April 2024

Moisture Sensitivity Technical Note

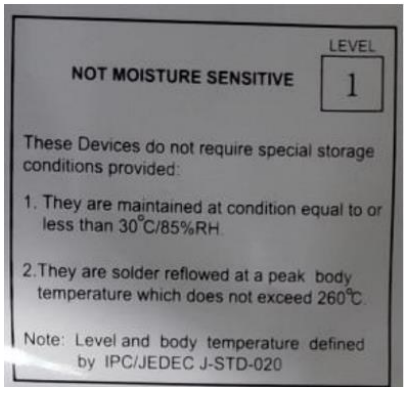
1. Introduction

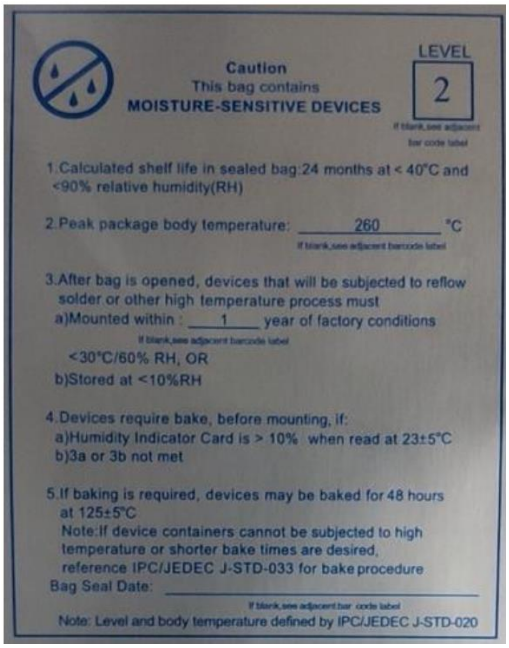
All plastic integrated-circuit packages have a tendency to absorb moisture. During surface-mount assembly, this moisture can vaporize when subjected to the heat associated with solder reflow operations. Vaporization creates internal stresses that can cause the plastic molding compound to crack. This cracking process is commonly referred to as the “popcorn effect.”

Cracks in the plastic molding may cause internal damage or may allow contamination to penetrate to the die, which can reduce the reliability of the semiconductor device.

Since plastic packages absorb moisture, care must be taken to prevent exposure to humid conditions greater than 10% RH for extended periods of time prior to surface mount reflow processing. If exposed to excessive moisture, the devices should be baked to remove moisture prior to solder reflow operations.

All MPS surface mount ICs have a moisture sensitivity level and peak reflow classification. This information is displayed on the reel, MBB and box packing.
The figure below shows an example of the labels.





2. Definition

Dry Pack Dry pack consists of desiccant material and a humidity indicator card (HIC) sealed with the SMD packages inside a moisture barrier bag (MBB).

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

Shelf Life The minimum time that a dry-packed, moisture-sensitive device can be stored in an unopened moisture barrier bag (MBB) such that a specified interior bag ambient humidity is not exceeded.

3. Dry Packing Requirements

a) **Requirements** Dry-packing requirements for the various moisture sensitivity levels are shown in the table.

Table 1: Dry Packing Requirements

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

*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.

b) The floor life of SMDs will be modified by environmental conditions other than 30 °C/60% RH. Please refer to below table.

Table 2 Moisture Classification Level and Floor Life

MSL 1	Floor Life (out of bag) is Unlimited
Other MSL	**Floor Life (out of bag) at factory ambient ≤30 °C/60% 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.

c) **Drying of SMD Devices**

Drying Requirements - Levels 2 - 5a

SMD devices classified at Levels 2 through 5a exceeds floor life may be adequately dried by baking according to Table 3 (for rebake prior to reflow) or Table 4 (for drying prior to dry packing).

Table 3 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 >0.5mm ≤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)
	2a	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 >0.8mm ≤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	2	18 hours	15 hours	63 hours	2 days	25days	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	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 x17 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 IPC/JEDEC J-SDT-033 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 baking time may be longer than that required in Table.

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

Note 1: If baking of packages >4.5 mm thick is required, see appendix B in IPC/JEDEC J-SDT-033

Table 5 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 ºC/85% RH	reset	NA	Table 4.1	Dry Pack after Bake
2, 2a, 3, 4, 5, 5a	> floor life ≤ 30 ºC/60% RH	reset	NA	Table 4.1	Dry Pack after Bake
2, 2a, 3	> 12 hrs ≤ 30 ºC/60% RH	reset	NA	Table 4.1	Dry Pack after Bake
2, 2a, 3	≤ 12 hrs ≤ 30 ºC/60% RH	reset	5X exposure time ≤ 10% RH	NA	NA
2, 2a, 3	Cumulative time < floor life≤ 30 ºC/60% RH	pause	Anytime ≤ 10% RH	NA	NA
4, 5, 5a	> 8 hrs ≤ 30 ºC/60% RH	reset	NA	Table 4.1	Dry Pack after Bake
4, 5, 5a	≤ 8 hrs ≤ 30 ºC/60% RH	reset	10X exposure time ≤ 5% RH	NA	NA

4. Shelf life

MPS warrants the shelf life of its analog IC devices for five (5) years based on production date code, assuming the integrity of the seal has not been compromised during that time period and has been stored in environment of <40°C / 90% RH.

Please see MPS International Ltd. Standard Terms and Conditions for other warranties applied to its products.

5. MPS Recommended IR Reflow Temperature Profile

The profile meets IPC/JEDEC J-STD-020 spec

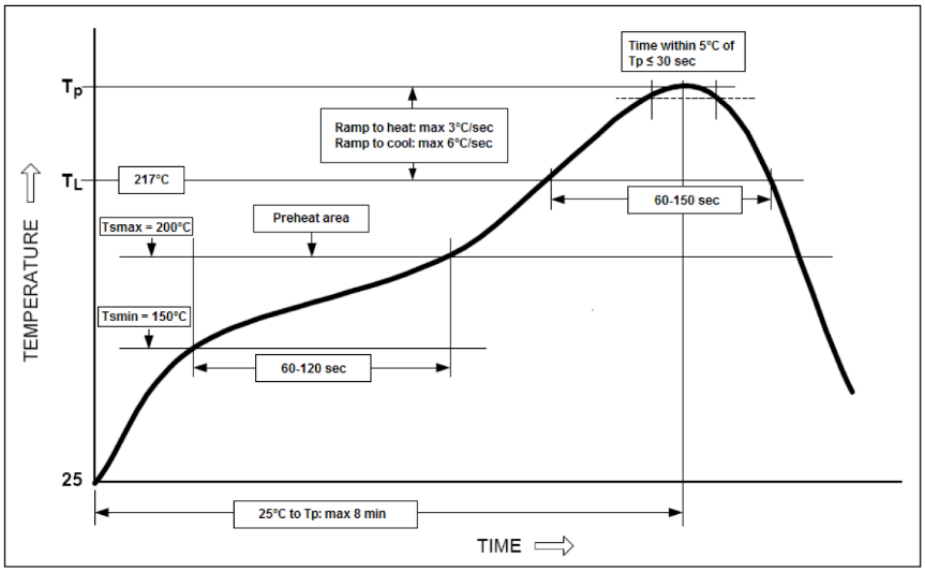


Table: T_P for Pb-Free Process

Package Thickness	Volume mm^3 <350	Volume mm^3 350 - 2000	Volume mm^3 >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

6. Reference Docs

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

IPC/JEDEC J-STD-020E Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices