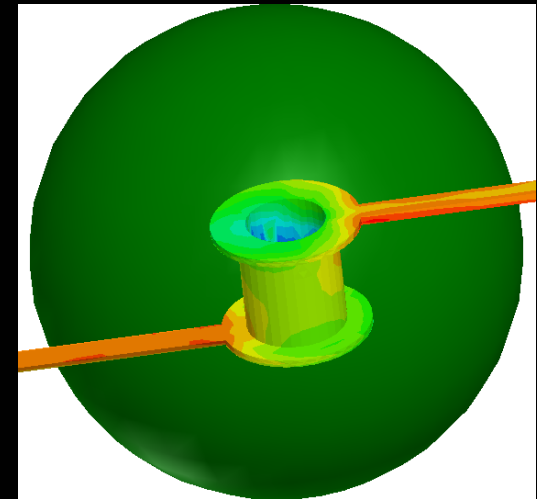


The background of the slide features a central image of a blue and white globe, resembling Earth, surrounded by a complex, glowing field of blue and orange energy lines that radiate outwards, creating a sense of dynamic motion and high-tech energy.

**ANSYS**<sup>®</sup>

## HFSS Application

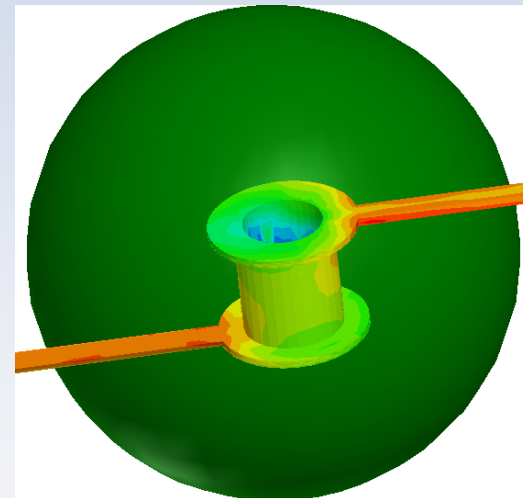


**Signal Integrity  
Via Wizard 3.0**

# Signal Integrity in HFSS



- Vias in Package and PCB Structures
  - Differential and Single-ended
    - Via Wizard
  - Terminal S-parameters
  - Setting up differential pairs
  - Viewing Results
  - Creating Reports



# Vias – Why Simulate Them?



- To stay out of trouble
- Vias can cause problems
  - Capacitive discontinuity leads to reflections/loss
  - Increase crosstalk
  - Change return path of the signal
  - Excite model cavities leading to EMI
- Properly designed vias limit signal degradation
  - Faster data rates
  - Lower BER

# Excuses, Excuses



- 3D simulations are difficult
  - Ports and boundaries are confusing
  - Tough to draw 3D geometries
- Takes too long to setup
- Takes too long to simulate
- Difficult to parameterize

# Via Wizard Overview



- The Via Wizard creates a ready to solve HFSS project for an arbitrary stackup and array of vias
- Anybody can use it regardless of CAD experience or simulation background
- Ports and boundaries automatically setup
- Geometry is fully parameterized and optimization studies are easy to perform
- Solution settings are optimized based on Ansoft's best known methods for speed and accuracy

# Step 1: Define Stackup



- Add Layers
- Define Materials
  - All Dielectric materials are frequency dependent, using a Djordjevic-Sarkar Model
- Enter Thickness
- Choose Solid or Plane Layer

The screenshot shows the ANSYS HFSS Stackup Editor interface. The main table is titled "Stackup" and contains the following data:

Name	Type	Material	Thickness	Layer Type
Metal-1	Metal	Copper	1.2	Signal
Dielectric-1	Dielectric	FR4	5	
Metal-2	Metal	Copper	1.2	Plane
Dielectric-2	Dielectric	FR4	5	
Metal-3	Metal	Copper	1.2	Plane
Dielectric-3	Dielectric	FR4	5	
Metal-4	Metal	Copper	1.2	Signal

On the right side, the "Substrate Editor" panel is visible, showing properties for FR4:

- Material: FR4
- er: 4.4
- TanD: 0.02
- f, GHz: 1

Buttons for "Delete", "Generate Project", and "External File" are also present.

# Step 2: Define Padstacks



- Drill Size
- Pads on Layers
- Antipads

Via Wizard V3.0 For HFSS 12. Expires in 171 days.

Stackup | **Padstack** | Via | Options

Layer	Barrel Radius	Drill Size	Padstack radius/Width	Antipad Height	Antipad x-Offset	Antipad y-Offset
1	8	12	16	0	0	0
2	8	8	16	0	0	0
3	8	8	16	0	0	0
4	8	12	16	0	0	0

Fit To Width  
 Synchronize Width  
Padstack Editor  
Add Delete  
Rename 2  
Signal\_L1\_L4  
Plating Ratio  
0.2  
Generate Project  
External File  
Store Read

# Step 3: Define Via Array



- Select Padstack
- Define Locations
- Port Type
- Connection Layers
- Trace Widths
- SE or Differential

Via Wizard V3.0 For HFSS 12. Expires in 171 days.

Stackup		Padstack			Via				Options
Via	Padstack	x Loc.	y Loc.	Ports	Trace Layer In	Trace Layer Out	Trace Width In	Trace Width Out	Diff. Pair
1	Gnd1	15	-30	Ground	1	4	5	5	SE
2	Signal_L1_L4	-15	0	Coax_Launch_Top	1	4	5	5	3
3	Signal_L1_L4	15	30	Coax_Launch_Top	1	4	5	5	2
4	Gnd1	-15	60	Ground	1	4	5	5	SE
5	Signal_L1_L4	15	90	Coax_Launch_Top	1	4	5	5	6
6	Signal_L1_L4	-15	120	Coax_Launch_Top	1	4	5	5	5
7	Gnd1	15	150	Ground	1	4	5	5	SE
8	Signal_L1_L4	-15	180	Coax_Launch_Top	1	4	5	5	9
9	Signal_L1_L4	15	210	Coax_Launch_Top	1	4	5	5	8
10	Gnd1	-15	240	Ground	1	4	5	5	SE

# Step 4: HFSS Options (optional)



- Set Model Units
- Solve and/or Launch HFSS
- Set Model Options
- Setup Frequency Sweep

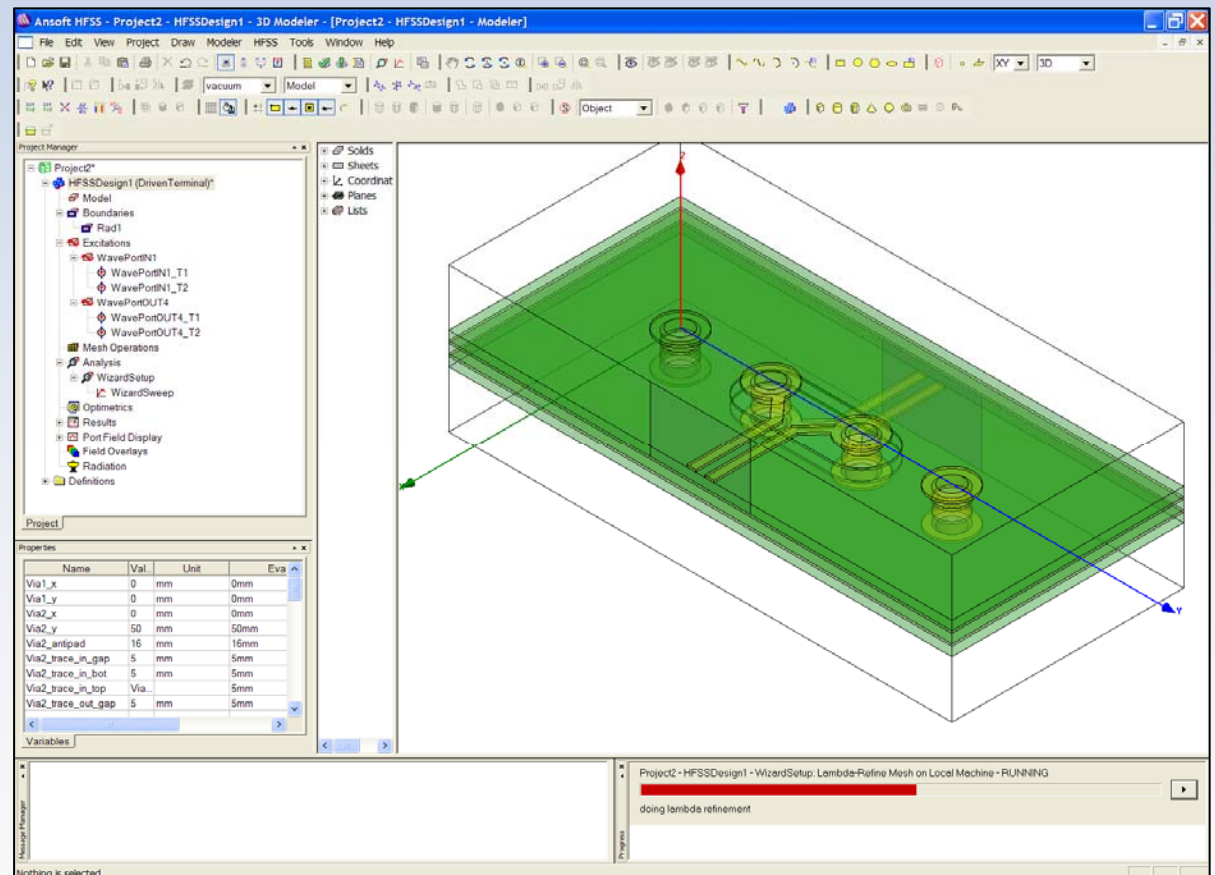
General Options	Solve Options
Units: mil	Sweep Type: Interpolating
Solve Project: <input type="checkbox"/>	Specify Rise Time: <input type="checkbox"/>
Run HFSS: <input checked="" type="checkbox"/>	Rise Time: 23 ps
	Start Freq: 0 Hz
	Stop Freq: 3.50e+11 Hz
	Freq Step: 50e8 Hz
	Delta S: .02
	Max Passes: 12
<b>Model Options</b>	
Facets: 12	
Model Resolution: 0	
De-embedding: Automatic	
Backdrill: 0	
Etchback %: 0	
Include Dogbone: <input checked="" type="checkbox"/>	
Block Dielectric: <input checked="" type="checkbox"/>	

Generate Project
External File
Store
Read

# Generate HFSS Project



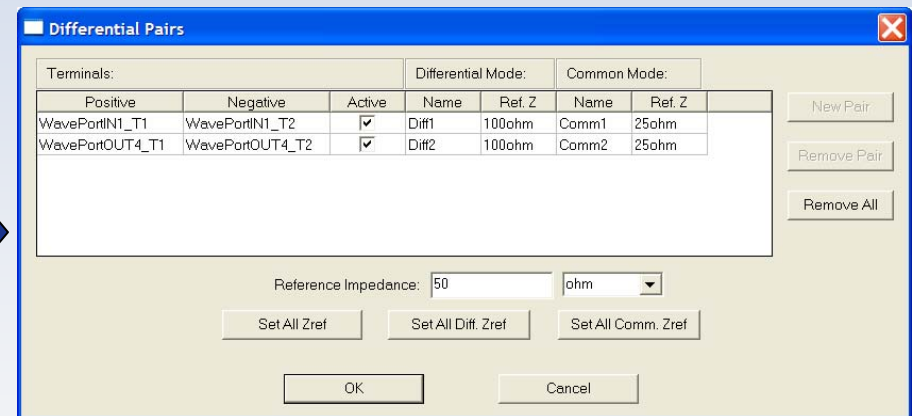
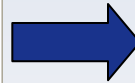
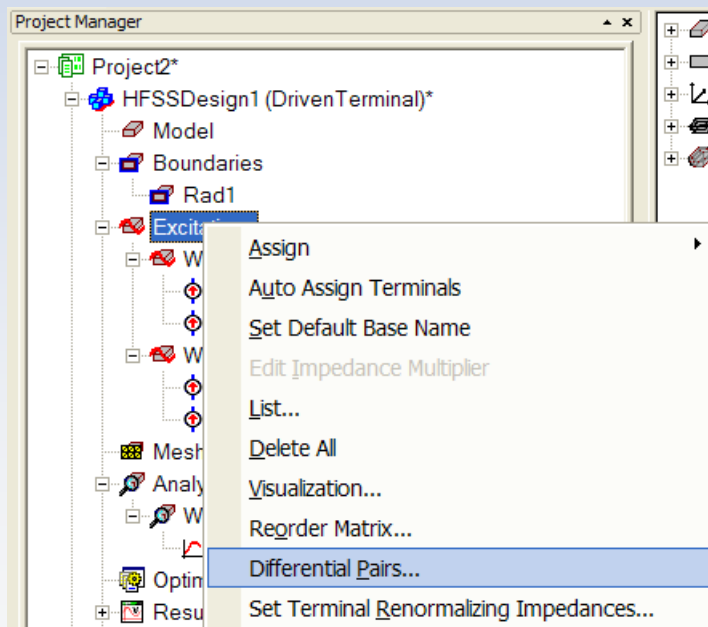
- Ready to Solve Project includes
  - Boundaries
  - Excitations
  - Analysis Setup
  - Variables



# Differential Pair Setup



- Right-click on Excitations to Setup Differential Pairs
  - Pairs can be created for both Wave Ports and Lump Ports



# Creating Reports



- Create Reports for Both Differential and Terminal Data

The image displays two screenshots of the ANSYS HFSS report creation dialog boxes. The left window is titled "Report: Project2 - HFSSDesign1 - New Report - New Trace(s)" and the right window is titled "Report: via\_wizard\_latest - HFSSDesign1 - New Report - New Trace(s)". Both windows show configuration options for solution, domain, sweep, and trace type, along with a list of categories and quantities.

**Left Window: Report: Project2 - HFSSDesign1 - New Report - New Trace(s)**

- Context:** Solution: WizardSetup : WizardSv, Domain: Sweep, Show: Differential Pairs
- Trace:** Primary Sweep: Freq, X:  Default Freq, Y: dB(St(Diff1,Diff1))
- Category:** Terminal S Parameter
- Quantity:** St(Diff1,Diff1)

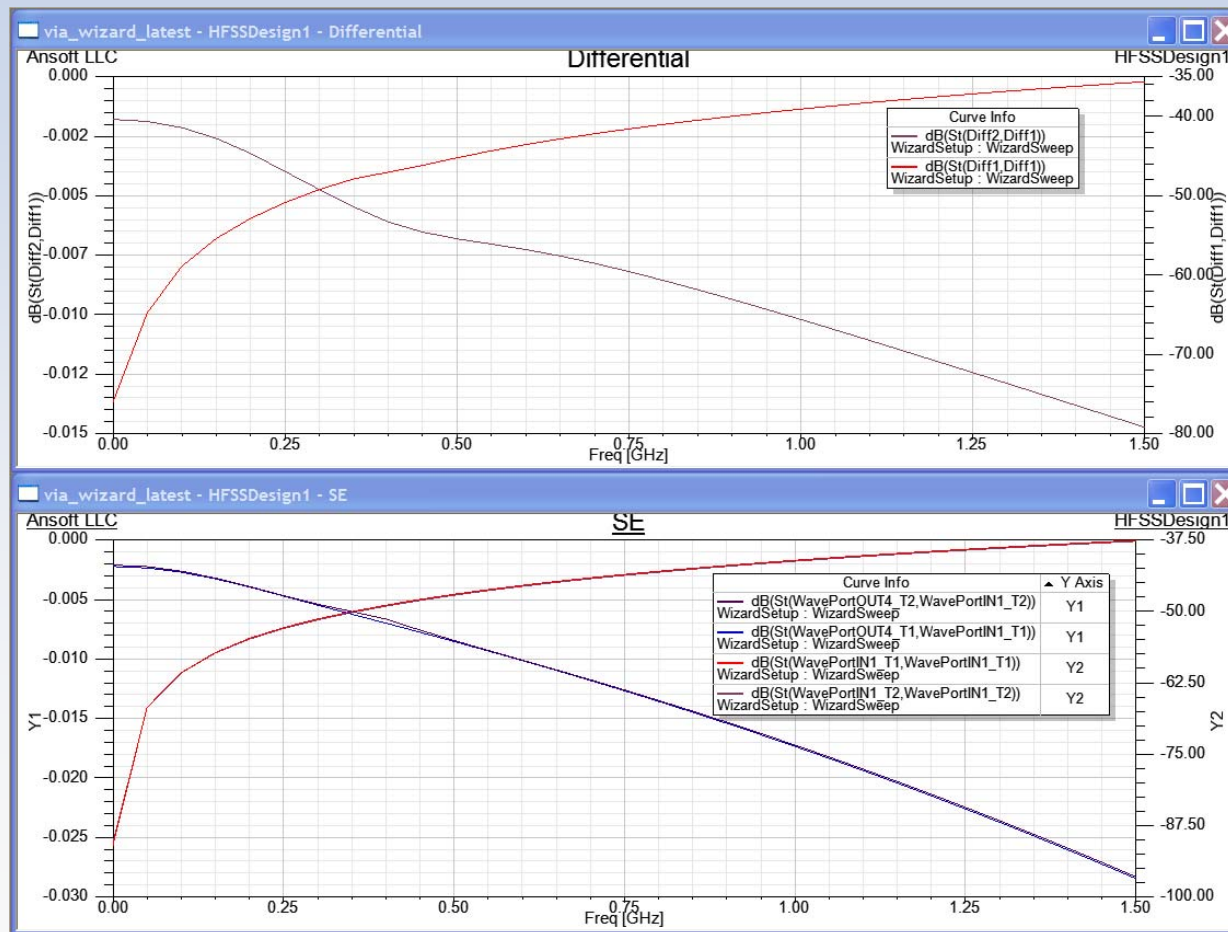
**Right Window: Report: via\_wizard\_latest - HFSSDesign1 - New Report - New Trace(s)**

- Context:** Solution: WizardSetup : WizardSv, Domain: Sweep, Show: Differential Pairs
- Trace:** Primary Sweep: Freq, X:  Default Freq, Y: dB(St(Diff1,Diff1))
- Category:** Terminal S Parameter
- Quantity:** St(Diff1,Diff1)
- Function:** dB

# Creating Reports



- Create and Display Both SE and DE at the Same Time



# Viewing Solution Data



- View Modal, Terminal and Differential Pair Data in the Solutions Window

Solutions: via\_wizard\_latest - HFSSDesign1

Simulation: WizardSetup WizardSweep

Design Variation: Xlength='128mil' Xmin='-64mil' Ylength='278mil' Ymin='-64mil' Zlength='79.8mil' Zmin='-49.8mil'

Profile | Convergence | Matrix Data | Mesh Statistics

S Matrix  Gamma 1.5 (GHz) Export Matrix Data...

Y Matrix  Zo  All Freqs. Edit Freqs... Equivalent Circuit Export...

Z Matrix

Magnitude/Phase(deg)

Modal Data

Passivity Tolerance: .0001

	Port Zo	Gamma	Lambda	Epsilon
Differential Pairs	(.61, 0.133)	(56.097, 89.1)	0.11202	3.1833
WavePortIN:2	(107.37, -0.00258)	(50.769, 89)	0.12378	2.6072
WavePortOUT4:1	(37.556, 0.129)	(56.11, 89.1)	0.11199	3.1847
WavePortOUT4:2	(107.14, -0.00934)	(50.78, 89.1)	0.12375	2.6084

Close

# Why Terminal S-parameters?



- Terminal S-Parameters

- By default the S-parameters in HFSS are expressed in terms of incident and reflected complex amplitudes of waveguide modes (modal S-parameters)
- In the multi-conductor problems (where multiple modes are propagating simultaneously) these modes can be converted to physical quantities directly related to conductors such as currents
  - Examples
    - Coupled lines on PCBs and Packages
    - Multi-pin connectors
- The Terminal S-parameter option was added to HFSS so terminal currents and voltages could be simulated directly. (Without this option we would have to determine these combinations ourselves)

# Via Wizard Website



- Free download from:
- <http://3DViaDesign.com>
- No license required
- Video training available

The screenshot shows the website's navigation menu on the left, categorized into High-Performance Electronic Design, Electromechanical Design, and Product options. The main content area is titled '3D VIA DESIGN' and includes a 'Home >' breadcrumb. A prominent red banner reads 'Via Wizard 3.0 Now Available!'. Below this, there are links for 'Download the Via Wizard 3.0', 'Video Demo', and 'Abridged Via Wizard 3.0 User Manual'. The 'History of the Via' section explains the importance of accurate via modeling in high-speed interconnects. The 'Via Wizard' section describes the tool's capabilities for creating and simulating via models. At the bottom, two images show 'Stub E-Fields' and 'Backdrilled E-Fields' with their respective field distributions.

Home >

## 3D VIA DESIGN

[Download the Via Wizard 3.0](#)  
[Video Demo](#)  
[Abridged Via Wizard 3.0 User Manual](#)

**Via Wizard 3.0 Now Available!**

### History of the Via

Vias are common entities to just about every electronic application involving a layered Printed Circuit Board or Package. Their purpose is to provide electrical connectivity between different layers. Originally, vias had little to no affect as a signal passed through them. As data rates increased, signal risetimes decreased and vias could no longer be considered electrically insignificant. Today, accurate via modeling is critical to Signal Integrity analysis of High Speed Interconnects

### Vias by Design

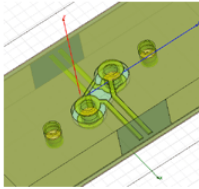
There are many factors which make via performance different from design to design. Stackup, pad shape, pad size, antipad shape, antipad size, registration (drill center offset), and plating can all affect a via's performance. Additionally, there are different types of vias such as Plated Through Hole, Buried, Blind and Backdrilled. Each of these types has a cost versus performance trade-off. Location of vias is also very important. For good signal integrity, it is important to have sufficient ground vias nearby for return path. Differential vias must also be spaced properly to ensure minimal impedance mismatch.

### Electrical Modeling

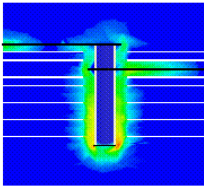
When designing high performance interconnects, it is important to accurately characterize the vias in the system. Accurate via models should be obtained by simulating using a 3D field solver with all relevant geometry modeled. Fields may be viewed to gain insight into electrical behavior and models may be exported in the form of Touchstone or Spice subcircuits. Via transitions should be examined individually to ensure optimal performance and also verified as a component in a full channel model.

### Via Wizard

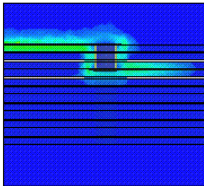
The Via Wizard is a powerful tool that allows for quick setup of via models in the 3D field solver HFSS. Using a straight-forward GUI, a user can enter all parameters necessary to create an arbitrary via array. Most projects will be launched ready to solve in HFSS however the user may easily modify or add to the geometry created by the wizard. All of the design types list above may easily be generated and most geometry is parameterized. The Via Wizard is available free of charge to all HFSS customers.



Differential Via



Stub E-Fields



Backdrilled E-Fields