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TECHNICAL REPORT

colour inside

Thermal standardization on semiconductor packages – Part 1: Thermal resistance and thermal parameter of BGA, QFP type semiconductor packages

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THERMAL STANDARDIZATION ON SEMICONDUCTOR PACKAGES –

Part 1: Thermal resistance and thermal parameter of BGA, QFP type semiconductor packages

FOREWORD

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IEC TR 63378-1 has been prepared by subcommittee 47D: Semiconductor devices packaging, of IEC technical committee 47: Semiconductor devices. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
47D/928/DTR	47D/935/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 63378 series, published under the general title *Thermal standardization on semiconductor packages*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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THERMAL STANDARDIZATION ON SEMICONDUCTOR PACKAGES –

Part 1: Thermal resistance and thermal parameter of BGA, QFP type semiconductor packages

1 Scope

This part of IEC 63378 specifies the terms and definitions that are commonly used for thermal characteristics of BGA and QFP type semiconductor packages, and guidelines to use these thermal characteristics.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60191-4, *Mechanical standardization of semiconductor devices – Part 4: Coding system and classification into forms of package outlines for semiconductor device packages*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60191-4 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and letter symbols related to temperature (unit [°C or K])

3.1.1
ambient air temperature
T_A
temperature of ambient air at location adequately distant from the package (see Figure 1)

Note 1 to entry: Conceptually, it refers to an ambient air temperature at a location that is not affected by the semiconductor package to be measured.

3.1.2
junction temperature
T_J
temperature of at an arbitrary position of the chip (see Figure 1)

Note 1 to entry: Especially when there is no specification, it is considered as the centre of a chip.

Note 2 to entry: Junction refers to the junction area of a semiconductor. Assuming that heat is generated at the junction of p-type and n-type, temperature at the junction becomes high and is used as representing temperature for semiconductor devices. Because there are many junctions built into a real chip, the term junction is used synonymously as the chip. The location is commonly placed at the centre of the circuit surface of the chip, although location dependence may be taken into consideration for chips requiring high power consumption.

3.1.3
case temperature
T_C
temperature at an arbitrary position on the surface of a package (see Figure 1)

Note 1 to entry: Especially when there is no specification, it is considered as the centre of a chip upper part.

3.1.4
top temperature
T_T
temperature at the centre of the package's upper surface (see Figure 1)

Note 1 to entry: Defined as T_T due to T_C used as definition for special surface at back of package of power device, etc. For normal package such as BGA, T_C and T_T are used synonymously.

3.1.5
board temperature
T_B
temperature of the board which is distant from an arbitrary end of a package 1 mm (see Figure 1)

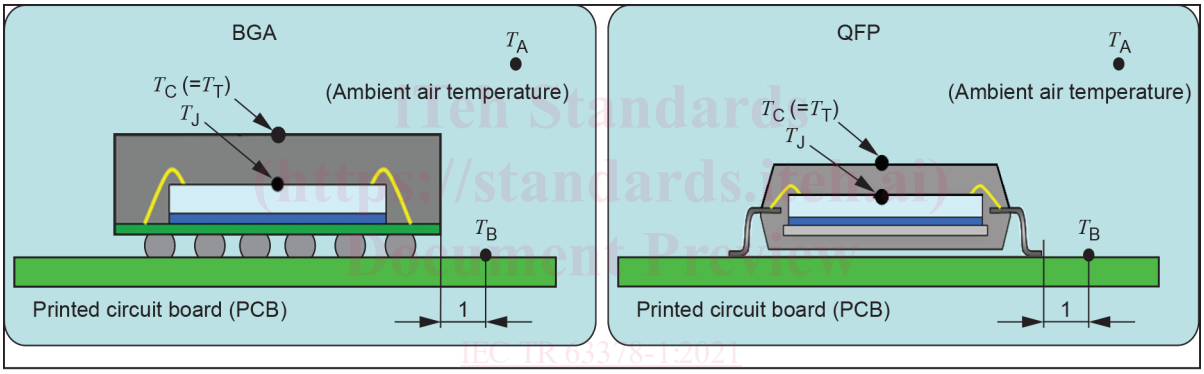

Figure 1 – Definition of temperature

3.2 Terms and letter symbols related to thermal characteristics

3.2.1
thermal resistance
quotient of the difference between the virtual temperature of the device and the temperature of a stated external reference point, by the steady-state power dissipation in the device (see Figure 2)

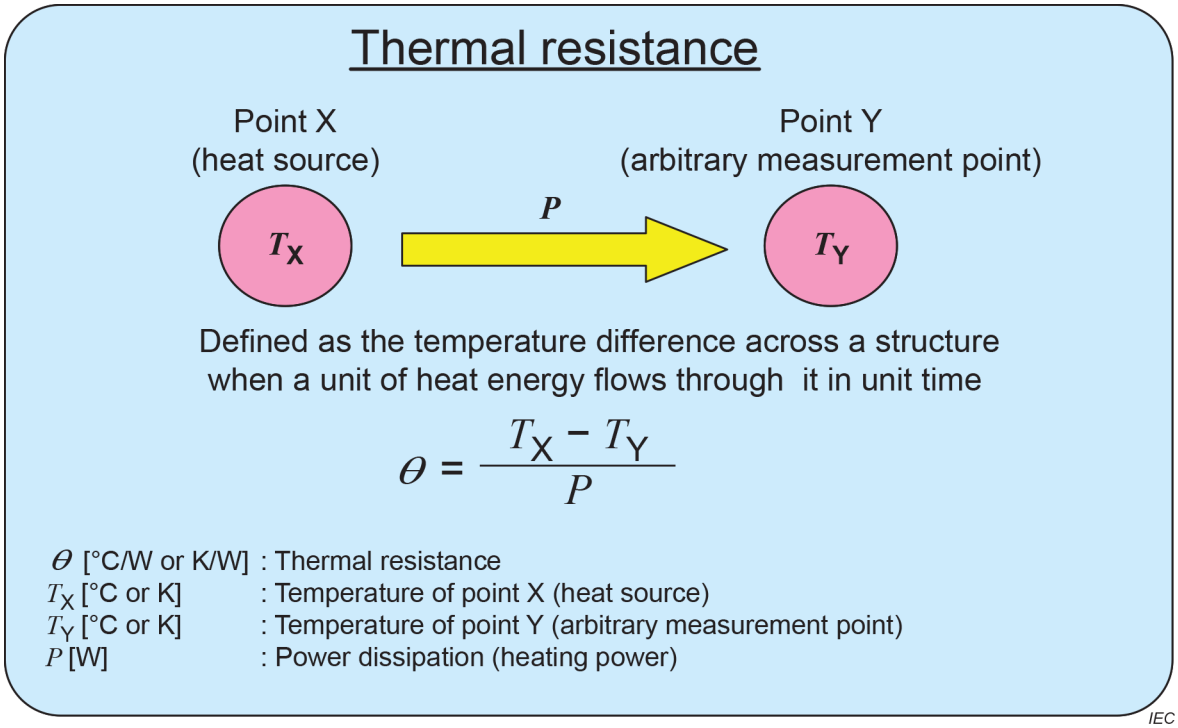

Figure 2 – Definition of thermal resistance

Note 1 to entry: It is the reciprocal of thermal conductance. Thermal resistance is the temperature difference across a structure when a unit of heat energy flows through it in a unit time.

[SOURCE: IEC 60050-521:2002, 521-05-13, modified – Figure 2 and Note 1 to entry have been added.]

3.2.1.1
thermal resistance from junction-to-ambient
$R_{th(j-a)}$
θ_{JA}
thermal resistance between chip (junction) and ambient air (see Figure 1)

$$\theta_{JA} = \frac{T_J - T_A}{P}$$

where

P is the power dissipation

3.2.1.2
thermal resistance from junction-to-case top
$R_{th(j-c)}$
θ_{JCTOP}
thermal resistance between chip (junction) and package surface (see Figure 3)

Note 1 to entry: Value in an ideal environment in which all heat dissipation from the chip goes towards the package top surface. (It is also shown simply as θ_{JC}).

3.2.1.3
thermal resistance from junction-to-board
$R_{th(j\text{-}b)}$
θ_{JB}
thermal resistance between chip (junction) and board surface (see Figure 3)

Note 1 to entry: Value in an ideal environment in which all heat dissipation from the chip goes towards the package board side only.

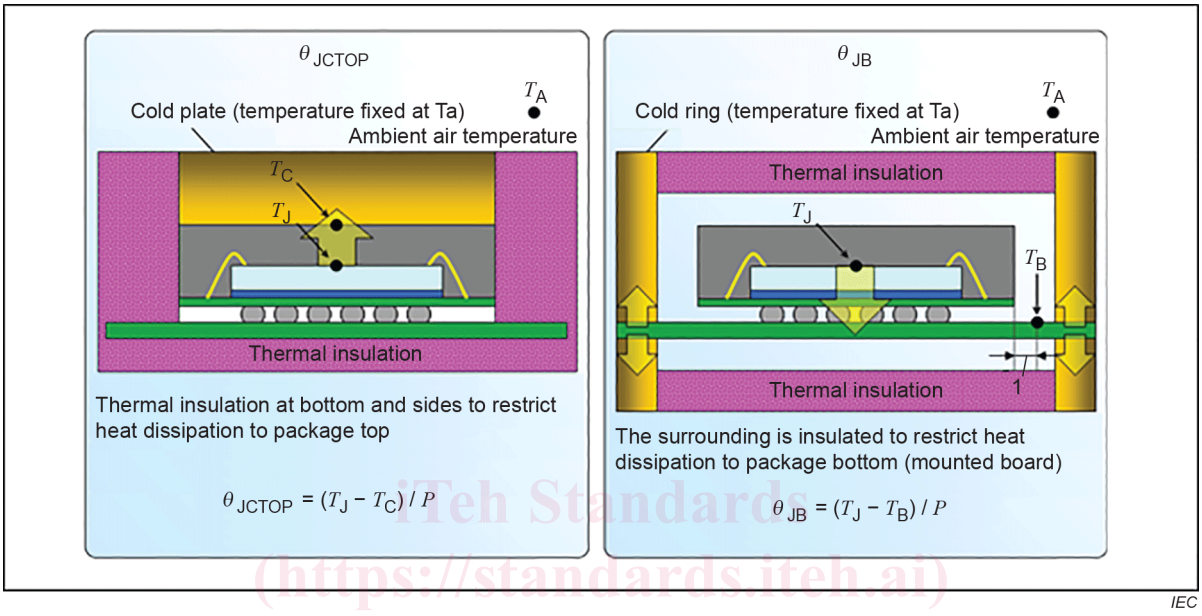

Figure 3 – Thermal resistance

3.2.2
thermal characterization parameter
quotient of the difference between the virtual temperature of the device and the temperature of a stated external reference point, by the total heat quantity of steady-state power dissipation in the device

Note 1 to entry: As is shown in Figure 4, thermal resistance is defined as the value dividing the temperature gap between X and Y by the heat volume from X to Y like the left hand figure, and thermal characterization parameter is defined as the value dividing the temperature gap between X and Y by the total heat quantity like the right hand figure. Since thermal characterization parameter cannot be strictly called thermal resistance, it was distinguished from thermal resistance by calling it thermal characterization parameter.