HFSS for ECAD: Package Modeling, MMIC and on-die extraction

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• Introduction

• HFSS Solver on Demand in Detail
  – Create a project from A to Z

• Application
  – Package and Board
  – MMIC application with UMS PH15 design kit

• Integration in ECAD Flow: ECAD Translator

• New Features in Designer 7.0

• Conclusion
Introduction
Why HFSS in Ansoft Designer?

- MCAD (Mechanical Computer-Aided Design) vs. ECAD (Electronic Computer-Aided Design)
  - HFSS application can be mostly split into two families:
    - Application originally designed with MCAD: Antennas, Connector, Wave Guide, filters …
    - Application originally designed with ECAD: PCB, RFIC, MMIC, Planar Antenna, Package …
- HFSS original GUI perfectly address MCAD application needs
- HFSS Solver on Demand provides a new interface for ECAD application
Available with Ansoft Designer 6.0
2D layout design entry
  - Import from APD, ODB++
  - Full custom layout
Layers stackup definition
Easy of Use with setup automation
Easily toggle between FEM and MOM solvers
Support scripted footprint
HFSS technology for reliable and accurate models
  - Adaptative meshing
  - 3D Objects: wirebonds, arbitrary shaped vias…
  - Finite dielectric
  - Support for multimoded wave ports and gap sources
HFSS Solver on Demand in Detail
Stackup Definition

- Standard HFSS design entry uses 3D Object
- HFSS in Designer combine 2D drawing with stackup definition

![Diagram showing stackup definition process]
Easy and Automated Port Setup

- Define port by selecting edge
- Solver specific properties
- HFSS gap or wave port available
• Size setup
• Deembedding available
• PEC launch allows wave port inside air box
Boundaries Setup

- Radiation Boundary for air box
- Dielectric size setup
- Air box size setup
• Solution Frequency
• Adaptive solution
• Mixed order elements and iterative solver available
Post-Processing

- Rectangular, smith chart … plots
- Current, far and near field display
- Meshing
Spirale example

- 1 project 2 setup
Package and Board
• From 2D to 3D
  – Finite dielectric definition in stackup
  – Use Bondwire type primitive
  – Padstack definition for BGAPad
• Quick and easy port setup
• Display current
Package example

- Current distribution
Imported Package Example

- Import from APD/Allegro
- .mcm, .sip, .brd, .anx
- Import stackup and bondwire profile
- Setup solderball profile
- Automatically port setup for pin
- Cutout sub-design
• Cutout region can either be auto generated or determined by user
• Select signal, power and ground nets to create cutout
Package/PCB Merge

Copy package

Paste into PCB layout

Independent package and board stackup

Synchronize Design

- Make copy
  - Design is copied, same stackup as parent, manufacturable with parent

- No copy - use instance of original
  - Design is linked to original, unrelated stackups, not manufacturable with parent

HFSS Solver on Demand
Final Model in Designer

Lumped ports on package bumps

Dielectrics not rendered

Wave Port on traces end
MMIC application with UMS PH15 design kit
• Provide UMS PH15 Design Kit with passive component simulable with HFSS
• Includes parameterized footprint for
  – MIM capacitor
  – Spirale inductor
  – Tan and TiWSi Resistors
  – Vias
• Footprint are both valid for GDS export and HFSS simulation
• Technology file loads design kit components, layer definition and stackup
• Stackup is defined with regards to process technology definition given by foundry
• Create parameterized footprint
  – With respect to design rules defined for manufacturing
  – With respect to physical design used for HFSS simulation
    • Layer deposition
    • Air bridges

Source UMS PH15 design guide
- Shape of the same layer is drawn twice
  - User type for manufacturing (GDSII export)
  - Signal, dielectric or ground for HFSS simulation
- Stackup definition validated with UMS
- Automatically loaded with the technology file
Simulation results: MIM capacitor 0.26pf

- Good agreement with UMS model

Simulation results:

MIM capacitor 0.26pf

\[
\begin{align*}
\text{CapOnGrid}_{\text{pF}} &= 0.263\text{pF} \\
w_{\text{int.um}} &= 28 \\
l_{\text{int.um}} &= 28.5
\end{align*}
\]

\[
\begin{array}{|c|c|c|}
\hline
\text{Name} & \text{X} & \text{Y} \\
\hline
m4 & 7.5000 & 0.2929 \\
m5 & 7.5000 & 0.2699 \\
m6 & 30.0000 & 0.5092 \\
m7 & 30.0000 & 0.4319 \\
\hline
\end{array}
\]

\[
\begin{align*}
\Delta(Y) &= d(m4,m5) = -0.0230 \\
&= d(m6,m7) = -0.0773
\end{align*}
\]
Spiral Inductor 1.91nh

Port1

Port2

Ldrawn=1.902nH
Ndrawn=4

Ind_Value_zoom

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• Coupling between components
• No need of internal port
What is ECAD Translator?

- It offers direct import of Cadence
  - APD, SiP, Allegro, layout files without creation of an .anx file
  - Virtuoso with .anx file creation
    - Integrated in Designer
    - Must have Cadence installed

- Support for ODB++
  - Common PCB Manufacturing format
    - Supported by Mentor, Zuken, Cadence, Altium
- Available through ECAD Translators
- Create models in Cadence SPB that are ready for simulation using HFSS Solver on Demand.
Cadence SPB Integration

- View of the package in the Designer layout editor after export from Allegro Package Designer
Virtuoso Integration

- User Interface for Solver on Demand model creation in Virtuoso
  - Lumped ports (vertical and horizontal)
  - Simulation setup and sweeps
- Improve storage of database for use with other designs in the same CDN lib.
- Simplify layer stackup
- Cluster via arrays
• Open layout cell view in Cadence and customized Ansys menu to load cadence interface to export to HFSS
• Load or define material to be used in the stackup
• Define and save stackup (only first time)
• Define port
• Create Flatten cell
• Define Air Box size
• Define HFSS setup
• Export .anx file
• Import .anx file using Ansoft Links from Designer
• Run simulation
Define Stackup

- Add layer in stackup
  - Select from LSW Layers for via and metal
  - Add dielectric
  - Specify thickness and elevation
- Merge operation (horizontal)
  - Metal
  - Dielectric
- Combine operation (Vertical)
  - Metal
  - Dielectric
- Stackup definition saved at selected levels
  - Cell view
  - Design library
  - Reference library
Merge layer: Ground Pattern example

- Original cell with ground pattern
- Flattened cell with 0.5 um setting
- Flattened cell with 1.1 um setting
Via Cluster

- Original cell no via cluster

- Flattened cell with via cluster

- Original cell no via cluster exported in HFSS Solver on Demand

- Flattened cell with via cluster exported in HFSS Solver on Demand
HFSS Setup

- Define HFSS setup for simulation
  - Mesh frequency
  - Frequency sweep
  - Order of basis functions
  - Iterative solver

- Create project
  - Create an .anx file for importing in Designer
HFSS Solver On Demand Project

- Import from anx file automatically create project ready to solve:
  - Stackup definition created
  - Port setup
  - HFSS setup
  - Air Box defined
• ODB++ Import via Designer Links
HFSS Solver On Demand
Designer 7.0
– One layout editor for 2D and 3D views
• Frequency dependent mesh
• Convergence versus output variable
Conclusion

- Target ECAD application
- 2D layout design entry
  - 2D Layout + Stackup
- Easy and quick setup of an HFSS project
- HFSS technology for reliable and accurate models
  - Adaptative meshing
  - 3D Objects: wirebonds, arbitrary shaped vias…
  - Finite dielectric
  - Support for multimoded wave ports and gap sources
- ECAD Translator offers powerful link with EDA tool
  - Preparing model for electromagnetic simulation
  - Automates settings: ports, setup, boundaries ...
Thank you