Module 1: Introduction

ANSYS HFSS 3D Layout
Getting Started Course LE01

Outline - Introduction - HFSS 3D Layout Getting Started

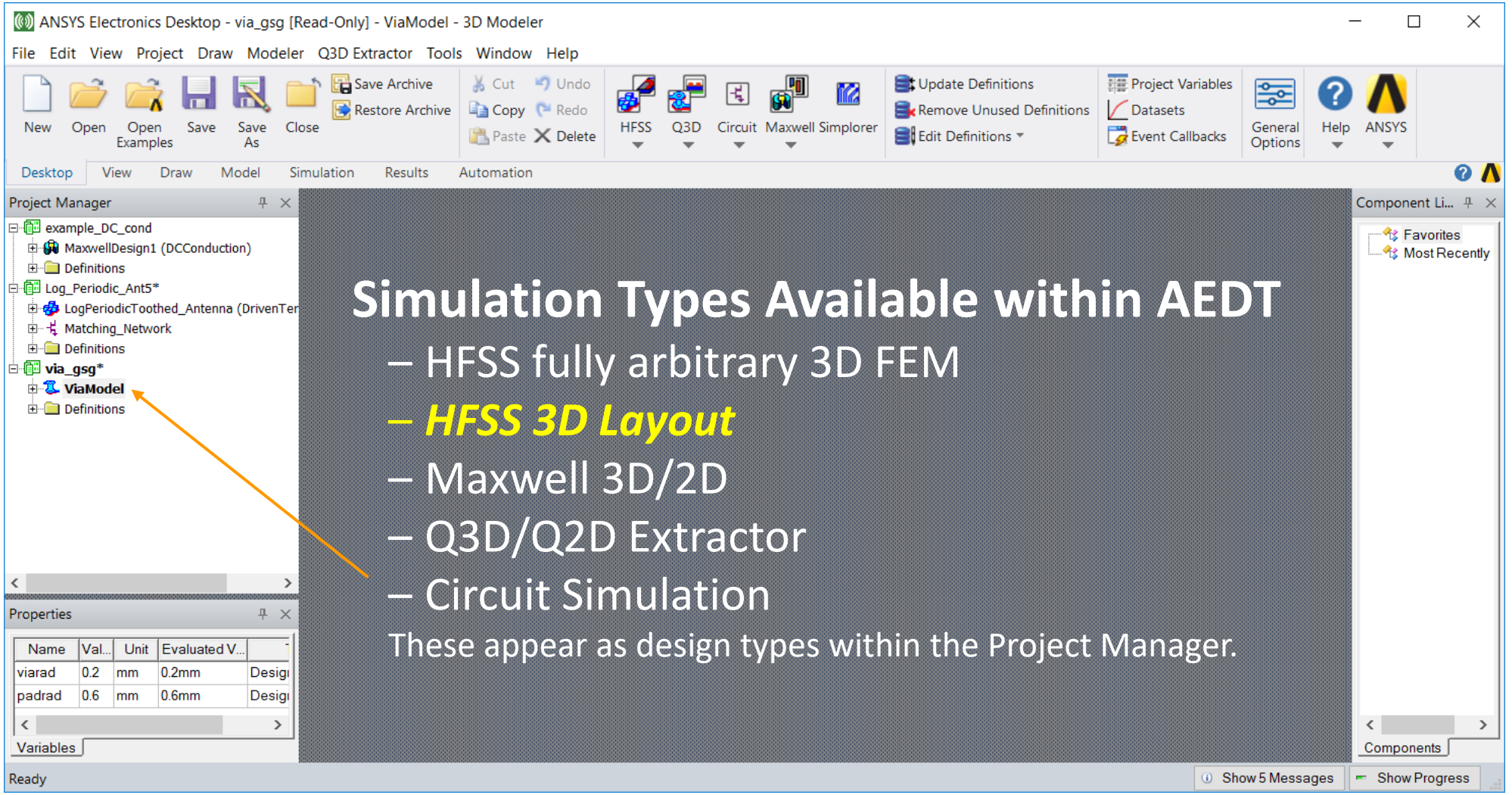
- **ANSYS Introduction**
  - Multiple Disciplines and Multiphysics Simulation Software
  - ANSYS is a Publicly Traded Company with Stock Symbol ANSS
  - Worldwide Headquarters in Canonsburg, PA USA
  - www.ansys.com

- **AEDT Introduction - ANSYS Electronic Desktop**
  - Common Graphical User Interface for Multiple Products
  - Common File Extension ***.aedt*** and ***.aedtz*** for Zip Archive
  - Multiple Projects and Different Simulators Can Be Open

- **HFSS 3D Simulations**
  - HFSS Offers Two Different Approaches and GUI Feature Sets:
    - HFSS FA3D - Fully Arbitrary 3D (also called MCAD)
    - HFSS 3D Layout - 3D FEM in Layered Structures - ***This course***
  - Benefits to using HFSS 3D Layout
    - Simulation with Layers, Nets, Components, and Padstacks
    - Multiple Solvers Available

HFSS in ANSYS Electronics Desktop (AEDT) with Many Design Types

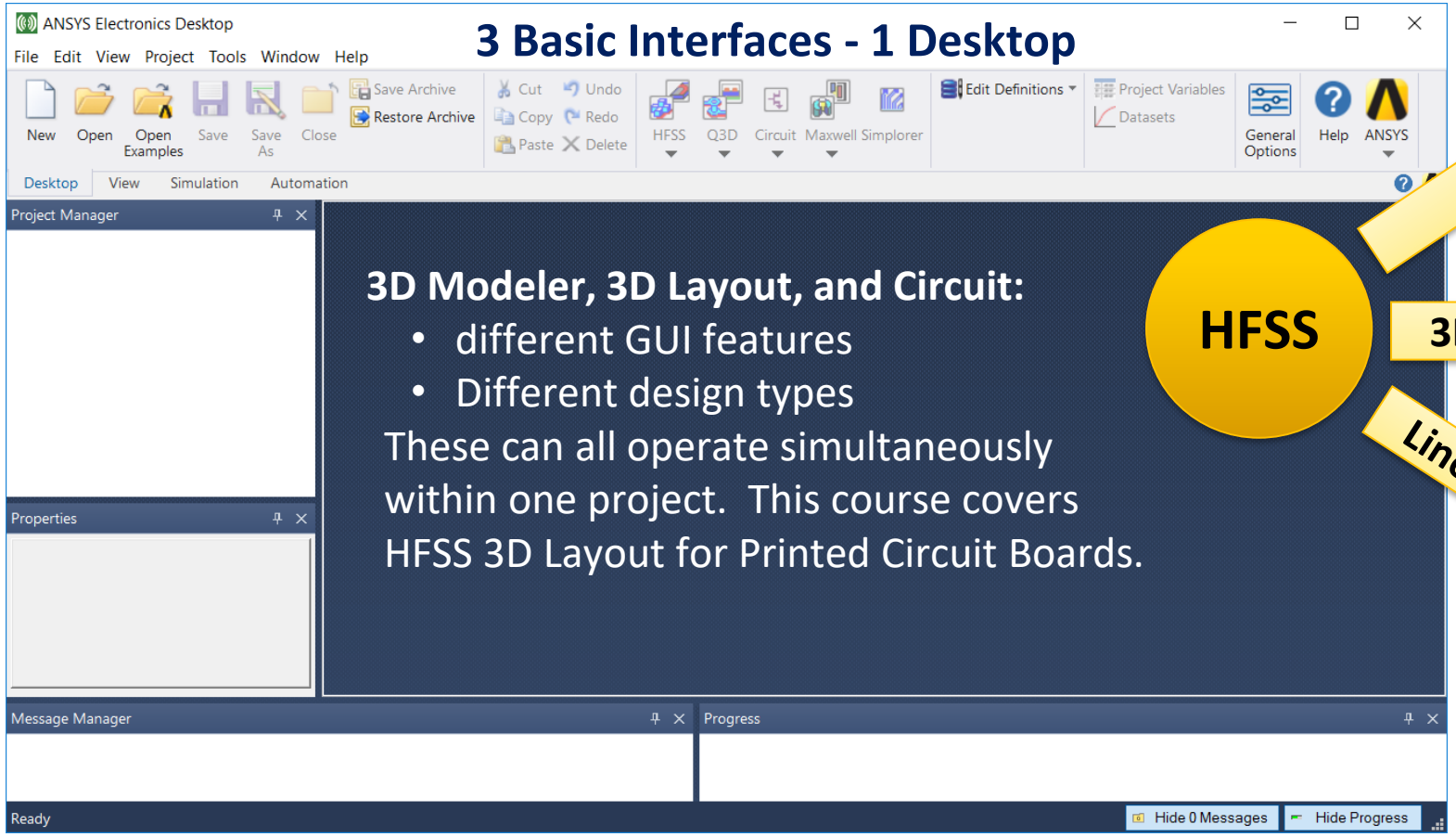
- The ANSYS Electronic Desktop is a graphical user interface (GUI) common to many electronic simulation tools.



HFSS runs in AEDT. An HFSS project file extension is ***.aedt.***

HFSS in ANSYS Electronics Desktop (AEDT) - 3 Interfaces

- HFSS 3D Layout is sometimes referred to as **ECAD** for electronic computer aided design.
- The HFSS design type is sometimes referred to as **MCAD** for mechanical CAD, referring to the fully arbitrary 3D (**FA3D**) geometry modeler.

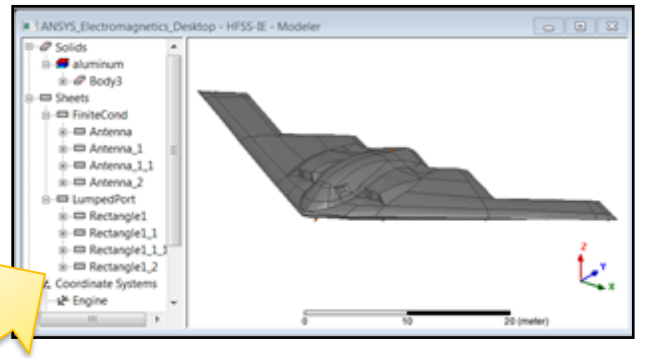


3D

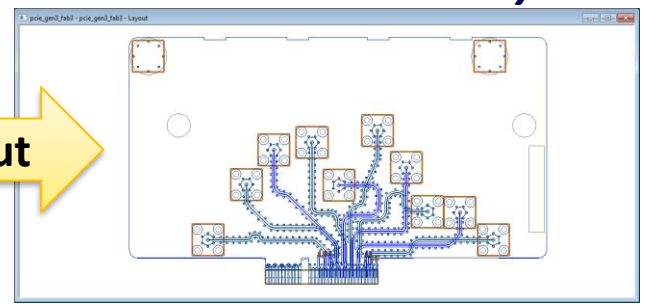
3D Layout

Linear Circuit

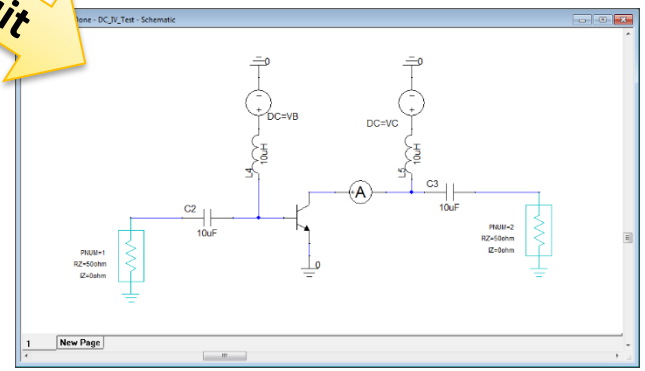
3D Modeler



3D Layout

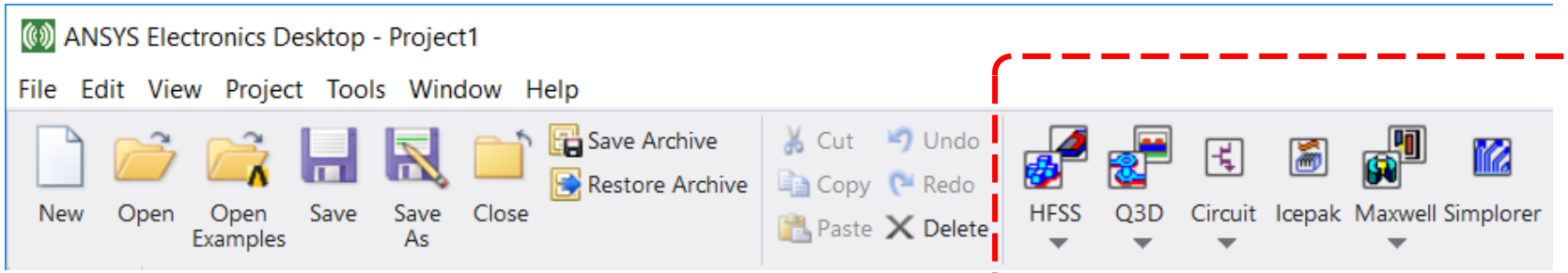


Schematic

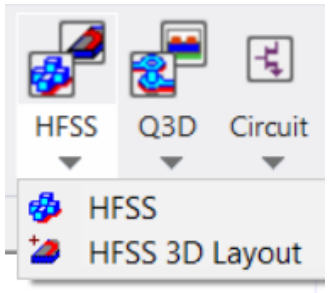


HFSS Product Umbrella - Design Types and Solution Types

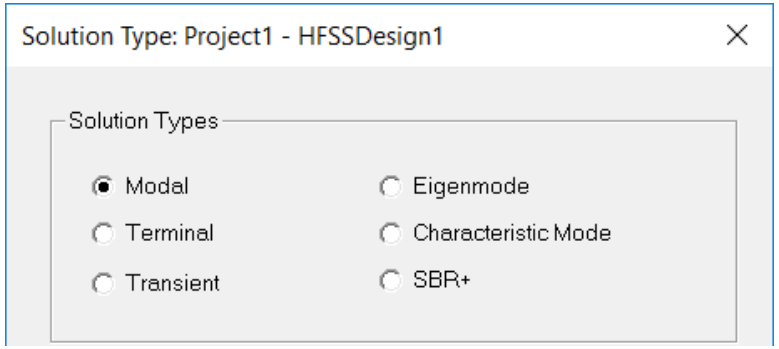
- HFSS ***Design Types*** illustrate HFSS as an umbrella product…including and containing a wide variety of solvers from the traditional finite element analysis (FEM) , to transient, to Shooting Bouncing Ray in SBR+.



AEDT hosts several ANSYS simulation products.



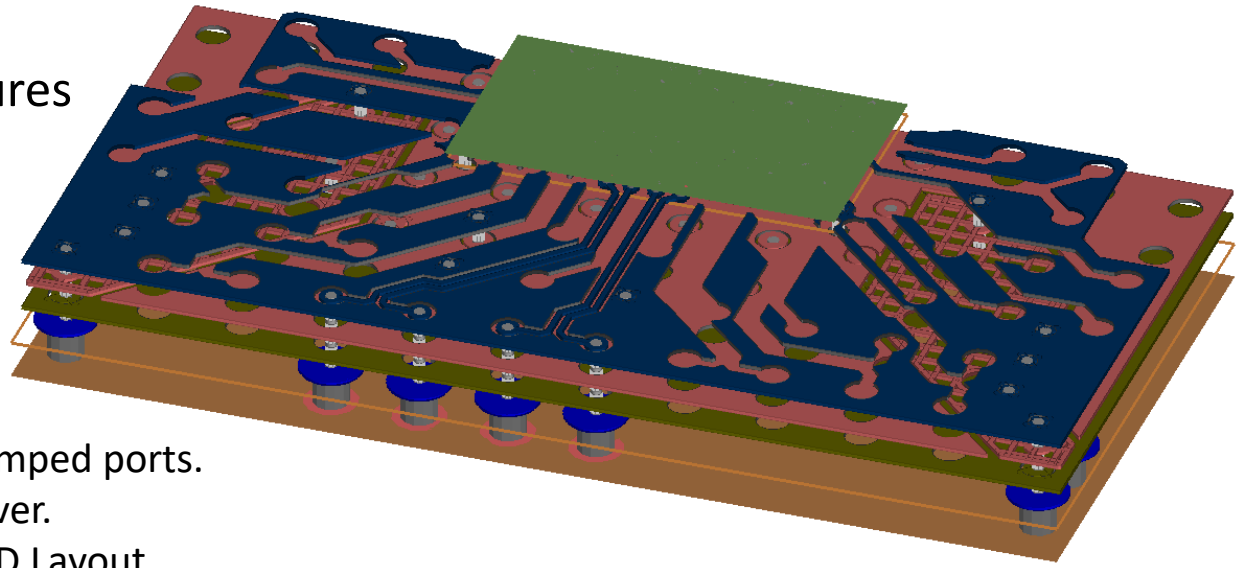
HFSS offers two ***Design Types***.



HFSS ***Design Type*** offers several ***Solution Types***.

What is HFSS 3D Layout?

- 3D Finite Element Simulation of Layered Structures
  - HFSS 3D Layout structures geometry in terms of layers that are common in electronic computer aided design (ECAD) including printed circuit board (PCB) layout and RF/microwave circuits.
  - HFSS 3D Layout 3D meshing and FEM simulation are the same as HFSS fully arbitrary 3D (FA3D) geometry (MCAD) simulation.

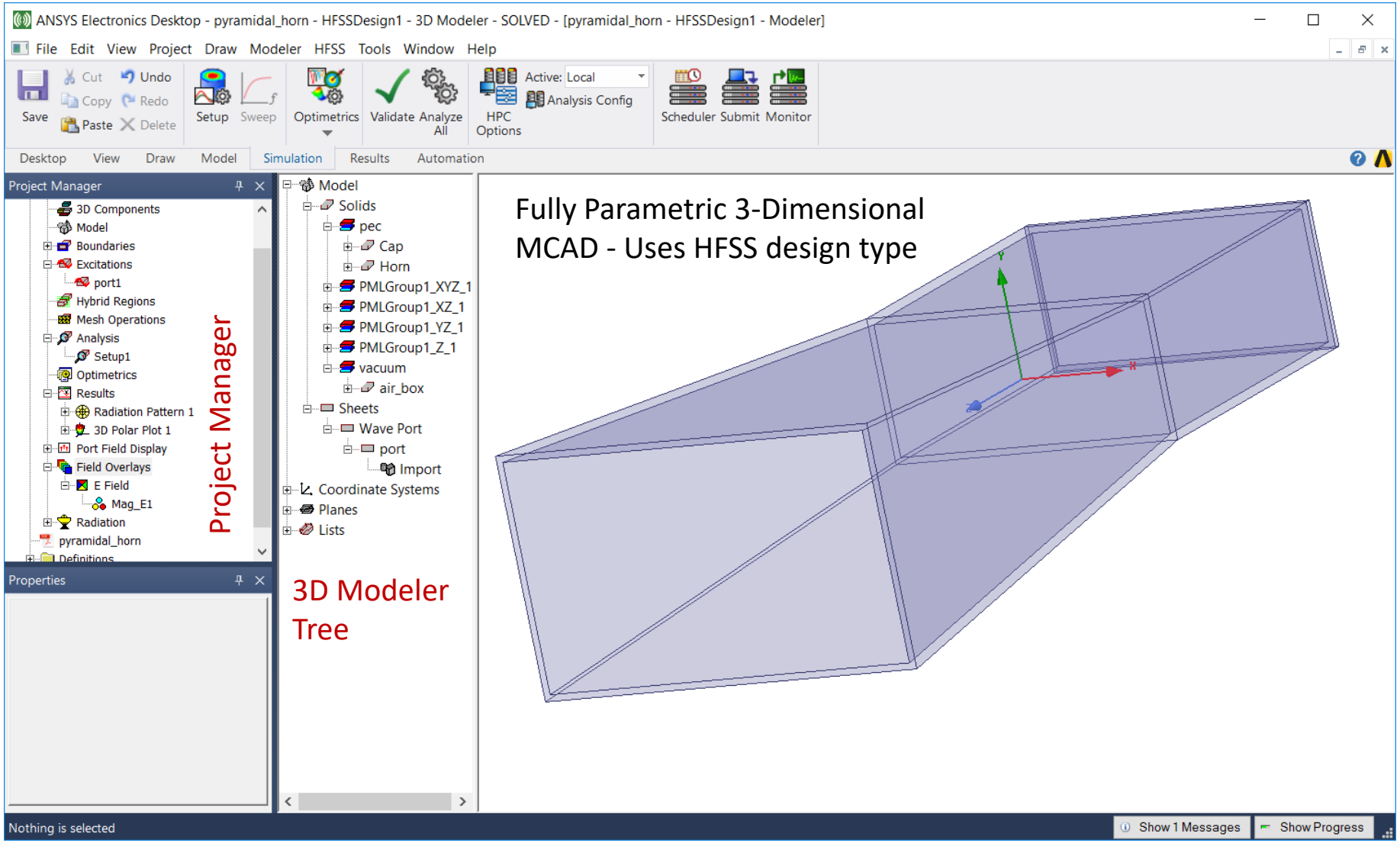


- HFSS 3D Layout Offers Printed Circuit Board Features
  - Layer Stackup
  - Nets & Via Padstacks
  - Components and Component libraries
  - 2D drawing in a 3D layout editor
- HFSS 3D Layout Has Multiple Ports and Solvers
  - HFSS 3D Layout has circuit ports in addition to wave and lumped ports.
  - HFSS 3D Layout offers the SIwave solver and planar EM solver.
  - Nexxim time domain circuit simulation is available within 3D Layout.
- HFSS 3D Layout is a Design Type in HFSS
  - HFSS 3D Layout has its own design type within the HFSS product umbrella.
  - HFSS 3D Layout projects share the *.aedt file extension within the ANSYS Electronic Desktop.
  - HFSS 3D Layout designs need to be shared in .aedtz format in order to include associated .aedb directory.

HFSS 3D: Arbitrary 3D Modeler - Mechanical CAD (MCAD)

HFSS 3D MCAD has the most general geometry with the fully arbitrary 3D (FA3D) Modeler.

HFSS Design Type is not covered in this 3D Layout course.

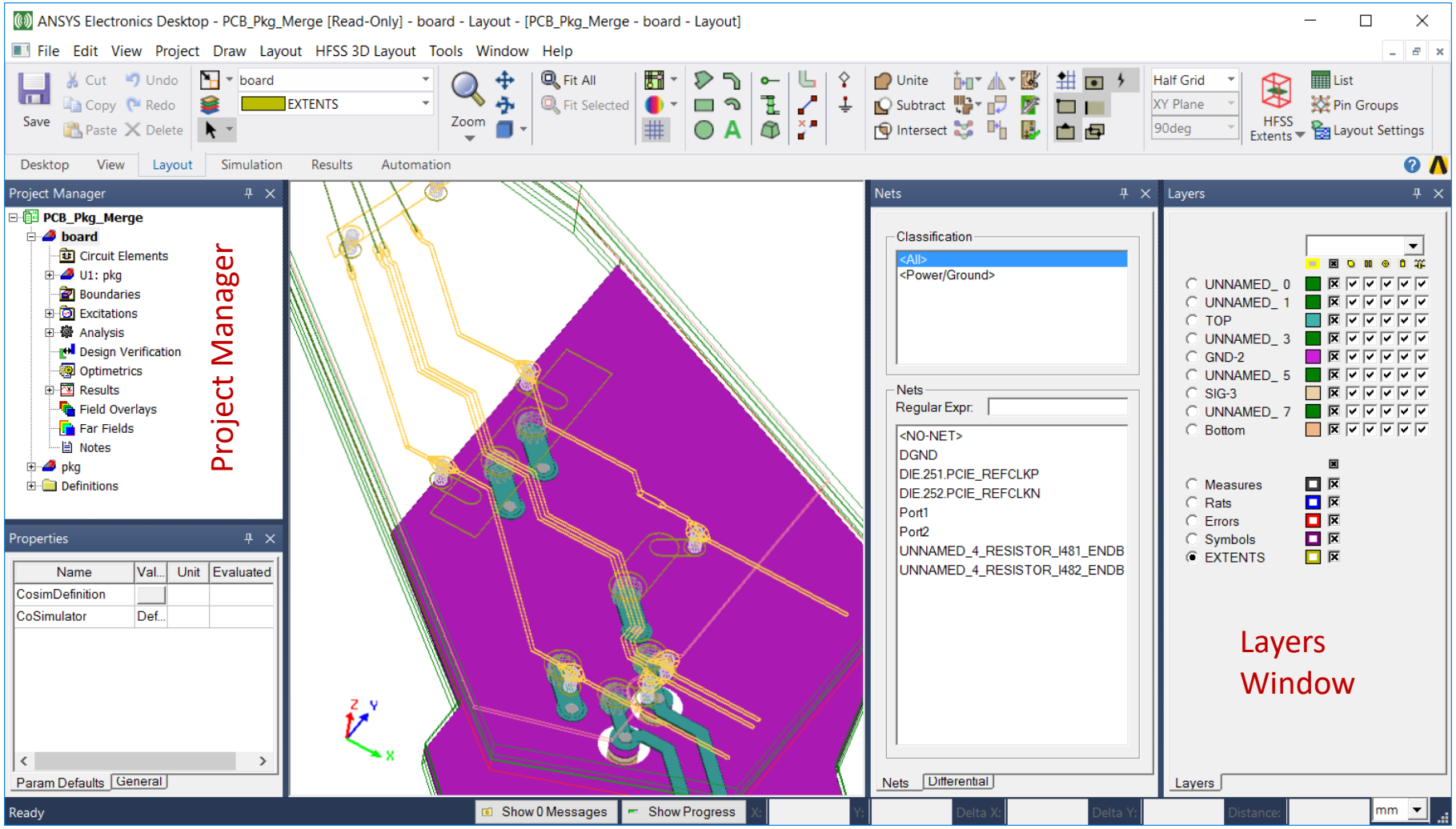


You can always tell an HFSS design type by the ***Model Tree*** between the ***Project Manager*** and the ***Modeler***.

HFSS 3D Layout Editor

3-Dimensional Electrical CAD (ECAD) - Fully Parametric

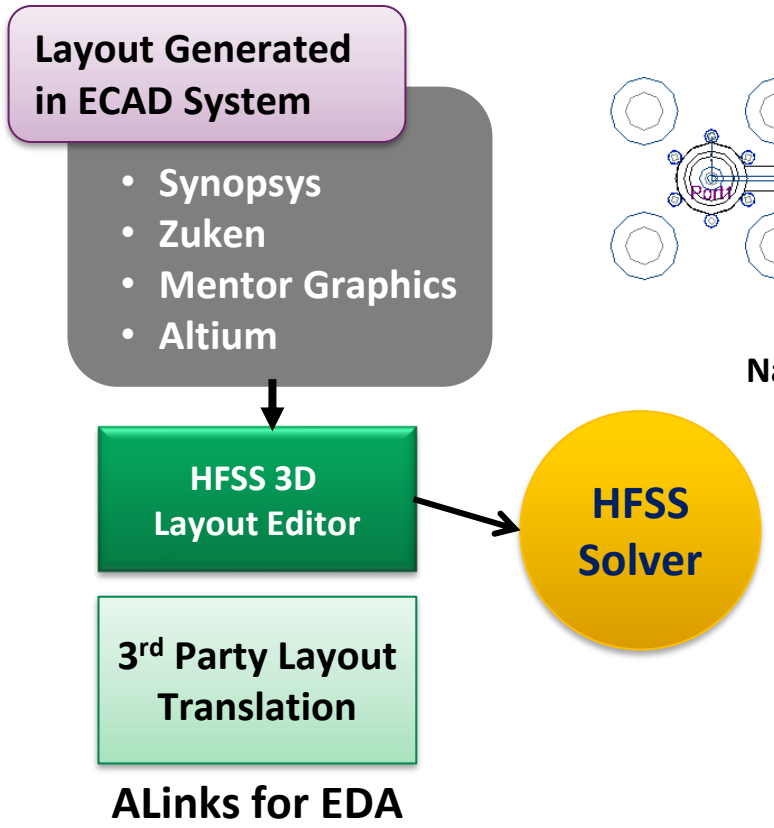
- HFSS 3D Layout is the subject of this course.
- There is an HFSS 3D Layout design type. The ***Layers*** and ***Nets*** functionality is available in HFSS 3D Layout.
- The geometry is based around a 2D layout view and a stackup.



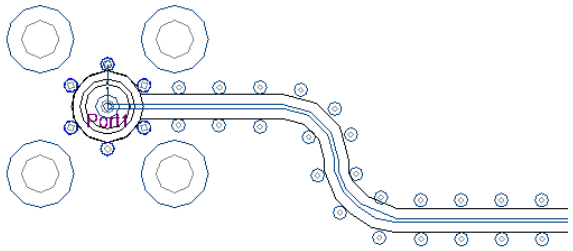
HFSS 3D Layout Editor

HFSS 3D Layout Integration

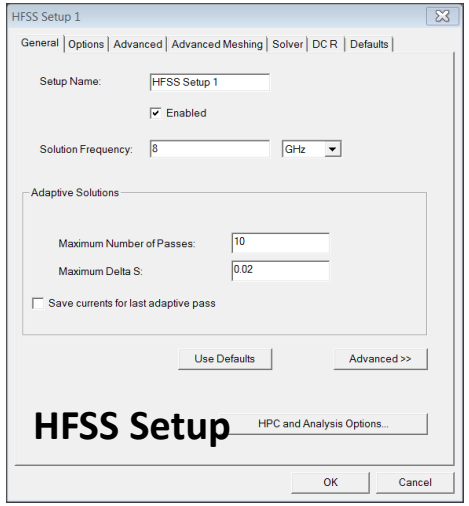
- Native Layout Editor for 3D HFSS simulations
  - Mentor, Zuken, Altium, DXF, GDSII



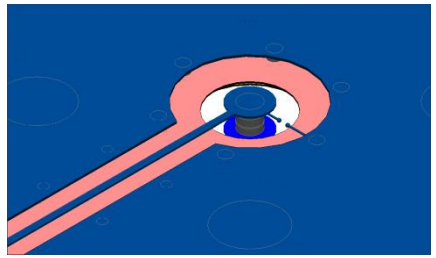
ALinks for EDA



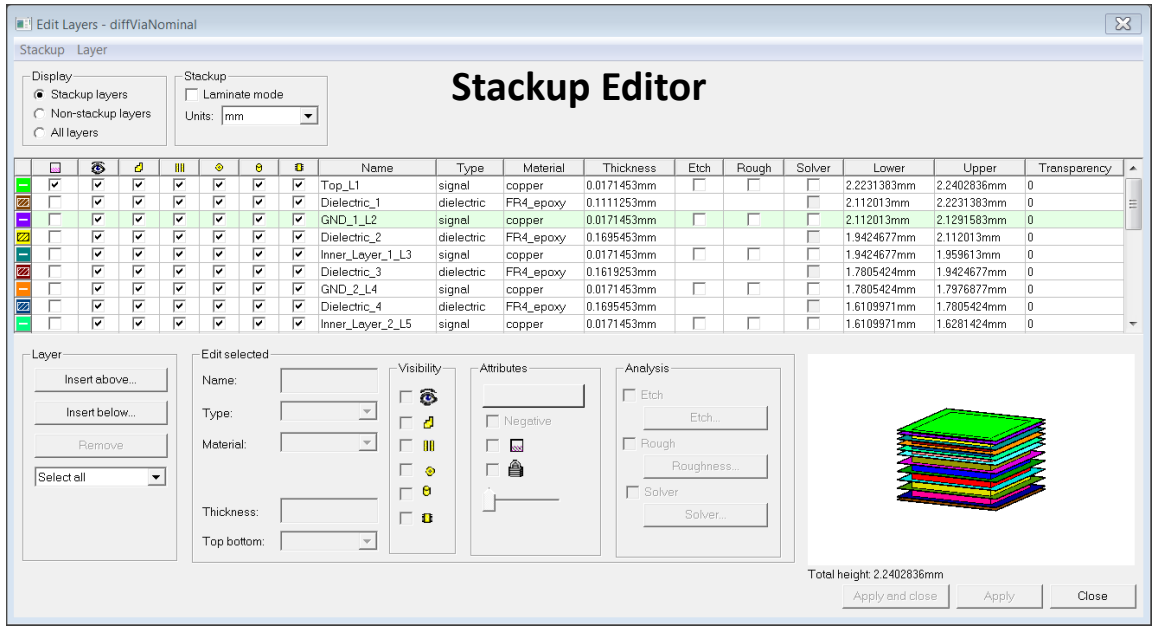
Native Layout Editor



HFSS Setup

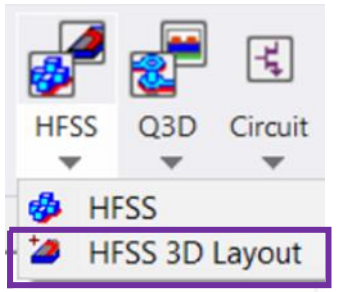


HFSS Circuit Port



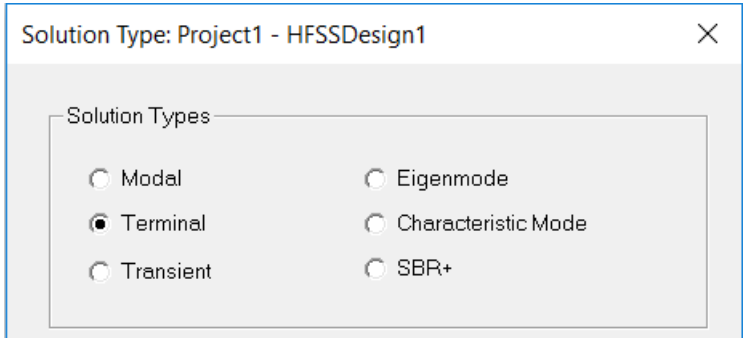
Stackup Editor

HFSS 3D Layout is a Design Type within the HFSS Product



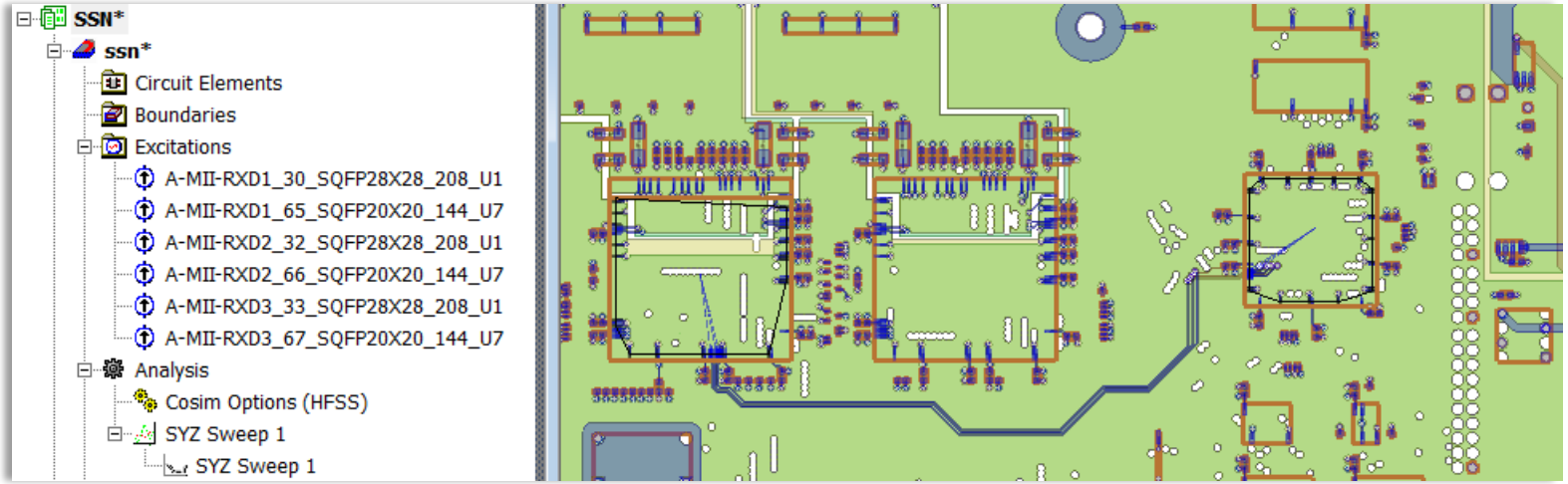
HFSS offers two ***Design Types***.

HFSS 3D Layout is an HFSS ***Design Type***.



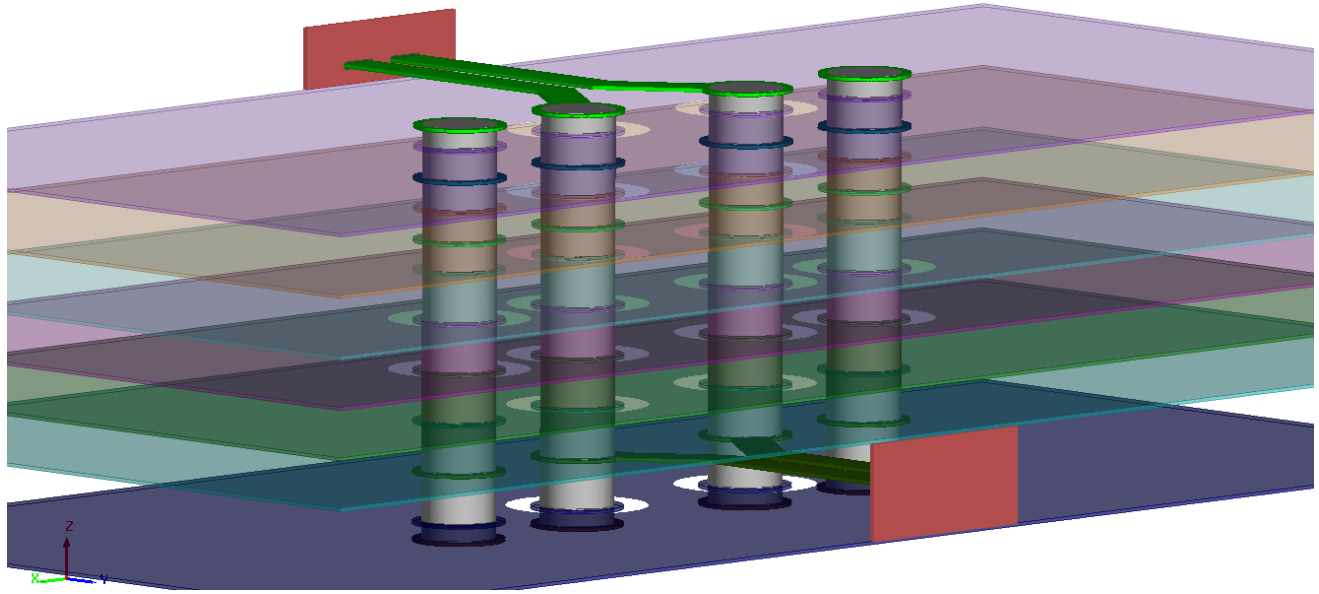
HFSS 3D Layout simulation corresponds to the HFSS ***Terminal Solution Type***.

HFSS 3D Layout ports have terminals.



HFSS 3D Layout Editor - 3D View of Layered 3D Geometry

- The HFSS 3D Layout ***Design Type***, within the HFSS product, simulates 3D geometries, using 3D meshing.
- The Layout Editor, in HFSS 3D Layout, represents simulation model geometry in terms of layers that are defined in a stackup.
- Arbitrary geometry shapes are available in horizontal layers.



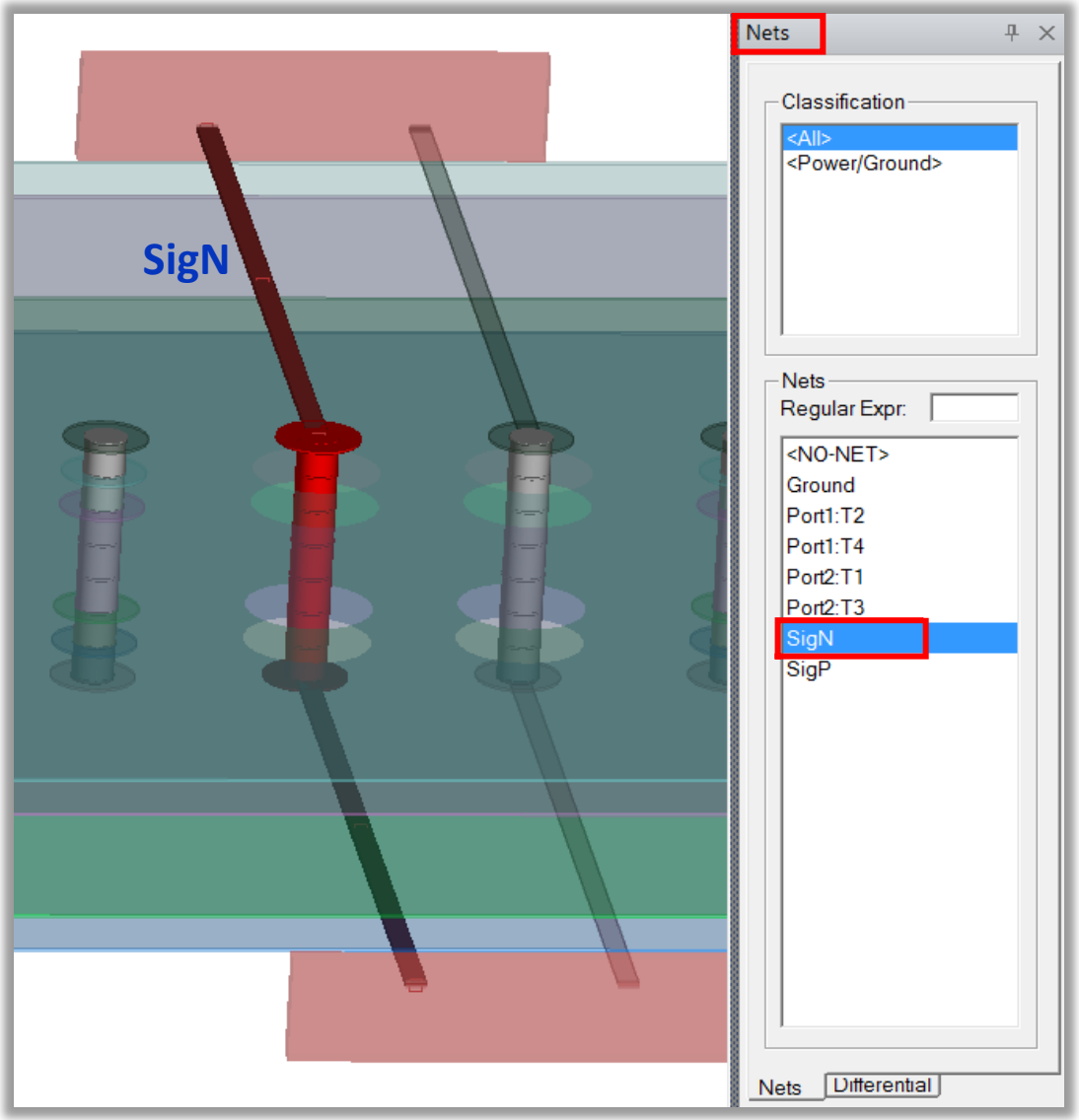
Name	Type	Material	Thickness
Top_L1	signal	copper	0.0171453mm
Dielectric_1	dielectric	FR4_epoxy	0.1111253mm
GND_1_L2	signal	copper	0.0171453mm
Dielectric_2	dielectric	FR4_epoxy	0.1695453mm
Inner_Layer_1_L3	signal	copper	0.0171453mm
Dielectric_3	dielectric	FR4_epoxy	0.1619253mm
GND_2_L4	signal	copper	0.0171453mm
Dielectric_4	dielectric	FR4_epoxy	0.1695453mm

This is the ***Layer Stackup*** where the layer transparencies, material thickness, and other properties are set.

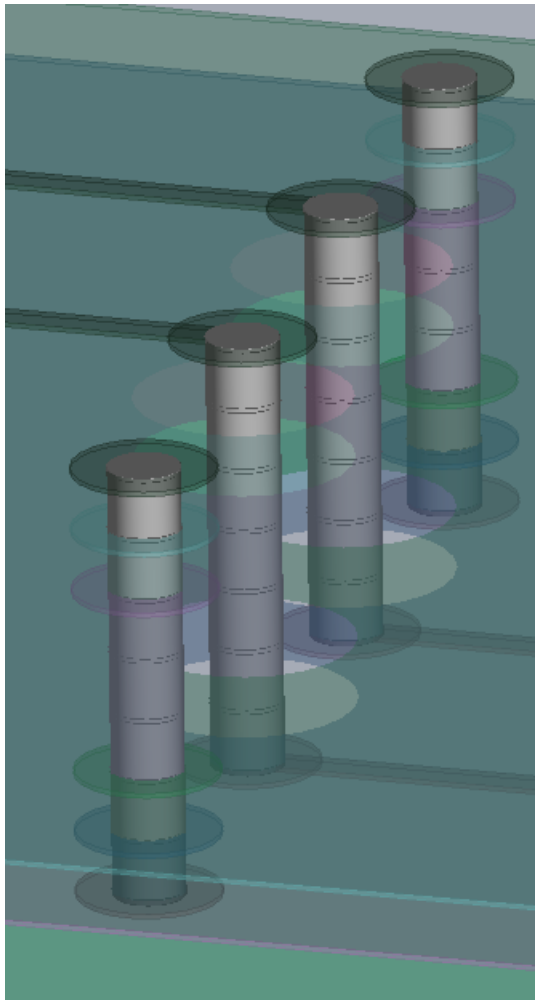
HFSS 3D Layout Nets

- The HFSS 3D Layout ***Design Type*** has the notion of ***Nets***, signal paths along a connection of several geometric shapes.
- There is a ***Nets*** window available in HFSS 3D Layout.
- The naming of ***Nets*** is important to the automated functioning of ***Padstacks***.
- For particular net names within long lists, searches may be done in the ***Regular Expr*** blank.
- Searches for specific net names, within long lists, may be done in the ***Regular Expr*** blank.

The Help document ***An Introduction to HFSS*** section titled ***Getting Started with ANSYS Electronics Desktop*** has a section ***Working with the Nets Window*** with additional information.

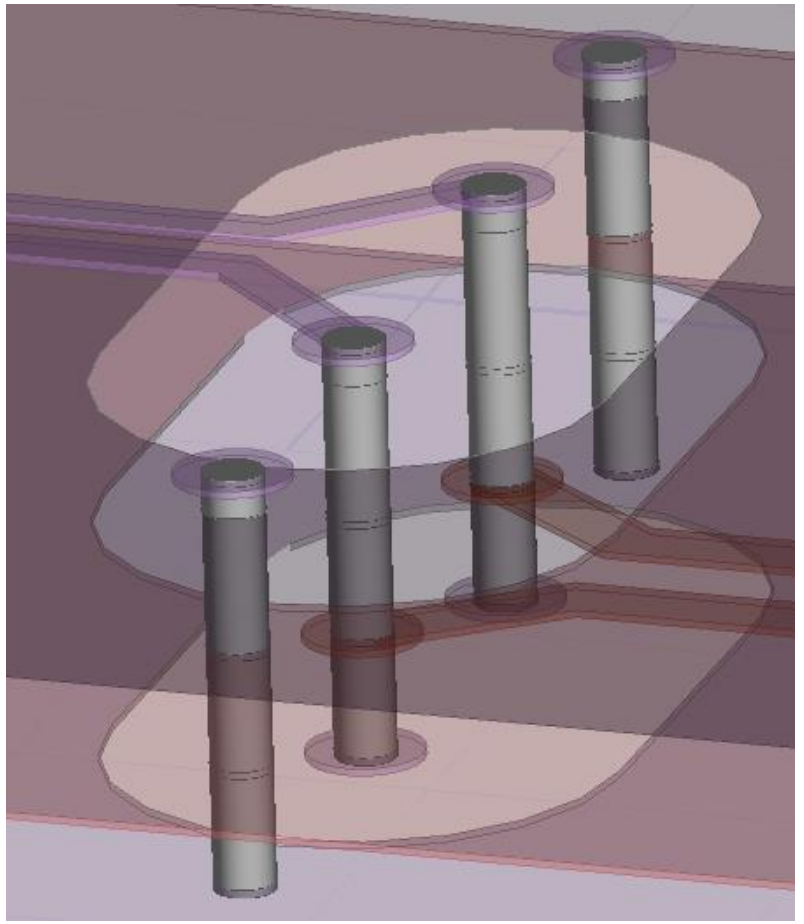


HFSS 3D Layout Via Padstacks and Antipad Approaches



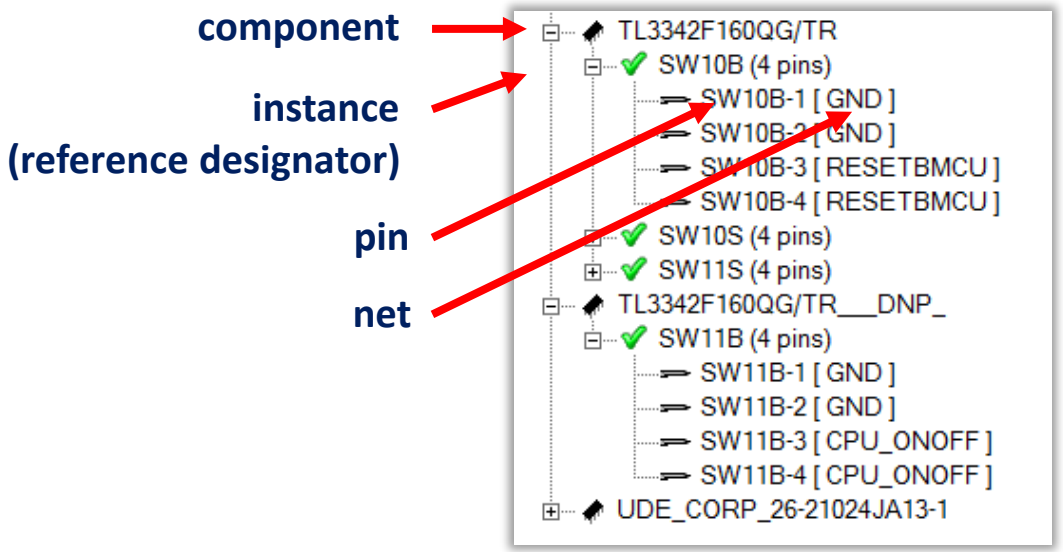
The pads and antipads on the left were made with automated and parameterized padstacks assigned to vias in HFSS 3D Layout. The ground planes are rectangles.

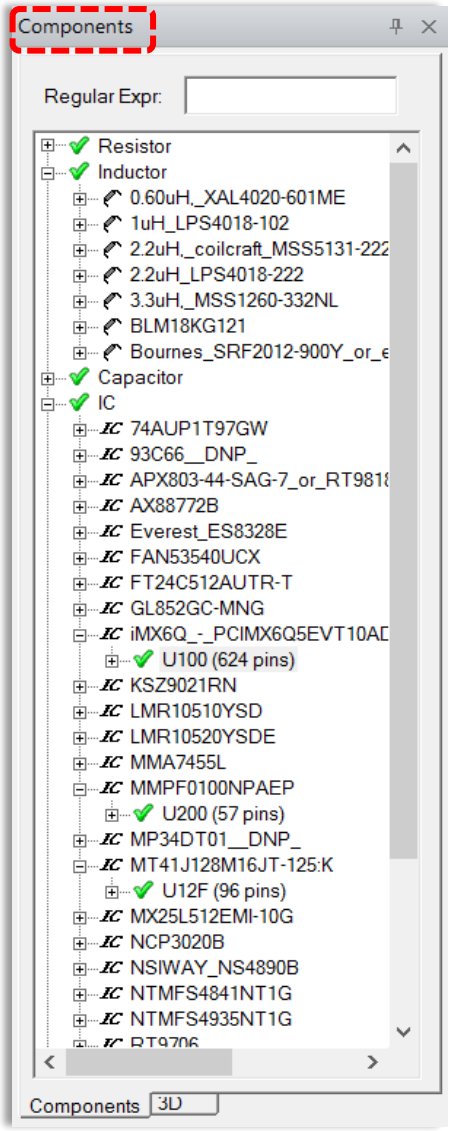
The antipads on the right were made with holes in the ground plane rectangles, either by Boolean subtraction or by voids or by negative geometries.

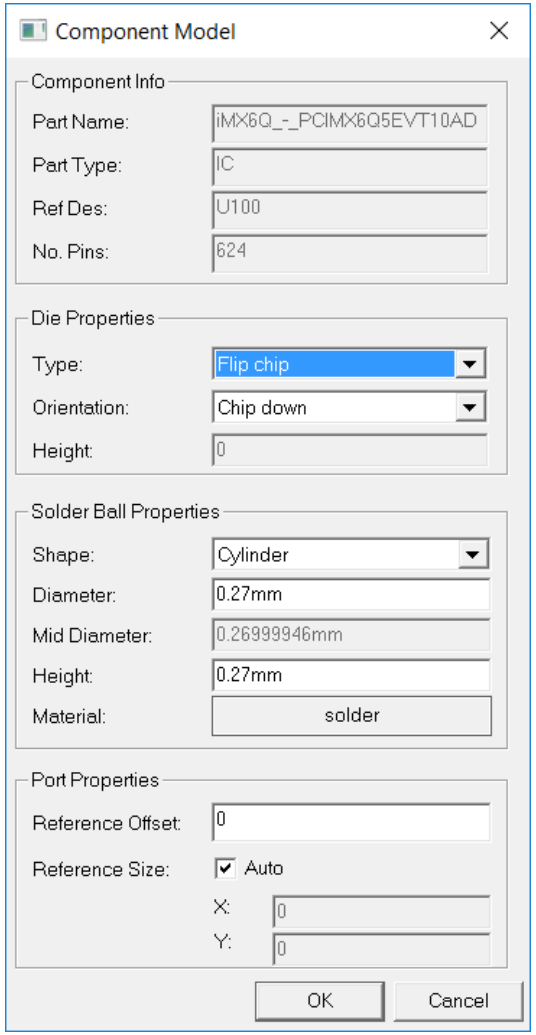


HFSS 3D Layout Components

- HFSS 3D Layout includes layout components, which consist of groups of pins and an outline which appears in layouts.
- Components can have ports attached and properties set (e.g. orientation and solder ball specification). See picture on far right.
- Components correspond to shapes and definitions that may be imported from ECAD layout software.





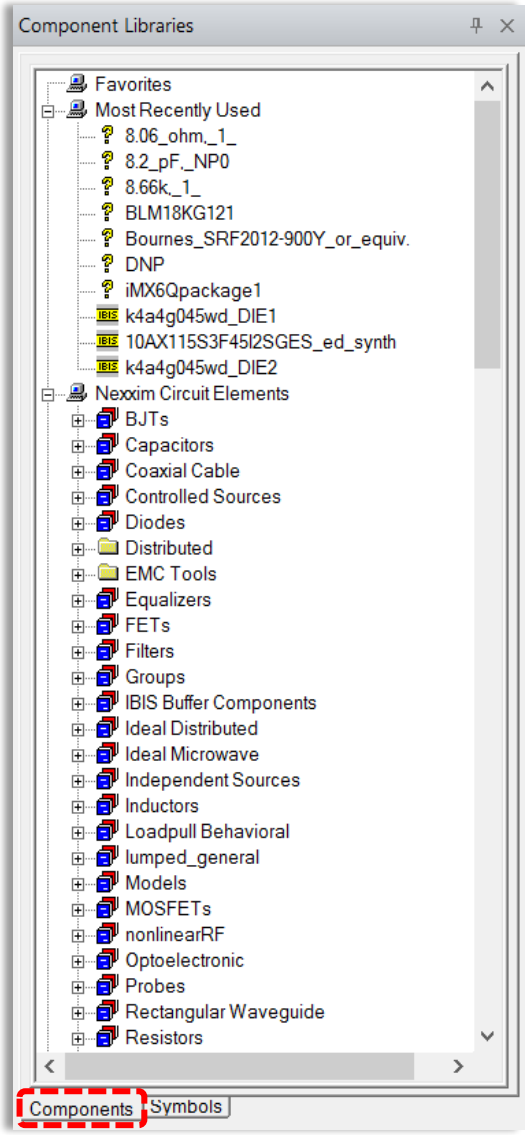


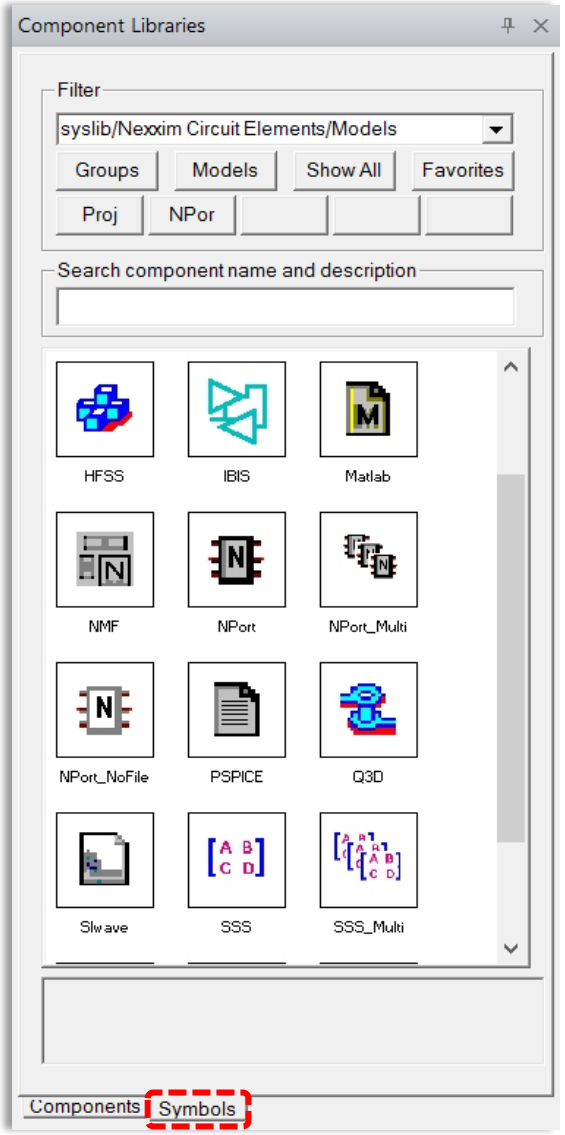
Right-click on a component and select ***Model***.

Components Libraries

- Library components can have models (from a variety of sources - see picture to right), footprints, and schematic symbols.
- Library components can be part of a circuit simulation within HFSS 3D Layout.
- Components can come from other HFSS designs, both 3D Layout and MCAD (fully arbitrary 3D).
- Components can include 3D Components for HFSS.
- For PCB Import, including the whole bill of materials, RLC components on the imported board are included and considered in simulations. Imported components can also be modeled with S-parameters.

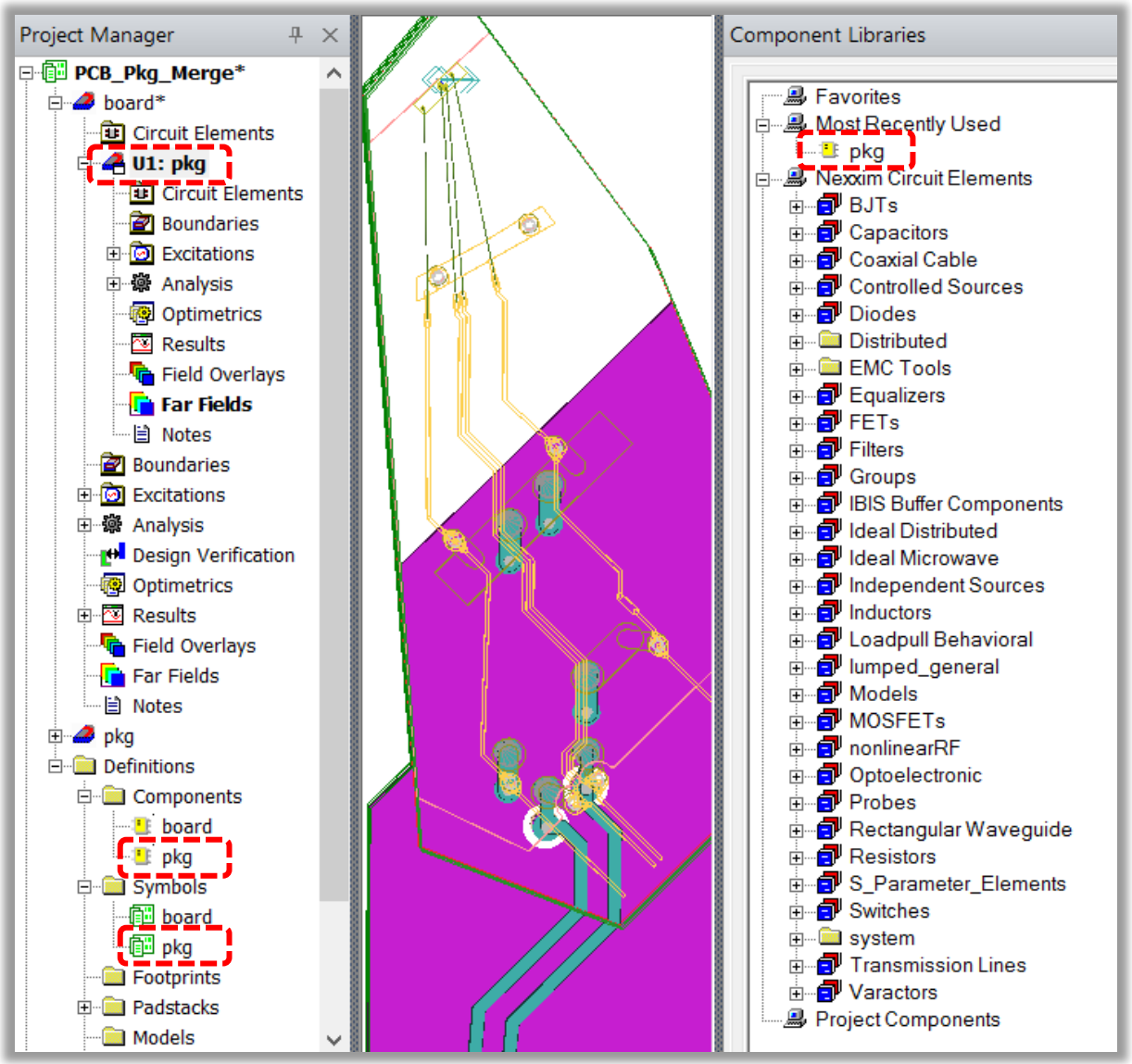
See also the Help document ***HFSS.pdf***, a section called ***Using the Component Libraries Window.***





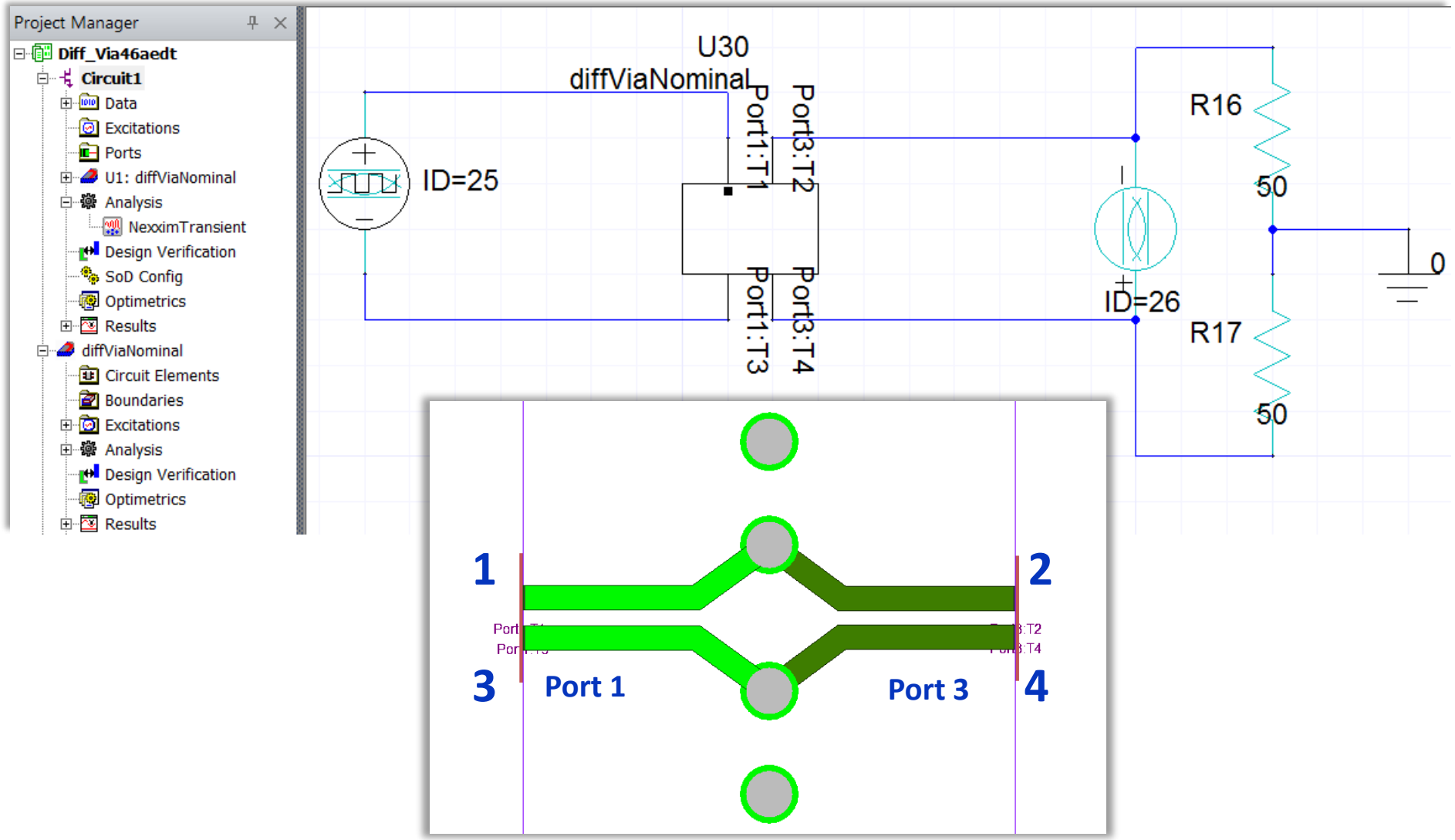
HFSS 3D Layout Components and Hierarchy

- In this example ***PCB_Pkg_Merge***, there is an HFSS 3D Layout design **pkg** hierarchically within the design **board.**
- **pkg** has reference designator ***U1***. and has its own layout as well.
- **board** is the purple/violet shape visible in the layout window and
- In the ***Project Manager***, under ***Definitions***, **pkg** can be seen underneath ***Components*** and ***Symbols***.
- In the ***Component Libraries*** window, **pkg** can be seen under ***Most Recently Used***.



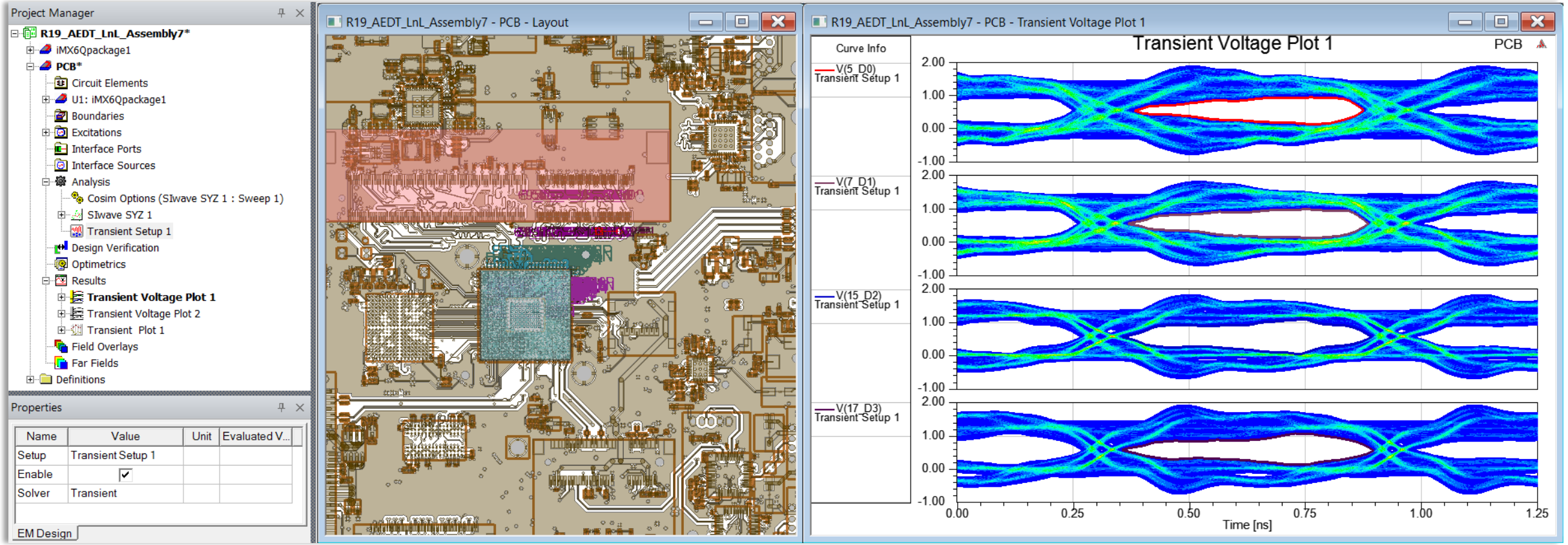
HFSS 3D Layout Circuit Simulation Hierarchy

Within one project, a Nexxim circuit design schematic ***Circuit1*** can hierarchically call an EM block (HFSS 3D Layout design) ***diffViaNominal*** in a circuit simulation.



HFSS 3D Layout Driven Schematic Cosimulation

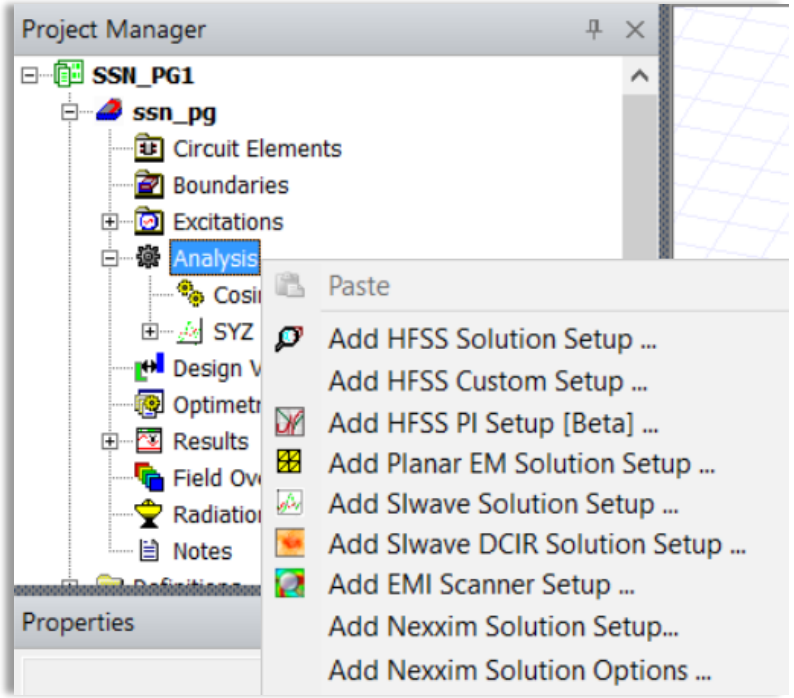
In addition to Nexxim circuit design schematics hierarchically calling an EM block (HFSS 3D Layout design) in a circuit simulation, Nexxim can simulate directly in the HFSS 3D Layout.



In this example, Nexxim drives the IBIS models which interface to the PCB and iMX6Q package. There isn't an explicit or separate schematic necessary in order to run the transient circuit simulation.

HFSS 3D Layout Solvers and Ports

- HFSS 3D Layout offers various electromagnetic solvers for use on layered structures, including the HFSS fully arbitrary 3D finite element method (FEM) solver, the SIwave hybrid solver, which is very efficient for large structures, and the planar EM solver.
- HFSS 3D Layout ports include wave ports, gap ports, and circuit ports. HFSS 3D Layout ports adjust to the solvers being used, not all ports are available with all solvers or structures.
- HFSS 3D Layout ***Design Type*** is sometimes referred to as **ECAD** for electronic computer aided design.
- The HFSS design type is sometimes referred to as **MCAD** for mechanical CAD, referring to the fully arbitrary 3D (FA3D) geometry modeler.

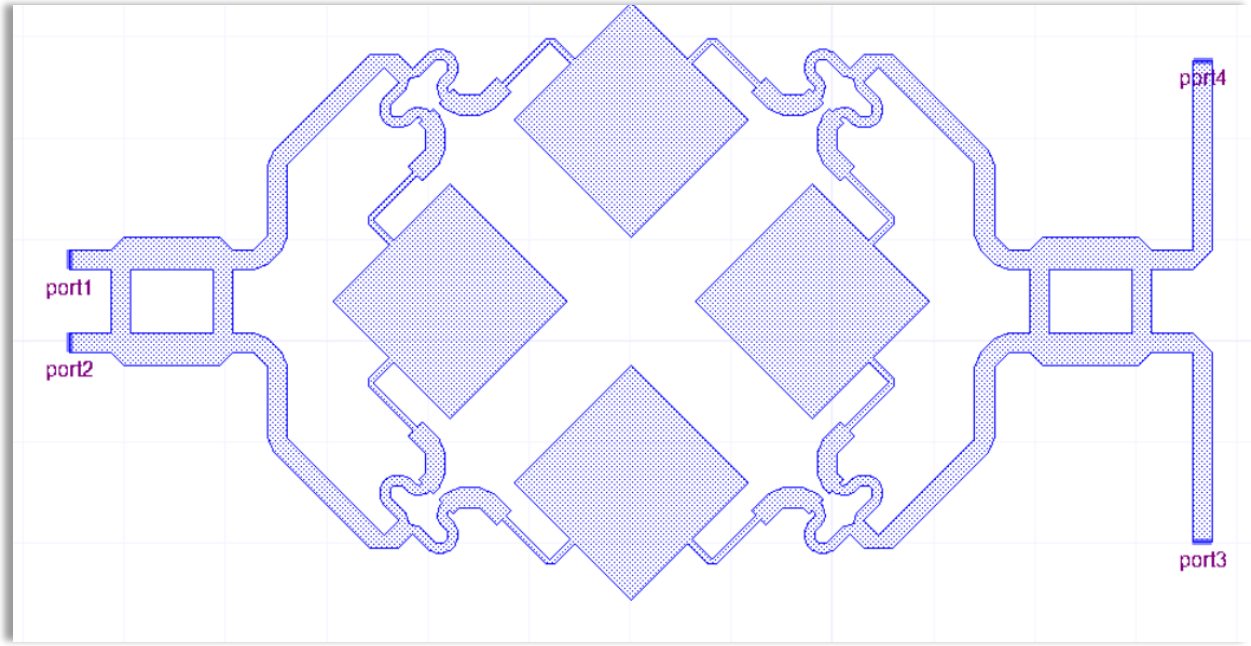


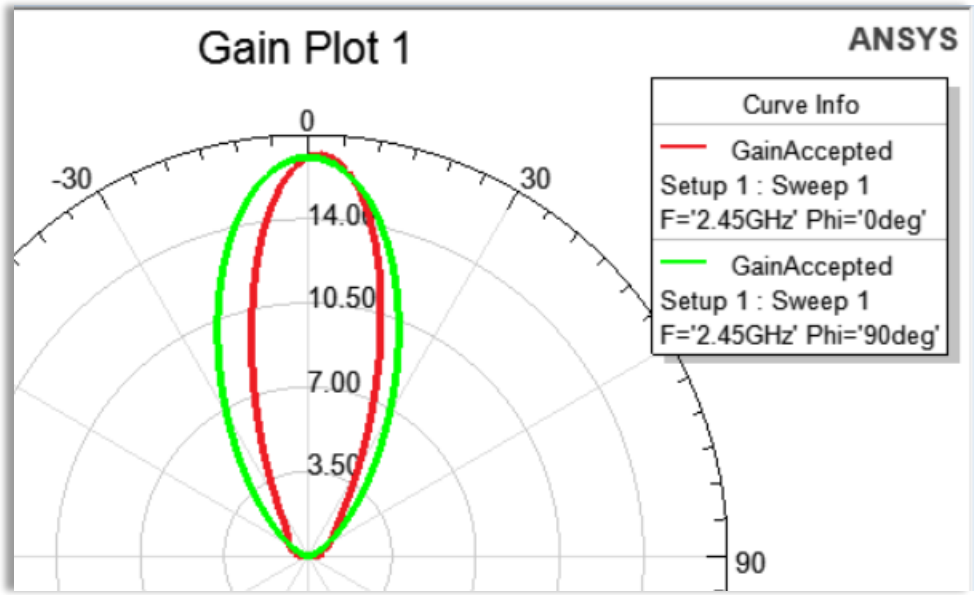
HFSS 3D Layout Planar MoM Solver for Antennas

Planar antennas often radiate broadside, from the surface of the antenna surface out. Far fields are calculated from currents.

This makes planar antennas well suited for the Planar EM solver in HFSS 3D Layout. The planar EM solver is an unshielded formulation of method-of-moments (MoM).

HFSS 3D Layout examples offer several antenna examples using the planar EM solver.






Ansys