Celsius Thermal Solver

A complete electrical-thermal co-simulation technology for IC packages, PCBs, and systems

The Cadence® Celsius™ Thermal Solver is the first thermal analysis technology designed for both the electrical and mechanical engineer. Electrical engineers can extend power integrity analysis to include fast, accurate, and easy-to-use thermal simulations, while mechanical engineers can expand their existing thermal analysis methodology, including realistic heat sources resulting from electrical-thermal interaction.

The Celsius Thermal Solver environment enables all aspects of thermal analysis to quickly and accurately identify thermal problems in IC packages, PCBs, and electronics systems. It features an innovative massive parallel solver technology that enables simulation speeds up to 10 times faster than conventional thermal simulators, with significantly reduced memory usage. It includes a powerful finite element analysis (FEA) field solver to analyze both transient and steady-state and heat conduction in complicated solid structures and utilizes a computational fluid dynamics (CFD) engine for convection and radiation heat transfer analysis.

Electrical-thermal co-simulation is implemented to accurately simulate interrelated electrical-thermal effects. The unified environment also includes 3D Workbench—a mechanical 3D CAD graphical user interface (GUI)—to create, edit, and import 3D designs and to incorporate advanced adaptive meshing capabilities. Targeting both pre-layout design and post-layout verification, the Celsius Thermal Solver approach enables users to quickly develop their product's thermal management system and identify hot spots and thermal stress-related issues that are among the leading field failure risks in electronic systems.

Benefits

- Avoid costly implementations, engineering delays, product iterations, and field failures
- Remove late-stage design iterations with the mechanical engineering team by enabling electrical engineers to perform thermal simulations early in the design phase
- Improve efficiency and communication between electrical and mechanical engineering teams
- Provide conclusive thermal analysis capabilities for chip, package, PCB, and electronic systems
- Accelerate product development with thermal simulations with near-linear scalability in speed enhancement and memory reduction
- Improve product reliability with fast and accurate transient simulations of the product using realistic power profiles

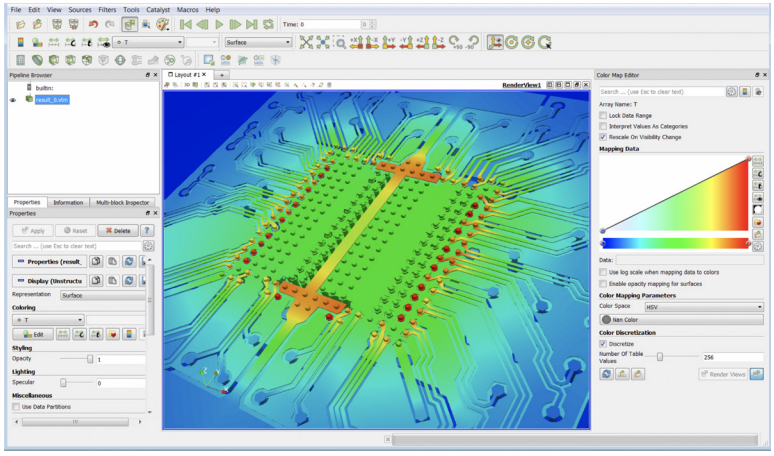

Figure 1: The Celsius Thermal Solver graphical interface.

- Locate temperature hot spots to avoid the risk of failure
- Identify potential reliability issues due to thermal stress and strain in solid materials with different coefficients of thermal expansion
- Avoid design re-spins with transient electrical-thermal co-simulations to accurately identify temperature and current density issues in 3D components such as packages, bonding wires, connectors, and transitions of connectors to the PCB
- Improve product design with what-if analysis using 3D Workbench's parameterization and user-defined equation expressions to easily edit, modify, and optimize mechanical structures

Features

Massive parallel computational solver

In performing computational simulation, traditionally large structures are either greatly simplified or cut up into smaller structures for analysis using the largest and most powerful computing resources. In contrast, the massively parallel computational solver equipped in the Celsius Thermal Solver is designed from the ground up to take advantage of multi-core compute resources by parallelizing the mathematical tasks required to solve for 3D structures. The tasks can be parallelized within one computer's cores or across multiple computers, cutting the time to solve for complex structures up to 10X and even more.

This industry-leading parallelization technology ensures that both meshing and physical structures can be partitioned and parallelized across as many computers, computer configurations, and cores as are available. The amount of time required to solve is scalable based on the number of computer cores. If a user can double the number of computer cores, performance will be nearly doubled as well. In addition, the memory usage per machine for computing is accordingly scaled down with the increase in the number of computer cores.

3D FEA field solver

The 3D FEA field solver provides accurate thermal conduction analysis and electrical simulation for arbitrary 3D structures, such as complicated packages with bumps or bonding wires, connectors, and transitions of connectors to the PCB. Powerful 3D thermal distribution analysis is combined with 3D electrical simulation in an automated environment for true electrical-thermal co-simulation that iterates on the vital interactions between temperature and current flow. This maximizes accuracy and considers full effects, such as the increasing electrical resistance that occurs at higher operating temperatures. This unified environment makes it easy to confirm the design has met specified temperature, voltage, and current density thresholds.

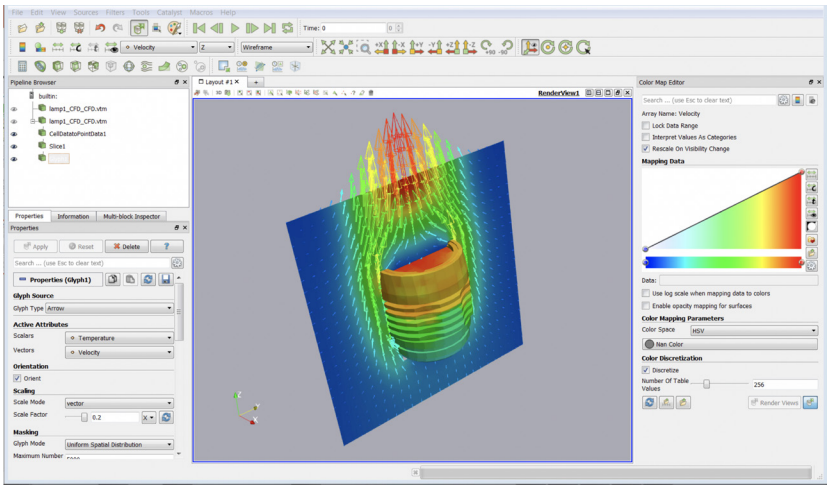

Figure 2: Modeling of convection and airflow.

2.5D FEA field solver

The 2.5D FEA field solver is a great option to quickly and accurately simulate thermal conduction in 3D planar layered structures, such as in packages and PCBs with multiple layers and interconnect vias. Thermal results, such as temperature, heat flux, conductivity, fusion current density, and mean time to failure, are graphically displayed in 2D plots to quickly identify problem areas. 3D distribution plots for temperature and heat flux are also available with *x*, *y*, and *z* slice plane options to provide further insight into the thermal response of the system. Cadence Sigrity™ PowerDC™ project files can also be directly imported into the 2.5D FEA field solver for further analysis.

CFD solver

CFD is a powerful analysis tool used to analyze fluid flow convection, conduction, and radiation heat transfer in systems. Systems with chassis and ventilation hole openings are easily simulated in natural convection or forced convection environments. Heat transfer coefficients can be extracted from the CFD simulations and used in both 2.5D and 3D FEA field solvers to account for air and other fluid flow effects over solid surfaces. The CFD solver can also perform fluid extraction of the airflow environment and the solid interfaces into thermal model boundary impedances for fast thermal simulations.

3D workbench

The Celsius Thermal Solver environment incorporates a 3D mechanical CAD GUI for creating, editing, and importing 3D solid models for electrical-thermal analysis. You can bring in design data from popular MCAD formats, such as ACIS, IGES, and STEP, as well as Cadence Allegro® and Sigrity formats. 3D components are easily created with parameterization and equation expressions to allow for modeling flexibility and simulation optimization. 3D CAD geometry problems and misalignment errors can be quickly repaired with the 3D Workbench model clean-up functions.

The advanced adaptive meshing algorithms allow you to automatically generate accurate meshes for intricate 3D components to large complex electronic systems with enclosures.

Thermal stress and strain

Designs today often include multiple different materials in a system with their various coefficients of thermal expansion. When subjected to temperature change, materials in the system experience different degrees of expansion and contraction, which can lead to product failures and/or reliability problems. The Celsius Thermal Solver accurately simulates thermal-induced stress and strain in solids, allowing you to pinpoint problem areas and avoid costly product reliability issues.

Operation Systems and Interface Databases

- Works with Microsoft Windows and Linux
- Interfaces to PCB and IC package layout databases from Cadence, Mentor Graphics, Altium, Zuken, and AutoCAD

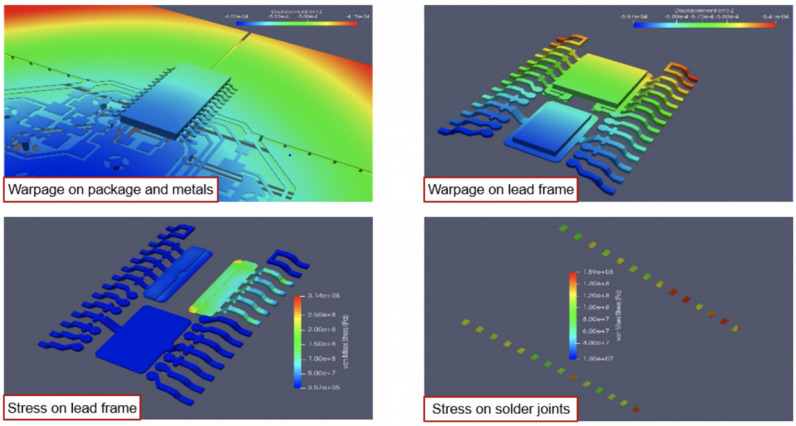

Figure 3: The Celsius Thermal Solver accounts for thermally induced stress.

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