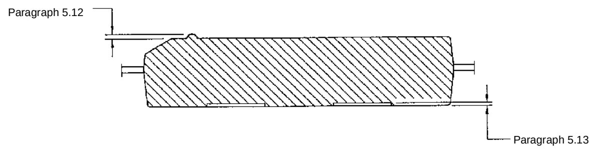


Figure 3

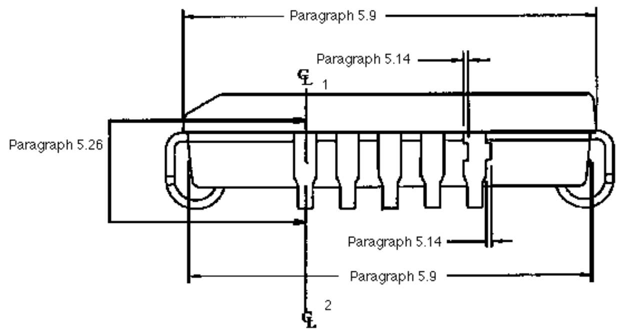


Figure 4

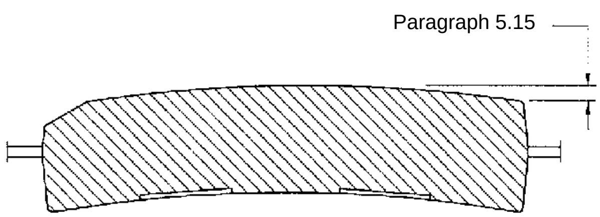


Figure 5

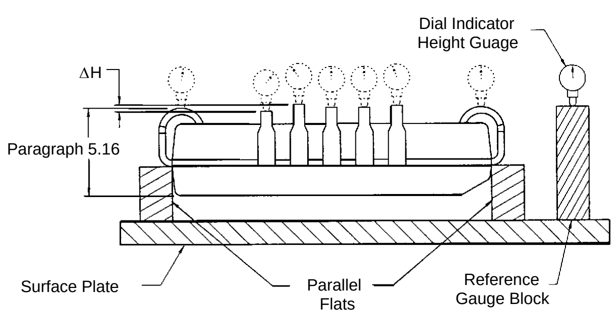


Figure 6

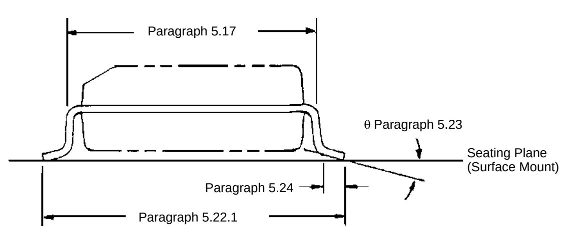


Figure 7

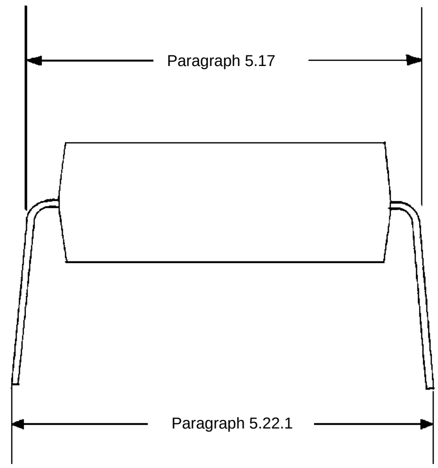


Figure 7A

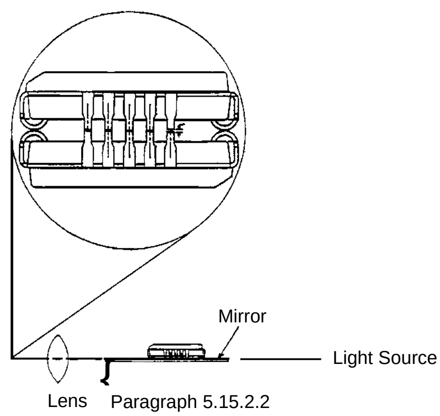


Figure 8

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI G49-93
SPECIFICATION FOR PLASTIC MOLDING PREFORMS

1 Preface

1.1 *Scope* — This specification defines the physical requirements for preforms made with thermosetting molding compounds.

1.2 *Significance* — Consistent preform quality enhances moldability and finished product reliability.

1.3 *Units* — SI or American Customary units may be used at the customers discretion. This specification uses SI units.

2 Applicable Document

2.1 *ASTM Specification*[1]

ASTM D 792 — Specific Gravity and Density of Plastic

3 Terminology

molding preform — Mold compound powder compressed into a cylindrical shape and size with specified diameter, weight, and density.

scoring — Marks, grooves, scratches, or notches with definite length, width, and depth physical characteristics.

side porosity — Voids or holes with visible shape, size, and depth that are detected around a molding preform.

4 Ordering Information

Purchase orders for preforms furnished to this specification shall include the following items:

Molding compound name/type

Preform diameter

Preform weight

5 Preform Specification

5.1 *Appearance* — The preform appearance, considering such items as side porosity, scoring and breakage shall be defined by agreement between supplier and customer.

5.2 *Preform Density as Percentage of Molded Density*

5.2.1 *Specification* — The minimum values for Preform Density as a Percentage of Molded Density for preforms of various diameters are shown in Table 1.

Table 1

Nominal Preform Diameter (mm)	*Percentage of Molded Density (% Minimum)*
< 16	87
> 16	85

5.2.2 *Calculation*

5.2.2.1 *Preform Density* — Measure weight, height, and diameter of preform.

Volume of approximately cylindrical preform (cm^3) =

$$\text{Height(cm)} \times \pi \times \frac{(\text{Average Diameter(cm)})^2}{4}$$

$$\text{Preform Density}(g/cm^3) = \frac{\text{Weight of Preform(g)}}{\text{Volume of Preform}(cm^3)}$$

5.2.2.2 *Molded Part Density* — Determine Molded Part Density (g/cm^3) per ASTM D 792.

5.2.2.3 *Preform Density as Percentage of Model Density.*

$$\begin{matrix}\text{Preform Density as Percentage} \\ \text{of Molded Density (\%)}\end{matrix} = \frac{(\text{Preform Density})}{(\text{Molded Part Density})} \times 100$$

5.3 *Preform Diameter Tolerance* — The tolerances on preform diameters for variously sized preforms are shown in Table 2.

Table 2

Nominal Preform Diameter (mm)	*Tolerance (± mm)*
< 16	0.30
> 16	1.25

5.4 *Preform Weight Tolerance* — The weight tolerances for variously sized preforms are shown in Table 3.

---

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

Table 3

Preform Weight Range (g)	*Tolerance (± g)*
1.8—4.0	0.15
> 4.0—8.0	0.20
> 8.0—< 15.0	0.25
15—< 16	0.50
16—40	1.00
> 40—80	2.00
> 80—150	3.00
> 150	4.00

NOTE 1: The handling characteristics of some molding compounds may require tolerances different from those shown above.

6 Sampling Plan

The sampling plan for inspecting preforms and the molding parameters shall be agreed between supplier and customer.

NOTE 2: *Recommendation* — It is suggested that a minimum of three preforms be measured. On each preform, height and diameter measurements, to the nearest 0.0254 mm (0.001 inch). Preform weight measurements should be taken to the nearest 0.1 gram.

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI G50-89
SPECIFICATION FOR CO-FIRED CERAMIC FINE PITCH LEADED AND LEADLESS CHIP CARRIER PACKAGE CONSTRUCTIONS

1 Preface

This specification defines the standard requirements for co-fired ceramic fine pitch chip carrier constructions, including both top brazed leaded and top metallized leadless configurations. These constructions are for hermetic packaging of various devices, (e.g., high speed, digital VLSI silicon devices), and next-level interconnection to printed wiring assemblies and modules by either lead solder attachment or by “leads last” techniques.

2 Applicable Documents

2.1 *ANSI Specification*[1]

ANSI Y14.5 — Dimensioning and Tolerancing

2.2 *Federal Specification*[2]

QQ-N-290 — Nickel Plating

2.3 *JEDEC Specification*[3]

JEDEC Publication 95 — Registered and Standard Outlines for Solid State Products

2.4 *Military Specifications*

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

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

MIL-STD-7883 — Brazing

MIL-I-23011 — Iron Nickel Alloys for Sealing to Glass and Ceramics

MIL-M-38510 — General Specification for Microcircuits

MIL-G-45204 — Gold Plating, Electrodeposited

3 Selected Definitions

blister (bubble) — ceramics — Any separation within the ceramic which does not expose underlying ceramic material.

blister (bubble) — metal — Any localized separation within the metallization or between the metallization and ceramic which does not expose underlying metal or ceramic material.

bond finger — A region of refractory metallization within the package cavity intended for wirebonding to a microcircuit die pad.

braze — An alloy with a melting point equal to or greater than 600°C.

burr — An adherent fragment of excess parent material at the component edge.

chip-out — A region of ceramic missing from the surface or edge of a package which does not go completely through the package. Chip-out size is given by its length, width, and depth from a projection of the design planform (see Figure 1).

co-fired — A process or technology for manufacturing products in which the ceramic and refractory metallization are fired simultaneously.

contact pad — That metallized pattern to which the leadframe is brazed.

crack — A cleavage or fracture, internal or external.

die-attach surface — A designated dimensional outline area intended for die attach (see Figure 1).

foreign material — An adherent particle other than parent material of that component.

laver — A dielectric sheet with or without metallization that performs a discrete function as part of the package construction.

lead offset — Lead centerlines must be aligned to within 0.254 mm (0.010") of the centerline of corresponding braze pad metallizations.

peeling (flaking) — Any separation from the basis material that exposes the basis material.

projection — An adherent fragment of excess material on the component surface.

pullback — The linear distance between the edge of the ceramic and the first measurable metallization surface (see Figure 3).

rundown — The linear distance down a vertical surface from the top to the point of maximum metallization over-hand (see Figure 3).

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

seal area — A dimensional outline area designated for either metallization or base ceramic to provide a surface area for lid sealing (see Figure 2).

terminal — Metallization at the point of electrical contact to package interior circuitry; also the brazing surface for a lead.

TIR — Total indicator reading; the span of readings, from minimum to maximum, of a given dimension over the total surface it applied to.

voids (ceramics) — An absence of screen printed ceramic from a designated area greater than 0.75 mm (0.003") in diameter.

metal — An absence of refractory metallization, braze, or plating material from a designated area greater than 0.075 mm (0.003") in diameter.

4 Ordering Information

4.1 Purchase orders for co-fired ceramic packaged devices shall specify the following information:

1. Quantity
2. Drawing number and revision level or date
3. Reference to this specification
4. Any exception to drawing or specification

4.2 Drawings for co-fired ceramic packaged devices shall specify the following information:

1. Drawing number and revision level
2. Number of terminals and terminal centerline spacing
3. Lead material, finish, and dimensions, if applicable
4. Ceramic material color and composition; and refractory metal type
5. Type and thickness of plating on both device body and leads, if applicable
6. Dimensioning and tolerancing per ANSI Y14.5
7. Internal bonding pattern
8. Lead number 1 position
9. Method of test and measurements
10. Electrical, mechanical, and environmental requirements

5 Dimensions and Permissible Variations

Packaged device dimensions shall conform to JEDEC JC-11 registered outline dimension drawings for co-fired ceramic fine pitch leaded and leadless chip carriers, unless otherwise specified.

6 Materials

6.1 *Ceramic*

6.1.1 Alumina content to be 90% minimum. Beryllia content to be 99% minimum.

6.1.2 Color to be black, dark brown, or dark violet unless otherwise specified.

6.2 *Metals* — External metal surfaces shall be in accordance with MIL-M-38510.

6.3 *Braze* — Copper/silver per MIL-STD-7883.

6.4 *Refractory Metallization* — To be per MIL-M-38510, Type C.

6.5 *Leadframe* — Fully annealed iron nickel cobalt alloy (per MIL-M-38410, Type A) or iron nickel alloy (per MIL-M-38510, Type B).

6.6 *Microcircuit Finishes* — Shall be per MlL-M-38510 unless otherwise specified.

7 Incoming Test Sequence

1. Visual inspection
2. Dimensional check
3. Electrical parameter testing
4. Sampling testing of plating quality, die attach, die shear, wire bond, pull, seal, hermeticity, lead integrity, and solderability

8 Visual Criteria (10× Magnification)

8.1 *Cracks* — None allowed per MIL-STD-883, Method 2009.

8.2 *Chips*

8.2.1 *Corner* — 0.762 mm (0.030") × 0.762 mm (0.030") × one tape layer thickness, maximum.

8.2.2 *Edge* — 0.54 mm (0.100") × 0.762 mm (0.030") × one tape layer thickness, maximum.

8.3 *Burrs, Projections, and Blisters* — Must fit within outline limit.

Top plane excluding seal area — 0.102 mm (0.004"), maximum

Unmetallized seal area — 0.0762 mm (0.003"), maximum

Metallized seal area — 0.025 mm (0.001"), maximum

Bottom surface — 0.051 mm (0.002"), maximum

Edges — 0.152 mm (0.006"), maximum

Terminal pads — 0.051 mm (0.002"), maximum

Wire bond fingers — 0.025 mm (0.001"), maximum

Die attach surface — 0.025 mm (0.001"), maximum

8.4 *Camber* — 0.004" inch/inch (mm/mm), maximum. For dimensions less than 10.05 mm (0.750"), 0.127 mm (0.003") camber is permitted along any planar dimension of the device package.

8.5 *Seal Area Flatness* — The seal area shall be flat within the limits listed in Table l.

8.6 *Die Attach Surface Flatness* — The die attach surface shall be flat within the limits listed in Table 2.

Table 1 Seal Ring Flatness Limits

Seal Ring OD		*Ring Flatness*
0–0.250"	(0–6.35 mm)	0.002" max. (0.051 mm)
0.251"–0.550"	(6.37–13.97 mm)	0.003" max. (0.076 mm)
0.501"–1.000"	(12.7–25.40 mm)	0.004" max. (0.101 mm)
> 1.000"	(> 25.40 mm)	0.004"/inch (0.101 mm/mm)

Table 2 Die Attach Area Flatness Limits

Die Attach Pad Dimension		*TIR Flatness*
0–0.500"	(0–12.7 mm)	0.002" max. (0.051 mm)
0.501"–0.750"	(12.7–19.5 mm)	0.003" max. (0.076 mm)

8.7 *Voids*

8.7.1 *Seal Area Void* — A maximum of three voids permitted. Not more than two voids per side of 0.010" diameter. Any two voids must be separated by 0.762 mm (0.010") minimum, not to degrade the seal width by more than 25%.

8.7.2 *Terminal Void* — A maximum of two voids per terminal pad permissible. Maximum void diameter acceptable is 0.127 mm (0.005"). Voids may never reduce the minimum terminal width to less than two-thirds of the nominal design dimension.

8.7.3 *Wire Bond Finger Void* — Void free 0.015" back from the bond finger tip.

8.7.4 *Die Attach Surface Voids* — Three voids of 0.010" diameter are the maximum allowed separated by 0.030" minimum.

NOTE: Voids within 0.015" of the cavity wall not included.

8.7.5 *Internal Metallization Voids* — Voids in internal metallization planes or traces shall not break continuity. Specific requirements for resistance and capacitance parameters shall be specified in the purchase order, if applicable.

8.8 *Pattern Metallizations*

8.8.1 *Seal Plane Rundown (internal cavity)* — Not to exceed 25% of the cavity layer thickness.

8.8.2 *Seal Plane Rundown (external to cavity)* — Not to exceed half the nominal design distance to adjacent edge metallization. In no event shall the rundown be closer than 0.254 mm (0.010") to any edge metalization.

8.8.3 *Wire Bond Rundown* — Wire bond finger rundown shall not exceed 25% of the cavity depth or 0.127 mm (0.005"), whichever is smaller.

8.8.4 *Wire Bond Finger Pullback* — Wire bond finger pullback shall not exceed 0.127 mm (0.005") from the nominal design dimension for finger end to cavity edge.

8.8.5 *Seal Plane Pullback* — Seal plane pullback shall not exceed 0.127 mm (0.005") from the nominal design dimension for seal plane metallization to edge.

8.9 *Lead Attachment (when applicable)*

8.9.1 *Voids in Braze* — Braze fillets must be 95% free of voids.

8.9.2 *Lead Alignment* — Brazed leads shall not overhang braze pads.

8.9.3 *Lead Offset* — Lead centerlines must be aligned to within 0.0762 mm (0.003") of the centerlines of corresponding braze pad metallizations.

8.9.4 *Lead-to-Lead Misalignment* — Not to exceed 10% of nominal spacing.

8.9.5 *Dimensional Criteria* — Per JEDEC JC-11 registered outline drawings in JEDEC Publication 95, or as specified on the user drawings.

9 Sampling

Sample sizes must meet requirements of MIL-STD-105 or MIL-M-38510 as agreed to between vendor and customer.

10 Test Methods (Mechanical, Electrical, and Thermal)

10.1 *Gold Plating Thickness* — Shall conform to MIL-G-45204. Gold thickness may be determined using the Beta Backscatter Radiation Method or x-ray fluorescence.

10.2 *Nickel Plating* — Shall conform to QQ-N-290. Nickel thickness may be determined using the Beta Backscatter Radiation Method or x-ray fluorescence.

10.3 *Destructive Die Shear Testing* — Shall be performed per Method 2019 of MIL-STD-883.

10.4 *Wire Bond Pill Testing* — Shall be performed per Method 2011, Condition D of MIL-STD-883.

10.5 *Temperature Cycling Testing* — Shall be performed per Method 1010, Condition C of MIL-STD-883.

10.6 *Thermal Shock Testing* — Shall be performed per Method 1011, Condition C of MIL-STD-883.

10.7 *Constant Acceleration Testing* — Shall be performed per Method 2001, Condition E, Y axis only, of MIL-STD-883.

10.8 *Mechanical Shock Testing* — Shall be performed per Method 2002 of MIL-STD-883.

10.9 *Insulation Resistance Testing* — Shall be performed per Method 2002 of MIL-STD-883.

10.10 *Internal Water Vapor Content Testing* — Shall be performed per Method 1018 of MIL-STD-883.

10.11 *Hermeticity Testing* — Shall be performed per Method 1014, Condition A of MIL-STD-883. The hermetic integrity of the packaged device must be maintained after all testing.

10.12 *Lead Integrity Testing* — Shall be performed per Method 2004, Condition A, B1, and B2 of MIL-STD-883.

10.13 *Solderability Testing* — Shall be performed per Method 2003 of MIL-STD-883.

10.14 *Moisture Resistance* — Shall be performed per Method 2003 of MIL-STD-883.

11 Packaging and Marking

11.1 *Packing* — Containers selected shall be strong enough and suitably designed to provide maximum protection against crushing, spillage, and other forms of damage to the container or its contents. Containers shall afford protection of the contents to contamination from exposure to excessive moisture or oxidation by gases. Packaging materials shall be so selected to prevent any contamination of the ceramic component part with paper fibers or organic particles.

11.2 *Marking* — The outer containers shall be clearly marked identifying:

1. Vendor part number
2. Customer part number
3. Quantity
4. Date of manufacture
5. Vendor lot number

12 Applicability

This specification is intended to apply to packages fabricated to the outline requirements for the fine pitch leaded and leadless chip carriers included in JEDEC Publication 95.

SEMI G51-90

SPECIFICATION FOR PLASTIC MOLDED (METRIC) QUAD FLAT PACK LEADFRAMES

1 Preface

This specification defines the acceptance criteria for leadframes designed for assembly of JEDEC proposed registered Publication 95 Standard Outlines for the Metric Quad Flat Pack Family Packages. It is a design guideline for packaging engineers, leadframe stampers and etchers, and 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 *Order of Precedence* — To avoid conflicts, the order of precedence when ordering tooling shall be as follows:

Purchase Order

This Specification

Referenced Documents

2.2 *Reference Documents*

2.2.1 *SEMI Specifications*

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

SEMI G10 — Standard Method Mechanical Measurement for Plastic Package Leadframes

SEMI G18 — Specification for Integrated Circuit Leadframe Material Used in the Production of Etched Frames

SEMI G21 — Specification, Plating Integrated Circuit Leadframes

2.2.2 *ANSI Specification*[1]

S Y 14.5 M-1982 — Dimensioning and Tolerancing

2.2.3 *JEDEC Specification*[2]

Reg.Prop. 11-286 — Metric Quad Flat Pack Family (Gullwing)

1 ANSI, 1430 Broadway, New York, NY 10018

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

2.2.4 *Military Specification*[3]

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).

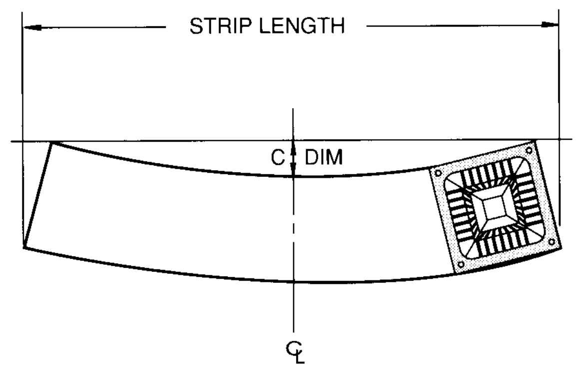


Figure 1
Camber

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

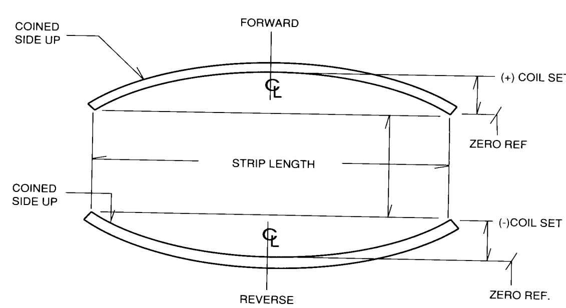


Figure 2
Coil Set

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

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

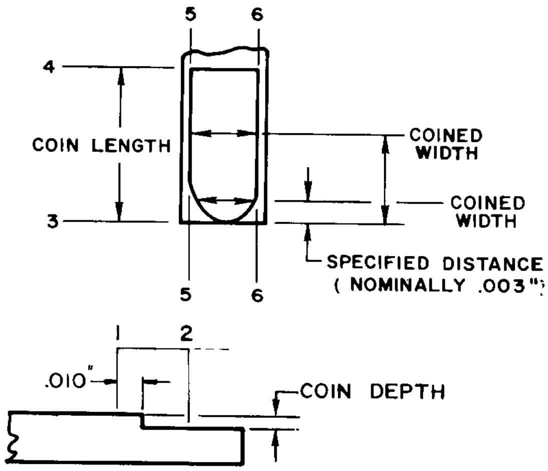


Figure 3
Coined Area

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

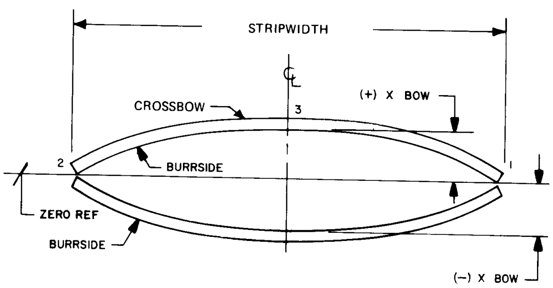


Figure 4
Crossbow

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

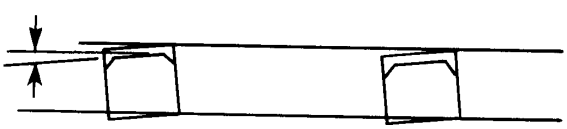


Figure 5
Lead Twist

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.

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 number and revision level.

4.2 Material alloy specification.

4.3 Lead count, and confirming number of units per strip.

4.4 Requirement for material certification.

4.5 Leadframe plating specifications.

5 Dimensions

5.1 Tables I, II.

5.2 See Figure 6 and Detail A.

6 Defect Limits and Parameters

(To measure, see SEMI G10).

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 0.635 mm (0.025") in length.

NOTE: This applies to stamped frames; percent of nominal lead width for etched frames must be determined between purchaser and supplier and is dependent on etch tolerances.

6.2 *Coining and Metal Clearance*

6.2.1 If coined, maximum depth = 30% material thickness. Minimum depth as agreed to between supplier and purchaser.

6.2.2 On stamped frames, dimensions shown on drawings are before coining.

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

6.3 *Lead Twist* — Shall not exceed 3.5 or 0.015 mm (0.0006") per 0.254 mm (0.010") 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 0.0254 mm (0.001").

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

6.5.1 *Tilt* — 0.025 mm (0.001") maximum per 2.54 mm (0.100") of length or width in the undepressed state, and 0.051 mm (0.002") maximum per 4.06 mm (0.160") of length or width in the depressed state, when measuring corner to corner: Overall maximum not to exceed a total of 0.102 mm (0.004").

6.6 *Pits and Slug Marks*

6.6.1 Within the functional area and on external leads, no slug marks and pits shall exceed 0.008 mm (0.0003") in depth and 0.0127 mm (0.0005") in length.

NOTE: There is a question regarding the ability of material suppliers to meet this specification. Revision of this specification is under review.

6.6.2 They shall not exceed 0.0254 mm (0.001") in depth and 0.051 mm (0.002") in length in nonfunctional areas.

6.7 *Material Thickness* — 0.150 mm (0.0059") ± 0.005 mm (0.0002") for all lead counts.

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

6.9 *Lead Tip Coplanarity* — Shall be within the following tolerances as measured relative to the Z datum plane located at the center of the die attach pad or per SEMI G10 measurement method:

44–52 lead counts: ± 0.10 mm (0.004")

64–100 lead counts: ± 0.15 mm (0.006")

120–232 lead counts: ± 0.20 mm (0.008")

6.10 *Progression*

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

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

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

6.12 *Strip Width Tolerance* — T.P.T. 0.102 mm (0.004").

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

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

6.15 *Cross Bow* — Shall not exceed 0.7% of the nominal strip width.

6.16 External nominal lead width dimension will be as follows for each respective lead pitch requirement:

1.0 mm lead pitch: 0.4 mm (stamped or etched)
8 mm lead pitch: 35 mm (stamped or etched)
65 mm lead pitch: 0.27 mm (etched)
3 mm (stamped)

Please note that specific etching and stamping tolerances associated with lead widths are to be negotiated and specified between purchaser and supplier.

PLEASE NOTE: THESE SPECIFICATION DIMENSIONS AND CRITICAL TOLERANCES, UNLESS OTHERWISE NOTED, APPLY TO ALL ALLOY 42, COPPER ALLOY, ETCHED AND STAMPED LEADFRAME MATERIALS.

7 Sampling

A sampling plan and buy-off procedure to determine compliance to the requirements of Sections 5 and 6 and other relevant specifications shall be determined between vendor and customer.

8 Packaging and Marking

8.1 *Packaging* — Tooling must be packed in containers designed and constructed to provide protection against normal transportation damage risks and spillage. The container will offer protection from contamination and exposure to moisture.

8.2 *Marking* — The following details shall be noted on the packing slip:

Quantity and Description
Vendor Lot Numbers
Vendor Part Number
Customer Drawing Numbers
Customer Part Number
Shipping Date
Customer P.O. Number

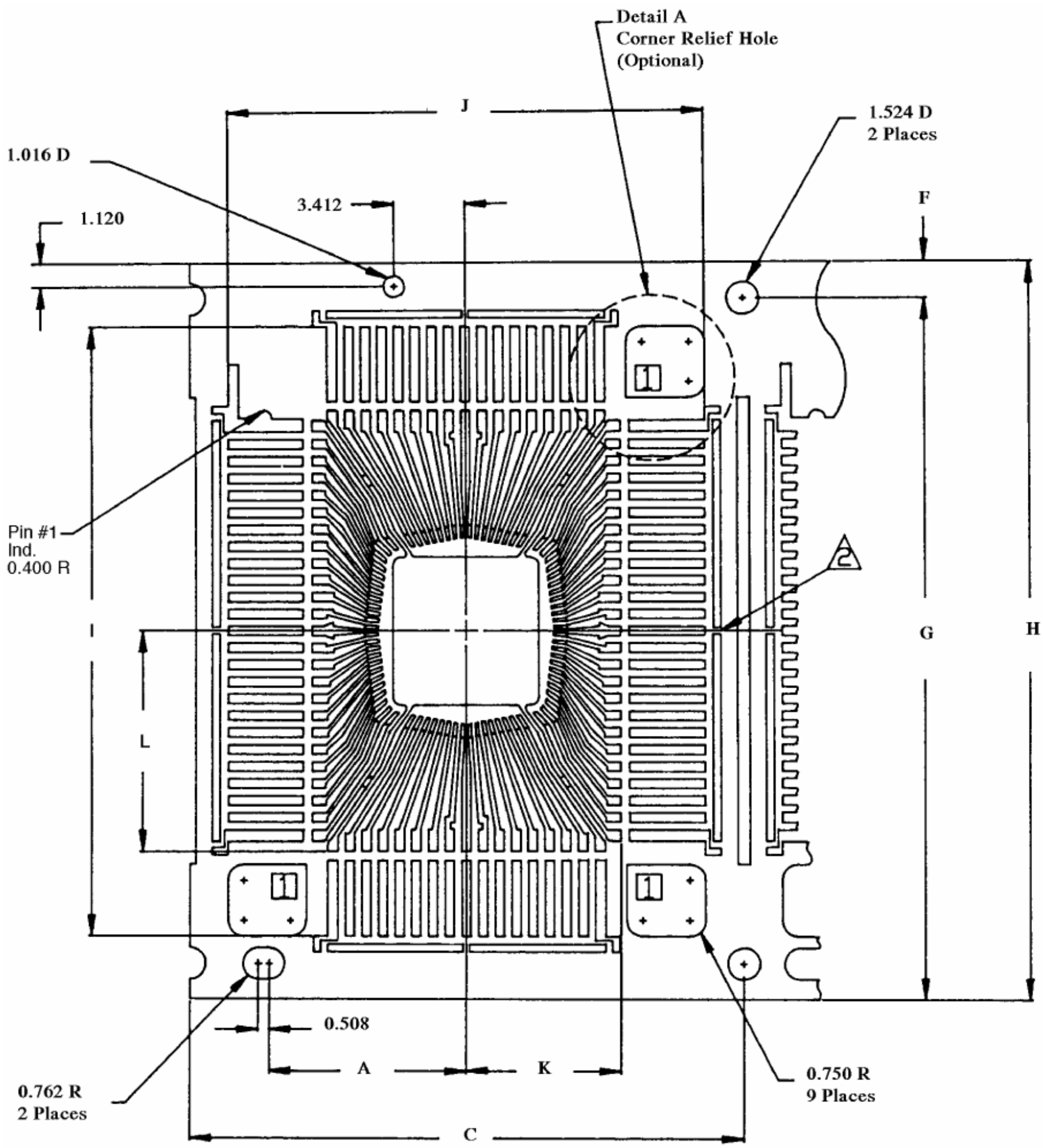


Figure 6
Frame Unit

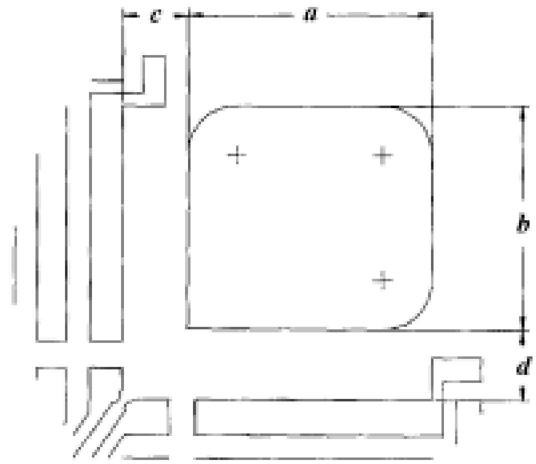
1. Corner relief holes are optional features only. Gating may require their exclusion.

2. Lead counts 100 and below have only 1 support tab per each frame expansion slot. Lead counts 120 and above have 3 support tabs evenly spaced for each frame expansion slot. Tabs are to be placed opposite the space.

Table 1 Leadframe Standard Dimensions

LEAD COUNT	*44*	*52*	*52*	*64*	*80*	*64*	*80*
PACKAGE SHAPE	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	RECT	RECT.
NOMINAL PACKAGE WIDTH (mm)	10.0	10.0	14.0	14.0	14.0	14.0	14.0
NOMINAL PACKAGE LENGTH (mm)	10.0	10.0	14.0	14.0	14.0	20.0	20.0
STRIP LENGTH (mm)	171.2	171.2	158.52	158.52	158.52	158.52	158.5
NO. OF UNITS PER STRIP	8	8	6	6	6	6	6
TOOLING DIM A (mm)	7.5	7.5	9.45	9.45	9.45	9.45	9.45
(PROGRESS) C (mm)	21.4	21.4	26.42	26.42	26.42	26.42	26.42
F (mm)	1.5	1.5	1.7	1.7	1.7	1.7	1.7
G (mm)	23.2	23.2	26.0	26.0	26.0	33.1	33.1
(STRIP WIDTH) H (mm)	24.7	24.7	27.7	27.7	27.7	34.8	34.8
I (mm)	20.0	20.0	22.82	22.82	22.82	28.8	28.8
J (mm)	20.0	20.0	22.82	22.82	22.82	22.82	22.82
K (mm)	5.18	5.18	7.18	7.18	7.18	7.18	7.18
L (mm)	5.18	5.18	7.18	7.18	7.18	10.18	10.18
DAMBAR WIDTH (mm)	0.4	0.4	0.4	0.4	0.4	0.4	0.4
EXP. SLOT WIDTH (mm)							
1) BETWEEN FRAMES	1)0.3	1)0.3	1)0.6	1)0.6	1)0.6	1)0.6	1)0.6
2) END OF SHT BAR	2)0.15	2)0.15	2)0.38	2)0.38	2)0.38	2)0.38	2)0.38
METAL THICKNESS (mm)	0.15	0.15	0.15	0.15	0.15	0.15	0.15
EXTERNAL LEAD Pitch (mm)	0.8	0.65	1.0	0.8	0.65	1.0	0.8

LEADCOUNT	*100*	*120*	*128*	*144*	*160*	*184*	*196*	*232*
PACKAGE SHAPE	RECT.	SQUARE	SQUARE	SQUARE	SQUARE	SQUARE	RECT.	SQUARE
NOMINAL PACKAGE WIDTH (mm)	14.0	28.0	28.0	28.0	28.0	32.0	28.0	40.0
NOMINAL PACKAGE LENGTH (mm)	20.0	28.0	28.8	28.0	28.0	32.0	40.0	40.0
STRIP LENGTH (mm)	158.52	200.0	200.0	200.0	200.0	200.0	200.0	248.0
NO. OF UNITS PER STRIP	6	4	4	4	4	4	4	4
TOOLING DIM A (mm)	9.45	18.8	18.8	18.8	18.8	18.8	18.8	18.8
(PROGRESS) C (mm)	26.42	50.0	50.0	50.0	50.0	50.0	50.0	62.0
F (mm)	1.7	3.5	3.5	3.5	3.5	3.5	3.5	3.5
G (mm)	33.1	57.9	57.9	57.9	57.9	57.9	57.9	57.9
(STRIP WIDTH) (mm)H	34.8	61.4	61.4	61.4	61.4	61.4	61.4	61.4
I (mm)	28.8	37.2	37.2	37.2	37.2	37.6	49. 8	49.2
J (mm)	22.82	37.2	37.2	37.2	37.2	37.6	37.8	49.2
K (mm)	7.18	14.18	14.18	14.18	14.18	16.18	14.18	20.18
L (mm)	10.18	14.18	14.18	14.18	14.18	16.18	20.18	20.18
DAMBAR WIDTH (mm)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
EXP. SLOT WIDTH (mm)								
1) BETWEEN FRAMES	1)0.6	1)3.6	1)3.6	1)3.6	1)3.6	1)3.6	1)0.4	1)3.6
2) END OF SHT BAR	2)0.38	2)2.0	2)2.0	2)2.0	2)2.0	2)2.0	2)0.4	2)2.0
METAL THICKNESS (mm)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
EXTERNAL LEAD PITCH (mm)	0.65	0.8	0.8	0.65	0.65	0.65	0.65	0.65



Detail A
Corner Relief Hole (Optional)

Table 2 Leadframe Standard Dimensions

LEADS	*PKG. BODY*	*a*	*b*	*c*	*d*
44	10 × 10	4.200	3.800	1.170	1.170
52	10 × 10	4.200	3.800	1.170	1.170
52	14 × 14	3.735	3.00	0.995	1.075
64	14 × 14	3.735	3.00	0.995	1.075
80	14 × 14	3.735	3.00	0.995	1.075
64	14 × 40	3.735	3.400	0.995	1.075
80	14 × 20	3.735	3.400	0.995	1.075
100	14 × 20	3.735	3.400	0.995	1.075
120	28 × 28	6.600	8.840	1.610	1.610
128	28 × 28	6.600	8.840	1.610	1.610
144	28 × 28	6.600	8.840	1.610	1.610
160	28 × 28	6.600	8.840	1.610	1.610
184	32 × 32	6.600	8.840	1.610	1.610
196	28 × 40	6.600	8.840	1.610	1.610
232	40 × 40	6.600	8.840	1.610	1.610

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their responsibility.

SEMI G52-90 (Reapproved 1104)
STANDARD TEST METHOD FOR MEASUREMENT OF IONIC CONTAMINATION ON SEMICONDUCTOR LEADFRAMES (PROPOSED)

This test method was technically approved by the Global Assembly & Packaging Committee and is the direct responsibility of the Japanese Packaging Committee. Current edition approved by the Japanese Regional Standards Committee on July 23, 2004. Initially available at www.semi.org September 2004; to be published November 2004. Originally published in 1990.

NOTE 1: Japan, Europe, and US task forces are planning to develop test methods which will address the different levels of ionic contamination on leadframes.

1 Scope

1.1 This standard describes the procedure to determine ionic contamination on leadframes using a water extraction method. The method is sensitive to Na^+, NH_4^+, K^+, Cl^-, NO_3^-, Br^-, SO_4^{2-}, PO_4^{3-}.

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

2 Referenced Standards

2.1 *ASTM Specifications*[1]

D 1193 — Specification for Reagent Water

D 4327 — Anions in Water by Ion Chromatography

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

3 Summary of Method

3.1 Ionic contamination is extracted in water at > 95°C for 30 ± 2 minutes. The contamination is quantitatively analyzed by ion type using Ion Chromatography and the result is presented as nanograms/unit area.

4 Significance

4.1 Contamination on leadframes can contribute to semiconductor device reliability problems. This method may be used by lead frame manufacturers at outgoing inspection and by users at incoming inspection. Correlation of device reliability with contamination levels may lead to improved leadframe cleaning processes.

1 American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, USA. Telephone: 610.832.9585, Fax: 610.832.9555, Website: www.astm.org

5 Terminology

5.1 *Definitions*

5.1.1 *eluent* — the solvent used to carry the extracted ions through the ion exchange chromatograph.

5.1.2 *regenerant* — a chemical solution containing the ions originally present in the chromatograph column prior to a test run and used to prepare the column for a new test.

5.1.3 *retention time* — the time required for a particular ion type to pass from the injection port to the detector. Retention time is characteristically different for each ion type.

5.1.4 *standard solution* — a solution containing a known concentration of the ion to be measured and used to calibrate the chromatograph.

6 Equipment

6.1 *Ion Chromatograph for Anion and Cation Analysis* — This equipment is to consist of a concentration pump, guard column, separator column, and a detector module consisting of a suppressor device to reduce the background eluent conductivity to a low level and a conductivity cell. The minimum sensitivity of the chromatograph for each ion type is defined in Table 1.

6.2 *Chart Recorder*

6.3 *Ion Extraction Vessels* — Polypropylene or teflon containers with sealing caps, or polypropylene/ polyethylene double layered bags.

NOTE 2: The contamination level of these vessels must be less than one-fifth (1/5) of the expected contamination level on the leadframes when measured in a control test.

6.4 *Hot Bar Bag Sealer*

6.5 *Water Bath* — 300 mmL × 300 mmW × 200 mmH, filled with DI water, and capable of holding 95°C.

6.6 *Volumetric Dispenser (e.g., Pipettes)* — 10 ml and 100 ml capacity.

6.7 *Quartz Flasks and Pipettes for Cation Standard Solutions* — 100, 250, 500, and 1000 ml capacity (flasks); 1, 10, and 25 ml capacity (pipettes).

6.8 *Borosilicate Glass flasks and Pipettes for Anion Standard Solutions* — 100, 250, 500, and 100 ml capacity (flasks); 1, 10, and 25 ml capacity (pipettes).

6.9 *Chemical Balance, Weighing Chemicals*

6.10 *Scissors, Tweezers, Spatula*

7 Reagents and Materials

7.1 Deionized water, resistivity ≥ 15 megohm centimeters at 25°C per ASTM D 1193.

7.2 Eluents and regenerants for specific chromatograph columns prepared per chromatograph equipment manufacturer's recommendations so that the water peak can be separated from the ionic peaks.

7.3 *Compounds for Cation Standard Solutions* — NaCl, NH_4Cl, KC1.

7.3.1 *Compounds for Anion Standard Solutions* — NaCl, Na_2HPO_4, $12H_2O$, NaBr, $NaNO_3$, K_2SO_4.

NOTE 3: All compounds are to be reagent grade.

8 Sampling

8.1 The leadframes must not be touched, except with previously cleaned tweezers or double-layered cotton gloves with polyethylene outer gloves in order to avoid additional contamination.

8.2 The sample size (i.e., the number of frames to be tested in this destructive test) may be determined by agreement between the customer and the vendor. The recommended sample sizes are 10–50 cm^2 for testing pads and 200–500 cm for the test of overall leadframes.

NOTE 4: The surface area of the frame is calculated from the leadframe drawing, and includes the top, bottom and side surfaces. It is important that user and supplier agree on the surface area calculation for any given leadframe configuration.

9 Preparation of Standard — Solutions and Chromatograph Calibration

9.1 *Standard Solutions*

9.1.1 The single-ingredient standard solutions of each ion (Na^+, NH_4^+, K^+; $C1^-$, No_3^-, Br^-, SO_4^{2-}, PO_4^{3-}) are made by dissolving 1.000 g of each ion into 1.000 liter of D.I. water, respectively. The stored multi-ingredient standard solutions shown in Table 2 are then made form these single-ingredient standard solutions by the dilution method.

9.1.2 Cation and anion standard solutions for calibration are made by diluting the stored multi-ingredient standard solutions as shown in Table 2.

9.1.3 Store the multi-ingredient standard solution and the calibration solutions in the correct flasks and label with the ion type and concentration.

NOTE 5: New standard solutions for calibration are required every 24 hours. Ensure that the flasks are cleaned with water before refilling with a new solution.

9.2 *Calibration*

9.2.1 Set up the chromatograph and regenerate the columns according to the manufacturer's instructions (ASTM D 4327 provides further details).

9.2.2 Run the eluent through the chromatograph until a stable baseline chromatograph is obtained.

9.2.3 Select the infection volume recommended by the manufacturer for each ion type and inject in to the chromatograph. Record the chromatograph for each ion type (see Figure 1), and make the calibration curve for each ion (ion concentration versus peak height or area).

NOTE 6: Peak height or area under the ion's characteristic curve is proportional to the concentration.

10 Procedure — Bag Extraction Method

10.1 *Preparation of Extraction Bags*

10.1.1 Add 100 ml of DI water to the polypropylene/polyethylene double layered bag and seal them with the hot bar bag sealer. The amount of air in the bags should be reduced as much as possible before sealing.

NOTE 7: Two bags are required for each test and must come from the same manufacturing lot.

10.1.2 Place the bags in the water bath at T > 95°C for 2 hours ± 5 minutes.

10.1.3 Allow the bags to reach room temperature but leave sealed until ready for use at which time open the bags (use clean scissors for the bags) and rinse out five (5) times with DI water.

10.2 *Extraction Process*

10.2.1 Place the samples in the bags. Cover the frames with a known volume of water (e.g., 100 ml and then seal the bags). Also, place a similar amount of water in an empty bag and seal.

NOTE 8: The amount of air in the bags should be reduced as much as possible before sealing. The bags that only contain water provide the background contamination of the bag. Do not select the frames or remove them from their shipping container until ready to test the surface contamination. The recommended volume of water is 10–30 ml for the testing die pads only and 100 ml for testing complete leadframes. Lead frames should be bent after sealing so that the water is in contact with all surfaces.

10.2.2 Place the bags in the water bath at T > 95°C for 30 ± 2 minutes.

10.2.3 Remove the bags from the bath and allow to reach room temperature.

10.2.4 The lead frames, which are inside the sealed bags, are moved to one side of the bags without opening the bags. Then the solution is separated from leadframes by sealing the mean portion of the bags without opening.

11 Procedure — Container Extraction Method

NOTE 9: The size of the containers to be used depends on the expected volume of water and the leadframes. The container must be at least three-quarters filled with the water and leadframes.

11.1 *Preparation of Extraction Vessels*

11.1.1 Fill the containers with DI water and attach the caps. In order to reduce the amount of air in the vessel, fill vessels to the amount of three-quarter.

NOTE 10: Two containers are required for each test and must come from the same manufacturing batch.

11.1.2 Place the containers in the water bath at T > 95°C for 2 hours ± 5 minutes.

11.1.3 Remove the containers from the bath and rinse out five (5) times with DI water.

11.2 *Process*

11.2.1 Place the samples in one of the containers cleaned per Section 11.1.1.

NOTE 11: Leadframes may be cut or rolled in order to ease loading to the container. Die pads may be tested separately, if desired, by cutting from the leadframes.

11.2.1.1 Add the required volume of DI water and cap the container. Place a similar amount of water into the other cleaned container and attach the cap.

NOTE 12: Do not select the frames or remove them from their shipping container until ready to test for the surface contamination. Recommended volumes of water are 10–30 ml for testing die pads only and 100 ml for the entire leadframe — samples must be covered by water.

11.2.2 Place the containers in the water bath at T > 95°C for 30 ± 2 minutes.

11.2.3 Remove the containers from the bath and allow to reach room temperature.

11.2.4 Remove the leadframes from the container and cap it again.

12 Measurements

12.1 Prepare the chromatograph for operation by regenerating the columns according to the manufacturer's recommendations.

12.2 Run the eluent through the chromatograph until a stable baseline calibration is established.

12.3 Inject the recommended sample size of test solution into the chromatograph and record the ion chromatogram.

12.4 Repeat for all the samples and also run the background sample.

NOTE 13: The time from extraction to insertion of sample is to be within eight hours.

12.5 Sample concentrations are determined from the calibration curves for each ion type.

12.6 The surface concentration of ionic contaminants for each ion type (SCIC) is given by the following equation:

$$\text{SCIC (ng/cm}^2) = \frac{\text{(Sample conc.} - \text{Background conc.)} \times \text{Extraction Volume (mL)}}{\text{Leadframe Surface Area (cm}^2) \times \text{No. of Leadframes}}$$

NOTE 14: Allowable concentration levels are to be agreed between the user and supplier.

Table 1 Sensitivity of Ion Chromatograph

	Ion	*Sensitivity (ng/ml)*
Cation	Na^+	0.2
	NH_4^+	0.5
	K^+	1.0
Anion	Cl^-	0.3
	PO_4^{3-}	2.0
	Br^-	1.0
	NO_3^-	1.0
	SO_4^{2-}	1.0

Table 2 Concentration of Standard Solution for Calibration

	Mixed Standard Solution (ug/ml)		*Standard Solution for Calibration(ng/ml)*		
	Ion		*I*	*II*	*III*
Cation	Na^+	10	5	10	20
	NH_4^+	10	5	10	20
	K^+	10	5	10	20
Anion	Cl^-	4	10	20	40
	PO_4^{3-}	10	25	50	100
	Br^-	4	10	20	40
	NO_3^-	4	10	20	40
	SO_4^{2-}	4	10	20	40

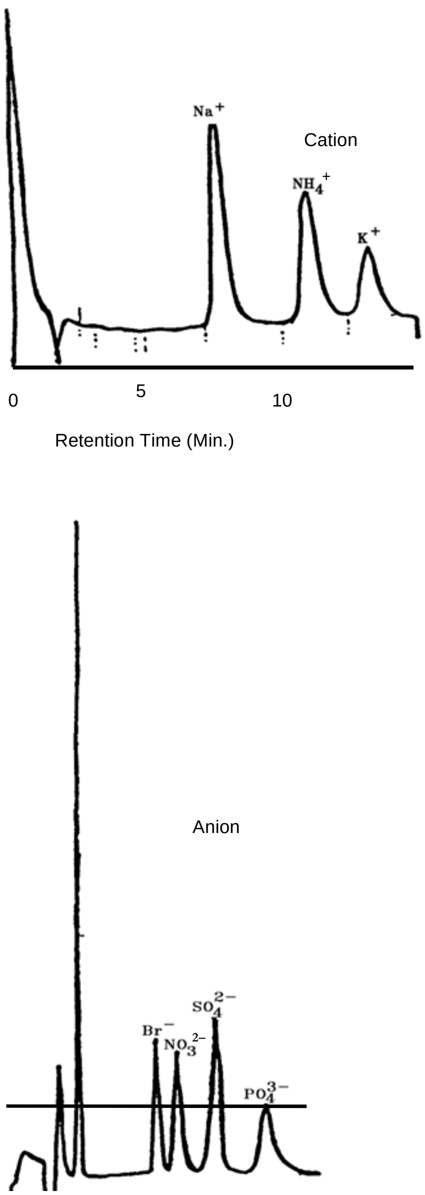


Figure 1
Schematic of Ion Chromatograph

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI G53-92
SPECIFICATION FOR METAL LID/PREFORM ASSEMBLY

1 Preface

1.1 *Scope* — This specification provides guidelines for the design and acceptance of metal lid/preform assemblies (see Figure 1). This specification may be used by suppliers at outgoing inspection and by the customers at incoming inspection.

The design and acceptance criteria may be used for metal lid/preform assemblies used on all types of semiconductor packages.

1.2 *Significance* — Improper lid/preform design and poorly specified lid/preforms contributes to low sealing yields and unreliable devices.

1.3 *Units* — U.S. Customary (inch-pound) or SI (metric) 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 metal lid-preform assemblies shall be as follows:

Purchase Order

Customer's Lid-Preform Drawing

This Specification

Reference Documents

Related Documents

2.2 *Referenced Documents*

2.2.1 *Military and Federal Specifications*[1]

MIL-STD 883 — Test Methods and Procedures for Microelectronics

MIL-M-38510 — General Specification for Microcircuits

2.2.2 *ANSI Specification*[2]

Y14.5M — Dimensioning and Tolerancing

2.2.3 *ASTM Specification*[3]

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

E 10 — Standard Test Method for Brinell Hardness of Metallic Materials

E 384 — Standard Test Method for Microhardness of Materials

E 29 — Practice for Using Significant Digits in Test Data to Determine Conformance to Specifications

E 1182 — Measurement of Surface Layer Thickness by Radial Sectioning

3 Definitions

blister — any enclosed localized separation of the plating from the base material or from another layer of plating which can be depressed by a sharp instrument.

bow — relative flatness of the preform to the lid after spot welding.

burr — an adherent fragment of parent material, lid or preform, at the edge of the lid or preform.

chipout — a region of material which is missing from the surface or edge of the lid or preform.

contamination — three dimensional alien material adhering to a surface.

corrosion — electrochemical degradation of the material usually exhibited by discoloration such as rust.

crack — a cleavage or fracture which extends to the surface of the lid or through the preform.

discoloration — any change in the color of the plating as detected by the unaided eye which normally occurs after the application of heat.

foreign material — an adherent particle other than parent material of that component.

NOTE: Adherent means inability to be removed with an air or Nitrogen blow-off at 20 psi.

gouges — mechanically formed depressions in the lid surface.

nodules — lumps of plating extending above the surface of the lid.

oil canning — lid concavity after sealing.

peeling — the lifting of plating from a surface.

pit — a hole or depression extending below the surface of the lid or preform.

preform — a solder material of defined volume that is attached to the base material.

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

2 ANSI, 1430 Broadway, New York, NY 10018

3 American Society of Testing and Materials, 100 Barr Harbor Drive, West Conshohoken, PA 19428-29597

protrusion — an adherent fragment of excess material on the surface of lid or preform.

scratch — surface mark which exposes underlying metal.

seal ring — area designated for attaching the lid to the package by welding or soldering techniques.

stain — a two-dimensional substance on a surface of the lid or preform.

tack weld — small spot welds, generally located in the corners which are used to attach the preform to the lid.

void — absence of plating from designated area.

weld splatter — melted preform material which extends from the weld.

4 Ordering Information

Purchase orders for metal lid/preform assemblies furnished to this specification shall include the following information.

4.1 Current customer drawing revision detailing:

All dimensions and tolerances per ANSI Y14.5M

Base material and hardness

Type, and thickness of the plating(s)

Preform type and composition

4.2 Reference to this specification.

4.3 Supplier certification requirements

4.4 Any additions to, or variations from, this specification.

5 Materials

The definitions, design guidelines, defect criteria, and functional tests described in this specification relate to lid/preform assemblies made with the following materials.

5.1 *Lid*

5.1.1 Base material to be Iron Nickel Cobalt alloy per MIL-M-38510, Type A; OR Iron Nickel alloy per MIL-M-38510, Type B unless otherwise stated on the purchase order.

5.1.2 Plating shall meet the requirements of MIL-M-38510 unless otherwise stated in the purchasing document.

5.2 *Preform*

5.2.1 Preform to be 80% (+0/-1% tolerance) gold, balance to be tin unless otherwise stated on the purchase order. Gold and tin to be 99.99% pure per ASTM E 29.

	Maximum Trace Elements
Silver (Ag)	100 ppm
Copper (Cu)	50 ppm
Lead (Pb)	50 ppm
Palladium (Pd)	20 ppm
Iron (Fe)	10 ppm

Others 10 ppm each

Total all impurities: 149 ppm

6 Design Guidelines

These guidelines are based on the use of a furnace sealing process, not seam sealing.

6.1 *General Guidelines*

6.1.1 The I.D. of the lid preform should be 0.010 larger than the package seal ring I.D. as long as preform width specifications are not violated.

6.1.2 The O.D. of the lid should be 0.025" to 0.035" smaller than the package seal ring O.D. as long as preform width specifications are not violated.

NOTE: The dimensions listed are based on nominal tolerances only. The worst case package and lid conditions must be considered.

6.1.3 *Recommendations* — The following table is a guideline only. Specific requirements may differ depending on the package type or style.

Lid Size	*Lid Thickness**	*Preform Thickness*	*Preform Width*	*Pkg.S/r Width*	*Corner Radii*
<0.251"	0.010"	0.0015–0.0021"	0.025" min.	0.0425" min.	0.020–min.
0.251–0.500"	0.010"	0.0021"	0.035" min.	0.0525" min.	"
0.501–0.650"	0.010–0.015"	0.0021–0.0024"	0.035" min.	0.0525" min.	"
0.651–1.000"	0.015"	0.0021–0.0030"	0.040–0.060"	0.0625–0.0675"	"
1.001–1.250"	0.015"	0.0021–0.0030"	0.045–0.065"	0.0675–0.0725	"
>1.250"	0.015"	0.0021–0.0030"	0.050" min.	0.0725" min.	"

* Tolerance for Lid Thickness is ± 10 %.

** Tolerance for Preform Thickness is ± 0.0003".

7 Defect Limits

Visual inspection shall be carried out at 3× magnification with verifiaction at 10×.

alpha emission — Alpha Emission Level Max: 0.05 counts/cm^2/hour +30/-0 seconds. **Test method to be agreed upon between user and supplier.**

blisters/peeling — None allowed after 3 minutes **dwell time** at 400 ± 10°C in air.

bow — Preform bow not to exceed:

Lid Size	*Maximum Allowable Bow*
< 0.500"	0.003"
0.501 – 1.500"	0.005"
1.500" and above	To be determined between supplier and user.

burrs (stamping) — None allowed greater than 0.001" in height.

chipouts — Chipouts exceeding 10% of the width of the preform (may be up to 20% in the corner) are not allowed. No chipouts allowed in lid.

cracks — Cracks in the lid not allowed. The preform shall not be broken, except in such cases where both sides of the break are in contact, and the preform is flat and firmly attached to the lid. Maximum of one (allowable) crack per preform allowed.

discoloration/stains — Discoloration of the finish shall not be cause for rejection unless there is evidence of corrosion or other contamination.

flatness — Lid must be flat within 0.001" per 0.500" T.I.R.

foreign material/contamination — Adherent material which cannot be removed by blowing with 20 psi air or nitrogen is not allowed.

pits — Pits larger than 0.005" are not allowed. No more than three acceptable pits are allowed on either surface of the lid and there must be a minimum of 0.030" between sites. Pits must not have exposed base metal.

NOTE: A sample of lids with pits may be subjected to Salt Atmosphere test per MIL-STD 883, Method 1009, Condition A as a condition of lot acceptance.

plating voids — No plating voids greater than .005" in any dimension. Lids with smaller plating voids may be subjected to Salt Atmosphere Test as described above as a condition of lot acceptance.

preform alignment — Misalignment shall not exceed 0.005" from any one edge of the lid.

preform attachment — Preform to be firmly attached to the lid in at least 3 corner locations.

protrusions — Protrusions larger than 0.005" in any horizontal dimension or 0.001" in height are not allowed.

scratches — Scratches which expose base metal not allowed.

tack weld height — Must be firmly adherent and max 0.003".

7.1 All lids must meet the following criteria:

Salt atmosphere per MIL-STD 883, Method 1009, Condition A

Resistance to Solvents per MIL-STD 883, Method 2015

Gold plating per MIL-M-38510

8 Sampling

The sampling plan shall be agreed upon between user and supplier.

9 Incoming Inspection

9.1 Incoming inspection to be performed per user drawing with reference to this specification.

9.1.1 *Plating Thickness* — Plating thickness shall be measured by X-Ray Fluorescence per ASTM B568. The tolerance on the thickness shall be agreed upon between user and supplier. For multilayer plated lids, additional layers should be measured by cross section.

9.1.2 *Material Hardness* — Hardness shall be evaluated per ASTM E 384 or E 10 to limits agreed upon between user and supplier.

9.1.3 *Functional Testing*

9.1.3.1 Functional testing may be performed at the option of the user or supplier. Test to be agreed upon between user and supplier.

9.1.3.2 Hermeticity parts should be evaluated per MIL-STD 883, Method 1014.

9.1.4 *Marking* — Marking permanency shall be evaluated per MIL-STD 883, Method 2015.

9.1.5 *Corrosion Resistance* — Corrosion resistance shall be evaluated per MIL-STD 883, Method 1009 (Salt Atmosphere).

10 Certification

Upon request of the user in the purchase order, a supplier's certification that the product was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment. Certification to user specification may also be required. This certification does not remove the supplier's responsibility for discrepant product subsequently found by the user.

11 Packaging and Package Marking

11.1 *Packaging* — The shipping containers and materials shall be suitably selected to provide the components with protection from normal transportation damage risks which include crushing, abrasion, spillage, and exposure to moisture and other corrosive gasses. The inner packing materials must be clean room compatible as defined by user.

11.2 *Package Marking*

11.2.1 *Internal Packages* — Each internal package shall be marked as follows:

User's Part Number

User's Order Number

Drawing Number (user's and supplier's, if appropriate)

Plating Lot Number

Manufacturing Lot Number

Quantity Date of Manufacture

External Marking — The external packing list shall include the following details:

User's Part Number

User's Order Number

Quantity Shipping Date

Any specific instructions for receiving personnel

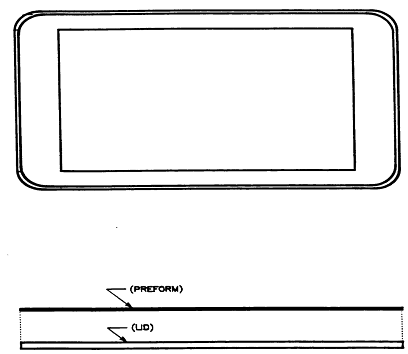


Figure 1

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI G54-93
SPECIFICATION FOR DIMENSIONS AND TOLERANCES USED TO MANUFACTURE MOLDED PLASTIC PACKAGES

1 Preface

This document is a guideline for ordering the tooling required to manufacture plastic semiconductor packages. These packages include the following JEDEC registered outlines:

Plastic Dual-in-Line Packages (PDIP)
Plastic Leaded Chip Carrier (PLCC)
Plastic Quad Flat Packages (PQFP)
Small Outline I.C. Packages (SOIC — Gull Wing and “J” lead)
Plastic TAB Quad Packages (PTAB)

NOTE 1: Package outlines registered with other organizations such as EIAJ and non-registered outlines may use the criteria in this document by choosing the outline which most closely resembles the particular package.

Packaging engineers, mold manufactures, and end-of-line tool makers may use this document to define the limits of tooling tolerances.

2 Applicable Documents

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

Purchase Order
Referenced Documents
This Specification

2.2 *Reference Documents*

2.2.1 *SEMI Specifications*

SEMI G48 — Specification, Measurement Method for Molded Plastic Package Tooling

2.2.2 *JEDEC Specifications*[1]

Pub. No. 95 — Registered and Standards Outline for Semiconductor Devices

2.3 *Related Documents for Information*

2.3.1 *Military Specifications*[2]

MIL-STD-100 — Engineering Drawing Practice

2.3.2 *ANSI Specifications*[3]

Y14.5 — Dimensioning and Tolerancing

3 Selected Definitions

3.1 *Cavity* — the plastic body formed by either the top or bottom mold cavities.

3.2 *Gate Feature* — plastic protrusions or intrusions which result from normal molding and degating operations.

3.3 *Lead Bend Angle* — the angle to which the leads are bent in reference to a plane normal to the X-Y plane of the package. After a suitable radius has been formed at the shoulder, there must be no compound angle formation to achieve the lead spread requirements. Lead Bend Angle may just be a reference if Lead Spread is specified (see Figures 1A, B, C).

3.4 *Lead Coplanarity* — the vertical position of a lead foot with respect to a reference plane created by the three leads with feet most extended from the bottom surface of the package body. The term “foot” applies to both PLCC foot radii and PQFP feet (see Figure 2).

3.5 *Lead Shoulder (Dambar Area) Protrusions or Intrusions* — a protrusion (tab) on the shoulder or lead, or intrusion cut into the shoulder or lead as a result of dambar trimming (see Figures 3 and 4).

3.6 *Lead Sweep* — lead movement measured with respect to a datum, perpendicular to the top or bottom surface of the package and which passes through the midpoint of the lead, when viewed from the sides of the package (see Figure 4).

3.7 *Mismatch* — misalignment between the top and bottom cavities. The measurement of mismatch is stated as the difference between the center lines of the top and bottom cavities (see Figure 5). All statements regarding mismatch of cavities are applicable to both the X and Y axis. All measurements are made prior to lead trim and form.

3.8 *Offset* — the difference in the bottom cavity position from a leadframe datum when compared to design (see Figure 6). This measurement ignores leadframe tolerances. All statements regarding offset are applicable to both the X and Y axis. All measurements are made prior to lead trim and form.

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

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

3 American National Standards Institute, 1430 Broadway, New York, NY 10018

3.9 *Overlap* — the difference in length or width between the top and bottom cavities. Overlap may be a feature designed into the mold to avoid mismatch (see Figure 5). All statements regarding overlap of cavities are applicable to both the X and Y axis. All measurements are made prior to lead trim and form.

3.10 *Package Warpage* — loss of planarity of a molded surface excluding protrusions and intrusions (see Figure 7). Each package type has a maximum allowable warpage and a warp factor is used to determine the maximum warpage for a particular package dimension. The Warp Factor (WF) is defined as follows:

$$\mathrm{WF} = \frac{\text{Total Warp in inches (mm)} \times 1000}{\text{Package dimension in inches (mm)}}$$

Package warpage is usually caused by incorrect package design and/or poor molding conditions.

3.11 *Parting Line Protrusions, or Intrusions* — plastic excesses (flash) or losses (chips or voids) at the parting line after normal processing to mold, deflash, trim, and singulate the packages.

3.12 *Surface Protrusions or Intrusions* — plastic excesses (bumps or blisters) or recesses (pits or voids) on any surface of the package.

4 Ordering Information

Purchase orders for molded plastic tooling furnished to this document, shall include the following items:

4.1 A package tooling outline drawing showing all the required dimensions listed in Section 5. The molded surface finish(es) and the lead finish shall be specified.

4.2 The plastic compound to be used shall be specified. If the compound is proprietary, then the molding and molded characteristics shall be supplied.

4.3 The leadframe drawing detailing the material, all dimensions, and, if applicable, lead finish pre-plate specifications.

4.4 The type and part number of the molding and trim, form, singulate press to be used.

4.5 Singulation or off-load requirements.

4.6 *Expectations of Tooling Performance* — Tooling performance is not limited to the items listed in Section 5 and 6. Any other customer requirements, such as the limits on wire sweep, resin bleed or internal voiding, shall also be included with the purchase order.

4.7 Reference to this specification.

4.8 Vendor certification requirements.

5 Dimensions

5.1 All package dimensions should be specified in detail.

5.2 Ejector pin mark location from the package centerline. This should include ejector pin sizes, depths, and draft angles.

5.3 Pin 1 ID shape and location from the package center with respect to the lead frame Pin 1 location.

5.4 All critical radii (unspecified radii, often shown sharp on the drawing, may have the maximum radius shown in the table of Section 6).

5.5 Plastic stand-off shape and locations from the package center.

5.6 Lead spread (the distance between the outer edge of opposing leads).

5.7 Shoulder bend location and lead bend angle (optional).

5.8 Foot angle radius (maximum and minimum).

5.9 Foot length.

5.10 Lead length.

5.11 Shoulder width (maximum width should include protrusion).

6 Dimensional Tolerance Limits

These criteria, where applicable, apply only to opaque, plastic molded semiconductor packages. If an item is not mentioned in the following table, then the tolerances on the dimensions of that item follow the general tolerance limits stated on the drawing. Dimensions are in inches (millimeters) except as noted. Dimensions are to be verified per SEMI G48.

Table 1 Tolerance Limits

Dimension (Tolerance)	*PDIP*	*PLCC*	*SOIC*	*PQFP*	*PTAB*	*UNITS*
Package Length/Width ±	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	in. (mm)
Cavity Mismatch ±	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	in. (mm)
Cavity Overlap (Max.)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	in. (mm)
Package/Leadframe Offset ±	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.001 (0.025)	in. (mm)
Plastic Body Thickness — Top and Bottom ±	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.002 (0.05)	0.001 (0.025)	in. (mm)
Surface Protrusions (Max.)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	in. (mm)
Surface Intrusions — Depth (Max.)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	in. (mm)
-X-Y Dimension (Max.)	0.010 (0.25)	0.010 (0.25)	0.010 (0.25)	0.010 (0.25)	0.005 (0.127)	in. (mm)
Ejector Pins — Intrusion only (Max.)	0.010 (0.25)	0.010 (0.25)	0.010 (0.25)	0.008 (0.20)	0.005 (0.127)	in. (mm)
Gate Feature — Intrusion only (Max.)	0.020 (0.50)	0.020 (0.50)	0.010 (0.25)	0.020 (0.50)	0.002 (0.05)	in. (mm)
Gate Feature — Protrusion only (Max.)	0.004 (0.10)	0.004 (0.10)	0.004 (0.10)	0.004 (0.10)	0.004 (0.10)	in. (mm)
Parting Line Protrusion — after deflash dambar removal (Max. per side)	0.006 (0.15)	0.006 (0.15)	0.006 (0.15)	0.006 (0.15)	0.005 (0.127)	in. (mm)
Parting Line Intrusion — Plastic (Max.)	0.010 (0.25)	0.010 (0.25)	0.005 (0.127)	0.010 (0.25)	0.005 (0.127)	in. (mm)
Parting Line Protrusion — after package singulation	0.006 (0.15)	0.006 (0.15)	0.006 (0.15)	0.006 (0.15)	0.005 (0.127)	in. (mm)
Warp Factor (Max.) — up to a Limit of	2.5% 0.003 (0.08)	2.5% 0.003 (0.08)	2.5% 0.003 (0.08)	2.5% 0.003 (0.08)	2.5% 0.003 (0.08)	in. (mm)
Draft Angles (Deg. ±)	1	1	1	1	1	
Package Radii — Noted Radii ±	0.0025 (0.06)	0.0025 (0.06)	0.0025 (0.06)	0.0025 (0.06)	* (*)	in. (mm)
Shown Sharp (Max.)	0.020 (0.50)	0.020 (0.50)	0.010 (0.25)	0.020 (0.50)	* (*)	in. (mm)
Lead Spread ±	0.025 (0.64)	0.010 (0.25)	0.010 (0.25)	0.005 (0.127)	* (*)	in. (mm)
Lead Bend Angles (Deg. ±)	-	5	2	2	2	
Shoulder Bend Location ±	0.010 (0.25)	0.010 (0.25)	0.005 (0.127)	0.005 (0.127)	* (*)	in. (mm)
Lead Sweep (from True position — Max.) (See Note 2)	0.007 (0.18)	0.004 (0.10)	0.004 (0.10)	0.003 (0.075)	0.003 (0.075)	in. (mm)
Foot Length ±	-	-	0.005 (0.127)	0.005 (.127)	* (*)	in. (mm)
Foot Radius ±	-	0.010 (0.25)	-	-	-	in. (mm)
Lead Length ±	0.005 (0.127)	-	-	-	-	in. (mm)
Foot Width ± incl. Leadframe Tolerance	-	-	0.002 (0.05)	0.002 (0.05)	* (*)	in. (mm)
Lead Coplanarity (Max.)	-	0.003 (0.08)	0.003 (0.08)	0.003 (0.08)	0.002** (0.05)	in. (mm)
Dambar Trim Protrusions (Max.)	0.003 (0.08)	0.003 (0.08)	0.003 (0.08)	0.003 (0.08)	0.003 (0.08)	in. (mm)
Dambar Trim Intrusions (Max.)	0.002 (0.05)	0.002 (0.05)	0.001 (0.025)	0.001 (0.025)	0.001 (0.025)	in. (mm)

* To be determined.

** If applicable.

NOTE 2: SOIC, J leaded packages have the plastic bodies and leads evaluated to the SOIC and PLCC tolerances as appropriate.

NOTE 3: Lead Sweep is not acceptable at buy-off.

7 Sampling Plan

A sampling plan and buy-off procedure to determine compliance to the requirements of Sections 5 and 6 and other relevant specifications shall be determined between vendor and customer.

8 Packaging and Marking

8.1 *Packaging* — Tooling must be packed in containers designed and constructed to provide protection against normal transportation damage risks and spillage. The container will offer protection from contamination and exposure to moisture. Tools may be coated with a suitable rust inhibitor as agreed between vendor and customer.

8.2 *Marking* — The following details shall be noted on the packing slip:

Vendor Part Number
Customer Part Number
Shipping Date
Customer P.O. Number
Shipment Items

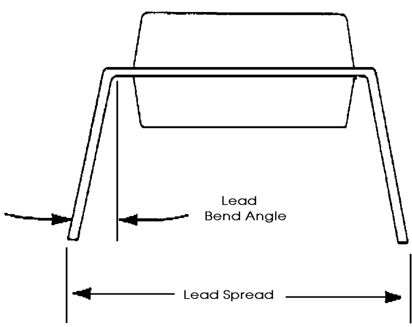


Figure 1A
PDIP Package

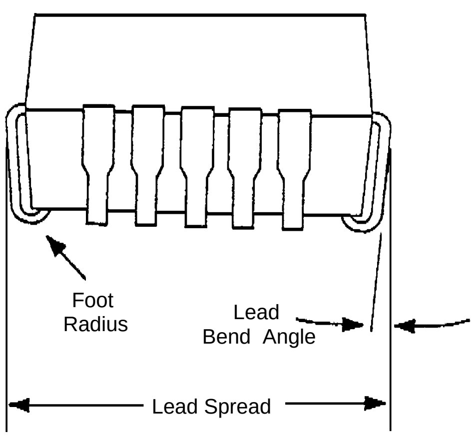


Figure 1B
PLCC Package

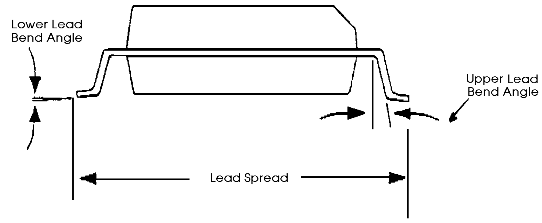


Figure 1C
SOIC and PQFP Packages

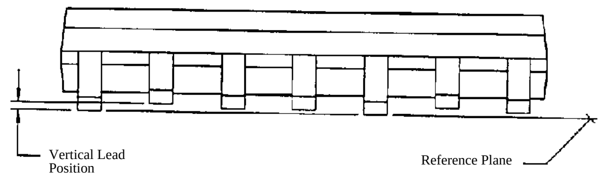


Figure 2
Lead Co-planarity

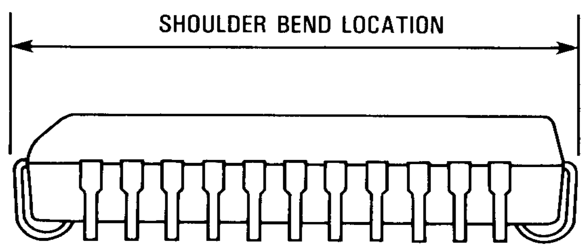


Figure 3
Shoulder Bend Location

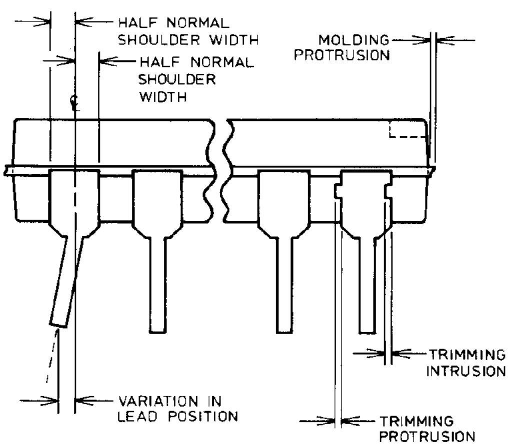


Figure 4
Parting Line Protrusion, Lead Sweep and Lead Shoulder Protrusions and Intrusions

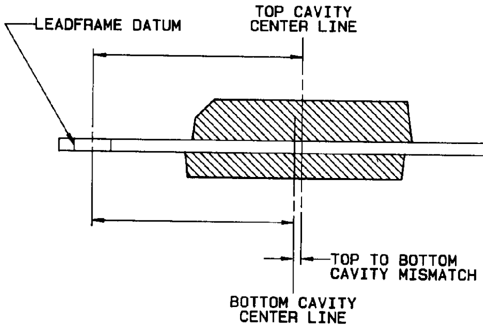


Figure 5
Mismatch

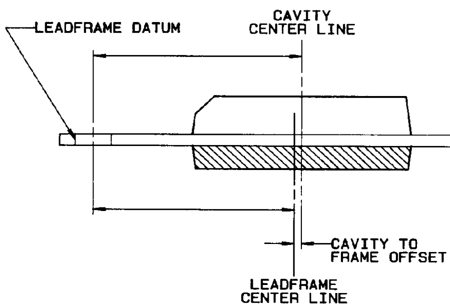


Figure 6
Offset

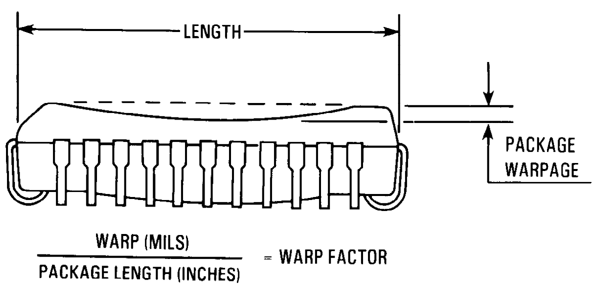


Figure 7
Package Warpage

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their responsibility.

SEMI G55-93 (Reapproved 1104)
TEST METHOD FOR MEASUREMENT OF SILVER PLATING BRIGHTNESS

This test method was technically reapproved by the Global Assembly & Packaging Committee and is the direct responsibility of the Japanese Packaging Committee. Current edition approved by the Japanese Regional Standards Committee on July 23, 2004. Initially available at www.semi.org September 2004; to be published November 2004. Originally published in 1993.

1 Preface

1.1 *Use* — This test may be used for process control and outgoing inspection at the supplier or by the user for incoming inspection.

2 Scope

2.1 This method describes the standard method for measuring the brightness of silver plating on semiconductor leadframes.

NOTE 1: This method determines quantitative measures which are not related directly to the traditional “Dull,” “Semi-Bright” and “Bright” descriptors for silver plating.

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

3 Referenced Standards

3.1 *SEMI Standard*

SEMI G21 — Specification for Plating Integrated Circuit Leadframes

3.2 *JIS Specifications*[1]

JIS H8621 — Electroplated Coatings of Silver for Engineering Use

JIS Z8722 — Method of Measurement for Color of Reflecting or Transmitting Objects

JIS Z8741 — Method of Measurement for Specular Glossiness

3.3 *Military and Federal Specifications*[2]

QQ-S-365 — General Requirements for Electro-deposited Silver Plating

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

4 Significance

4.1 Brightness values indicate surface roughness for given plating conditions. Surface roughness affects the wettability of resinous die attach processes on leadframes. If the surface is too smooth, poor wetting may occur which results in low die share strength values.

4.2 Brightness variations may also affect the ability of the pattern recognition systems used on assembly equipment to recognize the set points.

5 Summary of Method

5.1 The method is based on the use of a GAM Densitometer. This method is chosen as the standard because of the small measurement area requirements and the high accuracy of the method for typical silver plating brightness used on leadframes.

5.1.1 This method is based on the measurement of the reflectance of light at 45° from a surface illuminated from a light source perpendicular to the surface. This value of Reflectance (R) gives a Density Value (D) based on the following formula:

$$D = \log 1/R$$

Density is a measure of the Brightness.

6 Interferences

6.1 *Surface Finish*

6.1.1 Brightness values depend on surface roughness. A rough surface shows a low brightness value when compared to a smooth surface. Variable plating conditions, such as the addition of brighteners to the plating solution, may give brightness results, which are not comparable for the acceptance of plated leadframes.

6.1.2 Scratches and other flaws in the surface will affect reflectance.

6.2 *Storage Time and Conditions*

6.2.1 Figure 1 shows the brightness results for leadframes subjected to indoor, atmospheric storage for

1 Japanese Industrial Standards, Available through the Japanese Standards Association, 1-24, Akasaka 4-Chome, Minato-ku, Tokyo 107-8440, Japan. Telephone: 81.3.3583.8005; Fax: 81.3.3586.2014, Website: www.jsa.or.jp

2 United States Military Standards, Available through the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099, USA. Telephone: 215.697.3321

an extended time. Results are shown for silver plating on copper alloy and Alloy 42 leadframes.

6.2.2 Leadframes shall be stored in conditions agreed between supplier and customer in order to limit atmospheric tarnishing, and brightness measurements shall be taken within an agreed time of delivery.

6.3 Degradation of the standards will affect calibration.

7 Equipment

7.1 GAM Densitometer or equivalent.

8 Sampling

8.1 A sampling plan shall be agreed between user and supplier.

9 Preparation of Samples

9.1 No special preparation requirements are necessary. Do not contaminate the samples by touching with bare hands.

10 Measurement Conditions

10.1 To confirm the lamp is on enough to measure the brightness values. (Lamp intensity is automatically calibrated.)

11 Equipment Setup and Calibration

11.1 *Equipment Setup*

11.1.1 Set up and turn on the equipment according to the manufacturer's instructions.

11.1.2 Allow at least 30 minutes for equipment stabilization before beginning measurements.

11.2 *Calibration*

11.2.1 Calibration shall be performed using standard black and white plates.

11.2.2 The equipment shall be recalibrated every 30 minutes.

12 Procedure

12.1 *Procedure*

12.1.1 Measurements shall be made close to the center of the die pad, if possible. In those situations where the die pad is not plated, the measurement site shall be agreed between user and supplier.

12.1.2 Measure all the selected samples according to the equipment manufacturer's instructions. Take three readings on each sample and obtain an average result for that sample.

12.2 *Results*

12.2.1 Brightness values shall be rounded to the first decimal place.

13 Report

13.1 The report, when used by a supplier to certify a customer's requirements or by the customer at incoming inspection shall contain, at least, the following information, other information which is reported shall be agreed between supplier and customer.

13.2 *Supplier's Lot Number and Date of Shipment*

13.3 *Test Conditions*

13.4 Results from Section 11. (SPC charting techniques may be used to monitor results for each leadframe type and plating requirement.)

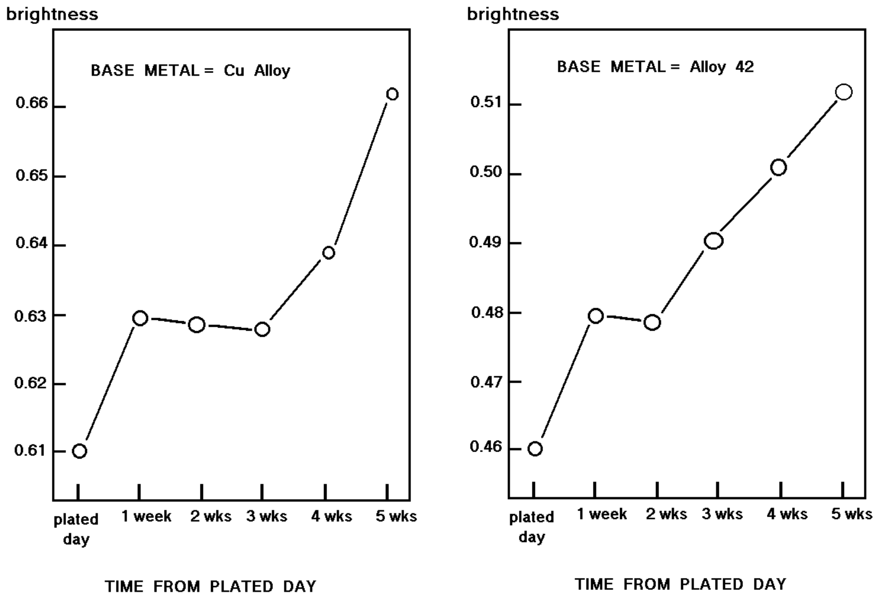
14 Repeatability and Precision

14.1 *Repeatability*

14.1.1 Values for brightness based on use of a densitometer are repeatable within ± 0.003.

14.2 *Precision*

14.2.1 Precision for brightness values based on use of a densitometer is ± 0.015.



NOTE: Specimens were kept in an office and directly exposed to the atmosphere.

Figure 1
Changes of the Brightness Value as Time Goes by

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI G56-93 (Reapproved 0302)
TEST METHOD FOR MEASUREMENT OF SILVER PLATING THICKNESS

This test method was technically approved by the Global Assembly and Packaging Committee and is the direct responsibility of the Japanese Assembly and Packaging Committee. Current edition approved by the Japanese Regional Standards Committee on November 26, 2001. Initially available at www.semi.org December 2001; to be published March 2002. Originally published in 1993.

1 Purpose

1.1 *Use* — This test may be used for process control and outgoing inspection at the supplier or by the customer for incoming inspection.

1.2 *Units* — This standard test method uses SI units.

2 Scope

2.1 This method describes the standard method for measuring the thickness of silver plating on semiconductor leadframes.

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

3 Referenced Standards

3.1 *ASTM Specifications*[1]

ASTM B 568 — Measurement of Coating Thickness by X-Ray Spectrometry

4 Significance

4.1 The thickness of plating affects assembly processes such as wire bonding. If the plating is too thin, heat processes such as die attach cause the surface to become unbondable due to bleeding of the base material through the plating.

4.2 Schematic picture for measurement principles is shown in Figure 2.

5 Summary of Method

5.1 The method is based on the use of fluorescent X-rays. This method is chosen as the standard because of the small measurement area requirements, the high accuracy of the method for typical silver plating thicknesses used on leadframes, and the non-contact method.

1 American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, USA. Telephone: 610.832.9585, Fax: 610.832.9555 Website: www.astm.org

6 Interferences

6.1 *Impurities in Plating*

6.1.1 Elements with atomic numbers between 42 (Molybdenum) and 52 (Tellurium) cause false readings.

6.2 *Measurement Time*

6.2.1 At small collimator diameters, the measurement time is no longer proportional to diameter. X-ray counting errors may occur for short measurement times.

6.3 Worn or abraded standards will affect calibration.

6.4 Base material variations will affect results. Standard samples and leadframes must have the same base material and plating system conditions for accurate results.

7 Equipment

7.1 Fluorescent X-ray spectrometer.

8 Sampling

8.1 A sampling plan shall be agreed between supplier and customer.

9 Preparation of Samples

9.1 No special preparation requirements are necessary.

10 Measurement Conditions

10.1 Collimator shall be set at 0.1 mm or 0.3 mm by agreement between user and supplier.

10.2 Measurement time shall be agreed between user and supplier.

11 Equipment Setup and Calibration

11.1 *Equipment Setup*

11.1.1 Set up the equipment according to the manufacturer's instructions.

11.1.2 Allow at least 30 minutes for equipment stabilization before beginning measurements.

11.2 *Calibration*

11.2.1 Calibration curves shall be generated using standard samples traceable to the National Institute of Standards and Technology or equivalent standards organization.

11.2.2 Calibration curves shall be generated after the equipment has stabilized per the manufacturer's instructions.

11.2.3 The equipment shall be recalibrated every 8 hours.

12 Procedure

12.1 *Procedure*

12.1.1 Measurements shall be made close to the center of the die pad, if possible. In those situations where the die pad is not plated, the measurement site shall be agreed between user and supplier.

12.1.2 Measure all the selected samples according to the equipment manufacturer's instructions.

NOTE: Refer to the equipment manufacturer's instructions and ASTM B 568 for safety conditions.

12.2 *Results*

12.2.1 Thicknesses shall be rounded to the first decimal place.

13 Report

The report when used by a supplier to certify a user's requirements or by the user at incoming inspection shall contain, at least, the following information. Other information which is reported shall be agreed between the user and supplier.

13.1 Supplier's Lot Number and Date of Shipment

13.2 Test Conditions

13.3 Results from Section 11. (SPC charting techniques may be used to monitor results for each leadframe type and plating requirement.)

14 Accuracy and Precision

14.1 *Accuracy*

14.1.1 Figure 1 shows curves of silver plating thickness measured by fluorescent X-Ray versus the percentage error in that measurement for two collimator settings for a constant measurement time.

15 Related Documents

15.1 *SEMI Specifications*

SEMI G21 — Plating Integrated Circuit Leadframes

15.2 *JIS Specifications*[2]

JIS H8501 — Methods for Thickness Testing for Metallic Coatings

JIS H8621 — Electroplated Coatings of Silver for Engineering Purposes

15.3 *Military and Federal Specifications*[3]

QQ-S-365 — General Requirements for Electro-deposited Silver Plating

MIL-S-19550 — General Specification for Semiconductor Devices

15.4 *ISO Specifications*[4]

ISO-3497 — Metallic Coating Measurement of Coating Thickness X-Ray Spectometry Methods

2 Japanese Industrial Standards, Available through the Japanese Standards Association, 1-24, Akasaka 4-Chome, Minato-ku, Tokyo 107-8440, Japan. Telephone: 81.3.3583.8005; Fax: 81.3.3586.2014 Website: www.jsa.or.jp

3 Available through the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099, USA. Telephone: 215.697.3321

4 ISO, 1 rue de Varembe, Case postale 56, CH01211 Geneva 20, Switzerland

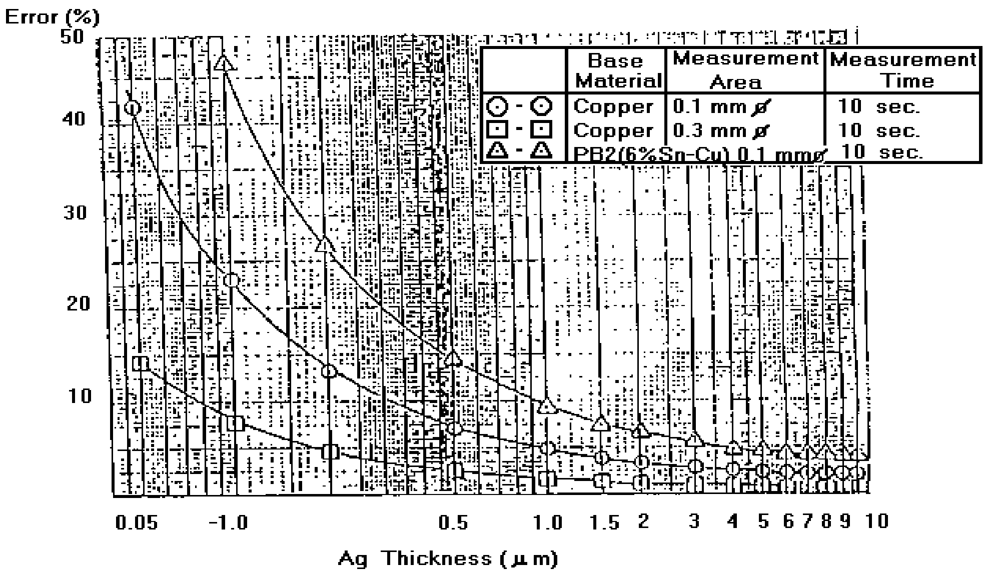


Figure 1
Error in Silver Thickness Measurement

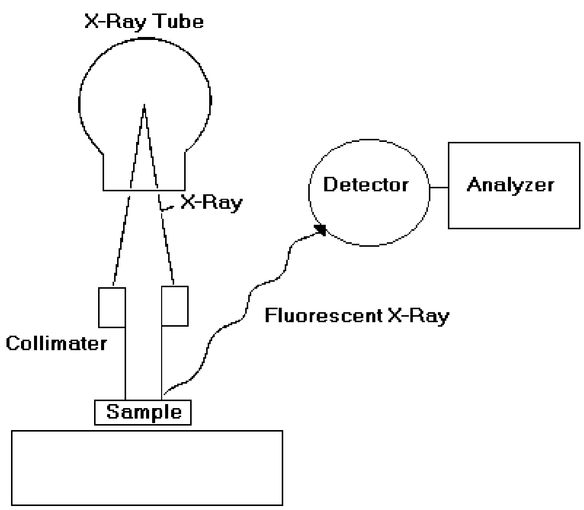


Figure 2
Measurement Principles

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their responsibility.

SEMI G57-0302
GUIDE FOR STANDARDIZATION OF LEADFRAME TERMINOLOGY

This guide was technically approved by the Global Assembly and Packaging Committee and is the direct responsibility of the Japanese Assembly and Packaging Committee. Current edition approved by the Japanese Regional Standards Committee on November 26, 2001. Initially available on www.semi.org December 2001; to be puiblished March 2002. Originally published in 1993.

1 Preface

1.1 *Purpose* — This guideline defines standard terminologies for all the features of leadframes used in the production of semiconductor circuits.

1.2 *Significance* — Use of this guide in communications between customers and vendors can reduce the errors caused by the current use of different nomenclatures for the same feature of a leadframe.

Table 1 Nomenclature for Figures

1	Die Pad
2	Die Pad Support
3	Lead Lock
4	Anchor Hole
5	Inner Lead
6	Outer Lead
7	Standard Pilot Hole
8	Pilot Hole
9	Top Rail Standard Pilot Hole Side
10	Bottom Rail
11	Lead Cut-off Notch
12	Dam Bar
13	Lead Shoulder
14	Mold Dam
15	Bumper Support Cut-off Notch
16	Lead Lock Groove
17	Mold Line
18	Expansion Slot
19	Down Set
20	Die Pad Dimple
21	Side Rail
22	Strip Cut-off Line
23	Coined Area
24	Degate Hole

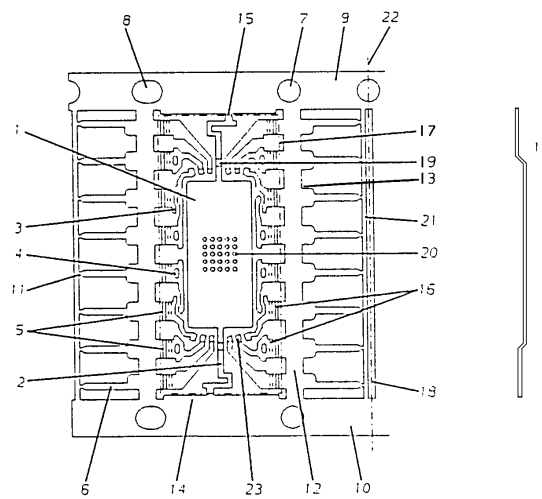


Figure 1

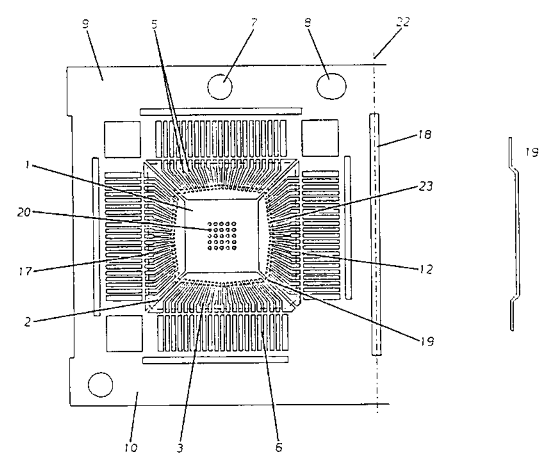


Figure 2

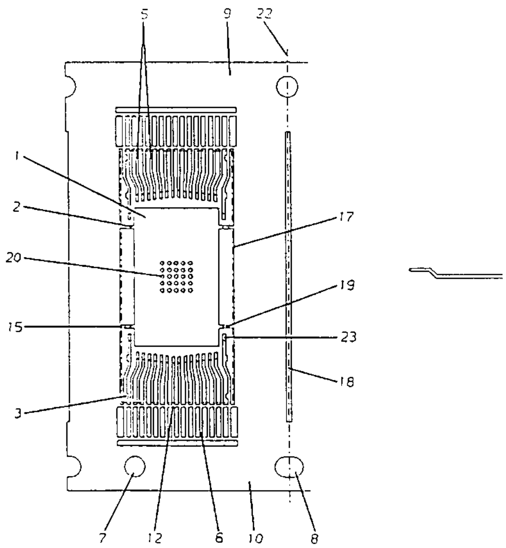


Figure 3

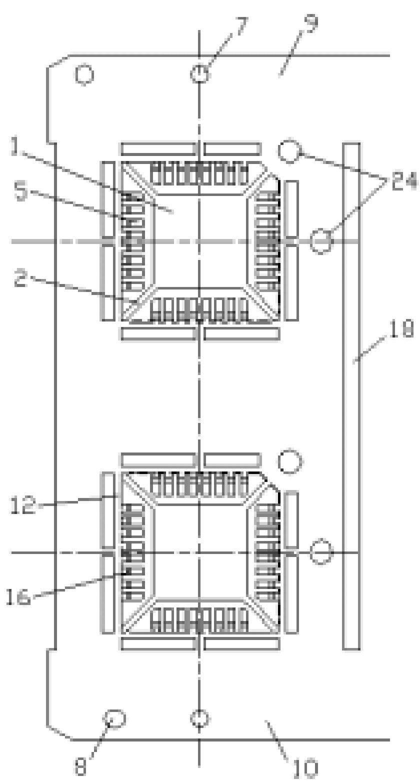


Figure 4

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their responsibility.

SEMI G58-94
SPECIFICATION FOR CERQUAD PACKAGE CONSTRUCTIONS

1 Preface

1.1 *Purpose* — This specification defines the acceptance criteria for Cerquad package components and includes requirements for the base, leadframe, window frame, cap and sealing glass materials.

1.2 *Scope* — This specification applies to all Cerquad packages which have a leadframe sandwich between two ceramic pieces — the base and the window frame — and sealed by glass, and a cap with a similar glass seal.

NOTE 1: The base, leadframe and window frame may be purchased as separate components or as a completed assembly.

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.

NOTE 2: In the figures only U.S. Customary units are shown.

2 Applicable Documents

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

Purchase Order

Customer's Component Drawings

This Specification

Referenced Documents

2.2 *Referenced Documents*

2.2.1 *SEMI Specifications*

SEMI G21 — Plating Integrated Circuit Leadframes

SEMI G23 — Measuring the Inductance of Package Leads

SEMI G24 — Measuring the Lead-to-Lead and Loading Capacitance of Package Leads

SEMI G25 — Measuring the Resistance of Package Leads

Compilation of Terms

2.2.2 *JEDEC Specifications*[1]

Pub. No. 95 — Registered and Standard Outlines for Semiconductor Devices

2.2.3 *Military and Federal Specifications*[2]

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

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

MIL-STD-1835 — Microcircuit Case Outlines

MIL-G-45204 — Gold Plating — Electrodeposited

MIL-M-38510 — General Specification for Microcircuits

3 Selected Definitions

3.1 *blister (bubble) metallization* — an enclosed locallized separation of the metallization from its base material (such as ceramic or another metallization layer component) that does not expose the underlying layer.

3.2 *burr* — an adherent fragment of parent material at a component edge. In leadframes, the metal burr, due to the stamping operation, may be in the horizontal or vertical direction to the surface. In ceramic packages, this type of characteristic is called a fin.

3.3 *camber (ceramic)* — arching of a nominally flat ceramic body.

3.4 *chip* — region of material missing from a component (e.g., ceramic from a package, or solder from a preform). The region does not progress completely through the component and is formed after the component is manufactured. Chip size is defined by its length, width and depth from a projection of the design planform. Also called chipout. (See Figure 1.)

3.5 *crack* — a cleavage or fracture that extends to the surface of a semiconductor package or solder preform. The crack may or may not pass through the entire thickness of the package or preform.

3.6 *critical seal area* — on a semiconductor package, the area bounded by the shortest nominal design distance from the largest cavity, usually the wire bond cavity, to the edge of the package or ceramic layer forming the seal area. (See Figure 2.)

3.7 *fin* — on a ceramic package or cap, a fine feathery-edged projection of parent ceramic material on the corner of the ceramic body.

1 JEDEC, 2001 Eye Street N.W., Washington, DC 20006.

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

3.8 *foreign material* — an adherent particle that is not parent material of the component. Adherence means that the particle cannot be removed by an air or nitrogen blast at 20 psi.

3.9 *glass flow* — on a semiconductor package or cap, the heating process which just removes all the screen printing mesh marks in the sealing glass when viewed at 10× magnification.

3.10 *glass void* — the absence of a sealing glass layer from a designated area.

3.11 *metallization void* — the absence of a clad, evaporated, plated or screen-printed metal layer or braze from a designated area.

3.12 *non-critical seal area* — on a semiconductor package that uses a lid, cap, or cover to effect the seal, the area of the sealing surface outside the critical sealing area. (See Figure 2.)

3.13 *overhang* — on a semiconductor package, the horizontal extension of the sealing glass past the vertical wall of a cavity cut into the ceramic layer on which the glass is printed. (See Figure 3.)

3.14 *peeling (flaking)* — any separation of a plated, vacuum deposited, or clad metal layer from the base metal of a leadframe, pin, heatsink, or seal ring, from an underplate, or from a refractory metal on a ceramic package. Peeling exposes the underlying metal.

3.15 *projection* — on a semiconductor package (plastic or ceramic), leadframe or preform, and irregularly raised portion of a surface indiginous to the parent material.

3.16 *pullback* — on a semiconductor package, the linear distance between the edge of a cavity cut into a ceramic layer and the first measureable glass or metallization layer interface coated onto the top surface of that layer. The total pullback may be the result of the high temperature processing required to manufacture the package or to coat the surface. It may also be the result of design considerations. (See Figure 3.)

3.17 *rundown* — on a semiconductor package, the linear distance from the upper surface of a ceramic cavity layer to the bottom point of the overhang into the cavity, of a sealing glass or metallization layer that has been screened onto that surface. (See Figure 3.)

4 Ordering Information

Purchase orders for cerquad packages and caps furnished to this specification shall include the following items:

4.1 Package description

4.2 Current drawing revision detailing

All dimensions

Type and color of ceramic

Type and thickness of sealant glass

Leadframe material type and design

Type and thickness of metallization in the lead bond area

Type and thickness of external lead plating, if applicable

Type and thickness of die attach metalization

4.3 Vendor certification requirements

4.4 Any additions to, or variations from, this specification

5 Dimensions

The component described in this specification shall produce packaged devices that conform to the outline dimesnions and lead numbering for Cerquad Package Constructions detailed in: JEDEC Publication 95; EIAJ; MILSTD1835. Package manufacturing tolerances shall be agreed between vendor and customer.

6 Materials

The definitions, defect criteria, and functional tests described in this specification relate to package components made with the following materials:

6.1 Base, Window Frame, and Cap

6.1.1 Material

6.1.1.1 *Alumina* — Content to be 90% minimum, or

6.1.1.2 *Beryllia* — Content to be agreed between vendor and customer.

6.1.2 *Color*

6.1.2.1 *Alumina* — Black, dark brown, or violet.

6.1.2.2 *Beryllia* — White.

6.2 *Sealant* — A solder glass suitable for hermetic sealing shall be specified.

6.3 *Die Attach Pad Metallization* — Gold or any other suitable material shall be specified.

6.4 *Leadframe*

6.4.1 *Base Material*

6.4.1.1 *Thickness* — Shall be specified.

6.4.1.2 *Composition* — Iron-Nickel-Cobalt alloy per MIL-M-38510, Type A or Iron-Nickel alloy per MIL-M-38510, Type B shall be specified.

6.4.2 *Finish* — Lead bond areas.

6.4.2.1 Metallization — Aluminum.

6.4.2.1.1 *Thickness* — 100 – 600 microinches (0.0025 – 0.015 mm).

6.4.2.1.2 *Coverage* — Total coverage for a distance of 0.030" (0.762mm) minimum as measured from the lead tip. Maximum length is defined by the lead bond cavity size.

6.4.2.1.3 *Composition* — 99.4% minimum for clad aluminum, 99.99% minimum for vapor deposited aluminum.

6.4.2.2 *Metallization* — Gold.

6.4.2.2.1 *Thickness* — 50 – 225 microinches (0.0013 – 0.0057mm).

6.4.2.2.2 *Coverage* — See paragraph 6.4.2.1.2.

6.4.2.2.3 *Composition* — See SEMI G21 and MIL-G-45204.

6.4.3 *Leadframe Finish* — External areas (if specified).

6.4.3.1 *Metallization* — Gold (see Section 6.4.2.2).

7 Defect Limits

The following defects shall be rejected if the limits shown are exceeded:

NOTE 3: The criteria apply to purchased pre-assemblies or, where applicable, to units assembled by the customer to process conditions agreed between vendor and customer.

7.1 *Ceramic Components*

7.1.1 *Cracks* — Not allowed.

7.1.2 *Chips* — See Figures 1 and 2.

7.1.2.1 *Corner Chips* — 0.030" (0.762 mm) × 0.030" (0.762 mm) × 25% of package element thickness.

7.1.2.2 *Edge Chips* — 0.060" (1.524 mm) × 0.030" (0.762 mm) × 25% of package element thickness.

7.1.2.3 *Critical Seal Area* — Chips must not reduce the critical seal path length, at any point, to less than one-half the nominal design dimension. No more than four chips are allowed in this area regardless of loss of seal length.

7.1.3 *Burrs, Projections (Fins), and Blisters*

7.1.3.1 *Base, Window Frame, and Cap* — 0.005" (0.127 mm) maximum allowable dimension or greater than 0.003" (0.076 mm) height.

7.1.3.2 *Die Attach Surface* — 0.001" (0.025 mm) maximum above the metallization surface excluding a zone, 0.010" (0.25 mm) wide, around the periphery of the cavity maximum allowable dimension is 0.005" (0.127 mm).

7.1.4 *Camber* — Shall be specified on the component drawing.

7.2 *Glass Sealant*

7.2.1 *Chips and Voids* — 0.010" (0.254 mm) maximum allowable dimension, with exposed or covered ceramic. No more than four chips or voids are allowed in the critical seal area. These defects must also meet the requirements of Table 1 in Section 7.2.2.4.

7.2.2 *Glass Misalignment (after glass flow)* — See Figure 3.

7.2.2.1 *Glass Overhang* — 0.15" (0.381 mm) maximum extension from the ceramic edge.

7.2.2.2 *External Rundown* — 50% of component thickness maximum.

7.2.2.3 *Rundown into Lead Bond Cavity* — 0.010" (0.254 mm) maximum extension from the top surface of the cavity.

7.2.2.4 *Pullback* — See Table 1.

Table 1 Maximum Allowable Pullback

External	0.015" (0.381 mm)
Internal	0.101" (0.254 mm)

NOTE 3: Glass pullback, at any point, shall not reduce the critical seal path width to less than one-half the designed width. (See Figure 2.)

7.2.2.5 *Foreign Material* — 0.020" (0.508 mm) maximum allowable dimension but 0.010" (0.254 mm) in the critical seal area, with no more than four sites allowed and a minimum separation of 0.030" (0.762 mm) between sites.

7.3 *Die Attach Cavity Metallization* — Excluding a 0.010" (0.254 mm) wide zone around the periphery of the cavity, the following criteria apply:

7.3.1 *Foreign Material, including Glass Splatters* — no more than four areas with 0.005" (0.13 mm) maximum dimension or greater than 0.001" (0.025 mm) height.

7.3.2 *Metallization Lumps* — No more than four allowed. If the metallization is Gold and eutectic Gold-Silicon die attach is to be used, then the lumps may not exceed 0.010" (0.254 mm) in diameter and 0.005" (0.127 mm) height. If eutectic bonding is not used, then the lumps will be treated as foreign material per Section 7.3.1

7.3.3 *Voids* — 0.005" (0.127 mm) maximum allowable dimension with no more than four allowed and a minimum separation of 0.030" (0.762 mm) between sites.

7.4 *Leadframe*

7.4.1 *Lead Bond Areas* — the minimum lead bond area on the lead tip is defined in Figure 4.

In these bond areas, the following defects are not allowed:

7.4.1.1 *Voids or Pits* — Exposure of base material with any dimension larger than 0.001" (0.0254 mm).

7.4.1.2 *Discoloration, Blistering, or Peeling of the Metallization*

7.4.1.3 *Scratches or Scrapes* — Any build-up of the metallization, or exposure of the base material.

7.4.1.4 *Foreign Material including Glass Splatter or Projections* — No more than four sites, each with a maximum dimension of 0.001" (0.0254 mm).

7.4.1.5 *Glass Wetting or Cracking* — Any lead finger which is not firmly embedded in the glass.

7.4.1.6 *Glass Pullback from the Lead Tip* — Greater than 0.010" (0.254 mm).

7.4.1.7 *Glass Bulge between Lead Fingers* — Greater than 0.005" (0.127 mm) height above the fingers except as agreed between vendor and customer for narrow pitch leads where this limit may cause wire bond interference problems.

7.4.1.8 *Lead Tip Coplanarity (Pre-assembled Bases, Leadframes, and Window Frames)* — Greater than 0.006" (0.15 mm) difference in the position of the top surface of the lead from highest lead to lowest lead.

7.4.1.9 *Lead Tip Pitch* — Greater than ± 0.002" (0.051 mm) variation from true position.

7.4.2 *Internal Lead Areas, excluding Lead Bond Areas* — In these areas, the following defects are not allowed:

7.4.2.1 *Burrs and Projections or Pits* — With a maximum dimension greater than 0.002" (0.0508 mm) in height or depth.

7.4.2.2 *Foreign Material (including Plating Discoloration)* — With a major dimension in the surface plane greater than 0.015" (0.381 mm) or exceeding 0.002" (0.0508 mm) in height.

7.4.2.3 *Voids which Expose Base Metal* — With a major dimension greater than 0.002" (0.0508 mm).

7.4.2.4 *Blistering or Peeling of Metallization*

7.4.2.5 Scratches and scrapes which cause metal build-up or expose base material.

7.4.3 *External Lead Areas*

NOTE 4: Non-functional areas of the leadframe, such as tie-bars, shall not be subjected to inspection.

7.4.3.1 Unplated Leads

NOTE 5: Plated leads shall also be required to pass these criteria.

7.4.3.1.1 *Scratches* — Causing loss of more than 25% of the leadframe thickness.

7.4.3.1.2 *Voids* — In violation of Section 7.4.3.1.1 or loss of more than 10% of the design width of a leadframe detail.

7.4.3.1.3 *Burrs* — In excess of 0.002" (0.051 mm) in height and 0.005" (0.127 mm) in the major dimension.

7.4.3.2 *Plated Leads*

7.4.3.2.1 *Scratches and Scrapes* — Exposure of base material or loss of plating integrity over 5% of the area of a lead finger.

7.4.3.2.2 *Voids* — Exposure of base material.

7.4.3.2.3 *Blistering or Peeling*

7.4.3.2.4 *Staining, Foreign Material, or Contamination* — In excess of 5% of the area of a lead finger.

7.4.4 *Lead Assembly*

7.4.4.1 *Lead Tip Overhang* — 0.010" (0.254 mm) maximum from the cavity wall, see Figure 5.

7.4.4.2 *Lead Misalignment* — 0.010" (0.254 mm) maximum, see Figure 6.

7.4.5 *Window Assembly Misalignment* — 0.015" (0.381 mm) maximum, see Figure 7.

8 Incoming Inspection and Functional Tests

8.1 *Incoming Inspection*

8.1.1 Dimensional inspection per Section 6.

8.1.2 Visual inspection per Section 7 at 10× magnification with vertical lighting.

8.1.3 *Metallization*

8.1.3.1 *Die Attach Metallization* — Thickness shall be measured by standard cross-sectioning without smearing or by X-Ray fluorescence.

8.1.3.2 *Lead Bond Metallization* — Thickness shall be measured by X-ray fluorescence.

8.1.3.3 *External Lead Plating (if applicable)*

8.1.3.3.1 *Thickness* — Shall be measured by X-ray fluorescence.

8.1.3.3.2 *Solderability* — Shall be tested per MIL-STD-883, Method 2003.

8.2 *Functional Testing*

NOTE 6: All procedures used to functionally test the components shall be agreed between user and supplier.

The sequence of functional testing shall be as shown in Figure 8.

8.2.1 *Die Attach*

8.2.1.1 *Visual Inspection*

Eutectic Bonding — Visually inspect the alloy wet-out after die attach. The minimum wet-out requirement shall be 100% of the die perimeter.

Silver Glass, Epoxy, or Polyimide Bonding — 100% die perimeter coverage shall be required.

NOTE 7: 100% coverage for resin bonding is not a function of package acceptability but is required to standardize die shear testing. The inability of the resins to wet the surface of the die attach area due to contamination is cause for rejection.

8.2.1.2 *Die Shear Test* — Perform destructive testing per MIL-STD-883, Method 2019.

NOTE 8: This test may also be performed after environmental testing. In the case of very large die, this test may not be appropriate to fully evaluate the package. In these cases, die sizes, agreed between vendor and customer, shall be used. Alternatively, die pull testing may be used by agreement between vendor and customer.

8.2.1.3 *Radiographic Inspection for Voids* — Perform inspection per MIL-STD-883, Method 2012.

8.2.1.4 *Ultrasonic Inspection for Voids, Delamination, and Cracks* — Perform inspection per MIL-STD-883, Method 2030.

8.2.2 *Wire Bond* — On wire bonds that meet the requirements of MIL-STD-883, Method 2010, perform destructive testing per MIL- STD-883, Method 2011, Test Condition D. Bonds which cause lifted metallization from the leadframe fingers shall also be cause for component rejection.

NOTE 9: This test shall be performed at pre-seal and post-seal.

8.2.3 *Seal*

8.2.3.1 *Visual Inspection* — The glass sealant appearance and flow shall be visually inspected for conformance to agreed process criteria.

8.2.3.2 *Cap Torque Test* — This test shall be performed per process agreement.

8.2.4 *Lead Finish* — Type A per MIL-M-38510 if required.

8.2.5 *Hermeticity* — This test shall be performed per MIL-STD-883, Method 1014, Test Condition A or B and C. The package must maintain hermetic integrity after each environmental test or sequence of tests.

8.2.6 *Environmental Testing* — Environmental evaluation shall include, but not be limited to, the following tests:

NOTE 10: The sequence of testing and the sample sizes for each sub-group shall be agreed between vendor and customer.

8.2.6.1 *Temperature Cycle* — Per MIL-STD-883, Method 1010, Condition C.

8.2.6.2 *Thermal Shock* — Per MIL-STD-883, Method 1011, Condition B.

8.2.6.3 *Vibration Fatigue* — Per MIL-STD-883, Method 2005, Test Condition B.

8.2.6.4 *Mechanical Shock* — Per MIL-STD-883, Method 2002, Test Condition B.

8.2.6.5 *Constant Acceleration* — Per MIL-STD-883, Method 2001, Test Condition D, "Y" axis only.

8.2.6.6 *Moisture Resistance* — Per MIL-STD-883, Method 1004.

8.2.6.7 *Additional Testing* — Additional tests performed at package qualification may include evaluation of electrical and thermal characteristics. These tests may be performed on a periodic basis to maintain package qualification.

These tests may include, but are not limited to, the following:

8.2.6.7.1 *Insulation Resistance* — Per MIL-STD-883, Method 1003, Test Condition as agreed between user and supplier.

8.2.6.7.2 *Lead Inductance* — Per SEMI Test Method G23.

8.2.6.7.3 *Lead-to-Lead Capacitance* — Per SEMI Test Method G24.

8.2.6.7.4 *Lead Resistance* — Per SEMI G25.

8.2.6.7.5 *Thermal Dissipation* — Per MIL-STD-883, Method 1012.

9 Sampling

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

10 Packaging and Marking

10.1 *Packaging* — The shipping containers and materials shall be suitability designed to provide the components with protection against normal transportation damage risks which include crushing and spillage, and exposure to moisture and other corrosive gases.

The packing materials must not cause particulate contamination on the components.

10.2 *Marking* — The shipping container shall be clearly marked with the following information:

Customer's Part Number

Customer's Purchase Order Number

Drawing Number (Customer's and Vendor's, if appropriate)

Quantity

Vendor Lot Number

Shipping date

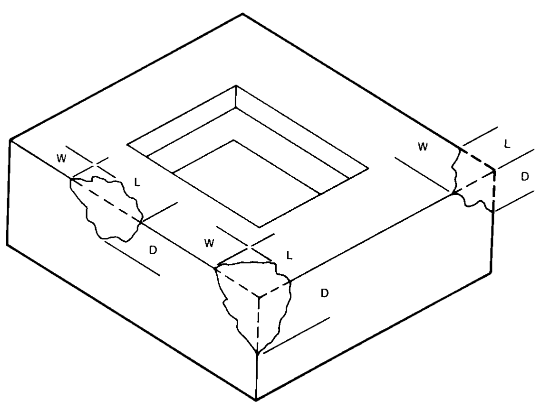


Figure 1
Chip Illustration

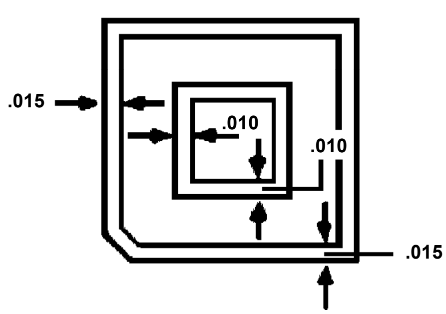


Figure 2
Critical and Non-Critical Seal Areas

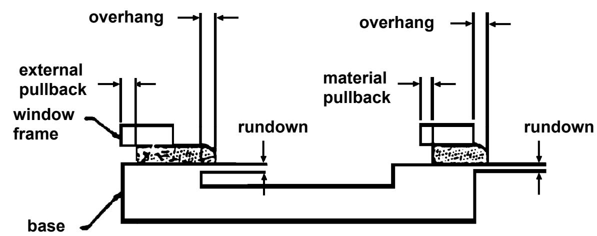


Figure 3
Glass Misalignment

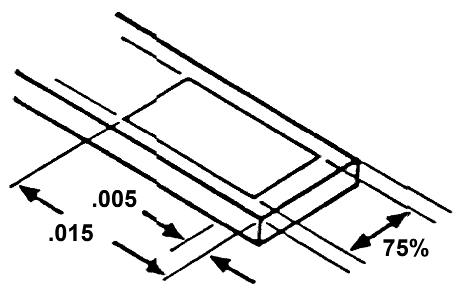


Figure 4

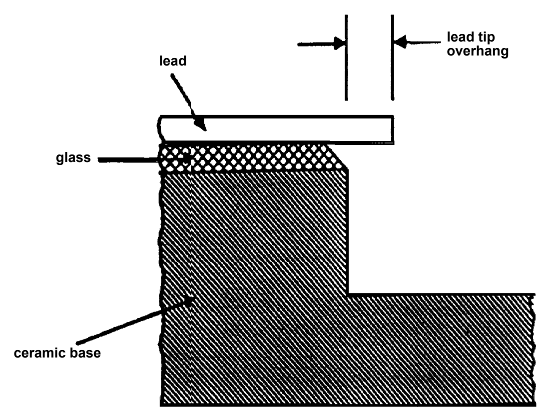


Figure 5

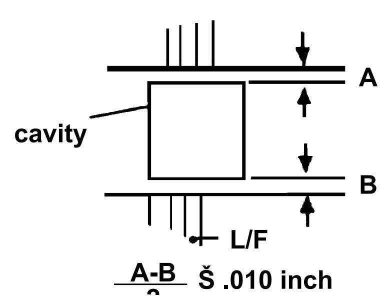
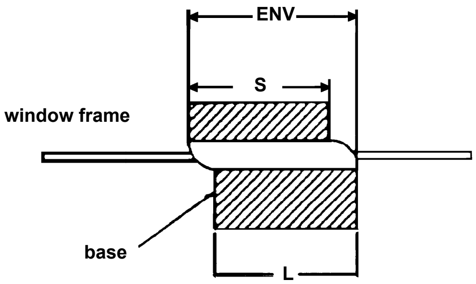


Figure 6



$ENV - L + \frac{L - S}{2}$ Š .015

Figure 7

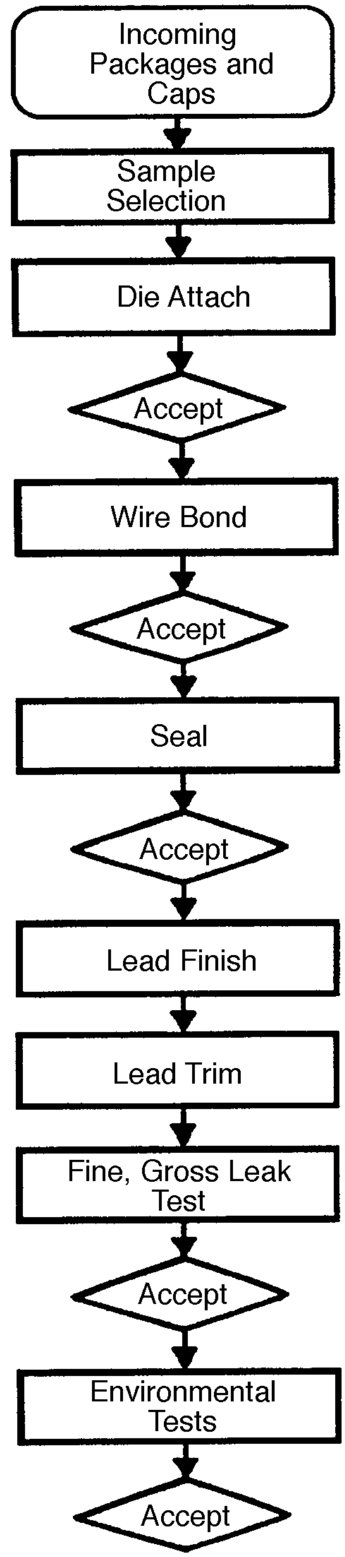


Figure 8

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their responsibility.

SEMI G59-94 (Reapproved 0302)
TEST METHOD FOR MEASUREMENT OF IONIC CONTAMINATION ON LEADFRAME INTERLEAFING AND THE CONTAMINATION TRANSFERRED FROM THE INTERLEAFING TO THE LEADFRAMES

This specification was technically approved by the Global Assembling and Packaging Committee and is the direct responsibility of the Japanese Assembling and Packaging Committee. Current edition approved by the Japanese Regional Standards Committee on November 26, 2001. Initially available at www.semi.org December 2001; to be published March 2002. Originally published in 1994.

1 Purpose

1.1 This test method describes a procedure to determine the ionic contamination on leadframe interleafing and the contamination transferred from the interleafing to the leadframes using a water extraction method.

2 Scope

2.1 This test method is sensitive to the following ionic species:

Na^+, NH_4^+, K^+, Cl^-, NO_3^-, Br^-, SO_4^{2-}, PO_4^{3-}.

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

3 Referenced Standards

3.1 *ASTM Specifications*[1]

D 4327 — Anions in Water by Ion Chromatography

D 1193 — Specification for Reagent Water

4 Terminology

4.1 *eluent* — The solvent used to carry the extracted ions through the ion exchange chromatograph.

4.2 *interleaf (for semiconductor leadframes)* — A paper or plastic film which is placed between layers of semiconductor leadframes strips to prevent tangling.

4.3 *regenerant* — A chemical solution containing the ions originally present in the chromatograph column prior to a test run, used to prepare the column for a new test.

4.4 *retention time* — The time required for a particular ion type to pass from the injection port to the detector. Retention time is characteristically different for each ion type.

4.5 *standard solution* — A solution containing a known concentration of the ion to be measured and used to calibrate the chromatograph.

5 Summary of Method

Ionic contamination is extracted in water at > 95°C for 30 ± 2 minutes. The contamination is quantitatively analyzed by ion type using ion chromatography, and the result is presented as nanograms/unit area.

6 Significance

6.1 Contamination on the interleaf may contribute to semiconductor device reliability problems by transference of the contamination to the leadframes.

6.2 The method may be used by leadframe manufacturers for the incoming inspection of the interleafing material, or by users at incoming inspection of the leadframes.

6.3 Correlation of device reliability results with interleaf contamination level measurements may lead to improved interleaf materials.

7 Interferences

7.1 The interleaf material and the leadframes must only be touched with cleaned tweezers or while wearing double-layer gloves with polyethylene outer gloves in order to avoid additional contamination.

8 Equipment

8.1 *Ion Chromatograph for Anion and Cation Analysis* — This equipment is to consist of a concentration pump, guard column, separator column, and a detector module.

The minimum sensitivity of the chromatograph for each ion type is defined in Table 1.

1 American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, USA. Telephone: 610.832.9585, Fax: 610.832.9555 Website: www.astm.org

Table 1 Sensitivity of Ion Chromatograph

Ion		*Sensitivity(ng/mL)*
Cation	Na^+	0.2
	NH_4^+	0.5
	K^+	1.0
Anion	Cl^-	0.3
	PO_4^{3-}	2.0
	Br^-	1.0
	NO_3^-	1.0
	SO_4^{2-}	1.0

8.2 *Chart Recorder*

8.3 *Ion Extraction Vessels* — Polypropylene or polytetrafluoroethylene containers with sealing caps.

NOTE 1: The contamination level of these vessels must be less than one fifth (1/5) of the expected contamination level on the interleaf of leadframes when measured in a control test.

8.4 *Water Bath* — 300 mm L × 300 mmW × 200 mmH, filled with DI water, and capable of holding 95°C.

8.5 *Constant Temperature and Humidity Chamber*

8.6 *Volumetric Dispenser* — (e.g., Pipettes — 10 mL and 100 mL capacity).

8.7 *Quartz Flasks and Pipettes for Cation Standard Solutions* — 100, 250, 500, and 1000 mL capacity (flasks); 1, 10, and 25 mL capacity (pipettes).

8.8 *Borosilicate Glass Flasks and Pipettes for Anion Standard Solutions* — 100, 250, 500, and 1000 mL capacity (flasks); 1, 10, and 25 mL capacity (pipettes).

8.9 *Chemical Balance, Weighing Chemicals*

8.10 *Scissors, Tweezers, Spatula*

9 Reagents and Materials

9.1 Deionized water, resistivity ≥ 15 megohm centimeters at 25°C per ASTM D 1193.

9.2 Eluents and regenerants for specific chromatograph columns prepared per chromatograph equipment manufacturer's recommendations so that the water peak can be separated from the ionic peaks.

9.3 *Compounds Required for the Preparation of Standard Solutions*

9.3.1 *Cations* — NaCl, NH_4Cl, KCl.

9.3.2 *Anions* — NaCl, $Na_2HPO_4 \bullet 12H_2O$, NaBr, $NaNO_3$, K_2SO_4.

NOTE 2: All compounds must be reagent grade.

10 Sampling

10.1 *Sample Conditioning*

10.1.1 In case of measurement of ionic contamination transferred from the interleaves to the leadframes, select a stack of ten (10) leadframe strips with their nine (9) interleaves alternately, from the lot to be tested, and place them horizontally into a chamber at 85 ± 5°C, 85 ± 5% Relative Humidity for 24 hours.

10.2 *Sample Selection*

10.2.1 Recommended sample size of interleaf used in interleaf extraction test is 10,000 sq. mm.

10.2.2 In the extraction procedure, do not use the top or bottom leadframe strips in the stack.

NOTE 3: If a load is used to hold the stack together, it shall be recorded as part of the conditions of test.

NOTE 4: The leadframe/interleaf contact area shall be recorded. The vender and customer shall agree on the surface area of the leadframes.

11 Preparation of Standard Solutions

11.1 *Standard Solutions*

11.1.1 The single ingredient standard solutions of each ion (Na^+, NH_4^+, K^+, Cl^-, NO_3^-, Br^-, SO_4^{2-}, PO_4^{3-})are made by dissolving 1.000 g of each ion into 1.000 liter of DI water, respectively. The stored multi-ingredient standard solutions shown in Table 2 are then made from these single ingredient standard solutions by the dilution method.

Table 2 Concentration of Standard Solution for Calibration

Ion		*Mixed Standard Solution (µg/mL)*	*Standard Solution for Calibration(ng/mL)*		
			I	*II*	*III*
Cation	Na^+	10	5	10	20
	NH_4^+	10	5	10	20
	K^+	10	5	10	20
Anion	Cl^-	4	10	20	40
	PO_4^{3-}	10	25	50	100
	Br^-	4	10	20	40
	NO_3^-	4	10	20	40
	SO_4^{2-}	4	10	20	40

11.1.2 Cation and Anion standard solutions for calibration are made by diluting the stored multi-ingredient standard solutions as shown in Table 2.

11.1.3 Store the multi-ingredient standard solution and the calibration solutions in the correct flasks and label with the ion type and concentration.

NOTE 5: New Standard solutions for calibration are required every 24 hours. Ensure that the flasks are cleaned with water before refilling with a new solution.

11.2 *Calibration*

11.2.1 Set up the chromatograph and regenerate the columns according to the manufacturer's instructions (ASTM D 4327 provides further details).

11.2.2 Run the eluent through the chromatograph until a stable baseline chromatograph is obtained.

11.2.3 Select the injection volume recommended by the manufacturer for each ion type and inject it into the chromatograph. Record the chromatograph for each ion type, and make the calibration curve for each ion (ion concentration versus peak height or area).

NOTE 6: Peak height or area under the ion's characteristic curve is proportional to the concentration.

12 Procedure — Container Extraction Method

NOTE 7: The size of the extraction vessels depends on the expected volume of water and the leadframes. The vessels must be at least threequarters filled with water and leadframes.

NOTE 8: The vessels must be from the same manufacturing batch.

12.1 *Extraction Vessels* — Cleaning

12.1.1 Fill three vessels three-quarters of the way full in order to reduce the amount of air in the vessel and attach the caps.

12.1.2 Place the vessels in a water bath at > 95°C for 30 ± 2 minutes.

12.1.3 Remove the vessels from the bath and rinse out five (5) times with DI water.

12.2 *Interleaf Contamination Extraction*

12.2.1 Place the interleaf sample in one of the cleaned vessels.

NOTE 9: The interleafing may be cut in order to ease loading into the vessels.

12.2.2 Add 100 mL of DI water and cap the vessels. Place a similar amount of water into the other cleaned vessel and attach the cap.

NOTE 10: 100 mL is the recommended volume of water; however, the samples must be covered with water.

12.3 *Leadframe Contamination Extraction*

12.3.1 Place five (5) leadframe strips in one of the vessels cleaned per Section 12.1.

NOTE 11: The leadframes may be cut as required to ease entry into the vessel.

12.3.2 Cover with DI water and cap.

NOTE 12: 25 mL is the recommended volume of water for a small volume of leadframe samples, 100 mL for a large volume. The samples must be covered with water.

12.3.3 Place a similar volume of water in one of the vessels cleaned per Section 12.1.

12.4 *Extration*

12.4.1 Place the three (3) vessels into the water bath at T ≥ 95°C, for 30 ± 2 minutes.

12.4.2 Remove the vessels from the bath and allow to cool.

12.4.3 Remove the leadframes and interleafing material from their respective vessel and recap.

13 Measurements and Calculations

13.1 *Chromatograph Preparation and Calibration*

13.1.1 Prepare the chromatograph for operation by regenerating the columns according to the manufacturer's recommendations.

13.1.2 Run the eluent through the chromatograph until a stable baseline calibration is established.

13.2 *Testing*

13.2.1 Inject the recommended sample size of solution from the interleaf extraction into the chromatograph and obtain the chromatogram.

13.2.2 Repeat 13.1 and then inject the recommended sample size from the leadframe extraction and obtain the chromatogram.

13.2.3 Repeat 13.1 and then inject the recommended sample size from the water-only vessel and obtain the chromatogram of the background sample.

NOTE 13: The time from extraction to insertion of the sample into the chromatograph shall not exceed eight (8) hours.

13.3 *Results*

13.3.1 Sample concentrations are determined from the calibration curves for each ion type.

13.3.2 The surface concentration of ionic contaminants (SCIC) for each ion type is given by the following equation:

$$\mathrm{SCIC}\left(\mathrm{ng/cm}^2\right)=\frac{\left(\begin{matrix}\text{Sample}\\\text{Concentration}\end{matrix}-\begin{matrix}\text{Background}\\\text{Concentration}\end{matrix}\right)\times\begin{matrix}\text{Extraction}\\\text{Volume(mL)}\end{matrix}}{\text{Total Interleaf(or Leadframe) Surface Area}(\mathrm{cm}^2)}$$

14 Report

The report, when used by a vender to certify a user's requirement, or by a user at incoming inspection, shall, at least, contain the following information. Additional information shall be agreed between user and supplier.

14.1 Vendor's lot numbers for leadframes and interleaf material, and date of shipment.

14.2 Sample conditioning conditions.

14.3 Test conditions.

15 Related Documents

15.1 *SEMI Specifications*

SEMI G52 — Standard Test Method for Measurement of Ionic Contamination on Semiconductor Leadframes (Proposed)

SEMI G60-94 (Reapproved 0302)
TEST METHOD FOR THE MEASUREMENT OF ELECTROSTATIC PROPERTIES OF SEMICONDUCTOR LEADFRAME INTERLEAFING MATERIALS

The test method was technically approved by the Global Assembly and Packaging Committee and is the direct responsibility of the Japanese Assembly and Packaging Committee. Current edition approved by the Japanese Regional Standards Committee on November 26, 2001. Initially available at www.semi.org on December 2001; to be published March 2002. Origianlly published in 1994.

1 Purpose

1.1 This test method describes a procedure to determine the electrostatic properties of interleaf materials in film or sheet form by measuring the magnitude and polarity of an induced charge and the time required for complete dissipation of the charge.

NOTE 1: The method is independent of volume or insulation resistivities.

2 Scope

2.1 This test method is suitable for all interleaf materials and may be used by vendors at outgoing inspection, or customers at incoming inspection.

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

3 Referenced Standards

3.1 None

4 Terminology

4.1 *electrostatic properties* — For the purposes of this document, electrostatic properties are defined as the ability of a material, when grounded, to dissipate a charge induced onto the surface of that material.

4.2 *interleaf (for semiconductor leadframes)* — A paper or plastic film placed between layers of semiconductor leadframe strips to prevent transformation.

5 Summary of Method

The method involves charging the interleaf material to a high voltage and observing the time required for the charge to be dissipated using an electrometer.

6 Significance

6.1 This procedure evaluates the electrostatic build up and dissipation properties of the interleaf materials which may affect the reliability and efficiency of devices.

7 Interferences

7.1 The interleaf material and the leadframes must only be touched while wearing double-layer gloves with polyethylene outer gloves in order to avoid contamination which may change the electrostatic properties.

7.2 The test is not valid if the interleafing material is dusty.

8 Equipment

8.1 Aluminum panel measuring 127 mm × 76.2 mm × 3.2 mm (5" × 3" × 1/8").

8.2 High voltage source, 0 to 15 KV, positive and negative.

8.3 Electrometer with a full scale reading of 0.01, 0.1, 1.0, 10, and 100, or a recording oscilloscope with a response of 1 microsecond per division, or equivalent.

8.4 Fabricated electrostatic test chamber with electrostatic test unit, illustrated in Figure 1.

8.5 Single channel, pen type recorder with speeds of 12.7 mm, 25.4 mm, 50.8 mm, 101.6 mm, and 203.2 mm (0.5" , 1.0" , 2.0" , 4.0" , and 8.0") per minute and per second.

8.6 Four RG 114/U cables for connections between the detector and the electrometer and between the electrometer and the recorder. The nominal lengths of the cables are:

8.6.1 127 mm (5") for the connections between the detector and the output connector on the electrostatic test chamber.

8.6.2 863.6 mm (34") between the electrostatic test chamber and the electrometer exclusive of the connectors.

8.6.3 800.1 mm (31.5") between the electrometer and the recorder (2 required).

8.7 Three position control switch for connecting the test specimen to the high voltage source or the ground or neutral potential.

8.8 The equipment shall be assembled as illustrated in Figure 2.

9 Sampling

9.1 Sample size shall be agreed between user and supplier.

NOTE 2: The minimum sample size shall be three (3) per lot. Each specimen shall measure 127 mm × 76.2 mm (5" × 3").

9.2 Each specimen shall be free of defects such as holes, cracks, and tears.

NOTE 3: If the specimen is coated, the coating shall be continuous.

10 Sample Conditioning

10.1 Prior to testing, specimens shall be placed in the electrostatic test chamber for 24 hours at the following conditions.

Temperature: 23 ± 3° C

Relative Humidity: 50 ± 5%

11 Set-Up Procedure

11.1 Turn on all the equipment and allow to warm up as noted in the operations manuals.

11.2 *Electrometer*

11.2.1 Set "MULTIPLIER" switch to provide a half scale reading when the test voltage is applied.

11.2.2 Set the "OPERATE" switch at "ZERO CHECK".

11.2.3 Set meter to read positive charge.

11.3 Set the high voltage for 5KV positive output.

11.4 Mount the 127 mm × 76.2 mm × 3.2 mm (5" × 3" × 1/8") aluminum panel between the electrodes in the electrostatic test unit so that the detector head is directly over the center of the panel. Tighten the four wing nuts to secure the panel.

11.5 Set the recorder chart speed to 25.4 mm/min. (1" /min.).

11.6 Set "OPERATION" switch to "OPERATE".

11.7 Turn the three-position control switch to "HIGH VOLTAGE".

11.8 Verify that the reading on the recorder is identical to the meter reading. Adjust the recorder as necessary.

11.9 Turn the three-position switch to "GROUND" to remove the charge from the test panel.

11.10 When the electrometer meter reaches "ZERO", stop the recorder and set the "OPERATE" switch to "ZERO CHECK".

11.11 Repeat the calibration for a high voltage 5KV negative output.

12 Measurements and Calculations

12.1 Mount the specimens vertically between the electrodes and tighten the wing nuts to insure intimate contact between specimen and the electrodes.

12.2 Set chart recorder to 12.7 mm/sec. (0.5" /sec.) and turn on recorder.

12.3 Set electrometer meter switch to indicate "POSITIVE" or "NEGATIVE" charge depending on the high voltage to be applied.

12.4 Adjust the high voltage to 5KV positive or negative as desired.

12.5 Set "OPERATION" switch to "OPERATE".

12.6 Turn the three-position control switch to "HIGH VOLTAGE".

12.7 When the meter reaches a peak, indicating that the specimen has received its maximum charge, turn the three-position switch to "GROUND".

12.8 When the meter needle reaches "ZERO" or after 10 seconds which ever comes first, stop the recorder and move the "OPERATION" switch to "GROUND CHECK".

12.9 Charge each specimen three (3) times with both positive and negative charges. Allow the specimens to remain grounded for 10 minutes after each charging cycle to remove any residual charge on the specimen.

NOTE 4: If the interleaf material is non-homogenous, both surface shall be charged by reversing the faces of the specimen in contact with the electrodes.

12.10 Calculate the decay time, in seconds, by measuring the horizontal distance on the chart from the point where the specimen was grounded until the point where the needle reached "ZERO".

13 Report

The report, when used by a vendor to certify a customer's requirements, or by a customer at incoming inspection shall, at least, contain the following information. Additional information shall be agreed between user and supplier.

13.1 Interleaf material.

13.2 Vendor's lot number for the interleaf material, and date of shipment.

13.3 Sample conditioning conditions.

13.4 Test conditions if different from this test method.

13.5 The surface charged.

13.6 Results from Section 11 indicating the calculated decay time for each specimen in the sample for both the positive and negative charges and the acceptance (or rejection) at incoming inspection. SPC charting techniques may be used to monitor results.

NOTE 5: Acceptance/rejection limits shall be agreed between user and supplier.

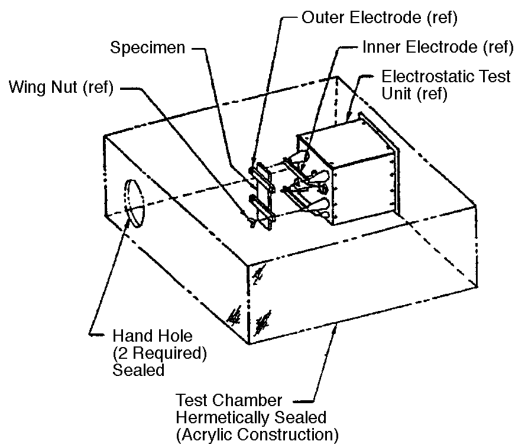


Figure 1
Electrostatic Test Chamber

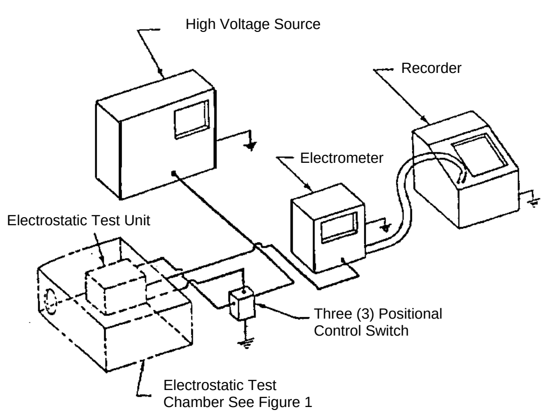


Figure 2
Electrostatic Test Arrangement

14 Related Documents

14.1 The following documents provide additional information for testing electrostatic properties. The test method described in this document is based on FED-STD-101C.

14.2 *Electronic Industries Association*[1]

EIA-541 — Packaging Materials Standards for ESD Sensitive Items

14.3 *Federal Specifications*[2]

FED-STD-101C — Test Procedures for Packaging Items

14.4 *JIS Specifications*[3]

JIS K6911 — Testing Methods for Thermosetting Plastics

JIS L 1094 — Testing Methods for Electrostatic Propensity of Woven and Knitted Fabrics

NOTICE: These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights, are entirely their responsibility.

---

1 Electronic Industries Alliance, EIA Engineering Department, Standards Sales Office, 2001 Eye Street, NW, Washington, D.C. 20006, USA. Website: www.eia.org

2 Federal Specifications, GSA Specifications and Consumer Information Branch, Bldg. 197, Washington Navy Yard, Washington, DC 20407

3 Japanese Industrial Standards, Available through the Japanese Standards Association, 1-24, Akasaka 4-Chome, Minato-ku, Tokyo 107-8440, Japan. Telephone: 81.3.3583.8005; Fax: 81.3.3586.2014 Website: www.jsa.or.jp