
# Getting Started with HFSS:
## A Probe Patch Feed Antenna

ANSYS Product Suite

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New editions of this manual incorporate all material updated since the previous edition. The manual printing date, which indicates the manual's current edition, changes when a new edition is printed. Minor corrections and updates that are incorporated at reprint do not cause the date to change.

Update packages may be issued between editions and contain additional and/or replacement pages to be merged into the manual by the user. Pages that are rearranged due to changes on a previous page are not considered to be revised.

| Edition | Date | Software Version |
|---|---|---|
| 1 | Jan 2006 | 10.0 |
| 2 | May 2007 | 11.0 |
| 3 | February 2009 | 12.0 |
| 4 | September 2010 | 13.0 |

# Conventions Used in this Guide

Please take a moment to review how instructions and other useful information are presented in this guide.

- Procedures are presented as numbered lists. A single bullet indicates that the procedure has only one step.
- Bold type is used for the following:
  - Keyboard entries that should be typed in their entirety exactly as shown. For example, "**copy file1**" means to type the word **copy**, to type a space, and then to type **file1**.
  - On-screen prompts and messages, names of options and text boxes, and menu commands. Menu commands are often separated by carats. For example, click **HFSS>Excitations>Assign>Wave Port**.
  - Labeled keys on the computer keyboard. For example, "Press **Enter**" means to press the key labeled **Enter**.
- Italic type is used for the following:
  - Emphasis.
  - The titles of publications.
  - Keyboard entries when a name or a variable must be typed in place of the words in italics. For example, "**copy** *file name*" means to type the word **copy**, to type a space, and then to type a file name.
- The plus sign (+) is used between keyboard keys to indicate that you should press the keys at the same time. For example, "Press **Shift+F1**" means to press the **Shift** key and the **F1** key at the same time.
- Toolbar buttons serve as shortcuts for executing commands. Toolbar buttons are displayed after the command they execute. For example,

  "On the **Draw** menu, click **Line**  " means that you can click the Draw Line toolbar button to execute the **Line** command.

*Alternate methods or tips are listed in the left margin in blue italic text.*

# Getting Help

## Ansoft Technical Support

To contact Ansoft technical support staff in your geographical area, please log on to the Ansoft corporate website, http://www.ansoft.com, click the **Contact** button, and then click **Support**. Phone numbers and e-mail addresses for the technical support staff are listed. You can also contact your Ansoft account manager in order to obtain this information.

All Ansoft software files are ASCII text and can be sent conveniently by e-mail. When reporting difficulties, it is extremely helpful to include very specific information about what steps were taken or what stages the simulation reached, including software files as applicable. This allows more rapid and effective debugging.

## Help Menu

To access online help from the HFSS menu bar, click **Help** and select from the menu:

- **Contents** - click here to open the contents of the online help.
- **Seach** - click here to open the search function of the online help.
- **Index** - click here to open the index of the online help.

## Context-Sensitive Help

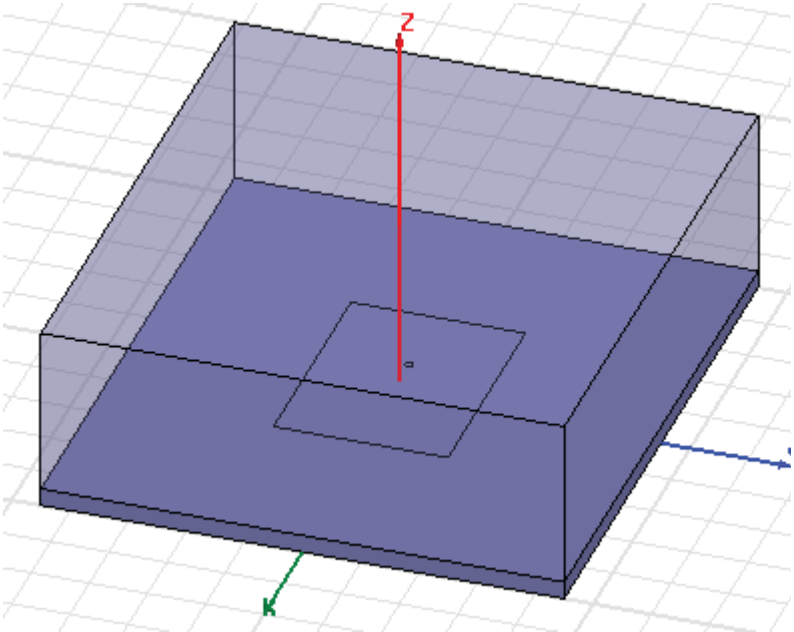
To access online help from the HFSS user interface, do one of the following:

- To open a help topic about a specific HFSS menu command, press **Shift**+**F1**, and then click the command or toolbar icon.
- To open a help topic about a specific HFSS dialog box, open the dialog box, and then press **F1**.

# Table of Contents

# Probe Feed Patch Antenna

This example is intended to show you how to create, simulate, and analyze a probe feed patch antenna using the Ansoft HFSS Design Environment.



# Getting Started

Click the Microsoft Start button, select **All Programs>Ansoft>HFSS 12>HFSS 12** or double click on the HFSS 12 icon on the Windows Desktop

# Adding a Project and Design

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.

## Setting Tool Options

To set the tool options:

Note: In order to follow the steps outlined in this example, verify that the following tool options are set :

1. Click **Tools>Options>HFSS Options**
2. In the **HFSS Option**s dialog click the **General** tab

   Check "Use Wizards for data input when creating new boundaries."

   Check "Duplicate boundaries/mesh operations with geometry."
3. Click OK to close the **HFSS Options** dialog.
4. Click **Tools>Options>Modeler Options**.
5. The **Modeler Options** dialog opens with the **Operation** tab.
6. Check "Automatically cover closed polyline."
7. Click the **Drawin**g tab

   Check "Edit property of new primitives."

   This causes the **Properties** window for new primitives to open automatically.
8. Click the **OK** button

## Set Solution Type

To set the solution type:

1. Click **HFSS>Solution Type**

   The **Solution Type** dialog opens.

2 Choose Driven Terminal

3 Click the OK button

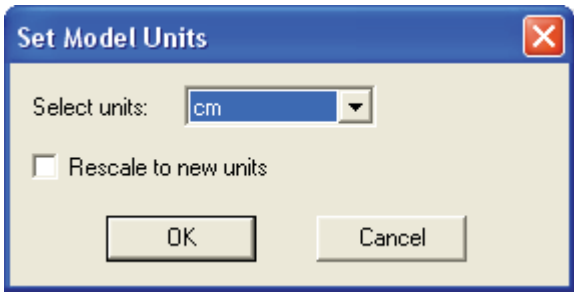
## Set Model Units

To set the units:

Click **Modeler>Units**

Set Model Units:

Select Units: cm

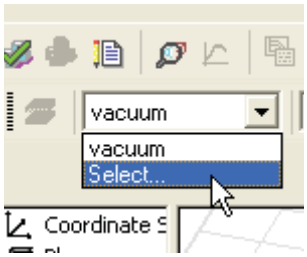



Click the OK button

## Set Default Material

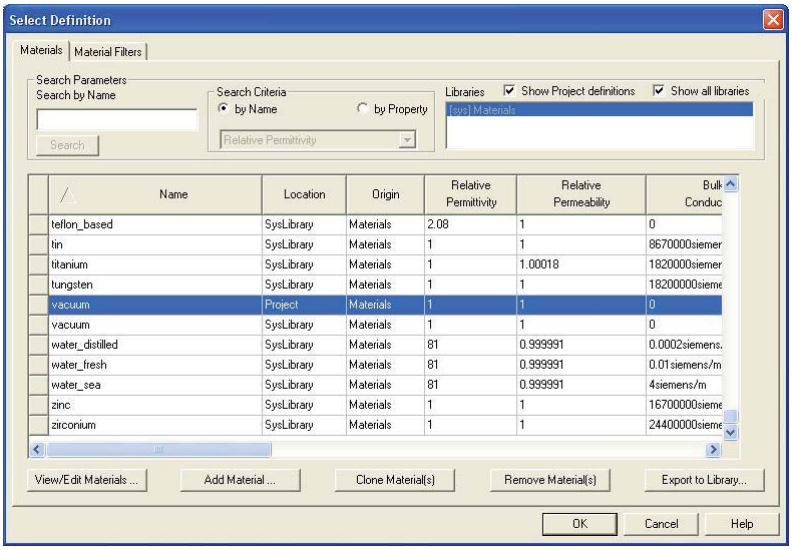
To set the default material:

1 Using the 3D Modeler Materials toolbar, choose **Select...**.




2 This opens the **Select Definition** window with the Materi-

als tab.




**3** 1. In the Search by Name field, type Rogers RT/ duroid 5880 (tm).

Click the OK button

## Create Substrate

To create the substrate:

**1** Click **Draw>Box**

**2** Using the coordinate entry fields, enter the box position

X: -5.0 Y: -4.5, Z: 0.0, Press the Enter key

**3** Using the coordinate entry fields, enter the opposite corner of the box

dX: 10.0, dY: 9.0, dZ: 0.32, Press the Enter key

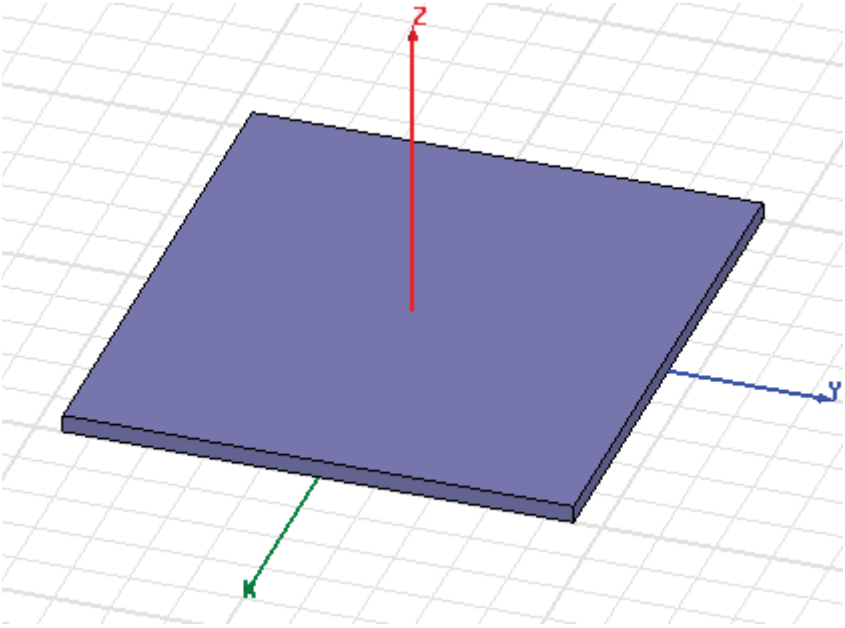
To set the name:

**1** In the **Properties** window Name field type: Sub1

**2** Click the OK button

To fit the view:

Click **View>Fit All>Active View**, or press the CTRL+D.




## Create Infinite Ground

To create the infinite ground:

1. Click **Draw>Rectangle**
2. Using the coordinate entry fields, enter the rectangle position

   X: -5.0, Y: -4.5, Z: 0.0, Press the Enter key
3. Using the coordinate entry fields, enter the opposite corner of the rectangle:

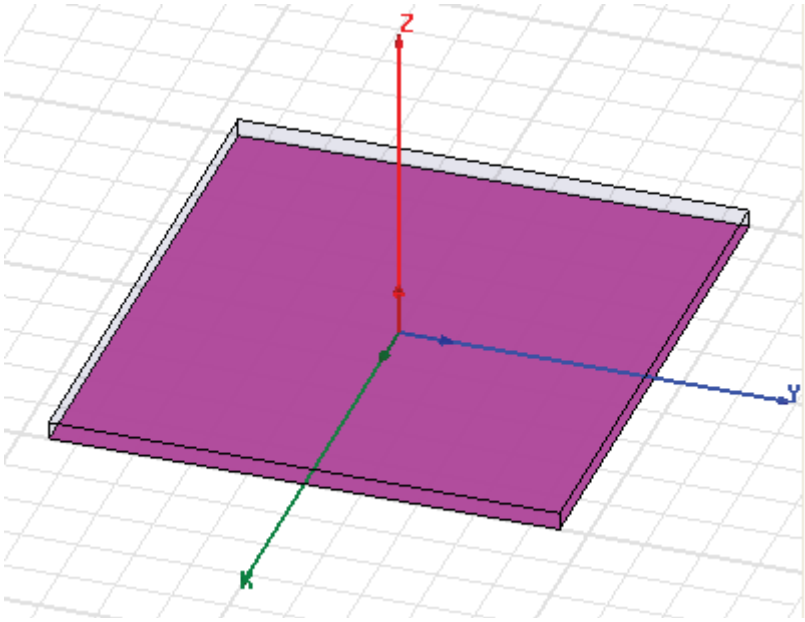
   dX: 10.0, dY: 9.0, dZ: 0.0, Press the Enter key

To set the name:

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

To fit the view:

Click **View>Fit All>Active View**.



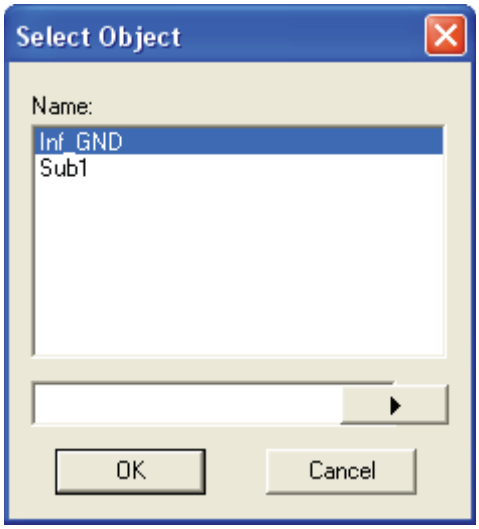

### Assign a Perfect E boundary to the Infinite Ground

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

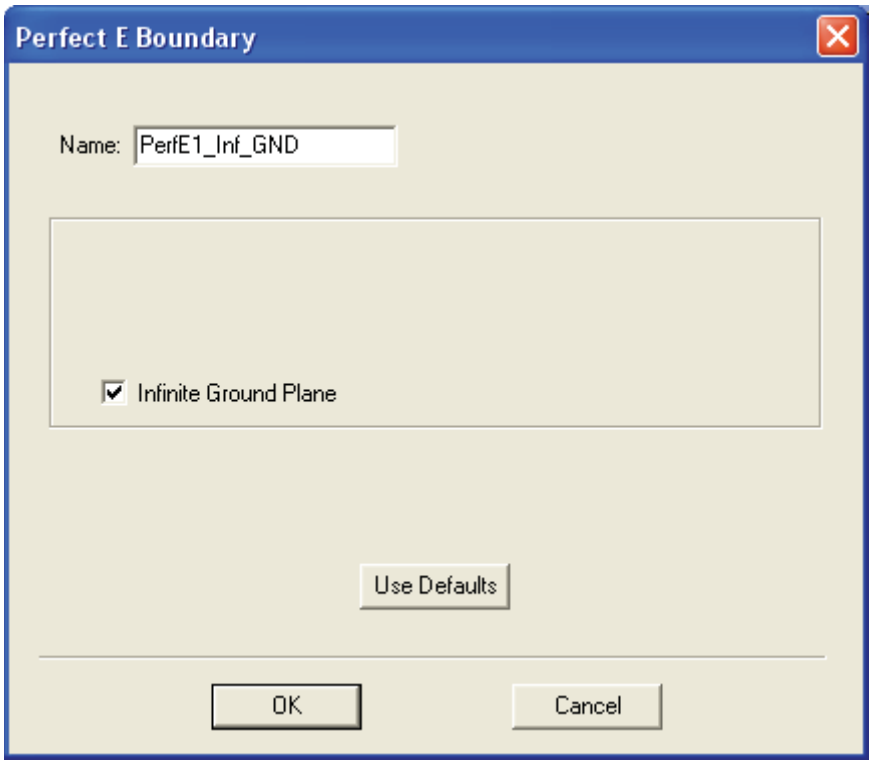
To assign the Perfect E boundary

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.”




3 Click the OK button

### Create Infinite Ground Cut Out

To create the cut out:

1 Click **Draw>Circle**

2 Using the coordinate entry fields, enter the center position

X: -0.5, Y: 0.0, Z: 0.0, Press the Enter key

3 Using the coordinate entry fields, enter the radius:

dX: 0.16 , dY: 0.0, dZ: 0.0, Press the Enter key

To set the name:

1 In the **Properties** window Name field type: Cut_Out

2 Click the OK button

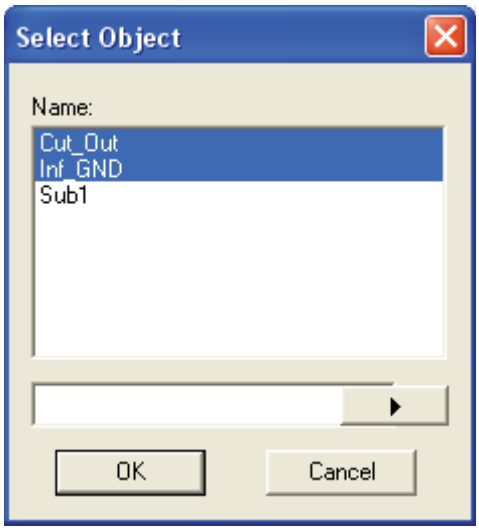
## Complete the Infinite Ground

To select the objects Inf_GND and Cut_Out:

1. Click **Edit>Select>By Name**

   The **Select Object** dialog opens.

2. Select the objects named: Inf_GND, Cut_Out




3. Click the OK button

## To complete the ring:

1. Click **Modeler>Boolean>Subtract**

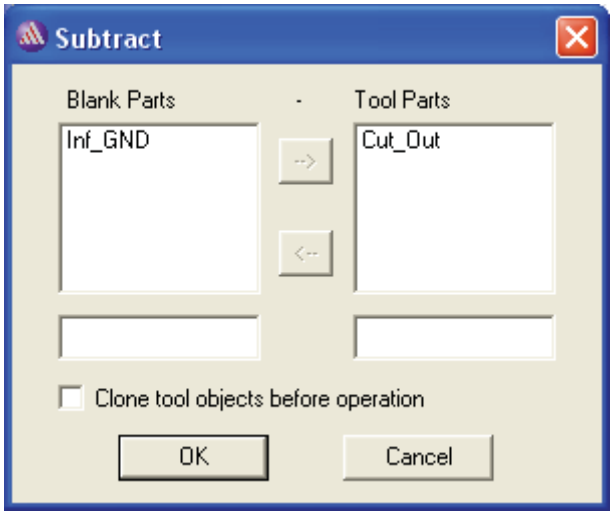
   The **Subtract** dialog opens:

2. Make the following assignments:

   Blank Parts: Inf_GnD

   Tool Parts: Cut_Out

Clone tool objects before subtract: Unchecked




3 Click the OK button

## Create Patch

To create the patch:

1 Click **Draw>Rectangle**

2 Using the coordinate entry fields, enter the rectangle position

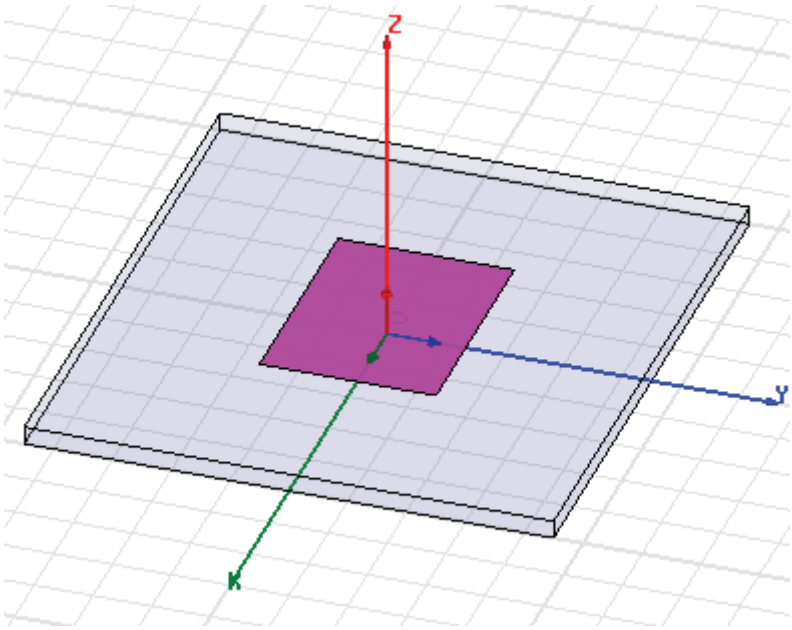
X: -2.0, Y: -1.5, Z: 0.32, Press the Enter key

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

dX: 4.0, dY: 3.0, 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




## Assign a Perfect E boundary to the Trace

To select the trace:

1. Click **Edit>Select>By Name**

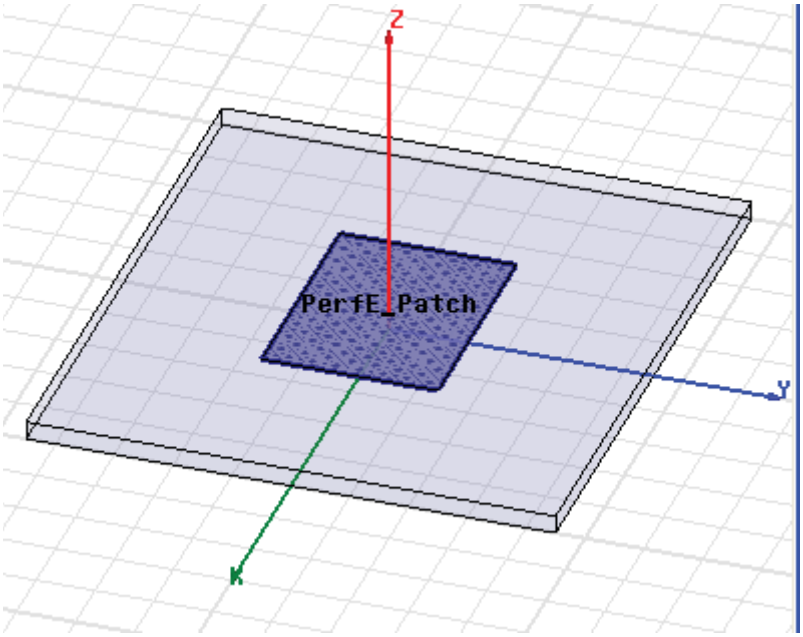
   2. The **Select Object** dialog opens.
2. Select the objects named: Patch
3. Click the OK button

## To assign the Perfect E boundary

1. Click **HFSS>Boundaries>Assign>Perfect E**

   The Perfect E Boundary dialog opens.
2. Specify the Name: PerfE_Patch

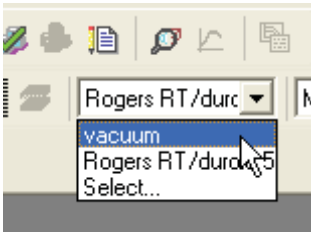
3 Click the OK button




## Create the Coax

To set the default material:

1 Using the 3D Modeler Materials toolbar, choose vacuum.




To create the coax:

1 Click **Draw>Cylinder**

2 Using the coordinate entry fields, enter the cylinder position

X: -0.5, Y: 0.0, Z: 0.0 Press the Enter key

3 Using the coordinate entry fields, enter the radius:

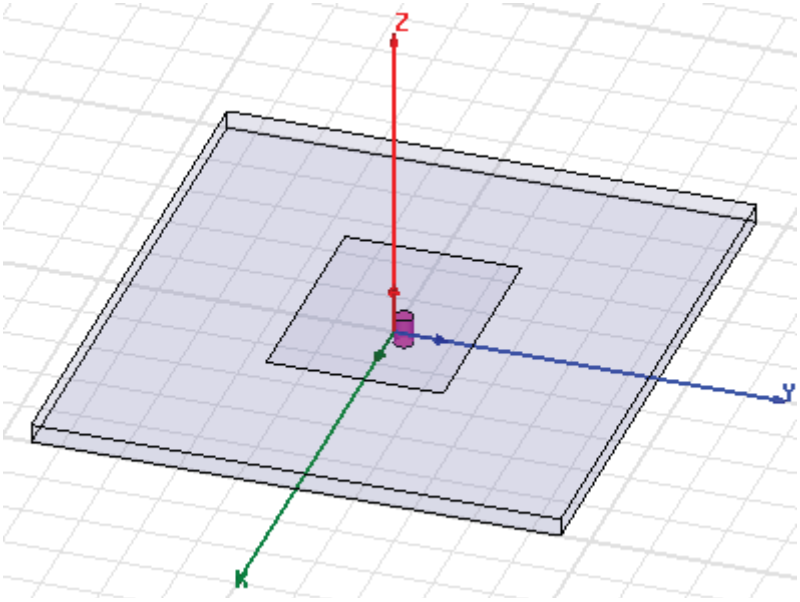
dX: 0.16, dY: 0.0, dZ: 0.0 Press the Enter key

4 Using the coordinate entry fields, enter the height:
dX: 0.0, dY: 0.0, dZ: -0.5 Press the Enter key

To set the name:

1 In the **Properties** window Name field type: Coax

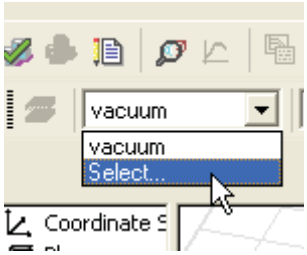
2 Click the OK button.




## Set Default Material

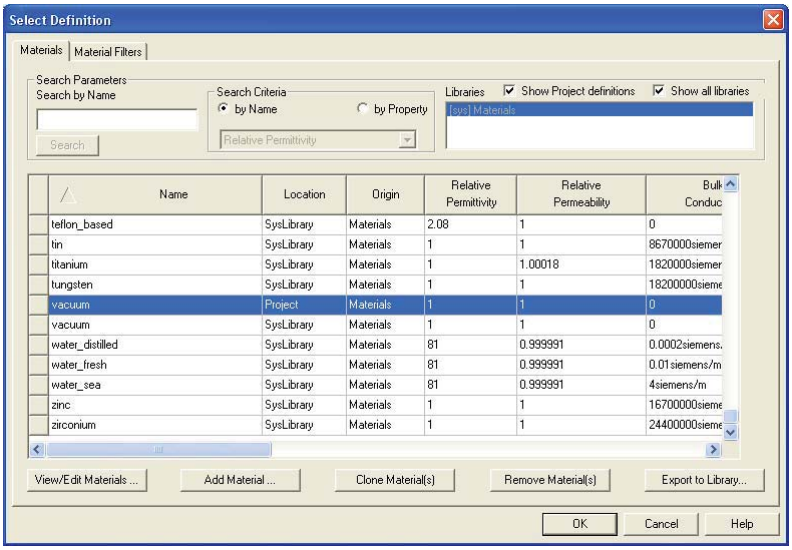
To set the default material:

1 Using the 3D Modeler Materials toolbar, choose **Select...**.

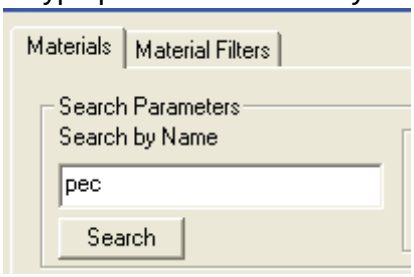



2 This opens the **Select Definition** window with the Materi-

als tab.




3 Type pec in the Search by Name field.




This highlights the pec material.

4 Click the **OK** button.

This sets the default material to pec

## Create the Coax Pin

To create the coax pin:

1 Click **Draw>Cylinder**

2 Using the coordinate entry fields, enter the cylinder position

X: -0.5, Y: 0.0, Z: 0.0 Press the Enter key

3 Using the coordinate entry fields, enter the radius:

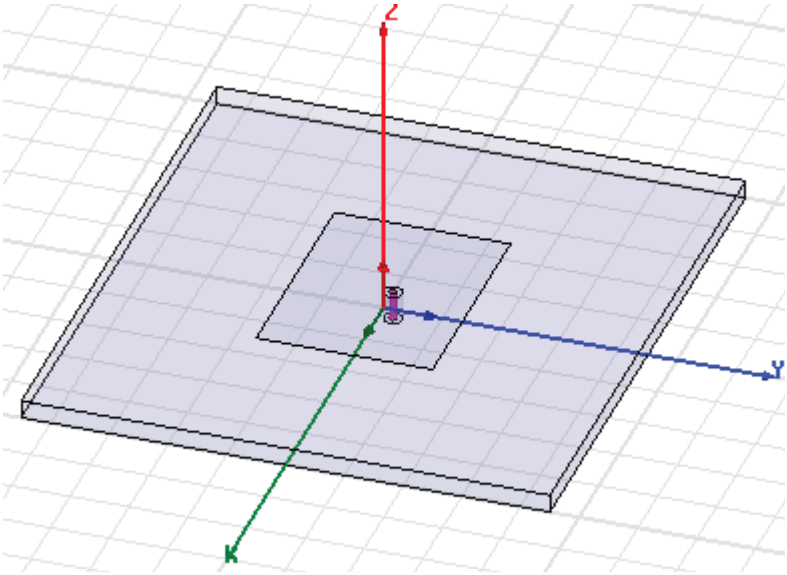
dX: 0.07, dY: 0.0, dZ: 0.0 Press the Enter key

4 Using the coordinate entry fields, enter the height:
dX: 0.0, dY: 0.0, dZ: -0.5 Press the Enter key

To set the name:

1 In the **Properties** window Name field type: Coax_Pin

2 Click the OK button.




## Create the Wave port

To create a circle that represents the port:

1 Click **Draw>Circle**

2 Using the coordinate entry fields, enter the center position
X: -0.5, Y: 0.0, Z: -0.5 Press the Enter key

3 Using the coordinate entry fields, enter the radius of the circle:
dX: 0.16, dY: 0.0, dZ: 0.0 : Press the Enter key

To set the name:

1 In the **Properties** window Name field type: Port1

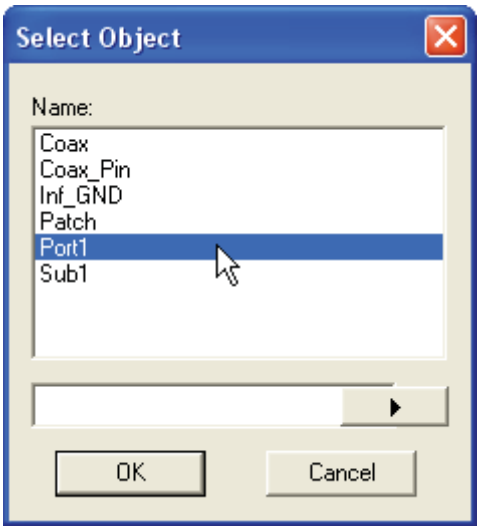
2 Click the OK button

To select the object Port1:

1 Click **Edit>Select>By Name**

This opens the Select Object dialog,

2 Select the objects named: Port1




3 Click the OK button

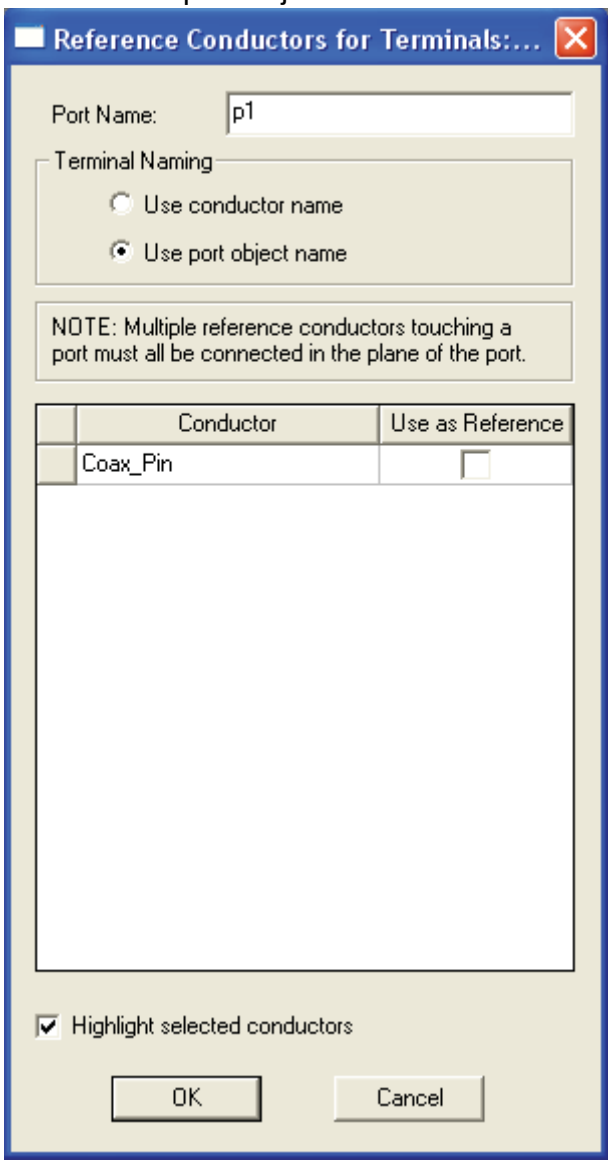
To assign wave port excitation

1 Click **HFSS>Excitations>Assign>Wave Port**

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

2 Ispecify the Name: p1

3 Select "Use port object name."




4 Leave Use as Reference unchecked and Highlight selected conductors checked.

5 Click OK.

The terminal is created under Excitations for the p1 Port

in the Project tree.


## Create the Probe

To create the probe:

1. Click **Draw>Cylinder**
2. Using the coordinate entry fields, enter the cylinder position

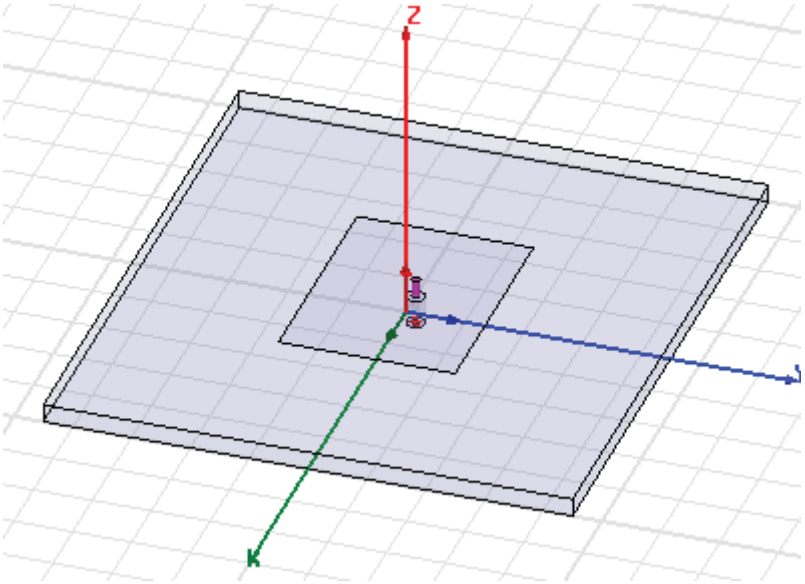
   X: -0.5, Y: 0.0, Z: 0.0 Press the Enter key
3. Using the coordinate entry fields, enter the radius:

   dX: 0.07, dY: 0.0, dZ: 0.0 Press the Enter key
4. Using the coordinate entry fields, enter the height:

   dX: 0.0, dY: 0.0, dZ: 0.32 Press the Enter key

To set the name:

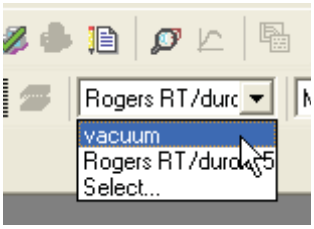
1. In the **Properties** window Name field type: Probe
2. Click the OK button



## Set Default Material

To set the default material:

1 Using the 3D Modeler Materials toolbar, choose vacuum.




## Create Air

To create the air:

1 Click **Draw>Box**

2 Using the coordinate entry fields, enter the box position

X: -5.0, Y: -4.5, Z: 0.0, Press the Enter key

3 Using the coordinate entry fields, enter the opposite corner of the box

dX: 10.0, dY: 9.0, dZ: 3.32, Press the Enter key

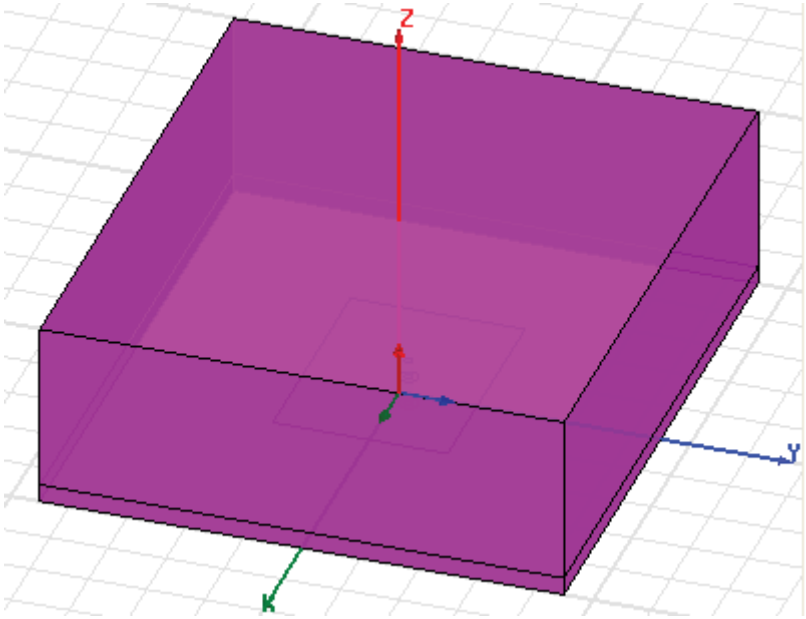
To set the name:

1 In the **Properties** window Name field type: Air

Click the OK button

To fit the view:

Click **View>Fit All>Active View**.




## 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)

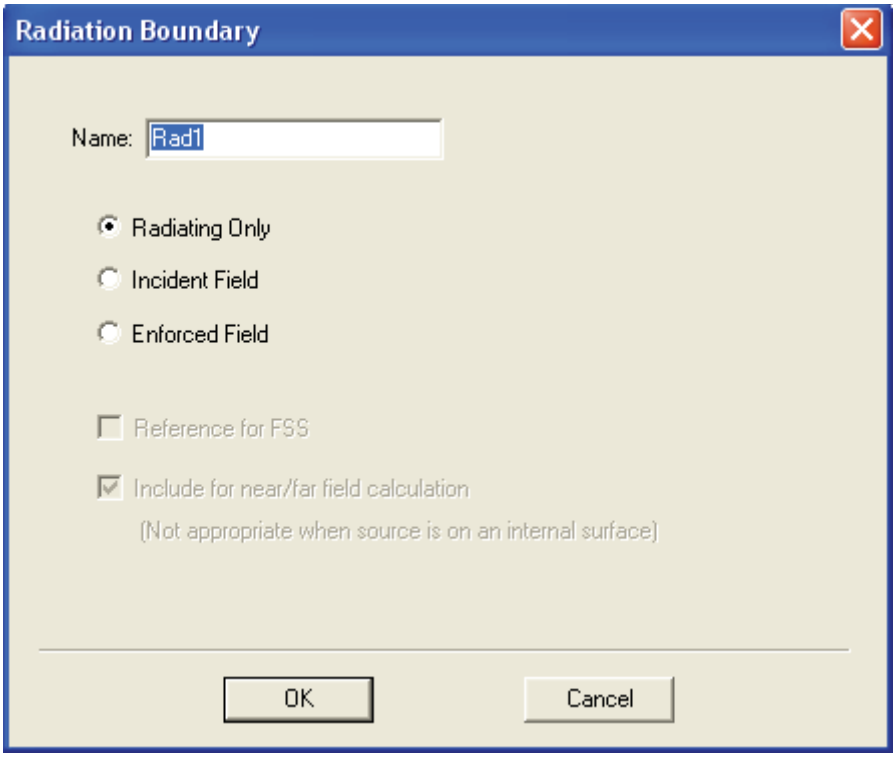
   You can hold down the Alt key, and click the top face, and then hit the “b” key to select a “face behind.” After selecting the two faces behind, you can select the remaining three surface faces.

To create a radiation boundary

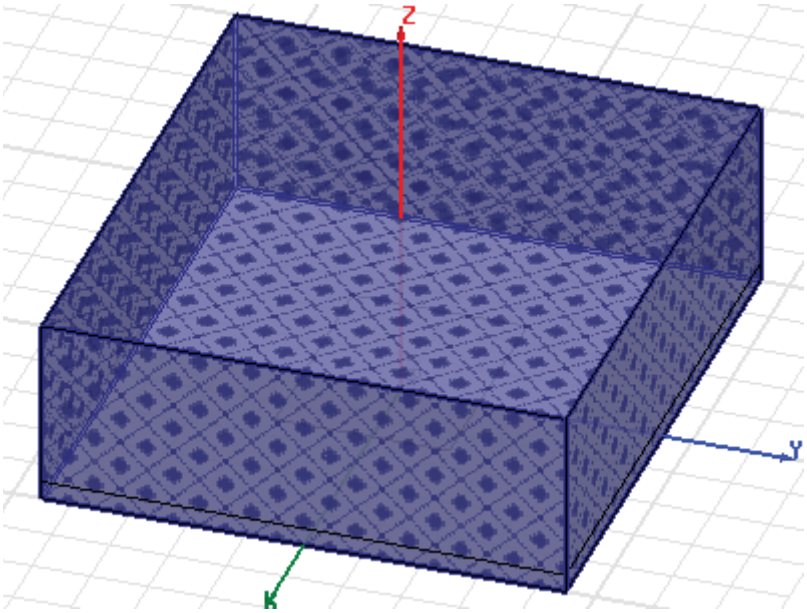
1. Click **HFSS>Boundaries>Assign>Radiation**

   The Radiation Boundary dialog opens.

2 Name: Rad1


Radiation Boundary
Name:
Rad1
Radiating Only
Incident Field
Enforced Field
Reference for FSS
Include for near/far field calculation
(Not appropriate when source is on an internal surface)
OK
Cancel

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**

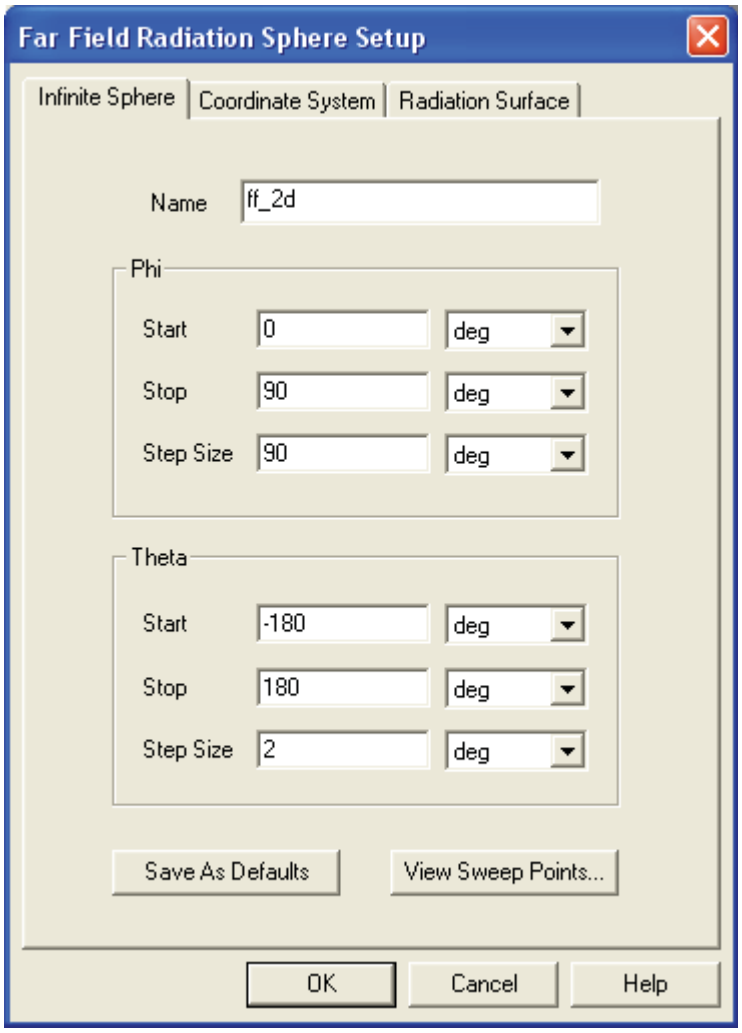
The **Far Field Radiation Sphere Setup** dialog opens.

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

# Analysis Setup

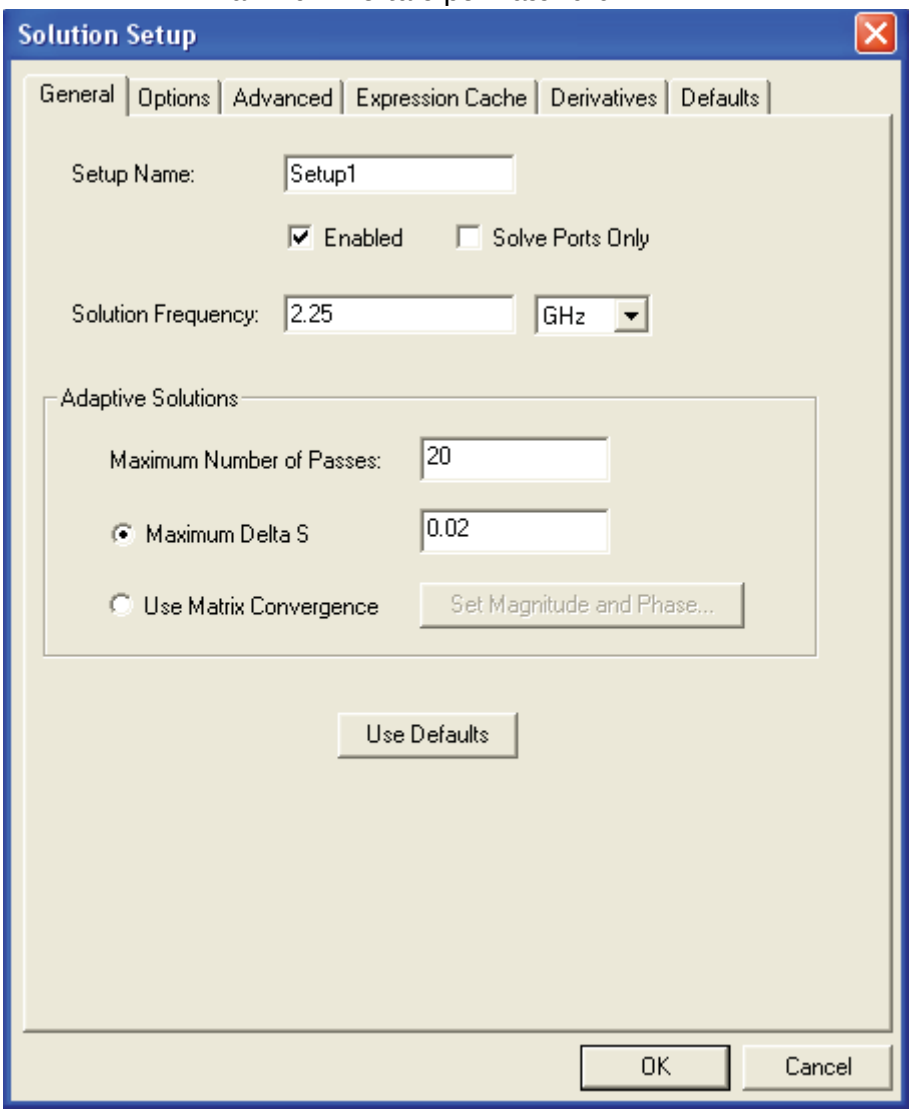
## Creating an Analysis Setup

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: 2.25 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

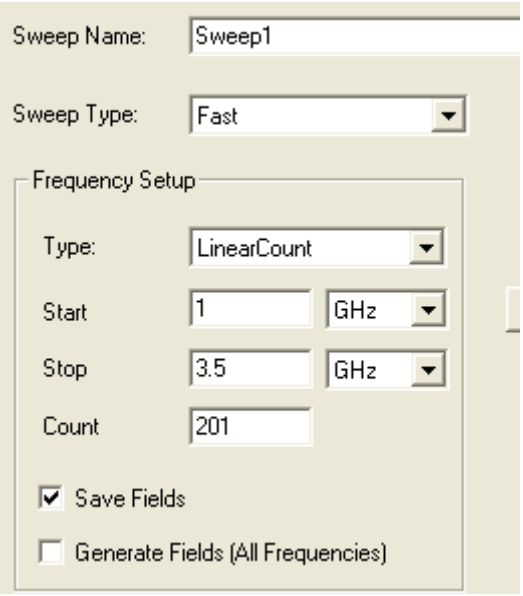
   Frequency Setup Type: Linear Count

   Start: 1.0GHz

   Stop: 3.5GHz

   Count: 201

   Save Fields: Checked




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_probepatch
3. Click the Save button

# Analyze

## Model Validation

To validate the model:

1. Click **HFSS>Validation Check**
2. Click the Close button

   Note: To view any errors or warning messages, use the Message Manager.

## 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

Note: The default view is for convergence is Table Table. 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

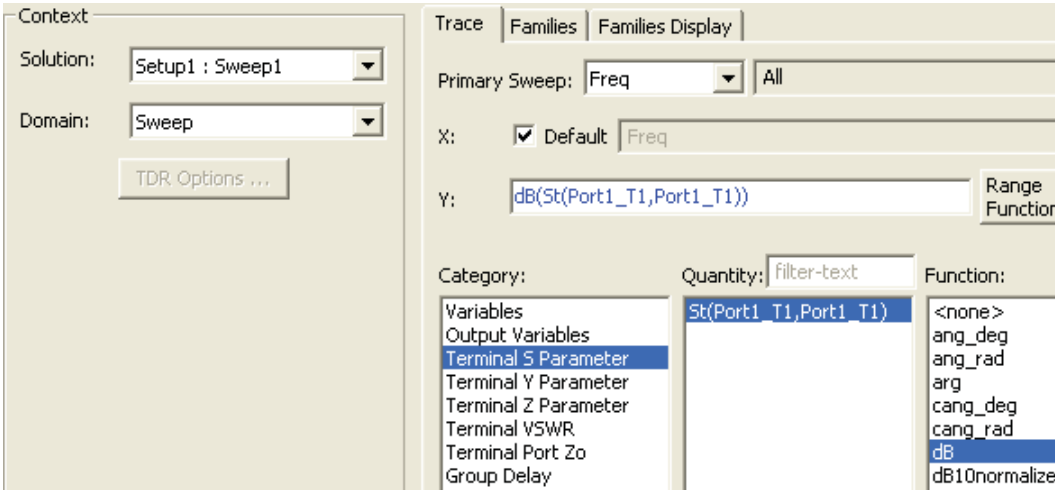
## Create Terminal S S-Parameter Plot - Magnitude

To create a report:

1. Click **HFSS>Results>Create Terminal Solution Data Report.**

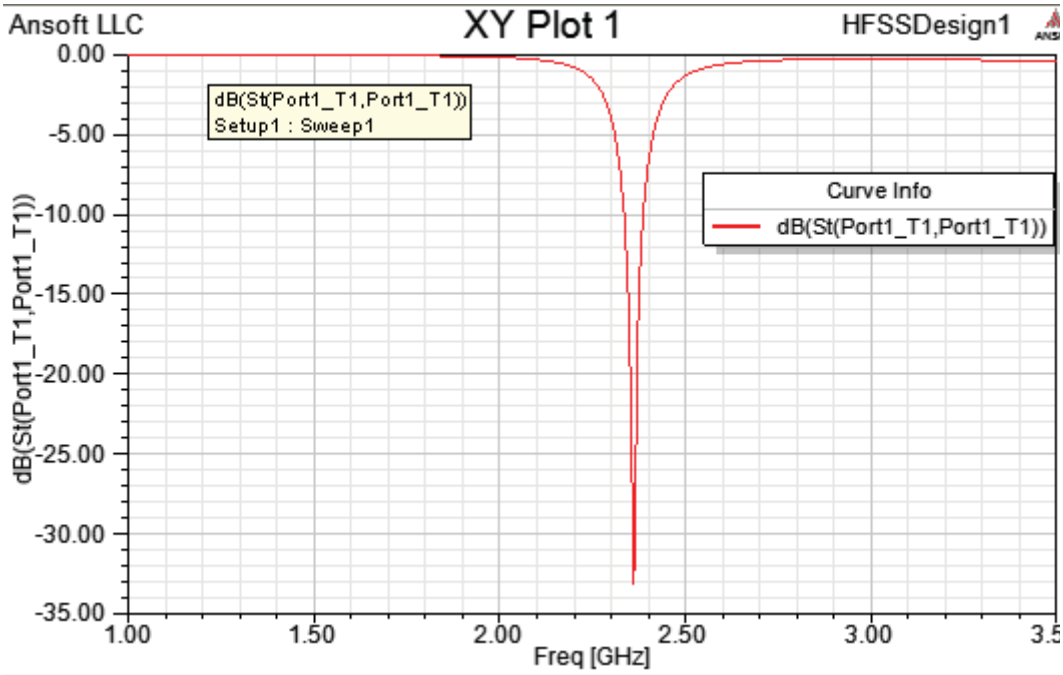
   The **Reports** window opens.

**2** Make the following selections:
Solution: Setup1: Sweep1
Domain: Sweep
Category: Terminal S Parameter
Quantity: St(Port1_T1,Port1_T1),
Function: dB



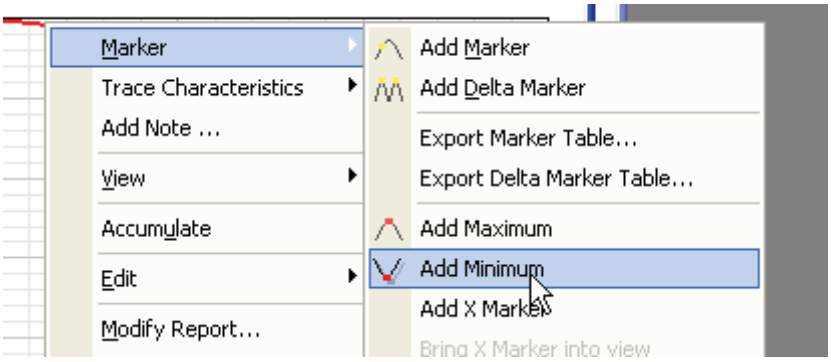

**3** Click the **New Report** button

4 Click the **Close** button.



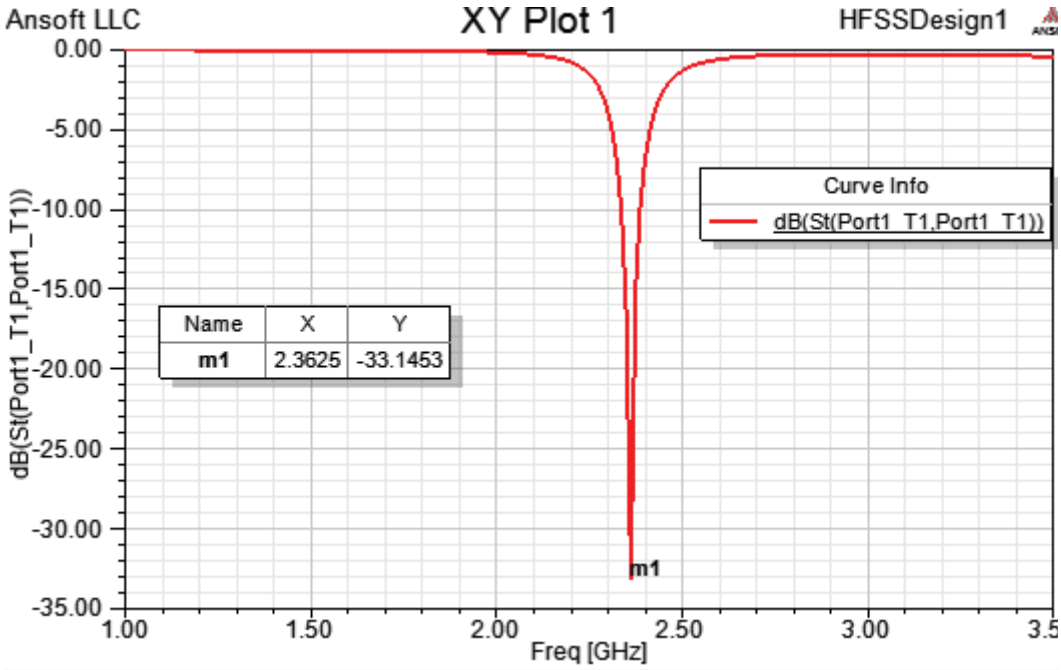

5 Select the trace on the plot.

6 Right click to display the shortcut menu and click **Marker>Add Minimum**.




A minimum marker (m1) appears on the trace, and a

marker table lists the x and y coordinate values.




# Far Field Overlays

## 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

**3** Click **New Report**.