AN-2029 Handling & Process Recommendations

Application Report

Literature Number: SNOA550B
June 2010–Revised June 2014

Contents

List of Figures

List of Tables

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ABSTRACT

This Application Note provides recommendations for handling, storing and mounting of Texas Instruments' surface mount IC packages.

1 Introduction

This Application Note provides recommendations for handling, storing and mounting of Texas Instrument's surface mount IC packages.

The final manufacturing yield and board level reliability are influenced by various factors and processes outside the control of the IC manufacturer. This Application Note can therefore only be used as a guideline and reference to support our customers. Due to the variety of possible board assembly materials and equipments, Texas Instruments advises the user to consult the individual suppliers and vendors to achieve the optimum board assembly yield.

2 Moisture Sensitivity Level

Due to the hygroscopic nature of the plastic encapsulants, the plastic ICs absorb a certain amount of moisture. When subjecting a SMT device to reflow soldering process (e.g. infrared, convection, vapor phase), the entrapped moisture inside the package can create excessive internal pressure resulting in delamination or even cracked package (popcorn effect).

TI's components that are considered moisture sensitive are sealed in moisture barrier bags (MBB) together with a desiccant and a Humidity Indicator Card (HIC). Texas Instruments generally follows Industry Standards IPC/JEDEC J-STD-020 and J-STD-033 to determine the moisture sensitivity level and corresponding floor life time for TI's plastic package types, for details on absolute maximum ratings for soldering see http://www.ti.com/lit/snoa549

The floor life time is the maximum time period from the opening of the MBB to the final reflow soldering process. The MSL Level and floor life time as per Table 1 is provided on TI's immediate and/or intermediate packing container label. Additionally, the MSL level and the maximum peak package temperature for TI's devices can be found within the Product Folder of TI's website.

Table 1. Moisture Sensitivity Levels (According to IPC-JEDEC J-STD-033B.1 Section 9

MSL Level	Floor Life (out of MBB)	
	Time	Conditions
1	Unlimited (no moisture barrier bag)	≤ 30ºC / 85% RH
2	1 year	≤ 30ºC / 60% RH
2A	4 weeks	≤ 30ºC / 60% RH
3	168 hours	≤ 30ºC / 60% RH
4	72 hours	≤ 30ºC / 60% RH
5	48 hours	≤ 30ºC / 60% RH
5a	24 hours	≤ 30ºC / 60% RH
6	Mandatory bake before use. After bake, must be reflowed within the time limit specified on the label	≤ 30ºC / 60% RH

3 Storage and Shelf Life

Solderability tests were conducted on components after long term storage in warehouse conditions and after exposure to accelerated aging environment. Based upon the results, TI's shelf life of dry-packaged moisture sensitive devices inside the unopened moisture barrier bag is 3 years after original seal date when stored in an environment not exceeding 40ºC / 90% RH. Component storage outside the MBB should be done in a dry storage cabinet at < 25°C and < 10% R.H. to prevent any moisture absorption.

The shelf life with regard to soldering of non dry-packed devices, i.e. MSL1, is 3 years provided the storage environment is controlled at ≤ 30ºC / 85% RH.

Please be aware that e.g. bare die & wafer products have different storage conditions and limitations.

4 Reflow Soldering

The most popular soldering method for surface mount devices is forced convection reflow and therefore the topic of this chapter. Other possible solder processes for surface mount devices are, with restrictions, infrared reflow (IR), vapor phase and wave soldering.

It is not possible for an IC manufacturer to provide a general reflow profile recommendation for the end customer in charge of the board assembly. Reflow furnace settings depend for example on the number of heating/cooling zones, type of solder paste/flux used, board and component size as well as component density.

The actual temperature setting needs to be above the liquidus temperature (solder melting point) of the solder paste in order to form a reliable solder joint, while the upper limit is clearly defined by the maximum peak package body temperature depending on package thickness and volume as provided by IPC /JEDEC J-STD-020, see Table 2 and Table 3

Table 2. Maximum Peak Package Body Temperature Tp (according to IPC-JEDEC J-STD-020D) For Pb-Free Process Section 9

Package Thickness	Volume < 350mm^3	Volume 350-2000mm^3	Volume > 2000mm^3
<1.6 mm	260 °C	260 °C	260 °C
1.6 -2.5 mm	260 °C	250 °C	245 °C
>2.5 mm	250 °C	245 °C	245 °C

Table 3. For SnPb Eutectic Process Section 9

Package Thickness	Volume < 350mm^3	Volume ≥ 350mm^3
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

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

It is important to understand that the temperature profile provided within IPC/JEDEC J-STD-020 reflects the profile used for device (MSL) classification see Figure 1 and Table 4 with the temperature measured on the top package surface during the reflow soldering process.

The actual board assembly reflow furnace settings need to be developed separately depending on furnace characteristics and board design. The selected temperatures should not exceed the parameters used for MSL classification.

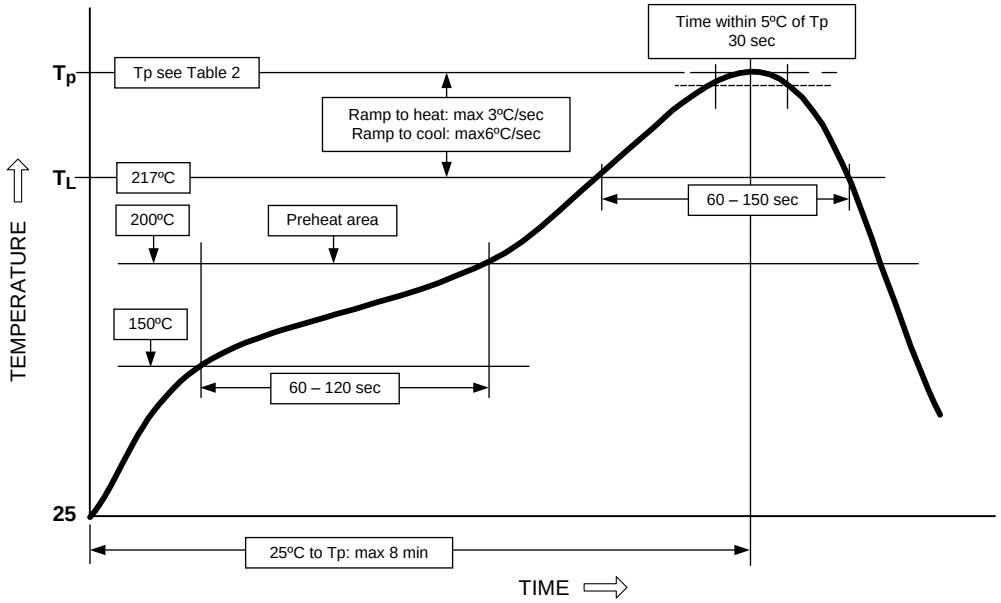

Figure 1. Classification Reflow Profile (peak package body temperature) for Pb-free reflow soldering

Table 4. Classification Reflow Profile Parameters (according to IPC-JEDEC J-STD-020D) Section 9

Profile Parameter	Pb-free Assembly	SnPb Assembly
Preheat Temperature range	150°C – 200°C	100°C – 150°C
Duration	60-120sec	60-120sec
Ramp-up rate	Max 3°C/sec	Max 3°C/sec
Liquidus Temperature T_L and	217°C	183°C
Time above T_L	60-150sec	60-150sec
T_P Peak Package Body Temperature	See Table 2	See Table 3
Dwell time within 5°C of at T_P	Max 30sec	Max 20sec
Ramp-down rate	Max 6°C/sec	Max 6°C/sec

5 Drying of Components

If the Floor Life time is exceeded or the Humidity Indicator Card indicates excessive moisture after opening the MBB (the color change is described on the HIC card, see Figure 2), baking is required prior to the reflow process in order to remove any moisture out of the plastic package.

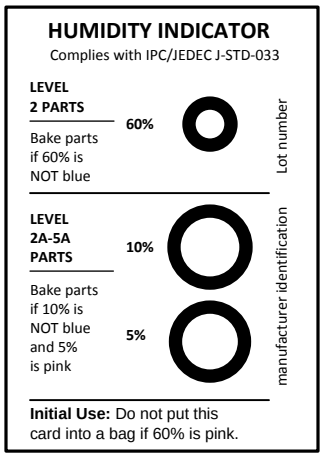

Figure 2. Humidity Indicator Card as per IPC/JEDEC J-STD-033B.1 Section 9

Conditions for drying components depend on package thickness, MSL Level and baking temperature. Table 5 provides an excerpt of IPC/JEDEC J-STD-033B.1 on drying mounted or unmounted SMD packages. Please note that standard packing material such as tape, reel and tubes are considered low temperature carriers and SMD packages may not be baked in these carriers at any temperatures higher than 40° C. Only high temperature trays are able to withstand baking process at 125 ºC.

Table 5. Reference Conditions for Drying Mounted and Unmounted SMD Packages (as per IPC-JEDEC J-STD-033B.1) Section 9

Package Body	Level	Bake @ 125°C		Bake @ 90°C ≤5% RH		Bake @ 40°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 ≤1.4 mm	2	5 hours	3 hours	17 hours	11 hours	8 days	5 days
	2a	7 hours	5 hours	23 hours	13 hours	9 days	7 days
	3	9 hours	7 hours	33 hours	23 hours	13 days	9 days
	4	11 hours	7 hours	37 hours	23 hours	15 days	9 days
Thickness >1.4 mm ≤2.0 mm	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
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

Note: For BGA package types >17x17mm, stacked die packages or packages with thickness > 4.5mm, please contact your local TI sales representative

6 Repair

In case repair or even replacement of a component is needed, it is important that the temperature used for repairing, desoldering or replacing the component, needs to be selected as low as possible to avoid any damage to the adjacent components or PC board. The repair profile should be similar to the actual reflow profile, common rework tools are either hot gun or available rework machines.

In addition, depending on the MSL level of the component and if the floor life time from initial reflow soldering process to the repair process is exceeded, a baking process is required with parameters provided in IPC/JEDEC J-STD-033B.1. Otherwise, the accumulated moisture can cause damage as described in the previous chapters.

Proper handling practices are required to prevent any ESD damages during any handling of the components.

7 Manual Repair Procedure

Definition for repair: To fix missing solder or solder bridging on PCB after SMT for production soldering methods.

Scope: This is applied to all surface mount packages without solder balls attached, and 8 to 20 pin DIP and TO packages.

1. Solder wire with flux core is used for repair.
2. Solder iron temperature setting: <360 ± 10°C.
3. Solder iron should be contacting to the lead.
4. Contact duration: 4 ± 2 seconds per lead x 2 times.
5. The package surface temperature should be less than their peak reflow temperature (245 or 250 or 260°C).
6. Follow shelf life /floor life specification on the moisture bag for SMT instruction.
7. The repaired part should be baked at 125°C for 48 hours or per J-std-033 if the shelf life of the part has exceeded the MSL specification or if it is unknown

8 Manual Rework Procedure

Definition for rework: To remove or replace IC package on PCB after SMT for production soldering methods

Scope: This is applied to all surface mount packages without solder balls attached, and 8 to 20 pin DIP and TO packages.

1. Solder wire with flux core is used for rework
2. Solder iron temperature setting: <360 ± 10°C
3. Solder iron should be contacting to the lead
4. Contact duration: 4 ± 2 seconds per lead x 2 times
5. The package surface temperature should be less than their peak reflow temperature (245 or 250 or 260°C)
6. Follow shelf life /floor life specification on the moisture bag for SMT instruction
7. The rework part and PCB should be baked at 125°C for 48 hours or per J-STD-033 if the shelf life of the part has exceeded the MSL specification or if it is unknown
8. Hot gas rework station should be used for removing and placing package on PCB during rework

   (a) Example: MetCal website for equipment, techniques and procedures.

9 Permissions

Revision History

Changes from A Revision (June 2012) to B Revision **Page**

- Changed National Semiconductor to Texas Instruments 4
- Changed link to http://www.ti.com/lit/snoa549 4
- Added "Manual Repair Procedure" and "Manual Rework Procedure" 8

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