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METHOD 2009.10

EXTERNAL VISUAL

1. PURPOSE. The purpose of this test method is to verify the workmanship of hermetically packaged devices. This test method shall also be utilized to inspect for damage due to handling, assembly, and/or test of the packaged device. This examination is normally employed at outgoing inspection within the device manufacturer's facility, or as an incoming inspection of the assembled device.

2. APPARATUS. Equipment used in this test shall be capable of demonstrating device conformance to the applicable requirements. Equipment shall include optical devices capable of magnification of at least 1.5X to 10X, with a relatively large and accessible field of view.

3. PROCEDURE

3.1 Magnification. Devices shall be examined at 1.5X to 10X magnification. Devices may be examined anywhere in the range of 1.5X to 10X, however, acceptable product must be capable of passing all criteria when examined at 10X magnification. Individual glass seals (see 3.3.8) shall be examined at 7X to 10X magnification.

3.2 Foreign material. When foreign material is present, and its adherence is in question, the device may be subjected to a clean filtered gas stream (vacuum or expulsion) of approximately 20 psig.

3.3 Failure criteria. Devices shall fail if they exhibit any of the following:

3.3.1 General

- a. Illegible marking, or marking content or placement not in accordance with the applicable specification.
- b. Presence of any secondary coating material that visually obscures a seal area(s) (i.e., any hermetic interface).
- c. Evidence of any nonconformance with the detail drawing or applicable procurement document, or absence of any required feature.

3.3.2 Foreign/displaced material

- a. Braze material flow, or other foreign material (i.e., contamination or corrosion) that reduces the isolation between leads or between braze pads to less than 50% of the lead separation (pad separation for brazed leads) but in no case less than the case outline minimum.
- b. Leads or terminals that are not free of foreign material such as paint or other adherent deposits.

3.3.3 Construction defects

- a. Protrusions on the bottom (mounting) surface of the package that extend beyond the seating plane.
- b. Protrusions (excluding glass run-out) on any other package surface that exceed the lead thickness in height (leaded packages).
- c. Protrusions on the lid or cover, or extending beyond the surface plane of solder pads, that exceed 25% of the terminal width in height (leadless packages).
- d. Metallization not intended by design between solder pads, between elements of thermal patterns and/or between seal ring or lid to metallized castellations that reduce the isolation to less than 50% of pad separation (leadless packages).

3.3.4 Package Body/Lid Finish

- a. Defective finish (peeling, flaking, pitting, blistering, or corrosion). Discoloration that does not exhibit these conditions is acceptable.
- b. Scratches, mars, or indentations, either due to damage or processing, that expose base metal. Exposed underplate is acceptable.

3.3.5 Leads

- a. Broken leads.
- b. Leads or terminals that are not intact or aligned in their normal location, free of sharp or unspecified lead bends, or twisted more than 20° from the normal lead plane.
- c. Leads with pits and/or depressions that exceed 25% of the width (diameter for round leads) and are greater than 50% of the lead thickness in depth.
- d. Leads with burrs exceeding a height greater than 50% of the lead thickness.
- e. Lead misalignment to the braze pad to the extent that less than 75% of the lead braze section is brazed to the pad.
- f. Metallization (including solder lead finish) in which the isolation between leads or between lead and other package metallization is reduced to less than 50% of lead separation (pad separation for brazed leads) but in no case less than the case outline minimum.
- g. Braze material that increases the lead dimensions to greater than 1.5 times the lead thickness above the design maximum between the seating plane and the ceramic body or that increases the lead dimensions to greater than the design maximum below the seating plane.
- h. Scratches that expose base metal over more than 5% of the lead surface area. Exposed base metal on the cut lead ends is acceptable and does not count in the 5%.

* 3.3.6 Ball/column grid array leads.

- a. Nonconformance with any design criteria (see 3.3.1.c herein).
- b. Solder columns/spheres off the edge of the pad by more than 10% of the column diameter.
- c. Broken, twisted or damaged solder columns/spheres. Damaged columns/spheres (scored, gouged) that fail to meet final dimensional requirements.
- d. Solder column bends or misalignments that do not meet the drawing design criteria.
- e. Solder columns/spheres containing any hole, pit, gouge or depression greater than 30% of the column/sphere diameter or, any vertical voids going the entire length of the column/sphere.

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- f. Solder columns/spheres containing surface cracks greater than 30% of the column/sphere diameter or any cracking of indeterminate measure.
- g. Columns/spheres with burrs or bumps exceeding 20% of the column/sphere diameter.
- h. Columns/spheres that exhibit peeling, flaking, or blistering.
- i. Solder column fillets that exhibit any of the following:
 - i. Voids, holes, and/or pits greater than 15% of the fillet surface area.
 - ii. Incomplete reflow as shown by poor wetting.
 - iii. Coverage less than 75% around the column circumference.
 - iv. Height less than 50% of the column diameter (for at least 75% of the column circumference).
- j. Dewetting or non-wetting of columns greater than 5% of the column surface area.
- k. For copper reinforced columns that exhibit any of the following:
 - i. Copper ribbon delamination exceeding 25% around the column circumference.
 - ii. Exposed copper greater than 5% of the column surface area. Exposed (cut) copper on the free end of the column is acceptable and does not count in the 5%.
- l. Discoloration of columns/spheres due to corrosion, crusting, or residual flux. Evidence of flux residue, stains, rust, or signs of corrosion that can be seen without magnification (1X).
- m. Foreign material, discoloration, or adherent deposits within 0.5 mm of the free end of the column as these may cause solderability problems.
- n. Solder columns/spheres that do not meet requirements for device co-planarity/uniformity of the drawing design criteria (typically < 150 μm).

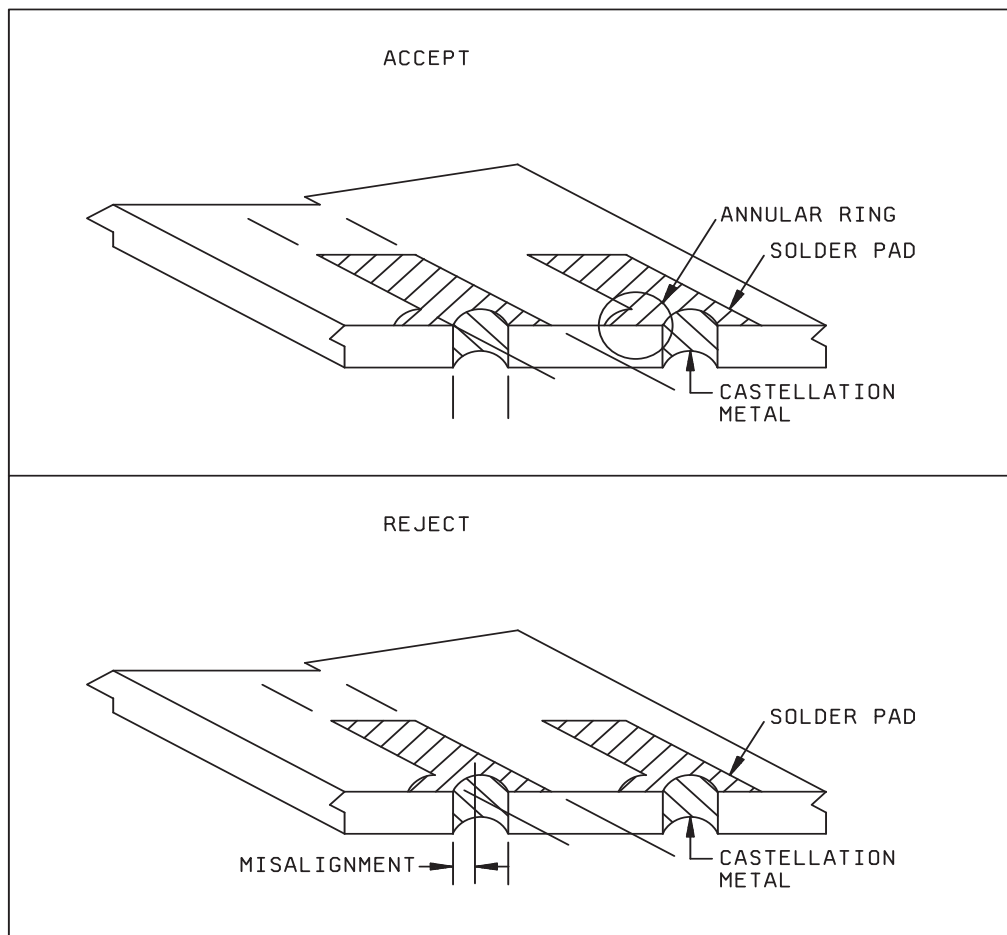
* 3.3.7 Package body/lid - leaded devices

- a. Broken packages or cracks in the packages. Surface scratches shall not be cause for failure except where they violate other criteria stated herein for marking, finish, etc.
- b. Any chipout dimension that exceeds 0.060 inch in any direction on the surface and has a depth that exceeds 25% of the thickness of the affected package element (e.g., cover, base, or wall).
- c. External lead metallization stripe forming a conductor to a brazed lead that exhibits voids greater than 25% of the conductor width.
- d. Evidence of cracks, delamination, separation, or voiding on any multilayer ceramic package.

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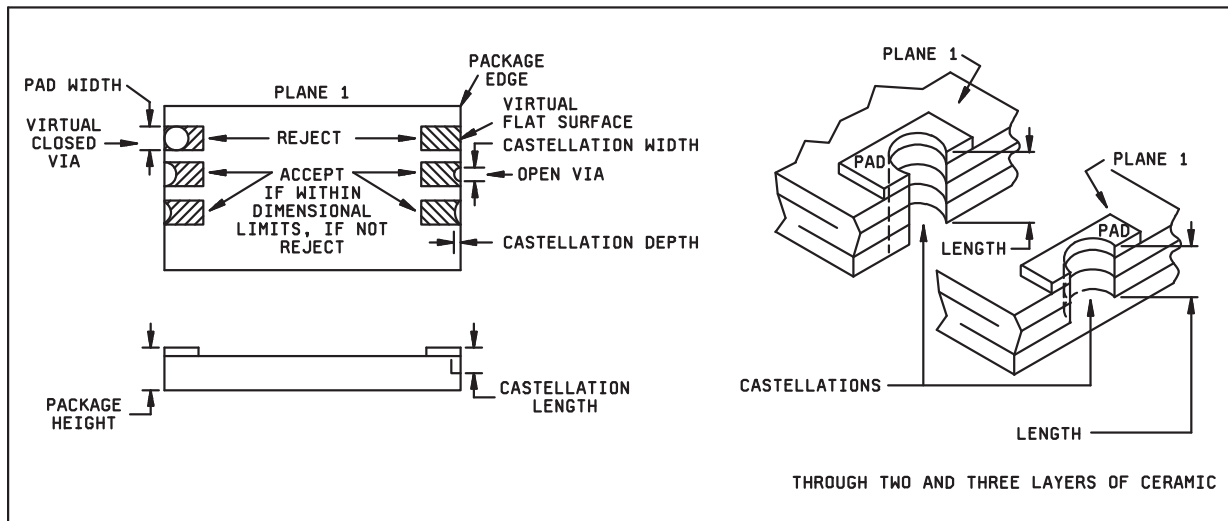
3.3.8 Package body/lid - leadless devices

- a. Ceramic chip-outs that dimensionally exceed 50% of the distance between terminals in any direction on the affected surface (edge or corner), and exceed a depth of 25% of the thickness of the affected package element (e.g., cover, lid, base, or wall).
- b. Evidence of cracks, delamination, separation, or voiding on any package element.
- c. Castellation to solder pad misalignment. The metal in the castellation, exclusive of the annular ring, shall be within the visually extended boundaries of the solder pad (see figure 2009-1).

FIGURE 2009-1. Castellation to solder pad misalignment.

- d. Castellation configuration not in accordance with the following (see figure 2009-2). The castellation shall be roughly concave, confined by a 3-dimensional space traversing all castellated ceramic layers at the package edge. The surface of the castellation may be irregular. The "3-dimensional space" has these dimensions:
1. Minimum width $> 1/3$ package terminal pad width.
 2. Minimum depth $> 1/2$ castellation minimum width.
 3. Length = as designed (see figure 2009-2).
 4. Maximum width \leq package terminal pad width.
 5. Maximum depth $\leq 1/2$ castellation maximum width.

These dimensions are an attempt to ensure with some reasonableness that the castellations are not viewed, in the extreme sense, as virtual flat surfaces on the package edge and are not virtual closed vias (holes).



NOTE: Ceramic layers shift, edges are rough after punching, plating buildup is not smooth etc., all of these combine during package manufacture to make the castellation measurement difficult. Therefore, in the event of conflicts in determining castellation acceptance, direct contact measurement shall be made using the limits specified in MIL-STD-1835.

FIGURE 2009-2. Castellation requirements

* 3.3.9 Glass seals.

a. Crazeing of the glass seal surface (see figure 2009-3).

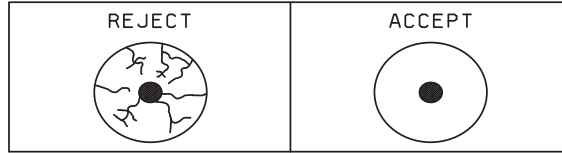


FIGURE 2009-3. Crazeing glass surface.

b. Any single circumferential crack (or overlapping crack) that does not lie completely within a single quadrant (i.e., extends beyond 90° arc or rotation about the lead), and extends beyond or is located in the region beyond the midpoint of distance from the lead to the case (see Figure 2009-4).

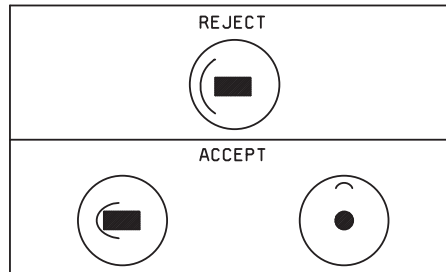


FIGURE 2009-4. Circumferential cracks.

c. Radial cracks that exhibit the following:

1. Cracks that do not originate at the lead (see figures 2009-5a and 2009-5b).
2. Three or more cracks that extend beyond the midpoints of distance from the lead to the case (see figure 2009-5c).
3. Two cracks that extend beyond the midpoint of the distance from the lead to the case and that lie within the same quadrant (see figure 2009-5d).

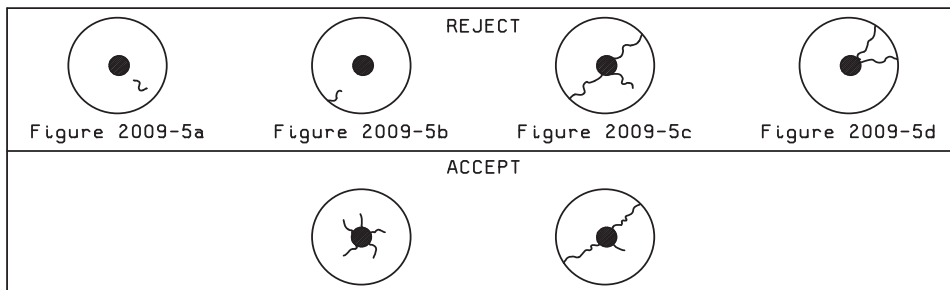


FIGURE 2009-5. Radial Cracks.

- d. Any chip-out that penetrates the sealing glass deeper than the glass meniscus plane. The glass meniscus is defined as that area of glass that wicks up the lead or terminal. Exposed base metal as a result of meniscus chip outs is acceptable, provided that the exposed area is no deeper than 0.010 inch (see figure 2009-6).

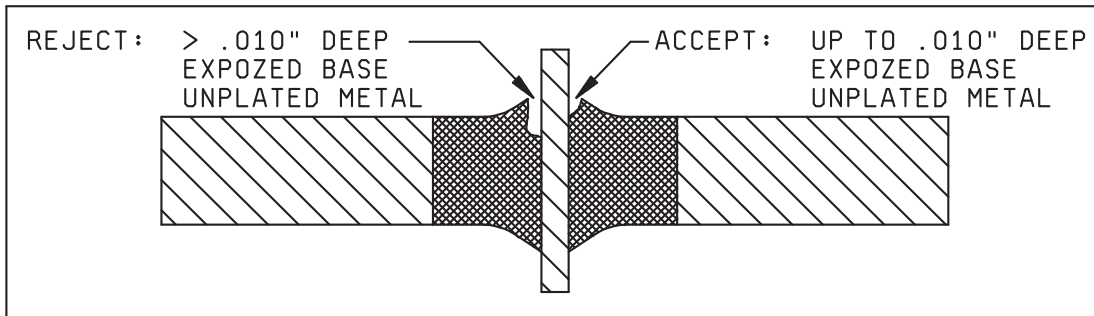


FIGURE 2009-6. Chip-outs.

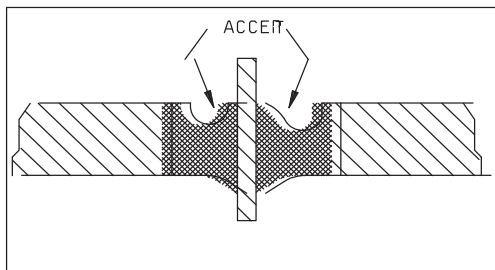


FIGURE 2009-7a. Surface bubbles.

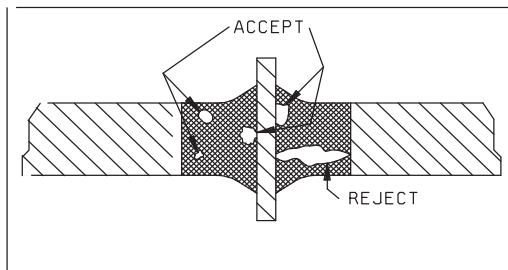


FIGURE 2009-7b. Subsurface bubbles.

e. Surface bubbles that exceed the following:

1. Open bubbles in the glass seal that exceed 5 mils in diameter (see Figure 2009-7a). For packages with a glass-filled header (i.e., TO-5), open bubbles that exceed 10 mils diameter, or an open bubble that exceeds 5 mils diameter situated closer than 10 mils to a lead.
2. Open bubbles in strings or clusters that exceed $2/3$ of the distance between the lead and the package wall.

f. Subsurface bubbles that exceed the following:

1. Large bubbles or voids that exceed $1/3$ of the glass sealing area (see Figure 2009-8a).
2. Single bubble or void that is larger than $2/3$ of the distance between the lead and the package wall at the site of inclusion (see Figures 2009-7b and 2009-8b).
3. Two bubbles in a line totaling more than $2/3$ distance from pin to case (see Figure 2009-8c).
4. Interconnecting bubbles greater than $2/3$ the distance between pin and case (see Figure 2009-8d).

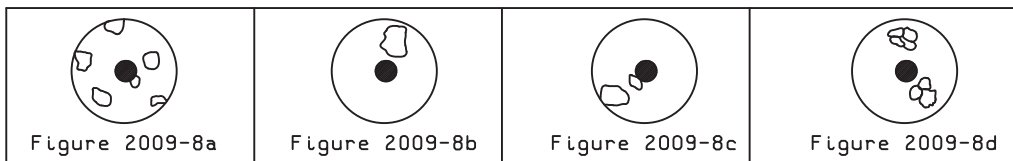


FIGURE 2009-8. Subsurface bubbles.

- g. Reentrant seals that exhibit non-uniform wicking (i.e., negative meniscus) at the lead and/or body interface (see Figure 2009-9).

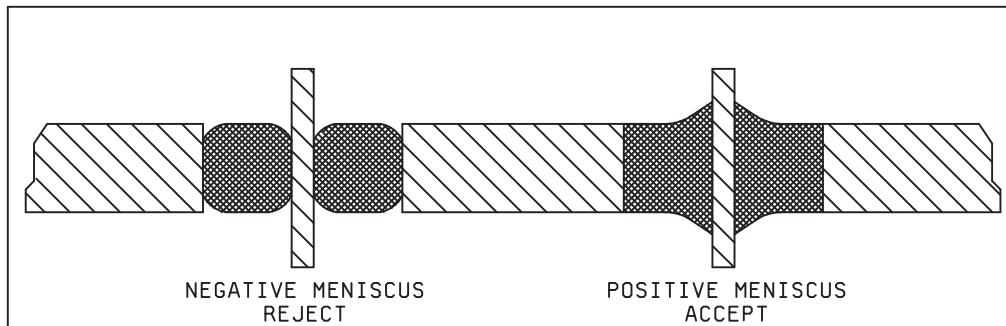


FIGURE 2009-9. Reentrant seals.

4. SUMMARY. The following details shall be specified in the applicable acquisition document:
- Requirements for markings and the lead (terminal), or pin identification.
 - Any additional detailed requirements for materials, design, construction, and workmanship.

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