AUTOMATIC THERMAL CALIBRATION OF DETAILED IC PACKAGE MODELS

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Topics

- Motivation
- Calibration Process Comparison
- Automated Calibration Example
Model Calibration - Motivation

- Calibrating thermal models to match *transient* measurements is critically important for modern electronics thermal design.

- **Maximize Model Accuracy**
  - Calibrating all model aspects for all package time constants ensures the package will respond accurately for any steady state or transient application. Relying on single metric type data is not enough.
  - Vital to demonstrate this accuracy to ensure informed design decisions are made

- **Certified Supply Chain Models**
  - Provide simulation models that will respond correctly to any driving power profile.
  - Provide empirical evidence that this is the case.
Model Calibration Process Comparison

Historical Process

Initial model with best known values
Experimental Measurement → Model Setup and Initial Simulation → Engineering Guess and Simulation
Steady state at discrete points
Good Enough?

FloTHERM and T3Ster Automated Process

Initial model with range of somewhat known values
T3Ster Experimental Measurement → FloTHERM Model and Auto-Calibration Setup → FloTHERM Calibration and Optimization
Transient thermal response
Fully Calibrated
T3Ster: Experimental Measurement
T3Ster Measurement Output
T3Ster Structure Function

- T3Ster Master software converts the measured thermal response into a Structure Function. One way to interpret this is the RC path that the heat takes from the junction, through the device, and to the ambient.
Calibration Example

- A detailed FloTHERM model of the package was simulated in a virtual test environment with best known input values.
Quantifying Uncertainties

...And the range of somewhat known values

<table>
<thead>
<tr>
<th>Design Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Die Solder : Conductivity [W/mK]</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>Source : X Size [mm]</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Source : Z Size [mm]</td>
<td>8</td>
<td>11.5</td>
</tr>
</tbody>
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Calibration Interface

Important factors

- Import measurement data, define temperature to calibrate
- Specify/adjust design limits
- Verify measurement and analysis consistency
- Design Experiments
- Calibration extent
Design Of Experiments

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- Solder Thermal Conductivity
- Active Area X Size
- Active Area Z Size
Calibration Results
Response Surface Optimization Output
Result Comparison: Peak Temperature

80 ms Pulse

Max Temperature [°C]

Power [W]

Time [sec]

Calibrated
Uncalibrated
Result Comparison: Temperature Distribution

80ms Pulse, t: 20ms

Uncalibrated

Calibrated
Summary

- Correlating a model against transient measurements provides the most accuracy
- Structure functions help identify areas of inconsistency between the assigned model values and measurement results
- Automating calibration provides for a repeatable and scalable process
- Thanks!