Automated Transient Thermal Analysis with ANSYS Icepak and Simulor Using EKM

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Overview

- Power Map Introduction
- Need for Chip-co Design Automation
- ANSYS solutions for Steady and Transient state
- Use Case Description for Transient state
  - Setup in Icepak
  - Setup in Simploter
  - Collaborative simulation using EKM
- Observations/Benefits
Introduction to Power map

Power map is a table of power values associated with respective locations on a chip.

Assumption of uniform power for silicon is a past approximation.

Current silicon needs demand non-uniform power.
Incepak

Computational Fluid Dynamics (CFD) code

Multi-mode heat transfer effects
  - Conduction
  - Convection
  - Radiation

Steady-state and transient

Single or multiple fluids

Volumetric resistances and sources for
  - Velocity and Energy

Joule Heating in tracers and conductors

Complex geometries
  - Round, Angled, Curved shapes require no approximations
Engineering Knowledge Manager (EKM)

DATA MANAGEMENT
- File Repository
- Meta-Data Extraction
- Advanced Search
- Data Mining
- Report Generation

PROCESS MANAGEMENT
- Automate Processes
- Manage Workflows
- Design Systems
- E-mail Notification
- Track Progress

ACCESS MANAGEMENT
- Enterprise Access
- Web Enabled
- Application Portal
- Job Submission

Current Thermal Management Process

Silicon Designer

EDA Software

Temperature map

Closure?

Iterative Process

Longer Design Cycles

Cooling roadmap

Thermal Software

Thermal Engineer

Power map
Collaborative Chip Design Solution

• *Single click quick solution* to Design Engineers for thermal evaluation of chip designs

• EKM based collaborative approach for steady and transient simulations
  – Steady State
    • Icepak for pre-characterization
    • Linear superposition computation for steady state
  – Transient
    • RC network generation for transient problems
    • Icepak and Simplorer based computation for transient results
  – It is assumed that the system is linear for both steady and transient simulations

Steady State Solution

Thermal/Mechanical Engineer

Library of custom applications deployed in ANSYS EKM

- Passive Heat sink Cooling (FPGA & ASICS)
- Active Heat sink Cooling (GPUs and CPUs)
- Liquid Cooling (High End GPUs & Supercomputer CPUs)

Chip Designer

Automatic Characterization Macro in Icepak

Power map

Chip Design software

Transient Solution

Thermal/Mechanical Engineer

- Library of custom applications deployed in ANSYS EKM
  - Passive Heat sink Cooling (FPGA & ASICs)
  - Active Heat sink Cooling (GPUs and CPUs)
  - Liquid Cooling (High End GPUs & Supercomputer CPUs)

Excitation Data

Chip Designer

- Icepak + Simplorer to generate RC network
- Liquid Cooling
- Passive Heat sink Cooling (FPGA & ASICs)
- Active Heat sink Cooling (GPUs and CPUs)

Use Case

Compact package model is considered for the analysis

Component Details
- 6 Dual Inline Packages
- 6 PBGA Packages
- 2 PQFP Packages
- TO Packages with Heat spreaders
- PCB

Boundary Conditions
- Opening with 1m/s velocity
- 4 PBGA packages with 1W power each
Work Flow

• Icepak
  – Identify the transient thermal elements in Icepak
  – Generate transient responses and simplorer input file

• Simplorer
  – Generate RC network in Simplorer

• EKM
  – Transfer RC networks to shared EKM repository
  – Using a template, run Simplorer to generate transient Thermal results
Work Flow

IC floor plan

ANSYS Icepak
Compute Step response matrix

Power input profile

Template schematic

ANSYS Simpler
Equivalent model computation based on step response matrix

Output:
Temperature response Vs time

ANSYS EKM
Collaborative Environment
Icepak setup

- Use Icepak parametric capability to generate transient responses for Simploter
- Each of the PBGA package is powered and simulation is performed for 50 seconds
- p1, p2, p3 and p4 is power associated with PBGA packages in the model
- Turn on “Write Simploter Files” option in Icepak
Icepak run generates

• Transient temperature response

• Simplorer input file
### Setup in Simplorer

- **Simplorer Circuit**: Add Icepack Component.
- **Specify the** `.simplinfo` **file provided from Icepak**, select Equivalent circuit model, select Non-Conservative. Click Generate to create the thermal model.
- **Specify the excitation profile files** as the input to the thermal model
Execute the analysis from EKM
# Thermal Results in EKM

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**Diagram:**

- **Temperature**
- **Simulation:** Simpler1

Benefits

• Icepak offers customized thermal management capability for Electronics simulation
• Unique connection with Simplorer for generating thermal models
• Fully Automated solution
• Shorter Design cycles, quicker turn around time
• Design and Thermal Engineer(s) can collaborate for what-if studies
• Past simulations and RC network data is stored centrally as a library and is accessible remotely
• Previous simulations can be re-used effectively
• Audit/Traceability for regulatory compliance
Thank You

Questions?