

Figure 1
Thermal Test Board — Dual In-Line Package

(Unit: mm)

1. Material — Epoxy Glass 1.52–1.65 mm thickness, FR-4 (Green). Copper Clad. 28.3 g (1 Oz.) 1/1
2. Gold-Plated Fingers — 0.8 μ m Min. Thickness, 18 on Each Side
3. Fabricate — IPC-D-320, Class III
4. Tolerance — \pm 0.1 mm (Unless noted)
5. Fingers on Component Side of Board — Designed as A thru R, Fingers on Solder Side of Board — Designated as 1 thru 18 (with 18 at Right When Viewing Face of Board)
6. All Holes Plated Thru
7. Mates with Dale Connector Part Number EB 7D-A18GFX or Equivalent

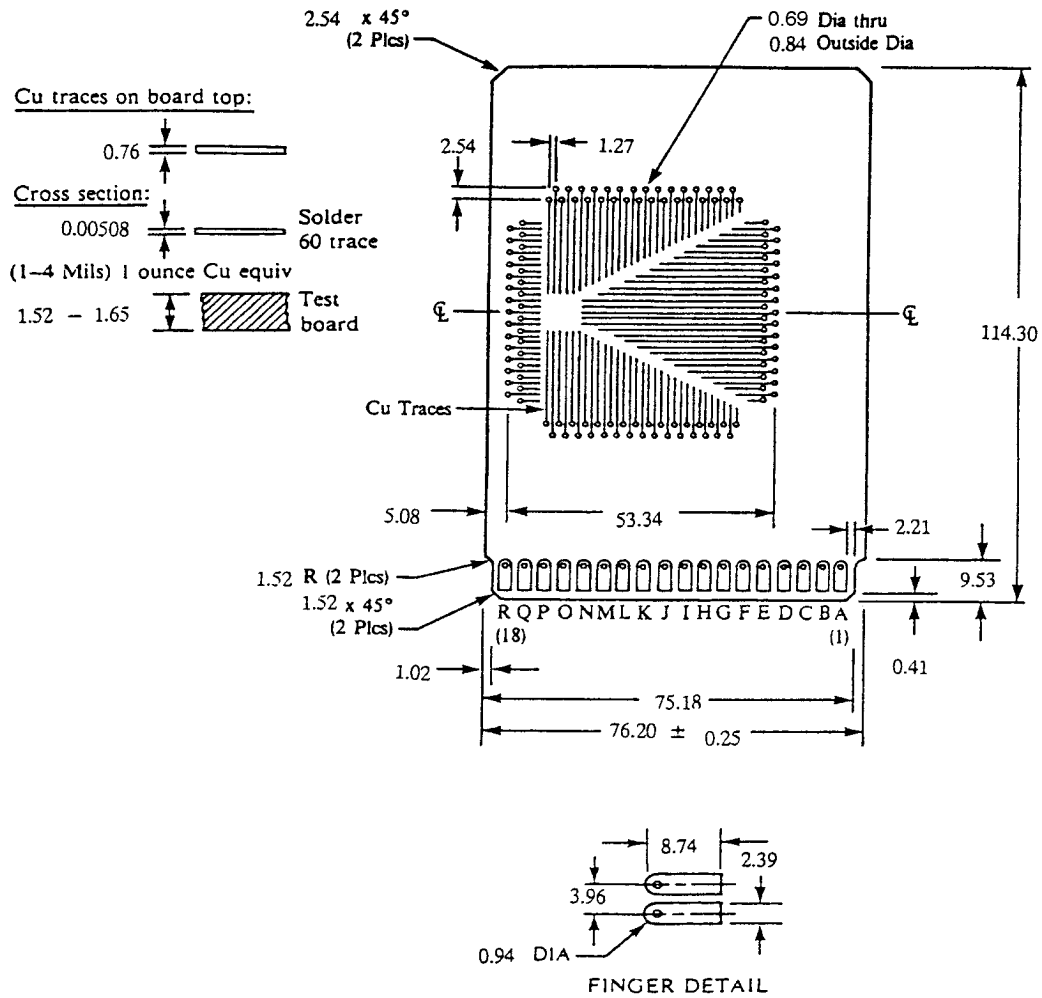


Figure 2
Thermal Test Board — PCC Packages

Unit: mm

1. Material — Epoxy Glass 1.52–1.65 mm thickness, FR-4 (Green). Copper Clad. 28.3 g (1 Oz.) 1/1
2. Gold-Plated Fingers — 0.8 μ m Min. Thickness, 18 on Each Side
3. Fabricate — IPC-D-320, Class III
4. Tolerance — ± 0.1 mm (Unless noted)
5. Fingers on Component Side of Board — Designed as A thru R, Fingers on Solder Side of Board — Designated as 1 thru 18 (with 18 at Right When Viewing Face of Board)
6. All Holes Plated Thru
7. Mates with Dale Connector Part Number EB 7D-A18GFX or Equivalent

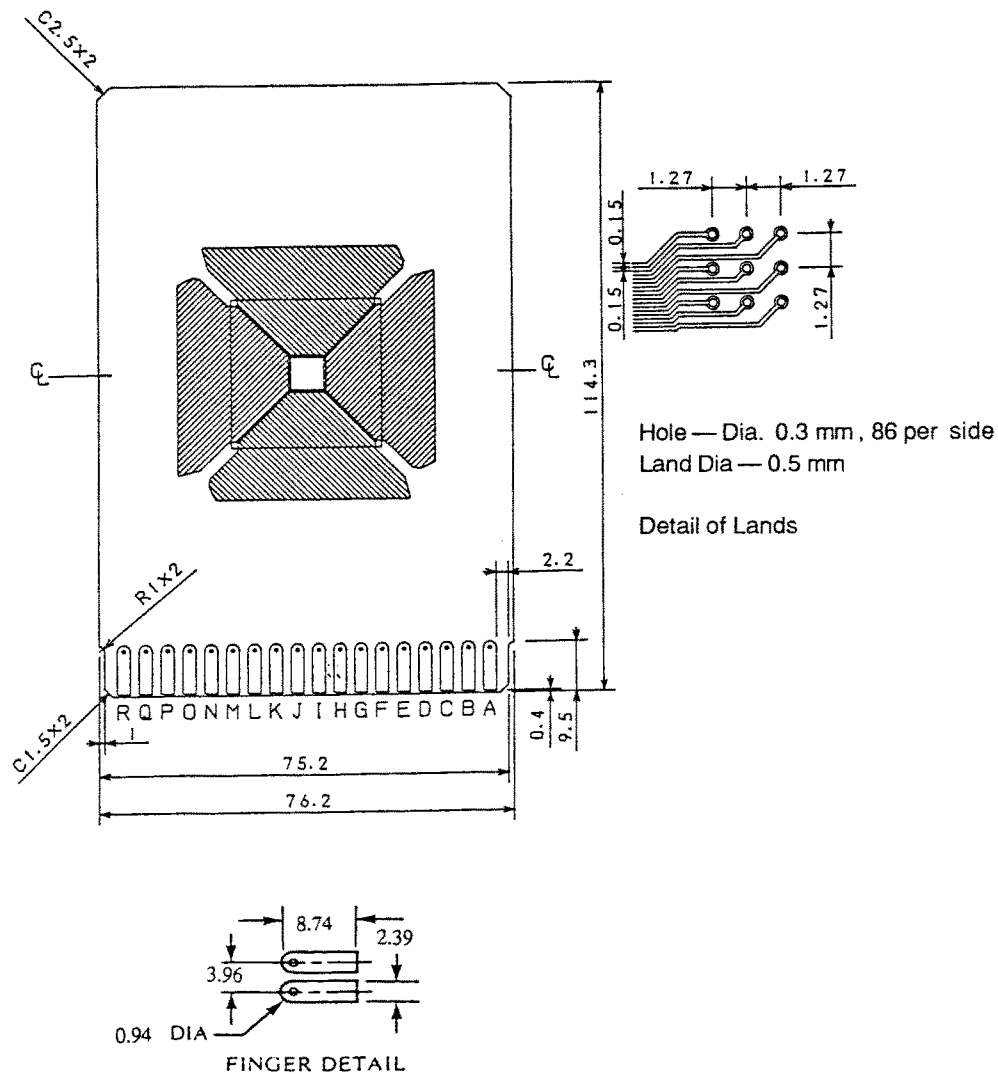


Figure 3
Thermal Test Board — 0.3 mm Pitch Quad Flat Package

Unit: mm

1. Material — Epoxy Glass 1.52–1.65 mm thickness, FR-4 (Green). Copper Clad. 28.3 g (1 Oz.) 1/1
2. Gold-Plated Fingers — 0.8 μ m Min. Thickness, 18 on Each Side
3. Fabricate — IPC-D-320, Class III
4. Tolerance — \pm 0.1 mm (Unless noted)
5. Fingers on Component Side of Board — Designed as A thru R, Fingers on Solder Side of Board — Designated as 1 thru 18 (with 18 at Right When Viewing Face of Board)
6. All Holes Plated Thru
7. Mates with Dale Connector Part Number EB 7D-A18GFX or Equivalent

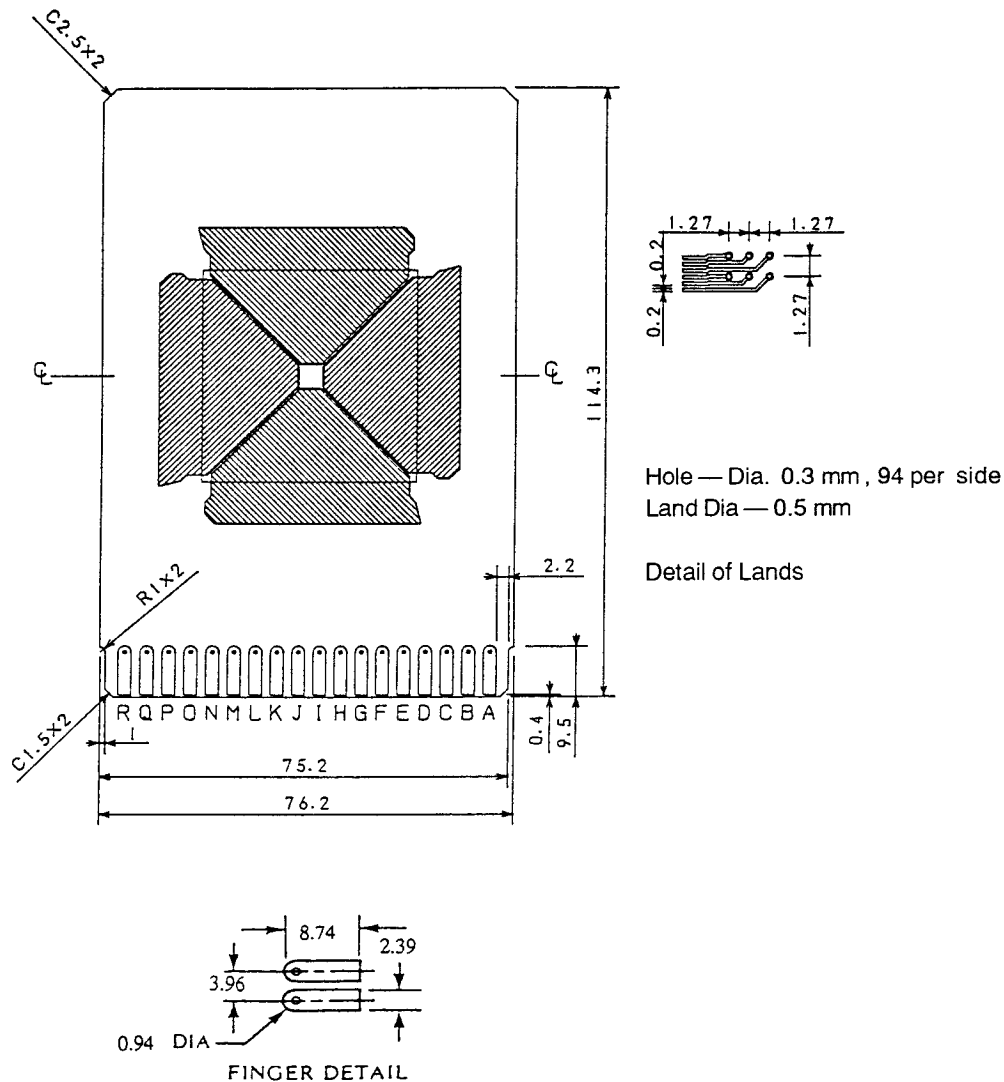


Figure 4
Thermal Test Board — 0.4 mm Pitch Quad Flat Package

Unit: mm

1. Material — Epoxy Glass 1.52–1.65 mm thickness, FR-4 (Green). Copper Clad. 28.3 g (1 Oz.) 1/1
2. Gold-Plated Fingers — 0.8 μ m Min. Thickness, 18 on Each Side
3. Fabricate — IPC-D-320, Class III
4. Tolerance — ± 0.1 mm (Unless noted)
5. Fingers on Component Side of Board — Designed as A thru R, Fingers on Solder Side of Board — Designated as 1 thru 18 (with 18 at Right When Viewing Face of Board)
6. All Holes Plated Thru
7. Mates with Dale Connector Part Number EB 7D-A18GFX or Equivalent

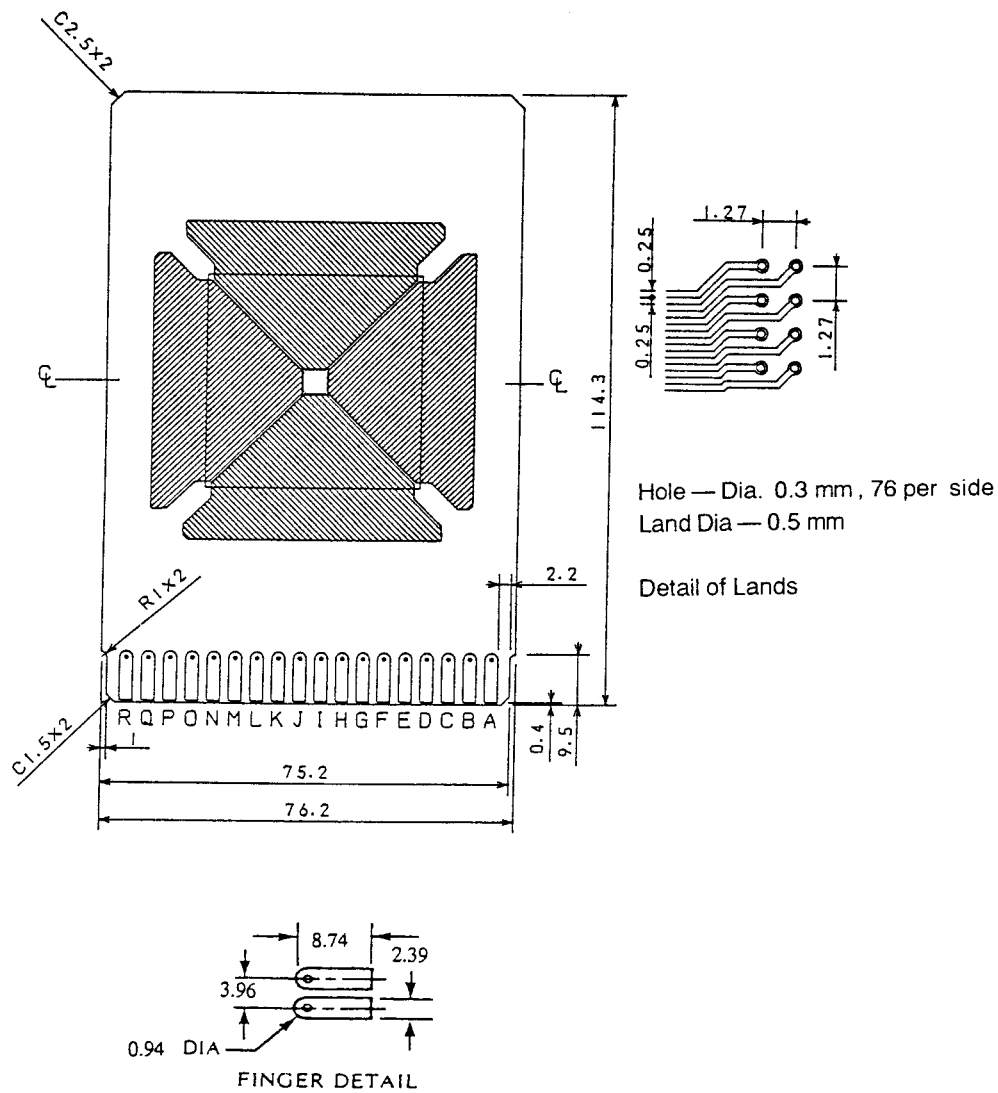


Figure 5
Thermal Test Board — 0.5 mm Pitch Quad Flat Package

Unit: mm

1. Material — Epoxy Glass 1.52–1.65 mm thickness, FR-4 (Green). Copper Clad. 28.3 g (1 Oz.) 1/1
2. Gold-Plated Fingers — 0.8 μ m Min. Thickness, 18 on Each Side
3. Fabricate — IPC-D-320, Class III
4. Tolerance — ± 0.1 mm (Unless noted)
5. Fingers on Component Side of Board — Designed as A thru R, Fingers on Solder Side of Board — Designated as 1 thru 18 (with 18 at Right When Viewing Face of Board)
6. All Holes Plated Thru
7. Mates with Dale Connector Part Number EB 7D-A18GFX or Equivalent

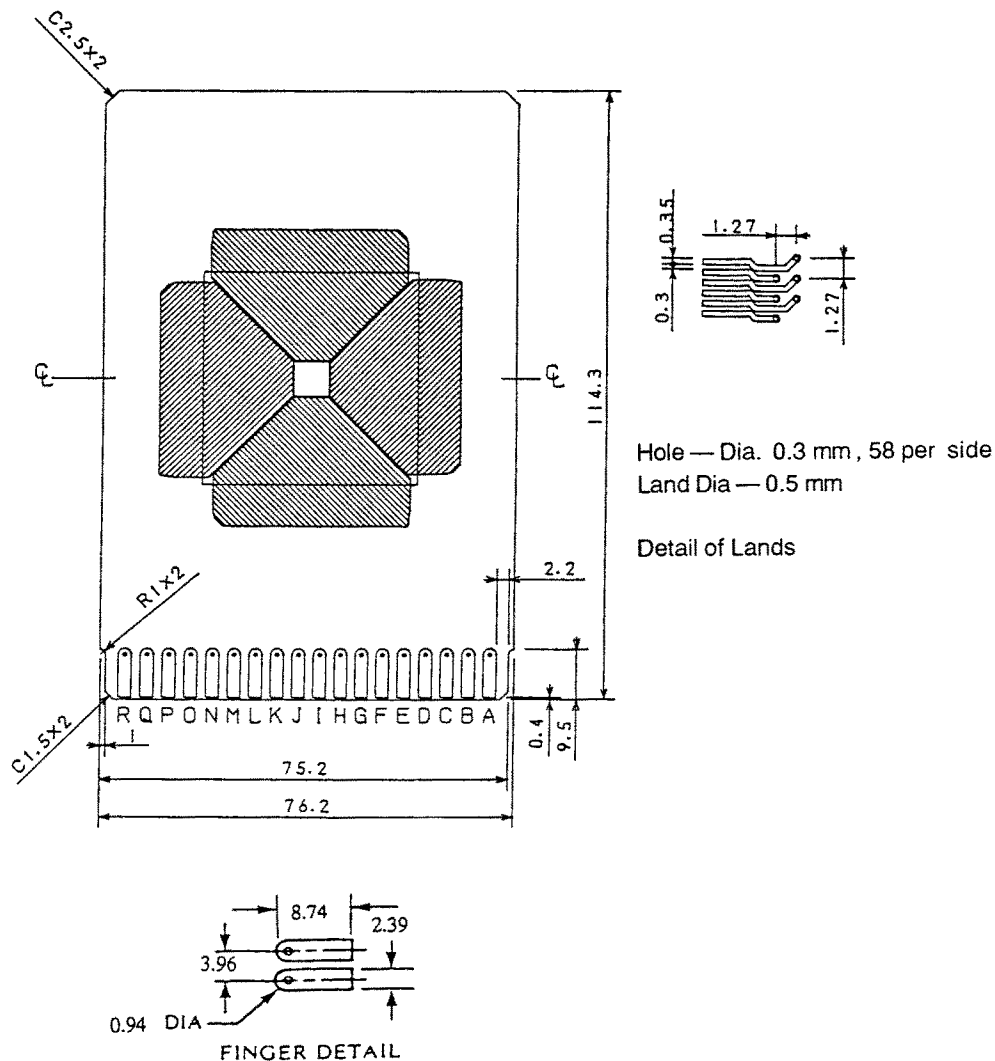


Figure 6
Thermal Test Board — 0.65 mm Pitch Quad Flat Package

Unit: mm

1. Material — Epoxy Glass 1.52–1.65 mm thickness, FR-4 (Green). Copper Clad. 28.3 g (1 Oz.) 1/1
2. Gold-Plated Fingers — 0.8 μ m Min. Thickness, 18 on Each Side
3. Fabricate — IPC-D-320, Class III
4. Tolerance — \pm 0.1 mm (Unless noted)
5. Fingers on Component Side of Board — Designed as A thru R, Fingers on Solder Side of Board — Designated as 1 thru 18 (with 18 at Right When Viewing Face of Board)
6. All Holes Plated Thru
7. Mates with Dale Connector Part Number EB 7D-A18GFX or Equivalent

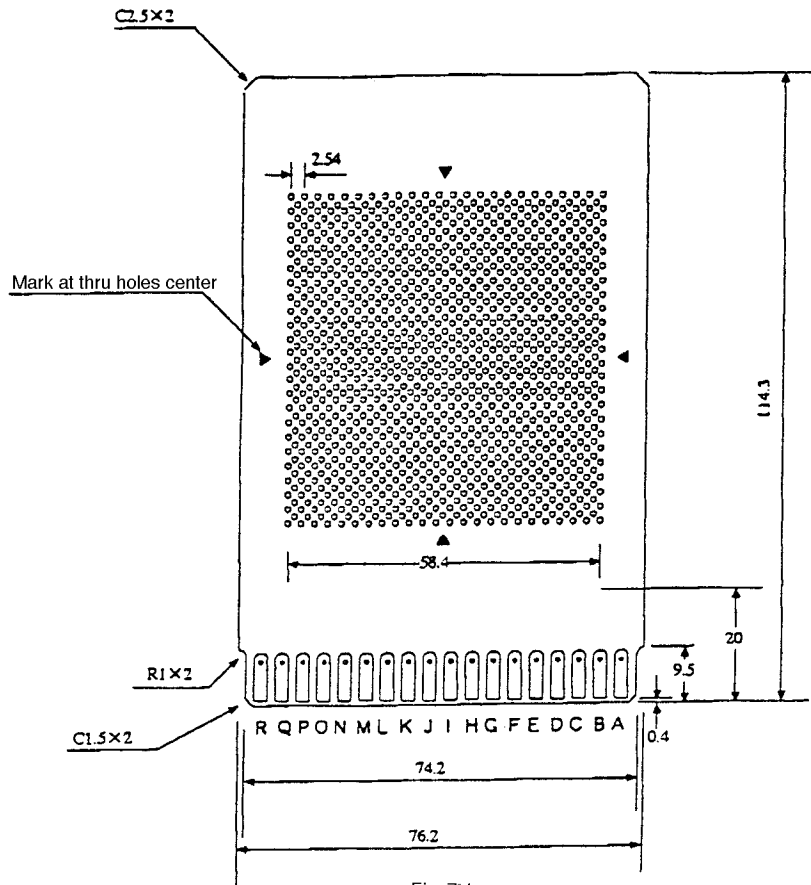


Fig. 7-1

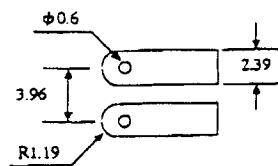


Fig. 7-2 Finger pattern

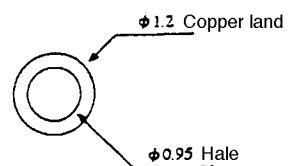


Fig. 7-3 Hole

Figure 7
Thermal Test Board — Pin Grid Array Package

Unit: mm

1. Material: Epoxy Glass 1.5 mm thickness, FR-4 (Green).
2. Gold Plated Fingers: 0.8 μ m Min, 18 pad on Each side
3. Fabricate: IPC-D-320 Glass III
4. Tolerance: + 0.1 mm (Unless noted)

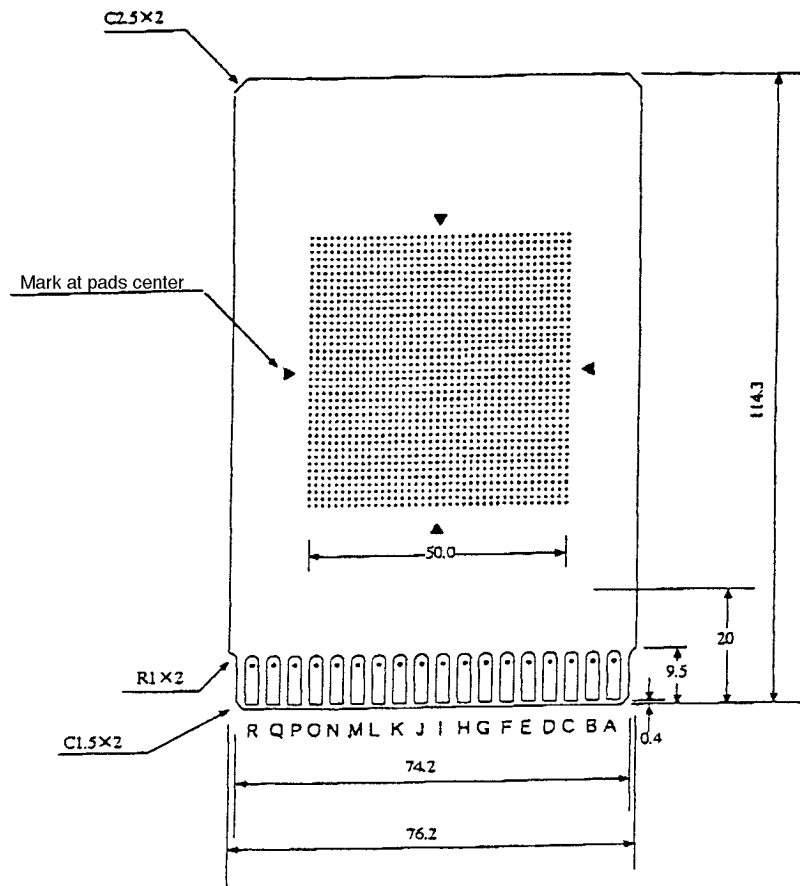


Fig. 8-1

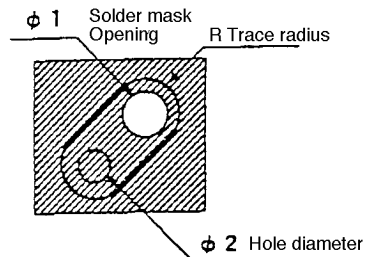


Fig. 8-2 Trace

Figure 8 Thermal Test Board — Ball Grid Array Package

Unit: mm

1. Material: Epoxy Glass 1.5 mm thickness, FR-4 (Green).
2. Gold Plated Fingers: 0.8 μ m Min. 18 pad on Each side
3. Fabricate: IPC-D-320 Class III
4. Tolerance: ± 0.1 mm (Unless noted)

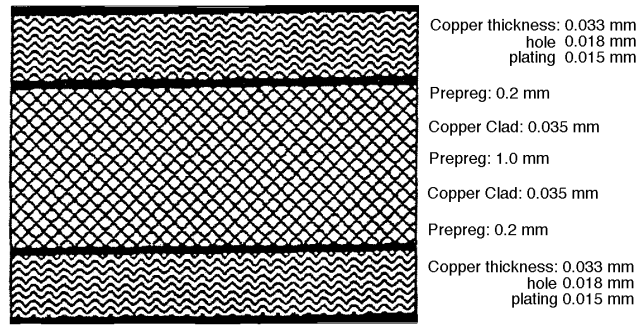


Figure 9
Multi-Layer Board Construction

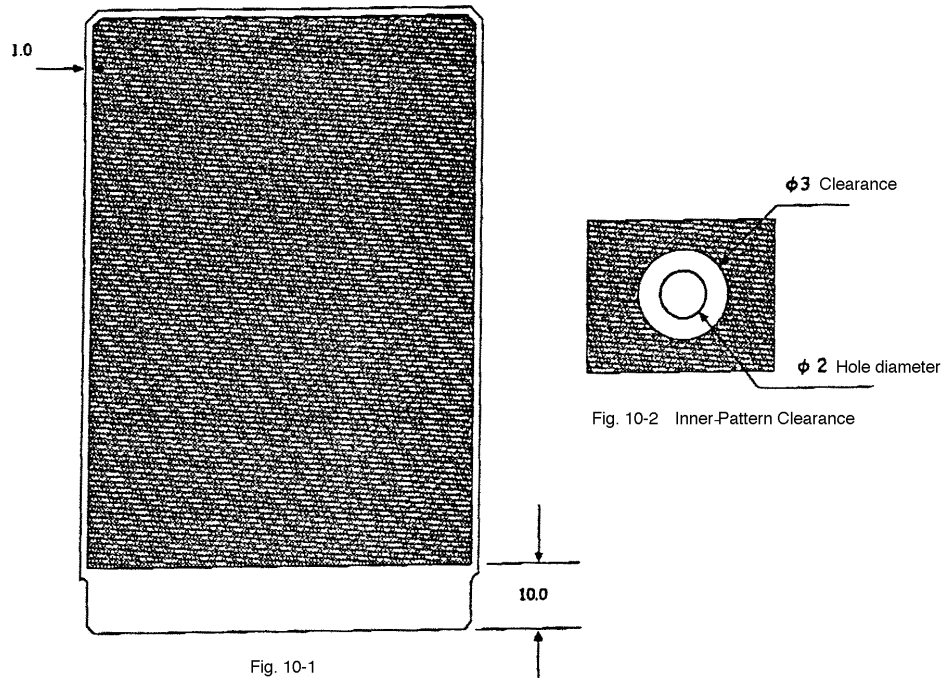
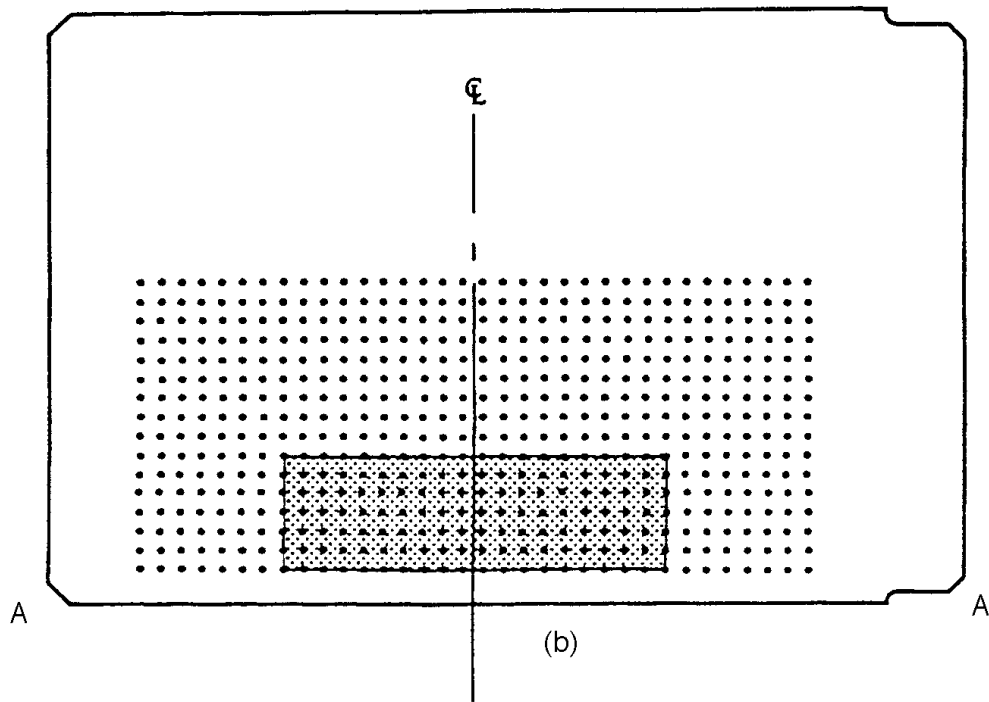


Figure 10
Inner Layer Pattern and Clearance for Multi-Layer Thermal Test Board

1. Material: Epoxy Glass 1.0 mm Isolation thickness, FR-4 (Green)
2. Inner Copper Clad thickness: 0.035 μ m
3. Tolerance: ± 0.1 mm (Unless noted)

Table 3 Clearance Diameter

	Pitch (mm)	Hole Diameter $\varnothing 2$ (mm)	Clearance Diameter $\varnothing 3$ (mm)
BGA	1.5	0.4	1.2
	1.27	0.35	1.1
	1.0	0.3	0.9
PGA	2.54	0.95	1.7



DIP

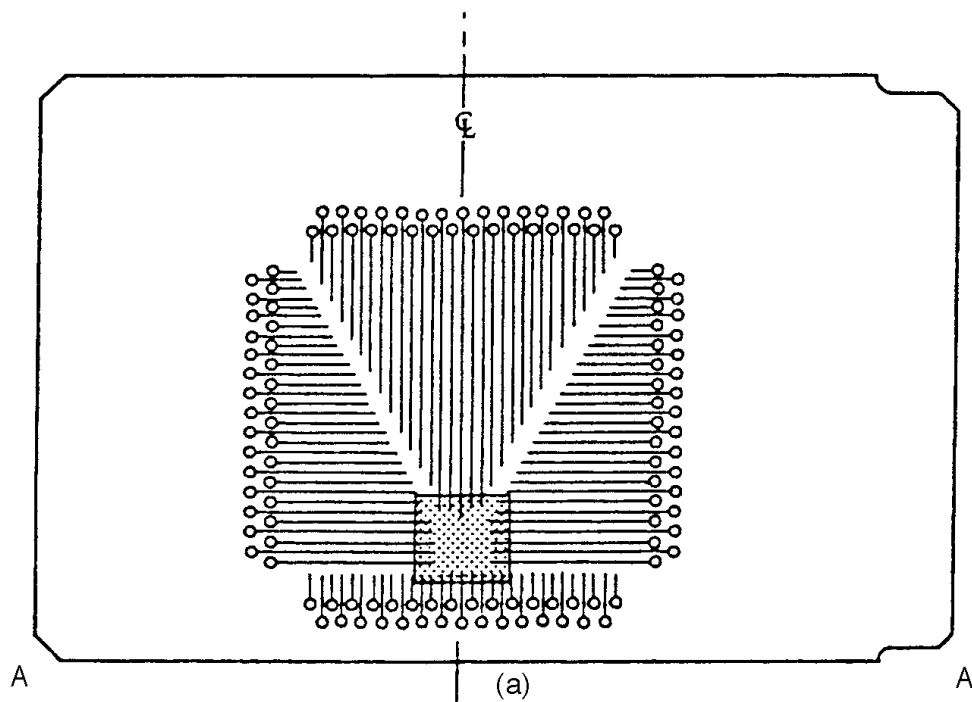


Figure 11
Location of Package While Mounting on Test Board

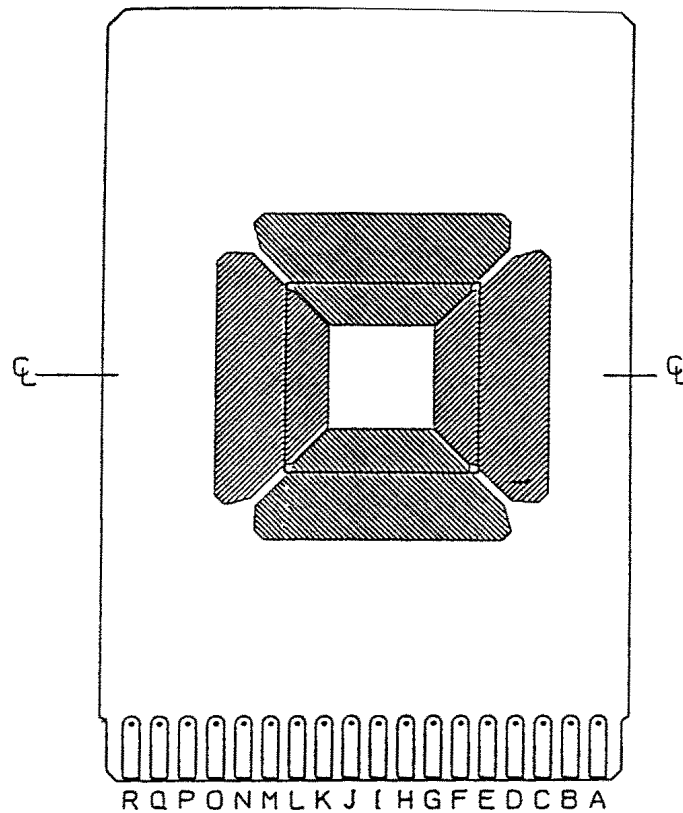


Figure 12
Location of Package While Mounting on Test Board (QFP)

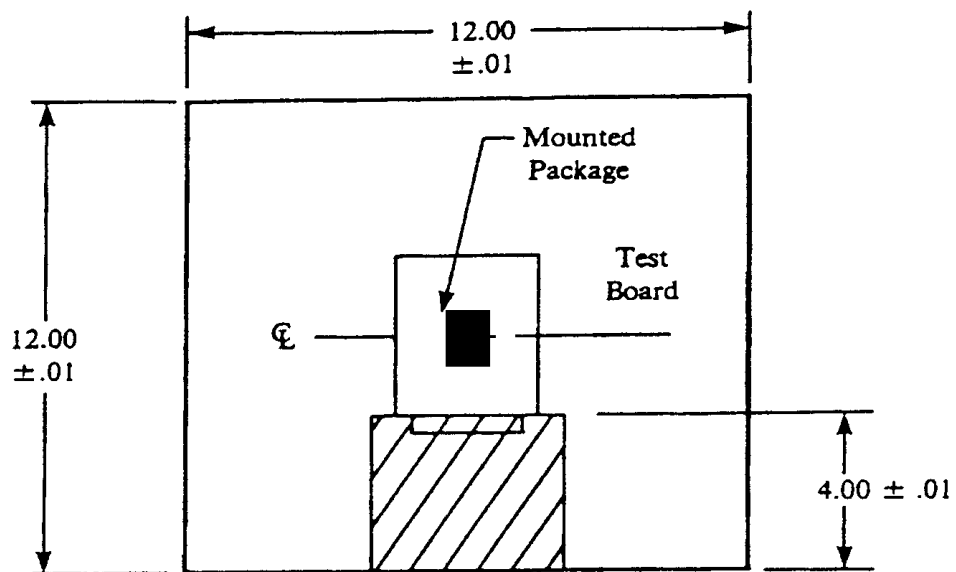


Figure 13
Test Board Positioning Inside Measuring Chamber

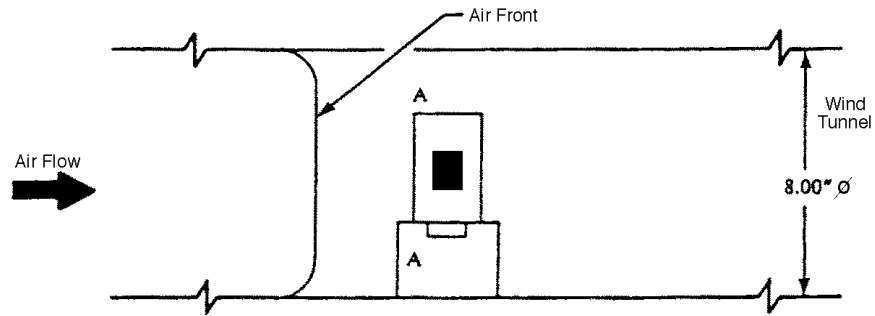


Figure 14
Test Board Orientation Inside Wind Tunnel

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SEMI G43-87

TEST METHOD FOR JUNCTION-TO-CASE THERMAL RESISTANCE MEASUREMENTS OF MOLDED PLASTIC PACKAGES

1 Purpose

The purpose of this test is to determine the thermal resistance of molded plastic packages using thermal test chips. This test method deals only with junction-to-case measurements of thermal resistance and limits itself to fluid bath testing environments. For this test, conduction through the leads is minimized, thus providing information on the ability of the plastic package material to dissipate heat. Due to the thermophysical properties of the heat transfer fluids used and the effects of the variable nature of the fluid-stirring and package-mounting procedures, this test method should only be used for comparing the thermal characteristics of plastic packages in the same fluid bath system.

2 Applicable Documents

2.1 SEMI Specification

SEMI G32 — Guideline for Unencapsulated Thermal Test Chip

3 Definitions

The following definitions and symbols shall apply for the purpose of this test:

case temperature, T_C — in degrees Celsius. The case temperature is the temperature at a specified accessible reference point on the package in which the microelectronic chip is mounted.

junction temperature, T_J — in degrees Celsius. The term is used to denote the temperature of the semiconductor junction in the microcircuit in which the major part of the heat is generated. For purposes of this test, the measured junction temperature is only indicative of the temperature in the immediate vicinity of the element used to sense the temperature.

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

thermal resistance, junction to specified reference point, $R_{\theta JR}$ — in degrees Celsius/watt. The thermal resistance of the microcircuit is the temperature difference from the junction to some reference point on the package divided by the power dissipation P_H .

temperature-sensitive parameter, TSP — the temperature-dependent electrical characteristic of the

junction under test which can be calibrated with respect to temperature and subsequently used to detect the junction temperature of interest.

4 Apparatus

The apparatus required for these tests shall include the following as applicable to the specified test procedures:

- a. Thermocouple material shall be copper-constantan (type T) or equivalent, for the temperature range -100 to + 300°C. The wire size shall be no larger than AWG size 30. The junction of the thermocouple shall be welded to form a bead rather than soldered or twisted. The accuracy of the thermocouple and associated measuring system shall be $\pm 0.5^\circ\text{C}$.
- b. Suitable electrical equipment as required to provide controlled levels of conditioning power and to make the specified measurements. The instrument used to electrically measure the temperature-sensitive parameter shall be capable of resolving a voltage change of 0.5 mV.
- c. Controlled temperature chamber or fluid bath capable of maintaining the specified reference point temperature to within $\pm 0.5^\circ\text{C}$ of the preset (measured) value. A typical temperature-controlled fluid bath assembly is presented for illustrative purposes only.

4.1 Fluid Bath Assembly — A typical temperature-controlled fluid bath for thermally characterizing the microelectronic device under test is shown in Figure 1. In this figure, the package is mounted in a fluid bath separate from the fluid circulator, although it can be immersed directly in an integrated fluid circulator/bath unit. The fluid in the bath should be continuously stirred or agitated to ensure the required temperature stability and uniformity. Since this working fluid is being used as an infinite heat-sink, the case-to-fluid (ambient) temperature difference at the case temperature reference point of interest should be minimized, i.e., $\leq 20^\circ\text{C}$. For case-to-fluid temperature differences $> 20^\circ\text{C}$, accuracy and repeatability difficulties may occur due to a large variable temperature gradient in the fluid film boundary layer at the package-fluid interface. The case-to-fluid temperature difference can be minimized by increasing

the fluid velocity and by decreasing the power density seen by the fluid.

The device under test should be mounted such that heat transfer to the fluid is not impeded. For leaded devices, the leads should be oriented in such a manner so as not to interfere with the heat transfer to the fluid and provide freedom to any thermal currents caused by the power dissipation within the package. The microcircuit package shall be mounted such that conduction cooling through the leads or test socket or both shall be small compared to the other cooling mechanisms. To minimize conduction through the leads, a special socket jig that connects No. 36 AWG wire to the device socket should be used.

The case temperature of the device under test should be measured with a thermocouple that is attached to the package/lead and should not be assumed to be at the fluid temperature. The working fluid should have a thermal conductivity at 25°C of at least 0.0006 W/cm°C. Working fluids such as inert fluorocarbon liquids and silicone oils are suitable as cooling media.

5 Procedure

5.1 Direct Measurement of Reference Point Temperature, $T_R = T_c$ — For the purpose of measuring a microelectronic device thermal resistance, the reference point temperature shall be measured at the package location of highest temperature which is accessible from outside the package. This reference point location is determined with the device operating in free air and with no external heat-sinking. In general, this reference point is found to be on the surface of the body of the package, or on a lead near the body, in the major path of heat flow from the chip heating surface to the ambient fluid. The package surface may be altered to facilitate this measurement provided that such alteration does not affect the original heat transfer paths and, hence, the thermal resistance, within the package by more than a few percent.

5.1.1 Case Temperature, T_c — The microelectronic device under test shall be mounted under specified conditions so that the case temperature can be held at the specified value. A thermocouple shall be attached on the surface of the device package directly under the chip (i.e., on the base plane of the package). A conducting epoxy may be used for this purpose. The thermocouple bead should be in direct mechanical contact with the package of the microelectronic device under test. Care should be taken to minimize exposure of the thermocouple bead to the high temperature gradient in the fluid film boundary layer at the package-fluid interface.

If it is found that attaching the thermocouple directly to the case is impractical, an alternate approach using a thermocouple welded to one side of a thin metal disk should be used. This can be accomplished by parallel gap welding the crossed thermocouple wires to one side of a 0.25 cm (0.094 in) diameter, 0.02 cm (0.008 in) thick beryllium-copper disk and then, with a thin layer of adhesive, bonding the other side of the disk to the case at the point of interest. The exposed thermocouple bead/wire on the disk shall be covered with epoxy or silicone rubber. The attached thermocouple should not unduly interfere with heat transfer to the fluid.

5.2 Thermal Resistance, Junction-to-Specified Reference Point, $R_{\theta JR}$

5.2.1 General Considerations — The thermal resistance of a semiconductor device is a measure of the ability of its carrier or package and mounting technique to provide for heat removal from the semiconductor junction. The thermal resistance of a microelectronic device can be calculated when the case temperature and power dissipation in the device and a measurement of the junction temperature are known.

When making the indicated measurements, the package shall be considered to have achieved thermal equilibrium when halving the time between the application of power and the taking of the reading causes no error in the indicated results within the required accuracy of measurement.

5.2.2 Indirect Measurement of Junction Temperature for the Determination of $R_{\theta JR}$ — The purpose of the test is to measure the thermal resistance of integrated circuits by using particular semiconductor elements on the chip to indicate the device junction temperature. In order to obtain a realistic estimate of the operating junction temperature, the whole chip in the package should be powered in order to provide the proper internal temperature distribution. During measurement of the junction temperature, the chip heating power (constant voltage source) shall remain constant while the junction calibration current remains stable. It is assumed that the calibration current will not be affected by the circuit operation during the application of heating power.

The temperature-sensitive device parameter is used as an indicator of an average (weighted) junction temperature of the semiconductor element for calculations of thermal resistance. The measured junction temperature is indicative of the temperature only in the immediate vicinity of the element used to sense the temperature.

The temperature-sensitive electrical parameters generally used to indirectly measure the junction temperature are the forward voltage of diodes and the

emitter-base voltage of bipolar transistors. Other appropriate temperature-sensitive parameters may be used for indirectly measuring junction temperature for fabrication technologies that do not lend themselves to sensing the active junction voltages.

5.2.2.1 Steady-State Technique for Measuring T_J —
The following symbols shall apply for the purpose of these measurements:

I_M — ring current in milliamperes.

V_{MH} — Value of temperature-sensitive parameters in millivolts, measured at I_M , and corresponding to the temperature of the junction heated by P_H .

T_{MC} — Calibration temperature in degrees Celsius, measured at the reference point.

V_{MC} — Value of temperature-sensitive parameter in millivolts, measured at I_M and specific value of T_{MC} .

The measurement of T_J using junction forward voltage as the TSP is made in the following manner:

Step 1 — Measurement of the temperature coefficient of the TSP (calibration).

The coefficient of the temperature-sensitive parameter is generated by measuring the TSP as a function of the reference point temperature, for a specified constant measuring current, I_M , by externally heating the device under test in an oven or in a fluid bath. The reference point temperature range used during calibration shall encompass the temperature range encountered in the power application test (see Step 2). The measuring current is generally chosen such that the TSP decreases linearly with increasing temperature over the range of interest and that negligible internal heating occurs in the silicon and metal traces. For determining the optimum TSP calibration or measuring current, V_{MC} vs. $\log I_M$ curves for two temperature levels that encompass the calibration temperature range of interest should be plotted. The optimum measuring current, I_M , is then selected such that it resides on the linear portion of the two V_{MC} vs. $\log I_M$ curves that were generated. A measuring current ranging from 0.05 to 5 mA is generally used, depending on the specifications and operating conditions of the device under test, for measuring the TSP. The value of the TSP temperature coefficient V_{MC}/T_{MC} , for the particular measuring current used in the test, is calculated from the calibration curve, V_{MC} vs. T_{MC} . At least three points should be used to generate the voltage vs. temperature curve for the determination of the TSP temperature coefficient.

Step 2 — Power application test.

The power application test is performed in two parts. For both portions of the test, the reference point

temperature is held constant at a preset value. The first measurement to be made is that of the temperature-sensitive parameter, i.e., V_{MC} , under operating conditions with the measuring current, I_M , used during the calibration procedure. The microelectronic device under test shall then be operated with heating power (P_H) applied. The temperature-sensitive parameter, V_{MH} , shall be measured with constant measuring current, I_M , that was applied during the calibration procedure (see Step 1).

The heating power, P_H , shall be chosen such that the calculated junction-to-reference point temperature difference as measured at V_{MH} is $\geq 20^\circ\text{C}$. In accomplishing this, the device under test should not be operated at such a high heating power level that the on-chip temperature-sensing and heating circuitry is no longer electrically isolated. Care should also be taken not to exceed the design ratings of the package-interconnect system, as this may lead to an overestimation of the power being dissipated in the active area of the chip due to excessive power losses in the package leads and wire bonds. The values of V_{MH} , V_{MC} , and P_H are recorded during the power application test.

The following data shall be recorded for these test conditions:

- Temperature-sensitive electrical parameters (V_F , V_{EB} , or other appropriate TSP).
- Junction temperature, T_J , is calculated from the equation:

$$T_J = T_R + (V_{MH} - V_{MC}) \left| \frac{\Delta V_{MC}}{\Delta T_{MC}} \right|^{-1}$$

where $T_R = T_C$

- Case temperature, T_C (including specific location).
- Power dissipation, P_H .
- Mounting arrangement (including method of thermocouple attachment and fluid temperature).

5.3 Calculations of $R_{\theta JR}$

5.3.1 Calculations of Package Thermal Resistance —

The thermal resistance of a microelectronic device can be calculated when the junction temperature, T_J , has been measured in accordance with procedures outlined in Sections 5.1 and 5.2.

With the data recorded from each test, the thermal resistance shall be determined from:

$$R_{\Theta JR} = \frac{T_J - T_R}{P_H(\text{Package})} \text{ junction - to - reference point}$$

where

$$R_{\Theta JR} = R_{\Theta JA} \text{ and } T_R = T_A.$$

6 Summary Report

The following details shall be specified as appropriate:

- Description of package; including thermal test chip, location of case or chip carrier temperature measurement(s), and mounting arrangement.
- Test condition(s), as applicable (see Section 5).
- Test voltage(s), current(s), and power dissipation of test chip.
- Recorded data for each test condition, as applicable.
- Symbol(s) with subscript designation(s) of the thermal characteristics determined.
- Accept or reject criteria.

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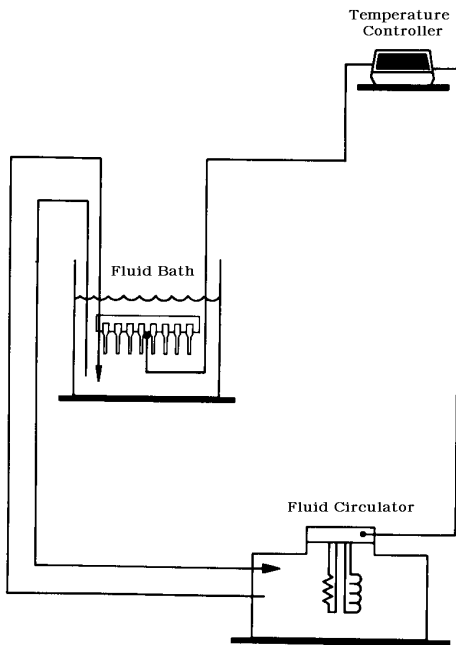


Figure 1
Temperature Controlled Fluid Bath Assembly

SEMI G44-94

SPECIFICATION FOR LEAD FINISHES FOR GLASS TO METAL SEAL CERAMIC PACKAGES (ACTIVE DEVICES ONLY)

1 Preface

1.1 This specification defines lead finishes for glass to metal seal ceramic packages assembled with iron-nickel alloy leadframe construction. It defines composition, properties, limits, and refers to appropriate tests for utility.

1.2 *Scope* — The criteria detailed in this document applies to glass to metal seal ceramic packages, assembled with iron-nickel alloy leadframe construction, which conforms to composition limits specified in MIL-M-38510 as lead material Type A or Type B.

1.3 *Units* — U.S. Customary (inch-pound) or metric (SI) units may be used at the customer's discretion. This specification uses U.S. Customary units as the prime unit.

2 Applicable Documents

2.1 *Order of Precedence* — To avoid conflicts, the order of precedence when ordering packages shall be as follows:

- Purchase Order
- Customer Package Drawing
- This Specification
- Reference Documents
- Related Documents

2.1.1 SEMI Specifications

SEMI G2 — Specification; Metallic Leadframes for Cer-DIP Packages

SEMI G35 — Specification; Test Methods for Lead Finishes on Semiconductor (Active Devices)

2.1.2 ASTM Specifications¹

B 487 — Measuring Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section

B 545 — Standard Specification for Electro-deposited Coatings of Tin

B 567 — Measurement of Coating Thickness by the Beta Backscatter Principle

B 568 — Measurement for Coating Thickness by X-Ray Spectrometry

B 571 — Adhesion of Metallic Coatings

E 384 — Standard Test Methods for Micro-hardness of Materials

2.1.3 Federal Specification²

QQ-S-571 — Solder, Tin Alloy; Tin-Lead Alloy; and Lead (Pb) Alloy

2.2 Military Specifications²

MIL-T-10727 — Tin Plating; Electrodeposits or Hot Dipped, for Ferrous and Non-Ferrous Metals

MIL-G-45204 — Gold Plating, Electrodeposited

MIL-STD-883 — Test Methods and Procedures for Microelectronics

MIL-M-38510 — Microcircuits, General Specification

3 Terminology

blister — An enclosed localized separation of the plating from its base metal or an underplated layer that does not expose the underlying layer.

pit — A shallow depression or crater. The bottom of the depression must be visible.

solder — As used in this specification, refers to tin lead (Pb) as 63/37 or 60/40, unless otherwise specified and agreed upon between user and supplier and stated on procurement drawings.

4 Dimensions and Material

Composition limits, mechanical and physical properties, dimensions and tolerances for Cer-DIP leadframes are as stated in SEMI G2.

Table 1 lists recommended finishes for devices employing iron nickel alloy leadframe (MIL-M-38510 Lead Material Type A or Type B).

Gold plate is useable in socketed applications as well as in soldered applications. Hardness, grain size, and other properties shall be specified in the procurement drawing.

¹ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

² Military Standards, Naval Publications and Form Center, 5801 Tabor Avenue, Philadelphia, PA 19120

5 Lead Finish Requirements

5.1 Tin Electroplate

5.1.1 *Composition* — The tin deposit shall not be less than 99.8% pure tin and shall not contain more than 0.05% pure carbon. The deposit is Type 1 as defined in MIL-T-10727.

5.1.2 *Characteristics* — The procedure used for evaluating the tin coating and the general requirements for the coating shall comply with ASTM B 545 or the latest current revision, except where noted below.

5.1.2.1 *Thickness* — The plated coating as measured on the major flat of the leads shall be a minimum of 300 microinches (7.5 micrometers).

5.1.2.2 *Appearance* — Surface appearance shall be smooth, fine grained, adherent and free from exposed basis metal or underplate, visible blisters, pits, nodules, porosity, indications of burning, excessive edge buildup and other detrimental defects.

5.1.2.3 *Hardness* — None specified.

5.1.2.4 *Preservation* — Preservation coating, if desired and agreed upon by user and supplier, is acceptable. (Example: Stearic acid solution in xylol as defined in MIL-T-10727.)

5.2 Tin Lead (SnPb) Electroplate

5.2.1 *Composition* — Major constituents shall be tin and lead (Pb) with minor impurities. Range of major constituents shall be:

Tin	50%-98%
Lead (Pb)	2%-50%
Nominal	60% Tin, 40% Lead (Pb)

NOTE: Users should be advised that many plating solutions containing lead (Pb) also contain acid fluorides. Such solutions will attack those glass materials commonly used in ceramic packages. Adequate process controls must be developed and used in conjunction with this plating process to ensure package and device integrity.

5.2.2 *Purity and Application* — Per MIL-M-38510.

5.2.3 *Thickness* — Shall be a minimum of 7.5 micrometers (300 microinches) as measured on the major flat of the leads.

5.2.4 *Appearance* — Surface appearance shall be smooth, fine-grained, adherent, and free from exposed basis metal or underplate, visible blisters, pits, nodules, porosity, indications of burning, excessive edge buildup and other detrimental defects.

5.2.5 *Hardness* — None specified.

5.3 Tin/Lead (Pb) Solder-Dip

5.3.1 *Solder Pot Composition and Purity* — Sn60 or Sn63, per QQ-S-571.

5.3.2 *Thickness* — Shall be a minimum of 5 micrometers (200 microinches) as measured on the major flat of the leads.

5.3.3 *Process Conformance* — Solder coating is applicable as shown in Table 1. In addition, the coating is acceptable as follows:

1. Over the electroplated tin or tin/lead as per Section 4.1 or 4.2.
2. Over the electroplated gold as per Section 4.4.

5.3.4 *Appearance* — Surface shall be smooth and continuous.

5.3.5 *Hardness* — None specified.

5.3.6 *Coverage* — Electroplated packages.

5.3.6.1 The solder dip shall extend up to and beyond the effective seating plane for Cer-DIPs.

5.3.6.2 The solder dip shall extend within .030" from glass seal for Cer-Packs.

5.3.7 *Coverage* — Non-coated packages.

5.3.7.1 When applied over the base metal, hot solder dip shall cover the entire lead to the glass seal or point of emergence of the lead or metallized contact through the package wall.

5.4 Gold Electroplate

5.4.1 *Composition* — Gold plating shall be applied in accordance with MIL-G-45204 in any and all of the following grades depending on application.

Type I	99.7% minimum
Type II	99.0% minimum
Type III	99.9% minimum

NOTE: Type II is suitable for socketing application only.

5.4.2 *Thickness* — Shall be 1.27–5.72 micrometers (50-225 microinches) as measured on the major flat of the leads per MIL-M-38510.

5.4.3 *Appearance* — Surface appearance shall be smooth, fine-grained, adherent and free from exposed basis metal or underplate, visible blisters, pits, nodules, porosity, indications of burning, excessive edge buildup, and other detrimental defects.

5.4.4 *Purity* — Composition limits are as specified in Section 4.4.1 above. Individual metallics in the deposit shall not exceed 0.1%. Metallic hardening agents,

purposely added to adjust a plating bath to specified hardness are not considered as impurities.

5.4.5 Hardness — Depending on type and application, hardness is specified, using Knoop indenter in the following categories (testing is done as per ASTM E 384):

<i>Type</i>	<i>Grade</i>	<i>Hardness (Knoop)</i>
I	A	90 max
	B	91-129
	C	130-200
II	B	91-129
	C	130-200
	D	201 and over
III	A	90 max

5.5 Reflowed Plated Tin or Plated Tin/Lead

5.5.1 Composition — As per the plated finish, Section 4.1.2 or 4.2.1, as applicable.

5.5.2 Characteristics — As per 4.1.2 and 4.2, as applicable.

5.5.3 Thickness — The thickness of such reflowed coatings must be a minimum of 200 microinches measured on a significant surface.

5.5.4 Appearance — The appearance of reflowed coatings must be smooth and continuous.

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Table 1 Recommended Finishes

<i>Finish</i>	<i>Mil Spec</i>	<i>Over Base Metal</i>	<i>Undercoating</i>			
			<i>Ni</i>	<i>Sn</i>	<i>SnPb</i>	<i>Au</i>
Tin	MIL-T-10727	X	X			
TinLead (SnPB)	MIL-M-38510	X	X			
Electroplate Solder	QQ-S-571	X	X	X	X	X
DIP(SnPb) Gold	MIL-G-45204	X	X*			

*Ni undercoat required by MIL-M-38510.

6 Test Methods

Tests for the lead finishes shall be in accordance with SEMI G35.

7 Sampling

The sampling plan, based on MIL-STD-105 shall be agreed between vendor and customer.

SEMI G45-93

RECOMMENDED PRACTICE FOR FLASH CHARACTERISTICS OF THERMOSETTING MOLDING COMPOUNDS

1 Scope

This method describes a procedure for measuring the flashing characteristics of semiconductor grade transfer molding compounds.

2 Significance

2.1 The flashing tendency for semiconductor grade molding compounds depends on the interaction of several variables, including mold conditions, process parameters, molding compound viscosity, and curing characteristics. This test is not a valid method for predicting the flashing performance in all mold types. It is a method for comparing flash tendency and flashing type of different molding compounds when evaluated under a specific set of molding process parameters.

2.2 Flashing presents problems with subsequent processing of plastic packaged devices after molding. A high flashing tendency increases die wear in the trim and form operation, may interfere with plating or solder dip finishing operations, and may prevent good contact for electrical test. Thus, reduced tendency toward flashing will improve the plastic package subassembly operations. The information from this test will be of value in rating flash performance of any given compound to that in production use.

3 Apparatus

3.1 Transfer molding press with a platen area sufficient to maintain a uniform mold temperature and having (1) a transfer piston pressure potential of 1000 psi on the material; (2) sufficient clamping pressure to prevent flashing of the molding compound at clamping lands; and (3) a minimum plunger speed of 25.4 mm (1 inch) per second without load. The pot diameter shall be 31.75 to 44.45 ± 0.735 mm (1.250 to 1.750 ± 0.025 inch) and the clearance between pot and ram shall be sufficiently small that flashing does not occur above the first sealing groove on the ram.

3.2 *Standard Flash Test Mold* — Per Figure 1.

3.3 *Force Gauge* — With appropriate range to calibrate transfer pressure to minimum of 10.343 mpa (1,500 psi).

3.4 *Steel Rule* — Measured in 0.25 mm (0.010 in).

3.5 *Halo Lamp* — 3× magnification, minimum.

3.6 *Thermocouple and/or Pyrometer Calibrated* — In the 160°–190°C range (calibration to be checked every 6 months).

4 Test Conditions

4.1 *Molding Compounds* — Refrigerated shipment and storage of some molding compounds is necessary. The molding compound is to be at room temperature before the container is opened. Care must be taken to preserve the original moisture content. The material should be in powdered form, unless otherwise specified.

4.2 *Flash Test Mold* — Shall be clean and free from any mold release agents or lubricants. A standard mold cleaning compound can be used to insure mold cleanliness.

4.3 Molding Conditions

4.3.1 The temperature of the mold shall be measured using a thermocouple inserted in the mold or with a surface pyrometer. The ram shall be kept at the mold temperature. Molding temperature is to be 175°C unless otherwise specified. Temperature must be maintained within $\pm 3^\circ\text{C}$ ($\pm 5^\circ\text{F}$) of the specified temperature.

4.3.2 The transfer pressure for test, as measured under the transfer plunger, is to be 6.895 ± 0.177 mpa (1000 ± 25 psi) unless otherwise specified.

4.3.3 The weight of the charge shall be adjusted to give a molded cull thickness of 3.303 ± 0.254 mm (0.130 ± 0.010 ") excluding vertical flash.

4.3.4 The free running ram speed shall be at least 25.4 mm/sec (1"/sec). Recommended speed is 100 ± 25 mm/sec into the pot and application of pressure on the charge shall be maintained throughout the mold cycle.

4.3.5 Unless otherwise specified, a minimum of 1.5 minutes close and cure time shall be used.

4.3.6 Flash length shall be measured in 0.25 mm (0.010 in) intervals.

5 Procedure

5.1 Thoroughly clean the ram, pot, and mold of any cured compound, or other foreign matter.

5.2 Heat the mold and ram to within $\pm 3^\circ\text{C}$ of the specified temperature.

5.3 At the beginning of each series of tests and at each change of compound, check and set the transfer pressure using the force gauge. The proper force gauge setting can be determined from the formula:

$$F = \frac{\pi D^2 P}{4}$$

where F is the force in pounds, P is the desired pressure on the material in psi, and D is the ram diameter in inches.

5.4 For each material change, make at least three clean out runs using the material to be tested before recording data. These runs may be used to determine the charge weight.

5.5 Weigh out the compound to the nearest 0.1 g as previously determined to yield a cull of 3.302 ± 0.254 mm (0.130 ± 0.010 in).

5.6 Raise the ram, add the compound to the pot, and immediately activate the transfer cycle.

5.7 Remove cull and measure thickness. If the cull is not within 0.130 ± 0.010 in, discard the run and repeat the test, adjusting the charge weight as necessary.

5.8 Open mold and measure longest flash for each channel to nearest 0.25 mm (0.010 in) using 3× minimum magnification. Be sure to check both top and bottom plates of mold before measuring flash.

NOTE: Care must be taken to include the measurement of transparent and semi-transparent flash which may be present in the smaller channel. After measurements, diligence is required to remove all flash, including the transparent and semi-transparent varieties prior to the next test.

5.9 Repeat Steps 5.6 through 5.8 at least 3 times for repeatability.

6 Reporting of Results

6.1 Report the material designation and lot number.

6.2 Report the average and standard deviation of the flash length in each channel.

6.3 Report the temperature and pressure used for the tests.

NOTE: Common Errors/Problems:

- Inadequate preheat of flash mold and/or transfer plunger prior to test and between shots.
- Incorrect cull thickness.
- Omission of transparent or semi-transparent flash in measurement (often present in smallest two channels).

- Inadequate cleaning of mold between shots.
- Starting from the end of the ruler to make flash length measurements instead of starting at a known distance from the end.
- Inadequate mold break-in. Three shots should be run and disregarded before recording flash measurements for each material.
- Sprue, channel entry point, and mating mold surface wear may produce error in measurement and correlation problem. The impact of wear on results has not been determined. Extent of permissible mold wear requires agreement between testing organizations.

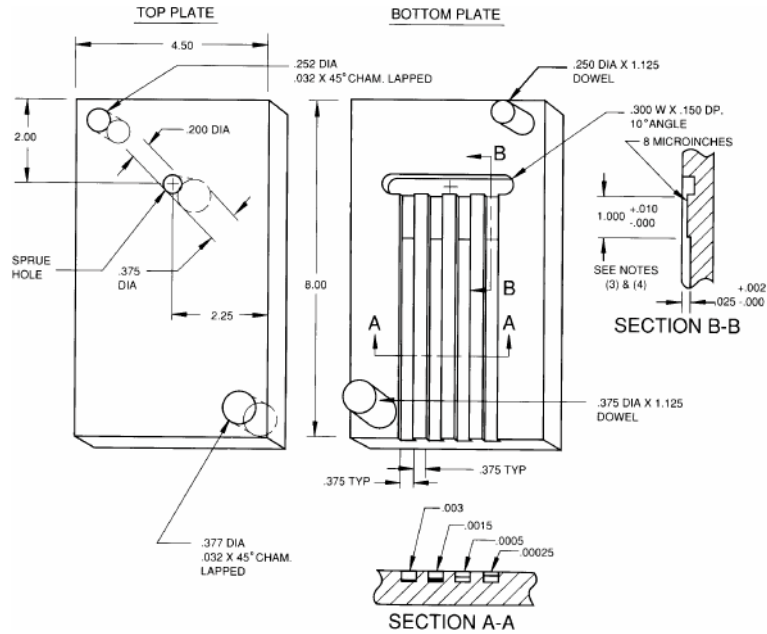


Figure 1
Flash Test Mold

1. Hand Mold, Polished, Very Well Mated Surfaces, Base Plates 0.75 thk.
2. Mold: Common Runner Feeds Flash Channels of 0.003, 0.0015, 0.0005, and 0.00025 inches by 0.375 wide \pm 0.00025.
3. Mold Flash Channels: Surface Finish 8 microinches
4. Mold Flash Channels Depth Tolerance:
 - a. \pm 0.00005" for 0.00025 and 0.0005: Channels
 - b. \pm 0.0002" for 0.0015 and 0.003 Channels

AUXILIARY INFORMATION

<i>Conversions Inches</i>	<i>Conversions Millimeters</i>
8.000	203.20
4.500	114.30
2.250	57.15
2.000	50.80
1.125	28.58
1.000	25.40
0.377	9.58
0.375	9.53
0.300	7.62
0.252	6.40
0.250	6.35



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SEMI G46-88

TEST METHOD FOR THERMAL TRANSIENT TESTING FOR DIE ATTACHMENT EVALUATION OF INTEGRATED CIRCUITS

1 Introduction

1.1 *Purpose* — Evaluation of semiconductor die attachment integrity using the thermal transient techniques as implemented by the Electrical Test Method on either thermal test chips or active devices.

1.2 *Rationale* — Steady state thermal response (or thermal resistance) and thermal transient response of discrete semiconductor devices and integrated circuits are sensitive to the presence of voids in the die attachment material between the semiconductor chip and package. These voids impede the flow of heat from the chip to the substrate (package). Due to the difference in the thermal time constants of the chip and package, the measurement of transient thermal response can be made more sensitive to the presence of voids than can the measurement of steady state thermal response. This is because the chip thermal time constant is generally several orders of magnitude shorter than that of the package. Thus, the heating power pulse width can be selected so that only the chip and the chip to substrate interface are heated during the pulse by using a pulse width somewhat greater than the chip thermal time constant, but less than that of the substrate. Heating power pulse widths ranging from 10 to 400 milliseconds have been found to satisfy this criterion. This enables the detection of voids to be greatly enhanced, with the added advantage of not having to heat sink the device under test. Thus, the transient thermal response technique is less time consuming than the measurement of thermal resistance for use as a manufacturing screen, process control or incoming inspection measure for die attachment integrity evaluation.

1.3 *References* — The following documents are recommended reading for reference and test method standard description purposes:

SEMI G32 — Unencapsulated Thermal Test Chip

*MIL-STD-883C*¹ — Method 1012, Thermal Characteristics

2 Definitions

The following symbols and terminology shall apply for the purpose of this test method.

2.1 V_F — the forward biased voltage of the diode junction within the Device-Under-Test (DUT) used for junction temperature sensing.

2.2 V_{Fi} — the initial V_F value before application of heating power.

2.3 V_{Ff} — the final V_F value after application of heating power.

2.4 ΔV_F — the change in the temperature sensitive parameter, V_F , due to the application of heating power to the DUT.

2.5 V_H — the voltage applied to the DUT during the heating time in order to cause power dissipation.

2.6 I_H — the heating current resulting from the application of V_H to the DUT.

2.7 P_H — the heating power pulse magnitude; product of V_H and I_H .

2.8 t_H — the duration of P_H (applied to the DUT).

2.9 I_M — the measurement current used to forward bias the temperature sensing diode junction for measurement of V_F .

2.10 t_{MD} — measurement delay time can be defined in one of two ways:

2.10.1 the time from the start of heating power (P_H) removal to the completion of the final V_F measurement; or

2.10.2 the time from the start of heating power (P_H) removal to the start of the final V_F measurement time, referred to as t_{SW} .

2.11 t_{SW} — sample window time during which final V_F measurement is made; applicable only if t_{MD} definition 2.10.2 is used.

2.12 K — the temperature-sensitive parameter temperature coefficient measured at IM in °C per millivolt.

2.13 CU — the comparison unit consisting of ΔV_F divided by I_H , that is used to normalize the transient thermal response for variations in power dissipation; in units of mV/A.

2.14 T_j — the device-under-test junction temperature.

2.15 ΔT_j — the change in T_j caused by the application of P_H for a time equal to t_H .

¹ Military Standards, Naval Publications and Form Center, 5801 Tabor Avenue, Philadelphia, PA 19120

2.16 σ_{Δ} — the standard deviation if the ΔV_F results for a given test condition.

2.17 σ_{CU} — the standard deviation of the CU results for a given test condition.

3 Test Operation

The following paragraphs describe in conceptual detail the operation of the test for integrated circuit thermal response.

3.1 *Set-Up* — Shown in Figure 1 is the set-up required for testing either active devices or thermal test chips. Figure 1a is used for those cases in which the TSP is the junction isolation diode forward biased voltage. Thermal test chips and test IC's for which the junction isolation diode is either not available, or desirable for temperature sensing, can be handled by the set-up shown in Figure 1b.

3.2 *Apparatus* — To implement either version of Figure 1 requires the following apparatus:

3.2.1 A constant voltage source capable of adjustment to the desired value of V_H and able to supply the I_H value drawn by the DUT.

3.2.2 A constant current source to supply I_M with sufficient voltage compliance to turn the TSP junction fully on.

3.2.3 An electronic switch capable of switching between the heating period conditions and measurement conditions in a time frame short enough to avoid DUT cooling during the transition; this typically requires switching in the microsecond range.

3.2.4 A voltage measurement circuit capable of accurately making the V_H measurement within the t_{MD} (or t_{MD} plus t_{SW} , depending on the definitions stated previously) time frame with millivolt resolution.

3.3 *Operation and Waveforms* — The test begins with the adjustment of I_M and V_H to the desired values. Then with the electronic switch in position 1, the value of V_F is measured. The switch is then moved to position 2 for a length of time equal to t_H and the value of I_H is measured. Finally, at the conclusion of t_H , the switch is again moved to position 1 and the V_F value is measured within a time period defined by t_{MD} (or t_{MD} plus t_{SW} , depending on the definitions stated previously). The voltage and current sources are then turned off at the completion of the test.

The voltage and current waveforms for the two versions of Figure 1 are shown in Figure 2.

4 Test Procedure

The procedures below describe how to set up the test conditions and determine the acceptance limits for implementing the transient thermal test for die attachment evaluation using the apparatus and definitions stated above.

4.1 *Initial Device Testing Procedure* — The following steps describe in detail how to set up the apparatus described previously for proper testing of various integrated circuit devices.

Step 1 — From a 10 to 15 piece sample of the integrated circuits to be tested, pick any one device to start the set-up process. Set up the test apparatus as follows:

$V_H = 5.0$ V (Or some other desired value near the device under tests (DUT's) normal operating voltage.)

$t_H = 200$ ms

$t_{MD} = 15$ μ s

$I_M = 1.0$ mA (Or some other value appropriate for the specific device under test; typically in the range of 80 μ A to 9.9 mA.)

Step 2 — Insert device into the apparatus test fixture and initiate a test.

(For best results, a test fixture that offers some form of heat sinking would be desirable.)

Step 3 — If ΔV_F is in the 20 to 40 mV range, then proceed to the next step. This range corresponds to a junction temperature change of roughly 10°C to 20°C and is sufficient for initial comparison purposes.

If ΔV_F is less than 20 mV, return to Step 1 and increase heating power into device by increasing V_H , or by reconfiguring the DUT connections for greater power dissipation, or a combination of both.

If ΔV_F is greater than 80 mV, corresponding to a junction temperature change greater than 40°C, it would probably be desirable to reduce the heating power by returning to Step 1 and reducing V_H , or by reconfiguring the DUT connections to reduce power dissipation, or a combination of the two. Reducing V_H is the preferable approach.

Because two different devices can show the same rise in junction temperature, even if the value of P_H is different, a comparison of the devices is best accomplished using the CU value. As defined in Section 2 above, CU provides a comparison unit that takes into account different device I_H values for a given V_H test condition.

Step 4 — Test each of the sample devices and record the ΔV_F and CU data as shown in Figure 3.

Step 5 — Select out the devices with the highest and lowest values of CU and put the remaining devices aside.

The ΔV_F values can be used instead of CU if the measured values of I_H are very tightly grouped around the average value.

Step 6 — Following the Heating Time (t_H) sequence shown in Figure 4, read and record the ΔV_F and CU data values for each of the two devices of Step 5.

Step 7 — Using the data from the previous step, prepare heating curves for the two devices in a manner similar to the examples shown in Figure 5.

Step 8 — Interpretation of the heating curves is the next step. Realizing that the thermal characteristics of identical chips should be the same if the heating time (t_H) is less than or equal to the thermal time constant of the chip, the two curves should start out the same for the low values of t_H . Non-identical chips (i.e., thinner or smaller in cross section) will have completely different curves, even at the smaller values of t_H . As the value of t_H is increased, thereby overcoming the chip thermal constant, heat will have propagated through the chip into the die attachment region. Since the heating curve devices of Step 5 were specifically chosen for their difference, the curves of Figure 5 diverge after t_H reaches a value where the die attachment variance has an effect on the device junction temperature. Increasing t_H further will probably result in a flattening of the curve as the heating propagates in the device package. If the device package has little thermal mass and/or is not well mounted to a good heat sink, the curve will not flatten very much, but will show a definite change in slope. Figure 6 shows the key elements of the heating curve.

Step 9 — Using the heating curve, select the appropriate value of t_H to correspond to the inflection point in the transition region between heat in the chip and heat in the package.

If there are several different elements in the heat flow path—chip, die attachment, substrate, substrate attachment, and package, for example, in a hybrid there will be several plateaus and transitions in the heating curve. Appropriate selection of t_H will optimize evaluation sensitivity to other attachment areas.

Step 10 — Return to the apparatus and set t_H equal to the value determined from Step 9.

Step 11 — Because the selected value of t_H is much less than that for thermal equilibrium, it is possible to significantly increase the heating power without degrading or destroying the device. The increased power dissipation within the device under test will result in high ΔV_F and/or CU values that will make determination of acceptable and non-acceptable devices much easier.

Step 12 — The pass/fail limit, the cutoff point between acceptable and non-acceptable devices, can be established in a variety of ways:

a) Correlation to other die attachment evaluation methods, such as die shear and/or x-ray; while these two methods have little actual value from a thermal point of view, they do represent standardized methods as described in MIL-STD specifications.

b) Maximum allowable junction temperature variation between devices; since the relationship between ΔT_J and ΔV_F is about $0.5^\circ\text{C}/\text{mV}$, the junction temperature spread between devices can be easily determined. The T_J predicts reliability. Conversely, the T_J spread necessary to meet the reliability projections can be translated to a ΔV_F and/or CU value for a Pass/Fail criteria, based on correlation with steady-state thermal equilibrium conditions.

To fully use this approach, it will be necessary to calibrate the devices for the exact value of the $T_J - V_F$ characteristic. The characteristic's slope, commonly referred to as K Factor, is easily measured on a sample basis using a voltmeter, environmental chamber, temperature indicator and a power supply setup for forcing, both active devices and thermal test chips as shown in Figure 7. A simple set of equations yields the junction temperature once K and ΔV_F are known:

$$\Delta T_J = |K| (\Delta V_F)$$

$$T_J = T_A + \Delta T_J$$

Where T_A is the ambient or reference temperature.

c) Statistically from a moderate size device sample; the distribution of ΔV_F or CU values should be a normal one with defective devices out of the normal range. Figure 8 shows a ΔV_F distribution for a sample lot of integrated circuits. Note that the left-hand side of the histogram envelope is fairly well-defined, but the other side is greatly skewed to the right. This comes about because the left-hand side is constrained by the absolutely best heat flow that can be obtained with a given chip assembly material and process. The other side has no such constraints because there is no limit as to how poorly a chip is mounted.

The usual rule of thumb in setting the maximum limit for ΔV_F or CU is to use the distribution average value and one standard deviation (σ) i.e. —

$$\left. \begin{array}{l} (\Delta V_F) \\ \text{high} \\ \text{limit} \end{array} \right\} = \overline{\Delta V_F} + X\sigma_{\Delta}$$

$$\left. \begin{array}{l} (CU) \\ \text{high} \\ \text{limit} \end{array} \right\} = \overline{CU} + X\sigma_{CU}$$

Where $X = 1$ in most cases.

The statistical data required is obtained by testing 40 or more devices under the conditions of Step 11.

Step 13 — Once the test conditions and pass/fail limit have been determined, it is necessary only to record this information for future testing requirements of the same device in the same package. With the apparatus properly set-up, including the fail limit selector on those apparatus set ups so equipped, the operator need only insert the device, initiate a test, and then either read the ΔV_F or CU display or observe the appropriate pass or fail indicators.

The steps listed hereto have been conveniently summarized in Figure 9. The total time required to perform these steps is greatly dependent on the operator but, in general, should require about one hour if the statistical approach of Step 12.C is used.

4.2 Routine Device Testing Procedure — Once the proper control settings have been determined for a particular device type from a given manufacturing process or vendor, repeated testing of that device type simply requires that the same test conditions be used as previously determined.

New device types or the same devices manufactured with a different process will require a repeat of Section 4.1.

4.3 Comparison of Different Vendor Devices — Each device type is defined as a specific chip manufactured to a given set of procedures. Integrated circuit users who buy a specific part number from more than one vendor or manufacturers that redesign or otherwise modify the fabrication of their devices will be able to use the heating power and approximately the same t_H for all vendors, but probably will have to use a different ΔV_F or CU pass/fail limit for each different vendor because the K Factor for parts manufactured by different vendors will probably be different. The difference can be determined in Step 12.B and using the setup described in Figure 7.

5 Test Condition Specification

To properly set up the test apparatus and to insure repeatable measurements, the following test conditions must be fully specified:

- V_H
- t_H
- I_M
- t_{MD} (and t_{SW} if appropriate)
- DUT/apparatus interface (i.e., wiring connection)
- ΔV_H or CU data requirement

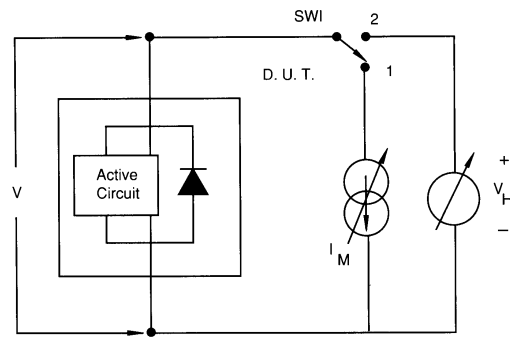


Figure 1A
Set-Up for Junction Isolation Diode Devices

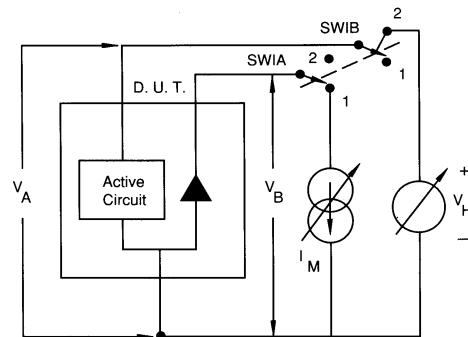


Figure 1B
Set-Up for Parasitic Diode or Thermal Test Chip Temperature Sensing

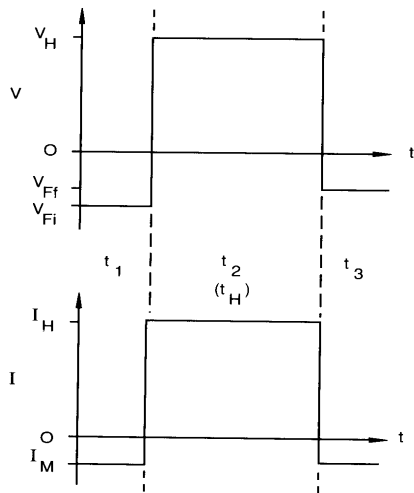


Figure 2A
Waferforms Associated with Figure 1A

DUT #	CU (mV/A)	
1	195	"Lo"
2	198	
3	242	
4	212	
5	226	
6	207	
7	219	
8	241	"Hi"
9	268	
10	218	
11	253	
12	199	
13	234	
14	227	
15	218	

Figure 3
Data Results for Initial 15-Piece Sample for tH
Value of 200 ms

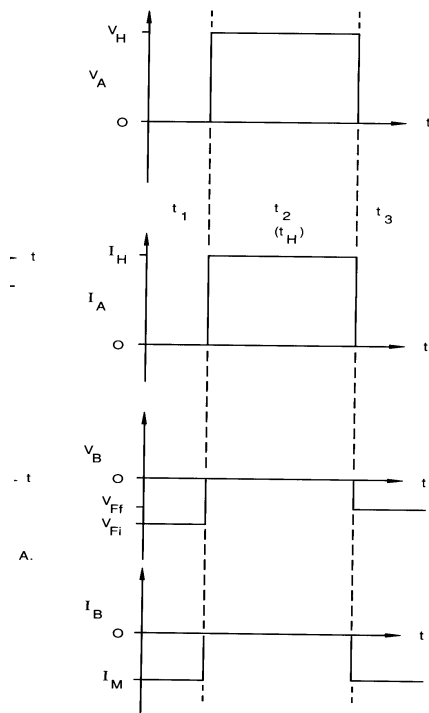


Figure 2B
Waferforms Associated with Figure 2B

Heating Time t_H (seconds)	DUT #1 CU (m V/A)	DUT#9 CU (m V/A)
1×10^{-4}	43	43
1.5	43	43
2	43	43
3	43	43
4	43	43
6	43	43
8	43	43
1×10^{-3}	45	45
1.5	45	45
2	47	47
3	48	48
4	50	50
6	51	53
8	58	63
1×10^{-2}	63	70
1.5	75	86
2	85	100
3	100	122
4	112	140
6	130	168
8	145	190
1×10^{-1}	157	208
1.5	179	243
2	195	268
3	220	308
4	239	337
6	265	373
8	285	398
1×10^0	300	416
1.5	323	449
2	340	470
3	362	497
4	377	518
6	398	518
8	411	563
1×10^1	421	578

Figure 4
Heating Curve Data for Highest and Lowest Reading Devices from Figure 3

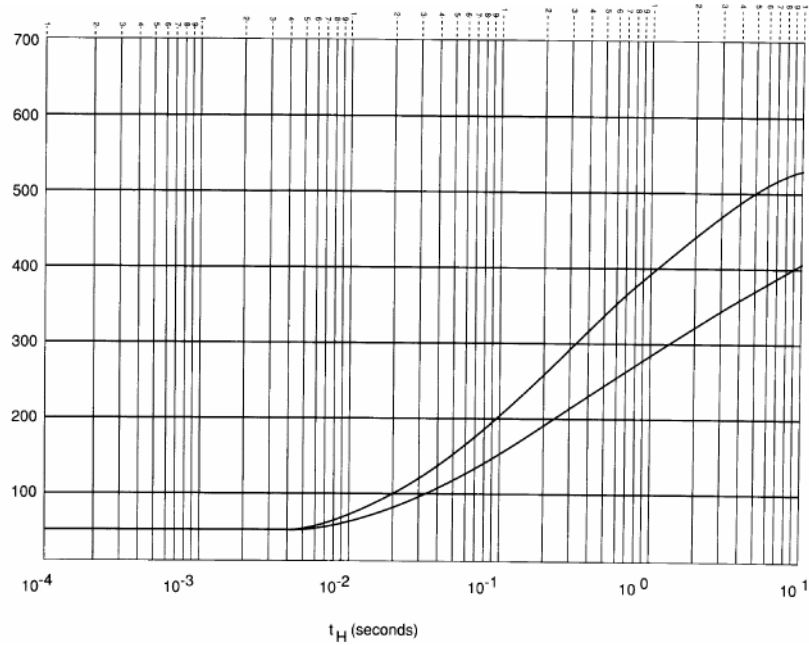


Figure 5

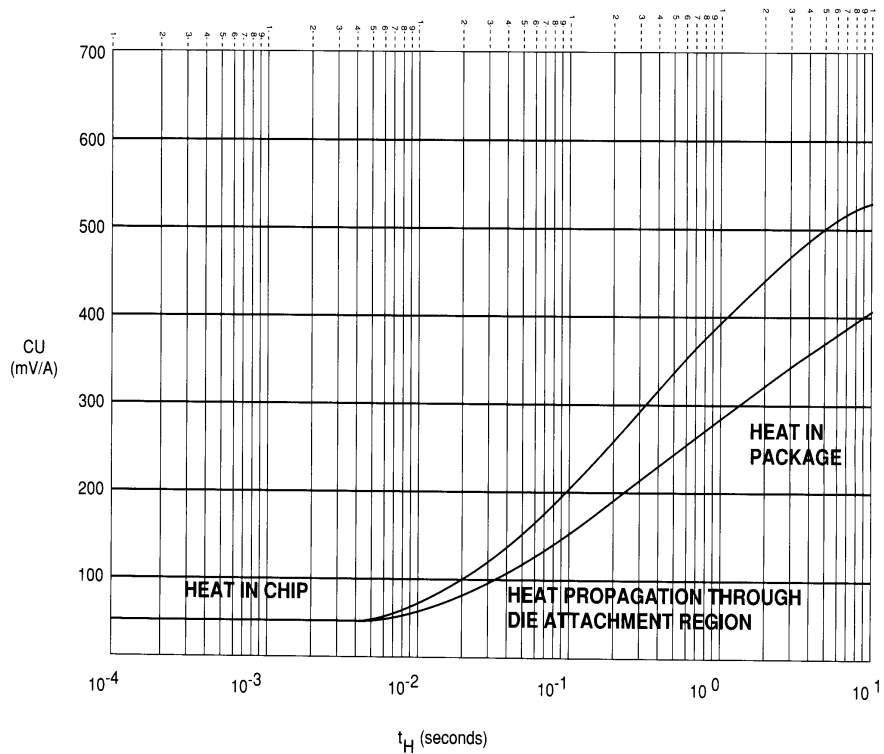
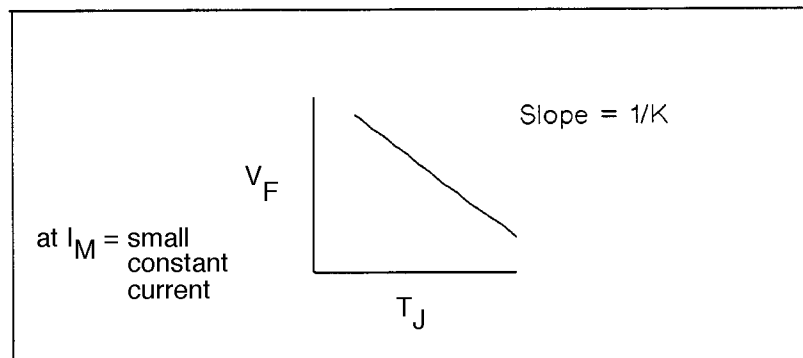
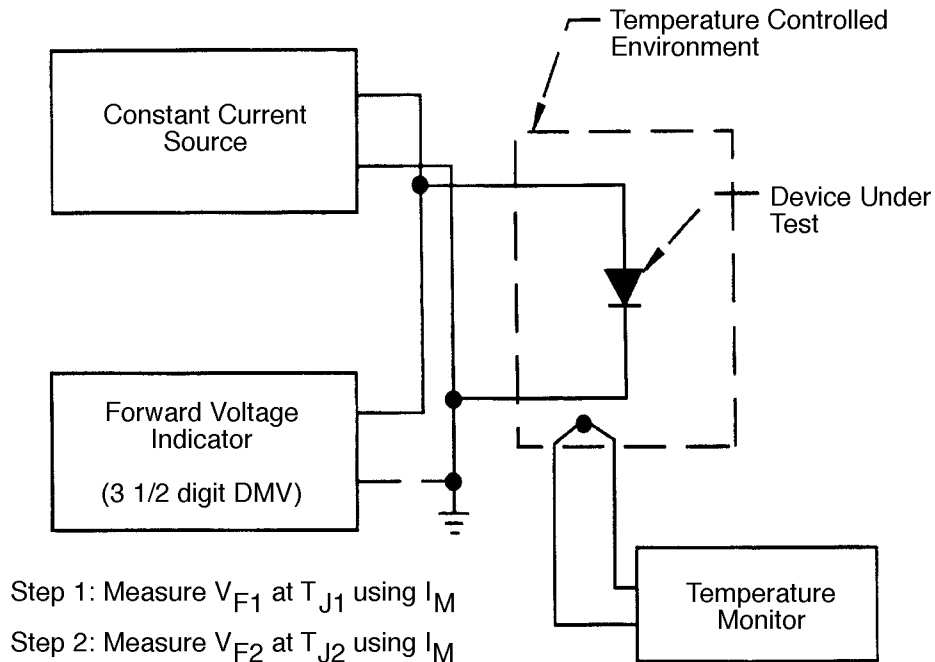


Figure 6
Interpretation of Heating Curves of Figure 5

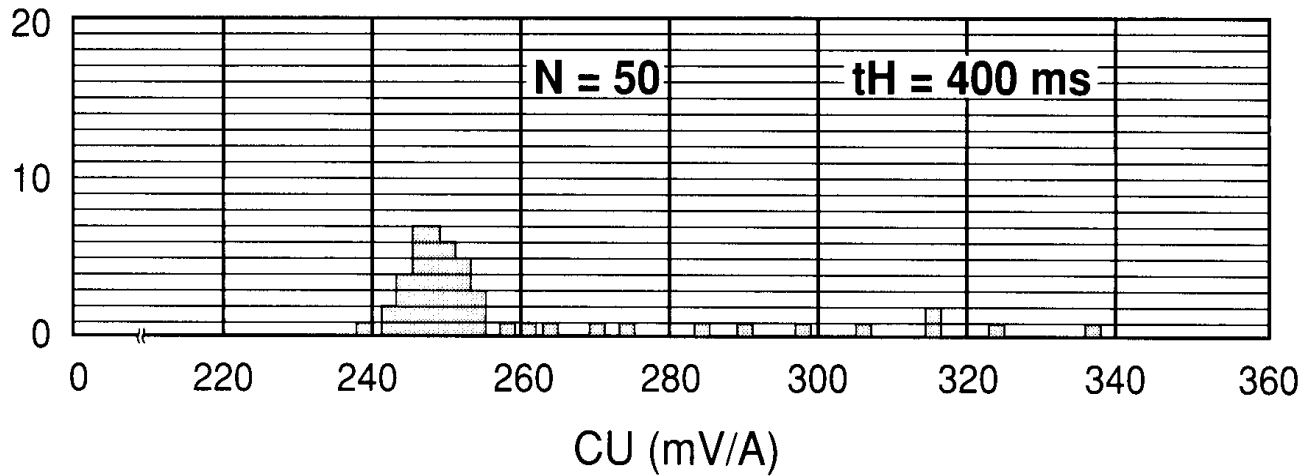
NOTE: Inflection point in curve occurs at approximately $t_H = 400$ ms.



I_M must be large enough to overcome surface leakage effects but small enough not to cause significant self-heating

T_J is externally applied - via oven, liquid, etc.
- environment

Figure 7
K Factor Calibration Setup and Procedure



$$V_H = 5.0 \text{ v}$$

$$\overline{CU} = 249 \text{ mV/A}$$

$$T_H = 400 \text{ ms}$$

$$\sigma_{cu} = 53.5 \text{ mV/A}$$

$$I_M = 1.0 \text{ mA}$$

$$CU = 302.5 \text{ mV/A}$$

$$t_{MD} = 20$$

high
limit

Figure 8

CU bar graph shows thermal distribution of 50 devices when tested at a heating time of 400 ms. (Note: CU data rounded off to nearest m V/A.)

	General Description	Steps	Comments
A	Initial Setup	1 thru 4	Approximate instrument settings to find variations among devices in 10 to 15 piece sample.
B	Heating Curve Generation	5 thru 7	Using highest and lowest reading devices, generate Heating Curves.
C	Heating Curve Interpretation	8 thru 10	Heating Curve is used to find more appropriate value for t_H corresponding to heat in the die attachment are (or some other desired interface in the heat flow path).
D	Final Setup	11	Heating Power applied during t_H is increased in order to improve measurement sensitivity to variations among devices.
E	Pass/F Determination	12 thru 13	A variety of methods is available for setting the fail limit; the statistical approach is the fastest and easiest to implement.

Figure 9 — Summary table of steps required to implement thermal transient testing for IC die attachment evaluation.

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SEMI G47-88

SPECIFICATION FOR PLASTIC MOLDED QUAD FLAT PACK LEADFRAMES

1 Preface

This specification defines the acceptance criteria for leadframes designed for assembly of JEDEC registered publication 95 standard outlines for "Plastic Quad Flat Pack 0.025" lead spacing (gull wing) packages". It is a design guideline for packaging engineers, leadframe stampers and etchers, mold and trim/form tooling manufacturers. It has been developed to meet the requirements of assemblers using automatic and manual equipment.

2 Applicable Documents

2.1 SEMI Specifications

SEMI G4 — Specification, Integrated Circuit Leadframe Materials in the Production of Stamped Frames

SEMI G18 — Specification, Integrated Circuit Leadframe Materials Used in the Production of Etched Frames

SEMI G10 — Standard Method, Mechanical Measurement for Plastic Package Leadframes

SEMI G21 — Specification, Plating Integrated Circuit Leadframes

2.2 ANSI Specification¹

Y 14.5M-1982 — Dimensioning and Tolerancing

2.3 JEDEC Specification²

Registration 95 — Plastic Quad Flat Pack, 0.025" Lead Spacing (Gull Wing)

2.4 Military Specification³

MIL-STD-105 — Sampling Procedures and Tables for Inspection by Attributes

3 Selected Definitions

burr — a fragment of excess material either horizontal or vertical attached to the leadframe.

camber — curvature of the leadframe strip edge (see Figure 1).

coil set — Longitudinal bowing of the leadframe (see Figure 2).

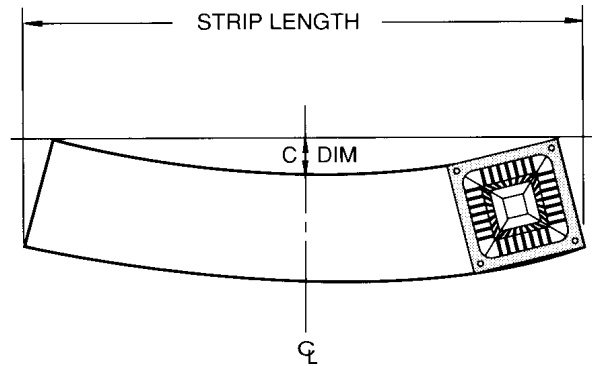


Figure 1
Camber

coined area — that area at the tip end of the bond fingers coined to produce a flattened area for functional use (see Figure 3).

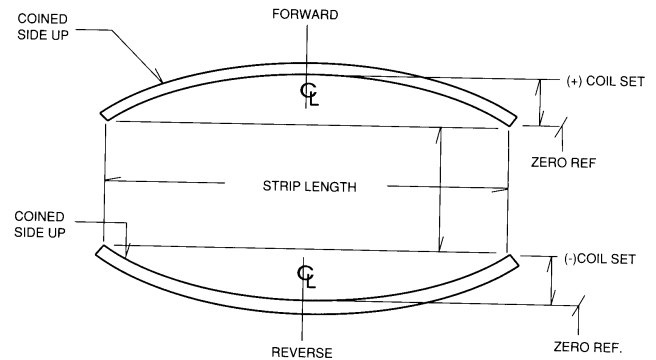


Figure 2
Coil Set

crossbow — transverse bowing of the leadframe (see Figure 4).

lead twist — angular rotation of bonding fingers (see Figure 5).

pits — shallow surface depressions or craters in the leadframe material.

true position circle — that circle with its center positioned at the center of the coined lead defines the design position of the lead tip.

¹ ANSI, 1430 Broadway, New York, NY 10018

² Military Standards, Naval Publications and Form Center, 5801 Tabor Ave., Philadelphia, PA 19120

³ JEDEC, 2001 Eye Street, N.W., Washington, D.C. 20006

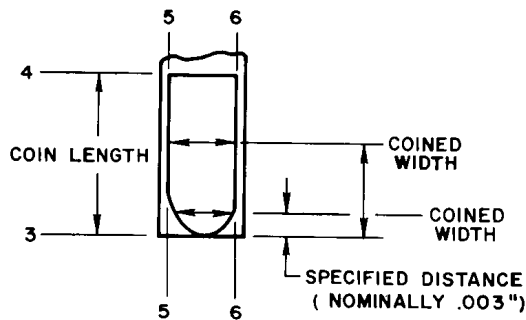


Figure 3
Coined Area

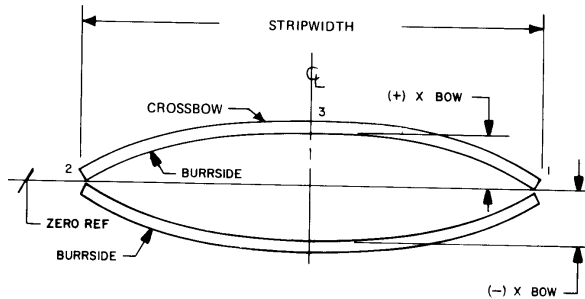


Figure 4
Crossbow

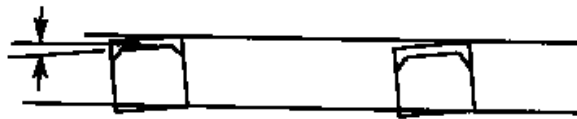


Figure 5
Lead Twist

4 Ordering Information

Purchasing orders for leadframes for plastic molded quad flat pack packages furnished to this specification shall include the following items:

- 4.1 Drawing no. and revision level.
- 4.2 Material, alloy specification.
- 4.3 Lead count, and confirming no. of units per strip.
- 4.4 Requirement for material certification.
- 4.5 Leadframe plating specifications.

5 Dimensions

5.1 Tables 1, 2, 3, and 4.

5.2 Reference Figures 6 and 7 and Details A and B.

6 Defect Limits and Parameters (to measure, see SEMI G10, Standard Method for Mechanical Measurement for Plastic Package Leadframes)

6.1 Lead Tip Width

6.1.1 *Minimum Lead Tip Width* — Shall be as agreed to between supplier and purchaser.

6.1.2 *Minimum Flat Wire Bonding Area* — 80% of nominal lead width and 0.025" (0.635 mm) in length.

6.2 Coining and Metal Clearance

6.2.1 *Coined Depth* — 0.0005" (0.013 mm) minimum to 30% material thickness maximum (stamped frames only).

6.2.2 Dimensions shown on drawings are before coining.

6.2.3 *Maximum Coining Bulge* — (Stamped frame only) shall not exceed 0.002" (0.051 mm) per edge and shall be governed by metal to metal clearance requirements (lead to lead and lead to pad).

6.2.4 *Metal-to-Metal Clearance* — Shall be as agreed to between supplier and purchaser.

6.3 *Lead Twist* — Shall not exceed 3.5 or 0.0006" (0.015 mm) per 0.001" (0.254 mm) of lead width.

6.4 *Burrs* — Shall be firmly attached and able to withstand a probe force of 10 grams. All burrs vertical and horizontal in any location shall not exceed 0.001" (0.0254 mm).

6.5 *Die Pad Tilt and Flatness* — (See SEMI G10 for measurement method.)

6.5.1 *Tilt* — 0.001" (0.025 mm) maximum per 0.100" (2.54 mm) of length or width in the undepressed state, and 0.002" (0.051 mm) maximum per 0.160" (4.06 mm) of length or width in the depressed state, when measuring corner to corner: overall maximum not to exceed a total of 0.006" (0.152 mm).

6.5.2 *Flatness* — 0.0002" (0.005 mm) per 0.100" (2.54 mm) pad length when measuring from the center to the average of four corners. The corners are defined at 0.005" (0.127 mm) from each edge.

6.6 Pits and Slug Marks

6.6.1 Within the functional area and on external leads, no slug marks and pits shall exceed 0.0003" (0.008

mm) in depth and 0.0005" (0.0013 mm) in length (see SEMI G4).

6.6.2 They shall not affect lead strength and shall not exceed 0.001" (0.0254 mm) in depth and 0.002" (0.051 mm) in length in non-functional areas.

6.7 Material thickness for both alloy 42 and copper alloys is 0.006" (0.152 mm), ± 0.00015 " (0.0038 mm) for all lead counts.

NOTE — The material thickness tolerance dimension listed in Section 6.7 is currently under committee review and is expected to be revised to ± 0.0002 ".

6.8 *Internal Position Tolerance* — The centerline of all leadframe features must be within T.P.T. 0.002" (0.051 mm) relative to center line of pilot holes on rail.

6.9 *Progression*

6.9.1 Single progression of one frame is T.P.T. 0.002" (0.051 mm).

6.9.2 Accumulated progression tolerance over the strip length (measured from pitch line tooling hole to pitch line tooling hole, across the strip length minus two units) is within T.P.T. of 0.004" (0.102 mm).

6.10 *Strip Cut Off Location* — Shall be within T.P.T. 0.006" (0.154 mm) of nominal strip length.

6.11 *Strip Width Tolerance* — T.P.T. 0.004" (0.102 mm) for copper and alloy 42 materials.

6.12 *Camber* — Shall not exceed 0.002" (0.051 mm) over nominal strip length.

6.13 *Coil Set* — Maximum of 0.020" (0.508 mm) over the nominal strip length. This does not include material thickness.

6.14 *Cross Bow* — Shall not exceed the following dimensions:

<i>No. of Leads</i>	<i>Maximum Cross Bow</i>
52—100	0.006" (1.52 mm)
132—164	0.010" (0.254 mm)
196—244	0.012" (0.305 mm)

7 Sampling

Sampling will be determined between supplier and purchaser.

8 Packaging and Marking

8.1 *Packaging* — Leadframes must be packaged in containers designed and constructed to prevent damage and contamination.

8.2 *Marking* — The outer containers shall be clearly marked identifying the user stock number, user purchase order number, drawing number, and vendor lot numbers within the carton.

Table 1 Leadframe Standard Dimensions

LEAD COUNT	52 LEAD	68 LEAD	84 LEAD	100 LEAD	132 LEAD	164 LEAD	196 LEAD	24 LEAD
PACKAGE SHAPE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE
JEDEC PACKAGE DESIGNATION	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"	PLASTIC QUAD FLAT PACK 0.025" SPACING "GULL WING"
NOMINAL PACKAGE WIDTH	0.450	0.550	0.650	0.750	0.950	1.150	1.350	T.B.D.
NOMINAL PACKAGE LENGTH	0.450	0.550	0.650	0.750	0.950	1.150	1.350	T.B.D.
STRIP LENGTH	8.800	8.640	8.640	8.400	8.400	8.000	7.200	T.B.D.
NO. OF UNITS PER STRIP	10	8	8	6	6	5	4	T.B.D.
TOOLING DIMENSIONS								
A	0.200	0.350	0.350	0.500	0.500	0.600	0.700	T.B.D.
(PROGRESSION) C	0.880	1.080	1.080	1.400	1.400	1.600	1.800	T.B.D.
F	0.050	0.050	0.050	0.050	0.050	0.050	0.050	T.B.D.
G	1.020	1.620	1.620	1.620	1.620	1.820	2.020	T.B.D.
(STRIP WIDTH) H	1.070	1.670	1.670	1.670	1.670	1.870	2.070	T.B.D.
I	0.810	0.910	1.010	1.110	1.310	1.510	1.710	T.B.D.
J	0.810	0.910	1.010	1.110	1.310	1.510	1.710	T.B.D.
DAMBAR TOPPACKAGE	0.030	0.030	0.030	0.030	0.030	0.030	0.030	T.B.D.
DAMBAR WIDTH	0.015	0.015	0.015	0.015	0.015	0.015	0.015	T.B.D.
EXPANSION SLOT WIDTH	0.015	0.015	0.015	0.015	0.015	0.015	0.015	T.B.D.
DIAMETER Ø	0.060	0.060	0.060	0.060	0.060	0.060	0.060	T.B.D.
METAL THICKNESS	0.006	0.006	0.006	0.006	0.006	0.006	0.006	T.B.D.
NOTE: ALL DIMENSIONS IN INCHES								

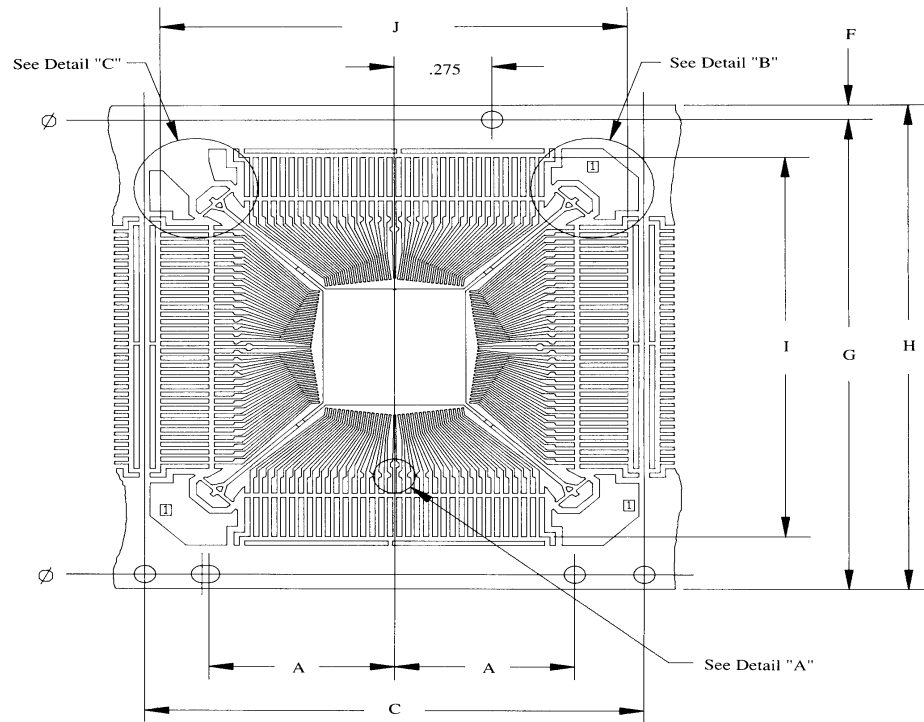


Figure 6

NOTE:

- 1 These are optional features only. Gating may require their exclusion.

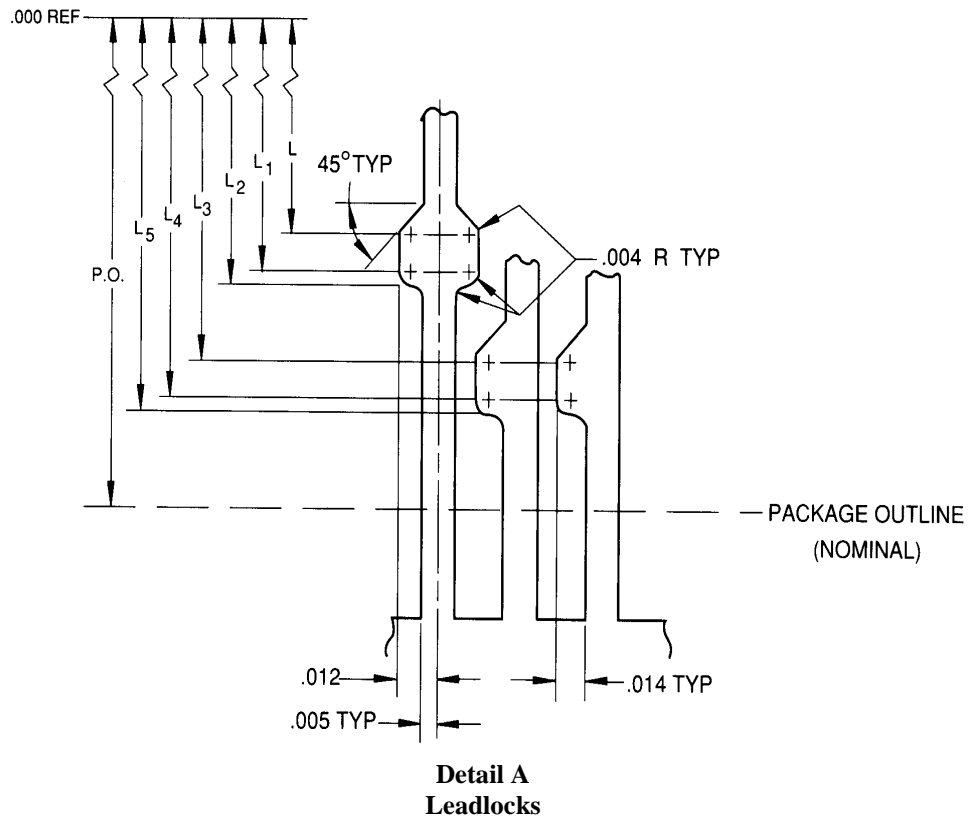
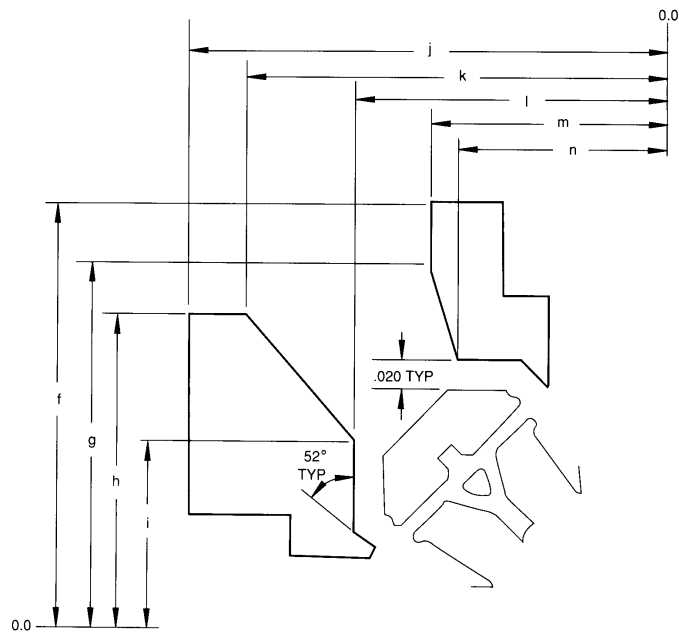


Table 2

<i>Leadcount</i>	52	68	84	100	132	164	196	244
L	0.151	0.201	0.251	0.301	0.401	0.501	0.601	T.B.D.
L ₁	0.161	0.211	0.261	0.311	0.411	0.511	0.611	T.B.D.
L ₂	0.165	0.215	0.265	0.315	0.415	0.515	0.615	T.B.D.
L ₃	0.186	0.236	0.286	0.336	0.436	0.536	0.636	T.B.D.
L ₄	0.196	0.246	0.296	0.346	0.446	0.546	0.646	T.B.D.
L ₅	0.200	0.250	0.300	0.350	0.450	0.550	0.650	T.B.D.
P.O.	0.225	0.275	0.325	0.375	0.475	0.575	0.675	T.B.D.



Detail C Gate Relief

Table 4

<i>Lead Count</i>	52	68	84	100	132	164	196	244
f	0.435	0.485	0.535	0.585	0.685	0.785	0.885	T.B.D.
g	0.394	0.444	0.494	0.544	0.644	0.744	0.844	T.B.D.
h	0.360	0.410	0.460	0.510	0.610	0.710	0.810	T.B.D.
i	0.272	0.322	0.372	0.422	0.522	0.622	0.722	T.B.D.
j	0.435	0.485	0.535	0.585	0.685	0.785	0.885	T.B.D.
k	0.399	0.449	0.499	0.549	0.649	0.749	0.849	T.B.D.
l	0.325	0.375	0.4325	0.475	0.575	0.675	0.775	T.B.D.
m	0.269	0.319	0.369	0.419	0.519	0.619	0.719	T.B.D.
n	0.253	0.303	0.353	0.403	0.503	0.603	0.703	T.B.D.

Table 4 (see Figure 7) Guidelines for Placement of Taping Dimensions 84 Lead Through 196 Leadframes

1. Nominal tape width maximum — 0.037"
2. Nominal tape width maximum — 0.060"
3. Tape width tolerance — ± 0.003 "
4. Tape location tolerance — ± 0.015 "
5. Absolute minimum location of outside tape edge from lead tip — 0.050".
6. Minimum location of outside tape edge from package outline nominal dimension — 0.065".
7. When window "W1" dimension cannot be met with minimum tape nominal width and recommended tolerancing which is the case with various given pad sizes of different lead counts, window "W2" dimension, 0.030", from package outline nominal should be used for the outside tape limit. If this window "W2" dimension still cannot be met negotiation of tape width and location tolerances between supplier and purchaser is suggested to maintain tape within the recommended window dimensions.
8. Recommended center line of tape for nominal location is midway between inside and outside tape edge limits for window "W1" & window "W2" dimensions as appropriate and within tolerance limits.
9. Downset angle — 30°
10. Downsetting must begin inside 0.025" minimum flat distance along tie bar from inside edge of applied tape.
11. Recommended downset length is maximum allowable within the above guidelines.

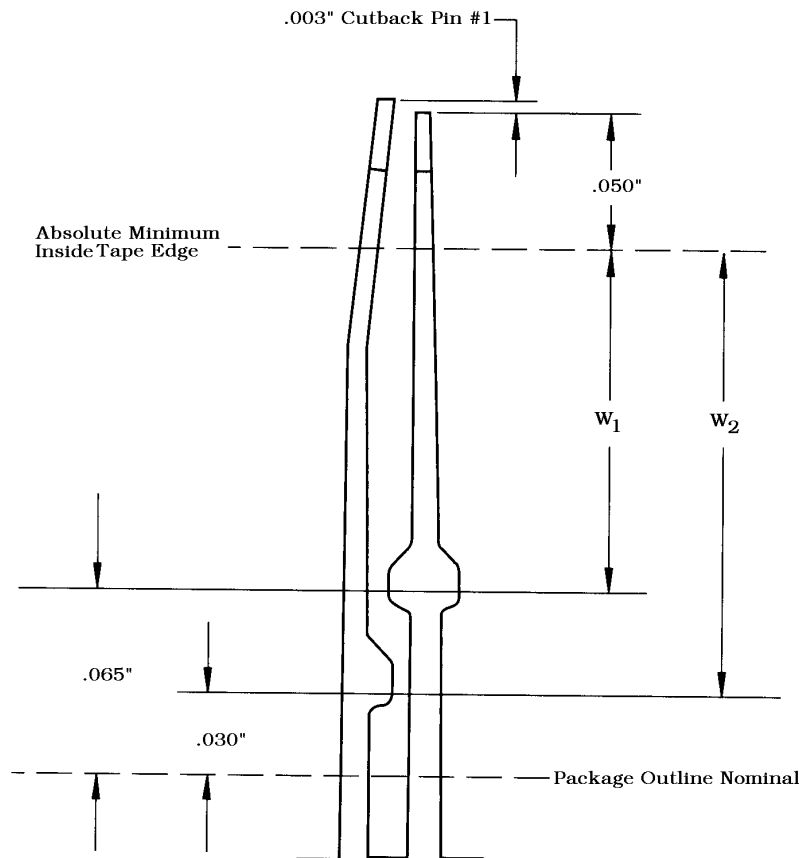


Figure 7

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SEMI G48-89

SPECIFICATION FOR MEASUREMENT METHOD FOR MOLDED PLASTIC PACKAGE TOOLING

1 Preface

This document is prepared to enable standard measurement techniques to be used. It is intended that the measurement techniques described in the specification will apply to all molded plastic package tooling, i.e. DIPS, SIPS, PCC, SO, Quad, and TAB.

2 Applicable Documents

2.1 SEMI Specifications

SEMI G14 — Plastic Molded DIP Tooling

SEMI G16 — Plastic Chip Carrier Tooling

SEMI G36 — Plastic Molded High Density TAB Quad Tooling

SEMI G37 — Plastic Molded SO Package Tooling

3 Basic Equipment

3.1 The following basic equipment is required to perform the specified measurements:

3.1.1 *Toolmaker's Microscope* — 3× objective and 10× eyepiece total 30× with X and Y axes digital readouts reading to 0.0001". Minimum travel of stage must be 2.0" × 2.0". Eyepiece must be ± 0.0002" minimum. The toolmaker's microscope should have a goniometer on the eyepiece as well as on the stage. Accuracy of the goniometer shall be 0.1. The TM microscope should have a Z axis with a digital measurement capability, reading in increments of 0.0001". The objective lens must be 20× minimum which will give 0.0005" accuracy to the Z axis measurements.

3.1.2 *Optical Comparator* — Surface illumination. 10" minimum screen with 3" × 8" minimum travel. Magnification of 10×, 20× minimum required. Accuracy of 10× is 0.001" ;accuracy of 20× is 0.0005". Some operators may be able to improve on this accuracy, but this is the best expected from average inspectors.

3.1.2.1 Overlays at 20× may be used for rapid measurement. The user is cautioned that the thickness of the line must be controlled. Line widths must not exceed 0.010" in width, which will give an inaccuracy of 0.0005" in the measurement. Overlays must have the datum marks clearly labeled. Overlays are tools which speed inspection; however, rejects must be verified by

toolmaker's microscope measurements, which are more accurate.

3.1.3 *Digital Depth Indicator* — Mounted on a stand. Digital reading with a range of 2" is available. Readout must display increments of 0.0001" with ± 1 digit accuracy.

3.1.4 *Micrometer* — 0 to 1.0" . 0.250" diameter for measuring to 0.001" accuracy.

3.1.5 Eight (8) inch dial calipers for measuring to 0.002" accuracy.

3.1.6 *Granite Surface Plate* — Minimum size 18" × 28" , with a surface accuracy of 0.0002" or better.

3.1.7 *Surface Finish*

3.1.7.1 *Charmille Visual Surface Finish Standard* — (For comparison of Electric Discharge Machined (EDM) surface only.)

3.1.7.2 *Surface Comparator Standards* — (For other machined surfaces.)

3.1.7.3 *Surface Analyzer*

3.1.8 *Binocular, Zoom Microscope* — 10—15× magnification with vertical or near vertical lighting.

3.1.9 *Dial Indicators* — With accuracy of .0001 and with force not to exceed 5 grams.

3.2 *Alternative Equipment* — Sophisticated, automatic equipment is not excluded from use, but the user must ensure that such equipment meets or exceeds the accuracy of the basic equipment so that correlation problems may be avoided.

3.3 *Calibration* — All equipment to be calibrated on a regular schedule.

4 Measurements

4.1 The following measurements will be made:

4.1.1 Package Thickness (Section 5.1)

4.1.2 Package Length (Section 5.2)

4.1.3 Package Width (Section 5.3)

4.1.4 Leadframe to Cavity Offset (Section 5.4)

4.1.5 Top Cavity Length (Section 5.5)

4.1.6 Top Cavity Width (Section 5.6)

4.1.7 Bottom Cavity Length (Section 5.7)

- 4.1.8 Bottom Cavity Width (Section 5.8)
- 4.1.9 Cavity Overlap/Underlap (Section 5.9)
- 4.1.10 Cavity to Cavity Mismatch (Section 5.10)
- 4.1.11 Cavity Depth (Section 5.11)
- 4.1.12 Molding Protrusions (Section 5.12)
- 4.1.13 Pin Depths (Section 5.13)
- 4.1.14 Dambar Trimming Defects (Section 5.14)
- 4.1.15 Package Warpage (Section 5.15)
- 4.1.16 Lead Coplanarity (Section 5.16)
- 4.1.17 Shoulder Bend Location (Section 5.17)
- 4.1.18 Surface Finish (Section 5.18)
- 4.1.19 Radii (Section 5.19)
- 4.1.20 Lead Position (Section 5.20)
- 4.1.21 Draft Angles (Section 5.21)
- 4.1.22 Lead Spread (Section 5.22)
- 4.1.23 Foot Angle (Section 5.23)
- 4.1.24 Foot Length (Section 5.24)
- 4.1.25 Plastic Stand-off (Section 5.25)

4.2 Conditions

4.2.1 All measurements to be made on molded components, which have been processed to agreed conditions including post mold cure.

4.2.2 All measurements to be performed at a temperature between 20° and 26.7° C (68° , 80° F).

4.2.3 Axis Definition

4.2.3.1 The X axis lies parallel to the rail of the frame and the Y axis lies perpendicular to the rails of the frame.

4.2.3.2 The package X and Y axes must be positioned parallel to the X and Y axes of the measurement stage travel to avoid measurement errors.

4.2.3.3 The datum of the X and Y axes is the pilot hole of the leadframe, because it is the most accurate feature. An additional pilot hole is required to establish the theta datum.

4.2.3.4 The Z axis is perpendicular to the X and Y axis. The datum is the leadframe or the top mold parting line, unless otherwise specified.

5 Measurement

5.1 Package Thickness — (Figure 1)

5.1.1 Equipment — Micrometer

5.1.2 Using the micrometer, measure the thickness of the package at three (3) places, diagonally across the package, where the contours allow, at the top edge, middle and bottom edge of the package. (Note: the top is the pin 1 identifier edge.)

5.2 Package Length — (Figure 1)

5.2.1 Equipment — Optical Comparator at 10×

5.2.2 Position the package so that the cross-sectional view is presented for measurement. Use care to assure the package is square to the datum plane.

5.2.3 Align the package side draft angle (see Section 5.21) where the draft angle intersects the leadframe. This is the parting line (datum point). Measure the overall width at the parting line, including cavity mismatch.

5.3 Package Width — (Figure 1)

5.3.1 Equipment — Optical Comparator at 10×

5.3.2 Position the package so that the cross-sectional view is presented for measurement. Use care to assure the package is square to the datum plane.

5.3.3 Align the package side draft angle (see Section 5.21) where the draft angle intersects the leadframe. This is the parting line (datum point). Measure the overall width at the parting line including cavity mismatch.

5.4 Leadframe to Cavity Offset — (Figure 2)

5.4.1 Equipment — Toolmaker's Microscope at 30×

5.4.2 Position the circle (cross hair) of the filar eyepiece of similar diameter to the leadframe pilot hole. Zero the digital readout. Move the stage to the point where the molded package meets the leadframe at the parting line. Record digital readout reading as (T1). Continue to move the stage until the point on the opposite side where mold compound and leadframe meet. Record digital readout reading as T2. Continue to move stage to center of leadframe rail (usually also a hole). Record the digital readout reading as T3.

5.4.3 Turn part over and BE SURE TO USE THE SAME HOLE AND PART; repeat the three (3) readings, B1, B2, and B3.

5.4.4 Derive the data from the readings as follows:

Top Centerline of Frame = (T3)/2

Bottom Centerline of Frame = (B3)/2

Measurement Error = (T3)/2 - (B3)/2

Frame Cavity Offset = (B3)/2 - (B2 + B1)/2

Centerline of Package = $(T2 + T1)/2$; $(B2 + B1)/2$.
(Relative to datum)

NOTE: Figure 2 calculations assume that the leadframe centerline is equidistant between T3 and the zero datum point.

5.4.5 In lieu of the frame pilot hole, the dambar may be used on the frame when measuring the offset; however, the possibility of tolerance error may become cumulative, particularly with etched rather than stamped frames.

NOTE: By SEMI convention the offsets are defined in relation to the bottom cavity of the mold.

5.5 Top Cavity Length “Y” Axis — (Figure 2)

5.5.1 Equipment — Toolmaker’s Microscope at 30×

5.5.2 Focus the microscope on the leadframe datum point. Zero the digital readout. Move the stage to the intersection of the mold compound and the leadframe parting line. Read and record. Continue to measure across the package length to the intersection of the mold compound and the leadframe parting line on the opposite edge of the package. Read and record.

5.5.3 The cavity length is defined as $(Ty2 - Ty1)$.

5.6 Top Cavity Width “X” Axis — (Figure 2)

5.6.1 Equipment — Toolmaker’s Microscope at 30×

5.6.2 Focus the microscope on the leadframe datum point. Zero the digital readout. Move the stage to the intersection of the mold compound and the leadframe parting line. Read and record the reading. Continue on to the intersection of the mold compound and the leadframe parting line on the opposite side. Read and record.

5.6.3 The cavity width is defined as $Tx2 - Tx1$.

5.7 Bottom Cavity Length “X” Axis — (Figure 2)

5.7.1 Equipment — Toolmaker’s Microscope at 30×

5.7.2 Focus the microscope on the same datum point used for the top cavity length (remember the package has been turned over). Zero the digital readout. Move to the intersection of the mold compound and the leadframe parting line. Read and record the reading. Continue to the intersection of the mold compound and the leadframe parting line on the opposite side. Read and record. The bottom cavity length is the difference of the two readings. Record the bottom cavity length $(By2 - By1)$.

5.8 Bottom Cavity Width “X” Axis — (Figure 2)

5.8.1 Equipment — Toolmaker’s Microscope at 30×

5.8.2 Focus the microscope on the leadframe datum point. Zero the digital readout. Move the stage to the

intersection of the mold compound and the leadframe parting line. Read and record. The bottom cavity width is the difference of the two readings $(Bx2 - Bx1)$.

5.9 Cavity Overlap/Underlap — (Figure 4)

5.9.1 Compare the top cavity length to the bottom cavity length and the top cavity width to the bottom cavity width. The difference in the number is the overlap/underlap for each axis.

5.10 Cavity to Cavity Mismatch — (Figure 2)

5.10.1 The comparison of the centerlines of the top cavity length to the bottom cavity length and the top cavity width to the bottom cavity width shall determine the cavity to cavity mismatch.

Formula:

Cavity to Cavity Mismatch =

$$(B2 + B1)/2 - (T2 + T1)/2$$

5.11 Cavity Depth — (Figure 1)

5.11.1 Equipment — Depth Indicator

5.11.2 Top Cavity Depth — Measure the distance from the top surface of the leadframe to the top of the unit, place the indicator on the surface of the leadframe, zeroing the readout, moving the part to a point where the top of the unit can be indicated, and read and record the readout.

5.11.3 Bottom Cavity Depth — The measurement is performed in the same manner as the measurement in Section 5.11.2 except the part is turned over and the bottom surface of the leadframe to the bottom of the unit is used.

5.11.4 The package depth is the sum of the frame thickness and the top and bottom depth. (This measurement should equal Section 5.1. Any variation may be considered measurement error.)

5.12 Molding Protrusions Top/Bottom of Part — (Figure 3)

5.12.1 Equipment — Digital depth indicator.

5.12.2 Place unit on the anvil and zero the indicator on the package surface away from area of protrusion. Carefully move the part to where the protrusion is located. Carefully lower the indicator to the top of the mold protrusion. Read and record the mold protrusion.

5.13 Pin Depths — (Figure 3)

5.13.1 Equipment — Depth indicator with a fine point or “Z” axis reading toolmaker’s microscope.

5.13.2 The measurement is made from the nominal plane of the package surface to the bottom of the design

mark (either ejector pin or Pin #1 indicator or other feature).

5.13.3 The indicator is set to zero on the package surface and then moved to the bottom of the feature. The readout is read and recorded.

5.14 *Dambar Trimming Defects* — (Figure 4)

5.14.1 *Equipment* — Toolmaker's Microscope

5.14.2 Measure from the edge of the lead to the edge of the protrusion or intrusion; record the reading and the lead number.

NOTE: Dambar trimming defects are those which can be caused by overcutting into the lead shoulder (stand off) i.e. cutting too much or undercutting the dambar, leaving too much dambar or a burr. Overcutting causes shoulder intrusions. Undercutting leaves shoulder protrusions. In some cases, an adjacent protrusion and intrusion is caused by misalignment of the part at the time of dambar removal.

5.15 *Package Warpage* — (Figure 5)

5.15.1 *Equipment* — Microscope "Z" Axis reading 40×

5.15.2 With the package sitting on the stage, obtain a two point datum by measuring two-points on opposite edges 0.005 from the radius readings; move to the center of the package and obtain the deviation from the datum, and read and record the reading as the warp.

5.15.3 For quad packages, it is equally important that there be minimum warp in each axis (X or Y) so that a three-point Z axis datum must be obtained; the two used in 5.15.2 and an additional one, on one adjacent edge.

5.16 *Lead Coplanarity*

NOTE: Applies to all surface mount devices.

5.16.1 *Contact Method* — (Figure 6)

NOTE: Not recommended for gull-wing leads.

5.16.1.1 *Equipment*

Dial Indicator 0.0001" Accuracy, 5 grams maximum pressure.

Granite Flat.

Transfer Stand.

Package Holding Fixture.

Reference Gauge Blocks, 0.0002" Accuracy.

5.16.1.2 Place the package on holding fixture so that the flat sections of the leads, as they exit from the plastic, are on the ground flats of the fixture. The leads are to be facing "UP" (Dead Bug).

5.16.1.3 On the granite flat, set up the dial indicator on its transfer stand and zero the reading using the reference block. Use a suitable reference block so that all measurements are positive to avoid confusion.

5.16.1.4 Measure the highest point on each lead (e.g., the tangent point of a "J" lead).

5.16.1.5 Determine the range of readings.

NOTE: Special Precautions

1. Be sure that the flat of the leadframe, as it exits from the plastic, rests on the flats of the holding fixture. If the radiused section supports the package, then spurious readings will result.
2. The pressure exerted by the dial indicator must not exceed 5 grams. To check the contact pressure of the dial indicator, use a gram gauge. The gram pressure must be noted at the initial deflection of the gauge and at the maximum deflection of the gauge. If the initial deflection is greater than 5 grams, then the point where 5 grams is obtained must be noted and the measurement must stay within this range to be valid.

5.16.2 *Comparator/Mirror Method*

5.16.2.1 *Equipment* — Optical comparator with at least 20× magnification as per Section 3.1.2. Mirror, flat within 0.0005 inch with a mirror finish having the reflective surface on top. (A polished silver wafer is suggested.)

5.16.2.2 Place the mirror on the measurement stage mirrored side up with the mirror in the plane of the XY axis. Place the package on the mirror with the leads down. Sufficient mirror must extend past the leads toward the lens of the comparator so that an image of the leads with its reflection can be viewed. Focus on the leads nearest the lens. (Care must be taken not to focus on the leads on the opposite side of the package.) (See Figure 8.)

5.16.2.3 Measure the distance between the lead tip and its reflection. Divide that measurement by two to obtain the coplanarity of the lead.

5.16.2.4 Repeat for each lead. Rotate part to measure all sides. Determine co-planarity by identifying maximum measurement.

5.17 *Shoulder Bend Location* — (Figures 1, 7, and 7a)

NOTE: This measurement is not precise, since radius tangent locations allow for considerable inspector interpretation.

5.17.1 *Equipment* — Comparator at 20× magnification. (Surface and shadow illumination).

5.17.2 The measurement is made from the intersection of the straight part of the shoulder with the shoulder bend radius of the lead on one side of the package to the same point on the lead on the opposite side of the package. Locate this point on the first lead by lining up the vertical comparator cross hair with the straight of the lead. Bring the center point of the cross hair to this intersection. Zero the readout, move to the opposite lead, and repeat the location of the intersection. Record the measurement.

NOTE: Due to shadowing of leads, only the end leads on the package can be measured. A visual check with a 10 to 20× microscope should be made to check for gross difference of other leads.

5.18 Surface Finish

5.18.1 Comparative Method — (EDM Finishes only)

5.18.1.1 *Equipment* — Charmille Standard Surface Gauge Binocular Microscope and Light.

5.18.1.2 Insert gauge and molded package to be checked into a holder so that both can be viewed at the same time under the microscope.

5.18.1.3 Estimate the surface finish on the package.

5.18.2 Absolute Method

5.18.2.1 *Equipment* — Automatic Surface Analyzer Surface Standards.

5.18.2.2 Calibrate the analyzer using the gauges.

5.18.2.3 Measure the surface finish on the package. The analyzer gives the average roughness (R_a) and the actual surface roughness. Use average roughness for acceptance.

5.18.3 Table of approximate equivalent finishes

	<i>Mirror</i>	<i>Satin</i>	<i>Extra Fine</i>	<i>Fine</i>	<i>Medium</i>	<i>Course</i>
Micro Inches	4	30 ± 10	50 ± 10	75 ± 10	105 ± 10	145 ± 10
Charmilles	N/A	N/A	18–21	21–24	24–27	27–30
Microns	N/A	1	1.5	2	2.5	3.5

5.19 Radii

5.19.1 Comparative Method

5.19.1.1 *Equipment* — Optical comparator at 20×.

5.19.1.2 Radii are measured by comparison to known radius overlays marked at the same magnification as the comparator.

5.19.2 Absolute Method

5.19.2.1 *Equipment* — Toolmaker's Microscope.

5.19.2.2 Radii are measured using the reticle lines and the X and Y axes to obtain the radius.

5.19.2.3 Care must be taken to assure that each radius is measured separately.

5.20 Lead Position

NOTE: Lead position is a combination of pitch variations due to lead movement after forming and lead width. If the lead is to fit a solder pad or hole, the combination must be considered. In some cases, the lead width can be a major contributor to poor lead position, eg. SO packages with gull-wing leads, PCC with J bend.

5.20.1 Comparative Method

NOTE: This method will only determine if the part is usable, not the breakdown of width and pitch variations.

5.20.1.1 *Equipment* — Optical Comparator at 20×.

5.20.1.2 Align the package to an overlay displaying limit lines for lead pitch/width.

5.20.2 Absolute Method

5.20.2.1 *Equipment* — Toolmaker's Microscope.

5.20.2.2 Move to the edge of the lead number and zero the readout.

NOTE: Where there is a definitive end to the lead as in the case of SO, SIP and DP, the end of the lead at the intersection of the lead in feature, will be the measurement point. Quad PCC packages will be measured at the top of the "J" bend when in the "Dead Bug" position.

5.20.2.3 Move to the opposite edge of that lead and record width.

5.20.2.4 Move to the first edge of the next lead. Record the measurement. Repeat the width measurements.

5.20.2.5 Repeat for all leads to be measured.

5.20.2.6 Pitch can be calculated from the measurements.

5.21 Draft Angles

5.21.1 Package Sides

5.21.1.1 *Equipment* — Optical comparator at 10×.

5.21.1.2 Lay the top or bottom surface of the package squarely onto the comparator to insure that no protrusions on the surface cause the package to be tilted. Align the horizontal cross-hair to the leadframe. Using the vertical cross hair, compare the draft angles to an overlay.

NOTE: This measurement should be taken before the leads are formed.

5.21.1.3 Repeat the procedure for all sides of the package.

5.21.2 Pin Marks (e.g., Pin 1 indicator at end of package).

5.21.2.1 *Equipment* — Toolmaker's Microscope.

5.21.2.2 Focus the microscope on the surface of the package and measure the diameter of the pin hole. (D1)

5.21.2.3 Focus on the bottom surface of the pin hole and measure the diameter. (D2)

5.21.2.4 Tangent of Draft angle = $(D1 - D2)/2H$ where H is pin depth from Section 5.12 or cavity thickness.

5.21.2.5 In some cases ejector pin holes may require measurement if a deep hole is specified.

5.22 *Lead Spread* — (Figures 1, 7, and 7a)

5.22.1 *MDIP, SO* — (Figure 7, 7a)

5.22.1.1 *Equipment* — Optical Comparator at 10× Magnification.

5.22.1.2 Place the package squarely on the comparator with the leads "UP" and find the mid-point of the bottom cavity width.

5.22.1.3 Measure the distance to the outer edge of each row of leads at the widest point of spread.

5.22.2 *PCC (J bend lead dimension) (Foot Print)* Measure from perpendicular to the greatest extension of the "J" radius of the leads on one side of the package to the perpendicular tangent to the greatest extension of the "J" radius of the leads on the opposite package side. (See Figure 1.)

5.23 *Foot Angle* — (Figure 7)

NOTE: Applies to gull-wing leads.

5.23.1 *Equipment* — Optical Comparator at 20× Magnification. Device Holding Fixture (see Section 5.16).

5.23.2 Place the device in the fixture, so that the flat section of the leadframe at the junction with the plastic body rests on the fixture's flats. Leads to be facing "UP".

NOTE: Do not rest the radiused sections of the leads on the flats. Be sure that all mold flash is removed from the area of the frame that rests on the flats.

5.23.3 Measure the angle of the foot with respect to the horizontal.

5.24 *Foot Length* — (Figure 7)

NOTE: Applies to gull-wing leads.

5.24.1 *Equipment* — Optical Comparator at 20× Magnification. Device Holding Fixture (see Section 5.23).

5.24.2 While the foot angle is being measured, place a circle template that contains the same radius as the formed part onto the comparator. Align this template to the radius of the outside bend. Where the radius of the template meets the radius of the outside bend, this is the tangent point to measure foot length.

5.25 *Stand-Off*

5.25.1 Measure the plastic stand-off, when applicable, using the procedures of Section 5.12.

5.26 *Lead Sweep*

5.26.1 *Equipment* — Toolmaker's Microscope or Optical Comparator.

5.26.2 *Method*

5.26.2.1 Determine centerline of lead at egress of lead from molded body (CL1) (see Figure 4).

5.26.2.2 Determine centerline at the end of the lead (CL2). The difference between the two centerlines CL2 – CL1, shall be the lead sweep.

NOTE: On "J" lead devices, the end of the lead is defined as the bottom of the "J" lead radius.

5.26.3 *Cautionary Notes*

5.26.3.1 Verify centerlines on leadframe before measuring to ensure lead-frame is correct.

5.26.3.2 Verify lead position in relation to the top cavity centerline.

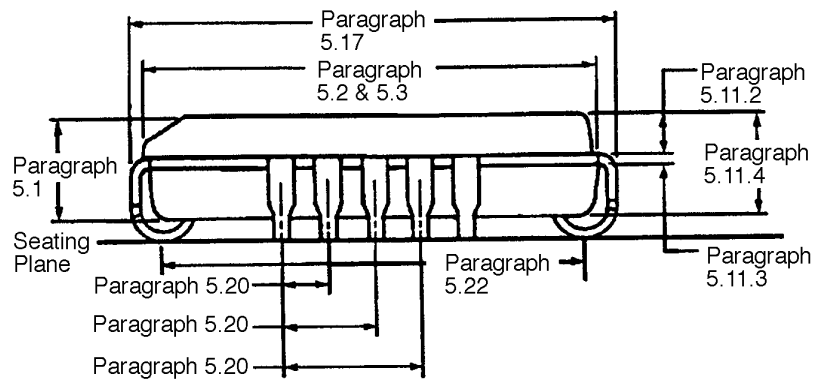


Figure 1

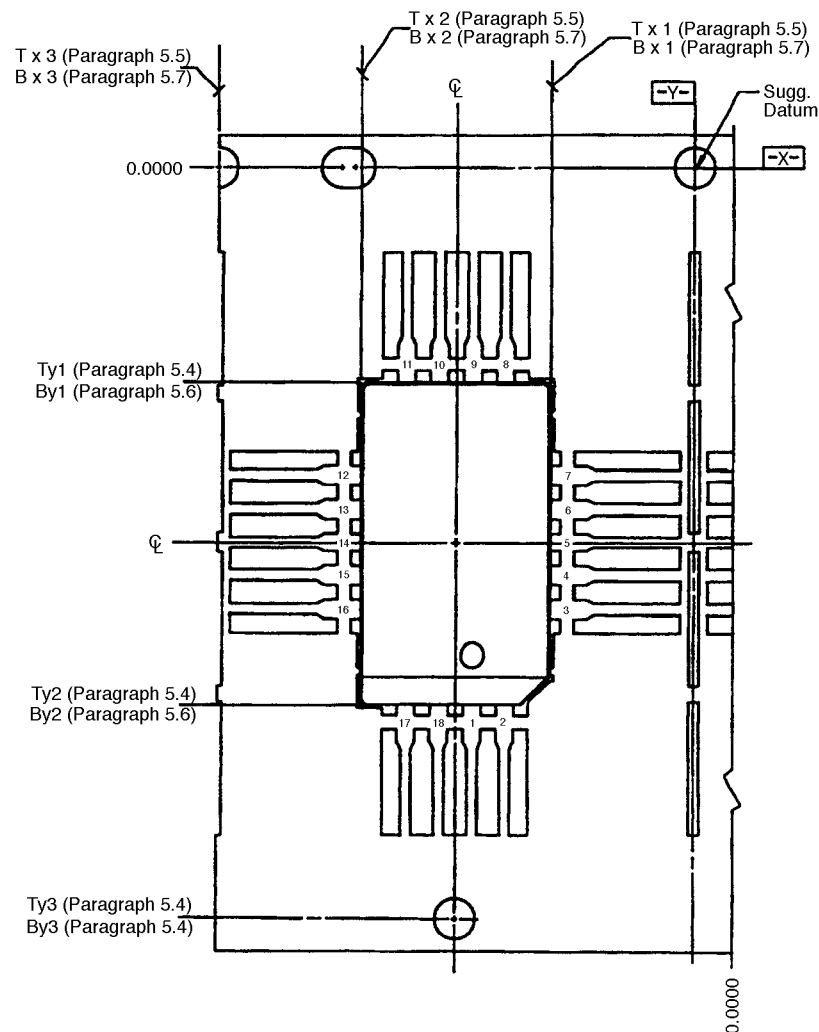


Figure 2