

# How to Store, Reflow and Solder onsemi Hybrids

## AND8493/D

### REFLOW INTRODUCTION

#### Storage and Shelf Life

Devices are classified according to their Moisture Sensitivity Level (MSL). There are several different MSL levels. Each vary in the maximum allowable time they can be exposed to ambient conditions. Some common MSL levels and room air exposure times are illustrated in Table 1. Typical moisture sensitive devices include: reflowable hybrids and any component packaged in a bag labelled as containing moisture sensitive devices. The moisture sensitivity level will be indicated on the product packaging.

**Table 1. TIME ALLOWED IN LAB ATMOSPHERE FOR VARIOUS MSL LEVELS (<30°C, <60% RH) \*Refer to J-STD-033 for more detail.**

| MSL Level | Time Allowed in Lab Atmosphere |
|-----------|--------------------------------|
| 2A        | 4 weeks                        |
| 3         | 168 hours                      |
| 4         | 72 hours                       |

#### General Handling and Storage Precautions

- All moisture sensitive components must be kept in a nitrogen storage area\* and/or in a sealed Moisture Barrier Bag (MBB) containing a Humidity Indicator Card\*\* when not in use.
- Once the MBB has been opened, the parts need to be reflowed onto product, as specified, within the allowed time.
- Any remaining exposed parts must be dry baked for a minimum of 16 hours at 125°C ±5°C before storage again in MBB, unless otherwise noted in the datasheet.
- Hybrid parts stored and handled in this manner will maintain a shelf life that exceeds 6 years.

#### Reflow

onsemi's SIP modules are laminate based hybrids housing integrated circuits, and discrete components. The package may use flip chip technology, wire bond technology and surface mount technology to connect various devices to a board. The hybrid inputs and output pad are SAC305 solder bumped on copper pads, with the typical spacing between adjacent input/output pads of 0.25 mm (10 mil).

onsemi's hybrid circuits that can be reflowed on to alumina, flex and FR4 materials use conventional reflow methods. The following information is to provide assistance to design and production personnel in the attachment of hybrid packages onto printed circuit boards or alumina substrates.

#### HYBRID CONFIGURATION

\* Materials not sealed in a moisture barrier bag must be kept in a dry nitrogen cabinet under the following conditions:

- Temperature: 25 ±5°C
- Relative Humidity: less than 10% RH

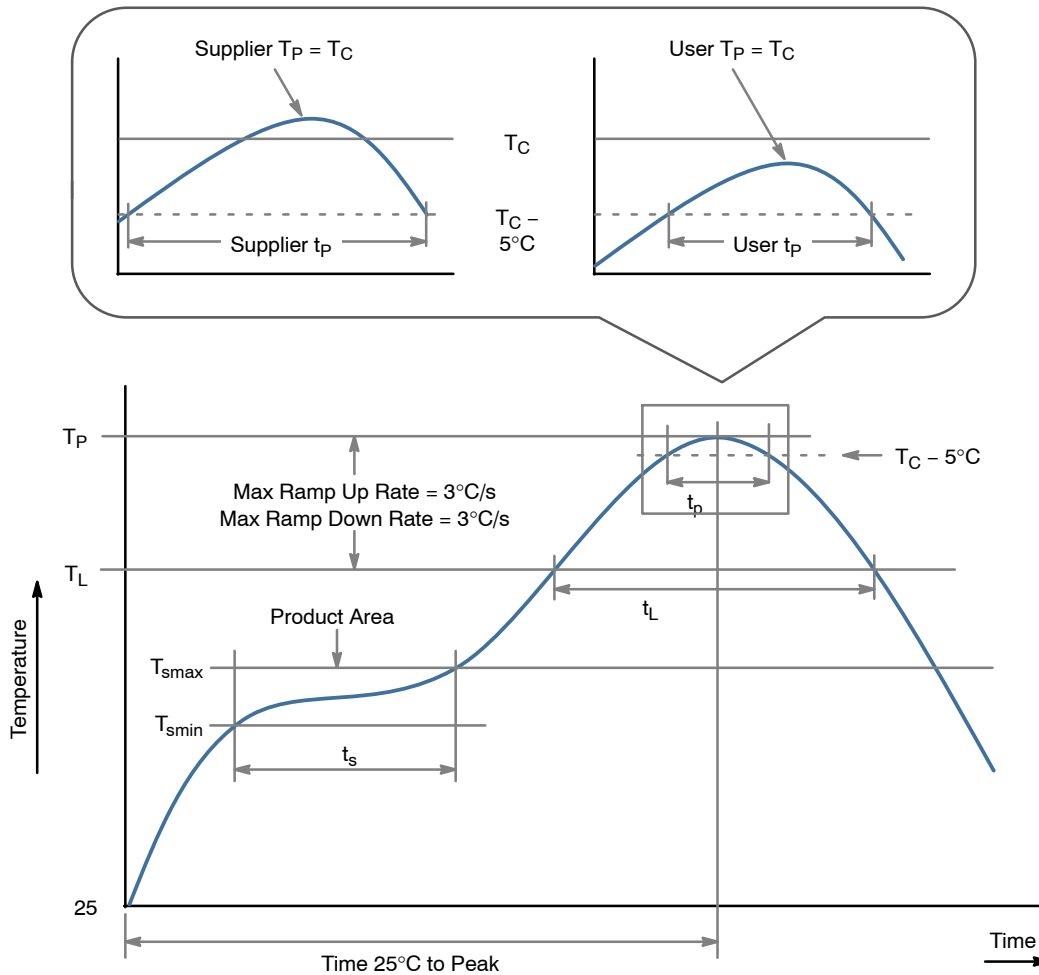
\*\* When removing components from a MBB, immediately evaluate the colours of the dots. If the 10% relative humidity dot is not blue, this is an indication that the parts have been exposed to an uncontrolled environment.

**WARNING: THE ROOM ENVIRONMENT CAN CHANGE THE COLOUR OF THIS LABEL. IT IS IMPORTANT TO VERIFY THE COLOUR IMMEDIATELY UPON OPENING THE PACKAGE.**

#### (RoHS Compliant SIP Modules – Hybrids)

All SIP modules (Hybrids) are RoHS compliant with copper pads tinned with the SAC305, (96.5 Sn/3.0 Ag/0.5 Cu) solder alloy. The height of the solder above the copper pad is typically 0.100 mm (4 mil).

Unless otherwise stated in the product datasheet, the maximum reflow temperature of the assembly must not exceed 260°C as measured on the top of the device package according to IPC/JDEC J-STD-020.



| Profile Feature  | Sn-Pb Eutectic Assembly          | Pb-Free Assembly                 |
|--|----------------------------------|----------------------------------|
| Preheat/Soak<br>Temperature Min ( $T_{smin}$ )<br>Temperature Max ( $T_{smax}$ )<br>Time ( $t_s$ ) from ( $T_{smin}$ to $T_{smax}$ ) | 100°C<br>150°C<br>60-120 seconds | 150°C<br>200°C<br>60-120 seconds |
| Ramp-up Rate ( $T_L$ to $T_P$ )  | 3°C/second max.                  | 3°C/second max.                  |
| Liquidous Temperature ( $T_L$ )<br>Time ( $t_L$ ) Maintained above $T_L$   | 183°C<br>60-150 seconds          | 217°C<br>60-150 seconds          |
| Time ( $t_p$ )* within 5°C of the Specified Classification Temperature ( $T_C$ )**, see Reflow Soldering Profile above               | 20* seconds                      | 30* seconds                      |
| Ramp-down Rate ( $T_P$ to $T_L$ )  | 6°C/second max.                  | 6°C/second max.                  |
| Time 25°C to Peak Temperature  | 6 minutes max.                   | 8 minutes max.                   |

\*Tolerance for peak profile temperature ( $T_P$ ) is defined as a supplier minimum and a user maximum.

Figure 1. RoHS Compliant Hybrids

NOTE: It is recommended to refer to the product datasheet for MSL rating verification and peak reflow temperature rating. MSL classification was designed for reflow operation and it is good practice to follow the recommendations for point-to-point hand soldering as well.

Please note that every hybrid has an integrated circuit under the encapsulation, therefore ESD precautions should be taken at all times.

## SUGGESTED ATTACHMENT LAND GEOMETRY FOR HYBRID

### Packaged Devices

The recommended land size to which the hybrid package is to be reflowed, is 0.05 mm (2 mil) shorter per axis. For example, 0.5 x 0.5 mm (20 x 20 mil) pad on the hybrid should be reflowed on to a 0.45 x 0.45 mm (18 x 18 mil) pad on the carrier board. Carrier board lands larger than the size of hybrid I/O pads should be avoided. Refer to Figure 2 for optimal joint geometry.

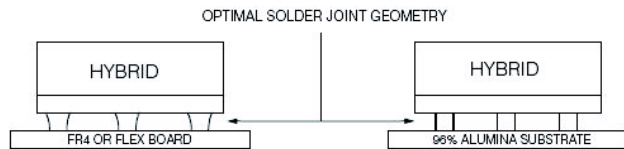


Figure 2. Solder Joint Geometry

### Suggested Stencil Design

The stencil apertures should be same size as the land sizes on the carrier board. Because of the fine pitch of the I/O pads on hybrids – typical 0.25 mm (10 mil) space between two pads – it is recommended that a metal stencil be used instead of a wire mesh screen. The stencil should be 0.15 mm (4 mil) thick, with the pattern obtained by a chemical etching or a laser machining process. If chemical etching is used the stencil should be etched from both sides.

### Solder Application Equipment

Several solder deposition methods are used by the industry to transfer solder onto board lands. One of the most common methods is a stencil to print solder onto carrier lands. It is recommended that the solder should be applied to the carrier board using a solder printer with controlled process parameters. A 90 durometer or harder squeegee should be used to ensure proper print resolution and deposited solder thickness. Adequate board-holding tooling should be used to ensure that an even thickness of solder paste is deposited throughout the printed area. Unsupported areas normally print thick and are therefore prone to solder bridges and other solder joint defects.

### Solder Printing Using Semiautomatic Screen Printer

To proceed with the solder printing cycle, the operator places the carrier board on the board holding tooling. Vacuum is recommended to hold the board on the carriage. The operator starts the print cycle and prints a substrate. After the print cycle, the printed board is inspected for printed solder paste defects. It is recommended to check the solder paste thickness periodically to ensure uniform process yield. The board is now ready for placement of the surface mount components and hybrid devices.

### Solder Reflow

The hybrid can be easily soldered to the board using industry standard solder reflow techniques. The typical minimum and maximum temperature profiles used to reflow **onsemi** hybrids is illustrated in Figure 1 for RoHS compliant hybrids. The hybrids reflow well with RMA or no-clean fluxes in air and inert (N<sub>2</sub>) atmospheres. The finish on Cu landing pads evaluated at **onsemi** for RoHS compliant hybrids was ENIG (Electroless Nickel Immersion Au).

### Recommended Steps in Assembly

#### Step 1: Solder Paste Application

Solder paste is deposited onto the board using a stencil and semiautomatic solder printer. Important variables include the following:

- Age of solder paste
- Time between solder paste application and reflow
- Deposited solder registration accuracy and consistency of solder paste thickness during printing process

It is recommended that the maximum misregistration of solder paste to the land on the board in X or Y direction should not be more than 0.05 mm (see Figure 3). A solder paste thickness of 125 to 175 μm is recommended.

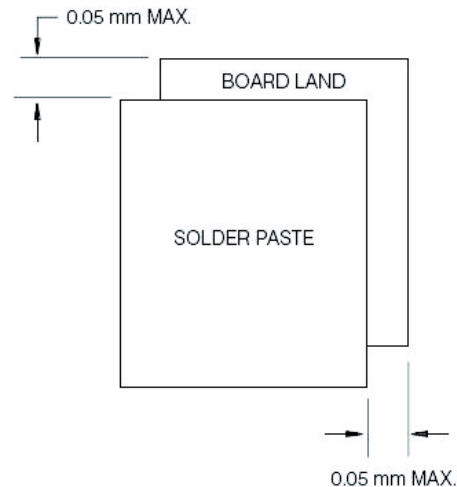


Figure 3. Solder Paste Application

#### Step 2: Hybrid Placement

For prototype applications or low volume applications, hybrids can be placed using tweezers. Alignment fiducials should be designed on the carrier board to assist in accurately placing hybrids. Refer to Figure 4 for reference fiducials' locations enabling easy and accurate placement of the device over the board lands. It is best to bring the device over the application area, then descend vertically in one movement to avoid smearing the solder paste. Make sure the

hybrid aligns to at least two corner fiducials. It is important to precisely position the device over the contact lands.

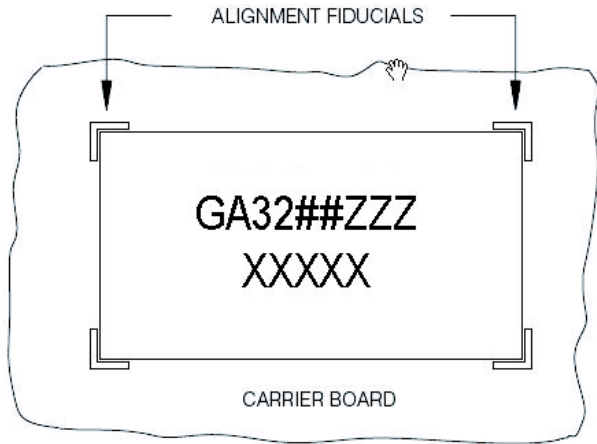


Figure 4. Alignment of Fiducials

For high volume production, a pick and place machine should be used. The pick and place machine should have vision capability with two attributes:

- Board error correction
- Hybrid pads to board land alignment capability

Adequate placement force should be applied to the hybrid device so that all the device pads contact the solder on the board lands. Excessive placement force will displace the wet solder under the device thus increasing the probability of solder bridging during reflow. Excellent results have been achieved using 10 g of placement force. It is important that the hybrid pads be aligned to the board land, rather than the deposited solder paste, to avoid cumulative placement error.

As shown in Figure 5, alignment tolerances must be sufficient to guarantee a maximum of 0.1 mm (4 mils) misalignment between hybrid pad and the board land.

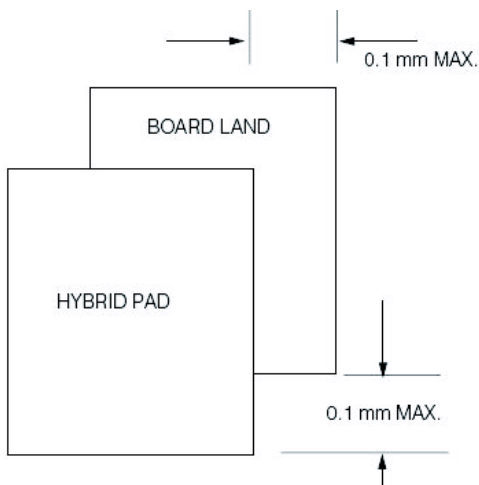


Figure 5. Hybrid Placement

### Step 3: Solder Reflow

The carrier board can be heated to 25°C for RoHS compliant hybrids for reflow (as measured on the carrier board close to the hybrid device). It can be accomplished using any of the following techniques:

- Infra-red/convection reflow oven
- Vapour phase solder reflow

Most reflowable hybrids have chip capacitors under the encapsulant, therefore the rate of heating and cooling must be controlled to avoid thermal shock cracking of the chip capacitor devices.

### Step 4: Cleaning of Solder Joints

Cleaning the reflowed hybrid circuit is the final step in this assembly process. The cleaning method will depend on the type of flux being used in the solder paste. For RMA based solder material, ultrasonic cleaning is preferred to remove any flux residues. Aqueous or semi-aqueous cleaning techniques may also be used.

### Rework Precautions

The temperature of the hybrid unit must not exceed 260°C for RoHS compliant hybrids. The dwell time at peak temperature during rework should not exceed 15 seconds.

### POINT TO POINT SOLDER INTRODUCTION

The purpose of this section is to provide technical advice regarding soldering lead wires and SMT (surface mountable) components to onsemi's hybrids. Successful soldering to hybrids requires special care and equipment. The components mounted on the hybrids, the soldering pads and materials holding together the hybrids can be damaged by excessive heat.

### General Soldering Recommendations

The soldering iron should be low power (25 watts) with a set temperature in the range of 385°C to 400°C (725°F to 750°F). Use a fine tip that has been pre-tinned. Keep the tip clean with a wet cellulose sponge. The tip of the soldering iron should be grounded to prevent electrical damage to the hybrid circuit during soldering (use an ESD safe soldering iron). When adding extra solder use SAC305 or SN100C solder wire. Normally the application of extra solder is not required. Leads to be attached should be pre-tinned using 100% Sn or SAC305 pre-tinned wires.

Do not attempt to solder 'solderable insulated wires' to hybrids without pre-tinning them. These wires should be pre-tinned either using a solder pot or soldering iron set to the correct temperature (usually around 345°C or 650°F) before the hybrid soldering operation. If SMT components are used, confirm that terminations have 100% Sn solder coating for RoHS compliant builds. Use of an optical microscope with at least x10 magnification is strongly recommended. onsemi does not recommend the use of thermal conductive fixtures (e.g., alumina or metal, etc.). These fixtures will heat sink the hybrid, therefore longer soldering times will be required to make the solder joints.

Longer soldering times usually result in poor quality solder joints and damaged hybrids.

## Equipment and Materials Used at onsemi

- Soldering iron Weller EC4001 ESD
- Soldering iron tip Weller EPH101, 0.38 mm, conical tip

## Soldering Procedure for Attaching Lead Wires to onsemi's Hybrids

1. Secure the hybrid firmly before soldering leads.
2. Dip the pre-tinned leads into liquid flux.
3. Clean the soldering iron tip on wet cellulose sponge.
4. Place the lead on to the solder pad and touch the lead with the soldering iron tip. If multiple lead wires are required to be attached to the same I/O pad, make sure to join the multiple leads together before soldering to the hybrid pad. The soldering time should be restricted to a maximum of 2 seconds. If the tip temperature is within the specified range, 2 seconds is adequate time. A minimum wait time of 3 seconds off of the solder pad is required before attaching a lead to the next pad.
5. Remove the soldering iron immediately and hold the lead wire in place with tweezers until the solder solidifies.
6. After soldering, the flux should be cleaned by following the flux manufacturer's specifications.

## Soldering Procedure for Attaching SMT Components to onsemi's Hybrids

1. Secure the hybrid firmly before attaching SMT components.
2. Apply small amount of flux to the I/O pads.
3. Place the SMT component on the solder pads and hold the component in place with a pair of fine tip tweezers (minimize heat sinking).
4. Clean the soldering iron tip on wet cellulose sponge.
5. Simultaneously touch the termination and solder pad with the soldering iron tip. The soldering time should be restricted to a maximum of 2 seconds for each termination. If the tip temperature is within the specified range, 2 seconds is adequate time. Add solder to the soldering iron tip if required.
6. Remove the soldering iron immediately and hold the SMT component in place with tweezers until the solder solidifies. Repeat steps 4 and 5 for the other termination of the component.
7. After soldering, the flux should be cleaned by following the flux manufacturer's specifications.

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