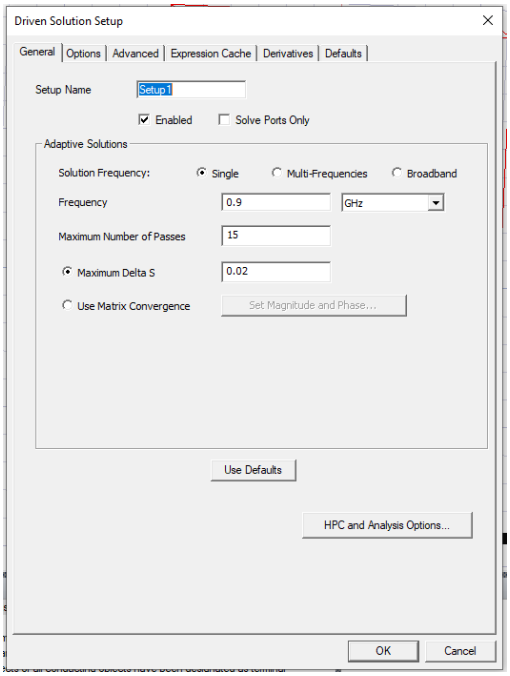
Frequency – 0.9GHz

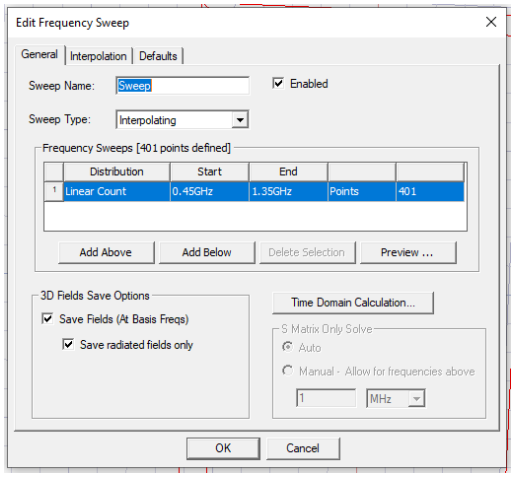
Maximum number of passes – 15

Maximum Delta S – 0.02

Click Ok







Frequency Sweep Window will apppear

Select Linear Step

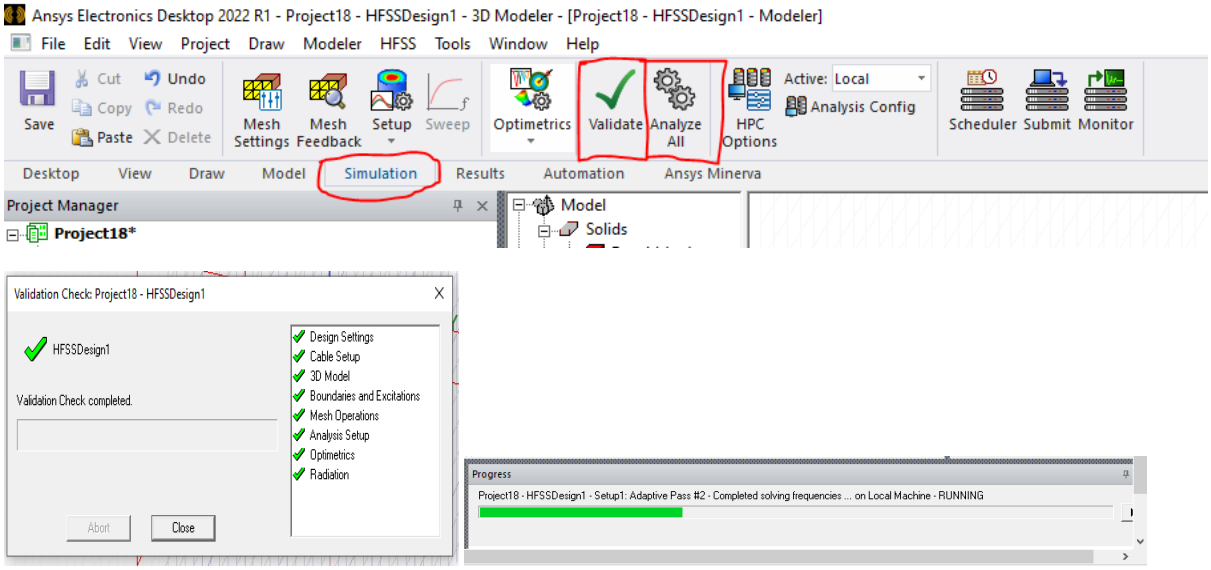
Start – 1GHz, End – 4GHz, Step size – 0.006GHz

Check Save Fields and Save radiated fields only

Click Ok.

channel.success@arkinfo.in

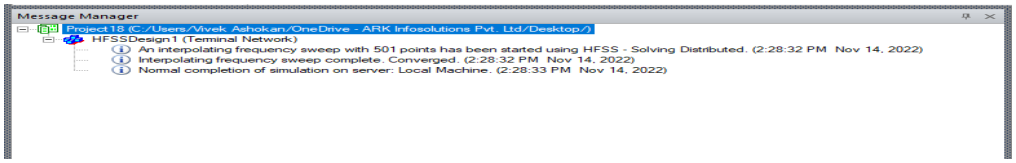
Run the Simulation
Choose Simulation tab ------ Click Validate
Validation Check Window will appear
Click Close
Click Analyze All



Once Simulation is completed

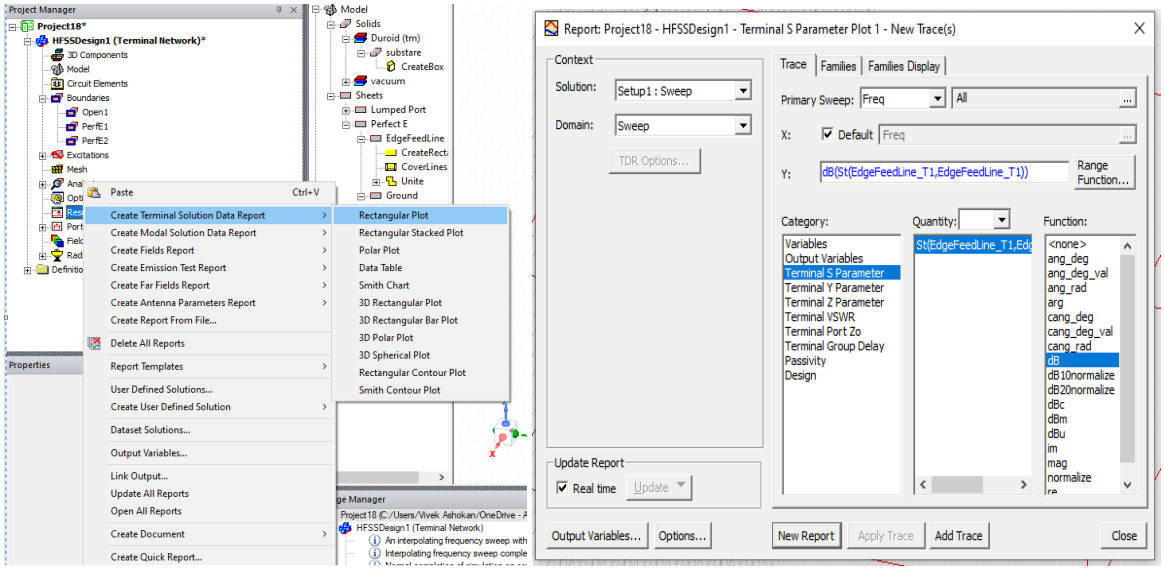
In message manager window

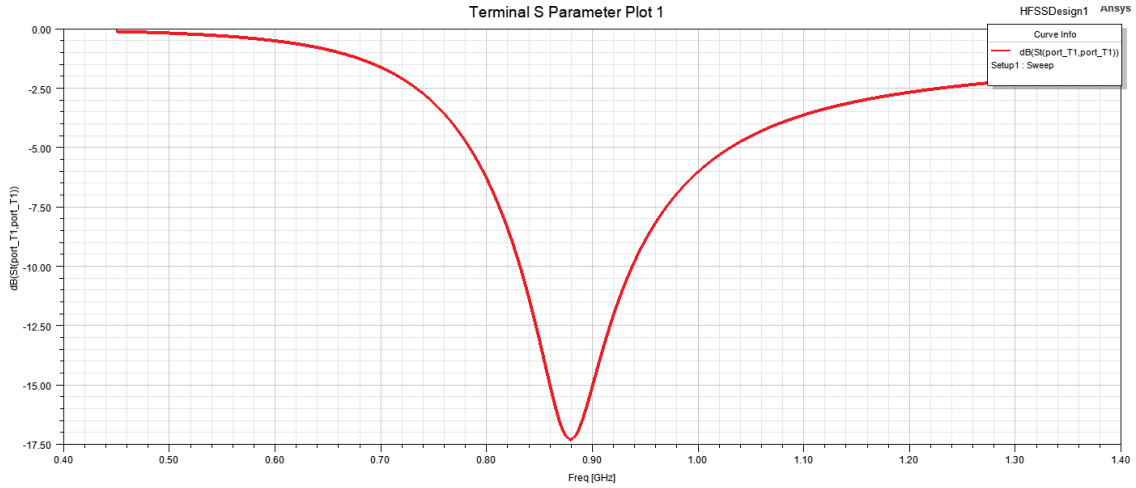
Normal completion of simuation on server will appear.



Step 4 : Viewing Result

1. **Reflection coefficient/Return Loss/S-Parameter**
   Right click on Results ------ Create terminal solution data report ------ Rectangular plot
   Plot Report will appear
   Choose Terminal S-Parameter in Category
   Choose St in Quantity and dB in function
   Click New Report





2. VSWR

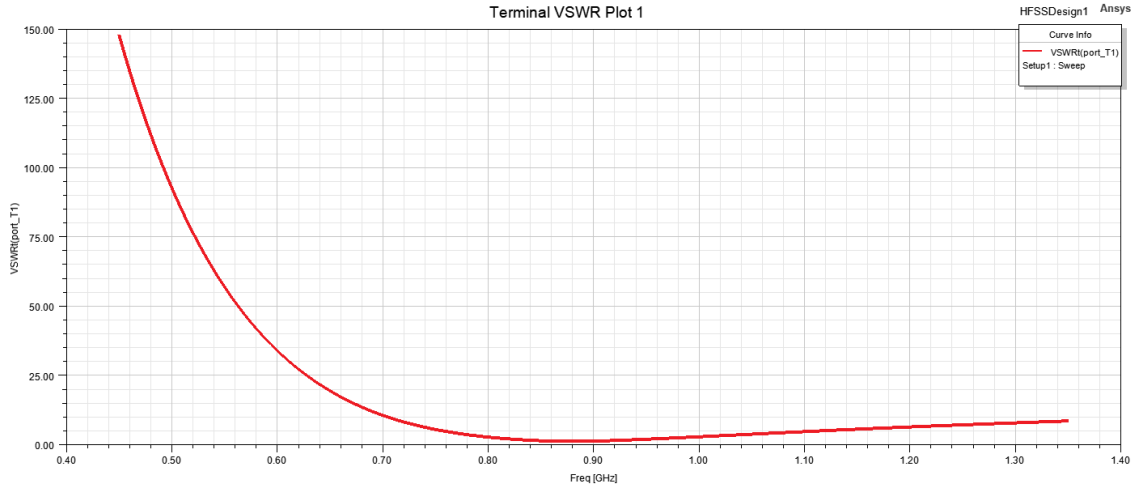
Right click on Results ------ Create terminal solution data report ------ Rectangular plot

Plot Report will appear

Choose Terminal VSWR in Category

Choose St in Quantity and dB in function

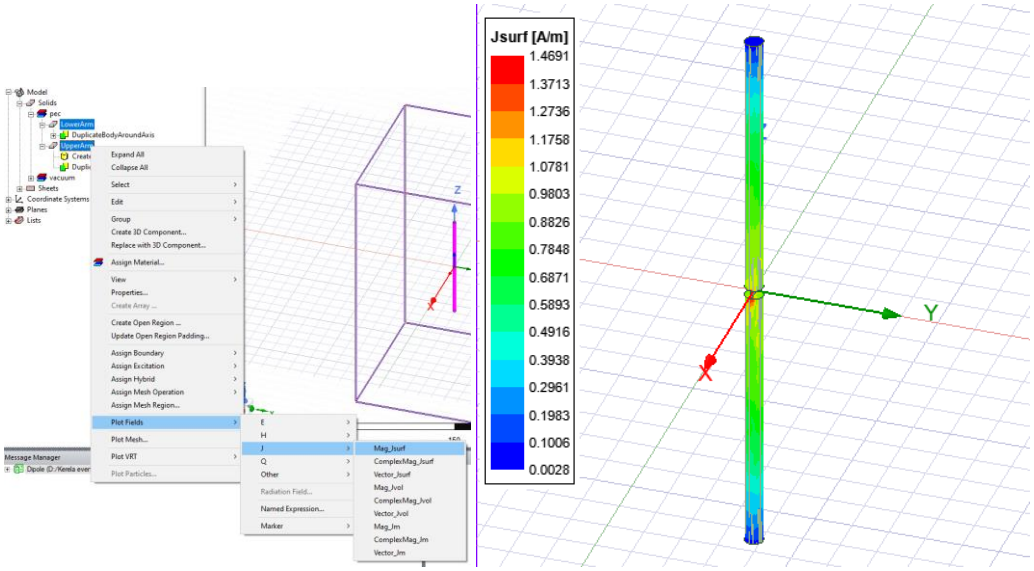
Click New Report



3. Surface current Distribution

In Modeller Window

Choose UpperArm and LowerArm together using control ---- Plot fields ---- J ----- Mag_Jsurf

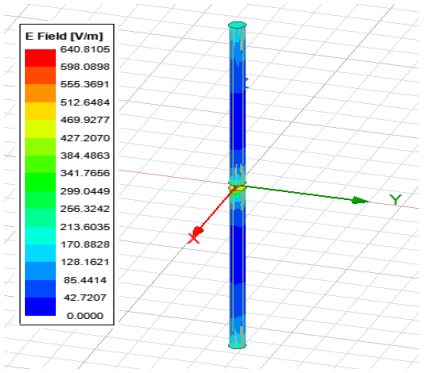


4. Electric Field Distribution

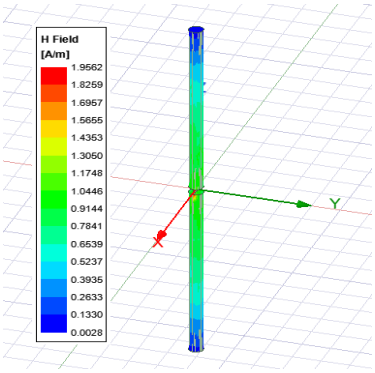
5. Magnetic field Distribution

Similarly,

Plot for Mag_E

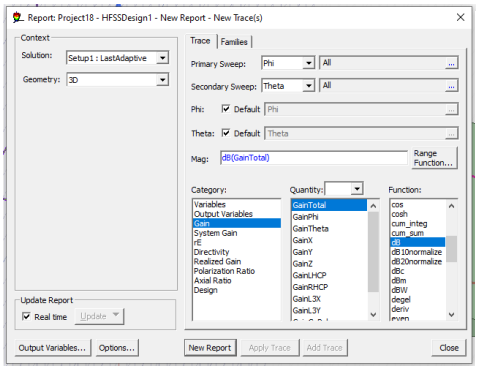


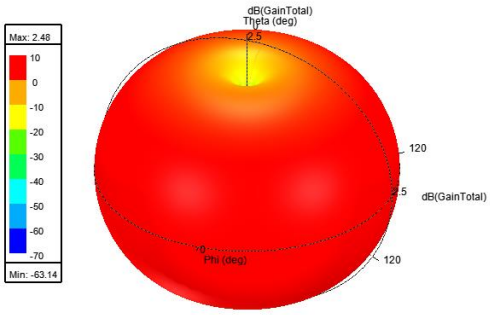
Plot for Mag_H



6 3D Radiation Pattern

Right click on Results ------ Create far field report ------ 3D polar plot

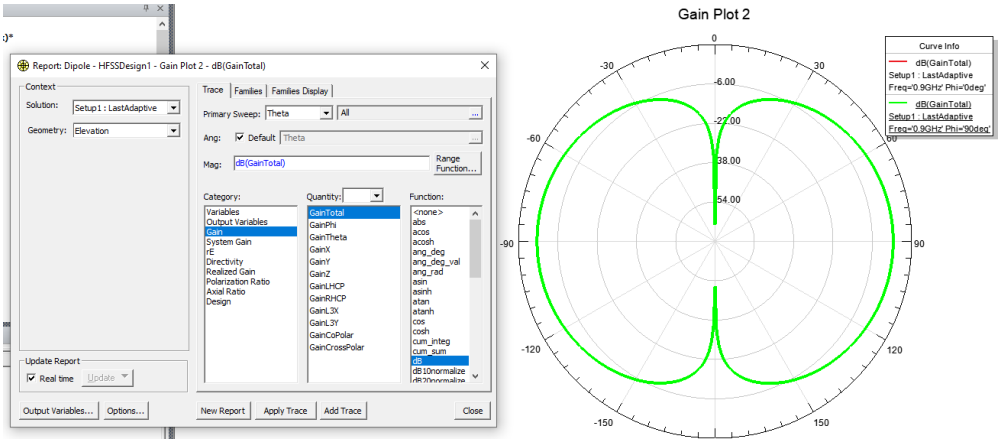




Plot Report will appear
Choose 3D in Geometry
Choose Gain in Category
Choose GainTotal in Quantity and dB in function
Click New Report

7 2D Radaition Pattern

Right click on Results ------ Create far field report ------ Radiation Pattern



Plot Report will appear
Choose Elevation in geometry
Choose Gain in Category
Choose GainTotal in Quantity and dB in function
Click New Report

WS. 2. Design and analysis of rectangular patch Antenna using edge feed technique

Aim:

To design and analyse a rectangular microstrip patch antenna for 10 GHz using edge feed technique.

Objective:

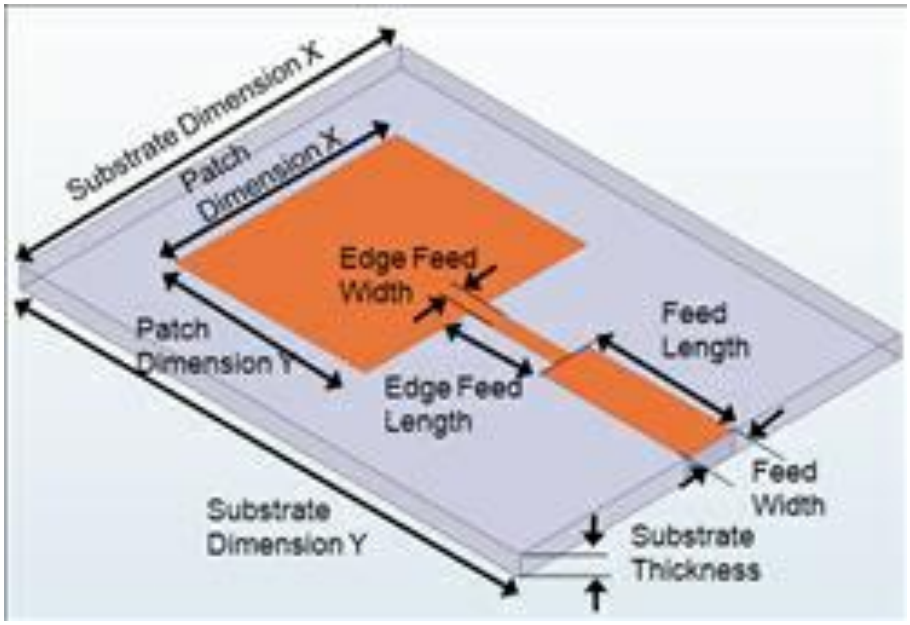
To design rectangular patch antenna and analyse the following antenna parameters

1. Reflection coefficient (S-Parameter)
2. Voltage standing wave ratio (VSWR)
3. Surface current distribution (J Surf)
4. Electric field distribution (E-field)
5. Magnetic field distribution (H-field)
6. 3-D radiation pattern
7. 2-D radiation pattern

Software required:

HFSS

Diagram:



Specifications:

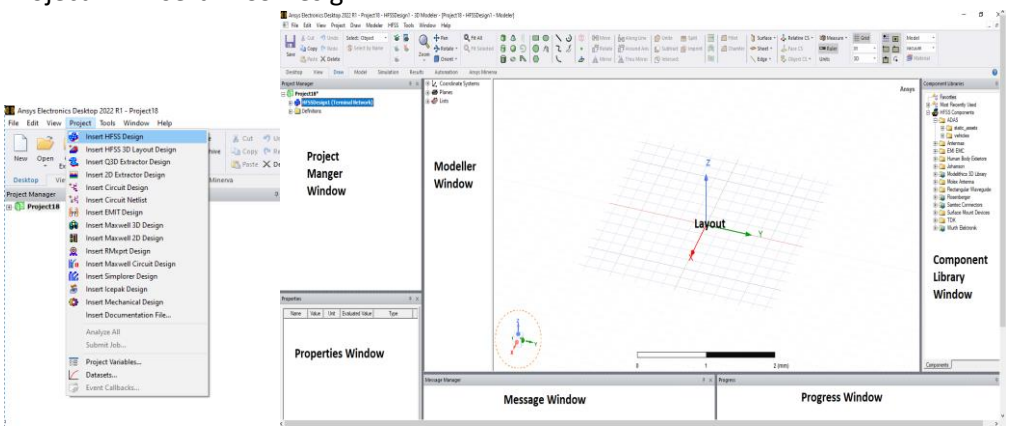
Substrate – Duriod ™ (Rel. Permittivity – 2.2, loss tan – 0.0009)

Parameter	Variable	Value
Substrate Dimension X	SubX	2.7cm
Substrate Dimension Y	SubY	4.05cm
Substrate Thickness	SubH	0.1575cm
Feed Length	FeedLength	0.914cm
Feed Width	FeedWidth	0.493cm
Edge Feed Length	EdgeFeedLength	0.562cm
Edge feed width	EdgeFeedWidth	0.192cm
Patch Dimension X	PatchX	1.19cm
Patch Dimensions Y	PatchY	0.91cm

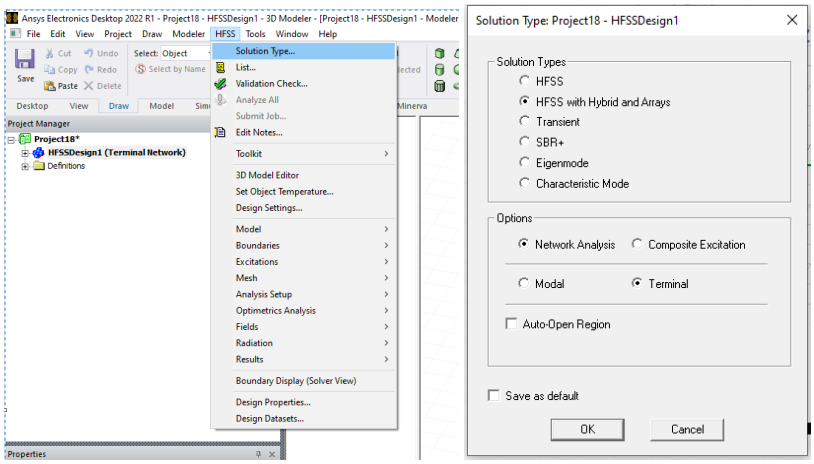
Procedure:

Step 1: Initial Project Setup

1. **Design**
   Open Ansys Electronics Desktop
   Project ---- Insert HFSS Design



2. **Solution type**
   HFSS ----- Solution type
   Under solution type widow
   Select HFSS with Hybrid and Arrays in solution types
   Select Network analysis and Terminal in options
   Click Ok



Step 2: Model Setup

1. **Creating Geometry / Material**

a. Creation of Substrate

Draw ----- box (Randomly draw a box on Layout)

To edit box size

Choose Model --- Solids ---- Vacuum ---- Box1 ----- Double click on CreateBox

Enter the value

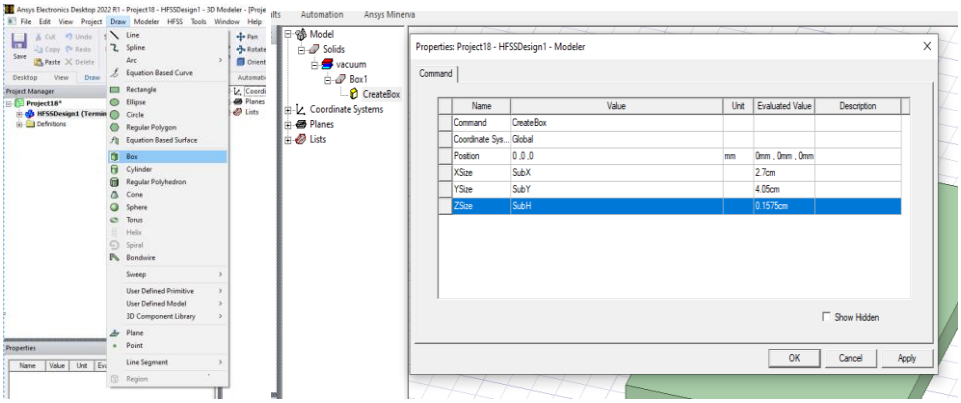
Position : 0,0,0

Xsize : SubX (2.7cm)

Ysize : SubY (4.05cm)

Zsize : SubH (0.1575cm)

Click Ok



Rename Box1 to substrate

Double click on Box1 ----- change Box1 to Substrate under name ---- Click Ok

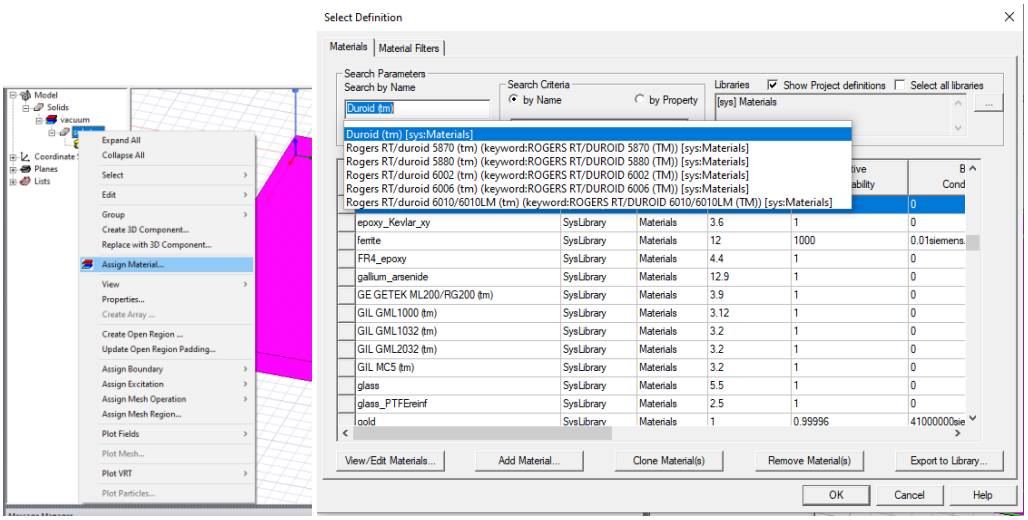
Material Assignment:

Right Click on Substrate ----- Choose Assign Material

Material Library Window will appear

In Search by name type Duroid and select the material Duroid tm.

Click Ok.



b. Creation of Ground

Draw ----- Rectangle (Randomly draw a rectangle on Layout)

To edit rectangle size

Choose Model --- Sheet ---- Unassigned ---- Rectangle1 ----- Double click on CreateRectangle

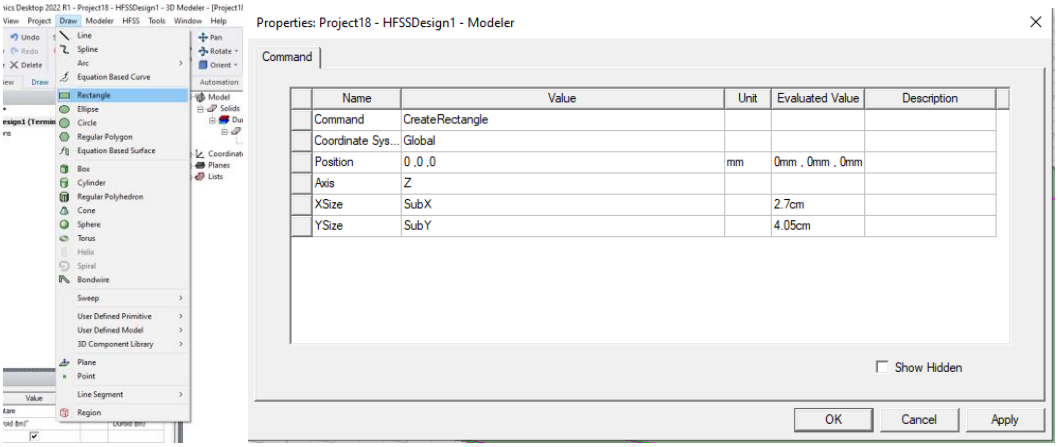
Enter the value

Position : 0,0,0

Xsize : SubX (2.7cm)

Ysize : SubY (4.05cm)

Click Ok



Rename Rectangle1 to Ground

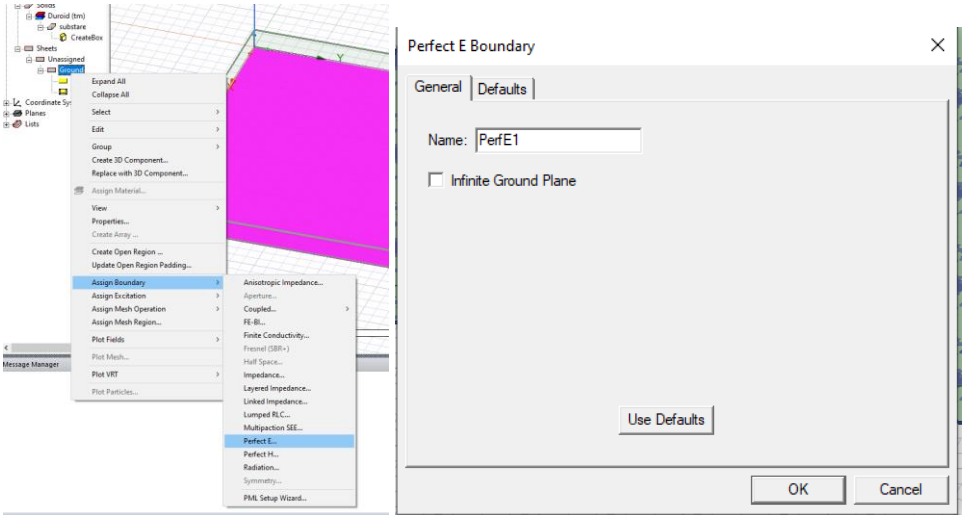
Double click on Rectangle1 ----- change Rectangle1 to Ground under name ---- Click Ok

Boundary Assignment:

Right Click on Ground ----- Assign Boundary ----- Choose PerfectE

PerfectE Boundary window will appear

Click Ok



c. Creation of Feed Line

Draw ----- Rectangle (Randomly draw a rectangle on Layout)

To edit rectangle size

Choose Model --- Sheet ---- Unassigned ---- Rectangle1 ----- Double click on CreateRectangle

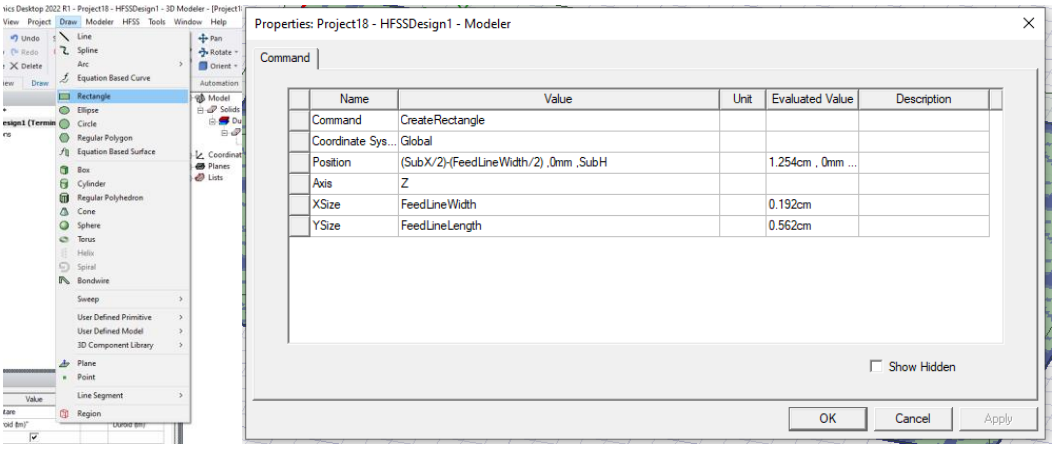
Enter the value

Position : (SubX/2)-(FeedWidth/2),0,SubH

Xsize : FeedWidth (0.493cm)

Ysize : FeedLength (0.914cm)

Click Ok



Rename Rectangle1 to FeedLine

Double click on Rectangle1 ----- change Rectangle1 to FeedLine under name ---- Click Ok

Boundary Assignment:

Right Click on FeedLine ----- Assign Boundary ----- Choose PerfectE

PerfectE Boundary window will appear

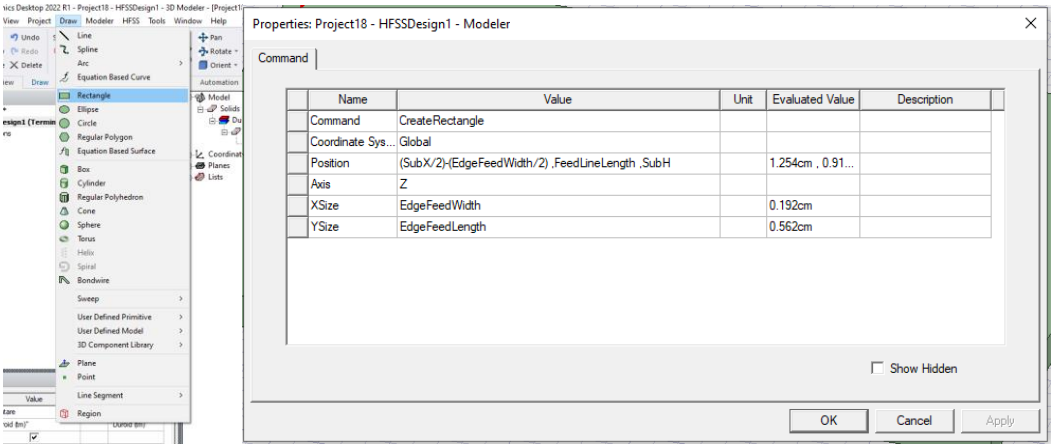
Click Ok

d. Creation of Edge Feed Line

Draw ----- Rectangle (Randomly draw a rectangle on Layout)

To edit rectangle size

Choose Model --- Sheet ---- Unassigned ---- Rectangle1 ----- Double click on CreateRectangle
Enter the value
Position : (SubX/2)-(FeedWidth/2), Feedlength, SubH
Xsize : EdgeFeedWidth (0.192cm)
Ysize : EdgeFeedLength (0.562cm)
Click Ok

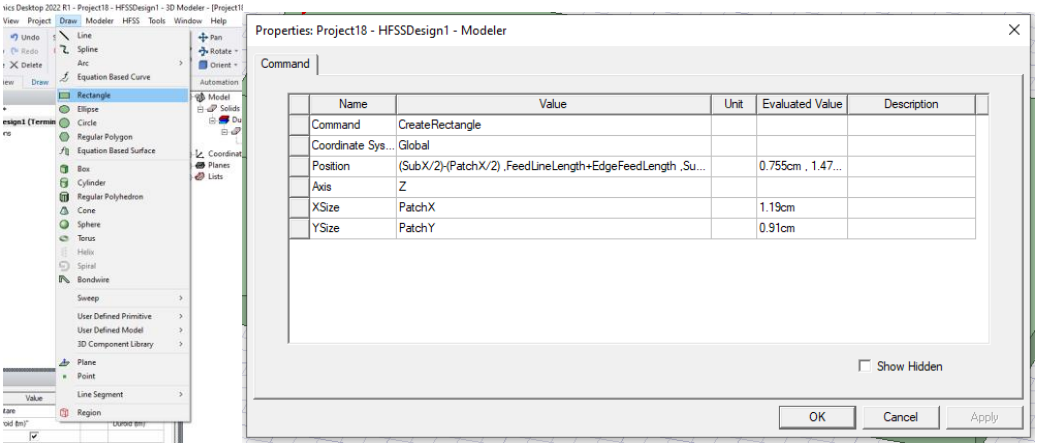


Rename Rectangle1 to EdgeFeedLine
Double click on Rectangle1 ----- change Rectangle1 to EdgeFeedLine under name ----
Click Ok

Boundary Assignment:
Right Click on EdgeFeedLine ----- Assign Boundary ----- Choose PerfectE
PerfectE Boundary window will appear
Click Ok

e. Creation of Patch

Draw ----- Rectangle (Randomly draw a rectangle on Layout)
To edit rectangle size
Choose Model --- Sheet ---- Unassigned ---- Rectangle1 ----- Double click on CreateRectangle
Enter the value
Position : (SubX/2)-(PatchX/2), Feedlength+EdgeFeedLength, SubH
Xsize : PatchX (1.19cm)
Ysize : PatchY (0.91cm)
Click Ok



Rename Rectangle1 to Patch

Double click on Rectangle1 ----- change Rectangle1 to Patch under name ---- Click Ok

Boundary Assignment:

Right Click on Patch ----- Assign Boundary ----- Choose PerfectE

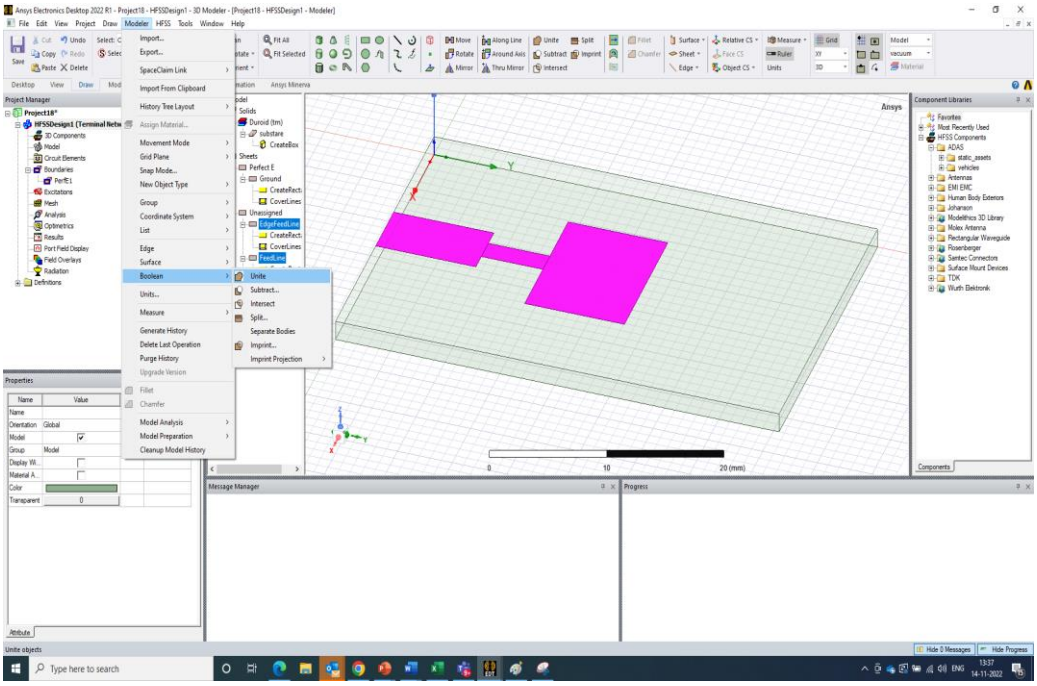
PerfectE Boundary window will appear

Click Ok

Unite FeedLine, Edge Feedline and Patch

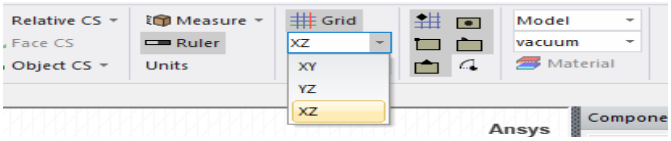
Chosse three goemetries simultaneously

Choose Modeller ----- Boolean ----- Unite



f. Creation of Excitation Geometry

Choose XZ plane



Draw ----- Rectangle (Randomly draw a rectangle on Layout)

To edit rectangle size

Choose Model --- Sheet ---- Unassigned ---- Rectangle1 ----- Double click on CreateRectangle

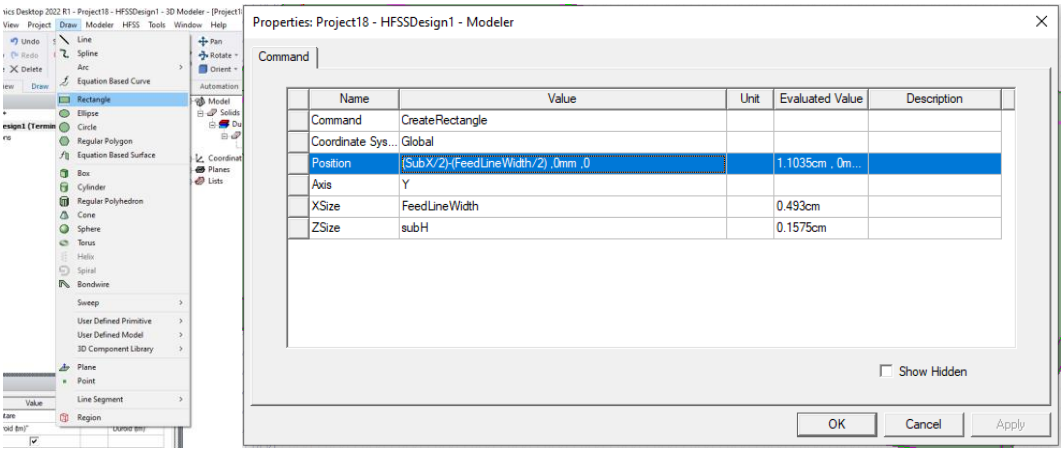
Enter the value

Position : (SubX/2)-(FeedWidth/2), 0, 0

Xsize : FeedWidth (1.19cm)

Zsize : SubH (0.91cm)

Click Ok



Rename Rectangle1 to Port

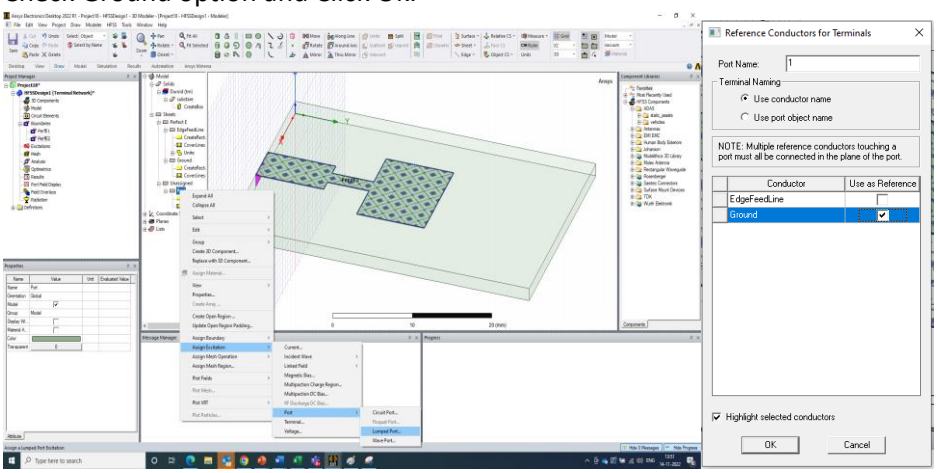
Double click on Rectangle1 ----- change Rectangle1 to Port under name ---- Click Ok

Excitation Assignment:

Right Click on Port ----- Assign Excitation ----- Port ------ Lumped Port

Reference Conductors for terminals window will appear

Check Ground option and Click Ok.



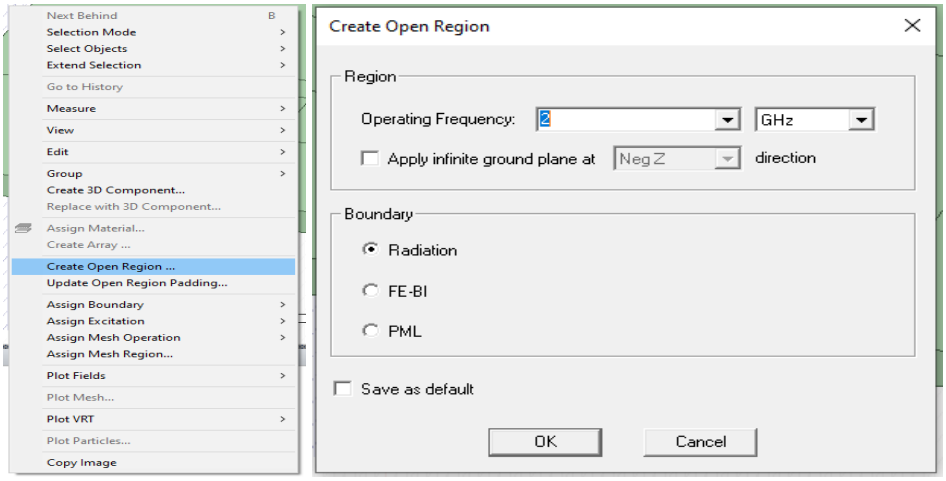
g. Assignment of Open region (Absorbing Boundary Condition)

Right Click on Layout ----- Choose create open region

Create Open Region window will apear

Opearting Frequency : 10GHz

Select Radiation in Boundary option.



Step 3 : Solution Setup

In Project Manager Window

Right Click on Analysis ----- Add Solution Setup ----- Advanced

Solution Setup window will appear

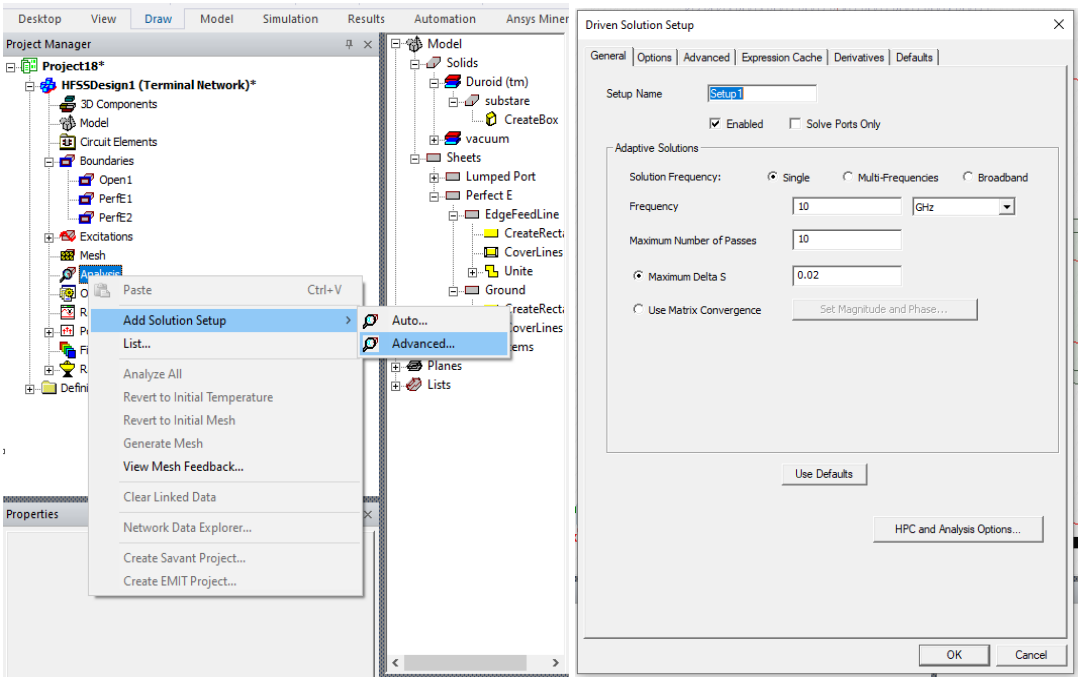
Select Single in Solution Frequency

Frequency – 10GHz

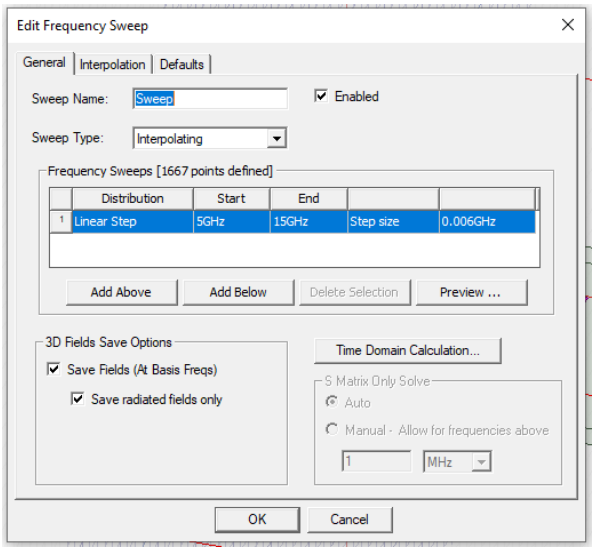
Maximum number of passes – 10

Maximum Delta S – 0.02

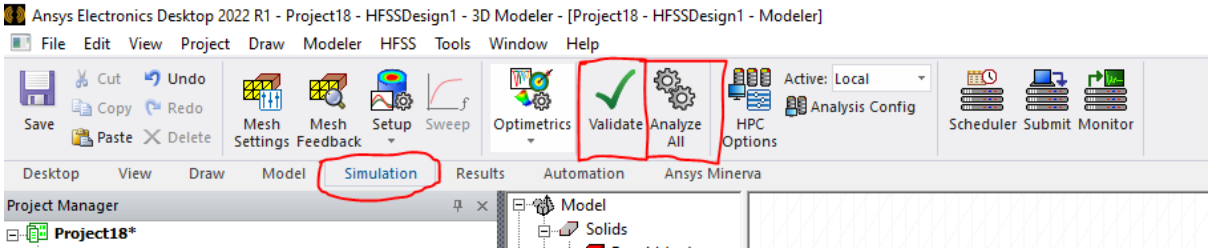
Click Ok

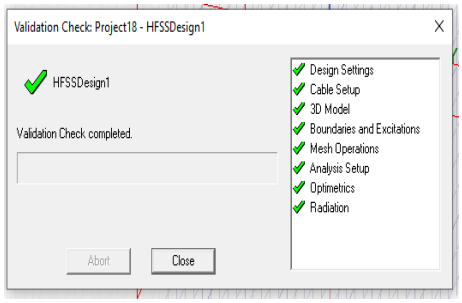


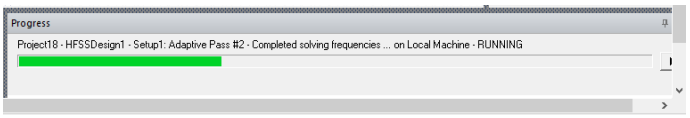
Select Frequency Sweep Window will apppear
Linear Step
Start – 1GHz, End – 4GHz, Step size – 0.006GHz
Check Save Fields and Save radiated fields only
Click Ok.



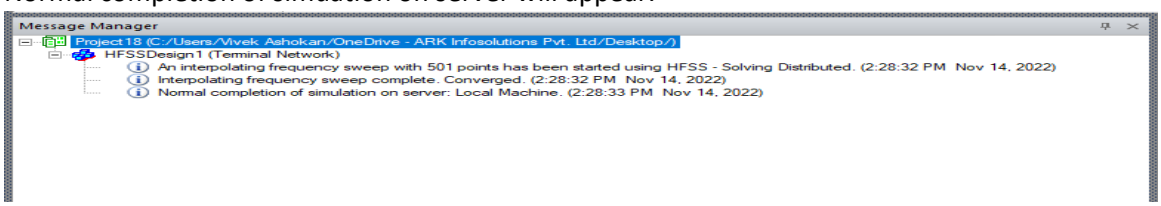
Run the Simulation
Choose Simulation tab ------ Click Validate
Validation Check Window will appear
Click Close
Click Analyze All





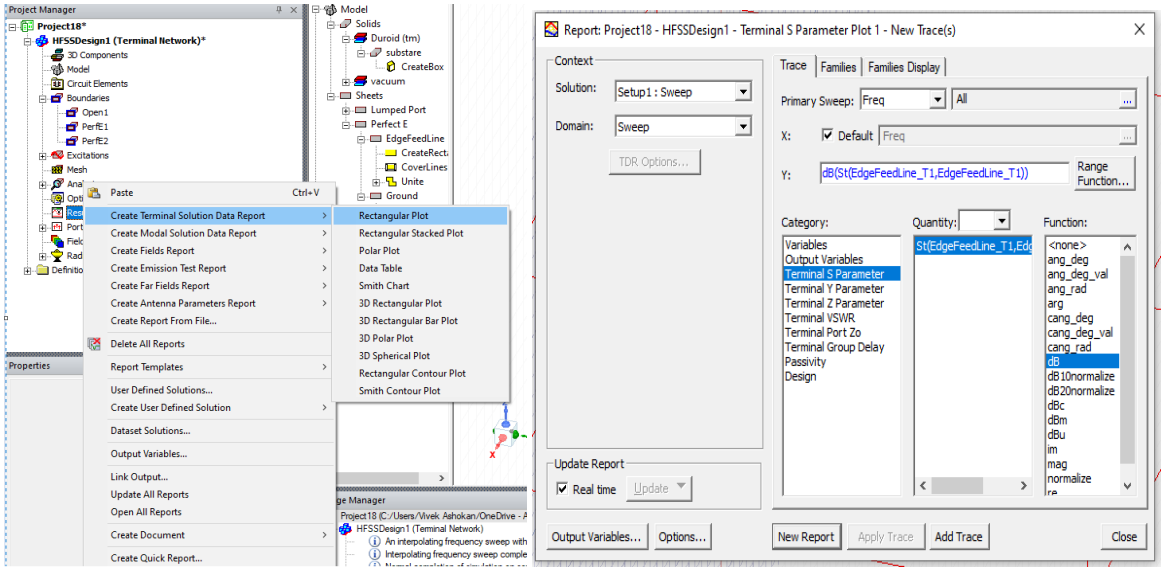


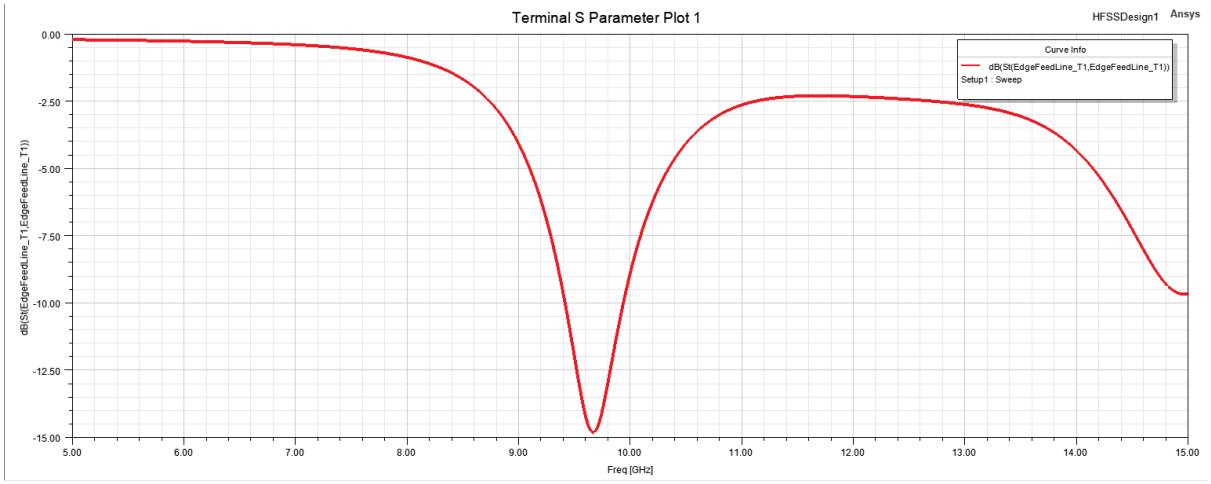
Once Simulation is completed
In message manager window
Normal completion of simuation on server will appear.



Step 4 : Viewing Result

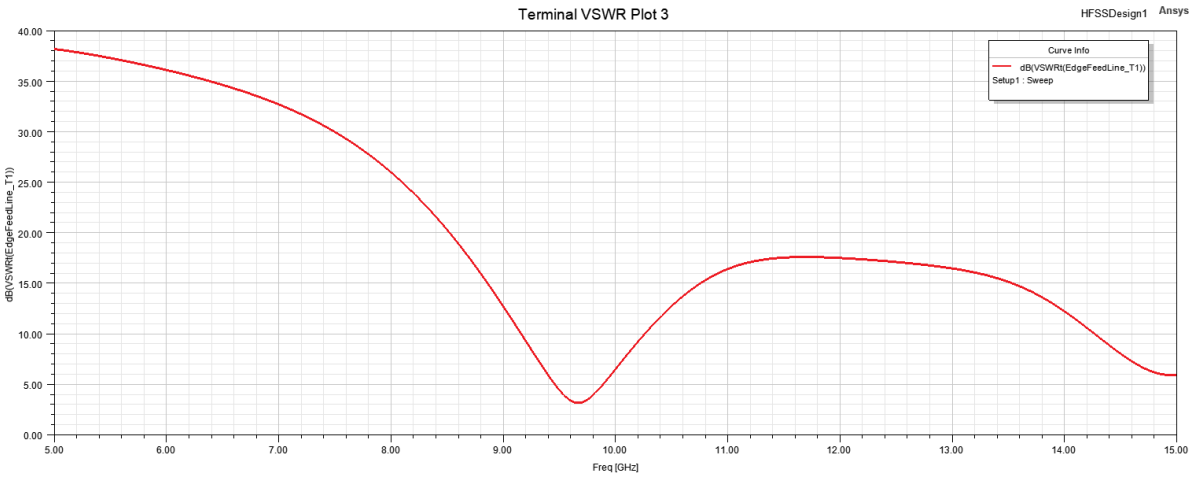
1. **Reflection coefficient/Return Loss/S-Parameter**
   Right click on Results ------ Create terminal solution data report ------ Rectangular plot
   Plot Report will appear
   Choose Terminal S-Parameter in Category
   Choose St in Quantity and dB in function
   Click New Report





2. VSWR

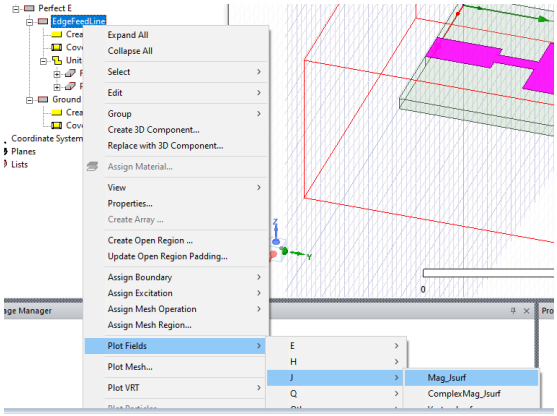
Right click on Results ------ Create terminal solution data report ------ Rectangular plot
Plot Report will appear
Choose Terminal VSWR in Category
Choose St in Quantity and dB in function
Click New Report

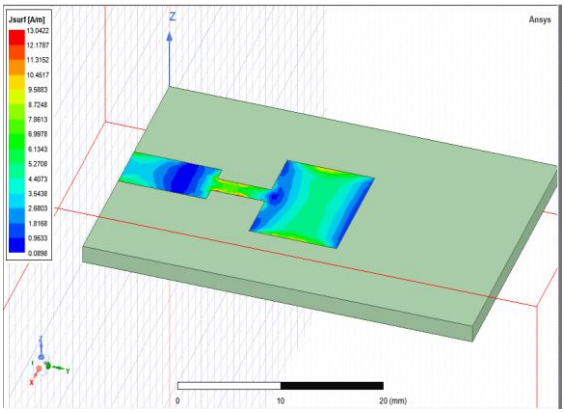


3. Surface current Distribution

In Modeller Window

Right click on EdgefeedLine ---- Plot fields ---- J ----- Mag_Jsurf



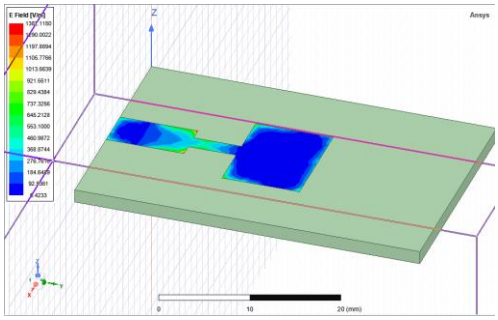


4. Electric Field Distribution

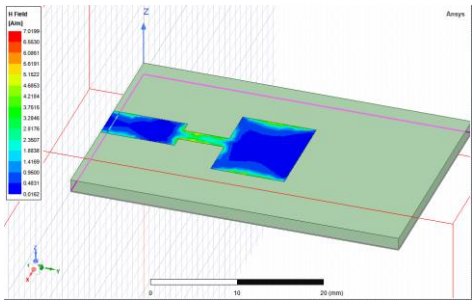
5. Magnetic field Distribution

Similarly,

Plot for Mag_E

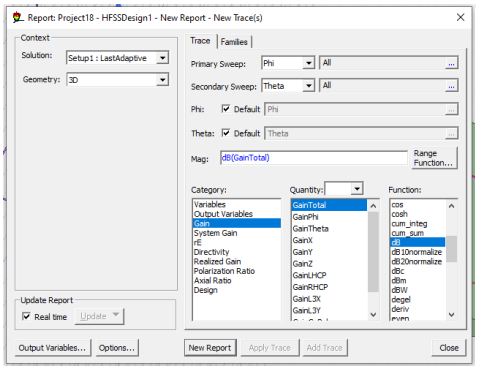


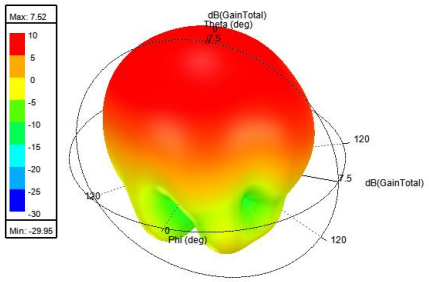
Plot for Mag_H



6 3D Radiation Pattern

Right click on Results ------ Create far field report ------ 3D polar plot

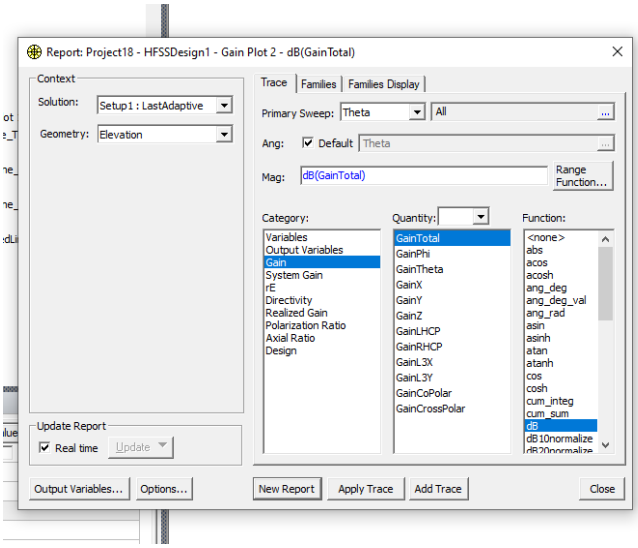


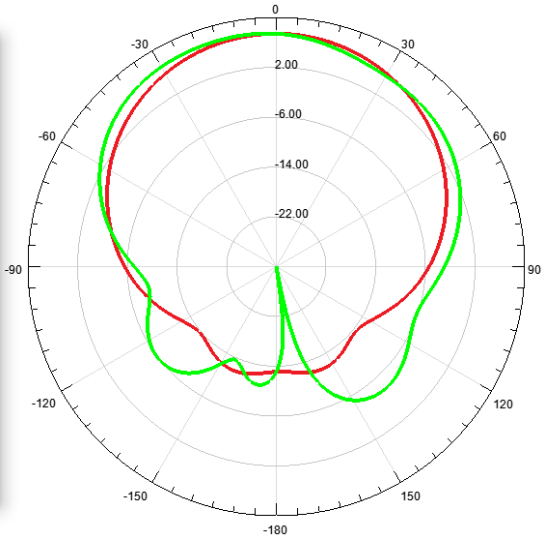


Plot Report will appear
Choose 3D in Geometry
Choose Gain in Category
Choose GainTotal in Quantity and dB in function
Click New Report

7 2D Radaition Pattern

Right click on Results ------ Create far field report ------ Radiation Pattern





Plot Report will appear
Choose Elevation in geometry
Choose Gain in Category
Choose GainTotal in Quantity and dB in function
Click New Report