

SEMI G68-0996 (Reapproved 1104) TEST METHOD FOR JUNCTION-TO-CASE THERMAL RESISTANCE MEASUREMENTS IN AIR ENVIRONMENT FOR SEMICONDUCTOR PACKAGES

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1 Purpose

1.1 The purpose of this test is to determine the thermal resistance of semiconductor packages using thermal test chips. This test method deals with junction-to-case measurements of thermal resistance in air environment.

2 Scope

2.1 The results of this test method are used to obtain the junction temperature.

2.2 The measurement results are usually different from the results obtained by testing in the fluid bath environment described in SEMI G30 and SEMI G43.

2.3 This test method uses SI units.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Limitation

3.1 This method applies only to packages whose surface is wide enough to place a thermocouple.

4 Referenced Standards

4.1 SEMI Standards

SEMI G30 — Test Method for Junction-to-Case Thermal Resistance Measurements of Ceramic Packages

SEMI G32 — Guideline for Unencapsulated Thermal Test Chip

SEMI G38 — Test Method for Still- and Forced-Air Junction-to-Ambient Thermal Resistance Measurements of Integrated Circuit Packages

SEMI G42 — Specification for Thermal Test Board Standardization for Measuring Junction-to-Ambient Thermal Resistance of Semiconductor Packages

SEMI G43 — Test Method for Junction-to-Case Thermal Resistance Measurements of Molded Plastic Packages

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 Definitions

5.1.1 The following definitions and symbols shall apply to this test:

5.1.2 *case top temperature measured in air environment, T_t* — in °C, is the temperature at the specified accessible reference point on the package in measured in air environment.

NOTE 1: T_C defined in SEMI G43 is different from T_t .

5.1.3 *junction temperature, T_j* — in °C, is the temperature of the semiconductor junction on the microcircuit in which the major part of the heat is generated.

5.1.4 *power dissipation P_H* — in watt, is the heating power applied to the device causing a junction-to-reference point temperature difference.

5.1.5 *thermal resistance measured in air environment, junction to package surface, Ψ_{jt}* — in °C/watt, is the temperature difference from the junction to the center point on the package divided by the power dissipation P_H .

6 Summary of Method

6.1 A thermocouple is attached on the surface of the package on the test board.

6.2 After the chip is heated, the junction temperature is measured by the diode in the test chip. The surface temperature is measured in an air environment by the thermocouple.

6.3 The junction-to-case thermal resistance is calculated using the case temperature, junction temperature and power dissipation.

7 Interference

7.1 It is recommended that an operator who is familiar with the measuring system and test method conduct the actual measurement in order to obtain the best result.

7.2 The procedure for attaching the thermocouple described in Section 12.3 on the test package should be followed in order to obtain the accurate measurement result.

8 Apparatus

8.1 Thermocouple

8.1.1 *Material* — Copper-constantan or equivalent.

8.1.2 *Temperature Range* — -100 to +300°C.

8.1.3 *Wire Size* — No larger than AWG size 36.

8.1.4 *The Junction* — Shall be welded to form a bead rather than soldered or twisted.

8.1.5 *Accuracy* — $\pm 0.5\%$.

8.2 *Suitable Electrical Equipment* — As required to provide controlled levels of conditioning power and to make the specified measurements.

8.2.1 *Resolution* — 50 μV and 5 μA .

8.3 *Wind Tunnel (as necessary)* — See SEMI G38 or equivalent.

9 Materials

9.1 *Test Chip* — Referred to in SEMI G32, or equivalent.

9.2 *Test Board* — Referred to in SEMI G42, or equivalent.

9.3 *Adhesive* — Alpha Cyano-Acrylate.

9.4 *Aluminum Foil* — 4 mm $\times$ 4 mm.

10 Setup

10.1 Warm up the test equipment before measurements.

11 Calibration

11.1 Calibrate the equipment in accordance with the operation manual as necessary.

12 Procedure

12.1 Preparation of Test Package

12.1.1 Prepare the semiconductor package in which the test chip is mounted.

12.2 Assemble the package on the test board using solder.

12.3 Attach the Thermocouple

12.3.1 Apply adhesive on the center point of the package.

12.3.2 Place the thermocouple and aluminum foil on the adhesive and press the aluminum foil using a finger in order to attach the thermocouple on the package surface as close as possible.

12.4 Measure the thermal characteristic of the diode of the test chip.

NOTE 2: It is recommended that the ambient temperature T_a is measured using the thermocouple.

12.5 Mount the test board in a test socket in a still-air enclosure or wind tunnel as necessary.

12.6 Heating Chip

12.6.1 Supply power to the chip.

12.6.2 Adjust the measurement equipment to the measured case temperature T_t or the measured power $P_{H(\text{package})}$.

NOTE 3: The thermal resistance usually depends on the power dissipation (see Figure 1). The thermal resistance is variable within a power and stable beyond the power.

12.7 Wait until the thermal characteristic of the diode is stable.

12.8 Calculate the junction temperature T_j by the diode thermal characteristics.

12.9 Measure the case temperature T_t using the thermocouple and record the case temperature.

12.10 Record the voltage and the current in order to obtain the $P_{H(\text{package})}$.

13 Calculation

13.1 The thermal resistance of the package can be calculated as follows:

$$\Psi_{jt} (^{\circ}\text{C}/\text{watt}) = (T_j - T_t) / P_{H(\text{package})}$$

14 Report

14.1 The following details shall be reported:

- Description of package.
- Description of test board.
- Power dissipation of test chip.
- Thermal resistance $R_{\Psi_{jt}}$ for test condition.