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Numerical Analysis Guidelines for Microelectronics Packaging Design and Reliability

Developed by the JEDEC Reliability Test Methods for Packaged Devices Committee (JC-14.1) and the SMT Attachment Reliability Test Methods Task Group (6-10d) of the Product Reliability Committee (6-10) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC

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1 SCOPE

1.1 Introduction This document is an effort to standardize and document some of the basic tenets of a typical Finite Element Analysis (FEA) model. The intent of this document is to help educate new designers (and in some cases even experienced designers) on the basic information and best practices that should be captured and provided to technical reviewers of the results of FEA data.

FEA has been used in the microelectronics industry for several decades. Numerical models offer several advantages in the design of microelectronics devices. If used correctly, they can provide guidance on:

1. Potential tradeoffs to be made in achieving the optimal design of microelectronic devices.
2. Performance and reliability of microelectronics devices will be evaluated by including the impact of multiple design, material, geometry, and process parameters.

With the exponential reduction in the cost of computing, numerical models can save significant time and expense because they can be used to reduce the number of iterations of experimental tests that may be needed to finalize and optimize a design. With ever increasing cost pressure, shrinking design margins and faster time to market, there is a need to rely more on numerical models rather than running multiple time consuming and expensive experiments.

However, to achieve all these benefits, numerical models must be used correctly. This involves setting up the problem correctly, obtaining the input parameters accurately, running the analysis properly and outputting and interpreting the results correctly.

There is considerable ‘‘tribal’’ knowledge across the industry where individual designers have their own best practices on how they run their models. However, there is a wide spectrum of knowledge proficiency. At one end, there are engineers who design and develop their own models, refined over decades of experience. At the other end of the spectrum, there are engineers who have very little experience, and use ad-hoc information to develop models that are incomplete and could result in even more expense and time-consuming losses if implemented incorrectly.

Across the industry, there is a need to standardize the basic information, terminology and methodologies used to develop these numerical models. While individual models can be quite complex and customized, some best practices could help make model comparison across different players in the microelectronics supply chain much easier and scalable. The basic structure of this document is outlined in the schematic in Figure 1-1.

1.2 Purpose FEA is versatile and is used to solve several complex problems in microelectronics. It is impossible to standardize all applications and flavors in which FEA is performed. This document is not intended to create device release requirements or to imply that simulation or design information is to be provided to customers as evidence for or as a condition of device suitability for any given application. It is expected that this document will be the first of a series of numerical analysis guideline documents. This will serve as a foundational document for other domain specific guidelines that delve deeper into best practices and guidelines for specific applications of FEA. The expected modular structure of the numerical analysis reliability guidelines documents is shown in Figure 1-2.

The objective of this document is to provide some guidelines for the basic information that should be provided when FEA is performed in most cases. Examples are provided for some select cases (illustrated as pattern filled topics in Figure 1-2) to help users understand why certain information should be captured and reported. In addition, some examples of best practices are provided, to help guide users on best practices that could be implemented to avoid loss of information or accuracy. The examples provided in this document are not meant to be exhaustive or all encompassing. They are meant to highlight examples of key aspects that need to be taken into account when an FEA analysis is set up and the results reported.

Several commercial FEA software are widely used across the industry. Due to the nature of the analysis, some recommendations may be specific to certain software and may be articulated in the context of a specific FEA software code. However, these recommendations are not exhaustive and do not imply endorsement of any one software over another.