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Standard for handling, packing, shipping and use of moisture/reflow sensitive surface mount devices

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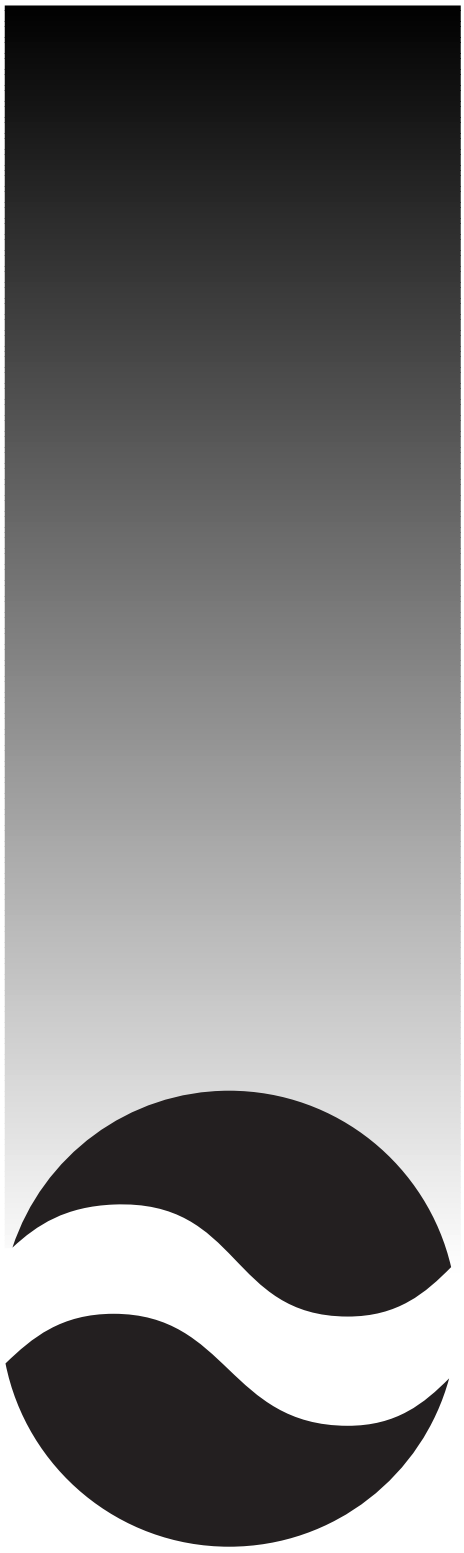
Standard for Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices



INTERNATIONAL ELECTROTECHNICAL COMMISSION

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STANDARD FOR HANDLING, PACKING, SHIPPING AND USE OF MOISTURE/REFLOW SENSITIVE SURFACE MOUNT DEVICES

FOREWORD

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IEC-PAS 62169 was submitted by JEDEC and has been processed by IEC technical committee 47: Semiconductor devices.

The text of this PAS is based on the following document:	This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document:
Draft PAS	**Report on voting**
47/1469/PAS	47/1502/RVD

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STANDARD FOR HANDLING, PACKING, SHIPPING AND USE OF MOISTURE/REFLOW SENSITIVE SURFACE MOUNT DEVICES

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(From JEDEC Board Ballot JCB-99-04, formulated under the cognizance the IPC Plastic Chip Carrier Cracking Task Group, B-10a, and the JEDEC JC-14.1 Committee on Reliability Test Methods for Packaged Devices.)

1 Foreword

The advent of surface mount devices (SMDs) introduced a new class of quality and reliability concerns regarding package cracks and delamination. 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, define the classification procedure and JEP113 define the labeling requirements.

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

The solder reflow processes of concern are convection, convection/IR, infrared (IR), vapor phase (VPR), and hot air rework tools. The use of assembly processes that immerse the component body in molten solder are not recommended for most SMD components.

2 Purpose

The purpose of this document is to provide SMD manufacturers and users with standardized methods for handling, packing, shipping, and use of moisture/reflow sensitive SMDs. 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, with the dry packing process, providing a minimum shelf life capability in sealed dry-bags of 12 months from the seal date.

3 Scope

3.1 Packages

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

3.1.2 Hermetic components are not at risk and do not require moisture precautionary handling.

3 Scope (cont'd)

3.2 Assembly processes

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

3.2.2 This standard also applies to moisture sensitive components that are removed or attached singly by local ambient heating, i.e., "hot air rework."

3.2.3 This standard does not apply to components that are socketed and not exposed to solder reflow temperatures. Such components are not at risk and do not require moisture precautionary handling.

3.2.4 This standard does not apply to components in which only the leads are heated to reflow the solder, e.g., hand-soldering, hot bar attach of gull wing leads, and pin-thru-hole with backside wave solder. 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.

3.3 Reliability

3.3.1 The methods set forth in this specification ensure that adequate component reliability, as evaluated and verified by J-STD-020 and/or by JESD22-A113 plus environmental reliability testing, is maintained during and after the PCB assembly operation.

3.3.2 This specification does not address or ensure solder joint reliability of attached components.

4 Applicable documents

4.1 EIA JEDEC/Institute for Interconnecting and Packaging Electronic Circuits (IPC) & Joint Industry Standards

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

4.2 Electronic Industries Alliance (EIA, JEDEC)

EIA-541	Packaging Material Standards for ESD Sensitive Items
EIA-583	Packaging Material Standards for Moisture Sensitive Items
EIA-625	Requirements for Handling Electrostatic Discharge Sensitive (ESD) Devices
JEP-113	Symbol and Labels for Moisture Sensitive Devices
JESD22-A113	Preconditioning of Nonhermetic Surface Mount Components Prior to Reliability Testing

4 Applicable documents (cont'd)

4.3 Department of Defense

MIL-B-131	Type I - Barrier Materials, Water vapor proof, Grease proof, Flexible, Heat sealable
MIL-B-81705	Type I - Barrier Materials Flexible. Electrostatic-free. Heat sealable
MIL-D-3464	Type II - Desiccant, Activated, Bagged, Packaging Use and Static Dehumidification
MIL-I-8835	Indicator, Humidity, Card, Chemically Impregnated

4.4 American Society for Testing and Materials (ASTM)

ASTM F 1249-90	Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
ASTM F 392-93	Standard Test Method for Flex Durability of Flexible Barrier Materials

5 Terms and definitions

active desiccant: Desiccant that is either fresh (new) or has been baked according to the manufacturer's recommendations to renew desiccant to original specifications.

bulk reflow: Reflow of multiple components, with simultaneous attachment, by an infrared (IR), convection/IR, convection, or vapor phase reflow (VPR) process.

carrier: Container that directly holds components, such as a tray, tube, or tape and reel.

desiccant: An absorbent material used to maintain a low relative humidity in moisture barrier bags for dry-packing moisture-sensitive devices. Desiccant may be a silica gel or other absorbent material packed in dustless pouches. Desiccant must meet or exceed MIL-D 3464 Class II requirements.

floor life: The allowable time period, after removal from a moisture barrier bag and before the solder reflow process, for a moisture sensitive device to be exposed to a factory ambient not exceeding 30 °C and 60% RH.

Humidity Indicator Card (HIC): A card on which a moisture sensitive chemical is printed such that it will change color from blue to pink when the indicated relative humidity is exceeded. This is packed inside the moisture sensitive bag, along with the desiccant, to aid in determining the level of moisture to which the moisture sensitive devices have been subjected. The humidity indicator card should comply with MIL-I-8835.

Manufacturer's Exposure Time (MET): The maximum time after bake that the component manufacturer requires to process components prior to bag seal. It also includes the maximum time allowed at the distributor for having the bag open to split out smaller shipments.

Moisture Barrier Bag (MBB): A bag designed to restrict the transmission of water vapor and used to pack moisture-sensitive devices. The MBB should meet or exceed MIL-B-81705 Type I requirements for flexibility, electrostatic discharge protection, mechanical strength, and puncture resistance. The water vapor transmission rate as measured using ASTM F 1249-90 is required to be ≤ 0.002 gm/100 in^2 in 24 hrs. at 40 °C after flex testing per condition "E" of ASTM F 392-93.

5 Terms and definitions (cont'd)

shelf life: The minimum time that a dry-packed moisture sensitive device may be stored in an unopened MBB, such that the required interior bag ambient humidity is maintained, based on the HIC reading.

solder reflow: The solder attachment process in which previously applied solder or solder paste is remelted to attach a component to the printed circuit board.

Water Vapor Transmission Rate (WVTR): A measure of the permeability of plastic film or metallized plastic film material to moisture, an important rating for moisture barrier bags.

6 Dry packing

6.1 Requirements

Dry packing requirements for the various moisture sensitivity levels are shown in Table 1. The levels are determined per J-STD-020 and/or per JESD22-A113 plus reliability testing. As a minimum all materials used in Dry Packing should conform to EIA-541 and EIA-583.

Table 1 — Dry packing requirements

Level	Dry Before Bag	MBB	Desiccant	MSID* Label	Caution Label
1	Optional	Optional	Optional	Not Required	Not Required if classified at 220 °C Required if classified at 235 °C
2	Optional	Required	Required	Required	Required
2a-5a	Required	Required	Required	Required	Required
6	Optional	Optional	Optional	Required	Required

* MSID = Moisture-Sensitive Identification Label

6.2 Drying of components before being sealed in MBBs

6.2.1 Components classified at levels 2a through 5a must be dried (see clause 7.) 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 time 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.

6.2.2 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 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).

6.2 Drying of components before being sealed in MBBs (cont'd)

6.2.3 If the allowable time between bake and bag is exceeded, the components must be redried per clause 7.

6.3 Dry pack

6.3.1 Description

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

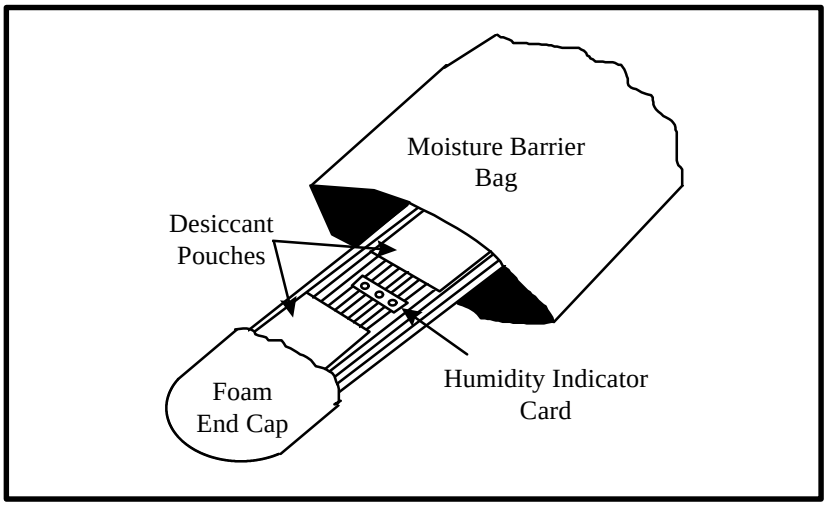

Figure 1 — Typical dry pack configuration for moisture-sensitive packages in shipping tubes

6.3.2 Materials

6.3.2.1 Moisture Barrier Bag (MBB)

The moisture barrier bag shall meet MIL-B-81075, 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 ≤ 0.002 gm/100 in^2 in 24 hrs. at 40 °C after flex testing per condition "E" ASTM F 392-93. The WVTR is measured using ASTM F 1249-90.

6.3.2.2 Desiccant

The desiccant material shall meet MIL-D-3464, TYPE II. Desiccant shall be dustless, noncorrosive, and absorbent to amounts specified in the standard. The desiccant 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 maintain an interior relative humidity in the MBB of less than 10% at 25 °C.

6.3.2 Materials (cont'd)

6.3.2.2 Desiccant (cont'd)

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. To meet the dry pack requirements of this standard the amount of water vapor that a UNIT of desiccant can absorb at 10% RH and 25 °C must be known.

The number of UNITS required per bag may be determined by the following equation:

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

where:

U = Amount of desiccant in UNITS
M = Shelf life desired in months
WVTR = Water vapor transmission rate in grams/100 in^2 in 24 hrs
A = Total surface area of the MBB in square inches
D = The amount of water in grams, that a UNIT of desiccant will absorb at 10% RH

NOTE If materials such as trays, tubes, reels, etc., are placed in the bag without baking, additional desiccant will be required to absorb the moisture contained in these materials.

6.3.2.3 Humidity Indicator Card (HIC)

The HIC shall comply with MIL-I-8835. At minimum, the HIC shall have three (3) color dots with sensitivity values of 8% RH, 10% RH, 20% RH. An example HIC is shown in Figure 2.

NOTE As they become available it is recommended that HIC color dots sensitivity values be 5%, 10% and 15%.

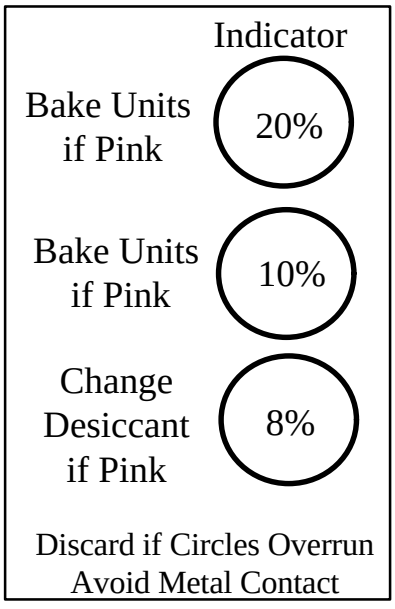

Figure 2 — Sample humidity indicator card

6.3.3 Labels

6.3.3.1 Labels relevant to the dry pack process are the “Moisture-Sensitive Identification" (MSID) label and the “Caution" label as specified in JEDEC JEP113 (see Figures 3 and 4 below). The MSID label shall be affixed to the lowest level shipping container that contains the MBB. The “Caution" label shall be affixed to the outside surface of the MBB.

6.3.3.2 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.

6.3.3.3 Level 1 parts classified for 235 °C reflow 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. Level 1 parts classified for 220 °C reflow do not require any moisture related labels.

Figure 3 — Moisture-sensitive identification label (Example)

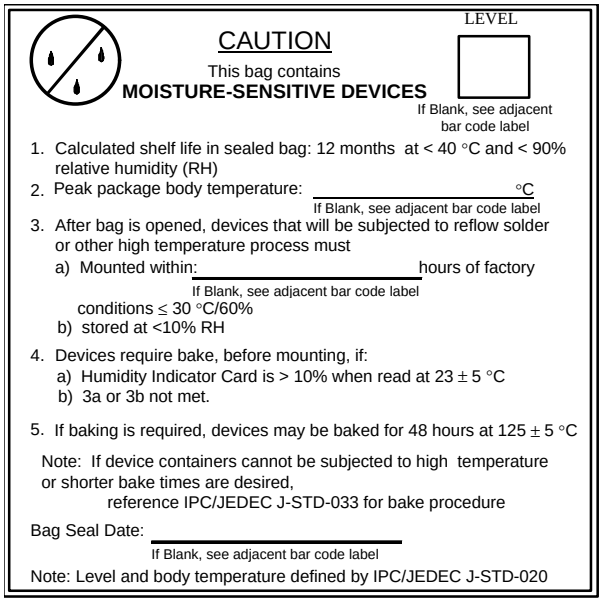

Figure 4 — Moisture-sensitive caution label (Example)

6.3.4 Shelf life

The calculated shelf life for dry packed components shall be a minimum of 12 months from the bag seal date, when stored in a noncondensing atmospheric environment of < 40 °C/90% RH.

7 Drying

Component drying options for various moisture sensitivity levels and ambient humidity exposures of ≤ 60% RH 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 2 and 3 give reference conditions for drying components. Table 2 gives conditions for rebake of components at a user site after the floor life has expired or other conditions have occurred to indicate excess moisture exposure. Table 3 gives conditions for bake prior to dry pack at a supplier or distributor and allows for 24 hour MET.

Table 2— Reference conditions for drying components that were exposed to conditions ≤ 60% RH (User Bake: Floor life begins counting at time = 0 after bake)

Package Thickness	Level	Bake @ 125 °C	Bake @ 40 °C ≤ 5% RH
≤ 1.4 mm	2a	4 h.	5 days
	3	7 h.	11 days
	4	9 h.	13 days
	5	10 h.	14 days
	5a	14 h.	19 days
≤ 2.0 mm	2a	18 h.	21 days
	3	24 h.	33 days
	4	31 h.	43 days
	5	37 h.	52 days
	5a	48 h.	68 days
≤ 4.0 mm	2a	48 h.	67 days
	3	48 h.	67 days
	4	48 h.	68 days
	5	48 h.	68 days
	5a	48 h.	68 days

Table 3— Default baking times used prior to dry-pack that were exposed to conditions ≤ 60% RH (Supplier Bake: "MET" = 24hrs)

Package Thickness	Level	Bake @ 125 °C	Bake @ 150 °C
≤ 1.4 mm	2a	8 h.	4 h.
	3	16 h.	8 h.
	4	21 h.	10 h.
	5	24 h.	12 h.
	5a	28 h.	14 h.
≤ 2.0 mm	2a	23 h.	11 h.
	3	43 h.	21 h.
	4	48 h.	24 h.
	5	48 h.	24 h.
	5a	48 h.	24 h.
≤ 4.0 mm	2a	48 h.	24 h.
	3	48 h.	24 h.
	4	48 h.	24 h.
	5	48 h.	24 h.
	5a	48 h.	24 h.

7 Drying (cont'd)

7.1 Post exposure to factory ambient

7.1.1 Any duration exposure

Moisture sensitive components which have been exposed only to factory ambient conditions of ≤ 60% RH for any length of time may be adequately dried by high or low temperature baking according to Table 2 for rebake prior to reflow or 3 for drying prior to dry pack.

7.1.2 Short duration exposure

Previously dry components, which have been exposed only to factory ambient conditions not exceeding 30 °C/60% RH for less than 8 hours may be adequately dried by room temperature desiccation. A minimum desiccating period of 5X the exposure time is required to dry the components enough to reset the floor life clock. The following options are available for room temperature desiccation.

7.1.2.1 Dry packed

Components may be dry packed, or re-sealed in the existing dry pack after replacing the desiccant with active desiccant. If total exposure is kept less than one hour, the original desiccant may be reused.

7.1.2.2 Dry box

Components may be placed in a dry box, capable of maintaining 25 ± 5 °C and less than 10% RH. Nitrogen or dry air may be used.

7.2 General considerations for baking

7.2.1 High temperature carriers

Unless otherwise indicated by the manufacturer, components shipped in high temperature carriers (e.g., high temperature trays) can be baked in the carriers at 125 °C.

7.2.2 Low temperature carriers

Components shipped in low temperature carriers (e.g., tubes, low temperature trays, tape and reel) may not be baked in the carriers at any temperature higher than 40 °C. If a higher bake temperature is required, components must be removed from the low temperature carriers to thermally safe carriers, baked, and returned to the low temperature carriers.

NOTE 1 Manual handling may increase the risk of mechanical and/or ESD damage.

NOTE 2 If components are placed in dry bags with unbaked carriers, refer to 6.3.2.2.

7.2.3 Paper and plastic container items

Paper and plastic container items such as cardboard boxes, bubble pack, plastic wrap, etc., shall be removed from around the carriers prior to baking. Rubber bands around tubes and plastic tray ties must also be removed prior to high temperature (125 °C) bake.

7.2 General considerations for baking (cont'd)

7.2.4 Bakeout times

Bakeout times start when all components reach the specified temperature.

7.2.5 ESD protection

Proper ESD handling precautions should be observed, per EIA 625. This is particularly critical if components are manually handled by vacuum pencils under low humidity conditions, e.g., in a dry environment, after baking, etc.

7.2.6 Reuse of carriers

The appropriate materials specification should be consulted before reusing carriers.

7.2.7 Solderability limitations

7.2.7.1 Oxidation risk

Baking components may cause solder oxidation and/or intermetallic growth, which if excessive can result in solderability problems during board assembly. The temperature and time for baking components are therefore limited by solderability considerations. Unless otherwise indicated by the supplier, one bake cycle is allowable on a finished component. If more than one bake cycle is needed, the supplier should be consulted.

7.2.7.2 Carrier outgassing risk

Care should be taken to ensure that outgassing of materials from the component carriers does not occur to any significant extent, such that solderability might be affected.

8 Use

Upon opening the MBB, the floor life clock starts. If an MBB is opened and the components will not be used within the specified floor life, the procedures in clause 7 should be followed.

8.1 Incoming bag inspection

8.1.1 Upon receipt

Dry packed components should be inspected for a bag seal date located on the caution or bar code label. The bags should be inspected to verify there are no holes, gouges, tears, punctures or openings of any kind that would expose either the contents or an inner layer of a multilayer bag. If openings are found, the humidity indicator card (HIC) should be read to determine the proper recovery action.

8.1 Incoming bag inspection (cont'd)

8.1.2 Component inspection

Intact bags may be opened for component inspection by cutting at the top of the bag near the seal. If the bags are opened under factory ambient conditions for less than 8 hours, resealing with active desiccant, or placing components in a dry atmosphere cabinet, for at least 5X the exposure time is required to redry the components. See 7.1.2.

8.2 Floor life

The floor life of SMDs per Table 4 will be modified by environmental conditions other than 30 °C/60% RH. Refer to clause 9 to determine maximum allowable time before rebake would be necessary. If partial lots are used, the remaining components must be resealed or placed in a dry box at < 10% RH within 1 hour of bag opening. If 1 hour exposure is exceeded, refer to 7.1.

Table 4 — Moisture classification level and floor life

Level	Floor Life (out of bag) at factory ambient ≤ 30 °C/60% RH or as stated
1	Unlimited at ≤ 30 °C/85%RH
2	1 year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Mandatory bake before use. After bake, must be reflowed within the time limit specified on the label

8.3 Safe storage
‘

Safe storage' means dry components held in a controlled humidity condition such that the floor life clock remains at zero. Acceptable safe storage conditions for components classified as level 2 through 5a are listed below.

8.3.1 Dry pack

Dry packed components in intact MBBs, stored per 6.3.4, shall have a calculated shelf life of at least 12 months from the bag seal date shown on the caution or bar code label.

8.3.2 Dry atmosphere cabinet

Loose components may be placed in a dry atmosphere cabinet, capable of maintaining 25 ± 5 °C and less than 10% RH. Nitrogen or dry air may be used.

8.4 Reflow

Reflow includes bulk reflow and single component attach/removal for rework.

8.4 Reflow (cont'd)

8.4.1 After a dry pack (MBB) has been opened, all components within that bag must complete all high temperature reflow processing, including rework, prior to the stated floor life, resealed in the MBB, or stored in a dry atmosphere cabinet per 7.1.2.2. If the floor life or factory ambient conditions are exceeded, refer to 8.5.2.

8.4.2 During reflow the component body temperature must not exceed the rated value, stated on the 'Caution' label. The body temperature during reflow directly influences component reliability.

NOTE 1 The component body temperature may be very different from the lead or solder ball temperature, particularly in IR and IR/convection processes, and should be checked separately.

NOTE 2 Some hot air attach processes may require heating the component body to temperatures hotter than 220 °C. If that temperature exceeds the classification temperature, moisture precautions and/or time-temperature limitations beyond the scope of this specification may be required. The supplier should be consulted.

8.4.3 During reflow, the additional thermal profile parameters stated in JESD22-A113 should not be exceeded. Although the body temperature during reflow is the most critical parameter, other profile parameters such as the total exposure time to hot temperatures, and the heating rates, may also influence component reliability.

8.4.4 If more than one reflow pass is used, care must be taken to ensure that no moisture sensitive components, mounted or unmounted, have exceeded their floor life prior to the final pass.

NOTE For cavity packages, in which water may be entrapped, water clean processes after the first reflow can be an additional source of moisture. This may present an additional risk, which should be evaluated.

8.4.5 A maximum of three reflow passes is allowed per component. If more than three are required for any reason, the supplier must be consulted.

8.5 Drying indicators

Events and conditions, that require component drying prior to reflow or continued safe storage.

8.5.1 Excessive humidity in the dry pack

Excessive humidity in the dry pack is noted by the humidity indicator card (HIC). It can occur due to misprocessing (e.g., missing or inadequate desiccant), mishandling (e.g., tears or rips in the MMB), or improper storage.

The HIC should be read immediately upon removal from the MMB. For best accuracy, the HIC should be read at 23 ± 5 °C. The following conditions apply regardless of the storage time, i.e., whether or not the shelf life has been exceeded.

8.5.1.1 If the 10%RH dot is blue, the parts are still adequately dry. The desiccant should be replaced by active desiccant if the bag is going to be resealed.

8.5.1.2 If the 8% RH dot is pink and the 10% RH dot is not blue, the components have been exposed to an excessive level of moisture, and drying must be done per clause 7.

8.5.2 Floor life or ambient temperature/humidity exceeded

8.5.2.1 If the floor life or ambient temperature/humidity conditions per Table 4 have been exceeded, components must be dried per clause 7 prior to reflow or safe storage.

8.5.2.2 If the factory ambient temperature and/or humidity conditions per Table 4 cannot be met, the component floor life must be derated to compensate. Floor life derating is discussed in clause 9.

8.5.3 Level 6 components

Components classified as level 6 must be dried by baking, then reflowed within the time limit specified on the label.

8.6 Board rework

If packages are to be removed from the board, it is recommended that localized heating be used and the maximum body temperature excursion of any surface mount component not exceed 200 °C. This method will minimize moisture related component damage. If the component temperature exceeds 200 °C, the board may require a bakeout prior to rework. The component temperature shall be measured at the top center of the package body. If the part is to be reused, it is recommended that it be baked dry before remount. Replacement components shall not have exceeded their specified floor life. Localized replacement reflow heating is recommended, so that the entire board is not re-subjected to reflow temperature profiles.

NOTE Temperatures on neighboring components above 183 °C may cause some solder joints to partially reflow, which may result in a potential solder joint reliability concern.

9 Derating due to factory environmental conditions

Factory floor life exposures for components removed from the dry bags will be a function of the ambient environmental conditions. A safe, yet conservative, handling approach is to expose the components only up to the maximum time limits for each moisture sensitivity level as shown in Table 4. This approach, however, does not work if the factory humidity or temperature are greater than the testing conditions of 30 °C/60% RH. A solution for addressing this problem is to derate the exposure times based on the knowledge of moisture diffusion in the component packaging materials. Recommended equivalent total floor life exposures can be estimated for a range of humidities and temperatures based on the nominal plastic thickness for each device. Table 5 lists equivalent derated floor lives for humidities ranging from 20-90% RH for three temperatures, 20 °C, 25 °C, and 30 °C. This table is applicable to SMDs molded with novolac, biphenyl or multifunctional epoxy mold compounds. The following assumptions were used in calculating Table 5:

1 Activation Energy for diffusion = 0.35eV (smallest known value)

2 For ≤ 60% RH, use Diffusivity = $0.121\exp(-0.35\text{eV}/kT)$ mm^2/s. (this uses smallest known Diffusivity @ 30 °C)

3 For > 60% RH, use Diffusivity = $1.320\exp(-0.35\text{eV}/kT)$ mm^2/s. (this uses largest known Diffusivity @ 30 °C)

9 Derating due to factory environmental conditions (cont'd)

Table 5 — Recommended equivalent total floor life (days) @ 20 °C, 25 °C & 30 °C
For ICs with Novolac, Biphenyl and Multifunctional Epoxies
(Reflow at same temperature at which the component was classified)

		Maximum Percent Relative Humidity								
Body Thickness	**M.S. Level**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	
Body Thickness ≥ 3.1 mm PQFPs > 84 pins, PLCCs (square) MQFPs or PBGAs	**Level 2a**	∞	60	41	33	28	10	7	6	**←30 °C**
		∞	78	53	42	36	14	10	8	**←25 °C**
		∞	103	69	57	47	19	13	10	**←20 °C**
	Level 3	10	9	8	7	7	5	4	4	``
		13	11	10	9	9	7	6	5	
		17	14	13	12	12	10	8	7	
	Level 4	4	4	4	3	3	3	2	2	``
		5	5	5	5	4	3	3	3	
		7	7	7	7	6	5	4	4	
	Level 5	3	3	2	2	2	2	1	1	``
		5	4	4	3	3	2	2	2	
		7	6	5	5	4	3	3	3	
	Level 5a	1	1	1	1	1	1	1	1	``
		2	2	2	2	2	1	1	1	
		4	3	3	3	2	2	2	2	
Body 2.1 mm ≤ Thickness < 3.1 mm PLCCs (rectangular) 18-32 pins SOICs (wide body) SOICs ≥ 20 pins, PQFPs ≤ 80 pins	**Level 2a**	∞	∞	86	39	28	4	3	2	**←30 °C**
		∞	∞	148	51	37	6	4	3	**←25 °C**
		∞	∞	∞	69	49	8	5	4	**←20 °C**
	Level 3	19	12	9	8	7	3	2	2	``
		25	15	12	10	9	5	3	3	
		32	19	15	13	12	7	5	4	
	Level 4	5	4	4	3	3	2	2	1	``
		7	5	5	4	4	3	2	2	
		9	7	6	6	5	4	3	3	
	Level 5	3	3	2	2	2	1	1	1	``
		4	3	3	3	3	2	1	1	
		5	5	4	4	4	3	3	2	
	Level 5a	1	1	1	1	1	1	0.5	0.5	``
		2	2	2	2	2	1	1	1	
		2	2	2	2	2	2	2	1	
Body Thickness < 2.1 mm TSOPs, SOICs < 18 pins TQFPs or TBGA s	**Level 2a**	∞	∞	∞	∞	28	1	1	1	**←30 °C**
		∞	∞	∞	∞	∞	2	1	1	**←25 °C**
		∞	∞	∞	∞	∞	2	2	1	**←20 °C**
	Level 3	∞	∞	∞	11	7	1	1	1	``
		∞	∞	∞	14	10	2	1	1	
		∞	∞	∞	20	13	2	2	1	
	Level 4	∞	9	5	4	3	1	1	1	``
		∞	12	7	5	4	2	1	1	
		∞	17	9	7	6	2	2	1	
	Level 5	13	5	3	2	2	1	1	1	``
		18	6	4	3	3	2	1	1	
		26	8	6	5	4	2	2	1	
	Level 5a	3	2	1	1	1	1	1	0.5	``
		5	3	2	2	2	1	1	1	
		6	4	3	2	2	2	2	1	

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