IPC/JEDEC J-STD-020D
June 2007
Supersedes IPC/JEDEC J-STD-020C
July 2004

JOINT INDUSTRY STANDARD

Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

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IPC/JEDEC J-STD-020D

Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

A joint standard developed by the IPC Plastic Chip Carrier Cracking Task Group (B-10a) and the JEDEC JC-14.1 Committee on Reliability Test Methods for Packaged Devices

Supersedes:

IPC/JEDEC J-STD-020C - July 2004
IPC/JEDEC J-STD-020B - July 2002
IPC/JEDEC J-STD-020A - April 1999
J-STD-020 - October 1996
JEDEC JESD22-A112
IPC-SM-786A - January 1995
IPC-SM-786 - December 1990

Users of this standard are encouraged to participate in the development of future revisions.

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Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

1 PURPOSE

The purpose of this standard is to identify the classification level of nonhermetic solid state surface mount devices (SMDs) that are sensitive to moisture-induced stress so that they can be properly packaged, stored, and handled to avoid damage during assembly solder reflow attachment and/or repair operations.

This standard may be used to determine what classification/preconditioning level should be used for SMD package qualification. Passing the criteria in this test method is not sufficient by itself to provide assurance of long-term reliability.

1.1 Scope This classification procedure applies to all nonhermetic solid state Surface Mount Devices (SMDs) in packages, which, because of absorbed moisture, could be sensitive to damage during solder reflow. The term SMD as used in this document means plastic encapsulated surface mount packages and other packages made with moisture-permeable materials. The categories are intended to be used by SMD producers to inform users (board assembly operations) of the level of moisture sensitivity of their product devices, and by board assembly operations to ensure that proper handling precautions are applied to moisture/reflow sensitive devices. If no major changes have been made to a previously qualified SMD package, this method may be used for reclassification according to 4.2.

This standard cannot address all of the possible component, board assembly and product design combinations. However, the standard does provide a test method and criteria for commonly used technologies. Where uncommon or specialized components or technologies are necessary, the development should include customer/manufacturer involvement and the criteria should include an agreed definition of product acceptance.

SMD packages classified to a given moisture sensitivity level by using Procedures or Criteria defined within any previous version of J-STD-020, JESD22-A112 (rescinded), or IPC-SM-786 (rescinded) do not need to be reclassified to the current revision unless a change in classification level or a higher peak classification temperature is desired. Annex B provides an overview of major changes from Revision C to Revision D of this document.

Note: If the procedures in this document are used on packaged devices that are not included in this specification's scope, the failure criteria for such packages must be agreed upon by the device supplier and their end user.

1.2 Background The vapor pressure of moisture inside a nonhermetic package increases greatly when the package is exposed to the high temperature of solder reflow. Under certain conditions, this pressure can cause internal delamination of the packaging materials from the die and/or leadframe/substrate, internal cracks that do not extend to the outside of the package, bond damage, wire necking, bond lifting, die lifting, thin film cracking, or cratering beneath the bonds. In the most severe case, the stress can result in external package cracks. This is commonly referred to as the ''popcorn'' phenomenon because the internal stress causes the package to bulge and then crack with an audible ''pop.'' SMDs are more susceptible to this problem than through-hole parts because they are exposed to higher temperatures during reflow soldering. The reason for this is that the soldering operation must occur on the same side of the board as the SMD device. For wave-soldered through-hole devices, the soldering operation occurs under the board that shields the devices from the hot solder. Through-hole devices that are soldered using intrusive soldering or ''pin in paste'' processes may experience the same type of moisture-induced failures as SMT devices.

1.3 Terms and Definitions

***accelerated equivalent soak* –** A soak at a higher temperature for a shorter time (compared to the standard soak), to provide roughly the same amount of moisture absorption. See also soak.

***acoustic microscope* –** Equipment that creates an image using ultrasound to view a specimen's surface or subsurface features, including defects and damage. See J-STD-035 for more information.

***area array package* –** A package that has terminations arranged in a grid on the bottom of the package and contained within the package outline.

classification temperature (T_c) – The maximum body temperature at which the component manufacturer guarantees the component MSL as noted on the caution and/or bar code label per J-STD-033.

crack – A separation within a bulk material. See also Delamination.

damage response – All irreversible changes caused by exposure to a reflow soldering profile.

dead-bug (orientation) – The orientation of the package with the terminals facing up.

delamination – An interfacial separation between two materials intended to be bonded. See also crack.

downbond area – An area for a wire bond on the die paddle, whose dimensions equal those of a single bond pad on the die.

floor life – The allowable time period after removal from a moisture barrier bag, dry storage or dry bake and before the solder reflow process.

full body hot air rework – The process of heating a package by directing heated gas at the package body in order to melt only that package's solder connections.

live-bug (orientation) – The orientation of the package when resting on its terminals.

manufacturer's exposure time (MET) – The maximum cumulative time after bake that components may be exposed to ambient conditions prior to shipment to the end user.

moisture/reflow sensitivity classification – The characterization of a component's susceptibility to damage due to absorbed moisture when subjected to reflow soldering.

moisture sensitivity level (MSL) – A rating indicating a component's susceptibility to damage due to absorbed moisture when subjected to reflow soldering.

package thickness – The component thickness excluding external terminals (balls, bumps, lands, leads) and/or nonintegral heat sinks.

peak package body temperature (T_p) – The highest temperature that an individual package body reaches during MSL classification.

reclassification – The process of assigning a new moisture sensitivity level to a previously classified device.

soak – The exposure of a component for a specified time at a specified temperature and humidity. See also accelerated equivalent soak.

wire-bond surface – The area where wire bonds are typically placed.

2 APPLICABLE DOCUMENTS

2.1 JEDEC[1]

JEP-140 Beaded Thermocouple Temperature Measurement of Semiconductor Packages

JESD22-A120 Test Method for the Measurement of Moisture Diffusivity and Water Solubility in Organic Materials Used in Integrated Circuits

JESD22-A113 Preconditioning Procedures of Plastic Surface Mount Devices Prior to Reliability Testing

JESD22-B101 External Visual

JESD22-B108 Coplanarity Test for Surface-Mount Semiconductor Devices

JESD22-B112 High Temperature Package Warpage Measurement Methodology

JESD-47 Stress Test Driven Qualification Specification

1. www.jedec.org

JESD-625 Requirements for Handling Electrostatic Discharge Sensitive (ESD) Devices

2.2 IPC[2]

IPC-TM-650 Test Methods Manual[3]

2.1.1 Microsectioning

2.1.1.2 Microsectioning - Semi or Automatic Technique Microsection Equipment

2.3 Joint Industry Standards[4]

J-STD-033 Standard for Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices

J-STD-035 Acoustic Microscopy for Nonhermetic Encapsulated Electronic Components

3 APPARATUS

3.1 Temperature Humidity Chambers Moisture chamber(s), capable of operating at 85 °C/85% RH, 85 °C/60% RH, 60 °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.

3.2 Solder Reflow Equipment

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

3.2.2 Infrared 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 mounting substrate and/or package terminal temperature).

3.3 Ovens Bake oven capable of operating at 125 +5/-0 °C.

3.4 Microscopes

3.4.1 Optical Microscope Optical Microscope (40X for external and 100X for cross-section exam, higher magnification might be required for verification).

3.4.2 Acoustic Microscope Typically a scanning acoustic microscope with C-Mode and Through Transmission capability. It should be capable of measuring a minimum delamination of 5% of the area being evaluated.

Note 1: The acoustic microscope is used to detect cracking and delamination. However, the presence of delamination does not necessarily indicate a pending reliability problem. The reliability impact of delamination must be established for a particular die/package system.

Note 2: Refer to IPC/JEDEC J-STD-035 for operation of the acoustic microscope.

3.5 Cross-Sectioning Microsectioning equipment as recommended per IPC-TM-650, Methods 2.1.1 and 2.1.1.2, or other applicable document.

2. www.ipc.org
3. Current and revised IPC Test Methods are available on the IPC website (www.ipc.org/html/testmethods.htm).
4. www.ipc.org

3.6 Electrical Test Electrical test equipment with capabilities to perform appropriate testing on devices.

3.7 Weighing Apparatus (Optional) Apparatus capable of weighing the package to a resolution of 1 microgram. This apparatus must be maintained in a draft-free environment, such as a cabinet. It is used to obtain absorption and desorption data on the devices under test (see Clause 8).

3.8 Beaded Thermocouple Temperature Measurement Refer to JEP140 for guidance on procedures to accurately and consistently measure the temperature of components during exposure to thermal excursions. JEP140 guideline applications can include, but is not limited to, temperature profile measurement in reliability test chambers and solder reflow operations that are associated with component assembly to printed wiring boards (PWBs).

4 CLASSIFICATION/RECLASSIFICATION

Refer to 4.2 for guidance on reclassification of previously qualified/classified SMDs.

Engineering studies have shown that thin, small volume SMD packages reach higher body temperatures during reflow soldering to boards that have been profiled for larger packages. Therefore, technical and/or business issues normally require thin, small volume SMD packages (reference Tables 4-1 and 4-2) to be classified at higher reflow temperatures. To accurately measure actual peak package body temperatures refer to JEP140 for recommended thermocouple use.

Note 1: Previously classified SMDs should only be reclassified by the manufacturer. Users should refer to the ''Moisture Sensitivity'' label on the bag to determine at which reflow temperature the SMD packages were classified.

Note 2: Unless labeled otherwise, level 1 SMD packages are considered to be classified at 220 °C.

Note 3: If supplier and user agree, components can be classified at temperatures other than those in Tables 4-1 and 4-2.

Table 4-1 SnPb Eutectic Process - Classification Temperatures (T_c)

Package Thickness	Volume mm³ <350	Volume mm³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 4-2 Pb-Free Process - Classification Temperatures (T_c)

Package Thickness	Volume mm³ <350	Volume mm³ 350 - 2000	Volume mm³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm - 2.5 mm	260 °C	250 °C	245 °C
>2.5 mm	250 °C	245 °C	245 °C

Note 1: At the discretion of the device manufacturer, but not the board assembler/user, the maximum peak package body temperature (T_p) can exceed the values specified in Tables 4-1 or 4-2. The use of a higher T_p does not change the classification temperature (T_c).

Note 2: Package volume excludes external terminals (e.g., balls, bumps, lands, leads) and/or nonintegral heat sinks.

Note 3: The maximum component temperature reached during reflow depends on package thickness and volume. The use of convection reflow processes reduces the thermal gradients between packages. However, thermal gradients due to differences in thermal mass of SMD packages may still exist.

Note 4: Moisture sensitivity levels of components intended for use in a Pb-free assembly process **shall** be evaluated using the Pb-free classification temperatures and profiles defined in Tables 4.2 and 5-2, whether or not Pb-free.

Note 5: SMD packages classified to a given moisture sensitivity level by using Procedures or Criteria defined within any previous version of J-STD-020, JESD22-A112 (rescinded), IPC-SM-786 (rescinded) do not need to be reclassified to the current revision unless a change in classification level or a higher peak classification temperature is desired.

4.1 Compatibility with Pb-Free Assembly Rework Pb-free area array components (classified per Table 4.2) should be capable of assembly rework at 260 °C within 8 hours of removal from dry storage or bake, per J-STD-033. Components that do not meet this assembly rework requirement or that the supplier does not support 260 °C rework **shall** be so specified by the component manufacturer. To verify this capability for components classified at a temperature below 260 °C, a sample of the size per 5.1.2 **shall** be soaked per level 6 conditions (see Table 5-1) using a time on label (TOL) of 8 hours, and subjected to a single reflow cycle with T_p of not less than 260 °C. All devices in the sample **shall** pass electrical test and have a damage response (per 6.1 and 6.2) not greater than that observed for the same package at its rated MSL level. Rework compatibility verification is not required for area array components rated at 260 °C or peripheral leaded metal lead frame packages that do not require full body hot air rework.

4.2 Reclassification SMD packages previously classified to a moisture sensitivity level and classification temperature (T_c) may be reclassified if the damage response (e.g., delamination/cracking) at the more severe condition for items listed in 6.1 and 6.2 is less than, or equal to, the damage response at the original classification condition.

If no major changes have been made to a previously qualified SMD package, this method may be used for reclassification to an improved level (i.e., longer floor life) at the same reflow temperature. The reclassification level cannot be improved by more than 1 level without additional reliability testing. Reclassification to level 1 requires additional reliability testing.

If no major changes have been made to a previously qualified SMD package, this method may be used for reclassification at a higher reflow temperature providing the moisture level remains the same or degrades to a more sensitive level.

No SMD packages classified as moisture sensitive by any previous version of J-STD-020, JESD22-A112 (rescinded), or IPC-SM-786 (rescinded) may be reclassified as nonmoisture sensitive (level 1) without additional reliability stress testing (e.g., JESD22-A113 and JESD-47 or the semiconductor manufacturer's in-house procedures).

To minimize testing, the results from a given SMD package may be generically accepted to cover all other devices which are manufactured in the same package, using the same packaging materials (e.g., die attach, mold compound and/or die coating, etc.), with the die using the same wafer fabrication technology, and with die pad dimensions not greater than those qualified.

The following attributes could affect the moisture sensitivity of a device and may require reclassification:

- Die attach material/process.
- Number of pins.
- Encapsulation (mold compound or glob top) material/process.
- Die pad area and shape.
- Body size.
- Passivation/die coating.
- Leadframe, substrate, and/or heat spreader design/material/finish.
- Die size/thickness.
- Wafer fabrication technology/process.
- Interconnect.
- Lead lock taping size/location as well as material.

5 PROCEDURE

The recommended procedure is to start testing at the lowest moisture sensitivity level the evaluation package is reasonably expected to pass (based on knowledge of other similar evaluation packages).

In the case of equipment malfunction, operator error, or electrical power loss, engineering judgment **shall** be used to ensure that the minimum intent/requirements of this specification are met.

5.1 Sample Requirements

5.1.1 Reclassification (qualified package without additional reliability testing) For a qualified SMD package being reclassified without additional reliability testing, select a minimum sample of 22 units for each moisture sensitivity level to be tested. A minimum of 2 nonconsecutive assembly lots must be included in the sample with each lot having approximately the same representation. Sample units **shall** have completed all manufacturing processing required prior to shipment. Sample groups may be run concurrently on 1 or more moisture sensitivity levels.

5.1.2 Classification/Reclassification and Rework Select a minimum sample of 11 units for each moisture sensitivity level to be tested. A minimum of 2 nonconsecutive assembly lots must be included in the sample with each lot having approximately the same representation. Sample units **shall** have completed all manufacturing processes required prior to shipment. Sample groups may be run concurrently on 1 or more moisture sensitivity levels. Testing must be continued until a passing level is found.

SMD packages should not be reclassified by the user unless approved by the supplier.

5.2 Initial Electrical Test Test appropriate electrical parameters (e.g., data sheet values, in-house specifications, etc.). Replace any components, while maintaining the sample requirements of 5.1.2, which fail to meet tested parameters.

5.3 Initial Inspection Perform an external visual (at 40X) and acoustic microscope examination on all components to establish a baseline for the cracking/delamination criteria in 6.2.1.

Note: This standard does not consider or establish any accept/reject criteria for delamination at initial/time zero inspection.

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

Note: This time/temperature may be modified if desorption data on the particular device under test shows that a different condition is required to obtain a ''dry'' package when starting in the wet condition for 85 °C/85% RH (see 8.3).

5.5 Moisture Soak Place devices in a clean, dry, shallow container so that the package bodies do not touch or overlap each other. Submit each sample to the appropriate soak requirements shown in Table 5-1. At all times parts should be handled using proper ESD procedures in accordance with JESD-625.

Table 5-1 Moisture Sensitivity Levels

LEVEL	FLOOR LIFE		SOAK REQUIREMENTS				
			STANDARD		ACCELERATED EQUIVALENT[1]		
					eV 0.40-0.48	eV 0.30-0.39	
	TIME	CONDITION	TIME (hours)	CONDITION	TIME (hours)	TIME (hours)	CONDITION
1	Unlimited	≤30 °C/85% RH	168 +5/-0	85 °C/85% RH	NA	NA	NA
2	1 year	≤30 °C/60% RH	168 +5/-0	85 °C/60% RH	NA	NA	NA
2a	4 weeks	≤30 °C/60% RH	696[2] +5/-0	30 °C/60% RH	120 +1/-0	168 +1/-0	60 °C/60% RH
3	168 hours	≤30 °C/60% RH	192[2] +5/-0	30 °C/60% RH	40 +1/-0	52 +1/-0	60 °C/60% RH
4	72 hours	≤30 °C/60% RH	96[2] +2/-0	30 °C/60% RH	20 +0.5/-0	24 +0.5/-0	60 °C/60% RH
5	48 hours	≤30 °C/60% RH	72[2] +2/-0	30 °C/60% RH	15 +0.5/-0	20 +0.5/-0	60 °C/60% RH
5a	24 hours	≤30 °C/60% RH	48[2] +2/-0	30 °C/60% RH	10 +0.5/-0	13 +0.5/-0	60 °C/60% RH
6	Time on Label (TOL)	≤30 °C/60% RH	TOL	30 °C/60% RH	NA	NA	NA

Note 1: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow (e.g., live-bug orientation). If parts are reflowed in other than the normal live-bug assembly reflow orientation (i.e., dead-bug), the damage response should be correlated to the normal reflow orientation. If the damage response is not the same, the package should be evaluated in the normal assembly reflow orientation, T_p **shall** be within ± 2 °C of the live-bug T_p and still meet the T_c requirements, otherwise the profile **shall** be adjusted to achieve the latter. To accurately measure actual peak package body temperatures refer to JEP140 for recommended thermocouple use.

Note 2: The oven should be loaded with the same configuration or verified equivalent thermal load when running parts orbeing profiled.

5.6 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 5-2 and Figure 5-1. 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 5.4 and 5.5. The time between reflows **shall** be 5 minutes minimum and 60 minutes maximum.

Table 5-2 Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	 100 °C 150 °C 60-120 seconds	 150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3 °C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body temperature (T_p)*	See classification temp in Table 4.1	See classification temp in Table 4.2
Time (t_p)** within 5 °C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25 °C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Note 1: All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow (e.g., live-bug). If parts are reflowed in other than the normal live-bug assembly reflow orientation (i.e., dead-bug), T_p **shall** be within ± 2 °C of the live-bug T_p and still meet the T_c requirements, otherwise, the profile **shall** be adjusted to achieve the latter. To accurately measure actual peak package body temperatures refer to JEP140 for recommended thermocouple use.

Note 2: Reflow profiles in this document are for classification/preconditioning and are not meant to specify board assembly profiles. Actual board assembly profiles should be developed based on specific process needs and board designs and should not exceed the parameters in Table 5-2.

For example, if T_c is 260 °C and time t_p is 30 seconds, this means the following for the supplier and the user.

For a supplier: The peak temperature must be at least 260 °C. The time above 255 °C must be at least 30 seconds.

For a user: The peak temperature must not exceed 260 °C. The time above 255 °C must not exceed 30 seconds.

Note 3: All components in the test load **shall** meet the classification profile requirements.

Note 4: SMD packages classified to a given moisture sensitivity level by using Procedures or Criteria defined within any previous version of J-STD-020, JESD22-A112 (rescinded), IPC-SM-786 (rescinded) do not need to be reclassified to the current revision unless a change in classification level or a higher peak classification temperature is desired.

5.7 Final External Visual Examine the devices using an optical microscope (at 40X) to look for external cracks.

5.8 Final Electrical Test Perform appropriate electrical testing on all devices (e.g., data sheet values, in-house specifications, etc.).

5.9 Final Acoustic Microscopy Perform acoustic microscope analysis on all devices.

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 if the known activation energy for diffusion of the package materials is in the range of 0.40 - 0.48 eV or 0.30 - 0.39 eV. Accelerated soak times may vary due to material properties (e.g., mold compound, encapsulant, etc.). JEDEC document 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.

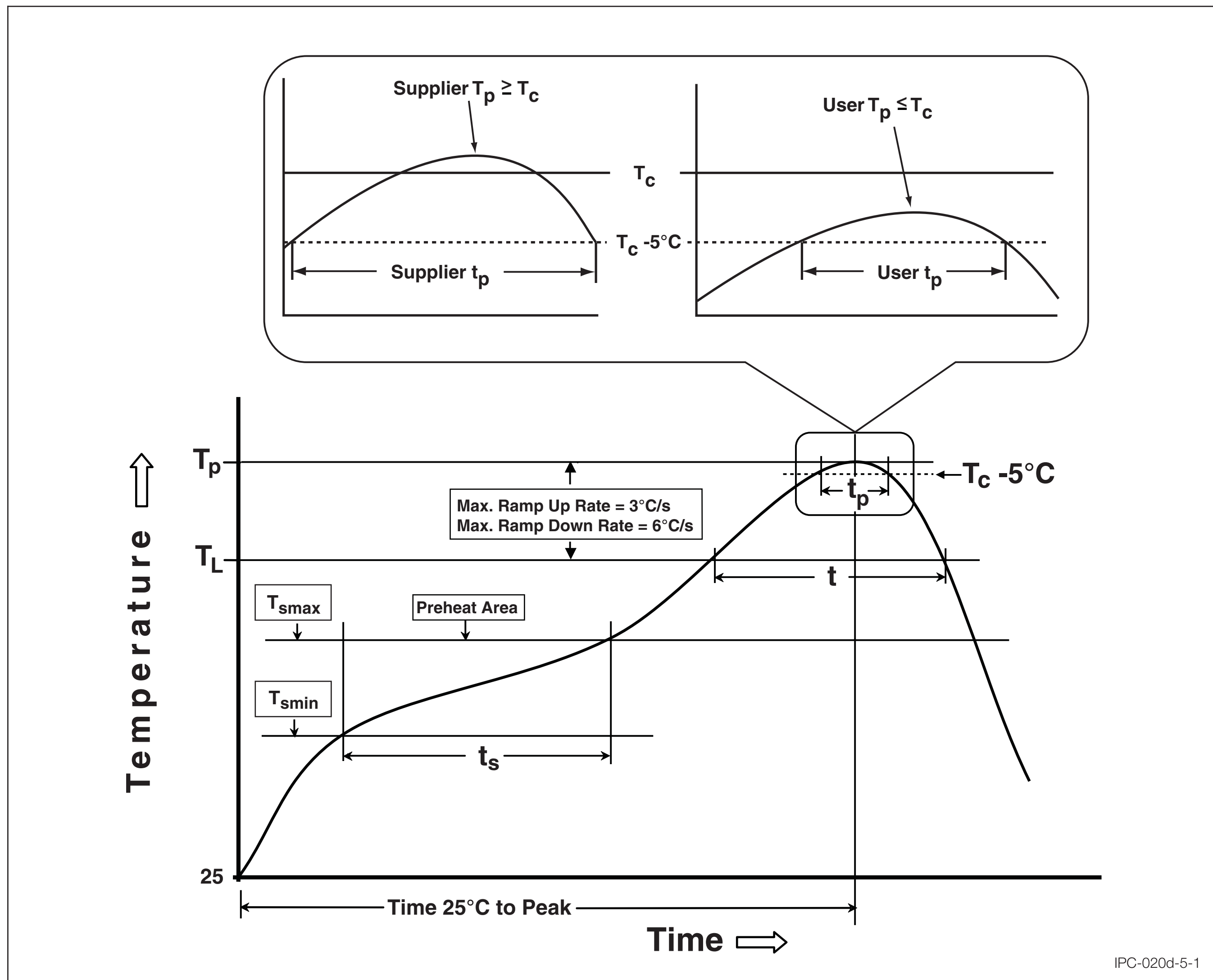


Figure 5-1 Classification Profile

6 CRITERIA

6.1 Failure Criteria If 1 or more devices in the test sample fail, the package **shall** be considered to have failed the tested level.

A device is considered a failure if it exhibits any of the following:

a. External crack visible using 40X optical microscope.

b. Electrical test failure.

c. Internal crack that intersects a bond wire, ball bond, or wedge bond.

d. Internal crack extending from any lead finger to any other internal feature (lead finger, chip, die attach paddle).

e. Internal crack extending more than 2/3 the distance from any internal feature to the outside of the package.

f. Changes in package body flatness caused by warpage, swelling or bulging invisible to the naked eye per JESD22-B101. If parts still meet co-planarity and standoff dimensions as measured at room temperature per JESD22-B108, they **shall** be considered passing.

Note 1: If internal cracks are indicated by acoustic microscopy, they must be considered a failure or verified good using polished cross sections through the identified site.

Note 2: For packages known to be sensitive to vertical cracks, it is recommended that polished cross sections be used to confirm the nonexistence of near vertical cracks within the mold compound or encapsulant.

Note 3: Failing SMD packages must be evaluated to a higher numeric level of moisture sensitivity using a new set of samples.

Note 4: If the components pass the requirements of 6.1, and there is no evidence of delamination or cracks observed by acoustic microscopy or other means, the component is considered to pass that level of moisture sensitivity.

6.2 Criteria Requiring Further Evaluation Delamination is not necessarily a cause for rejection. To evaluate the impact of delamination on device reliability, the semiconductor manufacturer may either meet the delamination requirements shown in 6.2.1 or perform reliability assessment using JESD22-A113 and JESD-47 or the semiconductor manufacturer's in-house procedures. The reliability assessment may consist of stress testing, historical generic data analysis, etc. Annex A shows the logic flow diagram for the implementation of these criteria.

If the SMD Packages pass electrical tests and there is delamination on the back side of the die paddle, heat spreader, or die back side (lead on chip only), but there is no evidence of cracking, or other delamination, and they still meet specified dimensional criteria, the SMD Packages are considered to pass that level of moisture sensitivity.

Note: Moisture induced body warpage during board assembly of substrate based packages (e.g., BGA, LGA, etc.) could result in solder bridging or open connections during board assembly solder attachment operations. It is known that ingressed moisture can either increase or decrease the total package body warpage depending on the specific design of the component. Total package body warpage can be a function of the moisture content and can be affected by the ramp rates and dwells used to measure the total warpage effect at elevated temperatures. Package body warpage measured per JESD22-B112 should be characterized during package development. Ability to attach components that exhibit warpage can be verified by using board assembly.

6.2.1 Delamination The following delamination changes are measured from pre-moisture soak to post reflow. A delamination change is the difference between pre- and post-reflow delamination. The percent (%) delamination or delamination change is calculated in relation to the total area being evaluated.

6.2.1.1 Metal Leadframe Packages:

a. No delamination on the active side of the die.

b. No delamination on any wire bonding surface including the downbond area or the leadframe of lead on chip (LOC) devices.

c. No delamination change >10% along any polymeric film bridging any metallic features that is designed to be isolated (verifiable by through transmission acoustic microscopy).

d. No delamination/cracking >50% of the die attach area in thermally enhanced packages or devices that require electrical contact to the backside of the die.

e. No surface-breaking feature delaminated over its entire length. A surface-breaking feature includes: lead fingers, tie bars, heat spreader alignment features, heat slugs, etc.

6.2.1.2 Substrate Based Packages (e.g., BGA, LGA, etc.):

a. No delamination on the active side of the die.

b. No delamination on any wire bonding surface of the laminate.

c. No delamination change >10% along the polymer potting or molding compound/laminate interface for cavity and over-molded packages.

d. No delamination change >10% along the solder mask/laminate resin interface.

e. No delamination change >10% within the laminate.

f. No delamination/cracking change >10% through the die attach region.

g. No delamination/cracking between underfill resin and chip or underfill resin and substrate/solder mask.

h. No surface-breaking feature delaminated over its entire length. A surface-breaking feature includes lead fingers, laminate, laminate metallization, PTH, heat slugs, etc.

Note 1: On substrate based packages, the C-mode acoustic image is not easy to interpret. Through Transmission Acoustic Imaging is recommended because it is easier to interpret and more reliable. If it is necessary to verify results or determine at what level in the package the cracking/delamination is occurring, cross-sectional analysis should be used.

Note 2: Moisture induced warpage during board assembly of substrate based packages (e.g., BGA, LGA, etc.) could result in solder bridging or open connections during board assembly solder attachment operations. It is known that ingressed moisture can either increase or decrease the total package body warpage depending on the specific design of the component. Total package body warpage can be a function of the moisture content and can be affected by the ramp rates and dwells used to measure the total warpage effect at elevated temperatures. (Exceedingly slow ramp rates or long dwells at elevated temperatures will begin to dry the package.) Care should be taken to ensure ramp rates and dwells used for the warpage measurements appropriately represent board assembly conditions. Package body warpage measured per JESD22-B112 should be characterized during package development. Ability to attach components that exhibit warpage can be verified by using board assembly.

6.3 Failure Verification All failures should be analyzed to confirm that the failure mechanism is associated with moisture sensitivity. If there are no reflow moisture-sensitive-induced failures in the level selected, the component meets the tested level of moisture sensitivity.

If the acoustic microscope scans show failure to any of the criteria listed in 6.2.1, the SMD Packages **shall** be tested to a higher numeric level of moisture sensitivity or subjected to a reliability assessment using JESD22-A113 and JESD-47 or the semiconductor manufacturer's in-house procedures.

7 MOISTURE/REFLOW SENSITIVITY CLASSIFICATION

If a device passes level 1, it is classified as not moisture sensitive and does not require dry pack.

If a device fails level 1 but passes a higher numerical level, it is classified as moisture sensitive and must be dry packed in accordance with J-STD-033.

If a device will pass only level 6, it is classified as extremely moisture sensitive and dry pack will not provide adequate protection. If this product is shipped, the customer must be advised of its classification. The supplier must also include a warning label with the device indicating that it either be socket mounted, or baked dry within time on label before reflow soldering. The minimum bake time and temperature should be determined from desorption studies of the device under test (see 8.3).

8 OPTIONAL WEIGHT GAIN/LOSS ANALYSIS

8.1 Weight Gain Weight gain analysis (absorption) can be very valuable in determining estimated floor life (the time from removal of a device from dry pack until it absorbs sufficient moisture to be at risk during reflow soldering). Weight loss analysis (desorption) is valuable in determining the bake time required to remove excess moisture from a device so that it will no longer be at risk during reflow soldering. Weight gain/loss is calculated using an average for the entire sample. It is recommended that 10 components be used in the sample. Dependent on weight, components may be weighed individually or in group(s).

Final weight gain = (wet weight - dry weight)/dry weight.
Final weight loss = (wet weight - dry weight)/wet weight.
Interim weight gain = (present weight - dry weight)/dry weight.
Interim weight loss = (wet weight - present weight)/wet weight.

''Wet'' is relative and means the package is exposed to moisture under specific temperature and humidity conditions.

''Dry'' is specific and means no additional moisture can be removed from the package at 125 °C.

8.2 Absorption Curve

8.2.1 Read Points The X-axis (time) read points should be selected for plotting the absorption curve. For the early readings, points should be relatively short (24 hours or less) because the curve will have a steep initial slope. Later readings may be spread out further (10 days or more) as the curve becomes asymptotic. The Y-axis (weight gain) should start with ''0'' and increase to the saturated weight gain. Most devices will reach saturation between 0.3% and 0.4% when stored at 85 °C/85% RH. Use the formula in 8.1. Devices **shall** be kept at room ambient between removal from the oven or chamber and weighing and subsequent reinsertion into the oven or chamber.

8.2.2 Dry Weight The dry weight of the sample should be determined first. Bake the sample for 48 hours minimum at 125 +5/-0 °C to ensure that the devices are dry. Within 1 hour after removal from the oven, weigh the devices using the optional

equipment in 3.7 and determine an average dry weight per 8.1. For small SMDs (less than 1.5 mm total height), devices should be weighed within 30 minutes after removal from oven.

8.2.3 Moisture Soak Within 1 hour after weighing, place the devices in a clean, dry, shallow container so that the package bodies do not touch each other. Place the devices in the desired temperature/humidity condition for the desired length of time.

8.2.4 Readouts Upon removal of the devices from the temperature/humidity chamber, allow devices to cool for at least 15 minutes. Within 1 hour after removal from the chamber, weigh the devices. For small SMDs (less than 1.5 mm total height), devices should be weighed within 30 minutes after removal from the chamber. After the devices are weighed, follow the procedure in 8.2.3 for placing the devices back in the temperature/humidity chamber. No more than 2 hours total time should elapse between removal of devices from the temperature/humidity chamber and their return to the chamber.

Continue alternating between 8.2.3 and 8.2.4 until the devices reach saturation as indicated by no additional increase in moisture absorption or until soaked to the maximum time of interest.

8.3 Desorption Curve A desorption curve can be plotted using devices that have reached saturation as determined in 8.2.

8.3.1 Read Points The suggested read points on the X-axis are 12 hour intervals. The Y-axis should run from ''0'' weight gain to the saturated value as determined in 8.2.

8.3.2 Baking Within 1 hour (but not sooner than 15 minutes) after removal of the saturated devices from the temperature/humidity chamber, place the devices in a clean, dry, shallow container so that the package bodies do not touch each other. Place the devices in the bake oven at the desired temperature for the desired time.

8.3.3 Readouts At the desired read point; remove the devices from the bake oven. Within 1 hour after removal of the devices from the bake oven, remove the devices from the container and determine their average weight using the optional equipment in 3.7 and formula in 8.1.

Within 1 hour after weighing the devices, place them in a clean, dry, shallow container so that the package bodies do not touch each other. Return the devices to the bake oven for the desired time.

Continue until the devices have lost all their moisture as determined by the dry weight in 8.2.2.

9 ADDITIONS AND EXCEPTIONS

The following details **shall** be specified in the applicable documentation:

a. Device selection criteria (if different from 5.1).

b. Test procedure sample size (if different from 5.1).

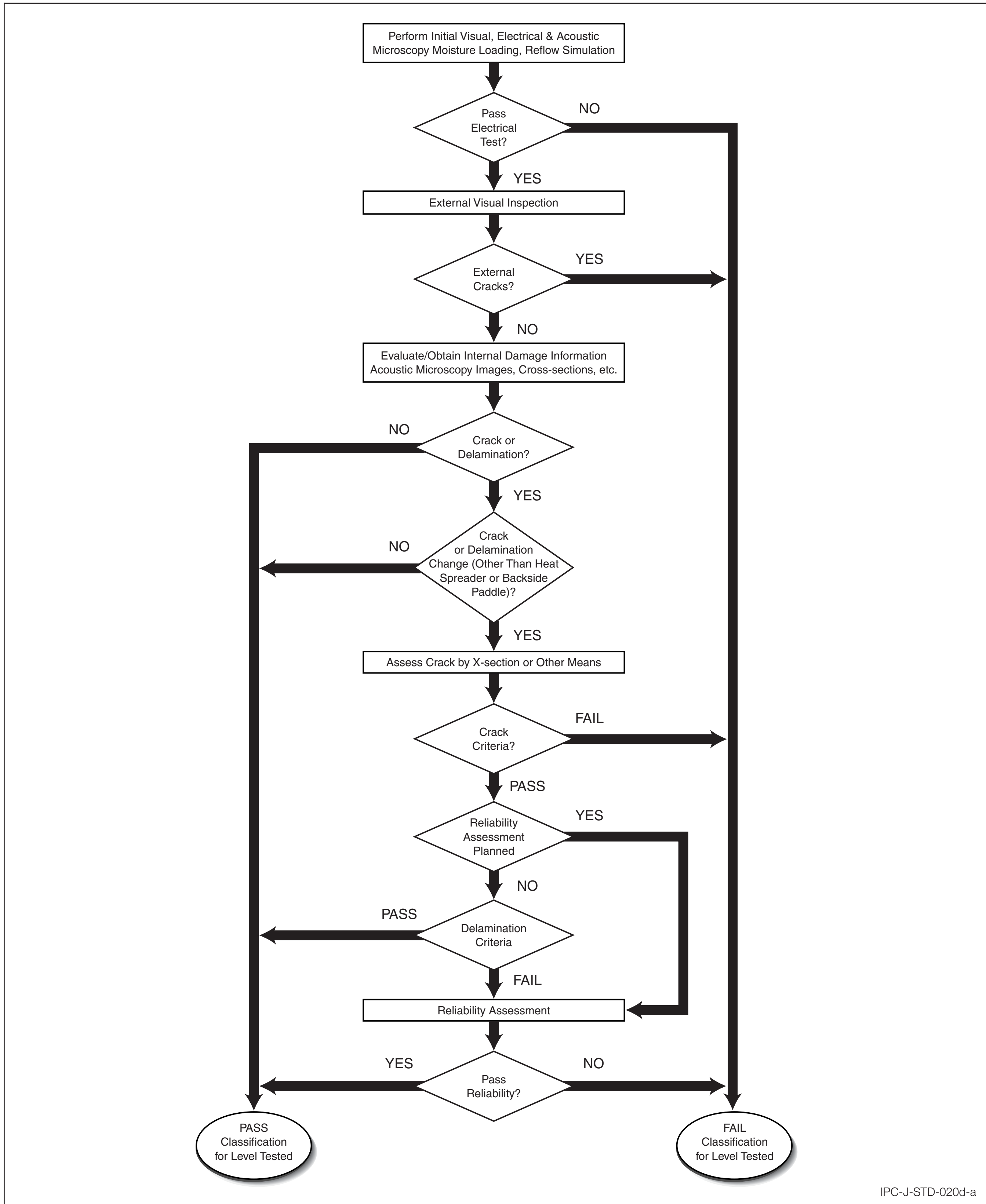
c. Package types to be evaluated.

d. Any reject criteria (including acoustic microscope criterion) in addition to those shown in Clause 6.

e. Any preconditioning requirements beyond those shown in Clause 5.

f. Conditions or frequency under which retest is required.

ANNEX A
Classification Flow



ANNEX B
Major changes from Revision C to Revision D

Page	Reference	J-STD-020D
	Misc.	Editorial changes throughout
6	Clause 4	Added Note 5 under Table 4-2
6	4.1	Added 2nd sentence and modified
7	5.3	Added 40X to visual
8	5.6	Added Note 1 and modified Note 2
10	Table 5-2	Revised T_p definition, changed tolerance for t_p
10, 11	Notes under Table 5-2	Revised Note 1, added Notes 3,4
11	Figure 5-1	New profile figure
12	6.2	Added Note 1 regarding high temperature warpage
13	6.2.1.2	Note 2 revised

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Standard Improvement Form

IPC/JEDEC J-STD-020D

The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:

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1. I recommend changes to the following:

___ Requirement, paragraph number __________

___ Test Method number __________, paragraph number __________

The referenced paragraph number has proven to be:

___ Unclear ___ Too Rigid ___ In Error

___ Other ____

2. Recommendations for correction:

____

____

____

____

3. Other suggestions for document improvement:

____

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Submitted by:

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