9. DESIGN AND SIMULATION OF MICROSTRIP ANTENNA. (USING HFSS 3D SIMULATOR)

Aim: To Design and simulate Microstrip antenna using HFSS 3D Software.

Components: HFSS Software

Theory:

Microstrip antenna consists of patch on one side of the substrate and a ground plane on the other side. The length of the microstrip patch antenna consists of lambda/2 patch which acts as a open circuited transmission line. The Microstrip antenna radiates from the edges open ended circuited line. The design formulas are as follows:

$$\Delta L = 0.412h \frac{(\varepsilon_{reff}+0.3)(W/h+0.264)}{(\varepsilon_{reff}-0.258)(W/h+0.8)} \quad (1)$$

The effective length of the patch Leff now becomes:

$$Leff = L + 2\Delta L \quad (2\text{-a})$$

For a given resonant frequency fo, The effective length is given as:

$$Leff = \frac{c}{2 fo \sqrt{\varepsilon_{reff}}} \quad (2\text{-b})$$

For a rectangular Microstrip patch antenna, the resonance

$$\varepsilon reff = \frac{\varepsilon r + 1}{2} + \frac{\varepsilon r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{1/2} \quad (3)$$

The width W is given by Bahl and Bhartia [3] as:

$$W = \frac{c}{2\,fo\sqrt{\frac{(\varepsilon r + 1)}{2}}} \quad (4)$$

Microstrip line feed : formulas in 7th experiment

Microstrip antenna Lay out in 3D HFSS:

HFSS 3D Design building procedure is in the Appendix-1

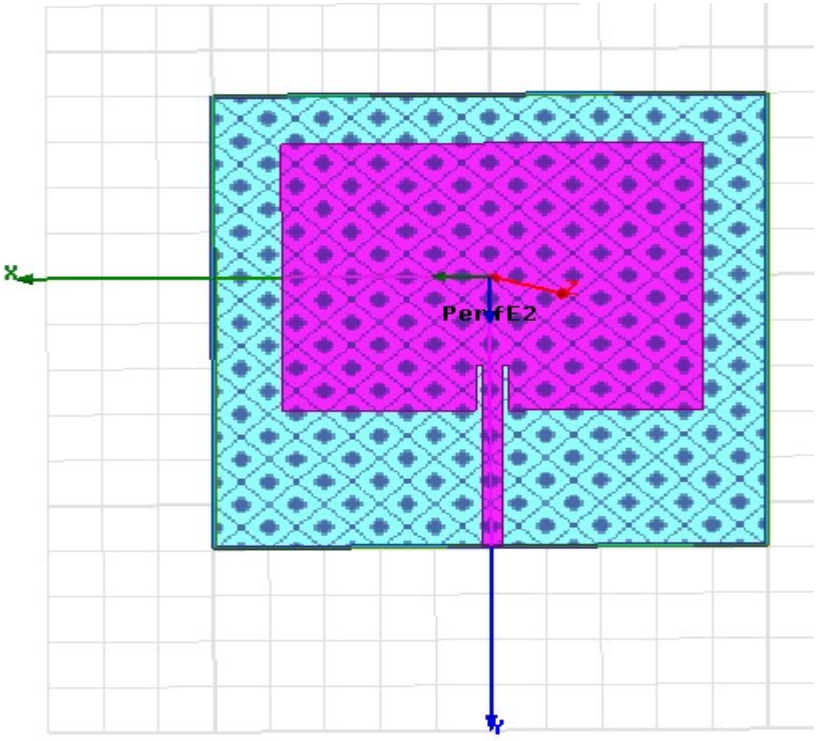


Fig. 1: Microstrip antenna in 3 D HFSS

APPENDIX-I

DESIGN PROCEDURE FOR MICROSTRIP ANTENNA IN 3D

1) **To insert a design into an open project:**

1 Click Project→Insert HFSS Design or on the Toolbar click the Insert HFSS Design icon. The new HFSS design appears in the Project tree.

2) Set Solution Type

To set the solution type:

1 Click HFSS→Solution Type ; Choose Driven Mosel

2 Click the OK button

3) Set Model Units

To set the units:

Click Modeler→Units

Set Model Units:

Select Units: cm

Creation of Microstrip antenna:

a) To create the substrate:

1 Click Draw→Box

2 Using the coordinate entry fields, enter the box position X: -25.0 Y: -20.5, Z: 0.0, Press the Enter key

3 Using the coordinate entry fields, enter the opposite corner of the box dX: 50.0, dY:49.72, dZ: 1.60, Press the Enter key

To set the name:

1 In the Properties window Name field type: Sub1

2 Click the OK button To fit the view:

b) Create Infinite Ground

To create the infinite ground:

1 Click Draw→Rectangle

2 Using the coordinate entry fields, enter the rectangle position X: -25.0, Y: -20, Z: 0.0, Press the Enter key

3 Using the coordinate entry fields, enter the opposite corner of the rectangle: dX: 50, dY: 49.72, dZ: 0.0, Press the Enter key

To set the name:

1 In the Properties window Name field type: Inf_GND

2 Click the OK button

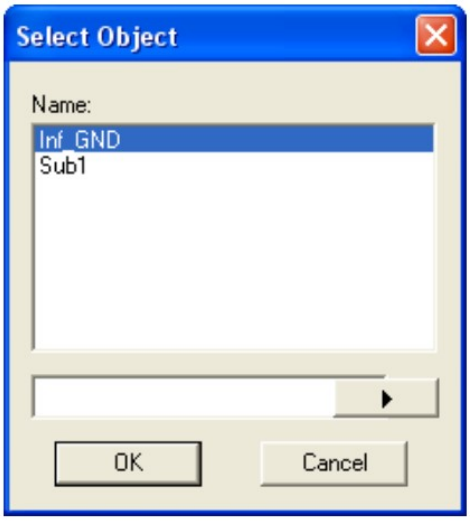
Assign a Perfect E boundary to the Infinite Ground

To select the trace:

1 Click Edit→Select→By Name

The Select Object dialog opens.

2 Select the objects named: Inf_GND



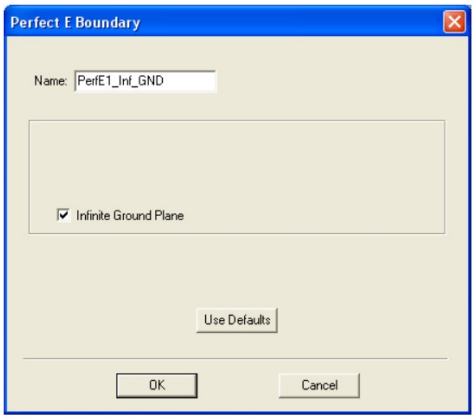
3 Click the OK button

To assign the Perfect E boundary

1 Click HFSS→Boundaries→Assign→Perfect E The Perfect E Boundary dialog opens.

2 Specify the Name as: PerfE_Inf_GND

Check “Infinite Ground Plane.”



c) Create Patch
To create the patch:

1 Click **Draw→Rectangle**

2 Using the coordinate entry fields, enter the rectangle position

X: -19.2, Y: -14.2, Z: 1.60, Press the Enter key

3 Using the coordinate entry fields, enter the opposite corner of the rectangle:

dX: 38.04, dY: 29.44, dZ: 0.0, Press the Enter key

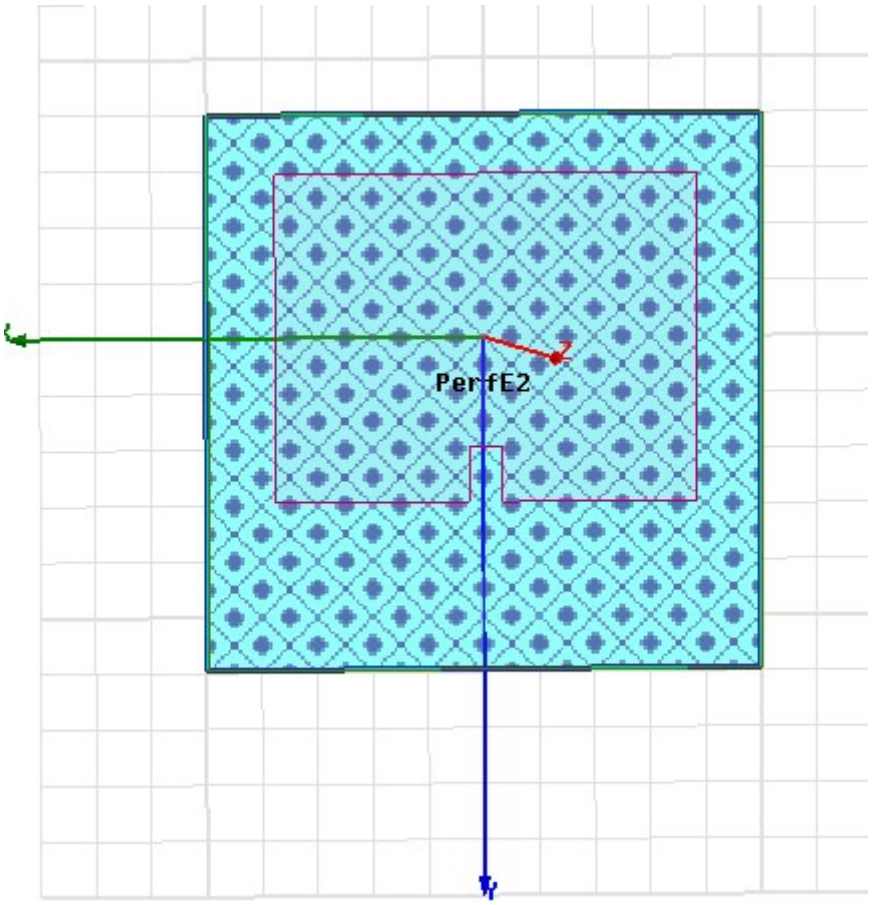
To set the name:

1 In the **Properties** window Name field type: Patch
2 Click the OK button

3 Assign a Perfect E boundary to the patch

Create Cut in the patch

To create the cut out:
1 Click **Draw→Rectangle**
2 Using the coordinate entry fields, enter the center position
X: -1.5, Y: 9.72, Z: 1.6, Press the Enter key
3 Using the coordinate entry fields, enter the radius:
dX: 3, dY: 5, dZ: 0.0, Press the Enter key

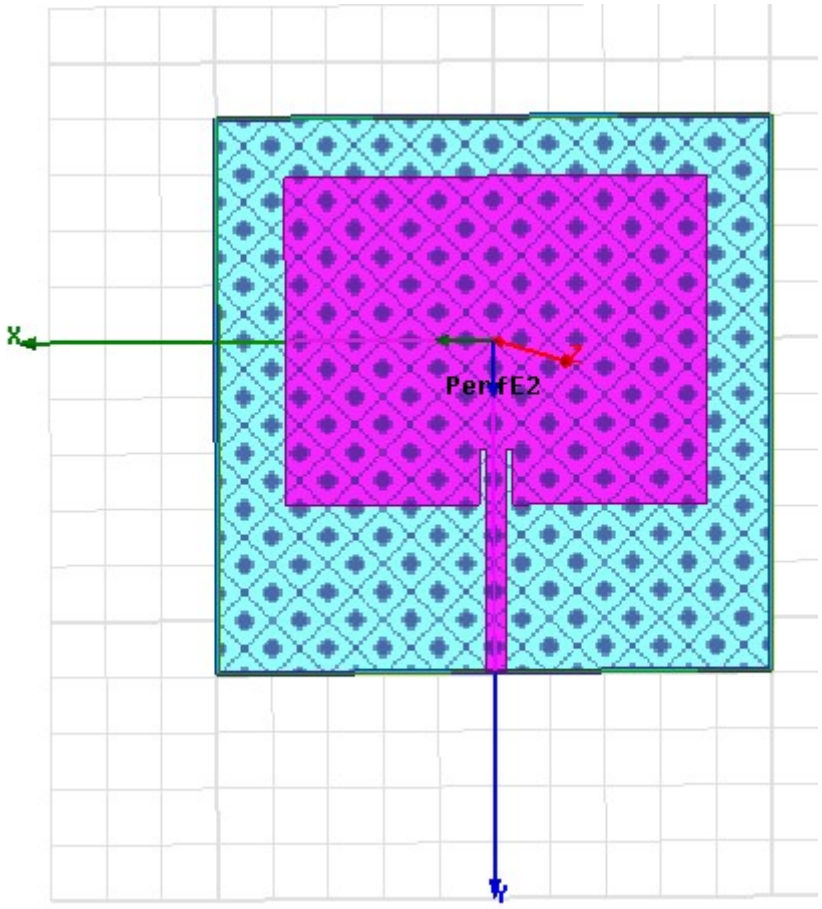


Create microstrip feed

To create the cut out:
1 Click **Draw→Rectangle**
2 Using the coordinate entry fields, enter the center position
X: -0.9, Y: 9.72, Z: 1.6, Press the Enter key
3 Using the coordinate entry fields, enter the radius:
dX: 1.8, dY: 20, dZ: 0.0, Press the Enter key

Combining Microstrip feed and Patch

1 click on Microstrip patch Press control and click→Microstrip feed
2 click the Unite icon in the tool bar
3 Now assign HFSS→Boundaries→Assign→Perfect E to the feed also



Create the Wave port

To create a circle that represents the port:
1 Click **Draw→Rectangle**
2 Using the coordinate entry fields, enter the center position
X: 12.5, Y: 29.72, Z:1.6 Press the Enter key
3 Using the coordinate entry fields, enter the radius of the circle:
dX: 24.5, dY:6.4, dZ: 0.0 : Press the Enter key
To set the name:
1 In the **Properties** window Name field type: Port1
2 Click the OK button

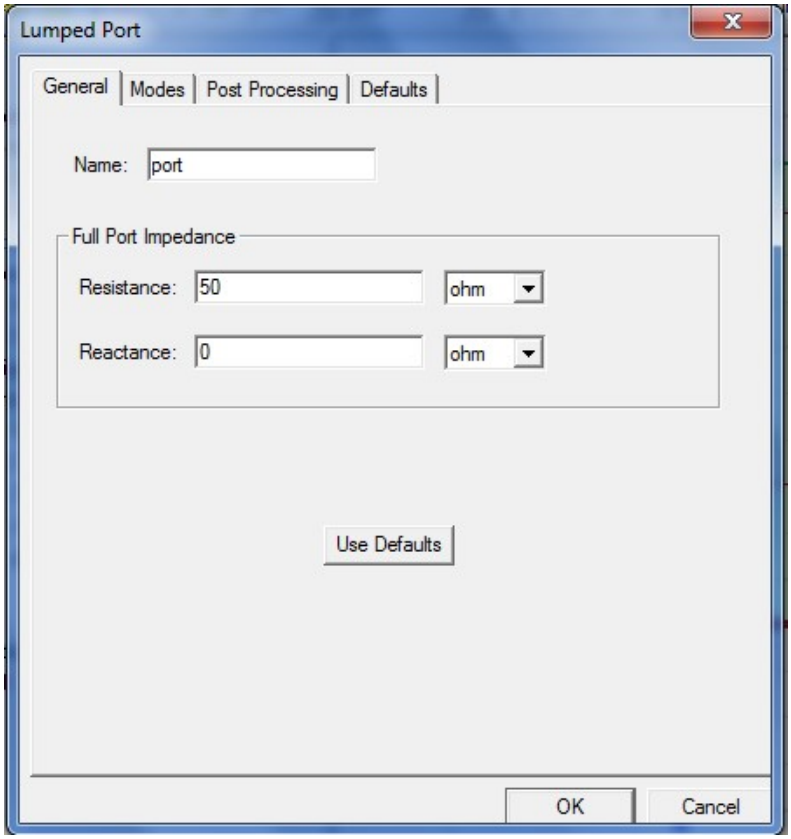
To assign wave port excitation

1 Select the port by it is name

2 Click **HFSS→Excitations→Assign→Lumped Port**

The **Reference Conductors for Terminals** dialog opens.

2 specify the Name: port



Create Air

To create the air:

1 Click **Draw→Box**

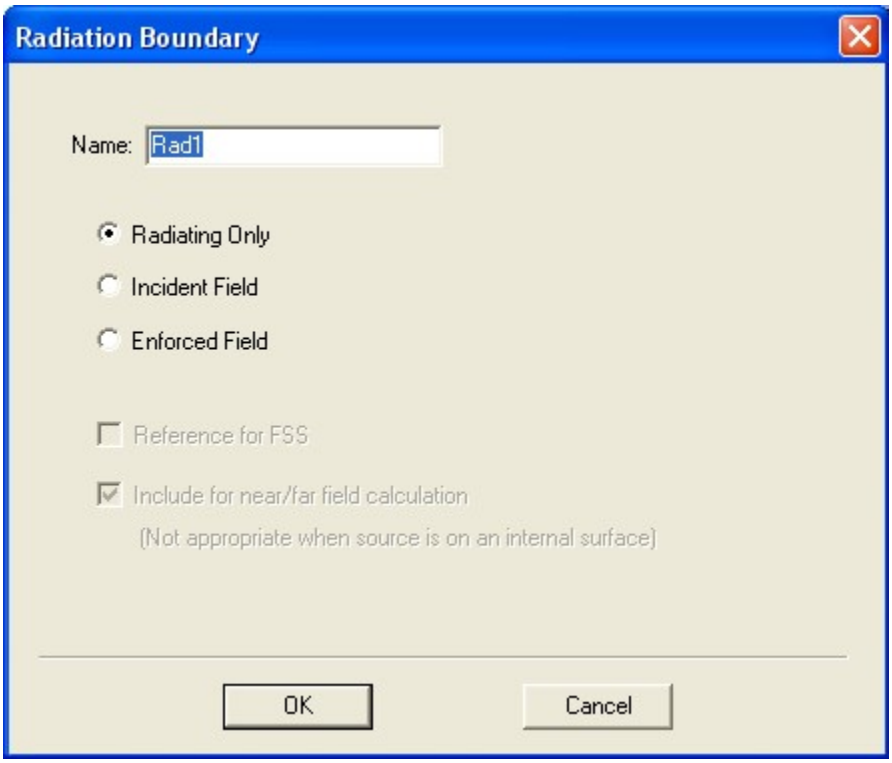
2 Using the coordinate entry fields, enter the box position
X: -45, Y: -40, Z: -20., Press the Enter key

3 Using the coordinate entry fields, enter the opposite corner of the box
dX: 100.0, dY:100, dZ:100, Press the Enter key

Create Radiation Boundary

Pick the faces:
1 Click **Edit-->Select-->Faces**
2 Graphically select all of the faces of the Air object except the face at Z=0.0cm. (The bottom) You can hold down the Alt key, and click the top face, and then hit the "b" key to select a "face behind." After selecting the two faces behind, you can select the remaining
three surface faces.

To create a radiation boundary
1 Click **HFSS>Boundaries>Assign>Radiation**
The Radiation Boundary dialog opens.
2 Name: Rad1

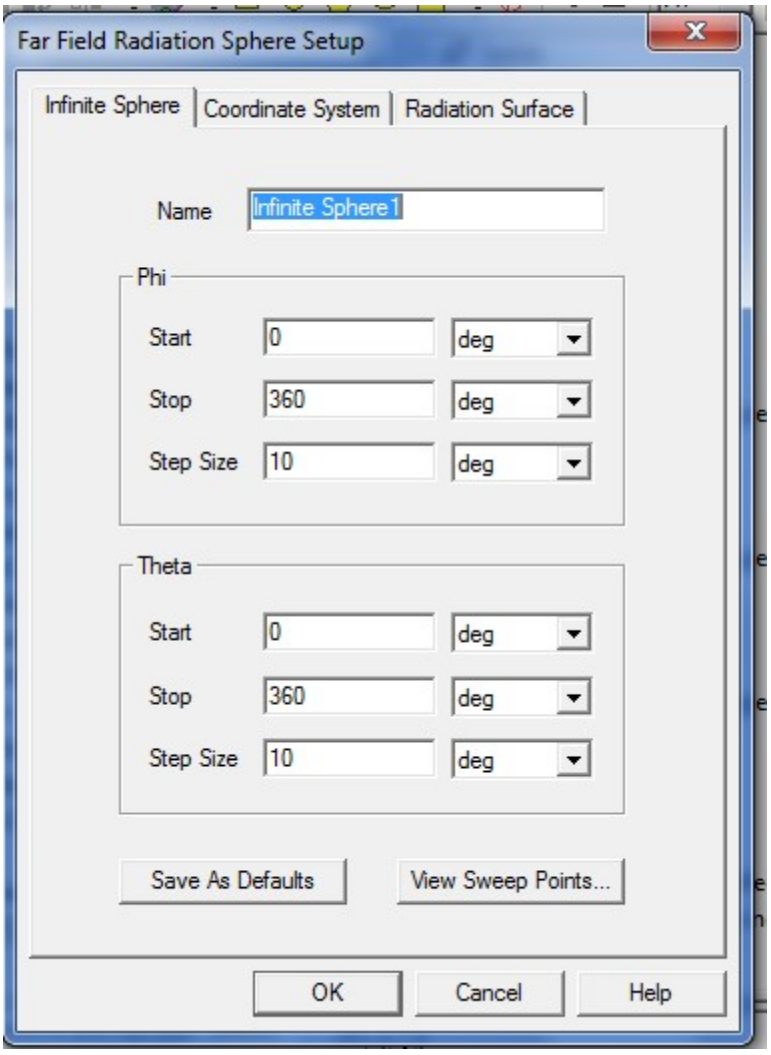


3 Click the OK button

Create a Radiation Setup

To define the radiation setup
1 Click **HFSS>Radiation>Insert Far Field Setup>Infinite**
1 Sphere
The **Far Field Radiation Sphere Setup** dialog opens.
2 Select the Infinite Sphere Tab
Name: ff_2d
Phi: (Start: 0, Stop: 90, Step Size: 90)

Theta: (Start: -180, Stop: 180, Step Size: 2)



3 Click the OK button
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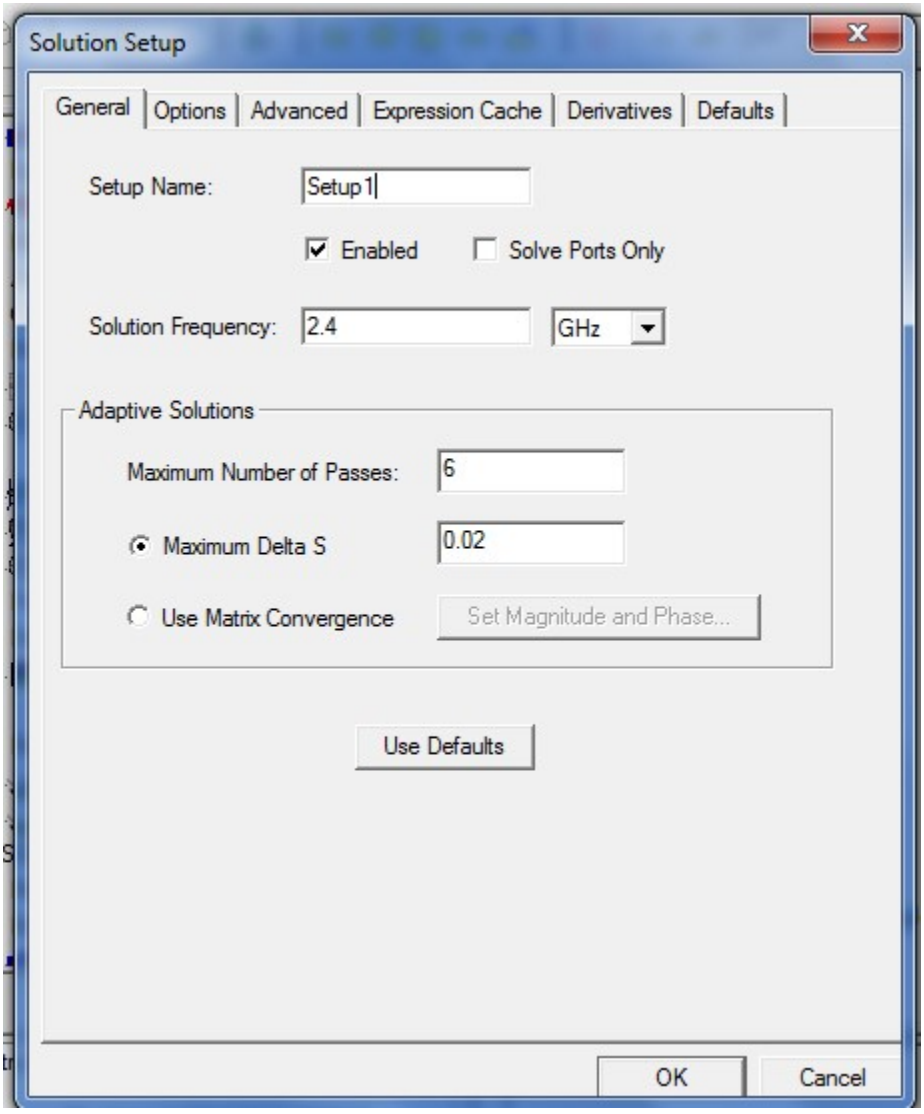
Creating an Analysis Setup

To create an analysis setup:
1 Click **HFSS>Analysis Setup>Add Solution Setup**
The **Solution Setup** dialog opens.
2 In the **General** tab:

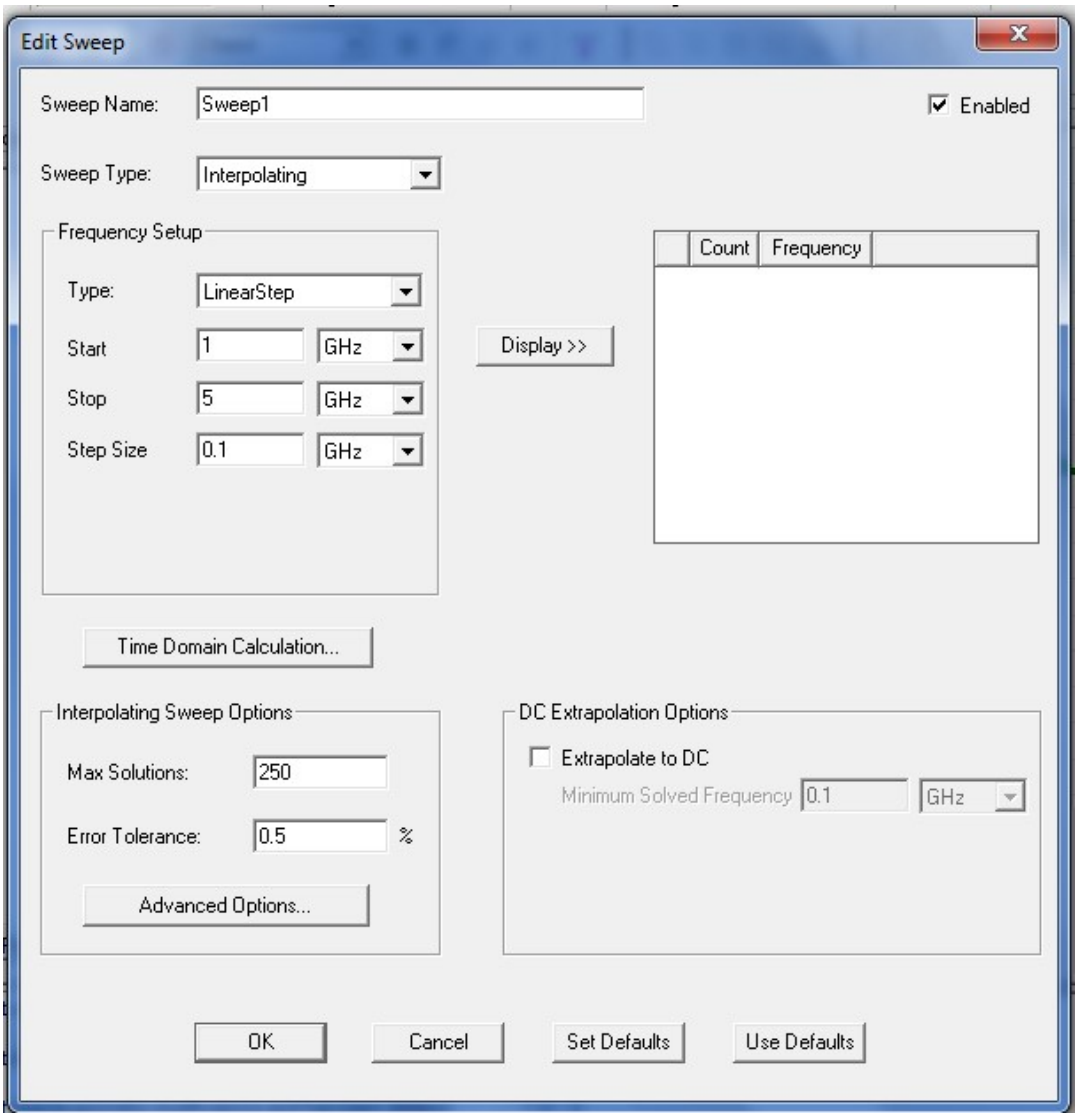
Solution Frequency: 2.240 GHz
: Maximum Number of Passes: 20
Maximum Delta S per Pass: 0.02



3 Click the OK button

Adding a Frequency Sweep

To add a frequency sweep:
1 Click **HFSS>Analysis Setup>Add Sweep**
The **Add/Edit Sweep** dialog opens.
2 Specify the following:
Sweep Type: Fast
Frequency Setup Type: Linear Count
Start: 1GHz
Stop: 5GHz
Step size: 0.1GHz



3 Click the OK button

Save Project

To save the project:

1 In an Ansoft HFSS window, click **File>Save As**.

2 From the Save As window, type the Filename:

Hfss micro strip patch antenna

3 Click the Save button

Analyze

Model Validation

To validate the model:
1 Click **HFSS>Validation Check**
2 Click the Close button

To start the solution process:

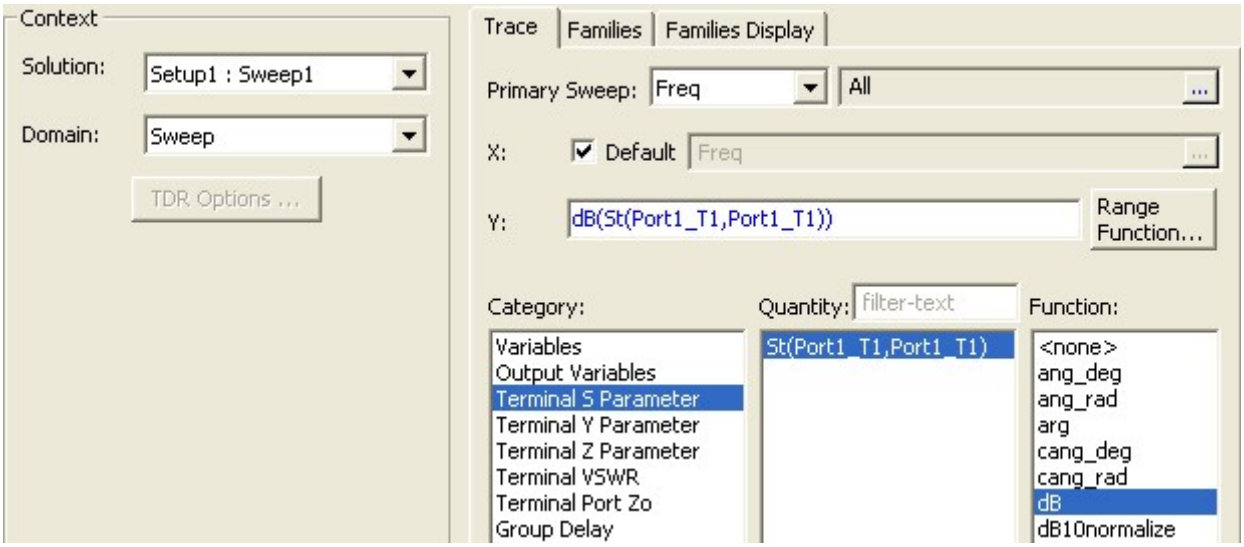
1 Click **HFSS>Analyze All** Solution Data

To view the Solution Data:
1 Click **HFSS>Results>Solution Data**
The Solution Data dialog opens.
To view the Profile→Click the Profile Tab.
To view the Convergence→Click the Convergence Tab
.
Select the Plot radio button to view a graphical representations of the convergence data.
To view the Matrix Data:
Click the Matrix Data Tab
Note: To view a real-time update of the Matrix Data, set
the Simulation to Setup1, Last Adaptive
2 Click the Close button

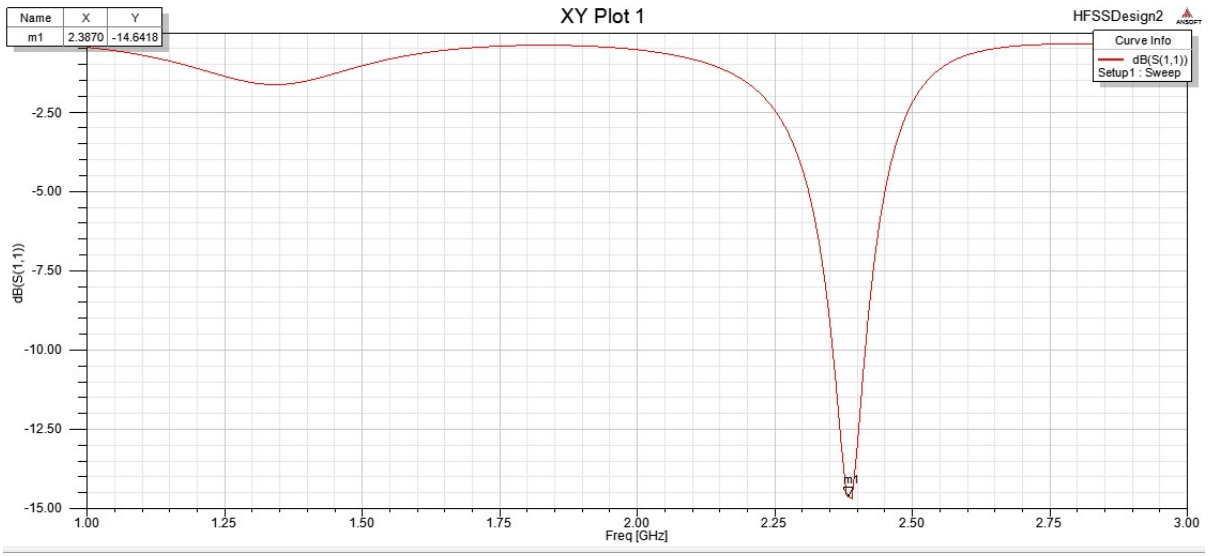
Create Reports

Create Terminal S S→Parameter Plot → Magnitude
To create a report:
1 Click **HFSS>Results>Create Terminal Solution Data Report.**
The **Reports** window opens.
2 Make the following selections:
Solution: Setup1: Sweep1
Domain: Sweep
Category: Terminal S Parameter

Quantity: St(Port1_T1,Port1_T1),
Function: dB

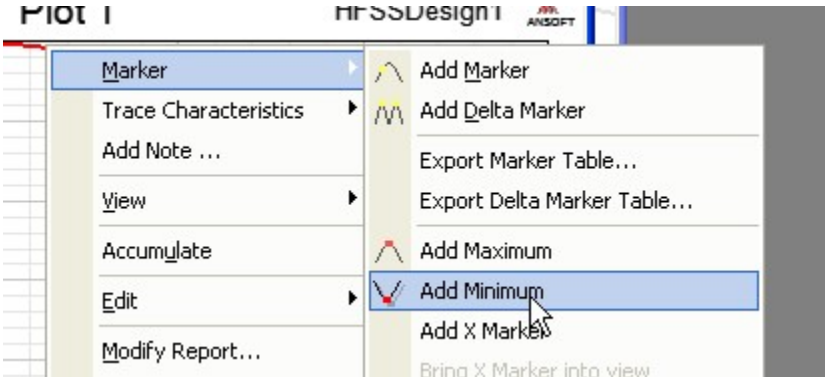


3 Click the **New Report** button



5 Select the trace on the plot.
6 Right click to display the shortcut menu and click

Marker>Add Minimum.



Create Far Field Overlay

To create a 2D polar far field plot :

1 Click **HFSS>Results>Create Far Fields Report>Radiation Pattern.**
The **Reports** dialog appears.
2 Specify the following:
Solution: Setup1: Sweep1
Geometry: ff_2d
In the **Trace** tab:
Select Theta the primary sweep.
Category: Gain
Quantity: GainTotal
Function: dB

Results:

The simulated results are as shown in the below Fig. 2. For the figure it is seen that the antenna resonates at 2.4 GHz. Good Returns loss of -25 dB is obtained.

Fig. 2: S_{11} characteristics of MSA

Conclusion: Microstrip antenna is design and develop in AWR. the antenna resonates at 2.4 GHz. Good Returns loss of -25 dB is obtained