### Automatic assembly recommendations

**BGA Modules**

with Sn10Pb90 solder balls
(SnPb soldering process)

**3300-8283-2**

<table>
<thead>
<tr>
<th>Written by</th>
<th>Responsibility</th>
<th>Date</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>William Ye</td>
<td>Process Engineering Engineer</td>
<td>03/29/2016</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Verified by</th>
<th>Responsibility</th>
<th>Date</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabrice Soufflet</td>
<td>Process Engineering Manager</td>
<td>03/29/2016</td>
<td></td>
</tr>
<tr>
<td>Alexandre Val</td>
<td>ADELES Program Manager</td>
<td>03/29/2016</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Approved by</th>
<th>Responsibility</th>
<th>Date</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loïc Le Roy</td>
<td>Quality Director</td>
<td>03/29/2016</td>
<td></td>
</tr>
<tr>
<td>Marie-Cécile Vassal</td>
<td>Project Group Manager</td>
<td>03/29/2016</td>
<td></td>
</tr>
</tbody>
</table>

### Creation date: 01/19/2016
---

**Language**

- Non protected
- 3D PLUS Confidential
- Customer Confidential

**Classification: Non protected**

|----------------------|
| Page 1/16

---

*This document is 3D PLUS property, it cannot be used by or communicated to third parties without written authorization*
This recommendation is now applicable to all 3D PLUS BGA Modules with Sn10Pb90 solder balls
- §8 : reflow profile parameters updated : process window enlarged to adapt itself to all 3D PLUS BGA modules.
- §9 : “For space applications, please use a new module instead” sentence added.
- §10 : Mechanical reinforcement recommendations are available on 3D PLUS website or on demand.
- §12.2. Mechanical reinforcement recommendations removed from annex.
TABLE OF CONTENT

1. Scope ........................................................................................................................................... 4
2. Documents in reference .................................................................................................................. 4
3. 3D PLUS modules storage/assembly flowchart ........................................................................... 4
4. Handling .......................................................................................................................................... 5
5. Storage ............................................................................................................................................ 5
   5.1. Background .............................................................................................................................. 5
   5.2. Storage Recommendations ....................................................................................................... 5
       5.2.1. Module storage preparation recommendations ............................................................... 5
       5.2.2. Module storage recommendations .................................................................................... 6
       5.2.3. About 3D PLUS modules packaging .............................................................................. 7
6. Assembly recommendations .......................................................................................................... 8
   6.1. Assembly process ..................................................................................................................... 8
   6.2. BGA Packages ......................................................................................................................... 8
7. Reflow profile specifications ......................................................................................................... 9
8. Vapor phase reflow profile recommendations ........................................................................... 10
9. Module rework recommendations ............................................................................................... 11
   9.1. Module removal ....................................................................................................................... 11
   9.2. Module rework/replacement .................................................................................................. 12
10. Module reinforcement recommendations ...................................................................................... 13
11. Module Coating recommendations .............................................................................................. 15
   12.1. High temperature carrier description .................................................................................. 16
   12.2. Low temperature carrier description ................................................................................... 16

TABLES AND FIGURES

Figure 1 : 3D PLUS modules storage/assembly flowchart ................................................................. 4
Figure 2 : Automatic soldering label for trays .................................................................................... 7
Figure 3 : Automatic soldering label for plastic boxes .................................................................... 7
Figure 4 : Vapor phase soldering profile .......................................................................................... 10
Figure 5 : Staking on module's small sides ....................................................................................... 13
Figure 6 : Clamping of the module .................................................................................................. 13
Figure 7 : Three-dot underfill through PCB ..................................................................................... 13
Figure 8 : Epoxy Adhesive Reinforcements on module sides ............................................................. 14
Figure 9 : Mini-tray for modules ....................................................................................................... 16
Figure 10 : Plastic box for modules ................................................................................................ 16

Table 1 : Time equivalence table ...................................................................................................... 6
Table 2 : Bake frequency for dry cabinet storage .............................................................................. 6
Table 3 : Sn-Pb reflow profile recommendations .............................................................................. 10
1. **Scope**

This document embodies various recommendations concerning 3D PLUS Modules storage and assembly conditions.

Furthermore, this recommendation is specific to 3D PLUS BGA modules with Sn10Pb90 solder balls, for a SnPb soldering process.

2. **Documents in Reference**

RD1 : IPC/JEDEC J-STD-033B.1 Handling, packing, shipping and use of moisture/reflow sensitive surface mount devices

RD2 : 3641-0842 Mechanical reinforcement of a BGA module

3. **3D PLUS Modules Storage/Assembly Flowchart**

![Flowchart](image)

**Figure 1 : 3D PLUS modules storage/assembly flowchart**
4. **Handling**

Components manufactured by 3D PLUS must be handled with care. Operators are requested to wear antistatic gloves and wrist straps.

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.

5. **Storage**

5.1. **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”.

5.2. **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.

5.2.1. **Module Storage Preparation Recommendations**

Before any storage operation, 3D PLUS modules must be dry. According to the duration of exposure to ambient conditions (30°C/60% RH), different durations of bake should be performed.

- **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, or stored in a dry cabinet.
- **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, or at 125°C during 48 hours for drying prior to dry packing.
- **For longer duration exposure (> 30days)**, a bake for a minimum duration of 48 hours at 125°C is mandatory.
• **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.

<table>
<thead>
<tr>
<th>Baking at 125 °C</th>
<th>Baking at 90°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 hours</td>
<td>5 days</td>
</tr>
<tr>
<td>48 hours</td>
<td>10 days</td>
</tr>
</tbody>
</table>

*Table 1: Time equivalence table*

5.2.2. **Module storage recommendations**

After drying up the modules, one can choose to store them either in a dry cabinet or to seal them in a moisture barrier bag with a dessicant bag.

• **Dry cabinet storage**:

Right after the moisture barrier bag opening, 3D PLUS components can be stored in a dry cabinet at 20°C in dryed 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 ≤10% RH cabinet, at 20°C, modules should be baked every 5 days. The cycle can be repeated as long as needed. Under 5% RH, 3D PLUS modules can be stored indefinitely.

<table>
<thead>
<tr>
<th>RH %</th>
<th>≤ 5%</th>
<th>≤ 10%</th>
<th>≤ 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bake frequency (days)</td>
<td>∞</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>24 hrs @ 125°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 2: Bake frequency for dry cabinet storage*

• **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.
5.2.3. ABOUT 3D PLUS MODULES PACKAGING

High temperature carriers: Unless indicated otherwise 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.

---

**Figure 2**: Automatic soldering label for trays

---

**Figure 3**: Automatic soldering label for plastic boxes

---
6. **ASSEMBLY RECOMMENDATIONS**

6.1. **ASSEMBLY PROCESS**

After sealed bag opening, 3D PLUS modules have to be baked 24 hours at 125°C. If taken out from a dry cabinet within their storage cycle (see 4.2. Storage Recommendations: dry cabinet storage section), 3D PLUS modules may be soldered right away.

The maximum storage duration under environmental conditions ≤ 30°C and < 60% RH is 6 hours. Beyond 6 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 vapor phase (VPR), processes.

**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.

**Module cleaning after assembly**: must be done with isopropyl alcohol preferentially, or with de-ionized water otherwise. For other cleaning products, please consult 3D PLUS for further information.

6.2. **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) or Sn(62)Pb(36)Ag(2) with melting point at +179/183°C.

The solder ball alloy of modules is Sn(10)Pb(90) with melting point at 290°C; the solder balls are not supposed to melt during reflow process.

The temperature profile of the equipment must be defined so that the temperature, measured on body module, is below 215°C. If the profile exceeds the time-temperature limitations beyond the scope of this specification, 3D PLUS should be consulted.

The recommended stencil parameters are: thickness = 200 µm, aperture = 800 µm, material = stainless steel.
7. **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 215°C, which is the maximum temperature that body package can be exposed to.

These high and low temperature limits provide a process window of 15°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 solder balls of the BGA modules as well as in other critical locations on the boards to ensure that all the components are heated to temperatures above minimum reflow temperatures and that the modules do not exceed their maximum temperature limit.
8. **Vapor Phase Reflow Profile Recommendations**

Only vapor phase process has been tested for the assembly of **3D PLUS** BGA Module.

The reflow profiles studied and recommended by 3D PLUS are based on real tests to ensure that all packages can be successfully and reliably assembled. Figure 4 shows the range of temperature profiles and Table 2 lists the reflow parameters and peak temperatures as recommended by 3D PLUS.

![Vapor phase soldering profile](image)

**Figure 4: Vapor phase soldering profile**

<table>
<thead>
<tr>
<th>Reflow parameter</th>
<th>Sn-Pb Eutectic Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum preheat temperature ($T_{SMIN}$)</td>
<td>100°C</td>
</tr>
<tr>
<td>Maximum preheat temperature ($T_{SMAX}$)</td>
<td>150°C</td>
</tr>
<tr>
<td>Preheat Time</td>
<td>60 – 120 seconds</td>
</tr>
<tr>
<td>$T_{SMAX}$ to $T_L$ ramp-up rate</td>
<td>3°C/second maximum</td>
</tr>
<tr>
<td>Time above temperature $T_L = 183°C$ ($t_L$)</td>
<td>45 – 90 seconds</td>
</tr>
<tr>
<td>Body package peak temperature</td>
<td>215°C maximum</td>
</tr>
<tr>
<td>Time 25°C to $T_P$</td>
<td>6 minutes maximum</td>
</tr>
<tr>
<td>Time within 5°C of peak $T_P$</td>
<td>10 – 30 seconds</td>
</tr>
<tr>
<td>Ramp-down rate</td>
<td>6°C/second maximum</td>
</tr>
</tbody>
</table>

**Table 3: Sn-Pb reflow profile recommendations**
9. **Module replacement recommendations**

The replacement process for 3D PLUS BGA modules typically consists of the following steps:

- Thermal pre-heating depending on board structure
- Removal of the module
- Removal of the solder balls
- Cleaning of the area
- Automatic reflow assembly of a new component: solder paste screenprint on board and reflow
- Post-reflow inspection (X-ray and visual inspection)

3D PLUS modules must be dry before any removal operations and should be baked 24-48 hours at 125°C (See §5.2.1).

9.1. **Module removal**

There are several possible ways in order to remove a BGA module: ZEVAC rework station, reflow oven,…

The recommended removal method is with a reflow oven, in order to minimize thermal stresses on the components. The board should be placed in the oven so that the modules will eventually fall by gravity when they reach the solder alloy liquidus temperature (183°C). Our customers should apply the same reflow profiles as for assembly (See §8).

The remaining balls should be removed manually with a soldering iron at 280°C, with a maximum duration of 4s per ball.

After ball removal, each pad should be individually cleaned with the soldering iron and desoldering braid to remove excess of solder alloy, then cleaned with solvent.

For these steps the flux recommended is: Pure Rosin Flux (ROL 0); solvent: Isopropyl Alcohol.
9.2. **MODULE REPLACEMENT**

After cleaning the pads, a new module may be re-soldered on the board according to the reflow guidelines (§8).

The replacing module should be baked prior to reflow if they have been exposed to moisture (see §5 of this document).

It is good practice to clean the solder balls before reflow in order to remove potential metal oxides.

Module cleaning after assembly must be done with isopropyl alcohol preferentially, or with de-ionized water otherwise. For other cleaning products, please consult 3D PLUS for further information.

9.3. **MODULE REWORK**

**Note**: 3D PLUS does not guarantee the electrical performances of its reworked modules if their body temperature exceed 215°C during the removal process.

A reworked module should not be used for space applications. **For space applications, please use a new module instead.**

3D PLUS should be notified of any rework operations, in order to guarantee their results.

After cleaning the pads of the removed module, it may be reballed with Sn63Pb37 solder paste and Sn10Pb 90 solder balls (diameter = 0.762mm) according to 3D PLUS reflow profile recommendations (See §8). Before assembly, reworked modules should be retested at 3D PLUS factory to guarantee their performances.
10. **Module Reinforcement Recommendations**

To guarantee a high level of mechanical requirements (vibrations, constant accelerations, and shocks), mechanical reinforcement may be added on the module.

Several kinds of mechanical reinforcement are presented below:

- **Figure 5**: Staking on module’s small sides

- **Figure 6**: Clamping of the module

- **Figure 7**: Three-dot underfill through PCB
3D PLUS recommends to use 4 points of epoxy adhesive, one at each corner of the module, on the smaller sides of the module, as shown below. 3D PLUS recommends the use of Emerson & Cuming Eccobond® 285 epoxy paste adhesive, with Catalyst 11.

Adhesive shall be in contact neither with the solder balls under the module nor with the module active zones on the sides of the module. Active zones are the plated areas of a module delimited with laser kerfs.

For further information about the staking process, please refer to [RD2].

This document is available in 3D PLUS website or on demand.

Figure 8: Epoxy Adhesive Reinforcements on module sides
11. **Module Coating Recommendations**

Upon customer request, modules may be delivered coated with MAPSIL 213B, SOLITHANE 113 or ARATHANE 5750. In that case, customers must check the compatibility of module coating products with their products.

Note that ARATHANE 5750 is not covered by 3D PLUS Process Identification Document.
12. ANNEX : CARRIER DESCRIPTION

12.1. HIGH TEMPERATURE CARRIER DESCRIPTION

Figure 9: Mini-tray for modules

12.2. LOW TEMPERATURE CARRIER DESCRIPTION

Figure 10: Plastic box for modules