JEDEC
STANDARD

Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing

JESD22-A113D
(Revision of JESD22-A113C)

AUGUST 2003

JEDEC SOLID STATE TECHNOLOGY ASSOCIATION
NOTICE

JEDEC standards and publications contain material that has been prepared, reviewed, and approved through the JEDEC Board of Directors level and subsequently reviewed and approved by the JEDEC legal counsel.

JEDEC standards and publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for use by those other than JEDEC members, whether the standard is to be used either domestically or internationally.

JEDEC standards and publications are adopted without regard to whether or not their adoption may involve patents or articles, materials, or processes. By such action JEDEC does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the JEDEC standards or publications.

The information included in JEDEC standards and publications represents a sound approach to product specification and application, principally from the solid state device manufacturer viewpoint. Within the JEDEC organization there are procedures whereby a JEDEC standard or publication may be further processed and ultimately become an ANSI/EIA standard.

No claims to be in conformance with this standard may be made unless all requirements stated in the standard are met.

Inquiries, comments, and suggestions relative to the content of this JEDEC standard or publication should be addressed to JEDEC at the address below, or call (703) 907-7559 or www.jedec.org

Published by
©JEDEC Solid State Technology Association 2003
2500 Wilson Boulevard
Arlington, VA 22201-3834

This document may be downloaded free of charge; however JEDEC retains the copyright on this material. By downloading this file the individual agrees not to charge for or resell the resulting material.

PRICE: Please refer to the current Catalog of JEDEC Engineering Standards and Publications online at http://www.jedec.org/Catalog/catalog.cfm

Printed in the U.S.A.
All rights reserved
PLEASE!

DON’T VIOLATE
THE
LAW!

This document is copyrighted by JEDEC and may not be reproduced without permission.

Organizations may obtain permission to reproduce a limited number of copies through entering into a license agreement. For information, contact:

JEDEC Solid State Technology Association
2500 Wilson Boulevard
Arlington, Virginia 22201-3834
or call (703) 907-7559
TEST METHOD A113D

PRECONDITIONING OF NONHERMETIC SURFACE MOUNT DEVICES PRIOR TO RELIABILITY TESTING

(From JEDEC Board Ballot JCB-02-120, and JCB-03-61, under the cognizance of the JC-14.1 Committee on Reliability Test Methods for Packaged Devices.)

1 Scope

This Test Method establishes an industry standard preconditioning flow for nonhermetic solid state SMDs (surface mount devices) that is representative of a typical industry multiple solder reflow operation. These SMDs should be subjected to the appropriate preconditioning sequence of this document by the semiconductor manufacturer prior to being submitted to specific in-house reliability testing (qualification and reliability monitoring) to evaluate long term reliability (which might be impacted by solder reflow).

NOTE Correlation of moisture-induced stress sensitivity (per J-STD-020 and JESD22-A113) and actual reflow conditions used are dependent upon identical temperature measurement by both the semiconductor manufacturer and the board assembler. Therefore, it is recommended that the top of package temperature on the hottest moisture-sensitive SMD during assembly be monitored to ensure that it does not exceed the temperature at which the components are evaluated.

2 Apparatus

This test method requires as a minimum access to the following equipment.

2.1 Moisture chamber temperature

Moisture chamber(s) capable of operating at 85 °C/85% RH, 85 °C/60% RH, and 30 °C/60% RH. Within the chamber working area, temperature tolerance must be ±2 °C and the RH tolerance must be ±3% RH. A chamber with 60 °C/60% RH capability is optional for accelerated soak conditions (See J-STD-020).
2 Apparatus (cont’d)

2.2 Solder reflow equipment

a) (Preferred) - Full Convection reflow system capable of maintaining the reflow profiles required by this standard.

b) Infrared (IR)/Convection solder reflow equipment capable of maintaining the reflow profiles required by this standard. It is required that this equipment use IR to heat only the air and not directly impinge upon the SMD Packages/devices under test.

NOTE The moisture sensitivity classification test results are dependent upon the package body temperature (rather than the reflow carrier and or package terminal temperature).

2.3 Optical microscope

Optical Microscope (40x for external visual exam)

2.4 Electrical test equipment

Electrical test equipment capable of performing room temperature dc and functional tests.

2.5 Bake oven

Bake oven capable of operating at 125 ±5/-0 °C.

2.6 Temperature Cycle Chamber

Temperature Cycle Chamber capable of operating as a minimum over the range of (-40 ±0/-10) °C to (60 °C ±10/-0) °C per JESD22-A104. Acceptable alternative test conditions and temperature tolerances are A through H, I, L, or M as defined in Table 1 of JESD22-A104, Temperature Cycling. This equipment is only required if Step 3.1.3 Shippability option is used.

3 Test procedure

3.1 Steps

It is recommended that a prior evaluation be run according to J-STD-020, using similar devices, to determine which preconditioning sequence is appropriate, i.e. likely to pass. Other relevant moisture evaluation data may be consulted, or an arbitrary selection may be made. However, the soak sequence in step 3.1.5 must be consistent with the floor life information in Table 1.
3.1 Steps (cont’d)

3.1.1 Initial electrical test

Perform electrical dc and functional test to verify that the devices meet the room temperature data sheet specification. Replace any devices that fail to meet this requirement.

3.1.2 Visual inspection

Perform an external visual examination under 40X optical magnification to ensure that no devices with external cracks or other damage are used in this test method. If mechanical rejects are found, corrective action must be implemented in the manufacturing process and a new sample must be drawn from product that has been processed with the corrective action.

3.1.3 Temperature cycling

Perform five (5) cycles of temperature cycle from -40 °C (or lower) to 60 °C (or higher) to simulate shipping conditions. This step is optional.

3.1.4 Bake out

Bake the devices for 24 hours minimum at 125 +5/-0 °C. This step is intended to remove all moisture from the package so that it will be “dry.”

NOTE 1 This time/temperature may be modified if desorption data on the particular device being preconditioned shows that a different condition is required to obtain a "dry" package. Refer to J-STD-020 for procedures on running absorption and desorption curves.

NOTE 2 If the preconditioning sequence is being performed by the semiconductor manufacturer, steps 3.1.1, 3.1.2, and 3.1.4 are optional since they are the supplier's risks. If the preconditioning sequence is being performed by the user, steps 3.1.7 through 3.1.9 are optional.
3.1 Steps (cont’d)

3.1.5 Soak conditions

The soak conditions in Table 1 shall apply to the eight (8) moisture sensitivity levels shown in Table 3. Soak should be initiated within 2 hours of bake.

Table 1 — Required soak times in hours

<table>
<thead>
<tr>
<th>Level</th>
<th>Floor life</th>
<th>Soak requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time</td>
<td>Conditions</td>
</tr>
<tr>
<td>1</td>
<td>Unlimited</td>
<td>≤30 °C/85% RH</td>
</tr>
<tr>
<td>2</td>
<td>1 year</td>
<td>≤30 °C/60% RH</td>
</tr>
<tr>
<td>2a</td>
<td>4 weeks</td>
<td>≤30 °C/60% RH</td>
</tr>
<tr>
<td>3</td>
<td>168 hours</td>
<td>≤30 °C/60% RH</td>
</tr>
<tr>
<td>4</td>
<td>72 hours</td>
<td>≤30 °C/60% RH</td>
</tr>
<tr>
<td>5</td>
<td>48 hours</td>
<td>≤30 °C/60% RH</td>
</tr>
<tr>
<td>5a</td>
<td>24 hours</td>
<td>≤30 °C/60% RH</td>
</tr>
<tr>
<td>6</td>
<td>Time on Label (TOL)</td>
<td>≤30 °C/60% RH</td>
</tr>
</tbody>
</table>

NOTE 1  CAUTION - The “Accelerated Equivalent” soak requirements shall not be used until correlation of damage response, including electrical, after soak and reflow is established with the “Standard” soak requirements or the known activation energy for diffusion is 0.4 – 0.48 eV. Accelerated soak times may vary due to material properties, i.e., Mold compound, encapsulant, etc. JESD22-A120 provides a method for determining the diffusion coefficient.

NOTE 2 The Standard soak time includes a default value of 24 hours for semiconductor Manufacturer's Exposure Time (MET) between bake and bag and includes the maximum time allowed out of the bag at the distributor's facility.

If the actual MET is less than 24 hours the soak time may be reduced. For soak conditions of 30 °C/60% RH the soak time is reduced by 1 hour for each hour the MET is less than 24 hours. For soak conditions of 60 °C/60% RH, the soak time is reduced by 1 hour for each 5 hours the MET is less than 24 hours.

If the actual MET is greater than 24 hours the soak time must be increased. If soak conditions are 30 °C/60% RH, the soak time is increased 1 hour for each hour that the actual MET exceeds 24 hours. If soak conditions are 60 °C/60% RH, the soak time is increased 1 hour for each 5 hours that the actual MET exceeds 24 hours.

NOTE 3 Supplier may extend the soak times at their own risk.
3.1 Steps (cont’d)

3.1.6 Reflow

Not sooner than 15 minutes and not longer than 4 hours after removal from the temperature/humidity chamber, subject the sample to 3 cycles of the appropriate reflow conditions as defined in Table 2. If the timing between removal from the temperature/humidity chamber and initial reflow cannot be met then the parts must be rebaked and resoaked according to 3.1.4 and 3.1.5. The minimum time between refloows shall be 5 minutes.

<table>
<thead>
<tr>
<th>Reflow condition</th>
<th>Sn-Pb eutectic assembly</th>
<th>Pb-Free assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pkg. thickness ≥ 2.5 mm or Pkg. volume ≥ 350 mm³</td>
<td>Pkg. thickness &lt; 2.5 mm and Pkg. volume &lt; 350 mm³</td>
</tr>
<tr>
<td>Average ramp-up rate (Liquidus Temperature (T_L) to Peak)</td>
<td>3 °C/second max.</td>
<td>3 °C/second max.</td>
</tr>
<tr>
<td>Preheat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Temperature Min (T_s(min))</td>
<td>100 °C</td>
<td>150 °C</td>
</tr>
<tr>
<td>- Temperature Max (T_s(max))</td>
<td>150 °C</td>
<td>200 °C</td>
</tr>
<tr>
<td>- Time (min to max) (t_s)</td>
<td>60-120 seconds</td>
<td>60-180 seconds</td>
</tr>
<tr>
<td>T_s(max) to T_L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Ramp-up Rate</td>
<td>3 °C/second max.</td>
<td></td>
</tr>
<tr>
<td>Time maintained above:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Temperature (T_L)</td>
<td>183 °C</td>
<td>217 °C</td>
</tr>
<tr>
<td>- Time (t_L)</td>
<td>60-150 seconds</td>
<td>60-150 seconds</td>
</tr>
<tr>
<td>Peak Temperature (T_p)</td>
<td>225 +0/-5 °C</td>
<td>240 +0/-5 °C</td>
</tr>
<tr>
<td>Time within 5 °C of actual Peak Temperature (t_p)</td>
<td>10-30 seconds</td>
<td>10-30 seconds</td>
</tr>
<tr>
<td>Ramp-down Rate</td>
<td>6 °C/second max.</td>
<td>6 °C/second max.</td>
</tr>
<tr>
<td>Time 25 °C to Peak Temperature</td>
<td>6 minutes max.</td>
<td>8 minutes max.</td>
</tr>
</tbody>
</table>

NOTE All temperatures refer to topside of the package, measured on the package body surface.
3.1 Steps (cont’d)

3.1.6 Reflow (cont’d)

![Reflow profile](image)

**Figure 1 — Reflow profile**

3.1.6.1 Solder attachment after reflow

If testing is to be performed in a second level configuration after final reflow the device, at the user discretion, can be baked and vacuum sealed until such time that it is solder attached to the test board or facsimile. Since the board attachment replicates a real life process of flux application, reflow and cleaning, 3.1.7 and 3.1.8 are no longer necessary or mandated prior to submission to reliability stress testing.

3.1.7 Flux application

After the reflow solder cycles are completed, allow the devices to cool at room ambient for 15 minutes minimum. Apply an activated water soluble flux to the device leads by bulk immersion of the entire parts in flux at room ambient for 10 seconds minimum.

3.1.8 Cleaning

Clean devices externally using multiple agitated deionized water rinses. No waiting time is required between flux application and cleaning.

3.1.9 Drying

Devices should be dried at room ambient prior to submission to reliability testing.

Test Method A113D
(Revision of Test Method A113-C)
3.1 Steps (cont’d)

3.1.10 Final electrical test

Submit the devices to electrical dc and functional testing per the room temperature data sheet specification. (For the semiconductor manufacturer, this step is optional and may be omitted since it is a supplier's risk.) Any valid failures found at this point due to the preconditioning sequence indicate that the device may have been classified in the wrong level. Failure analysis should be conducted. If appropriate, this device type should be reevaluated to determine the correct moisture sensitivity level. This would require resubmitting a sample to the correct level preconditioning sequence prior to reliability testing per 4.

4 Applicable reliability tests

SMDs should be subjected to the appropriate preconditioning sequence of this document prior to being submitted to reliability tests per JESD47 or the semiconductor manufacturer’s in-house reliability procedures.

5 Summary

The following details shall be specified in the applicable procurement document.

a) Number of reflow cycles if other than three.

b) Type flux if other than Step 3.1.7.

c) Reliability tests if other than 4.

d) Test conditions and duration of reliability tests in 4.

e) Electrical test description, including test temperature(s).
## Summary (cont’d)

<table>
<thead>
<tr>
<th>Moisture sensitivity level</th>
<th>1</th>
<th>2</th>
<th>2a, 3, 4, 5, &amp; 5a</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Pack Requirements</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Floor Life Maximum Conditions &amp; Time</td>
<td>≤30 °C/85% RH unlimited</td>
<td>≤30 °C/60% RH 1 year</td>
<td>≤30 °C/60% RH “Y” hours</td>
<td>≤30 °C/60% RH 6 hours after bake</td>
</tr>
<tr>
<td>Preconditioning Sequence (Step 3.1.1) dc electrical/functional 25 °C</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.2) 40x Visual Exam.</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.3) Shippability Temp Cycle 5 cy -40 °C to 60 °C</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>(Step 3.1.4) Bake 125 °C for 24 Hours</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.5) Moisture Soak 168 hours 85 °C/85% RH</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>168 hours 85 °C/60% RH</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>“z” hours 30 °C/60% RH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 hours 30 °C/60% RH</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Step 3.1.6) Reflow Solder Temperature per Table 2, 3 cycles</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.7) Flux immersion for 10 seconds minimum</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.8) Rinse in deionized water</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.9) Dry room ambient</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(Step 3.1.10) dc electrical/functional 25 °C</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(4) Reliability tests</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>(4) dc electrical/function 25 °C end points</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
</tbody>
</table>

R = required unless text indicates optional step.  
O = optional.

NOTE For possible 60 °C/60% RH accelerated soak conditions, see J-STD-020.
Annex A (informative) Differences between JESD22-A113D and JESD22-A113-C

The following list briefly describes most of the changes made to entries that appear in this standard, JESD22-A113D, compared to its predecessor, JESD22-A113-C (February 2003). If the change to a concept involves any words added or deleted, it is included. Punctuation changes may not be included.

<table>
<thead>
<tr>
<th>Page</th>
<th>Description of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Add subclause 3.1.6.1, Solder attachment after reflow</td>
</tr>
</tbody>
</table>
The purpose of this form is to provide the Technical Committees of JEDEC with input from the industry regarding usage of the subject standard. Individuals or companies are invited to submit comments to JEDEC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:
JEDEC
Attn: Publications Department
2500 Wilson Blvd. Suite 220
Arlington, VA  22201-3834
Fax: 703.907.7583

1. I recommend changes to the following:
   - Requirement, clause number
   - Test method number
   - Clause number

   The referenced clause number has proven to be:
   - Unclear
   - Too Rigid
   - In Error

   - Other

2. Recommendations for correction:
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. Other suggestions for document improvement:
   __________________________________________________________
   __________________________________________________________

Submitted by
Name: ___________________________ Phone: ___________________________
Company: ___________________________ E-mail: ___________________________
Address: ___________________________ Date: ___________________________
City/State/Zip: ___________________________