

# Ansys RaptorH

Analyze Designs from Inductor to Connector with Best-in-class Electromagnetic Solvers

- **The fastest, most accurate, and scalable electromagnetic extraction for advanced nanometer silicon designs**
- **Models electromagnetic coupling and interference in analog, mixed-signal, RF, digital SoCs, and 3D-ICs**

## / Key Features

- Delivers unrivaled capacity and speed on single- and multi-host architectures
- Models even the most advanced layout-dependent effects down to 3nm
- Reads encrypted foundry tech files
- Is optimized for silicon
- Provides various output formats for maximum efficiency in circuit simulation
- Sets boundary conditions automatically
- Is compatible with all IC designs, IC design platforms, and circuit simulators
- Is certified by major foundries for 2.5D/3D integrated circuits and systems
- With its dual-solver nature, it integrates Ansys HFSS™ and Ansys RaptorX™ electromagnetic solvers in the same user interface – RaptorH is the bridge between IC design and system design teams

## / On-silicon Electromagnetic Modeling

Uses best-in-class HFSS and RaptorX electromagnetic solvers together to analyze designs from inductor to connector.

- Provides the ultimate electromagnetic analysis solution for 3D-ICs and high-performance SoCs in 10/7/5/3nm
- Takes a holistic approach for 5G, server multi-core SoCs, and 3D-ICs
- Addresses fundamental designers' wish list to drive system design from a chip design perspective

Ansys RaptorH™ electromagnetic (EM) modeling software delivers high accuracy with two best-in-class electromagnetic solvers — the gold-standard Ansys HFSS engine with the silicon-optimized Ansys RaptorX engine. Its unrivaled capacity and modeling speed allows you to model circuits of any complexity with electromagnetic accuracy starting from passives, like spiral inductors or MiM/MoM capacitors, and expanding to power grids, on-die clock trees, full custom blocks, and 3D-IC architectures. RaptorH can analyze partial and unfinished layouts during the design phase and does not require boundary conditions or special ports. It also seamlessly interfaces with the leading IC physical implementation platforms.

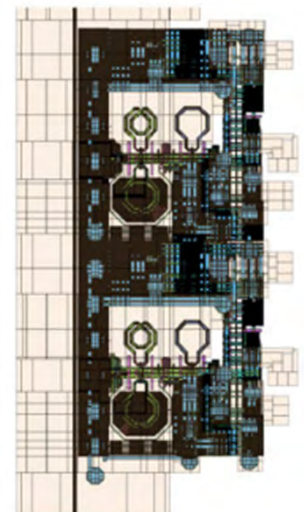


Figure 1: RF circuit layout

## **/ Delivers Gold-standard Accuracy with the HFSS 3D Electromagnetic Solver and the RaptorX Silicon-optimized Electromagnetic Solver**

Ansys RaptorH lets you transparently choose between the HFSS engine and the RaptorX engine with no concern about accuracy compromises. Both solvers guarantee golden accuracy for radio frequency (RF) and analog/mixed-Signal (AMS) circuits, high-speed digital systems-on-chip (SoCs) and 3D-IC assemblies. In RaptorH gold-standard accuracy is combined with ultra-high capacity, fast modeling times, and the power to analyze from the chip to the system level.

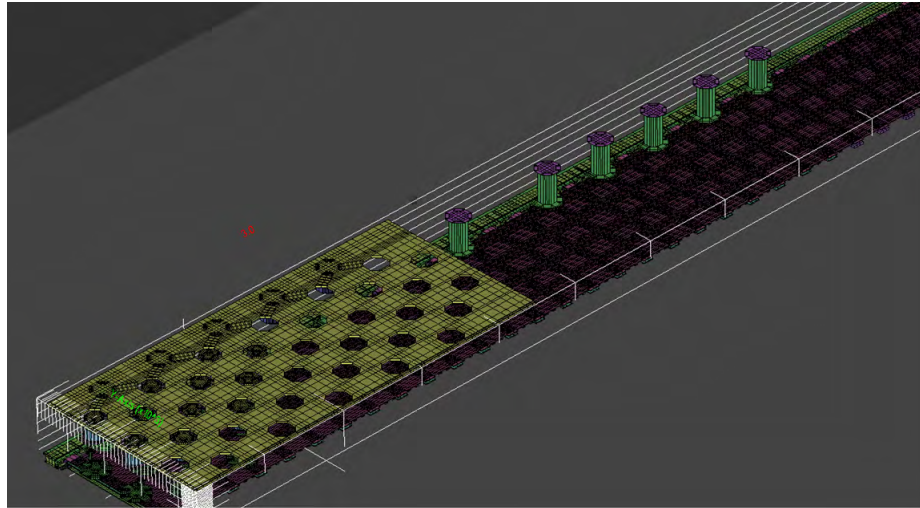


Figure 2: RaptorH mesh of 5mm x 0.11mm silicon interposer with 48 signals and the power distribution network (PDN)

## **/ Unprecedented Capacity And Speed to Model the Most Complex SoCs and 3D-ICs**

Ansys RaptorH delivers unrivaled capacity and speed to accurately analyze the most complex SoCs and 3D-ICs you have ever imagined. Break the boundaries of traditional electromagnetic methodologies and co-analyze your die with the package. Alternatively, you can accurately sign off your high-speed channels together with the power and ground networks in a cutting-edge interposer with the confidence of silicon-proven RaptorH models. This holistic system-level methodology co-analyzes the die, the package, and the printed circuit board.

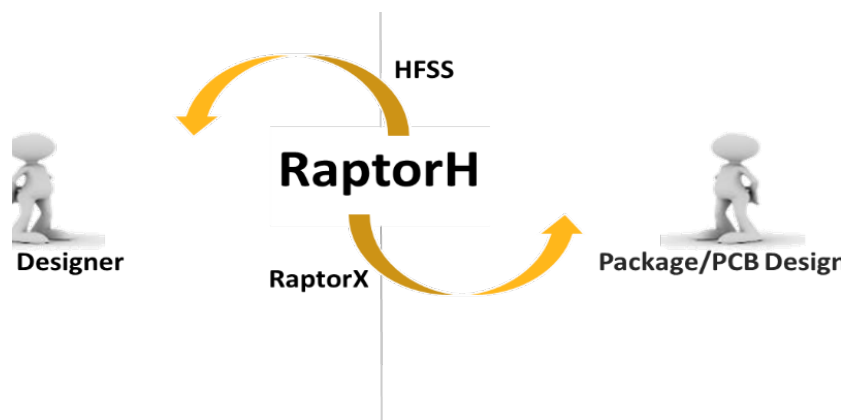


Figure 3: RaptorH allows IC and package/PCB design teams to collaborate seamlessly on a common design database.

## / Silicon-proven Accuracy Down to the Most Advanced Process Nodes with Coverage of All Layout-dependent Effects

Advanced process nodes introduce a multitude of challenges for electromagnetic solvers. Etching, multi-patterning, conformal dielectrics, damage, and loading effects should be analytically calculated to produce an accurate electromagnetic model. RaptorH is unique in its ability to model all layout-dependent effects in advanced CMOS processes, thus delivering the highest accuracy for the most demanding applications. Both electromagnetic solvers in RaptorH — HFSS and RaptorX — can read foundry-encrypted technology description files.

Category	Description	RaptorH	
		RaptorX solver	HFSS solver
Conductor	Multi-patterning / Coloring	✓	✓
Conductor	ETCHING (single or multiple tables)	✓	✓
Conductor	Width dependent TC1/TC2	✓	✓
Conductor	Metal thickness variation (Resistance)	✓	✓
Conductor	Metal thickness and density bounds (Resistance)	✓	✓
Conductor	Metal thickness variation (Capacitance)	✓	n/a
Conductor	Metal thickness and density bounds (Capacitance)	✓	n/a
Conductor	Sidewall damage thickness variation	✓	n/a
Dielectric	Constant damage thickness	✓	n/a
Dielectric	Bottom dielectric thickness variation	✓	n/a
Dielectric	Side dielectric thickness variation	✓	n/a
Via	RPV vs via area (Contact table)	✓	✓
Via	RPV TC1/TC2 vs via area	✓	✓

Table 1: Details of advanced layout-dependent effects modeled by Ansys RaptorH for the HFSS and RaptorX EM solvers

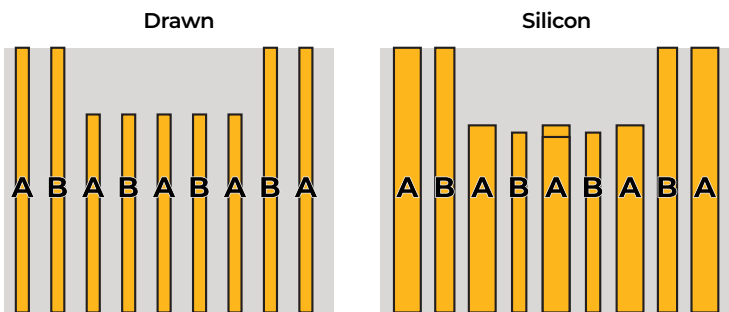


Figure 4: Multi-patterning variation

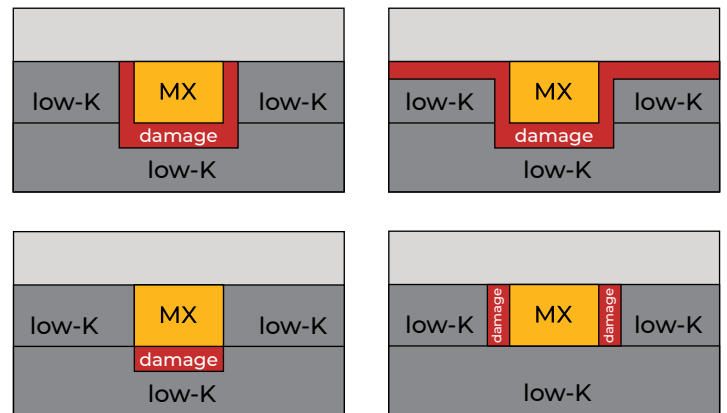
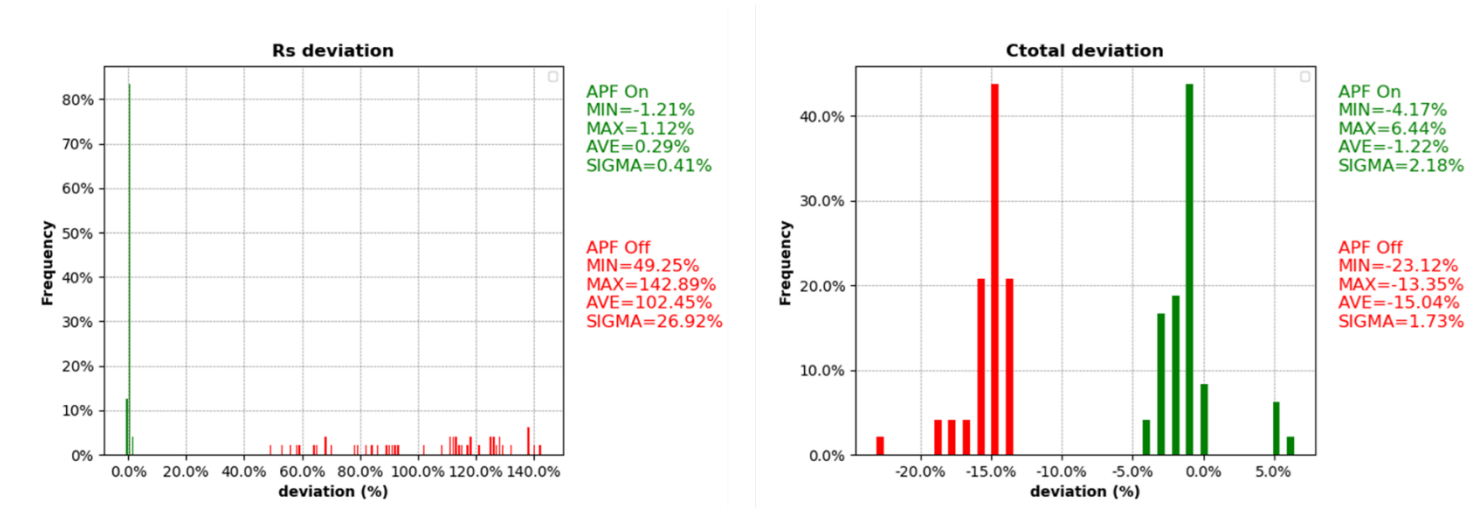


Figure 5: Various types of dielectric damage variation

Ignoring advanced layout-dependent effects can result in up to 140% deviation from the reference in series resistance ( $R_s$ ) and up to 25% deviation from the reference in total capacitance ( $C_{total}$ ) according to benchmarks.



Advanced Process Features ON  
Advanced Process Features OFF

Figure 6: Deviations of RaptorX models from reference with (green plots) and without (red plots) modeling of advanced layout-dependent effects. Metrics compared are Rs (series resistance) and Ctotal (total capacitance).

## / Multi-host Electromagnetic Simulation

With its innovative distributed compute architecture, RaptorH capacity knows no limits. Reduce the runtime, RAM footprint, and overall cost of your electromagnetic simulation by taking advantage of multiple small machines available on your grid. Model huge areas of layouts many orders of magnitude faster than any other electromagnetic solver. **Indicative benchmarks show ~2X runtime and memory utilization improvements going from 1 node to 16 nodes with the RaptorX solver.**

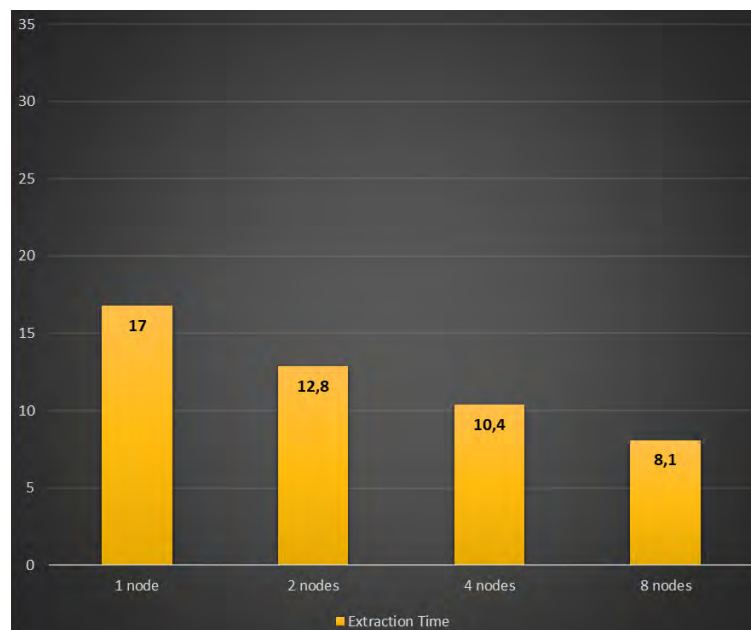
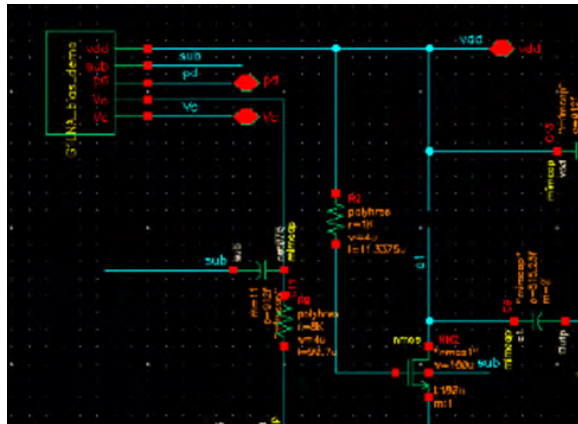


Figure 7: Benchmark on a 2mm x 1mm high-speed bus with 324 ports, 4 conductor layers on sub-7nm fabrication technology, 0-20 GHz extraction range



## / Accelerate Circuit Simulation Using the Most Appropriate Model Format

RaptorH generates passive, causal models in S-parameter format (for AC, harmonic-balance, and SP analyses) and rational function models (RFM) format suitable for transient, shooting, and noise analyses. Accelerate your circuit simulations and sign off your designs with the electromagnetic fidelity of RaptorH. Circuit simulation is no longer a challenge when you use RaptorH.

## / Interactive and User Friendly

Ansys RaptorH's GUI allows a point-and-click-based net selection process and can use existing layout pins and labels. It can easily add or exclude nets for debugging circuits with "what-if" analysis and for the evaluation of crosstalk among blocks. RaptorH also supports batch runs for routine jobs.

## / Compatible with All IC Design Platforms and Flows

Ansys RaptorH seamlessly interfaces to all leading EDA platforms, offering user-friendly point-and-click net selection, automatic recognition of ports, and definition of the extraction settings on a per net and/or per metal basis.

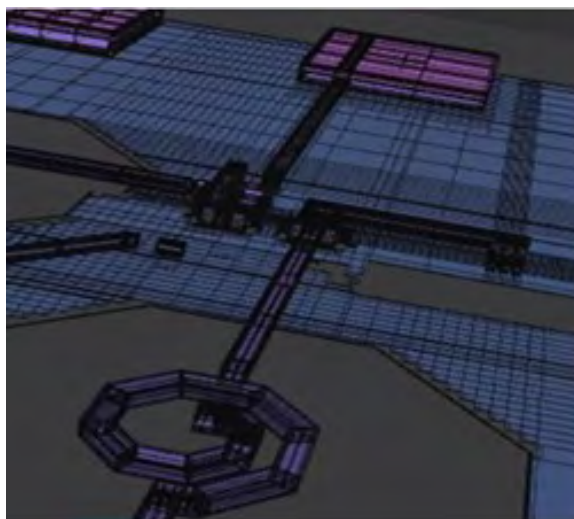


Figure 8: Mesh of RF circuit as produced by the RaptorX electromagnetic solver



## / Certified by Major Foundries for 2.5D/3D Integrated Circuits and Systems

Ansys RaptorH is continuously certified upon key releases and key advancements in silicon technologies. It has been certified by major foundries like Samsung and TSMC for developing advanced systems-on-chip (SoC) and 2.5D/3D integrated circuits.

- Samsung Foundry Certifies Ansys RaptorH for Countering Electromagnetic Effects in 2.5D/3D Integrated Circuits and Systems. [Click Here](#)
- Realtek and Ansys Accelerate Complex IC Design for RFIC & High-Speed IC with Advanced Simulation Workflow. [Click Here](#)
- Ansys Multiphysics Solutions Certified by TSMC for High-Speed Next-Generation 3D IC Packaging Technologies. [Click Here](#)

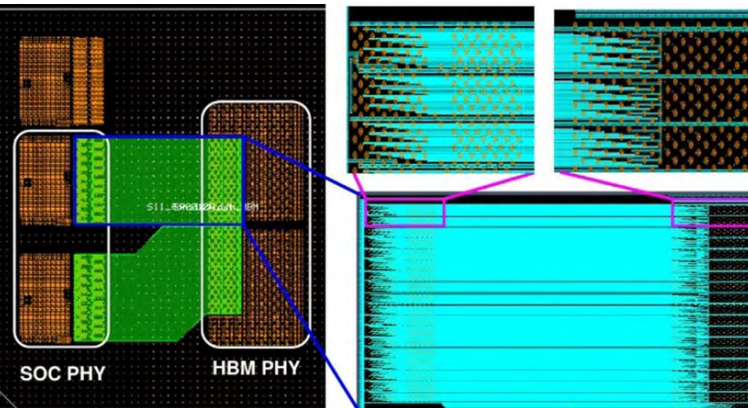


Figure 8: Mesh of RF circuit as produced by the RaptorX electromagnetic solver

## / Fundamental Block of the Ansys On-chip SI Flow for High-speed SoCs and 3D-ICs

Signal Integrity in advanced nanometer CMOS and 3D-ICs presents key challenges to existing solutions. Due to the high complexity of the system that skyrockets at the die level, different components are traditionally modeled and simulated separately, ignoring key interactions and critical electromagnetic coupling that compromise their performance. Signal integrity issues that are not properly taken into consideration early in the design cycle due to the lack of a consistent SI analysis flow will cause products to malfunction and require re-spins that raise the overall cost and delay production.

Ansys RaptorH, with its unrivaled accuracy, capacity, and speed, is an integral part of the Ansys on-chip signal integrity (SI) flow for high-speed SoCs and 3D-ICs and substantially expedites the advancement of state-of-the-art artificial intelligence (AI), high-performance computing (HPC), and 5G semiconductor designs.

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