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Methodology for the Thermal Measurement of Component Packages (Single Semiconductor Device)

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METHODOLOGY FOR THE THERMAL MEASUREMENT OF COMPONENT PACKAGES
(SINGLE SEMICONDUCTOR DEVICE)

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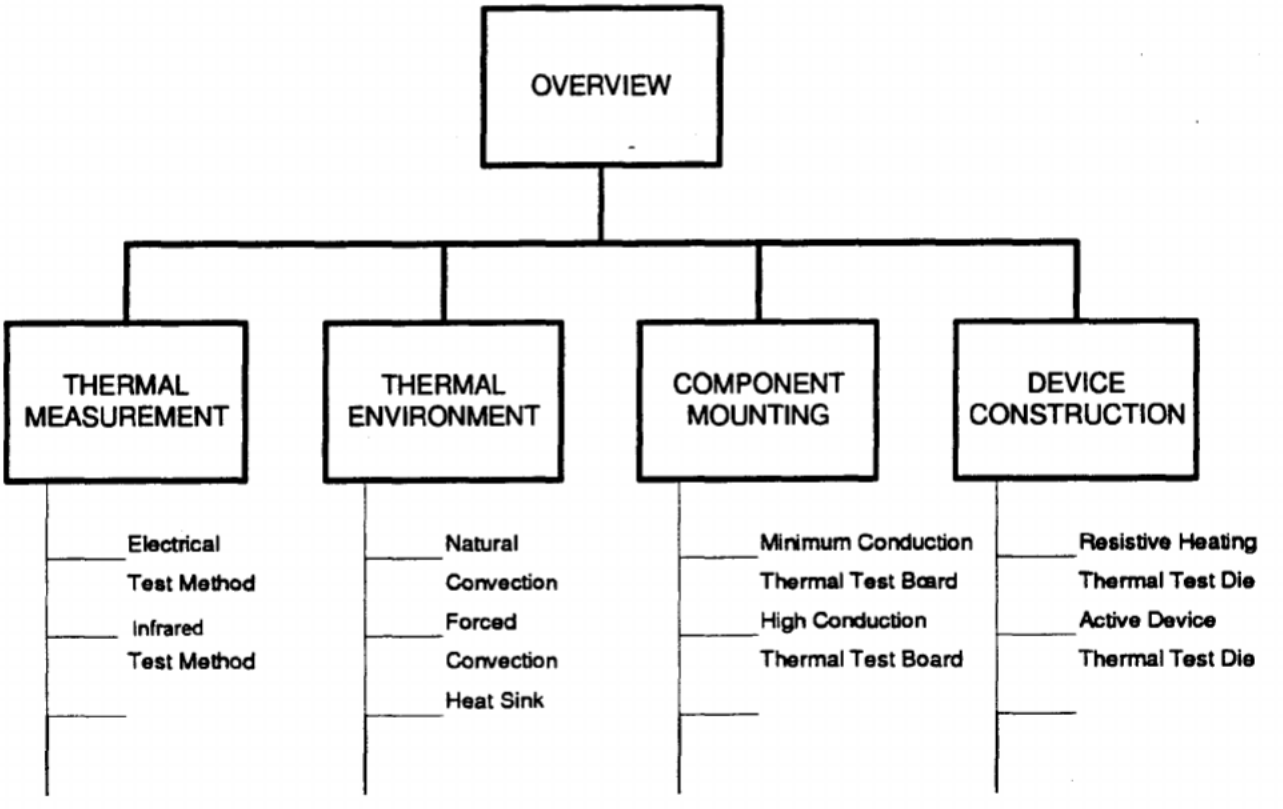
1. INTRODUCTION

This document provides an overview of the methodology necessary for making meaningful thermal measurements on packages containing single chip semiconductor devices. The actual methodology components are contained in separate detailed documents.

2. SCOPE

The measurement methodology described herein is distributed among several documents so that the appropriate combination of documents can be selected to meet specific thermal measurement requirements. This document provides the OVERVIEW; the rest of the documents are grouped as shown below:



Each group will have one or more applicable documents to reflect different thermal measurement requirements. Because environmental conditions, component mounting approaches and device construction techniques and processes will change as technology changes, additional documents will be added to these groups as the needs arise and standards established. As appropriate, each of these documents will contain terminology and symbolic definitions specific to the material covered by the individual document.

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3. RATIONALE

The junction temperature of a semiconductor device greatly influences the performance, reliability, quality and cost of the device. This document, and the subsequent documents it calls on, provides a standard for thermal measurements that, if followed fully, will provide correct and meaningful data that will allow for determination of junction temperature for specific conditions, e.g., device environment, mounting and construction. The data can be used for package design evaluation, device (i.e., chip/package combination) characterization, reliability predictions, etc.

4. PURPOSE

Two key thermal parameters for any semiconductor device are junction temperature (T_J) and thermal resistance ($R_{\theta JX}$ or θ_{JX}). The former is the prime parameter while the latter is a vehicle for determining the former. Since T_J usually can not be measured directly, the following approach is used:

$$T_J = T_{J0} + \Delta T_J \qquad (1)$$

where T_{J0} is the junction temperature before application of power [°C]
ΔT_J is the change in junction temperature due to applied power [°C]

Under carefully defined conditions for a specific environment, the change in junction temperature can be determined as follows:

$$[\Delta T_J]_X = P_D \times R_{\theta JX} = P_D \times \theta_{JX} \qquad (2)$$

where P_D is power dissipated in the device (also referred to as heating power) [W]
$R_{\theta JX}$ is the thermal resistance from the device junction to the specific environment (alternative symbol is θ_{JX}) [°C/W]

The thermal resistance term ($R_{\theta JX}$ or θ_{JX}) is highly dependent on the environment surrounding the device. The two most common environments, still-air and infinite heat sink, usually define the practical limits of thermal resistance, but do not represent typical integrated circuit environments. The Environmental and Component Mounting documents that accompany this document provide alternatives that approach those found in actual semiconductor applications.

5. DATA PRESENTATION

Thermal data are not meaningful unless all the pertinent test condition information is provided with the actual thermal data. Because the test conditions and data will vary with the type of thermal test being performed, the documents for each of the measurement areas listed below in table 1 state the thermal information necessary for a complete description of the data.

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Table 1. Thermal measurement test condition and data parameter summary.

Measurement Area	Condition Parameter(s)	Data Parameter(s)
Thermal Measurement	Refer to appropriate document	Refer to appropriate document
Environmental	Refer to appropriate document	Refer to appropriate document
Component Mounting	Refer to appropriate document	Refer to appropriate document
Device Construction	Refer to appropriate document	Refer to appropriate document

Environmental conditions, component mounting approaches and device construction techniques and processes will change as technology and applications change, thus necessitating continual additions to each of the measurement area groups listed in table 1.