AND8493/D

How to Store, Reflow and Solder ON Semiconductor Hybrids

ON Semiconductor®

http://onsemi.com

APPLICATION NOTE

Reflow Introduction

Storage and Shelf Life

Devices are classified according to their **M**oisture **S**ensitivity **L**evel (MSL). There are several different MSL levels. Each vary in the maximum allowable time they can outside moisture barrier bags. These 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 ±5, 60% RH)

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.
- Hybrid parts stored and handled in this manner will maintain a shelf life that exceeds 6 years.

Reflow

ON Semiconductor's hybrids are miniature thick−film hybrids housing integrated circuits, ceramic chip capacitors, tantalum capacitors and discrete thick−film resistors. The package may use flip chip technology, wire bond technology and surface mount technology to connect various devices to a thick−film substrate. The hybrid inputs and outputs are pre−tinned copper pads, with the typical spacing between adjacent input/output pads of 0.25 mm (10 mil). ON Semiconductor'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. For information on whether a hybrid is reflowable, refer to the note in Hybrid Layout and Dimensions in the appropriate hybrid data sheet.

Hybrid Configuration

(Non−RoHS compliant Hybrids)

The standard Pb−alloy soldered hybrids have the thick−film copper pads tinned with 62Sn/36Pb/2Ag solder and the height of the solder above the copper pad is typically 0.15 mm (6 mil). Because the eutectic temperature of the solder composition under the encapsulation is 220°C, the reflow temperature of the assembly must not exceed 218°C (refer to Figure 1 and IPC/JDEC J−STD−020C).

* The materials sealed in the moisture barrier bag will be kept in a dry nitrogen cabinet under the following conditions:
Temperature: 25 ±5°C
Relative Humidity: 45% ±15%

** 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

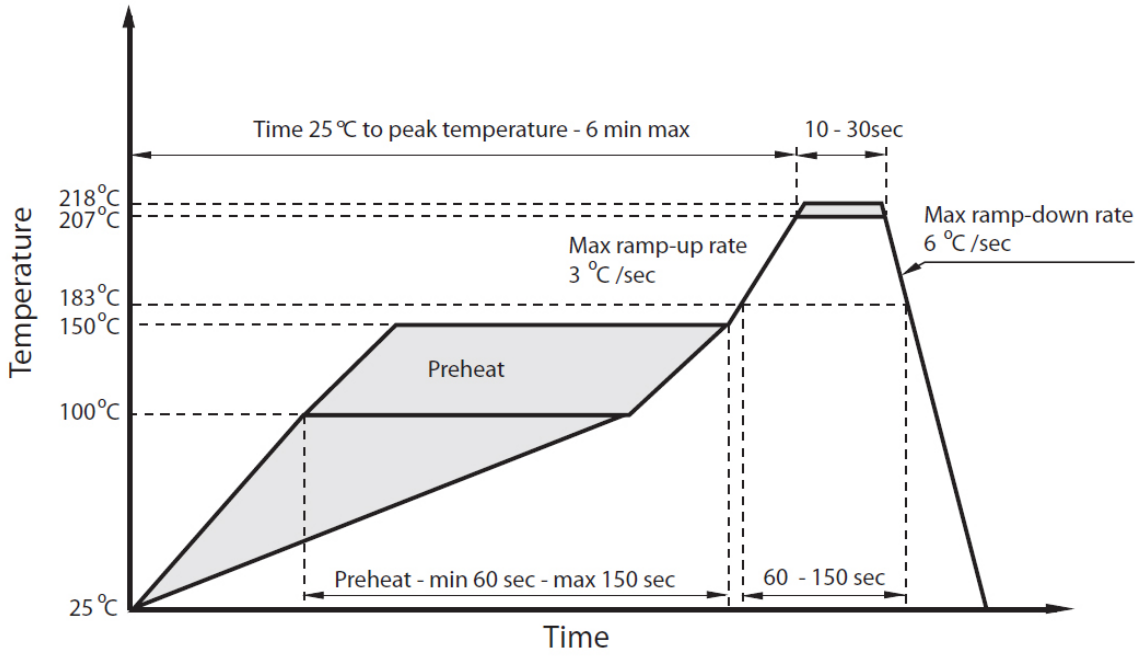

Figure 1. Pb−Bearing Hybrids

(RoHS compliant Hybrids) −E1 products

The RoHS compliant hybrids are denoted with a '–E1' extension after the product identifier has the copper pads tinned with the SAC305, (96.5Sn/3.0Ag/0.5Cu) solder alloy. The height of the solder above the copper pad is typically 0.15 mm (6 mil). The –E1 hybrids maximum reflow temperature of the assembly must not exceed 240°C as measured on the top of the device package (refer to Figure 2 and IPC/JDEC J−STD−020C).

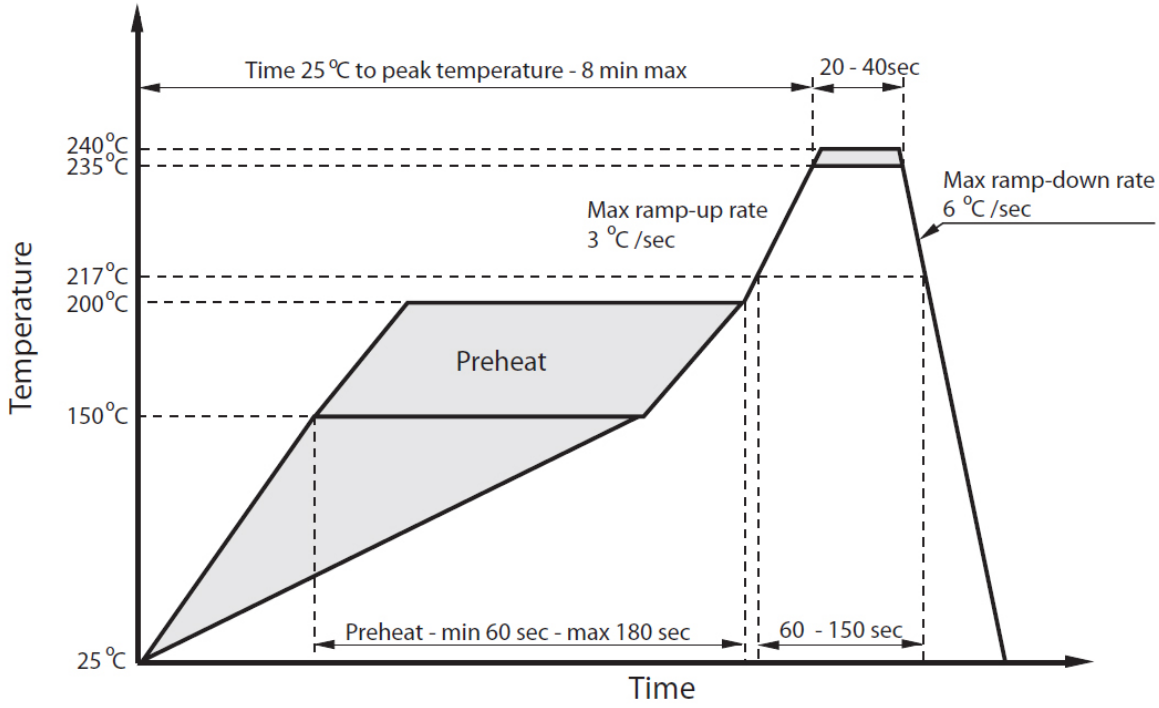

Figure 2. RoHS Compliant Hybrids

NOTE:

ON Semiconductor's hybrids have one of two moisture sensitivity ratings:

1. Rating of '3' (MSL #3), according to IPC/JEDEC J−STD−020C Moisture/reflow sensitivity Classification for Non−Hermetic Components (168 hour floor life at 30°C/60%RH after opening dry pack).
2. Rating of '4' (MSL#4), according to IPC/JEDEC J−STD−020C Moisture/reflow sensitivity Classification for Non−Hermetic Components (72 hour floor life at 30°C/60%RH after opening dry pack).

The Non−RoHS compliant Hybrids are rated MSL #3 and RoHS compliant Hybrids are rated MSL #4 unless otherwise specified in the appropriate Data Sheet. It is recommended to refer to data sheets for MSL rating verification.

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 3 for optimal joint geometry.

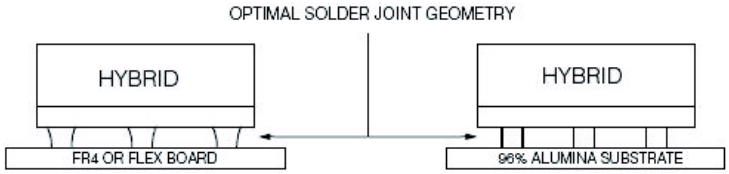

Figure 3. Solder Joint Geometry

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 (6 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 ON Semiconductor hybrids is illustrated in Figure 1 for Pb−bearing and in Figure 2 for RoHS compliant hybrids. The hybrids reflow well with RMA or no−clean fluxes in air and inert (N2) atmospheres. The finish on Cu landing pads evaluated at ON Semiconductor 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 4). A solder paste thickness of 125 to 175 μm is recommended.

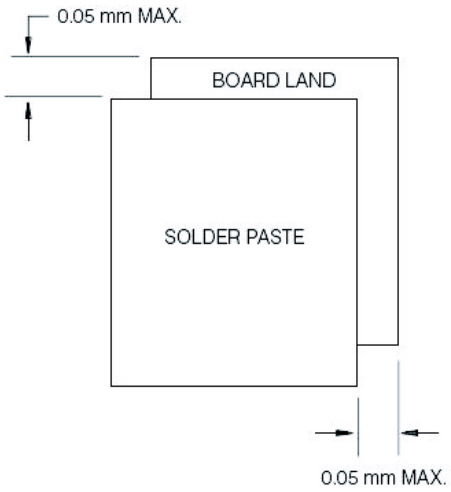

Figure 4. Solder Paste Application

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 5 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.

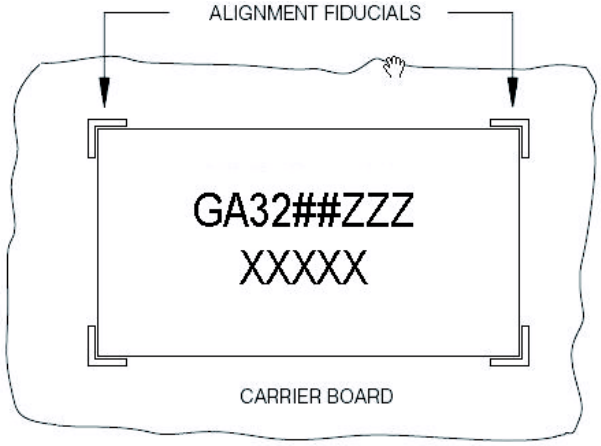

Figure 5. Alignment of Fiducials

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

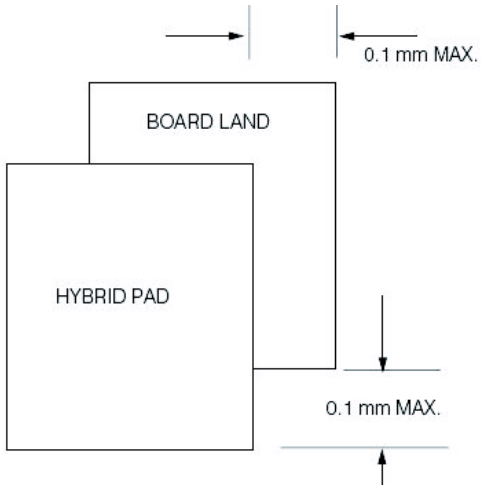

Figure 6. Hybrid Placement

Step 3: Solder Reflow

The carrier board can be heated to 214°C for Pb−bearing hybrids and 235°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 218°C during rework for Pb−bearing and 240°C for RoHS compliant. The dwell time at peak temperature during rework should not exceed 15 seconds in both instances.

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 ON Semiconductor'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. With thick film hybrids excess heat and repetitive solderings dissolves the pad material into the solder. When this occurs, connections to the hybrid become unreliable and have poor adhesion to the substrate. Hybrid pads with Pd/Ag thick film materials are particularly prone to this problem, however ON Semiconductor's hybrid products have copper metalization on the pads, which significantly reduce the dissolution of the pads into the solder. Passive components on moulded side of ON Semiconductor's hybrids are attached using a solder with a eutectic temperature of 221°C (430°F). The components are encapsulated using filled epoxy, therefore care should be taken that the temperature under the encapsulation material does not exceed 221°C (430°F). Temperature over 221°C (430°F) will melt the solder under the encapsulation material, damaging the hybrid circuit.

General Soldering Recommendations

The soldering iron should be low power (25 watts) with a set temperature in the range of 290°C to 315°C (550°F to 600°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 62Sn/36Pb/2Ag alloy for the Pb−bearing hybrids or SAC305 for RoHS compliant hybrids (−E1 product extension). Normally the application of extra solder is not required. Leads to be attached should be pre−tinned using either 63Sn/37Pb or 62Sn/36Pb/2Ag solder alloys for Pb−bearing hybrids. 100% Sn or SAC305 pre−tinned wires should be used for RoHS compliant hybrids.

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. ON Semiconductor 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 ON Semiconductor

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

Soldering Procedure for Attaching Lead Wires to ON Semiconductor'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.
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 ON Semiconductor'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.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5773−3850

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative