AND9788/D

Handling and Soldering of Molded Leadframe Packaged SiPM Sensors

ON Semiconductor®

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APPLICATION NOTE

INTRODUCTION

This document applies to any ON Semiconductor SiPM part that ends with the suffix '−SMT' or '−MLP', such as:

- MicroXX−NNNNN−SMT
- MicroXX−NNNNN−MLP

where an 'X' represents any letter, and an 'N' represents any number.

Please discuss the contents of this document with your contract manufacturer.

ADDITIONAL APPLICABLE DOCUMENTS

- IPC/JEDEC J−STD−020
- IPC/JEDEC J−STD−033

THE MLP PACKAGE

The MLP (molded lead frame) package is a surface mount, 4-side tileable packaging solution used for ON Semiconductor SiPM sensors. The sensor die is attached to a metal lead frame, with the topside silicon contacts wire bonded to the leads. The die and lead frame are molded in a clear mold compound which completely encapsulates the silicon, creating a robust package (see Figure 1).

In this document, 'MLP' is used to cover all sensors that have either the −MLP or −SMT suffix in the part number.

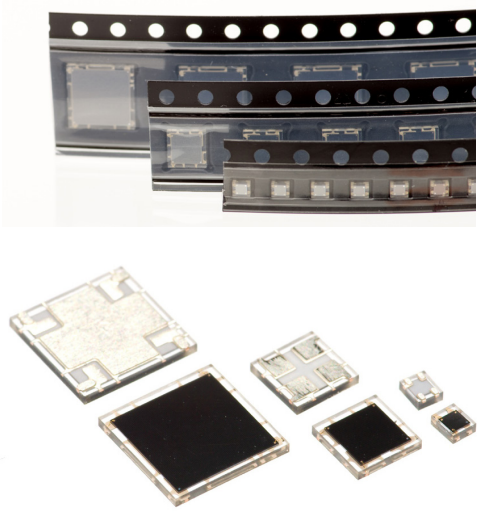

Figure 1. The ON Semiconductor MLP Sensors in Tape (Top) and the Top and Bottom View of the Sensor Package (Bottom)

SAFE HANDLING OF SENSORS

ON Semiconductor SiPM sensors undergo 100% electrical test and automatic visual inspection at end of line, immediately prior to shipment on tape and reel. Therefore all ON Semiconductor sensors should reach the customer in perfect condition. To ensure that the sensors remain in this condition, please note the following guidance.

- Remember that the SiPM is a sensitive optoelectronic sensor and should always be handled as carefully as possible.
- Physical contact with the sensor should be minimized during assembly, and ON Semiconductor recommends the use of automatic assembly directly from reels.
- In particular, care should be taken to avoid contact with abrasive materials.
- When unpacking, care should be taken to prevent dropping or misorienting the sensors.
- SiPM sensors are ESD sensitive. Please note the precautions given in JESD625.
- Assembled units should be carefully packaged following assembly, to prevent damage to the sensor optical surface and edges.
- The sensor should be disconnected from the bias supply when not in use.
- Particular care should be taken when exposing MLP sensors to cleaning agents. See the cleaning advice on page 4.

SURFACE CONDITION

The surfaces of the clear MLP sensors are susceptible to both physical and chemical damage. By following the guidance in this document, damage to the surface during handling and the assembly process can be avoided.

Excessive manual handling and contact with hard or contaminated tool surfaces may result in scratching, permanent contamination and other cosmetic damage. However, such damage to the package surface does not impact the sensor performance or reliability. This Application Note shows that surface scratching is tolerable and has a negligible impact on the measured responsivity of the sensor.

The clear mold compound is an organic epoxy which may be damaged by solvents causing potential reliability issues. Users should note the cleaning guidance on page 4.

STORAGE CONDITIONS

MLP packaged devices are moisture sensitive. If not stored correctly, moisture can diffuse into the package from atmospheric humidity. Surface mount soldering of the MLP packages to PCB exposes the entire package body to temperatures up to 260°C. Rapid expansion of any trapped moisture during this process could result in package cracking, delamination of critical interfaces within the package, or damaged bond wires.

To avoid this, parts are shipped in moisture barrier bags (MBB) according to the J−STD−033 standard. Unopened MBBs should be stored at a temperature below 40°C with humidity below 90% RH (Relative Humidity). After the MBB has been opened, the devices must be reflow soldered within a period of time depending upon the moisture sensitivity level (MSL), which is indicated on the packaging. ON Semiconductor MLP sensors from Tape & Reel are MSL 3 and cut tape MLP are MSL 4 (see Table 1 for details).

The parts must be baked (according to J−STD−033, Table 4.1) if any of the following occurs:

1. The parts are not reflow soldered within the applicable exposure time of opening the MBB (see Table 1).
2. The MBB is expired (according to the packing date and shelf life on the label).
3. The humidity indicator card (HIC) shows the moisture level within the MBB has increased beyond the required level.
4. The parts are shipped with a bake instruction note.

REBAKE CONDITIONS

If any of the conditions above are true, then a rebake is required according to J−STD−033, Table 4.1. The information in Table 2 should also be taken into account. Please discuss this with your contract manufacture for their recommended baking cycle which adheres to IPC/JEDEC J−STD−20 MSL Classification. Note the temperature of the bake should not exceed the recommended product storage temperature listed in the product's datasheet.

Table 1. MSL DEFINITIONS APPLICABLE TO ON SEMICONDUCTOR SiPM MLP PARTS (REFERENCE J−STD−20)

MLP Shipping Format	MSL	Exposure Time	Condition	Calculated Shelf Life in Sealed Bags*	Peak Package Body Temperature
Tape and reel	3	168 hours	≤ 30°C/60% RH	24 months (< 40°C and < 90% RH)	260°C
Cut tape and partial reels	4	72 hours	≤ 30°C/60% RH	12 months (< 40°C and < 90% RH)	260°C

*Calculated shelf life is based on the packing date at the manufacturer. This 'bag seal date' is displayed on the reel's Moisture Sensitivity Label, located on the packaging. ON Semiconductor guarantees that reels will ship with a minimum of 3 months left before the expiry date of the MBB (according to the packing date and shelf life on the label).

Table 2. REBAKE PROCEDURES FOR MLP DEVICES ON TAPE, AND TAPE AND REEL

Condition	Rebake Procedure if the Exposure Time Exceeds the Floor Life Expectation by...	
	> 72 hours	< 72 hours
Not on tape	33 hours at 90°C	23 hours at 90°C
On tape	13 days at 40°C	9 days at 40°C

GENERAL ASSEMBLY ADVICE

- Contract manufacturers should be given a copy of this document in order to implement the necessary precautions when assembling the parts.
- Physical contact with the sensor should be minimized during assembly and ON Semiconductor recommend the use of automatic assembly directly from reels. Contact with the sensitive surface should be avoided and particular care should be taken to avoid contact with abrasive materials.
- The sensors can be damaged during unpacking or placement steps. A magnified visual inspection step immediately prior to reflow can identify problems due to placement such as sensor edge damage or sensor misalignment.
- SiPM sensors are polarized. Ensure correct orientation during placement. The parts come on tape and reel and are orientated consistently on the tape as per the CAD, which is linked to in the product datasheet. It is important to communicate the correct sensor orientation in the Gerber and assembly files to the contract manufacturer.
- If a volume build is being assembled then an initial trial build on one board or a small quantity is recommended. Any trial boards should be thoroughly tested before proceeding, to ensure a successful volume build. This is especially important when creating arrays of the MLP sensors.
- If the MLP part is being assembled into an array, the advice in the Array Design Application Note should be followed.

BOARD LAYOUT CONSIDERATIONS

- Example solder footprints and product specific soldering recommendations are provided for guidance in the relevant product CAD files. Links to CAD files are in the product datasheets – see page 4.
- To ensure correct sensor orientation please consult the CAD drawings where orientation fiducials are clearly indicated. A manual check at the time of manufacture is recommended to ensure correct orientation.
- Unless otherwise indicated, all solder pads, including those for *fast output* and *NC* (No Connect) should be soldered to the PCB. This is for mechanical stability and alignment, as well as for optimal thermal performance.
- The *NC* pins can be soldered to a thermal plane to help heat dissipation (these are floating in the sensor package)
- To prevent unexpected problems please also be aware that the PCB pads should be made as uniform as possible. The final pad produced by intersection of metal and soldermask layers should be consistent in terms of area with all other pads. Ensuring this will prevent stress due to components tilting during reflow and will make the resulting array surface completely planar. Uniform deposition of solder paste is important to create planar array finish.

SOLDER REFLOW CONDITIONS

The MLP package is compatible with standard reflow solder processes (J−STD−20) and so is ideal for high-volume manufacturing.

Solder paste (ON Semiconductor recommends using no-clean solder paste) must be evenly applied to each solder pad to ensure proper bonding and positioning of the component.

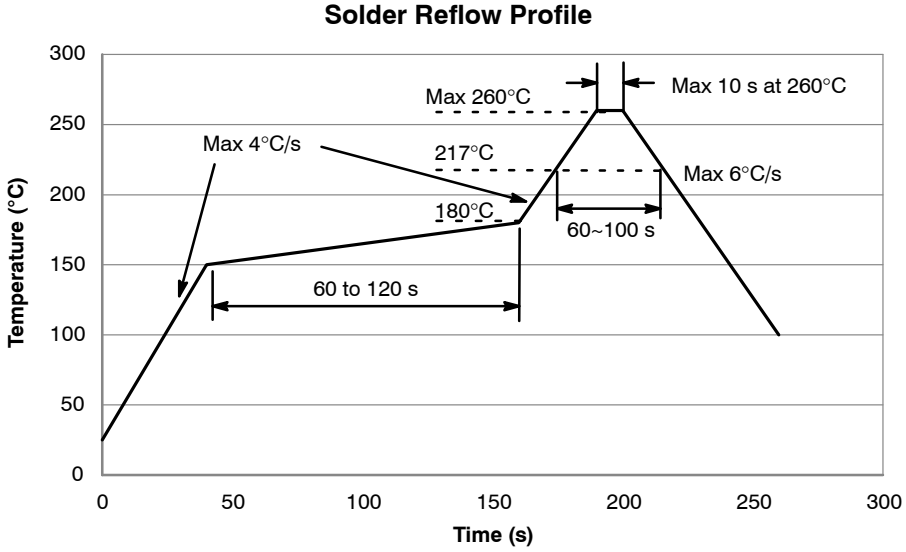

Figure 2. Solder Reflow Profile

As a guideline, ON Semiconductor arrays of MLP sensors employ the following solder paste stencil design:

- Aperture dimension is copper pad dimension, less 10% on X & Y
- Stencil foil thickness 0.1 mm

Solder reflow conditions must be in compliance with J−STD−20, Table 5.2. This is summarized in Figure 2. The number of passes should not be more than 2. After soldering, allow the component to cool to room temperature before further operations.

CLEANING

Exposure to solvents such as *concentrated* isopropyl alcohol (propan-2-ol) or commercial flux removal fluids such as Fluxene will cause severe, irreversible damage to the MLP package. If cleaning is necessary, a 20% solution of isopropyl alcohol can be used.

Compounds such as optical grease may be difficult to remove using only dilute isopropyl alcohol. Additional cleaning may be done by agitating with a nylon brush in warm soapy water (for example, 20% solution of a regular dish washing detergent in water at 60°C). Drying stains from the solution can then be removed using a 20% dilute isopropyl alcohol solution. The components can be baked for up to 33 hours at 90°C in order to dry them out. The user should take care to ensure other components built onto the PCB can withstand the cleaning and baking.

In order to minimise the requirement for such cleaning agents, we recommend using no-clean solder flux.

It is important to allow the PCB to cool to room temperature after reflow and before flux cleaning in order to avoid thermal shock.

REWORK OF THE MLP PACKAGES

Manual rework of MLP sensors after reflow soldering is not recommended. Manual removal of surface mount components from a PCB involves heating to temperatures above 250°C for long periods (> 60 seconds) with minimal process controls. Such treatment may result in internal damage to the package and may impact performance and reliability. This is especially true for SiPM components made with clear mold compound due to its relatively high rate of thermal expansion.

It is possible to remove, discard and replace components where the packing density is sufficiently low to prevent excessive heating of adjacent components during removal of the component of interest. Rework of densely packed components (such as an array) can be achieved using semi-automated equipment such as Metcal APR−5000. Such equipment enables control of the reflow profile and removal of the component using a vacuum collet.

CAD & SOLDER FOOTPRINTS

Links to the full CAD files, which include the sensor CAD, the solder footprint and the tape and reel CAD, can be found in the appropriate datasheets, linked below, and found at onsemi.com.

- C−Series datasheet
- RA−Series datasheet

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
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