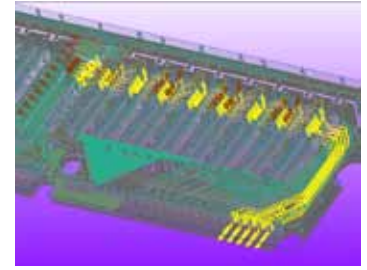


Realize Your Product Promise™

ANSYS

SIwave



SIwave is ideal for solving signal integrity, power integrity and EMI. Highlighted is a byte from a DDR3 DIMM module.

Perform complete channel analysis, quickly and accurately, with ANSYS 3-D EM simulation tools.

ANSYS SIwave builds in leading hybrid solver technology with a wide array of advanced features to thoroughly analyze your planar designs.

Successful first-pass PCB, package and IC design requires accurate electromagnetic (EM) frequency and time-domain analyses — for the entire PCB or IC package as well as any packages merged on the board. Without a thorough 3-D EM simulation tool, designers get only part of the signal story. ANSYS SIwave™ evaluates the entire design,

from package to board, including the coupling effects between traces, packages and boards. Emulating real-world conditions, SIwave quickly and accurately analyzes signal and power integrity of the entire PCB — from DC up to frequencies beyond 50 GHz.

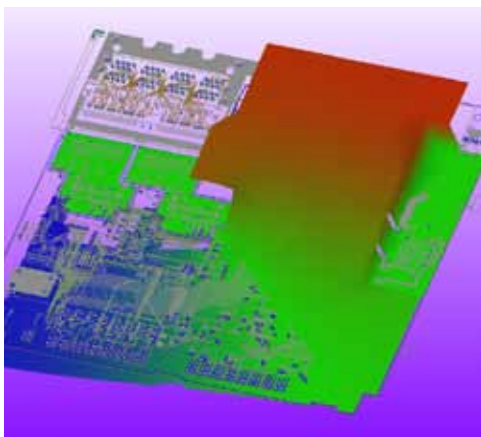
Unless you understand the complete EM environment, you cannot accurately predict how the system or subsystem will perform in the field,

or how performance might be affected by any physical structures on the PCB. SIwave addresses the challenges of designing planar EM structures by identifying signal- and power-integrity problems — challenges that can easily throw off tight design cycles — leading to more successful first-pass designs.

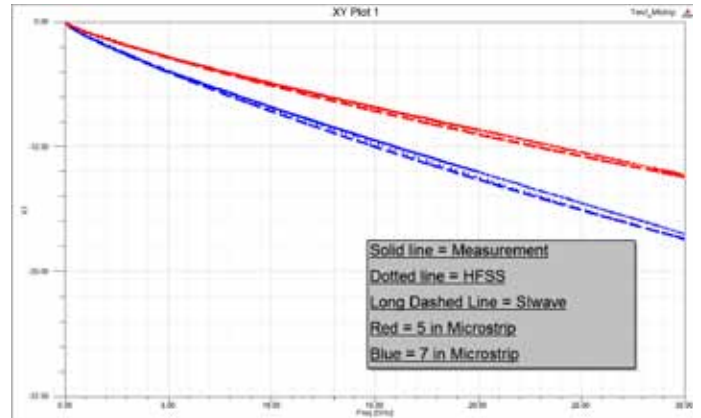
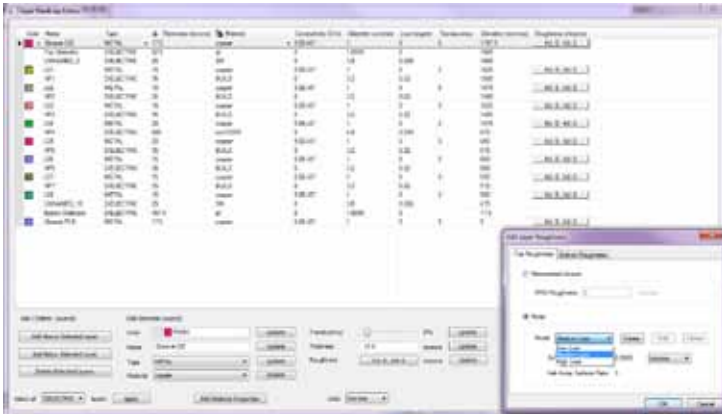
SIwave's distinct advantage is its use of hybrid field solver technologies to provide frequency- and time-domain analyses in planar structures. Our product uses the PCB or package's physical stackup and geometry when performing a simulation, and you can directly import layout data from a variety of commercial ECAD packages. As a result, SIwave extracts frequency-dependent circuit models of signal nets and power distribution networks based on the precise physical dimensions and characteristics of the structure being investigated, providing the highest fidelity solution possible.

With SIwave's advanced features, you can identify and resolve signal- and power-integrity problems — all before hardware prototyping. In addition, SIwave's IC die network modeler allows you to include first-order silicon effects for a complete channel description. Available RedHawk™ die models from Apache (an ANSYS subsidiary) enable analysis of dynamic switching effects.

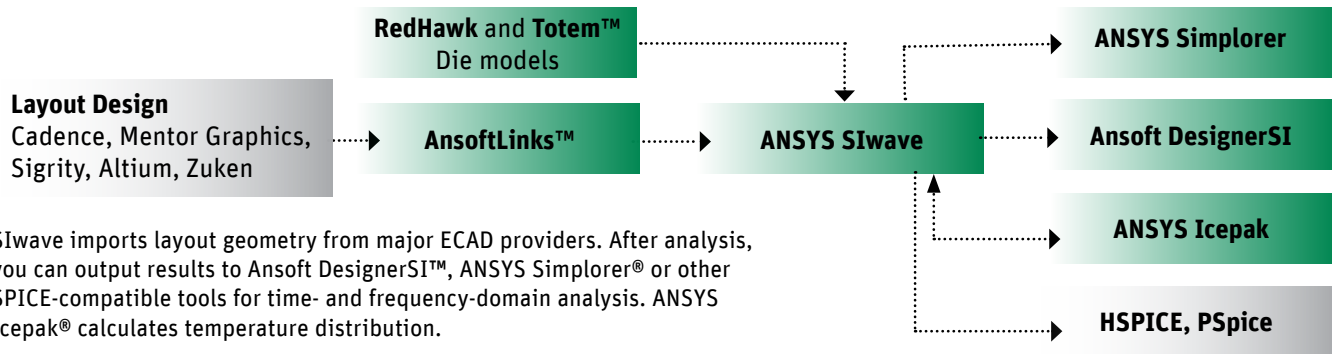
With an easy-to-use interface and proven accuracy, engineers can translate concepts into product designs quickly and easily with SIwave. You can be confident of achieving superior simulation accuracy for planar design.



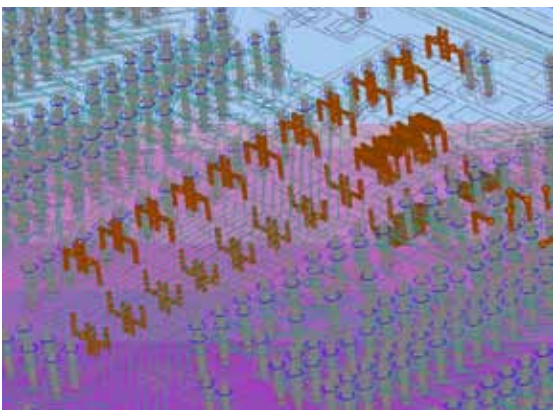
SIwave performs resonance mode analysis used to determine impedance variations between planes of a PCB.



SIwave's stackup editor includes the Huray surface roughness capability.



SIwave imports layout geometry from major ECAD providers. After analysis, you can output results to Ansoft DesignerSI™, ANSYS SImplorer® or other SPICE-compatible tools for time- and frequency-domain analysis. ANSYS Icepak® calculates temperature distribution.



With SIwave, you can solve S,Y and Z parameters from vias, ports, capacitors and inductors.

SIwave provides powerful modeling capabilities for comprehensive PCB and package analysis



Easy Layout Extraction

SIwave extracts complete designs (which include multiple arbitrarily shaped power/ground layers, vias, signal traces and circuit elements) with unprecedented accuracy and speed from

commercial ECAD software, without requiring time-consuming manual layout partitioning.

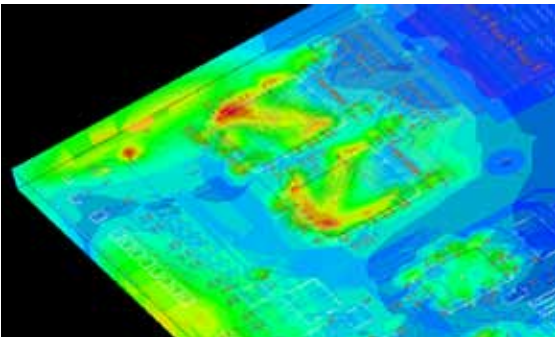
Specifically, SIwave extracts S, Y and Z parameters as well as IBIS interconnect models (ICM). Then, the tool displays

3-D EM fields and generates ANSYS Full-Wave SPICE™ models for subsequent time- and frequency-domain analyses within DesignerSI, DesignerRF™, Simplorer or third-party SPICE-compatible circuit tools (including Synopsys® HSPICE® and Cadence® PSpice®).

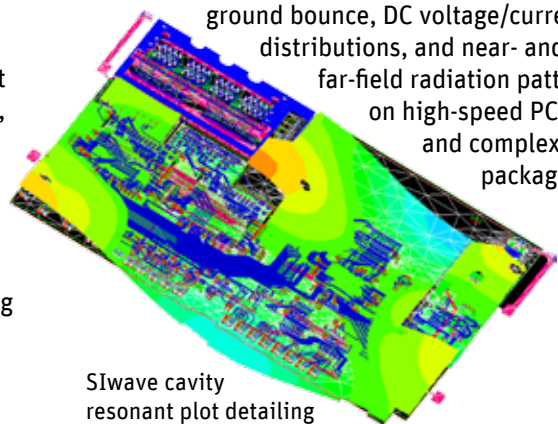
a transient simulation directly in SIwave using HSPICE or ANSYS Nexxim®. You can import the resulting SYZ networks or Full-Wave SPICE models into SPICE-compatible circuit tools, such as DesignerSI, DesignerRF and Simplorer.

Signal- and Power-Integrity Analysis

SIwave employs specialized full-wave finite element algorithms to compute resonances, trace characteristics (including Z_0 , T_d , R, L, C and G), discontinuity reflections, inter-trace coupling, simultaneous switching noise, power/ground bounce, DC voltage/current distributions, and near- and far-field radiation patterns on high-speed PCBs and complex IC packages.



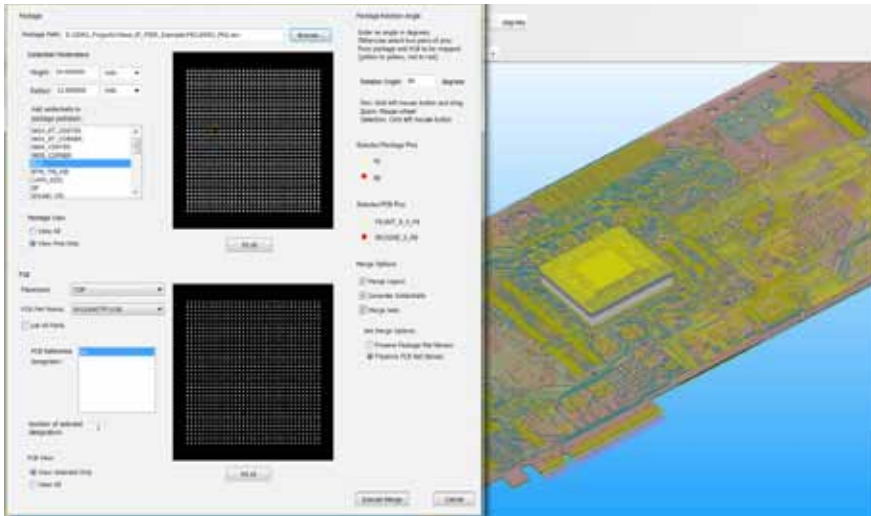
Prediction of EMI on a dual-processor quad-core PCB. Plot depicts near-field magnetic field at 778 MHz.



SIwave cavity resonant plot detailing potential difference (voltage) between 1.8V DC plane and ground including all parasitics. Colors indicate a resonance yielding voltage differences between Vdd and ground, and the FEM mesh is depicted by white triangles.

Design Automation

SIwave seamlessly integrates your existing design flow by importing geometries directly from manufacturing-standard or EDA layout tools. After solving the imported structure, you can perform

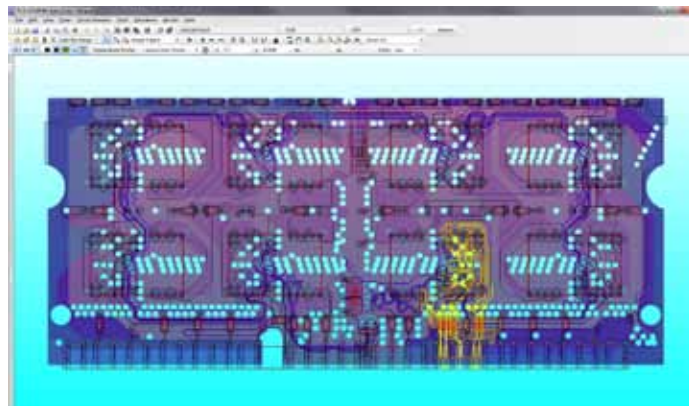


Users can easily merge electronic package models to a PCB.

To achieve the highest fidelity results possible, our software includes modeling capabilities for trapezoidal and hexagonal trace cross sections, frequency-dependent materials, and highly accurate surface-roughness models. For advanced analysis, SIwave incorporates built-in capacitor libraries; it can import measured S-parameter datasets.

Layout Editor for PCBs and Packages

Even with embedded sophisticated solvers, SIwave has an intuitive, easy-to-use interface that allows you to quickly and easily create or manipulate layouts. The interface gives you access to trace drawing utilities, padstack editors, and standard JEDEC bondwire, non-standard bondwire, and solderball and bump creation utilities. You can easily place sources, circuit elements and probes anywhere on a PCB or package. The pin grouping utility sources multiple pins simultaneously. This combination of functionalities decreases setup complexity when performing complicated full PCB or package-level simulation.



SIwave's easy-to-use interface enables designers to analyze complex PCB designs.

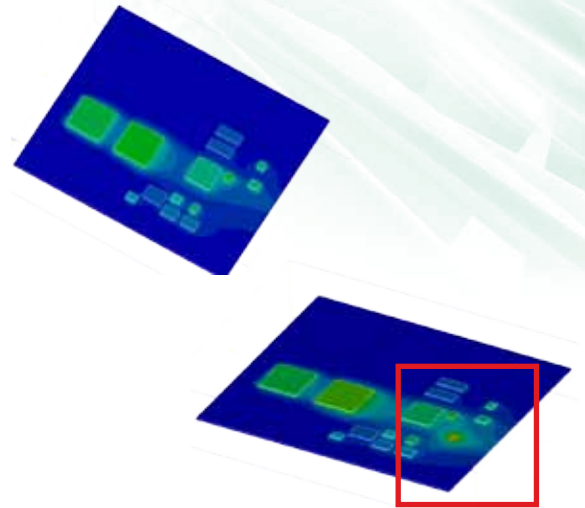


Integrated DC Voltage, Current and Power-Loss Computation Module

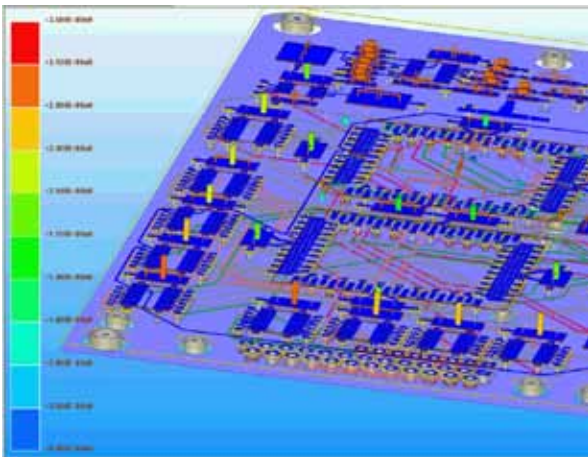
Using an adaptive mesh refinement procedure, SIwave enables you to perform pre- and post-layout DC voltage drop, DC current density, and DC power density analyses. These ensure that a given power distribution network (PDN) can source the power required by integrated circuits.

You can combine this feature with ANSYS Icepak® to calculate the effect of DC current on the PCB's overall thermal characterization, an industry-leading capability that enables closed-loop simulation that takes into account the change in conductivity of copper as a function of temperature. The closed-loop calculation gives unprecedented insight into the thermal behavior of key PCB sections.

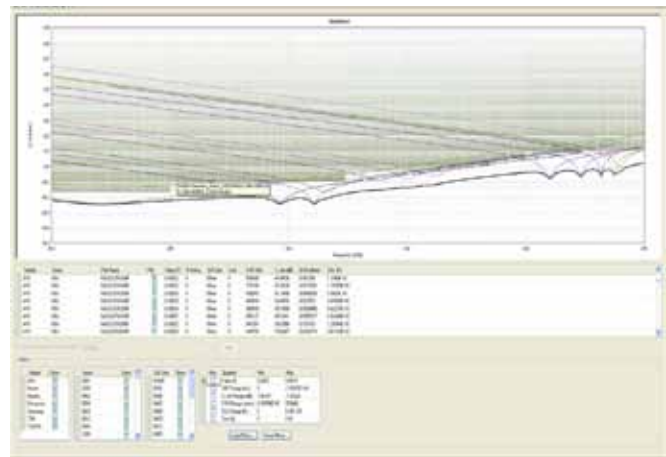
You can also employ SIwave to calculate whether or not the PDN has the proper copper weighting as well as the optimal bump, ball and pin sizes to minimize loss. The tool calculates loop resistance and generates a distributed resistive network in SPICE format.



Icepak simulation (above) performed without the heat distribution input from SIwave does not show any hotspot. Temperatures approaching 110 degrees C were revealed using the two programs coupled in a cosimulation (below).



SIwave plots loop inductance between observation point and all capacitors on voltage plane



PI Advisor's capacitor library explorer

SIwave PI Advisor

An optional tool is PI Advisor™, a full-wave electromagnetic field solver that automatically optimizes power distribution systems for packages and boards. You can develop smaller form factor and lower-cost solutions by applying PI Advisor throughout the design cycle, from pre-layout to production boards (post-layout).

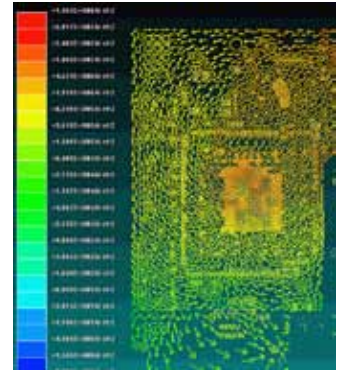
Our leading-edge technology simplifies power-integrity analysis via a unique genetic algorithm. As a result, it quickly determines the optimal capacitors using a lumped-circuit equivalent model for on-the-fly analyses.

The underlying engine allows you to specify various constraints — capacitor price, total number of capacitors, desired network impedance, etc. — for consideration in its cost function. PI Advisor utilizes accurate frequency-dependent S-parameter capacitor models during simulation. In addition, the full-wave SIwave extraction

engine captures the impact of capacitor physical location and mounting technique. Once optimization is completed, PI Advisor presents several decoupling schemes that meet your specified constraints.

A lumped analysis using PI Advisor provides you a quick calculation for determining capacitor values and placement. It is useful for developing the best-candidate capacitors for a given design.

PI Advisor incorporates an easy-to-use capacitor library browser. All capacitor models provide measured data from manufacturers in the form of two-port Touchstone® models. For example, SIwave provides a library of low-leakage inductance capacitors from X2Y® Attenuators.



Specialized features address a wide range of design concerns, from near- and far-fields to trace characteristics to solution time.

EM Interference/Compatibility

You can apply SIwave for EMI/EMC testing for near- and far-field problems. By leveraging algorithms from ANSYS HFSS™, SIwave provides accurate, detailed descriptions of field interactions above and below boards and packages. When combined with resonant mode simulations, this feature predicts PCB field radiation patterns prior to manufacturing, thereby reducing the number of fabrication spins needed to meet emission standards.

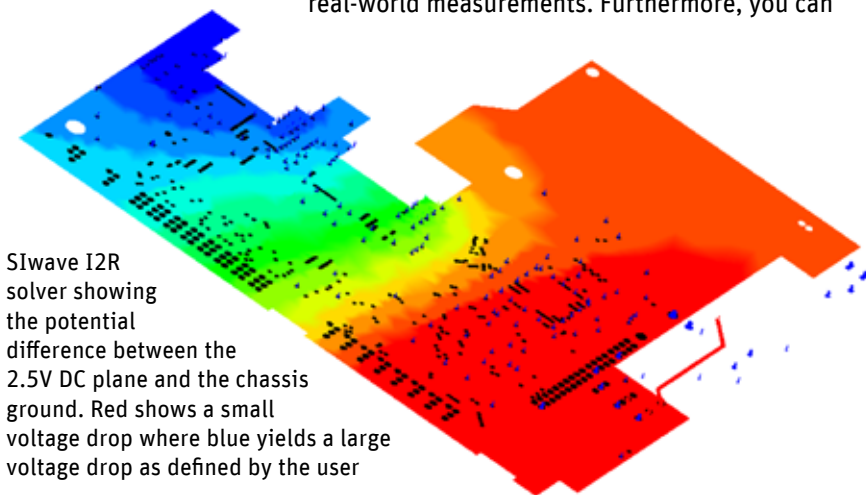
Our technology imparts valuable insight into the sources of EMI, which is not obtainable through real-world measurements. Furthermore, you can

quantify directional electric and magnetic fields with 3-D plotting mechanisms using $|E_{x,y,z}|$ and $|H_{x,y,z}|$. This feature ensures that any changes made will correct problems found during simulation testing.

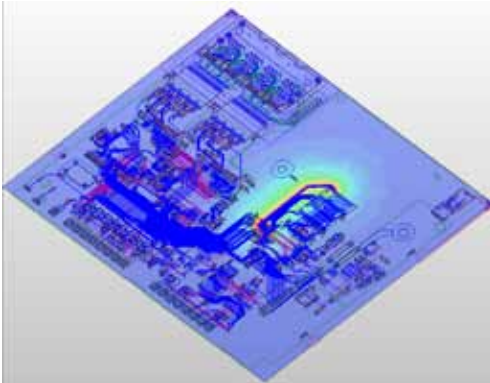
To maximize EMI/EMC result accuracy, you can couple SIwave with DesignerSI, DesignerRF and/or HFSS. The combined approach enables study of EMI/EMC emissions and issues as a function of data rate and bit shape.

Signal Net Analyzer

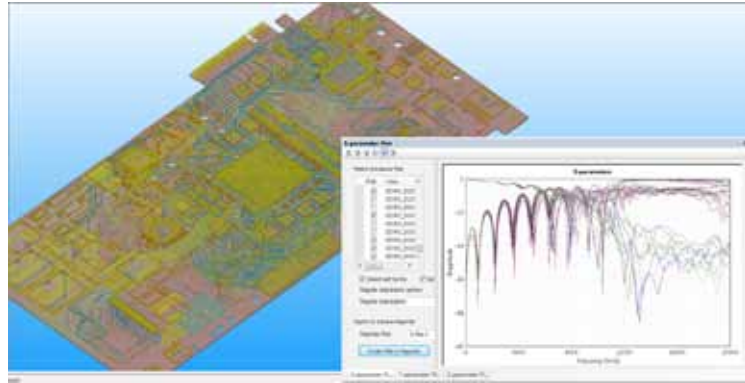
SIwave's signal net analyzer offers basic information for a given trace or traces on a PCB. With the click of a button, you can view trace characteristic impedance (Z_0), length, time delay and reference layer. (It can also use a non-ideal reference layer.) All possible paths — from each pin to every other pin — are displayed and sorted in order of path distance. Signal net analyzer rapidly performs a transient simulation using Nexxim or HSPICE with a user-specified input pulse, which quickly outputs the time-domain behavior of a given signal channel or trace.



SIwave I2R solver showing the potential difference between the 2.5V DC plane and the chassis ground. Red shows a small voltage drop where blue yields a large voltage drop as defined by the user



Near-field EMI plot of DDR signal line



Insertion and return losses on Xilinx FPGA board solved by SIwave

Macro Modeling

SIwave delivers an unprecedented level of 3-D EM simulation accuracy for complete board and package designs. You can achieve full-channel transient simulation in multiple circuit simulator platforms. Patent-pending Tsuk-White algorithm (TWA) technology makes it possible to check and enforce passivity and causality across PCBs, ICs and packages. This unique technology eliminates errors that are frequently introduced when simulating time-domain circuit analyses using different simulation platforms.

SIwave is engineered to be a part of the design flow, supporting SPICE-level models using HSPICE and PSpice syntax along with native Nexxim and Simplorer state-space models.

Automated DC IR Reporting

A number of features enhance the user experience and reduce the amount of time required for post-processing data. The automated DC IR reporting

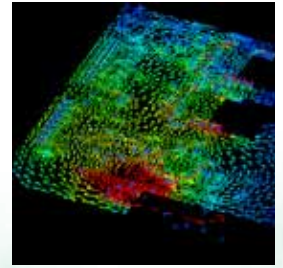
feature, for example, automatically creates output tables that contain stackup information, current and voltage sources, and DC current and voltage plots.

Automated Validation Checking and Correction

Number-validation checking routines ensure that imported ECAD data is ready to be simulated. Before running a simulation, SIwave checks for a variety of common errors that can occur during the layout process, such as self-intersecting polygons, overlapping vias, bondwire collisions or illegal connections, shorted or disjointed nets, and misaligned or unreferenced traces.

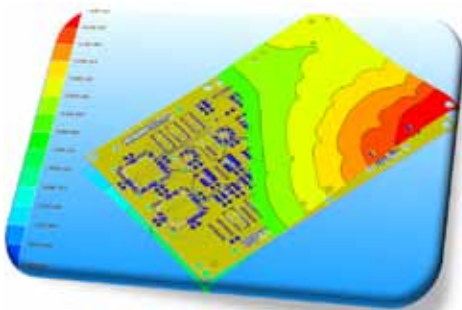
High-Performance Computing

SIwave solver capabilities make use of multiple threads, cores and processors while performing a simulation, converging large simulations with shorter solve times. This automatic parallelization helps engineers achieve fast signal-integrity, power-integrity and EM-interference simulations.



ANSYS SIwave leverages the complete ANSYS portfolio for thermal distribution and optimization.

SIwave and related electromagnetics tools are one part of our suite that delivers state-of-the-art functionality — depth, breadth, a plethora of advanced capabilities and integrated multiphysics — providing confidence that your simulation results reflect real-world outcomes. The comprehensive range of solutions provides access to virtually any field of engineering simulation that a design process requires. Organizations around the world trust ANSYS to help them realize their product promises.



Preparing Layout and Geometry

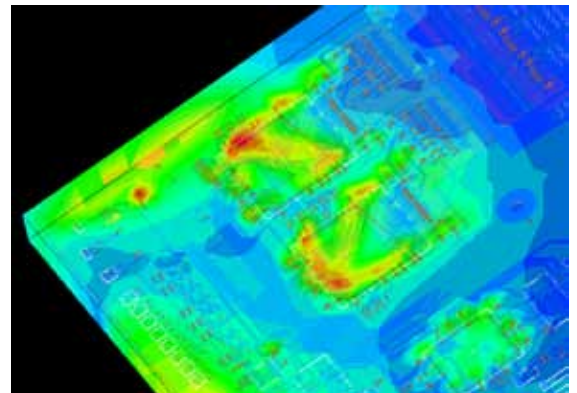
With the addition of AnsoftLinks for ECAD, SIwave integrates tightly with layout design tools from Cadence, Mentor Graphics®, Sigrity, Altium and Zuken™.

Multiphysics Simulation

Current flow and thermal analysis simulations once performed separately can be combined in a multiphysics-based board-level electrothermal cosimulation via linkage between SIwave and ANSYS Icepak. The solvers work together as next-generation tools that enable engineers to accurately predict heat distribution and temperature in complex circuit boards.

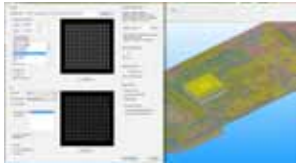
Systems-Level Integration

SIwave forms an integral part of a system solution that involves circuit and PCBs/packages. You can analyze these with SIwave, then merge them into an overall circuit or system model. The end result is a unique system simulation in which system performance is reliant on physics-based models.



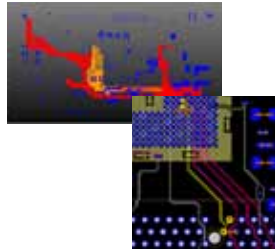
ANSYS SIwave

Modeling



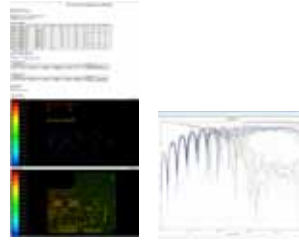
AnsoftLinks can import ECAD geometry from Cadence, Mentor Graphics, Sigrity, Zuken, Altium

Solvers



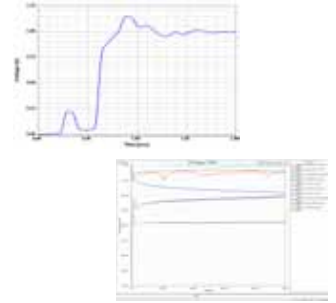
Signal integrity (top) and power integrity (bottom) EMI

Post-Processing



S, Y, Z plot; automated DCIR reporting; signal net analyzer

Circuit Simulation



Frequency- and time-domain analysis can be performed in DesignerSI, Simplorer, HSPICE and PSpice using SIwave results.

Pre-Processing

Simulation

Post-Processing

Archive

Other ANSYS Engineering Simulation Capabilities

ECAD



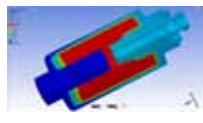
The ANSYS suite provides modeling and geometry creation functions as well as tools for importing ECAD data from various sources. In addition, we collaborate with leading ECAD developers to ensure an efficient workflow.

Integration



ANSYS Workbench is the framework for the industry's broadest and deepest suite of advanced engineering simulation technology. It delivers unprecedented productivity, enabling Simulation-Driven Product Development™.

Multiphysics



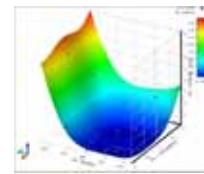
To help ensure a successful product, R&D teams must accurately predict how complex products will behave in a real-world environment. The ANSYS suite captures the interaction of multiple physics: structural, fluid dynamics, electro-mechanics and systems interactions. A single, unified platform harnesses the core physics and enables their interoperability.

HPC



High-performance computing enables creation of large, high-fidelity models that yield accurate and detailed insight. ANSYS offers scalable solutions and partners with hardware vendors to ensure that you get the power and speed you need.

Design Optimization



Good design starts with identifying the relationship between performance and design variables. ANSYS design exploration tools enable engineers to perform design of experiments (DOE) analyses, investigate response surfaces and analyze input constraints in pursuit of optimal design candidates.

Data Management



ANSYS EKM™ addresses critical issues associated with simulation data, including backup and archival, traceability and audit trail, process automation, collaboration and capture of engineering expertise, and IP protection.

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ANSYS is dedicated exclusively to developing engineering simulation software that fosters rapid and innovative product design. Our technology enables you to predict with confidence that your product will thrive in the real world. For more than 40 years, customers in the most demanding markets have trusted our solutions to help ensure the integrity of their products and drive business success through innovation.

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