

JEDEC STANDARD

DELPHI Compact Thermal Model Guideline

JESD15-4

OCTOBER 2008

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION



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Published by
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DELPHI COMPACT THERMAL MODEL GUIDELINE

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DELPHI COMPACT THERMAL MODEL GUIDELINE

(From JEDEC Board Ballot JCB-08-26, formulated under the cognizance of the JC-15.1 Committee on Thermal Characterization.)

1 Scope

This guideline specifies the definition and lists acceptable approaches for constructing a compact thermal model (CTM) based on the DELPHI methodology.

The purpose of this document is twofold. First, it aims to provide clear guidance to those seeking to create DELPHI compact models of packages. Second, it aims to provide users with an understanding of the methodology by which they are created and validated, and the issues associated with their use.

The scope of this document is limited to single-die packages that can be effectively represented by a single junction temperature.

The scope of the current document is also limited to steady state compact models. Dynamic compact models (which are necessary for simulating time-dependent behavior) are not covered.

Boundary condition independence is a measure of the predictive capabilities of the model in application-specific environments.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

1. JESD51, *Methodology for the Thermal Measurement of Component Packages (Single Semiconductor Device)*, Dec. 1995.
2. JESD51-2, *Integrated Circuits Thermal Test Method Environmental Conditions – Natural Convection (Still Air)*, Dec. 1995.
3. JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*, Aug. 1996.
4. JESD51-5, *Extension of Thermal Test Board Standards For Packages With Direct Thermal Attachment Mechanisms*, Feb. 1996.
5. JESD51-6, *Integrated Circuit Thermal Test Method Environmental Conditions - Forced Convection (Moving Air)*, March 1999.
6. JESD51-7, *High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*, Feb. 1999.
7. JESD51-8, *Integrated Circuit Thermal Test Method Environmental Conditions – Junction-to-Board*, Oct. 1999.

2 Normative references (cont'd)

8. JESD51-9, *Test Boards for Area Array Surface Mount Package Thermal Measurements*, July 2000.
9. JESD51-10, *Test Boards for Through-Hole Perimeter Leaded Package Thermal Measurements*, July 2000.
10. JESD51-11, *Test Boards for Through-Hole Area Array Leaded Package Thermal Measurement*, June 2001.
11. JESD15, *Thermal Modeling Overview*.
12. JESD15-1, *Compact Thermal Modeling Overview*.
13. JESD15-2, *Terms and Definitions for Modeling Standards*¹.
14. JESD15-3, *Two-Resistor Compact Thermal Model Guideline*.

3 Definition of the DELPHI compact model

3.1 Overview

The DELPHI methodology was developed by the DELPHI Research Consortium, which completed a 3-year research project from 1993 to 1996. The project was partially funded by the European Community under ESPRIT III Contract # 9197. The results of the Consortium's investigation into compact package models is non-proprietary and in the public domain. The consortium proposed a methodology for the generation of compact models with a high degree of boundary condition independence. This methodology is documented in a comprehensive report published by the consortium as well as a number of technical journals and conference proceedings that are available in the literature (see Bibliography).

The fundamental vision that underlies compact thermal models is the principle of division of responsibility. It is the responsibility of the CTM supplier to characterize the part, whereas the end-user must specify the environment that defines the application. Thus the CTM supplier then becomes responsible for supplying a properly characterized model of the component.

The concept of "a properly characterized model" is tied to a metric of boundary condition independence (BCI). This metric is defined as the BCI Index. A discussion of the BCI concept is available. An additional metric is also defined for the accuracy of a CTM over sub-ranges of boundary conditions relevant to specific application environments. This metric is known as the boundary condition subset (BCS) Index.

¹⁾ To be published.