Handling and Soldering of SensL TSV Sensors

Contents

Introduction

This document contains information on the handling, storage and soldering of the SensL TSV (through silicon via) packaged sensors.

This document applies to the following sensors:

- MicroFJ-*XXXXX*-TSV

where the *X*s represent numerals in the part number.

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

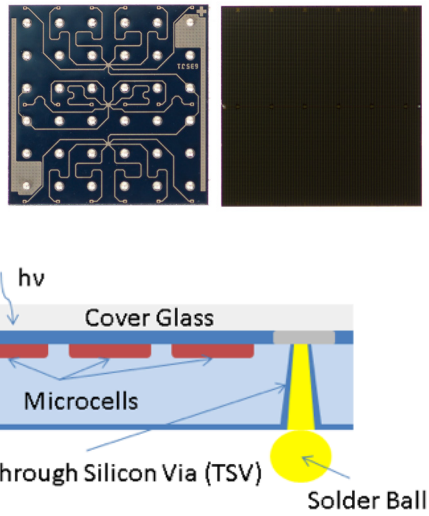

Figure 1, The SensL TSV sensor (top) and the TSV concept (bottom).

Additional Applicable Documents

IPC/JEDEC J-STD-020; IPC/JEDEC J-STD-033.

The TSV Package

The TSV package is fabricated while the die are still on the wafer. A glass substrate is bonded to the top of the silicon wafer and the silicon is back-ground to a thin layer (<0.10mm). Contact vias are etched in the silicon, oxide is deposited to isolate the substrate from further processing, and metal is deposited to form a contact layer with the output terminals of the SiPM. Solder bumps are then attached to the deposited metal on the back side of the sensor. The wafer is finally sawn into individual die. The TSV concept is shown in Figure 1.

The glass surface of the SiPM is delicate and care must be taken to avoid any impact or contact with abrasive or sharp materials. Because the die is so close to the edge of the package, even seemingly minor damage at the glass edge may affect sensor operation.

Safe Handling of TSV Sensors

SensL SiPM sensors undergo 100% electrical test and automatic visual inspection at end of line, immediately prior to shipment on tape and reel. Therefore all SensL 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 SensL 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 the sensor edges. The most common problem that arises with TSV sensors is damage due to lack of handling precautions during assembly and transport.
- The sensor should be disconnected from the bias supply when not in use.
- Particular care should be taken when coupling and decoupling scintillation crystals. Please follow the advice in this Tech Note.

Storage Conditions

These sensors are moisture sensitive. If not stored correctly moisture can diffuse into the package from atmospheric humidity. Surface mount soldering of the TSV 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 or delamination of critical interfaces within the package.

To avoid this, parts are shipped in moisture barrier bags (MBBs) according to the J-STD-033 standard. Unopened MBBs should be stored at a temperature below 40°C with relative humidity <90%. 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. SensL TSV parts on Tape & Reel are MSL 3 (see Table 1 for details).

The parts must also 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.

TSV 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
Gel pack or waffle pack	N/A	Indefinite	Always follow the rebake instruction for >72hrs	N/A	N/A

Table 1, MSL definitions applicable to SensL TSV parts (reference J-STD-20).

** 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, which is located on the packaging. SensL 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).*

Rebake Conditions

If any of the conditions on page 2 occurs then a rebake is required, according to J-STD-033, table 4.1. The information in Table 2, below, 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 product's datasheet.

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

Table 2, Rebake procedures for TSV devices on tape, and not on tape.

General Assembly Advice

- The most common problem that arises with TSV sensors is damage due to lack of handling precautions during handling, assembly and transport.
- 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 SensL recommends the use of automatic assembly directly from reels. Contact with the light-sensitive surface, which is glass, should be avoided. In 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.
- 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 TSV sensors.

- SiPM sensors are polarized. Ensure correct orientation during placement. Topside orientation features on TSV are visible under magnification. 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 the TSV part is being assembled into an array, the advice in the Array Design Tech 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 6.
- To ensure correct sensor orientation please consult the CAD drawings where orientation fiducials are clearly indicated. A manual visual check between placement and assembly is recommended to ensure correct orientation.
- All solder bumps, 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.
- Where there are 2 pins per signal, connect both pins together on the PCB. This helps reduce series resistance and give optimal performance.
- The *NC* pins can be soldered to a 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 in the case of an array will result in a planar optical surface.

Solder Reflow Conditions

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

Solder paste (SensL recommends using no-clean solder paste) must be evenly applied to each solder pad to ensure proper bonding and positioning of the component. Consult with the contract manufacturer regarding the best solder stencil design for your PCB

Suggested solder stencil for TSV BGA package:

- Cu Pad to stencil aperture ratio 1:1
- Stencil foil thickness 100 μm

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 at least three minutes for the component to cool to room temperature before further operations.

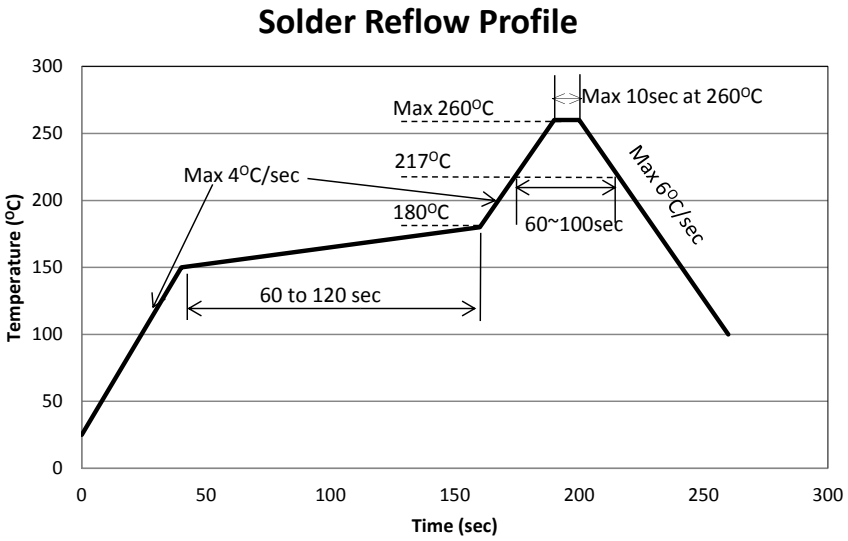

Figure 2, Solder reflow profile

Cleaning

Isopropyl alcohol (propan-2-ol) in concentrated form can be used for cleaning the TSV devices.

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 TSV Packages

Manual rework of TSV packages 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.

It is possible to remove, discard and replace components where the packing density of devices 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 and Solder Footprints

The MicroFJ-**30020**-TSV-A1 CAD, including tape and reel, and solder footprint, is available to download here.

The MicroFJ-**30035**-TSV-A2 CAD, including tape and reel, and solder footprint, is available to download here.

This PCN describes the changes to the tape and reel between revisions A1 and A2.

The MicroFJ-**40035**-TSV-A2 CAD, including tape and reel, and solder footprint, is available to download here.

The MicroFJ-**60035**-TSV-A2 CAD, including tape and reel, and solder footprint, is available to download here.

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