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Automatic assembly recommendations  
 BGA packages  
 Industrial applications  
 (Lead-free and SnPb soldering process)

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## CHANGE RECORD

Ed./Rev.	Date	Approbation	Description	Rédacteurs
3	29/07/14	FS/AV/LLR	<ul style="list-style-type: none"><li>- Graphic standard updated</li><li>- §4 Label updated</li><li>- §4.2. Dry cabinet storage added</li><li>- §5.2. information about solder balls and solder pastes added</li><li>- §6 Sn-Pb reflow profile added</li><li>- §7 Lead-free soldering process peak temperature lowered from 245°C to 235°C</li></ul>	WY

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## 1. SCOPE

This document embodies various recommendations concerning 3D PLUS Modules storage and assembly conditions. **It is only applicable for modules guaranteed by 3D PLUS for automatic reflow, stated in 3D PLUS certificate of conformity (CoC) and/or end item data package (EIDP).**

## 2. DOCUMENTS IN REFERENCE

**RD1** : IPC/JEDEC J-STD-033B Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices

**RD2** : IPC/JEDEC J-STD-020D Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices

## 3. HANDLING

Components manufactured by 3D PLUS must be handled with care. Operators are requested to wear antistatic gloves and antistatic brackets. The use of tools that could damage sides of components is also prohibited.

**Note** : Manual handling may increase the risk of mechanical and/or ESD damage

## 4. STORAGE

### 4.1. BACKGROUND

The vapor pressure of moisture inside a non hermetic 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”.

### 4.2. STORAGE RECOMMENDATIONS

In order to avoid degradation due to humidity, components must be handled according to the following procedure. 3D PLUS recommends to store the modules in dry environment (dry sealed bags, dry cabinet) for a better use of its products.

- **Opened moisture barrier bag**

#### **Dry cabinet storage [RD1] :**

Right after the moisture barrier bag opening, 3D PLUS components can be stored in a dry cabinet at 20°C in dried carriers/ ESD plates (low temperature carrier excluded). According to the relative humidity (RH) level in the cabinet, 3D PLUS modules should be baked on a regular basis at 125°C, during 24 hours, then put back in the cabinet. For example, for a ≤20% RH cabinet, at 20°C, modules should be baked every 17 days. The cycle can be repeated as long as needed. Under 10% RH, 3D PLUS modules can be stored indefinitely.

RH %	≤ 5%	≤ 10%	≤ 20%
<b>Bake frequency (days) 24 hrs @ 125°C</b>	∞	∞	17

**Long duration exposure (≤ 30days)** : Components which have been exposed only to ambient conditions of 60% RH for a maximum of 30 days may be adequately dried by high temperature baking at 125°C during 24 hours for re-bake prior to reflow or storage in dry cabinet (see above), or at 125°C during 48 hours for drying prior to dry packing. Beyond 30 days, a minimum of 48-hour bake at 125°C is mandatory.

**Short duration exposure (≤ 30 minutes)** : Components, which have only been exposed to ambient conditions below 30°C / 60% RH, and for 30 minutes or less, may be resealed with the original dessicant bag without any drying treatment.

- **Unopened moisture barrier bag**

The calculated shelf life for dry sealed packed components is 12 months from the pack seal date, when stored in a non-condensing atmospheric environment of < 40°C and < 90% RH. Beyond this period, the reconditioning is mandatory; modules shall be baked at 125°C during 48 hours.

- **Baking at 90°C**

If baking at 125°C is not possible, 3D PLUS modules can be baked at 90°C for a longer time. Below a comparative table of baking duration according to the oven temperature.

Baking at 125 °C	Baking at 90°C
24 hours	5 days
48 hours	10 days

**Time equivalence table**

**Note :**

High temperature carriers : Unless otherwise indicated by 3D PLUS, modules shipped in high temperature trays can be baked in the trays at 125°C (see annex 1).

Low temperature carriers : Modules shipped in low temperature carriers (e.g. plastic box, low temperature trays, tape and reel,...) may not be baked in the carriers at any temperature higher than 40°C or stored in a dry cabinet. If a higher bake temperature is required, modules must be removed from the low temperature carriers to thermally safe carriers, baked, then returned to the low temperature carriers (see annex 1).

Labelling : A specific label that details the recommendations is stamped on the sealed bag, see below.



**Automatic soldering label for plastic boxes / Tray**

## 5. ASSEMBLY RECOMMENDATIONS

### 5.1. ASSEMBLY PROCESS

After sealed bag opening, within the 12-month limit, 3D PLUS modules may be soldered right away. However, if the humidity indicator card is > 10% when read at 23°C +/-5°C, modules should be baked 48 hours at 125°C +/-5°C.

The maximum storage duration under environmental conditions  $\leq 30^{\circ}\text{C}$  and  $< 60\% \text{ RH}$  is 168 hours. Beyond 168 hours, a new 24-hour bake at 125°C has to be performed on modules.

**Mass reflow** : This recommendation 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 component bodies in molten solder (e.g., wave soldering bottom mounted components).

**Multiple reflow passes** : if more than one reflow pass is used, care must be taken to ensure that modules, mounted or un-mounted, have **not** exceeded their floor life prior to the final pass. If any module on the board has exceeded its floor life, the board needs to be baked prior to the next reflow.

### 5.2. BGA PACKAGES

**The use of scotch tape (e.g. Kapton) on the side of the module during assembly is prohibited.**

A wide range of tin-lead solder paste is available in the industry. The solder alloy selected should be non-hazardous, mechanically reliable, thermal fatigue resistant, good wetting, and must be compatible with a variety of lead-bearing and surface coatings.

3D PLUS recommends solder paste Sn(63)Pb(37) with melting point at +183°C (eutectic point) for SnPb soldering process or Sn(96.5)Ag(3)Cu(0.5) with melting point at +217 to +219°C for lead free soldering process.

The solder ball alloy of Modules is most of the time either Sn(63)Pb(37) or Sn(96.5)Ag(3)Cu(0.5) (SAC305) according to customers requirements. Sn(10)Pb(90) balls with melting point at 290°C are used on some products. Unlike the two first ones, these solder balls are not supposed to melt down during reflow process.

Lead-free modules should be mounted preferentially with lead-free solder paste (SAC 305). Modules with SnPb solder balls should be mounted exclusively with Sn(63)Pb(37) solder paste.

The temperature profile of the equipment must be defined so that the temperature, measured on body module, is below 235°C. If the profile exceeds the time-temperature limitations beyond the scope of this specification, 3D PLUS should be consulted.

## 6. **SNPB** PROCESS REFLOW PROFILE SPECIFICATIONS

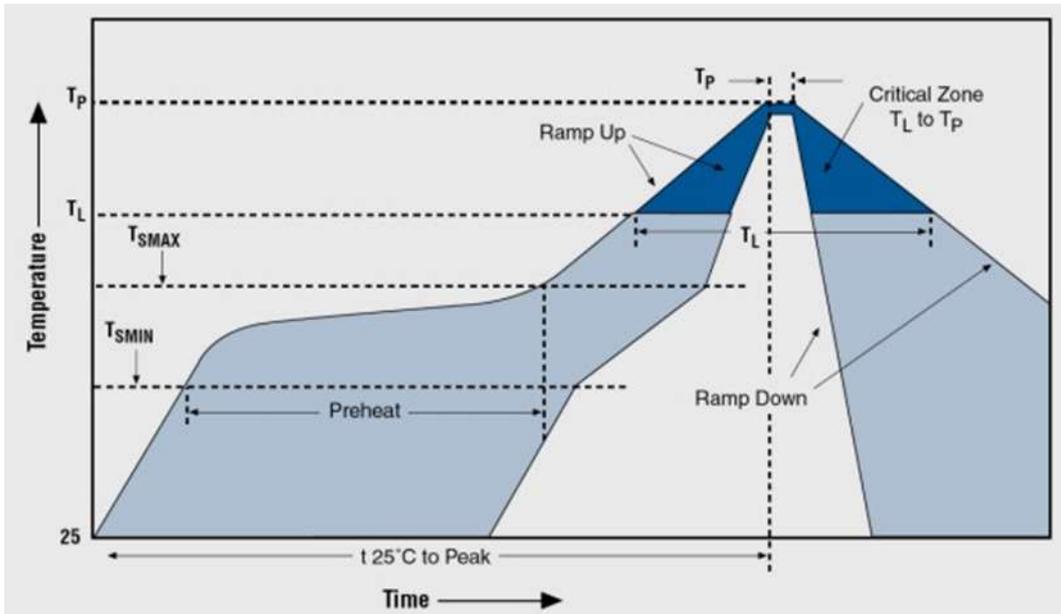
The characterization and optimization of the reflow process is the most important factor to be considered for tin-lead soldering. The reflow process window (RPW) for conventional soldering is relatively wide. The melting point of the eutectic solder alloy is 183°C. The lower temperature limit for reflow is usually 200°C. The upper limit is **220°C\*** as recommended in **[RD2]**. These high and low temperature limits provide a **comfortable** process window of **20°C**.

*\*The maximum temperature that body package can be exposed to is 235°C.*

**Note :**

The major factors contributing to the development of an optimal thermal profile are the size and weight of the assembly, the density of the components, the mix of large and small components and the solder paste chemistry being used. The reflow profiling should be performed by attaching calibrated thermocouples embedded in the spheres of the BGA modules as well as other critical locations on the boards to ensure that all components are heated to temperatures above minimum reflow temperatures and that modules do not exceed maximum temperature limits.

The reflow profiles studied and recommended by 3D PLUS are based on experiences to ensure that all packages can be successfully and reliably assembled. Figure 1 shows the range of temperature profiles and Table 1 lists the reflow parameters and peak temperatures as recommended by 3D PLUS.



**Figure 1 : Sn-Pb Reflow profile**

Reflow parameter	Sn-Pb Eutectic Assembly
Minimum preheat temperature ( $T_{S_{MIN}}$ )	100°C
Maximum preheat temperature ( $T_{S_{MAX}}$ )	150°C
Preheat Time	60 to 120 seconds
$T_{S_{MAX}}$ to $T_L$ ramp-up rate	3°C/second maximum
Time above temperature $T_L = 183^\circ\text{C}$ ( $t_L$ )	60 – 90 seconds
Peak temperature	<b>220 °C maximum*</b>
Time 25°C to $T_P$	6 minutes maximum
Time within 5°C of peak $T_P$	10 – 30 seconds
Ramp-down rate	6°C/second maximum

**Table 1: Sn-Pb reflow profile recommendation**

*\*The maximum temperature that body package can be exposed to is 235°C.*

## 7. LEAD-FREE PROCESS REFLOW PROFILE SPECIFICATIONS

The melting point of the SAC 305 solder alloy is 217°C. The upper temperature limit is 235°C, which is the maximum temperature that body package can be exposed to.

**Note :**

The major factors contributing to the development of an optimal thermal profile are the size and weight of the assembly, the density of the components, the mix of large and small components and the solder paste chemistry being used. The reflow profiling should be performed by attaching calibrated thermocouples embedded in the spheres of the BGA modules as well as other critical locations on the boards to ensure that all components are heated to temperatures above minimum reflow temperatures and that modules do not exceed maximum temperature limits.

The reflow profiles studied and recommended by 3D PLUS are based on experiences to ensure that all packages can be successfully and reliably assembled. Figure 2 shows the range of temperature profiles and Table 12 lists the reflow parameters and peak temperatures as recommended by 3D PLUS.

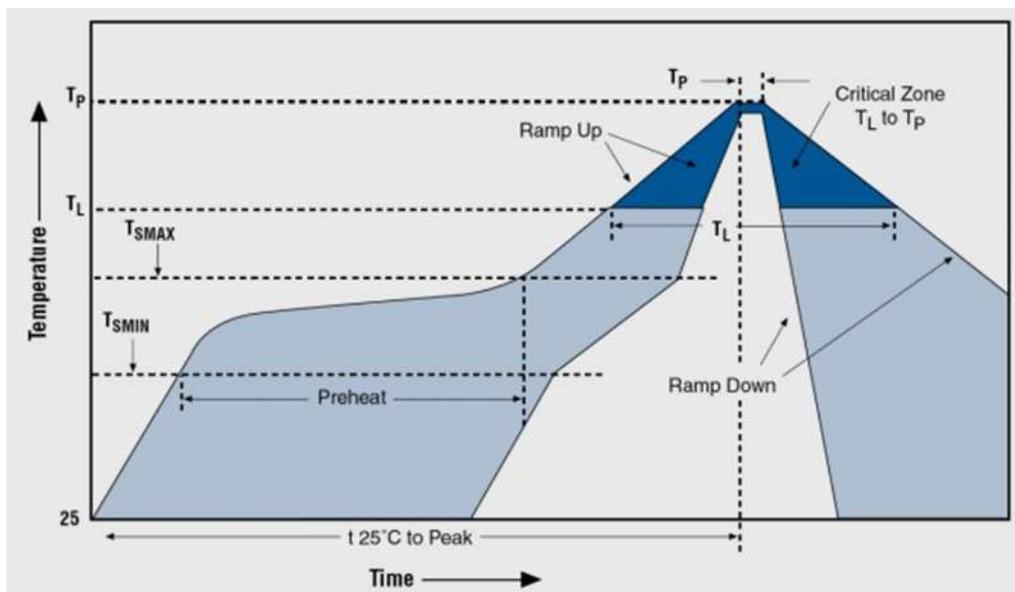


Figure 2 : Lead-free reflow profile

Reflow parameter	Lead-free assembly
Minimum preheat temperature ( $T_{SMIN}$ )	150°C
Maximum preheat temperature ( $T_{SMAX}$ )	200°C
Preheat Time	60 to 120 seconds
$T_{SMAX}$ to $T_L$ ramp-up rate	3°C/second maximum
Time above temperature $T_L = 217^\circ\text{C}$ ( $t_L$ )	60 – 90 seconds
Peak temperature	235°C maximum*
Time 25°C to $T_P$	6 minutes maximum
Time within 5°C of peak $T_P$	10 – 30 seconds
Ramp-down rate	6°C/second maximum

Table 2: Lead-free reflow profile recommendation

\*The maximum temperature that body package can be exposed to is 235°C.

8. ANNEX : HIGH TEMPERATURE CARRIER DESCRIPTION



Plastic tray for modules



Maximum temperature for baking, marked on tray