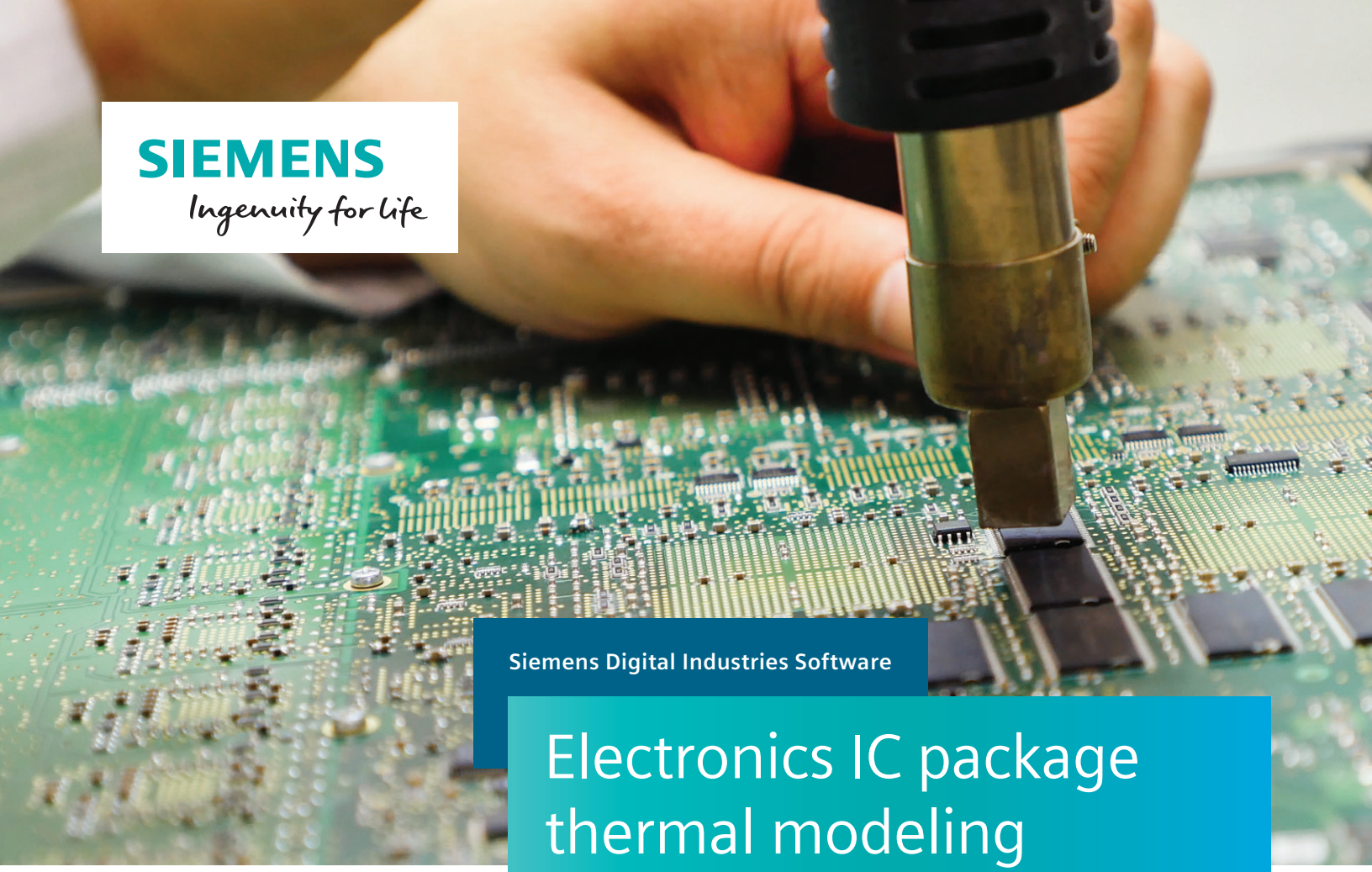

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Electronics IC package thermal modeling

ROHM uses Simcenter solutions to develop dynamic compact thermal models

Executive summary

It is commonly accepted that two of the trends in the electronics industry are miniaturization and the electrification of all things. As a result, electronics today are deployed in dynamic and sometimes harsh environments. As the environments have changed, so have the requirements for the system integrators. Today, companies need integrated circuit (IC) package models that can accurately predict dynamic thermal performance.

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Abstract

Currently, there is no standardized methodology for developing a dynamic compact thermal model (DCTM), though there are important elements that exist. At ROHM Semiconductor Co., Ltd., well-established standards and processes have been extended to meet the needs of their customers. ROHM is able to provide validated DCTM models that facilitate more robust designs in a shorter amount of time. ROHM is coordinating with the Japan Electronics and Information Technology Industries Association (JEITA) to provide a standardized approach to DCTM development.

Measure and calibrate

The initial step in the process is to accurately measure the transient behavior of the IC device to calibrate a detailed thermal model. Simcenter™ T3STER™ hardware thermal tester and Simcenter Flotherm™ software from Siemens Digital Industries Software were used to measure and calibrate the thermal model. Figure 1 compares the structure function of the measured device with the Simcenter Flotherm analysis model. The structure function is derived from the transient thermal measurement and represents the thermal resistances and capacitances along the heat flow path. A model calibrated against the structure function is valid for any transient scenario.

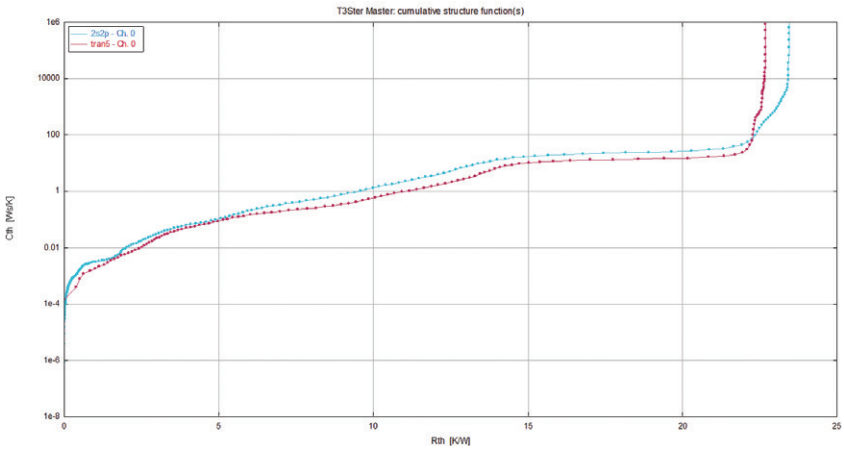

Figure 1: Comparing structure function IC models.

DELPHI compact thermal model

Though the detailed model provides value to ROHM Semiconductor for internal design processes, it doesn't represent the preferred method for use in system-level thermal design. Detailed IC models represent a significant computational expense and also expose internal packaging details. The calibrated detailed model was used to develop a DELPHI compact thermal model (CTM). Simcenter Flotherm PACK software was used to develop the DELPHI model from the calibrated detailed model. Figure 2 shows the DELPHI resistor network of the HTSSOP-B24 with the node locations shown in figure 3.

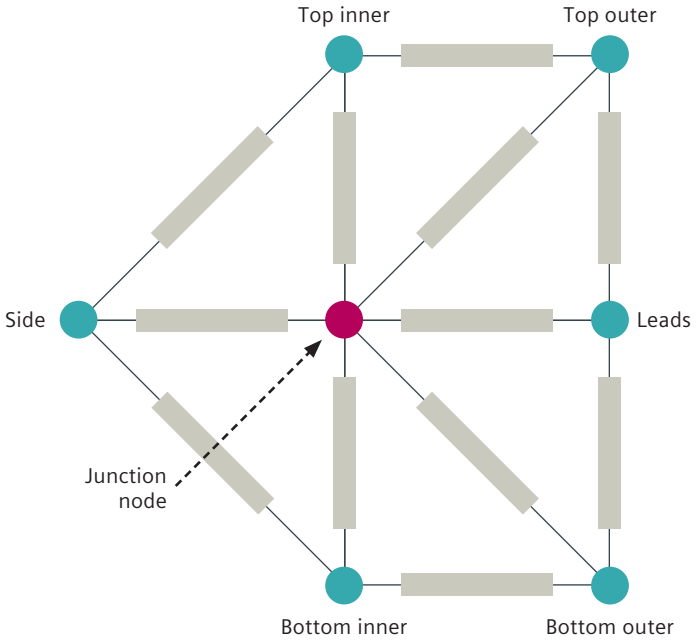

Figure 2: DELPHI resistor network of an IC model.

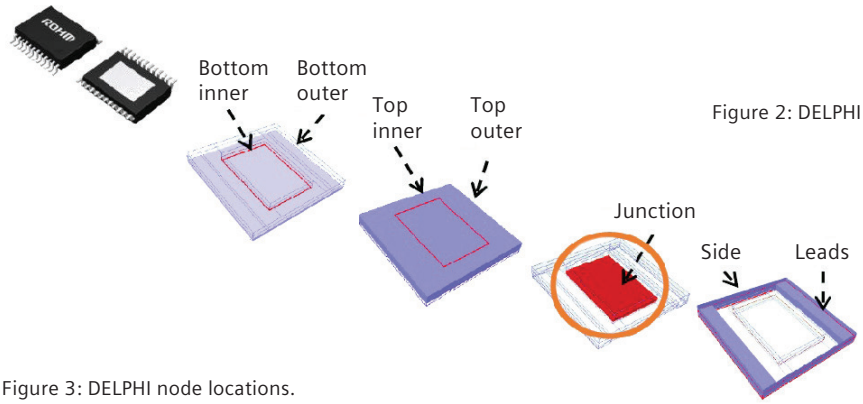

Figure 3: DELPHI node locations.

Modified DELPHI CTM development

The DELPHI CTM was tested in an environment and it was determined that representing the die with one node wasn't sufficient to capture the local heating present on the die. A modification to the network was made as shown in figure 4. With the additional resistors the error in junction temperature prediction was reduced from 33 percent to within 1 percent.

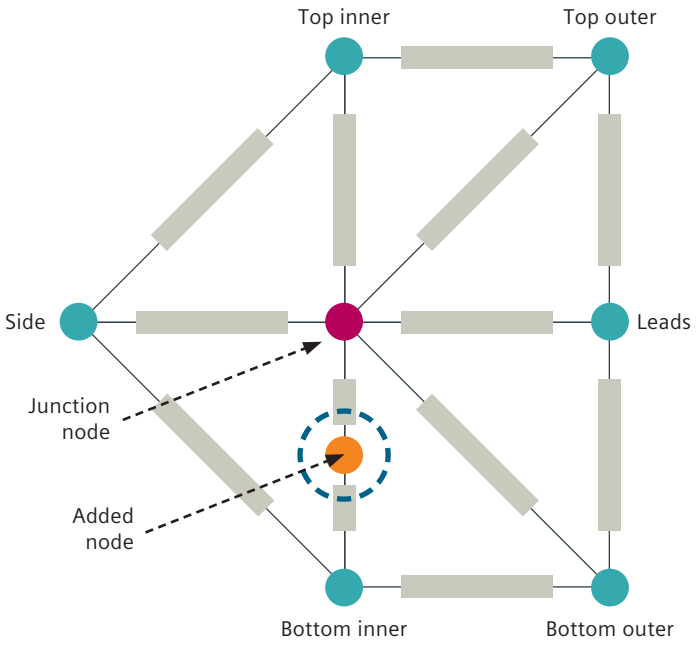

Figure 4: Modified DELPHI resistor network.

Modified DELPHI DCTM development

The final step in the development of the DTCM was to add capacitance to nodes within the network. Capacitance was added at the nodes, shown in figure 5, and were based on the physical properties on the detailed IC model.

A comparison of the transient response between the detailed thermal model and the modified DELPHI DCTM is shown in figure 6. Overall the correlation between the two is quite good with the DCTM junction temperature matching the detailed model at 2 percent difference at the end of the transient, or overall thermal resistance. The behavior of the temperature response during the transient is captured by the DCTM as well.

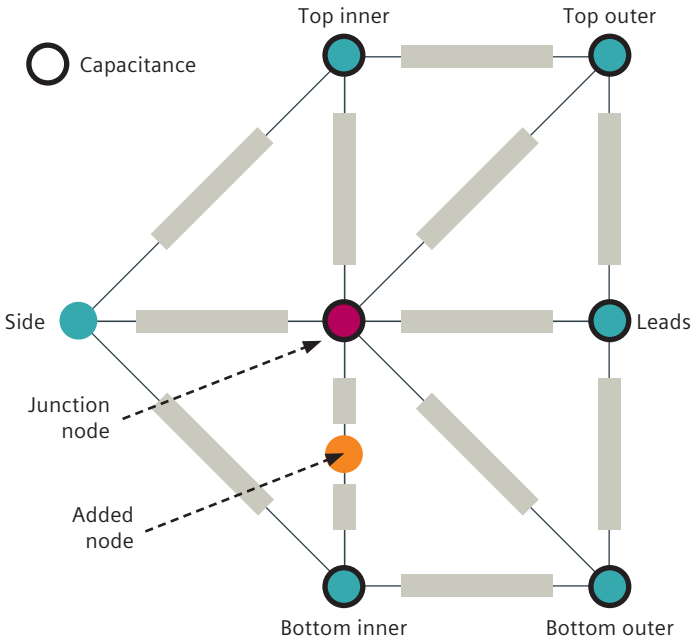

Figure 5: Modified DELPHI network capacitance.

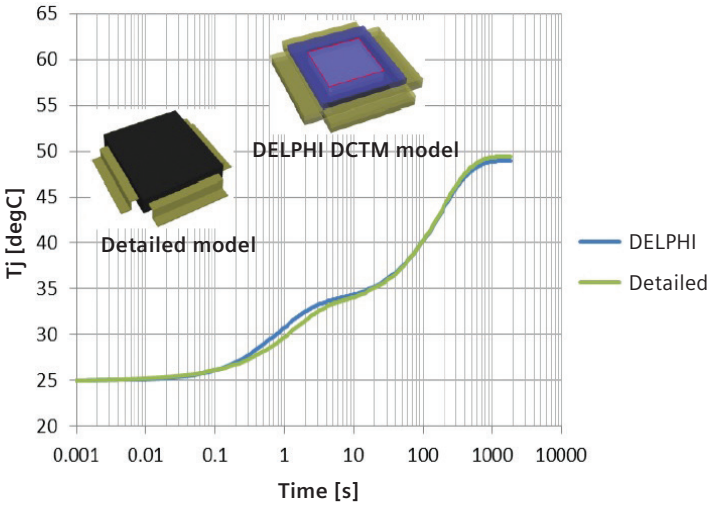

Figure 6: Junction temperature versus time comparison.

Conclusion

To design electronics for the dynamic world we must understand their dynamic behavior, and the IC component is an integral part of that. With Simcenter T3STER and the structure function, the transient response of IC packages can be accurately measured. The development of a DELPHI CTM is outlined using standards, with the first requirement being to start with a validated detailed model. Currently, there are no standards regarding the development of a DCTM. However, ROHM Semiconductor has implemented a process to develop a DCTM to a quantifiable degree of accuracy that allows their customers to design in a dynamic world. It is also used in a collaborative effort with JEITA to develop a standardized approach to DCTM development.

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About ROHM

ROHM Semiconductor is an industry leader in system LSI, discrete components and module products, utilizing the latest in semiconductor technology. ROHM's proprietary production system, which includes some of the most advanced automation technology, is a major factor in keeping it at the forefront of the electronic component manufacturing industry. In addition to its development of electronic components, ROHM has also developed its own production system so that it can focus on specific aspects of customized product development. ROHM employs highly skilled engineers with expertise in all aspects of design, development and production. This allows ROHM the flexibility to take on a wide range of applications and projects and the capability to serve valuable clients in the automotive, telecommunication and computer sectors, as well as consumer OEMs.

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