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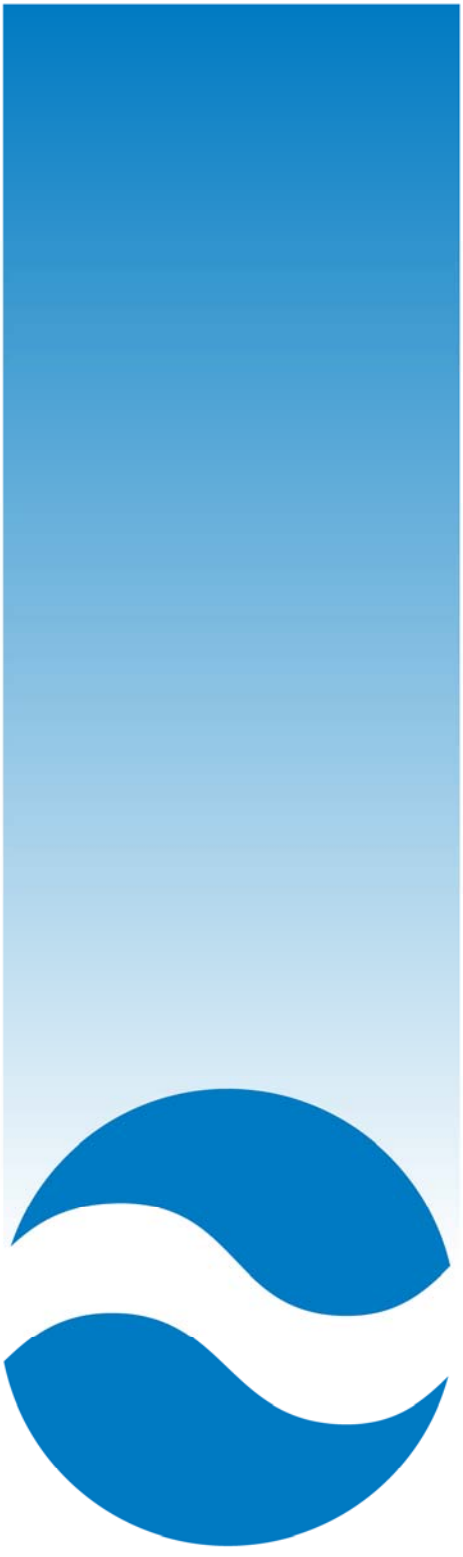
August 2014

JOINT INDUSTRY STANDARD

Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices



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

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IPC/JEDEC J-STD-033D

Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices

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

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In Memorium

The Joint Committee would like to especially acknowledge Jack T. McCullen and Richard L. Shook for their outstanding contributions and leadership in the development of J-STD-033.

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Handling, Packing, Shipping and Use of Moisture, Reflow, and Process Sensitive Devices

1 FOREWORD

The advent of surface mount devices (SMDs) introduced a new class of quality and reliability concerns regarding damage such as "cracks and delamination" from the solder reflow process. This document describes the standardized levels of floor-life exposure for moisture/reflow sensitive SMDs along with the handling, packing and shipping requirements necessary to avoid moisture/reflow related failures. Companion documents J-STD-020, J-STD-075 and JEP113 define the classification procedure and the labeling requirements, respectively.

For moisture sensitivity, moisture from atmospheric humidity enters permeable packaging materials by diffusion. Assembly processes used to solder SMDs to printed circuit boards (PCBs) expose the entire package body to temperatures higher than 200 °C. During solder reflow, the combination of rapid moisture expansion, materials mismatch, and material interface degradation can result in cracking and/or delamination of critical interfaces within the device.

Typical solder reflow processes of concern for all devices are convection, convection/IR, infrared (IR), vapor phase (VPR), hot air rework tools, and wave solder, including full immersion.

Non-semiconductor devices may exhibit additional process sensitivities beyond moisture sensitivity such as thermal sensitivity, flux sensitivity or cleaning process sensitivity.

1.1 Purpose The purpose of this document is to provide manufacturers and users with standardized methods for handling, packing, shipping, and use of moisture/reflow and process sensitive devices that have been classified to the levels defined in J-STD-020 or J-STD-075. These methods are provided to avoid damage from moisture absorption and exposure to solder reflow temperatures that can result in yield and reliability degradation. By using these procedures, safe and damage-free reflow can be achieved. The dry-packing process defined herein provides a minimum shelf life of 12 months from the seal date.

1.2 Scope This standard applies to all devices subjected to bulk solder reflow processes during PCB assembly, including plastic encapsulated packages, process sensitive devices and other moisture sensitive devices made with moisture-permeable materials (epoxies, silicones, etc.) that are exposed to the ambient air.

1.3 Assembly Processes

1.3.1 Mass Reflow This standard applies to bulk solder reflow assembly by convection, convection/IR, infrared (IR), and vapor phase (VPR) processes. It does not apply to bulk solder reflow processes that immerse the device bodies in molten solder (e.g., wave soldering bottom mounted devices). Such processes are not allowed for many SMDs and are not covered by the device qualifications standards used as a basis for this document.

1.3.2 Localized Heating This standard also applies to moisture/reflow sensitive SMD packages that are removed or attached singly by local ambient heating, i.e., "hot air rework." See Clause 6.

1.3.3 Socketed Devices

This standard does not apply to SMD packages that are socketed and not exposed to solder reflow temperatures during either bulk reflow or rework of adjacent devices. Such SMD packages are not at risk and do not require moisture precautionary handling.

1.3.4 Point-to-Point Soldering This standard does not apply to SMD packages in which only the leads are heated to reflow the solder, e.g., hand-soldering, hot bar attach of gull wing leads, and through hole by wave soldering. The heat absorbed by the package body from such operations is typically much lower than for bulk surface mount reflow or hot air rework and moisture precautionary measures are typically not needed.

1.3.5 Aqueous Cleaning For non-cavity SMDs typical short term aqueous cleaning processes will not impact the floor life (internal moisture content). Special consideration should be given to non-hermetic cavity packages.

1.4 Reliability The methods set forth in this specification ensure that an adequate SMD package reliability can be achieved during and after the PCB assembly operation, when the SMD packages are evaluated and verified by J-STD-020, J-STD-075, and/or by JESD22-A113 plus environmental reliability testing.

Note: This specification does not address or ensure solder joint reliability of external interconnects for attached devices.

1.5 Terms and Definitions

1.5.1 Active Desiccant Desiccant that is either fresh (new) or has been baked according to the manufacturer's recommendations to renew it to original specifications.

1.5.2 Bar Code Label A label that includes information in a code consisting of parallel bars and spaces or a 2-D matrix format.

Note: For the purpose of this standard, the bar code label is on the lowest-level shipping container and includes information that describes the product, e.g., part number, quantity, lot information, supplier identification, and moisture-sensitivity level.

1.5.3 Bulk Reflow Reflow of multiple devices with simultaneous attachment by an infrared (IR), convection/IR, convection, or vapor phase reflow (VPR) process.

1.5.4 Carrier A pocket tape, tray, tube, or other container used to store and transport packaged devices.

1.5.5 Desiccant An absorbent material used to maintain a low relative humidity.

1.5.6 Floor Life The allowable time period after removal of moisture-sensitive devices from a moisture-barrier bag, dry storage, or dry bake and before the solder process.

1.5.7 Humidity Indicator Card (HIC) A card on which a moisture-sensitive chemical is applied as a spot that will make a significant, perceptible change when the indicated relative humidity is exceeded.

Note 1: Two types of HICs have been defined.

Type 1 HIC (reversible) For reversible spots the change is temporary and occurs as a change in color (hue), typically from blue (dry) to pink (wet). A perceptible change will be seen if the humidity threshold is only momentarily surpassed.

Type 2 HIC (nonreversible) For nonreversible spots the change is not temporary and can be a spot color migration outside of the spot border or some other nonreversible indicator. A nonreversible HIC includes at least a 60% RH indicator spot, but can have other nonreversible RH% indicators that do not revert after exposure to a humidity threshold.

Note 2: The HIC is packed inside the moisture-barrier bag, along with a desiccant, to aid in determining the level of moisture to which the moisture-sensitive devices have been subjected. Type 1 and Type 2 HICs that have been exposed to 60% or greater RH will no longer be considered accurate.

1.5.8 Manufacturer's Exposure Time (MET) The maximum cumulative time after bake that devices may be exposed to ambient conditions prior to shipment to end user.

1.5.9 Moisture-Barrier Bag (MBB) A bag designed to restrict the transmission of water vapor and used to pack moisture-sensitive devices.

1.5.10 Moisture-Sensitive Identification (MSID) A symbol indicating that the contents are moisture-sensitive.

1.5.11 Moisture-Sensitivity Level (MSL) A rating indicating a device's susceptibility to damage due to absorbed moisture when subjected to reflow soldering as defined in J-STD-020.

1.5.12 Rework The removal of a device for scrap, reuse, or failure analysis; the replacement of an attached device; or the heating and repositioning of a previously attached device.

1.5.13 Process-Sensitivity Level (PSL) A rating used to identify a device that is solder-process-sensitive because the device cannot be used in one or more of the base solder process conditions defined in J-STD-075.

1.5.14 Shelf Life (of a device in a sealed MBB) The allowable time that a dry-packed moisture or reflow-sensitive device can be stored in an unopened moisture-barrier bag (MBB).

1.5.15 SMD Surface mount device.

Note: For the purpose of this standard, SMD is restricted to include only plastic-encapsulated SMDs and other packages made with moisture-permeable materials.

1.5.16 Solder Reflow A solder attachment process in which previously applied solder or solder paste is melted to attach a device to a printed circuit board.

1.5.17 Water Vapor Transmission Rate (WVTR) A measure of the permeability of plastic film or metallized plastic film material to moisture.

2 APPLICABLE DOCUMENTS (Normative)

2.1 American Society for Testing and Materials (ASTM)[1]

ASTM F 1249 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

ASTM F 392 Standard Test Method for Flex Durability of Flexible Barrier Materials

2.2 Electronic Industries Alliance (ECIA, ESDA, JEDEC) ANSI/ESD S541 Packaging Material for ESD Sensitive Items [2]

ANSI/ESD S541 Packaging Material Standards for ESD Sensitive Items

JESD625 Requirements for Handling Electrostatic Discharge Sensitive (ESD) Devices

JEP160 Long Term Storage Guidelines for Electronic Solid State Wafers, Dice, and Devices

JESD22-A113 Preconditioning of Non-hermetic Surface Mount Devices Prior to Reliability Testing

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

2.3 IPC Standards[3]

IPC-7711/21 Rework, Modification and Repair of Electronic Assemblies

2.4 Joint Industry Standards[4]

J-STD-020 Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices

J-STD-075 Classification of Non-IC Electronic Components for Assembly Processes

2.5 Department of Defense[5]

MIL-PRF-81705 Type I - Barrier Materials Flexible. Electrostatic-free. Heat Sealable

MIL-D-3464 Type II - Desiccant, Activated, Bagged, Packaging Use and Static Dehumidification

3 DRY PACKING

3.1 Requirements Dry-packing requirements for the various moisture sensitivity levels are shown in Table 3-1. The levels are determined per J-STD-020, J-STD-075, and/or per JESD22-A113 plus reliability testing. As a minimum all materials used in dry packing should conform to ANSI/ESD S541.

1. www.astm.org
2. www.ecianow.org; www.esda.org; www.jedec.org
3. www.ipc.org
4. www.eia.org; www.jedec.org; www.ipc.org
5. http://quicksearch.dla.mil/qsSearch.aspx

Table 3-1 Dry-Packing Requirements

Level	Dry Before Bag	MBB With HIC	Desiccant	MSID Label	Caution Label
1	Optional	Optional	Optional	Not Required	Not Required if classified at 220 °C –225 °C Required* if classified at other than 220 °C – 225 °C
2	Optional	Required	Required	Required	Required
2a-5a	Required	Required	Required	Required	Required
6	Optional	Optional	Optional	Required	Required
Socket Only	Not Applicable	Not Applicable	Not Applicable	Not Required	Not Required

Note: * A "Caution" label is not required if level and reflow temperature are given, in human readable form, on the barcode label attached to the lowest level shipping container.

3.2 Drying of SMD Packages and Carrier Materials Before Being Sealed in MBBs

3.2.1 Drying Requirements - Levels 2a - 5a SMD packages classified at Levels 2a through 5a must be dried (see Clause 4.) prior to being sealed in MBBs. The period between drying and sealing must not exceed the MET less the time allowed for distributors to open the bags and repack parts. If the supplier's actual MET is more than the default 24 hours, then the actual MET must be used. If the distributor practice is to repack the MBBs with active desiccant, then this time does not need to be subtracted from the MET.

3.2.2 Drying Requirements for Carrier Materials Carrier materials, such as trays, tubes, reels, etc., that are placed in the MBB can affect the moisture level within the MBB. Therefore, the effect of these materials must be compensated for by baking or, if required, adding additional desiccant in the MBB to ensure the calculated shelf life of the SMD packages.

3.2.3 Drying Requirements Suppliers may use the drying effect of normal in-line processes such as post mold cure, marking cure, and burn-in to reduce the bake time. An equivalency evaluation is recommended to ensure that high temperature processing maintains moisture weight gain to an acceptable level. The total weight gain for the SMD package at the time it is sealed in the MBB must not exceed the moisture gain of that package starting dry and then being exposed to 30 °C/60% RH for MET hours (less the time for distributors).

3.2.4 Excess Time Between Bake and Bag If the allowable time between bake and bag is exceeded, the SMD packages must be dried again per Clause 4.

3.3 Dry Pack

3.3.1 Description Dry pack consists of desiccant material and a Humidity Indicator Card (HIC) sealed with the SMD packages inside a Moisture Barrier Bag (MBB). A representative dry-pack configuration is shown in Figure 3-1.

3.3.2 Materials

3.3.2.1 Moisture Barrier Bag (MBB) The moisture barrier bag **shall** meet MIL-PRF-81705, TYPE I requirements for flexibility, ESD protection, mechanical strength, and puncture resistance. The bags **shall** be heat sealable. The Water Vapor Transmission Rate (WVTR) **shall** be ≤ 0.0310 g/m^2 [0.002 g/100 in^2] in 24 hours at 40 °C after flex testing per condition "E" ASTM F 392. The WVTR is measured using ASTM F 1249.

3.3.2.2 Desiccant The desiccant material **shall** meet MIL-D-3464, TYPE II. Desiccant **shall** be dustless, non-corrosive, and absorbent to amounts specified in the standard. Desiccant has a very limited floor life and should be stored and handled per the manufacturer's recommendation prior to insertion in the MBB. The desiccant material **shall** be packaged in moisture permeable bags or pouches. The amount of desiccant used, per moisture barrier bag, **shall** be based on the bag surface area and WVTR in order to limit the interior relative humidity in the MBB, at the end of the calculated shelf life, to less than 10% at 25 °C.

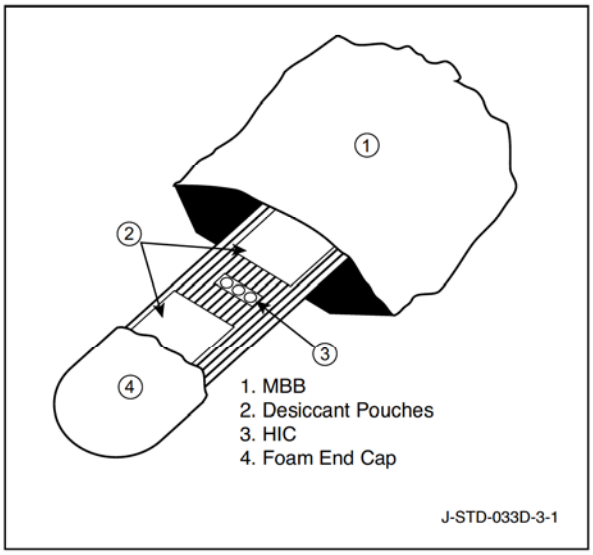

Figure 3-1 Typical Dry-Pack Configuration for Moisture-Sensitive SMD Packages in Shipping Tubes

For comparison between various desiccant types, military specifications adopted the "UNIT" as the basic unit of measure of quantity for desiccant material. A UNIT of desiccant is defined as the amount that will absorb a minimum of 2.85 g of water vapor at 20% RH and 25 °C.

3.3.2.2.1 Desiccant Quantity Calculation

When the desiccant capacity at 10% RH and 25 °C is known, the following equation should be used:

$$U = (0.304 * M * WVTR * A) / D$$

Where:
U = Amount of desiccant in UNITS
0.304 = Average number of days per month/100 in^2 (30.4/100)
M = Shelf life desired in months (see 3.3.6 for shelf life)
WVTR = Water vapor transmission rate in grams/m^2 [grams/100 in^2] in 24 hrs
A = Total exposed surface area of the MBB in square decimeters (square inches)
D = The amount of water in grams, that a UNIT of desiccant will absorb at 10% RH and 25 °C

When the desiccant capacity at 10% RH and 25 °C is not known a conservative value of D = 1.40 can be used.

Note 1: If it is desired to minimize the amount of desiccant used for dry-packing level 2 devices a value of D based on the amount of water in grams, that a UNIT of desiccant will absorb at 60% RH and 25 °C must be used in the formula. This value should to be obtained from the desiccant manufacturer. When this option is used it must be verified that when the device was classified per J-STD-020 it must have achieved full saturation during moisture soak.

Note 2: No moisture-absorbing material (e.g., trays, tubes, reels, foam end caps) should be placed in the dry bag without low temperature baking. Any such material that is included increases the amount of desiccant needed to meet the calculated shelf life (see 5.3.1) by an amount based on the moisture content of the material. This can be determined by weighing a representative quantity of material known to be at equilibrium with the manufacturing environment, baking to a new constant weight, and subtracting the final from the initial weight.

Additional UNIT(s) of desiccant, based on 10% RH @ 25°C, must be added to absorb the amount of water, in grams, egressed from the packing materials (dunnage) after baking.

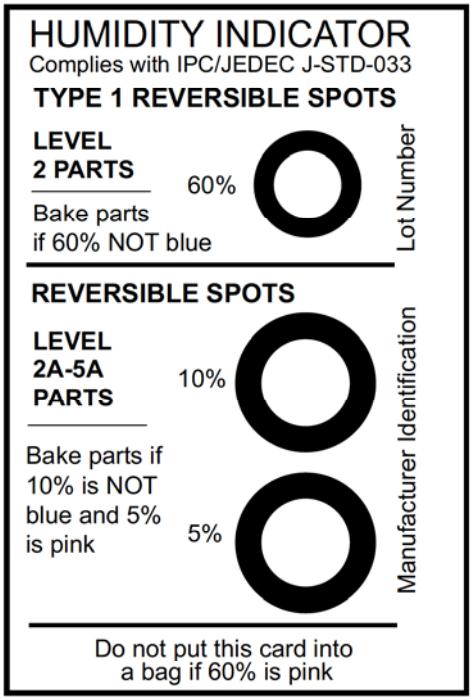

Figure 3-2A Humidity Indicator Card (HIC) – Type 1

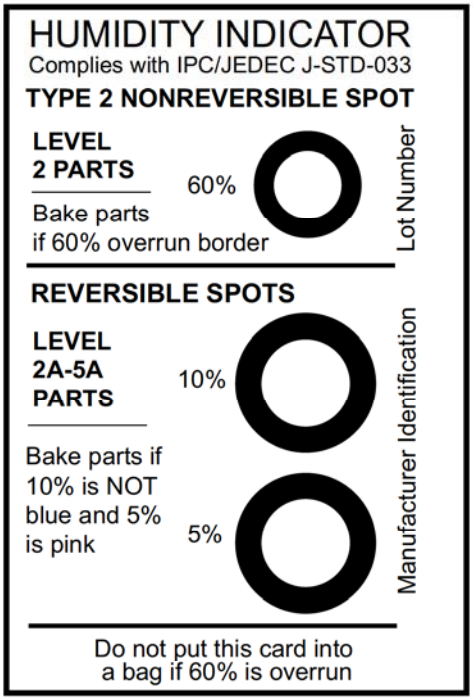

Figure 3-2B Humidity Indicator Card (HIC) – Type 2

3.3.2.2.2 Desiccant Handling and Storage Desiccant capacity decreases rapidly when exposed to 30° C/60% RH. Therefore the desiccant should remain in the manufacturer's container or stored in a dry cabinet at <5% RH until use. When dry packing, the desiccant **shall** be removed from the storage container just prior to placing it into the MBB and sealing the MBB. Appendix C provides a method to validate the desiccant unit absorption capacity.

3.3.2.3 Humidity Indicator Cards (HIC) Type 1 (Reversible) and Type 2 (Nonreversible) At a minimum, the HIC **shall** have three (3) color spots with sensitivity values of 5%, 10% RH and 60% RH. An example Type 1 HIC is shown in Figure 3-2A. The spots **shall** indicate the humidity with a significant, perceptible change in color (hue) as indicated in Table 3-2. Hue **shall** be tested using the test method in Appendix A. The colors **shall** be described in writing on the card. The 5% and 10% HIC spots **shall** be reversible to allow reuse. HIC reuse is not allowed if the 60% spot has indicated it has surpassed the threshold. Reuse is not allowed, due to loss of accuracy of the 5% and 10% spot chemistry, if the 60% spot has changed color or colored spot migration outside of the spot border has occurred. Therefore the use of a Type 2 HIC as shown in Figure 3-2B, with a nonreversible 60% spot indicator is preferred. It is not required to reuse the same HIC from the MBB if the MBB is to be resealed; a fresh HIC may be used. At a 30 °C/60% RH environment the 5% spot **shall** begin to change from dry indication in a maximum of 4 minutes and complete change (to wet indication) in 7 minutes and the 10% spot **shall** begin to change from dry indication in a maximum of 6 minutes and complete change (to wet indication) within 10 minutes when removed from manufacturer's original container.

Note 1: For proper disposal of HICs, please consult the HIC supplier.

Note 2: For appropriate use of HICs that include reversible (Type 1) and/or nonreversible (Type 2) spots, please consult the HIC supplier.

3.3.2.3.1 HIC Paper White blotting paper made from fibrous cellulosic material, with a minimum basis weight of, 255 g/m^2 (equivalent to a nominal 170 pounds basis weight) **shall** be used for HIC's.

3.3.2.3.2 Visual Defects HIC's as manufactured **shall** be free from defects including missing spots, tears, improperly located spots, and indicating color overrunning the black circles.

3.3.2.3.3 Preservation HIC's should be stored per the manufacturer's recommendation prior to insertion in the MBB. At a minimum, the 10% spot **shall** indicate dry when the cards are removed from the original container.

Table 3-2 Typical Reversible (Type 1) HIC Spot Compliance

	Indication at 2 % RH Environment	Indication at 5% RH Environment	Indication at 10% RH Environment	Indication at 55% RH Environment	Indication at 60% RH Environment	Indication at 65% RH Environment
5% Spot	Dry (blue)	Spot Value change ≥7% hue (lavender)	Wet (pink)	Wet (pink)	Wet (pink)	Wet (pink)
10% Spot	Dry (blue)	Dry (blue)	Spot Value **change ≥10% hue** (lavender)	Wet (pink)	Wet (pink)	Wet (pink)
60% Spot	Dry (blue)	Dry (blue)	Dry (blue)	Dry (blue)	Spot Value **change ≥10% hue** (lavender)	Wet (pink)

Note: Other color change schemes may be used to indicate dry to wet. Please consult with the supplier for specific interpretation.

3.3.3 Labels

3.3.3.1 Labels - Moisture Sensitive Identification labels relevant to the dry-pack process are the Moisture-Sensitive Identification (MSID) label and the Caution label (see Figures 3-3 and 3-4). The MSID and Caution labels **shall** be contrasting colors. These labels **shall** be legible to normal vision at a distance of three feet. Monochromatic reproduction in any color that contrasts with the background may be used. Where the choice of color is arbitrary, it is recommended that:

- The MSID label background should be blue (Pantone #297C) with a black symbol and letters.
- The Caution label background should be white with a blue (Process blue) symbol and letters.

Note: Wherever possible, the color red should be avoided as red suggests a personal hazard.

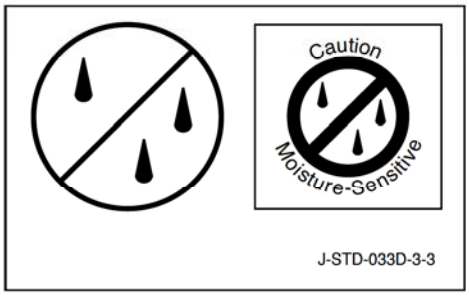

Figure 3-3 Moisture-Sensitive Identification Label (Examples)

3.3.3.1.1 Moisture-Sensitive Identification (MSID) Label The MSID label **shall** be affixed to or printed on the lowest-level shipping container that contains the MBB. This label is recommended to be a minimum of 19 mm [0.75 in] in diameter. See examples in Figure 3-3.

3.3.3.1.2 Caution Label The Caution label **shall** be affixed to the outside surface of the MBB. The Caution label includes fields for the moisture classification level per J-STD-020 or process classification level per J-STD-075; the peak package body temperature allowed during reflow soldering (the classification temperature); the floor life; and the bag seal date. If the calculated shelf life is greater than 12 months, item # 1 of the Caution label should be changed accordingly. The Caution Label **shall** be a minimum of 76 mm [3.0 in] by 76 mm [3.0 in] square.

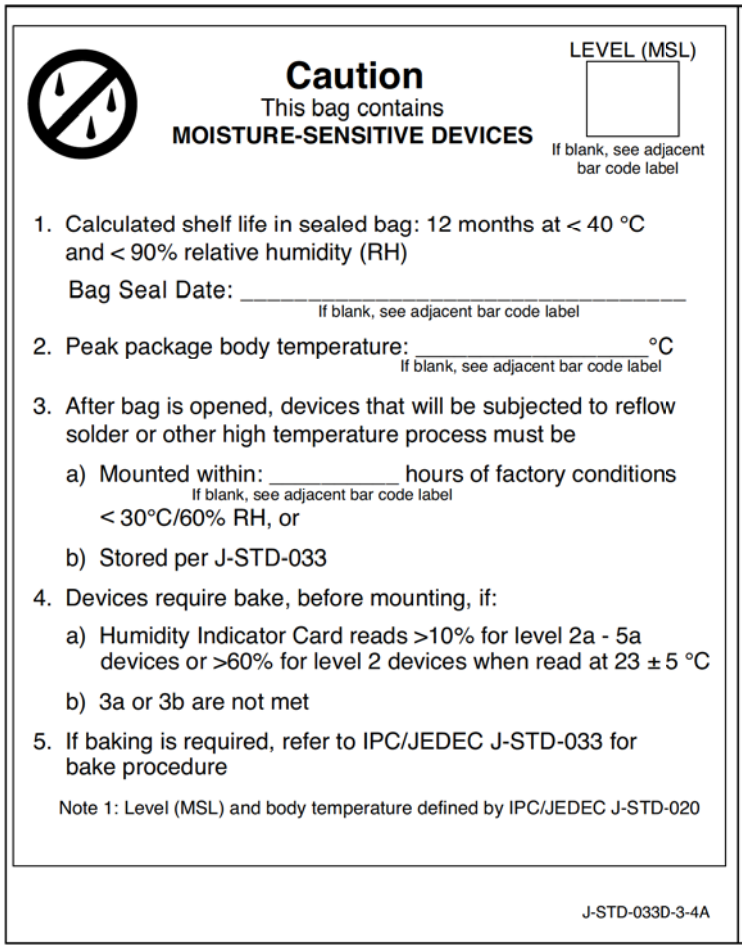

Figure 3-4A Caution Label (Examples with MSL only)

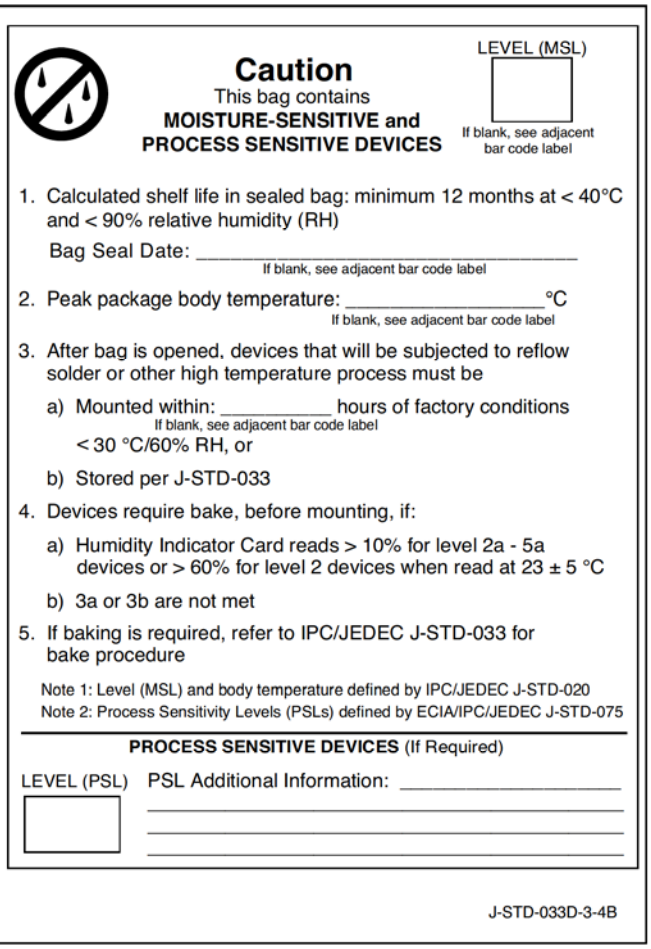

Figure 3-4B Caution Label (Examples with MSL and PSL)

3.3.3.2 Labels - Level 6 Requirements Level 6 parts not shipped in MBBs **shall** have both an MSID label and the appropriate Caution label affixed to the lowest level shipping container.

3.3.3.3 Labels - Level 1 Requirements Level 1 parts classified for other than 220 °C - 225 °C maximum reflow temperature **shall** have a Caution label with the maximum reflow temperature specified. The Caution label **shall** be affixed to the MBB (if used) or to the lowest-level shipping container. The Caution label is not required if a "Bar Code" label includes the Level 1 classification and maximum reflow temperature information in human readable form. Level 1 parts classified at 220 °C - 225 °C maximum reflow temperature do not require any moisture related labels.

3.3.4 Moisture Barrier Bag Sealing The bag **shall** be heat sealed so as not to damage or cause delamination of the MBB.

3.3.5 Dry-Pack Precautions

3.3.5.1 HIC Placement The HIC may be placed anywhere in the MBB, but should not be placed under, on top or touching a desiccant pouch.

3.3.5.2 HIC Reuse

3.3.5.2.1 HIC with 10% RH Indicated HIC cards where the 10% spot indicates wet **shall not** be used/reused if the bag will be opened and the HIC card inspected within 48 hours.

3.3.5.2.2 HIC with 60% RH Indicated HIC **shall** be discarded if the 60% spot has indicated wet. HICs that have been exposed to 60% or greater RH will no longer be accurate.

3.3.5.3 Moisture Barrier Bag Sealing In actual practice air evacuation is not required (Figure 3-5). Light air evacuation may be used to reduce the packaging bulk and enhance carton packing (Figure 3-6). Full evacuation **shall not** be used as it will impede desiccant and HIC performance and possibly lead to MBB puncture (Figure 3-7).

Note: Typically the equilibrium within MBB is not reached until 7 days from bag seal date.

3.3.6 Shelf Life The calculated shelf life for dry-packed SMD packages **shall** be a minimum of 12 months from the bag seal date, when stored in a non-condensing atmospheric environment of <40 °C/90% RH. If the calculated shelf life is greater than 12 months, item # 1 of the Caution label should be changed accordingly (see Fig. 3-4).

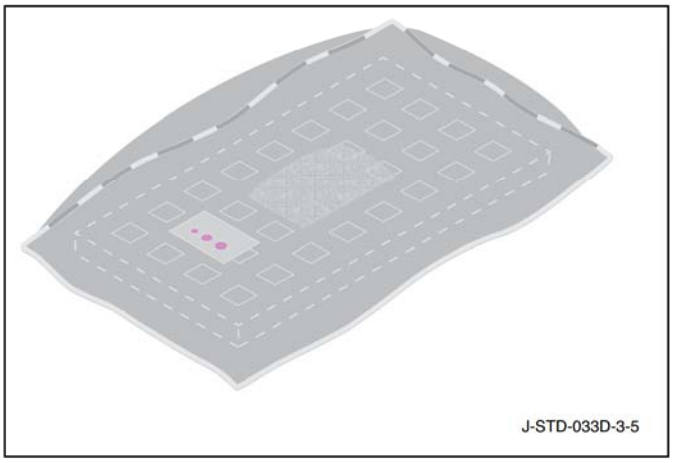

Figure 3-5 MBB with No Evacuation (Example)

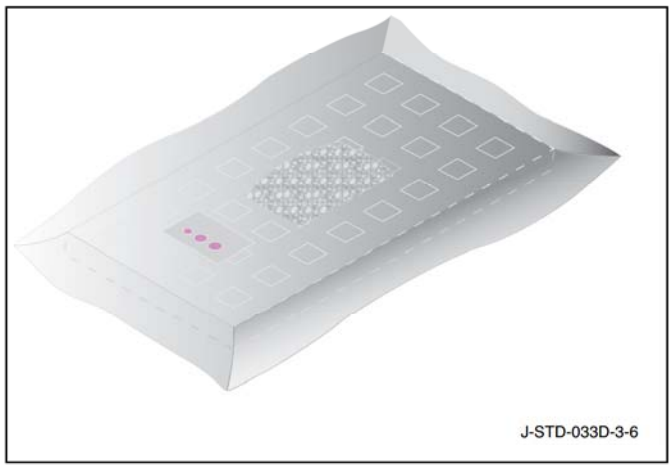

Figure 3-6 MBB with Recommended Light Air Evacuation (Example)

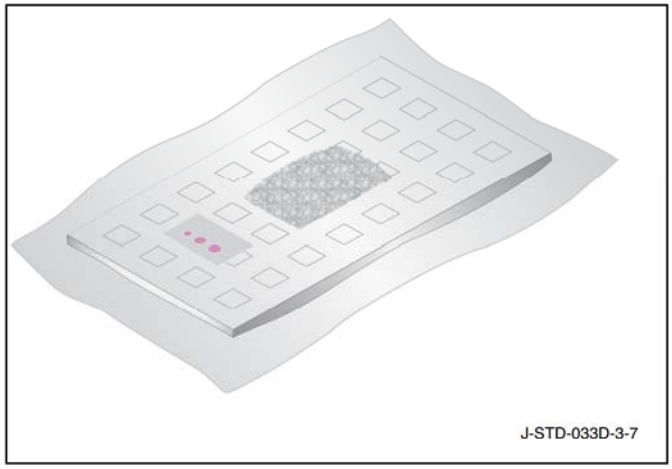

Figure 3-7 MBB with Too Much (Full) Evacuation (Example)

4 DRYING

Device drying options for various moisture sensitivity levels and ambient humidity exposures are given in the following two tables. Drying per an allowable option resets the floor-life clock. If dried and sealed in an MBB with fresh desiccant, the shelf life is reset. Tables 4-1, 4-2 and 4-3 give reference conditions for drying SMD packages. Table 4-1 gives conditions for rebake of SMD packages at a user site after the floor life has expired or other conditions have occurred to indicate excess moisture exposure.

Table 4-2 gives conditions for bake prior to dry pack at a supplier and/or distributor and allows for a maximum total of 24 hour MET. Table 4-3 summarizes conditions for resetting or pausing the floor-life clock at the user site per clause 4.1. The supplier **shall** formally communicate to the distributor the maximum time that the product may be left unsealed (at the distributor) before rebaking is required.

Note: If bake is interrupted for greater than 15 minutes the total time of the interruption should be added to the bake time.

Table 4-1 Reference Conditions for Drying Mounted or Unmounted SMD Packages (User Bake: Floor life begins counting at time = 0 after bake)

Package Body	Level	Bake @ 125 °C + 10/-0 °C < 5% RH		Bake @ 90 °C + 8/-0 °C ≤ 5% RH		Bake @ 40 °C + 5/-0 °C ≤ 5% RH	
		Exceeding Floor Life by > 72 h	Exceeding Floor Life by < 72 h	Exceeding Floor Life by > 72 h	Exceeding Floor Life by < 72 h	Exceeding Floor Life by > 72 h	Exceeding Floor Life by < 72 h
Thickness < 0.5 mm (see Note 5)	2	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)
	2a	1 hour	1 hour	2 hours	1 hour	12 hours	8 hours
	3	1 hour	1 hour	3 hours	1 hour	22 hours	8 hours
	4	1 hour	1 hour	3 hours	1 hour	22 hours	8 hours
	5	1 hour	1 hour	3 hours	1 hour	23 hours	8 hours
	5a	1 hour	1 hour	4 hours	1 hour	26 hours	8 hours
Thickness > 0.5 mm ≤ 0.8 mm (see Note 5)	2	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)
	2s	4 hours	3 hours	15 hours	13 hours	4 days	3 days
	3	4 hours	3 hours	15 hours	13 hours	4 days	3 days
	4	4 hours	3 hours	16 hours	13 hours	4 days	3 days
	5	4 hours	3 hours	16 hours	13 hours	4 days	3 days
	5a	4 hours	3 hours	16 hours	13 hours	4 days	3 days
Thickness > 0.8 mm ≤ 1.4 mm (see Note 5)	2	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)	Not Required (see Note 4)
	2a	8 hours	6 hours	25 hours	20 hours	8 days	7 days
	3	8 hours	6 hours	25 hours	20 hours	8 days	7 days
	4	9 hours	6 hours	27 hours	20 hours	10 days	7 days
	5	10 hours	6 hours	28 hours	20 hours	11 days	7 days
	5a	11 hours	6 hours	30 hours	20 hours	12 days	7 days
Thickness > 1.4 mm ≤ 2.0 mm (see Note 5)	2	18 hours	15 hours	63 hours	2 days	25 days	20 days
	2a	21 hours	16 hours	3 days	2 days	29 days	22 days
	3	27 hours	17 hours	4 days	2 days	37 days	23 days
	4	34 hours	20 hours	5 days	3 days	47 days	28 days
	5	40 hours	25 hours	6 days	4 days	57 days	35 days
	5a	48 hours	40 hours	8 days	6 days	79 days	56 days
Thickness > 2.0 mm ≤ 4.5 mm (see Note 5)	2	48 hours	48 hours	10 days	7 days	79 days	67 days
	2a	48 hours	48 hours	10 days	7 days	79 days	67 days
	3	48 hours	48 hours	10 days	8 days	79 days	67 days
	4	48 hours	48 hours	10 days	10 days	79 days	67 days
	5	48 hours	48 hours	10 days	10 days	79 days	67 days
	5a	48 hours	48 hours	10 days	10 days	79 days	67 days
Exception for BGA package > 17 mm x 17 mm or any stacked die package	2 -5a	96 hours (See Note 2 and Note 5	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level	Not applicable	As above per package thickness and moisture level

Note 1: Table 4-1 is based on worst-case molded lead frame SMD packages. Users may reduce the actual bake time if technically justified (e.g., absorption/desorption data, etc.). In most cases it is applicable to other non-hermetic surface mount SMD packages. If parts have been exposed to > 60% RH it may be necessary to increase the bake time by tracking desorption data to insure parts are "dry".

Note 2: For BGA packages > 17 mm x17 mm, that do not have internal planes that block the moisture diffusion path in the substrate, may use bake times based on the thickness/moisture level portion of the table.

Note 3: If baking of packages > 4.5 mm thick is required see appendix B.

Note 4: Baking not required if Floor Life exposure is limited to < 30C & < 60%RH for thin (< 1.4 mm) MSL2 devices. This is due to the moisture diffusion behavior of the thin devices, which were fully saturated after the absorption at MSL 2 (168 hours @85C/60%RH).

Note 5: The bake times specified are conservative for packages without blocking planes or stacked die. For a stacked die or BGA package with internal planes that impede moisture diffusion the actual bake time may be longer than that required in Table 4-1.

Table 4-2 Supplier Bake: Default Baking Times Used Prior to Dry Pack that were Exposed to Conditions ≤ 60% RH ("MET" = 24 h)

Package Body Thickness	Level	Bake @ 125°C + 10/-0 °C < 5% RH	Bake @ 150°C + 10/-0 °C < 5% RH
≤ 1.4 mm	2 2a 3 4 5 5a	7 hours 8 hours 16 hours 21 hours 24 hours 28 hours	3 hours 4 hours 8 hours 10 hours 12 hours 14 hours
> 1.4 mm ≤ 2.0 mm	2 2a 3 4 5 5a	18 hours 23 hours 43 hours 48 hours 48 hours 48 hours	9 hours 11 hours 21 hours 24 hours 24 hours 24 hours
> 2.0 mm ≤ 4.5 mm	2 2a 3 4 5 5a	48 hours 48 hours 48 hours 48 hours 48 hours 48 hours	24 hours 24 hours 24 hours 24 hours 24 hours 24 hours

Note 1: If baking of packages > 4.5 mm thick is required see appendix B.

Note 2: The bake times specified are conservative for packages without blocking planes or stacked die. For a stacked die or BGA package with internal planes that impede moisture diffusion the actual bake time may be longer than that required in Table 4-2if packages have had extended exposure to factory ambient before bake. Also the actual bake time may be reduced if technically justified. The increase or decrease in bake time **shall** be determined using the procedure in JEDEC JESD22-A120 (i.e., < 0.002 % weight loss between successive readouts) or per critical interface concentration calculations.

Table 4-3 Resetting or Pausing the Floor-Life Clock at User Site

MSL Level	Exposure time @ temp/humidity	Floor Life	Desiccator time @ relative humidity	Bake	Reset shelf life
2, 2a, 3, 4, 5, 5a	Anytime ≤ 40 °C/85% RH	reset	NA	Table 4.1	Dry Pack after Bake
2, 2a, 3, 4, 5, 5a	> floor life ≤ 30 °C/60% RH	reset	NA	Table 4.1	Dry Pack after Bake
2, 2a, 3	> 12 hrs ≤ 30 °C/60% RH	reset	NA	Table 4.1	Dry Pack after Bake
2, 2a, 3	≤ 12 hrs ≤ 30 °C/60% RH	reset	5X exposure time ≤ 10% RH	NA	NA
2, 2a, 3	Cumulative time < floor life ≤ 30 °C/60% RH	pause	Anytime ≤ 10% RH	NA	NA
4, 5, 5a	> 8 hrs ≤ 30 °C/60% RH	reset	NA	Table 4.1	Dry Pack after Bake
4, 5, 5a	≤ 8 hrs ≤ 30 °C/60% RH	reset	10X exposure time ≤ 5% RH	NA	NA

4.1 Post Exposure to Factory Ambient Placing SMD packages which have been exposed to factory ambient conditions for greater than one hour in a dry cabinet or dry pack does NOT necessarily stop/pause the floor-life clock. However, if the conditions of 4.1.2 are met, the floor-life clock can be paused or reset (see Table 4-3).

4.1.1 Any Duration Exposure Moisture sensitive SMD packages that have been exposed only to ambient conditions of ≤60% RH for any length of time may be adequately dried by high or low temperature baking according to Table 4-1 for rebake prior to reflow or Table 4-2 for drying prior to dry pack.

4.1.2 Short Duration Exposure Previously dry SMD packages, which have been exposed only to ambient conditions not exceeding 30 °C/60% RH may be adequately dried by room temperature desiccation using dry pack or a dry cabinet.