Guidelines for soldering of Through Hole Devices (THD)

1. Scope
2. PCB design considerations
3. Soldering methods for THT
1. Scope

Applicable soldering methods for Melexis products

Soldering refers to a set of processes for electrically connecting the IC (Integrated Circuit) leads to the PCB (Printed Circuit Board) terminals. Each Melexis product is qualified to one or more methods of soldering following the standards listed below. For THD (Through Hole Devices), the four soldering methods below are applicable and are covered in this document. For SMD devices, only reflow soldering is applicable, refer to Guidelines for Surface Mount Technology (SMT) soldering.

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<tr>
<th>Soldering Method</th>
<th>THD</th>
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<th>THD</th>
<th>THD</th>
<th>PCB-less</th>
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<td>Reflow soldering</td>
<td>(J-STD-020)</td>
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<td>Wave soldering</td>
<td>(IEC 60068-2-20)</td>
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<td>Selective wave soldering</td>
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<td>Robot point-to-point</td>
<td>(IEC 60068-2-20)</td>
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For mass production, manual soldering is not allowed because of the unsafe temperature and time control. However manual rework is allowed.
1. Scope

Family of packages at Melexis from soldering perspective

Refer to Annex I for the different abbreviations

If leadforming is required before soldering, refer to Guidelines for leadforming of SIP Hall sensors and Guidelines for leadforming of DMP Hall sensors in Melexis website
1. Scope

2. PCB design considerations

3. Soldering methods for THT
2. PCB design considerations

PCB via design

It is recommended to use oblong shaped copper pads for PTH (Plated through hole vias). Oblong pad wetting forces prevent solder bridging between neighbor pads during wave or selective wave soldering.

Both double side metallization/metallized via or single side metallization/non-metallized via design are applicable.

Supported holes (PTH)
Double side metallization

Unsupported holes
Single side metallization
2. PCB design considerations

Hole and pad size for SIP packages

Minimum hole size can be calculated using *IPC-2222, 9.2.2 Plated-Through Holes*. The minimum pad size can be calculated using *IPC-2221, 9.1.1 Land requirements*. Both dimensions depend on technological capabilities of the PCB manufacturer. Clearance between lands should respect electrical clearances as per *IPC-2221, 6.3 Electrical Clearance*

The following numbers are calculated using the pin diagonal of SIP packages:

<table>
<thead>
<tr>
<th>UA, VK</th>
<th>VA, VC</th>
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<tr>
<td>Minimum hole size</td>
<td>1.00 mm</td>
</tr>
<tr>
<td>Minimum land size</td>
<td>0.70 mm</td>
</tr>
<tr>
<td>Pitch</td>
<td>1.27 mm</td>
</tr>
<tr>
<td>Electrical clearance</td>
<td>0.27 mm</td>
</tr>
<tr>
<td>1.10 mm</td>
<td>0.17 mm</td>
</tr>
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</table>

Note: VK has four pins
Component body height above PCB

The dambar protrusion is a remnant from tie bar cutting: it can be centered on the pin or shifted to one side, but total maximum dimension (F1) is the same in both cases.

To avoid conflict of the PTH (Plated Through Hole) with the dambar protrusion for UA, VK and VC packages, it is recommended to place the IC at a height higher than L1 (distance from mold to dambar protrusion). VA has dambar wings which acts as stoppers of the IC to the PCB. In both cases, the distance of mold body to PCB will be higher than 0.3 mm, as required in J-STD-001, 6.1 Through hole Terminations – General.

DESIGN FOR UA, VK, VC:
Distance of mold to PCB is higher than distance of mold to dambar protrusion (L1).
Refer to POD (Product Outline Drawing) for L1 dimensions

DESIGN FOR VA:
Dambar wings act as stoppers
1. Scope

2. PCB design considerations

3. Soldering methods for THT
3. Soldering methods for THT

Reflow soldering

Melexis THD products can be reflow soldered using Pin-in-paste technology – also known as intrusive soldering, which allows to use standard SMT assembly equipment and processes to assemble the devices into the board.
3. Soldering methods for THT

Reflow soldering profile development

Melexis uses reflow profiles in product/package qualification testing and MSL qualification, as defined in the standard “Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices” (J-STD-020). Melexis products are qualified for a maximum of 3 times reflow process in a sequence with parameters specified in the “Table 5.2 - Classification Profiles” of J-STD-020 standard where the classification temperature $T_c = 260^\circ$C. This reflow profile is for classification/preconditioning and is not meant to specify board assembly profiles.

Development of actual reflow soldering profile and parameters at customer should follow recommendations from solder paste supplier, be based on specific process needs and board designs and should not exceed the parameters in the table below:

- Peak temperature: 260 °C
- Peak temperature duration: 30 seconds
- Temperature ramp-up rate: 3 °C/second max.
- Temperature ramp-down rate: 6 °C/second max.
- Time 25 °C to peak temperature: 8 minutes max.
3. Soldering methods for THT

Wave soldering

Melexis products are qualified for wave soldering using the solder bath method as defined in “Test methods for solderability and resistance to soldering heat of devices with leads” (IEC 60068-2-20). This test is to determine whether an IC can withstand the temperatures encountered during soldering, and is not meant to specify board wave soldering parameters. Development of actual wave soldering parameters at customer should follow recommendations from solder supplier, be based on specific process needs and board designs, and should not exceed the parameters in “Table 2 – Resistance to soldering heat, solder bath method: Test severities (duration and temperature)” for lead free alloys:

- **Temperature of solder:** 260 ± 3 °C
- **Dwell time:** 10 ± 1 seconds

During preheating of top component side (destination side, as per 4.13.1 Preheating of J-STD-001), the temperature seen at the mold body should be below 260 degC, as per “Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices” (J-STD-020).

Testing methodology for wave soldering qualification is also described in JESD22-B106
3. Soldering methods for THT

Device tilting

Wave and selective wave soldering might push the IC during soldering, leading to tilting of the device after the solder joint is cooled down. As per IPC-A-610, section 7.1.6 Component Mounting – Radial Leads – Vertical, this might be acceptable if the component tilt does not violate minimum electrical clearance, and it is a process indicator if the distance between the mold body and the PCB surface is less than 0.3mm (for class 2 and 3).

However, for Melexis Hall sensors, tilting might lead to misalignment with the magnetic target and might impact the performance. Therefore, to avoid tilting of the IC, it is recommended to hold the IC during wave soldering (as per 4.13.4 Holding Devices and materials in J-STD-001).

![Diagram of device tilting due to wave soldering pushing up](image)

\[Mold\text{ tot PCB} > L1\]

Tilting of IC due to wave soldering pushing up
3. Soldering methods for THT

Methods for IC holding during wave soldering

There are two main methods for IC holding during wave soldering:

- **Plastic holder**: Holds the part by friction. Depending on the design, channels might be needed to accommodate the dambar protrusion.

- **Pusher**: For VA, a pusher is enough since the dambar wings will act as stoppers. For UA, VC and VK packages, a comb is also needed to guarantee the appropriate clearance between mold and PCB. The pusher force should be limited to a maximum force of 2N to avoid mechanical damage of the parts. It also requires some clearance to the gate burr.
3. Soldering methods for THT

Selective wave soldering

Selective wave soldering can be done with manual or automatic placement of the IC into the PCB. The solder is transported from the solder bath to the tip of the nozzle by means of a wave, usually flooded with an inert gas to avoid oxidation of the solder.

During preheating of top component site (destination side), the temperature seen at the mold body (p. A) should be below 260 degC, as per “Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices” (J-STD-020).

The following parameters are resulting from the best customer practice.

- Temperature at A: 260 degC
- Dwell time: 2 - 4 s
- Soldering passes: max. 2 times
3. Soldering methods for THT

Methods for IC positioning during selective wave soldering

There are two main methods for IC holding during wave soldering:

- **Gripper**: Holds the part at a determined height from the PCB
- **Holding pusher**: It is recommended to use a flat tip to avoid mechanical damage to the mold body during high temperature processes.

In both cases, the maximum holding pressure is 3N/sq.mm.
3. Soldering methods for THT

Robot point-to-point soldering

Melexis products are qualified for robot point-to-point soldering using the dip solder method as defined in “Test methods for solderability and resistance to soldering heat of devices with leads” (IEC 60068-2-20). This test is to determine whether an IC can withstand the temperatures encountered during soldering, and is not meant to specify board assembly parameters. Development of actual robot point-to-point soldering parameters at customer should follow recommendations from solder wire supplier, be based on specific process needs and board designs, and should not exceed the parameters in “5.2 – Method 2: Soldering iron” of IEC 60068-2-20.

In practice, this means that the robot point-to-point soldering shall be limited to the following values for a maximum of 2 times:

- Temperature of soldering iron: 350 °C
- Dwell time: 10 ± 1 seconds

It might be possible to use a higher temperature of the soldering iron to reduce the time, as long as the temperature at a distance of 1 mm from the mold body does not exceed 270 degC. Contact Melexis for an assessment.

If laser point-to-point soldering or any other new process not covered by standards is foreseen, contact Melexis to check for compatibility with the current products.

The core flux inside the solder wire shall be of No-clean, Halogen-free type (NC HF). Solder wire flux is often too aggressive, containing halogen elements that may trigger copper corrosion and/or conductive dendrite growth between solder pads.
3. Soldering methods for THT

Thermocouple measurement at mold-leads interface for robot soldering

It is strongly recommended to measure the temperature ramp and peak value of the ICs leads at 1mm from the mold body. This is because soldering process might exceed the maximum temperature of 270degC. The reasons might be a large copper plane on the PCB or other heat-sinking components connected to the node where the IC is to be soldered. **The maximum mold body temperature at point A is 260degC**

Below is an example of robot iron soldering temperature profile study, taken from the sensor leads #1 and #4 with micro-wire thermocouples. It is important to use a fast-response thermocouple (**minimum 5 samples/sec**), in order to see the rapid temperature ramp. Once temperature profile is captured, consult Melexis for risk assessment.
3. Soldering methods for THT

Robot point-to-point soldering of PCB-less assemblies

It is possible to solder PCB-less devices to fork terminals with robot point-to-point soldering.

Orientation of the iron tip is important and it should touch both the pin and the fork. This is to guarantee that a pin-to-fork fillet forms on the bottom of the fork. It is also recommended to adjusting the pre-heating time and temperature (to a maximum of 370 degC) to secure good wetting when the solder wire is fed in, as well as reducing solder wire feed time to avoid a big blob of solder. Temperature at point B should be less than 270 degC.
## Annex I: List of Abbreviations

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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
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<td>BGA</td>
<td>Ball Grid Array</td>
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<tr>
<td>BTC</td>
<td>Bottom Terminated Component</td>
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<tr>
<td>DMP</td>
<td>Dual Mold Package</td>
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<tr>
<td>HF</td>
<td>Halogen Free</td>
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<tr>
<td>IC</td>
<td>Integrated Circuit</td>
</tr>
<tr>
<td>NB</td>
<td>Narrow Body</td>
</tr>
<tr>
<td>NC</td>
<td>No Clean</td>
</tr>
<tr>
<td>PCB</td>
<td>Printed Circuit Board</td>
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<tr>
<td>PTH</td>
<td>Plated Through Hole</td>
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<tr>
<td>POD</td>
<td>Package Outline Drawing</td>
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<tr>
<td>QFN</td>
<td>Quad Flat No-Leads</td>
</tr>
<tr>
<td>QFP</td>
<td>Quad Flat Package</td>
</tr>
<tr>
<td>SMD</td>
<td>Surface Mount Device</td>
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<tr>
<td>SMT</td>
<td>Surface Mount Technology</td>
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<tr>
<td>SSOP</td>
<td>Thin Shrink-Small Outline Package</td>
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<tr>
<td>THD</td>
<td>Through-Hole Device</td>
</tr>
<tr>
<td>THT</td>
<td>Through-Hole Technology</td>
</tr>
<tr>
<td>TSSOP</td>
<td>Thin Shrink-Small Outline Package</td>
</tr>
<tr>
<td>UTDFN</td>
<td>Ultra Thin Dual Flat No-Leads</td>
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<tr>
<td>WB</td>
<td>Wide Body</td>
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</table>
Annex II: List of Standards

J-STD-001 Requirements for Soldered Electrical and Electronic Assemblies

J-STD-002 Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires

J-STD-020 Moisture/Reflow Sensitivity Classification for Nonhermetic Surface Mount Devices

J-STD-033 Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices


IPC-A-610 Acceptability of Electronic Assemblies

IPC-2221 Generic Standard on Printed Board Design

IPC-2222 Sectional Design Standard for Rigid Organic Printed Boards
Annex III: List of Related Application Notes

For the latest revision of this document and related Application Notes, visit www.melexis.com/ic-handling-and-assembly

Solder techniques for TO39 IR sensor product

Guidelines for storage and handling of plastic encapsulated ICs

Guidelines for Surface Mount Technology (SMT) soldering

Guidelines for leadforming of SIP Hall sensors

Guidelines for leadforming of DMP Hall sensors
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