

JEDEC STANDARD

Environmental Acceptance Requirements for Tin Whisker Susceptibility of Tin and Tin Alloy Surface Finishes

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ENVIRONMENTAL ACCEPTANCE REQUIREMENTS FOR TIN WHISKER SUSCEPTIBILITY OF TIN AND TIN ALLOY SURFACE FINISHES

Foreword

This standard was generated under the auspices of the JEDEC JC14.3 Subcommittee on Silicon Device Reliability Qualification and Monitoring and the iNEMI Tin Whisker User Group. It is intended to provide a uniform environmental acceptance testing and reporting methodology for tin whisker susceptibility of tin and tin alloy surface finishes used in the Electronics Industry.

Introduction

Many companies in the electronics industry have adopted tin-based surface finishes as one of the methods to comply with various legislative lead-free (Pb-free) initiatives, e.g., the European Union's RoHS directive. However, tin (Sn) and tin alloy surface finishes may be prone to tin whisker formation with associated possible reliability degradation. Appropriate mitigation practices, as described in JEDEC guidance document JP002, may be incorporated to reduce tin whisker propensity to an acceptable level.

Test conditions per JESD22-A121. Test Method for Measuring Whisker Growth on Tin and Tin Alloy Surface Finishes, and qualification limits presented in this document are based on known Sn-whisker data from around the globe. These test conditions have not been correlated with longer environmental exposures of components in service. Thus, there is at present no way to quantitatively predict whisker lengths over long time periods based on the lengths measured in the short-term tests described in this document. At the time of writing, the fundamental mechanisms of tin whisker growth are not fully understood and acceleration factors have not been established. Therefore, the testing described in this document does not guarantee that whiskers will or will not grow under field life conditions.

**ENVIRONMENTAL ACCEPTANCE REQUIREMENTS FOR TIN WHISKER
SUSCEPTIBILITY OF TIN AND TIN ALLOY SURFACE FINISHES**

(From JEDEC Board ballot JCB-08-43, formulated under the cognizance of the JC-14.3 Subcommittee on Silicon Devices Reliability Qualification and Monitoring.)

1 Scope

The methodology described in this document is applicable for environmental acceptance testing of tin based surface finishes and mitigation practices for tin whiskers. This methodology may not be sufficient for applications with special requirements, (i.e. military, aerospace, etc.). Additional requirements may be specified in the appropriate requirements (procurement) documentation.

This specification is intended for use in conjunction with JESD22A121, This specification does not apply to components with bottom-only terminations where the full plated surface is wetted during assembly (for example: QFN and BGA components, Flip Chip bump terminations). Adherence to this standard shall include meeting the reporting requirements described in clause 7.

2 Normative reference

JESD22-A121	Test Method for Measuring Whisker Growth on Tin and Tin Alloy Surface Finishes
JESD22-A104	Temperature Cycling
JP002	Current Tin Whisker Theory and Mitigation Practices Guideline

3 Terms and definitions

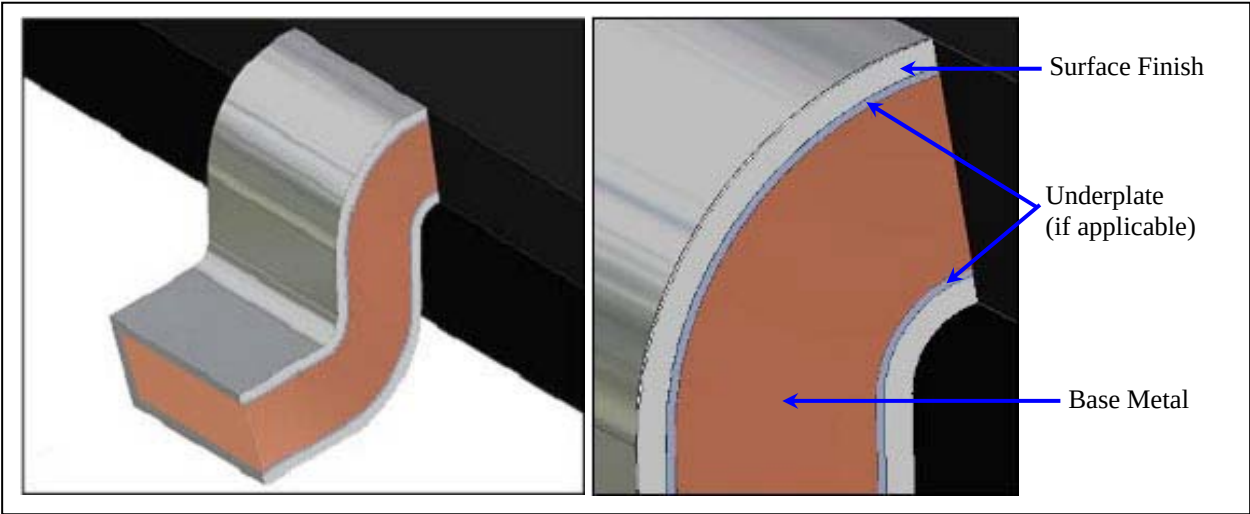


Figure 1 — Cross-sectional View of Component Surface Finishes

3 Terms and definitions (cont'd)

base metal: Metal alloy residing beneath all surface finish(es) and/or underplate.

manufacturing process change acceptance, surface finish: Acceptance testing of a change to a surface finish manufacturing process already accepted by *technology acceptance* (q.v.) tests.

minimum lead-to-lead gap: The minimum gap between leads (terminals) as shown in Figure 2.

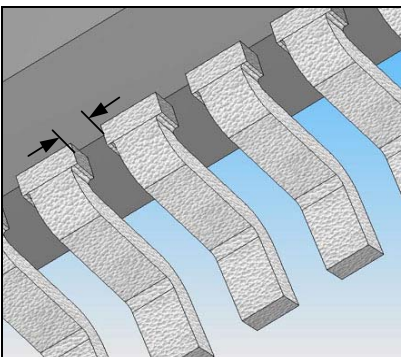


Figure 2 — Minimum lead-to-lead gap

similarity acceptance, surface finish: Acceptance of a change to a surface finish manufacturing process based upon similarity and data available from previous tin whisker *technology and manufacturing process change acceptance* (q.v.) tests.

surface corrosion: A localized corrosion of the silver-colored tin surface finish appearing in an optical microscope as nonreflective dark spots ranging in size from about 25 micrometers on the longest dimension to the entire terminal.

NOTE While tin oxide is ubiquitous on tin surface finishes, surface corrosion creates a locally thick layer of tin oxide that may span from the substrate to the surface of the deposit at the black spot. Typical photos of termination corrosion are shown in Annex A.

technology acceptance, surface finish: Acceptance testing of surface finish material set and manufacturing processes that includes a defined set of base metals, underplating metals, surface finish alloy, surface finish bath chemistry, and process flow steps.

tin and tin alloy surface finish: Tin-based outer surface finish for external component terminations and other exposed metal.

tin whisker mitigation practice: The process(es) performed during the manufacture of a component to reduce the propensity for tin whisker growth by minimizing the surface finish internal compressive stress.

underplate: Plated layers between the base metal and the outer surface finish.

whisker: A spontaneous columnar or cylindrical filament, usually of monocrystalline metal, emanating from the surface of a finish. (See JESD22-A121)

3 Terms and definitions (cont'd)

whisker length: The straight line distance from the point of emergence of the whisker to the most distant point on the whisker (i.e., the radius of a sphere containing the whisker with its center located at the point of emergence.). See Figure 3.

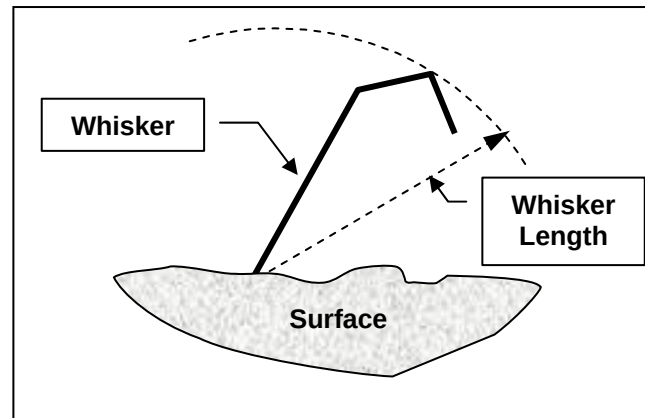


Figure 3 — Whisker length measurement

4 Test Method for Measuring Tin Whisker Growth

Except as specifically noted in this document, the procedures for conducting stress testing and inspections for tin whisker growth in JESD22A121, shall be used as applicable to satisfy this acceptance specification. Where differences with JESD22A121 exist this acceptance document takes precedence.

4.1 Test Samples

In most cases, individual production components shall be used for the acceptance test. However, for some assembled components with internal tin plated surfaces that cannot be inspected optically, e.g., internal surfaces of cans and hybrid component lids, testing and inspection of piece parts may be necessary. In addition, components with tin or tin alloy surface finishes used in press-fit, socketed applications, or with other compressive mechanical connections, should be qualified in their end use configuration. Additional testing and/or specifications may be needed for testing mechanically loaded components.

4.2 Handling Precaution

Careful test sample handling is important in order to avoid possible damage or detachment of whiskers from the test samples. Excessive vibration, impact, or physical contact with the termination finish should be avoided because whiskers may be dislodged. Test sample contamination as a result of improper handling or as a result of the application of a conductive material for SEM inspection should be avoided if the samples are to be returned to the test condition for further exposure, because such material may impact whisker growth behavior. The procedures outlined in JESD22A121 to limit condensation on the samples should also be followed during elevated temperature-humidity testing since condensation increases the likelihood of surface corrosion.

5 Acceptance procedure for Tin and Tin Alloy surface finishes

5.1 Determination of whether a Technology, Manufacturing Process, or Similarity Acceptance test is required

The acceptance requirements for tin and tin alloy finishes depend on the acceptance testing history of the surface finish. For a surface finish without any acceptance testing history, a rigorous technology acceptance test shall be completed as described in 5.3. If the tin or tin alloy finish has already passed a technology acceptance test, then any change to the manufacturing process or the metallurgy shall be categorized as either a technology change, a manufacturing process change, or a negligible change based on similarity. Table 1 may be used as guidance to differentiate between a technology and a manufacturing process acceptance change. Table 2 shall be used to categorize a change as either a technology change, a manufacturing process change, or a negligible change based on similarity. In addition, Table 2 indicates required testing that is described in detail in Tables 3 and 4 in clause 5. The acceptance procedure for tin and tin alloy surface finishes shall follow the procedural flow outlined in Figure 4. A specific Surface Finish / Mitigation process or change will necessitate a Technology or Manufacturing Process Change Acceptance unless the change is covered by Similarity. Annex B shows the typical Technology Acceptance test flow, using minimum sample size, for multi-leaded components using copper alloy leadframe with post bake mitigation technology.