Power module soldering and handling

Intended for TDM22544/45x

About this document

Scope and purpose

Power modules from Infineon are designed to be assembled onto PCBs using a reflow soldering process.

The purpose of this document is to provide guidelines for:

- Handling of power modules in a factory setting
- Successful design of a solder paste application and module placement process
- A module reflow profile compliant with JEDEC J-STD-020F standards
- Correct post-processing of attached power modules including rework and replacement

The recommendations in this document apply to the LG-MLGA-72-5 and LG-MLGA-72-6 packages.

Intended audience

The intended audience for this document is design engineers, technicians, developers of electronic systems, manufacturing/process engineers, and customer quality engineers of end systems using dual-phase power modules from Infineon.

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1 Packaging description

The 9 mm x 10 mm dual-phase power stage modules from Infineon consist of passive components (capacitors, inductors, resistors) and chip embedded (CE) power stages mounted on a substrate (Figure 1). The module is manufactured using lead-free solder and offered in an open frame format. The module does not contain glues or other adhesives to hold components fixed to the substrate.

The mounting surface of the module is an 8 mm x 9 mm land grid array (LGA) package with 0.55 mm square pads mounted on a 1.1 mm pitch (Figure 2). The pad finish can be electroless nickel immersion gold (ENIG) or electroless nickel electroless palladium immersion gold (ENEPIG).

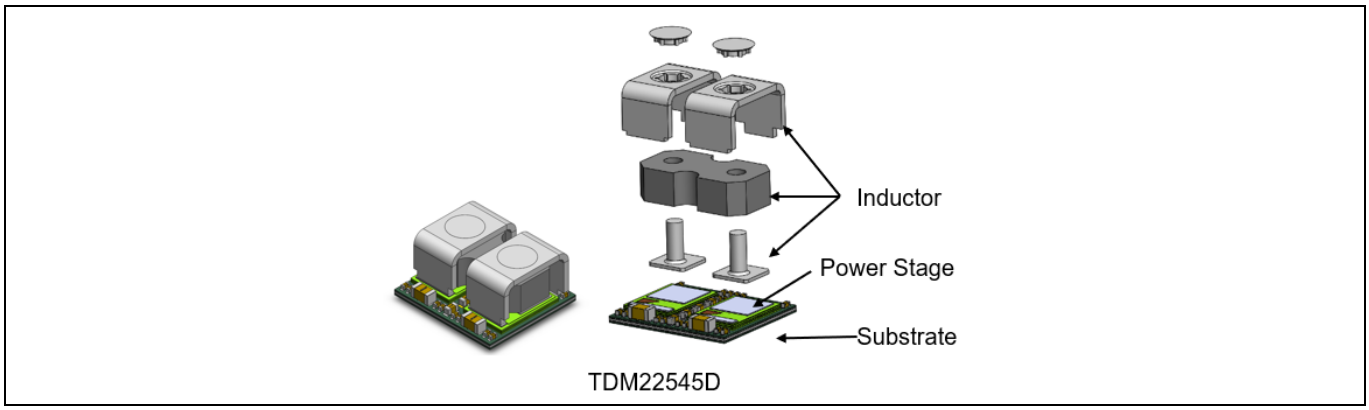

Figure 1 Dual-phase power module example (TDM22545D shown)

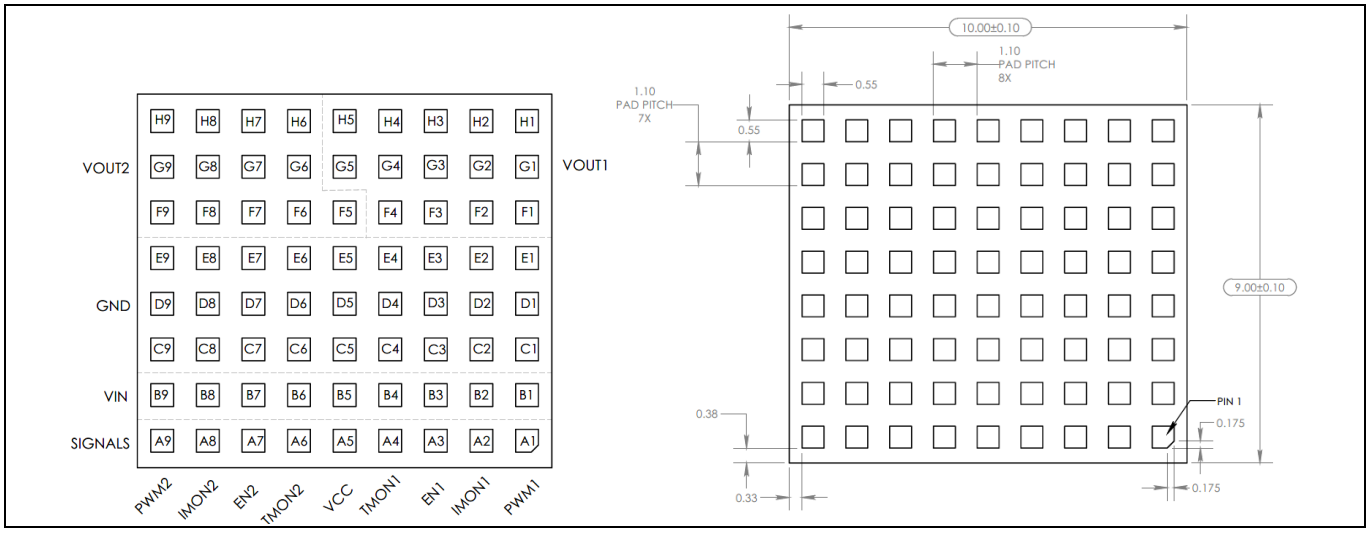

Figure 2 Transparent top view of dual phase power module LGA

2 Handling

2.1 Moisture sensitive level (MSL)

Moisture sensitivity level (MSL) ratings provide an indication of the floor life of the module after it is removed from its packaging. MSL ratings are applicable when exposed to relative humidity between 30% and 60% and temperatures between 20°C and 35°C. Unless specified on the packaging or product datasheet, power modules from Infineon are MSL 3, meaning they can be exposed to ambient conditions for up to one week without requiring baking.

Ambient exposure is cumulative if the module undergoes multiple reflow cycles, the time in between reflows all counts as time out of the bag.

2.2 General handling guidelines

- Given that the mounting LGA surface is ENIG or ENEPIG plated, the module must be kept in a vacuum-sealed bag prior to manufacturing assembly to minimize the potential for contamination.
- Do not handle modules with bare hands, as the plating will tarnish within hours after touch. Once oxidized solder will not flow on the pads.
- If the LGA pads have become contaminated after the modules have been removed from packaging, they must be cleaned before soldering. Isopropyl alcohol, a weak acid, or flux without solder may be used to clean the pads.

3 Solder process

3.1 Stencil design

Proper solder stencil design is important to ensure that the appropriate volume of solder is deposited onto the LGA pads before module placement and reflow. Infineon recommends the parameters shown in the following table for stencil design.

Table 1 Solder stencil design

Parameter	Recommendation
Stencil thickness	0.13 mm
Aperture ratio	1:1 (0.6 mm x 0.6 mm)

In addition to the appropriate stencil design, ensure to keep the stencil clean to eliminate residual solder being transferred to another board once the stencil is lifted. Applying a nano-coating to the stencil will improve release once solder has been placed. Following the print of solder, the solder should appear uniform and should fully cover the LGA pad.Use SAC305 no clean, SMQ75 indium, or other equivalent solder paste. If desired, a 0.13mm thick stencil with no-clean solder paste containing flux can be used to provide some etching of the pads during the pre-heat cycle. If flux is used, the module must be reflowed onto a board, not in an open air. Heat the flux while in a closed space to be effective.

3.2 Stencil design for LG-MLGA-72

Stencil design for LG-MLGA-72-5 and LG-MLGA-72-6 packages. A recommended stencil design is shown below.

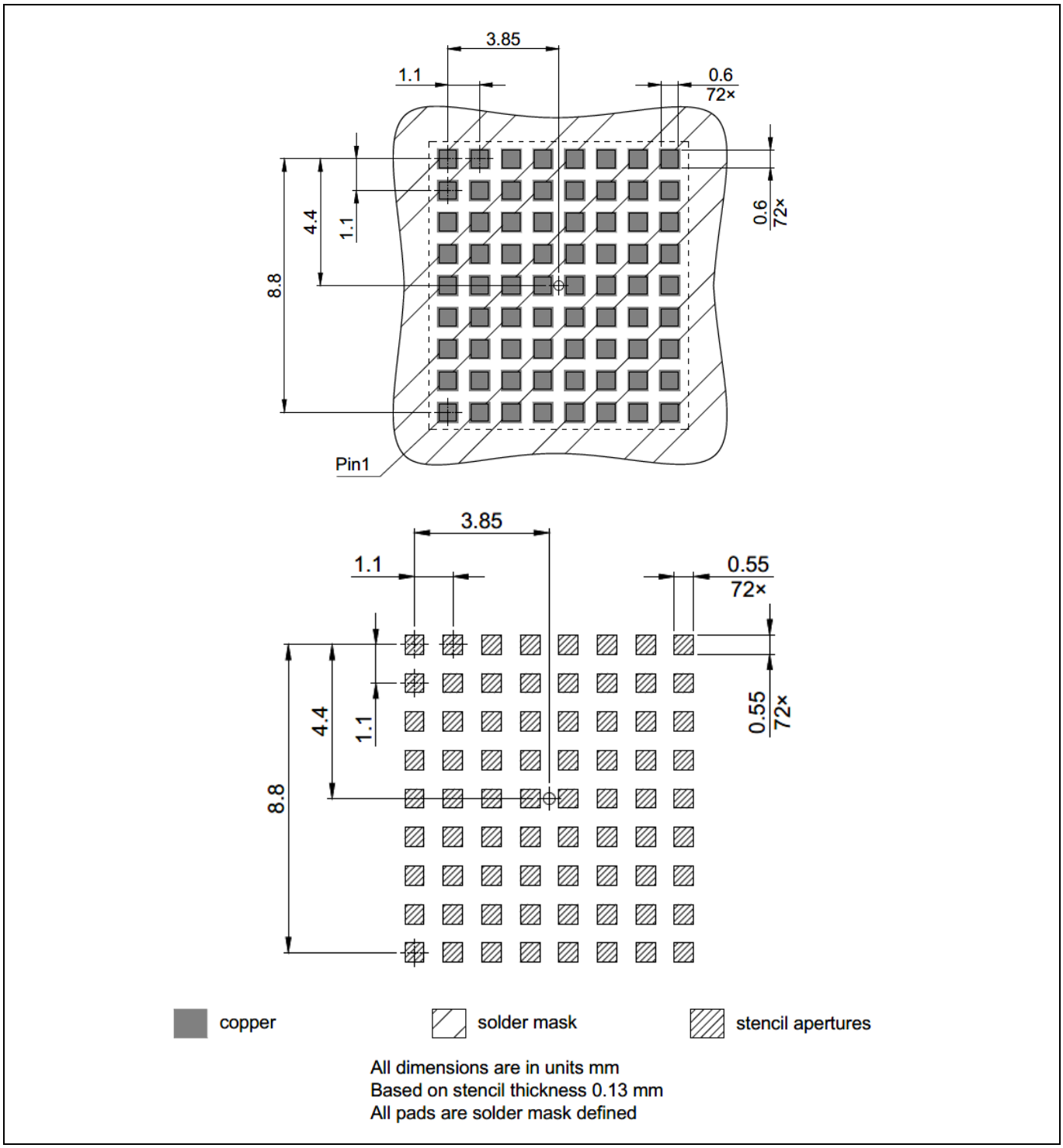

Figure 3 Stencil design

3.3 Pick and place

Design the pick and place nozzle to make a good seal with the module top surface. The dual-phase modules have distinct top inductor surfaces that can be used with a dual pick and place nozzle as shown in the figure below.

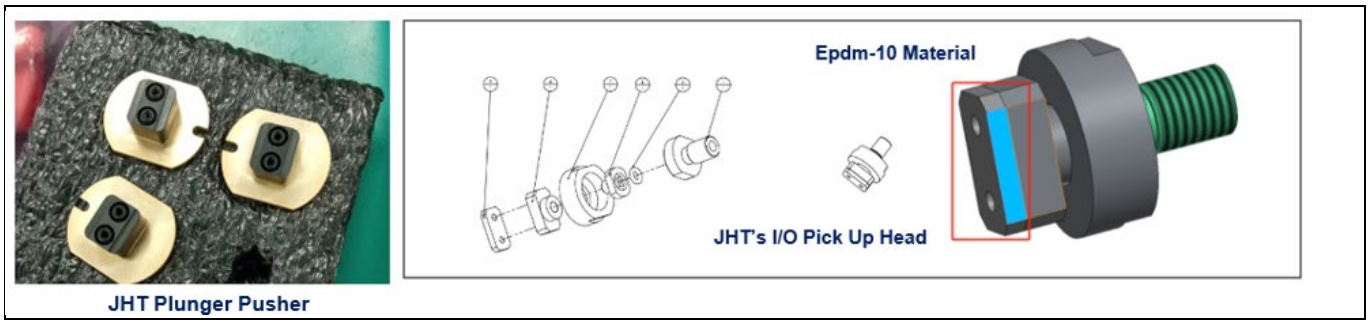

Figure 4 Pickup head design for dual-phase modules

Placement force should be high enough to ensure that all module pads get in touch with the solder paste, but low enough to not squeeze the solder paste out of the pad area. Typcial values are 1 to 2 N.

The pick and place mechanism will vary based on what equipment is used to handle the modules. The following figure shows an alternate pick-up nozzle design.

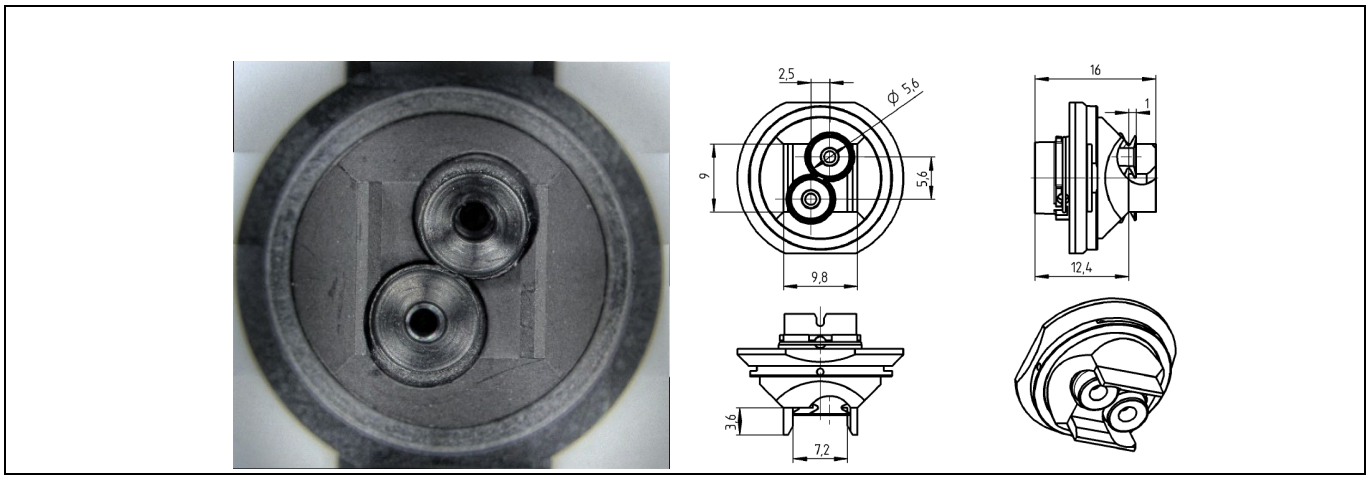

Figure 5 Alternate pick-up and place mechanism

4 Reflow

4.1 Profile

Modules are qualified for three 245°C reflows. Each reflow operation must follow the JEDEC J-STD-020D standard to form proper solder joints and minimize stresses on the module body. Three reflow operations allow for an initial mounting reflow, a second mounting reflow for additional components on a customer board and a rework reflow. The following figure shows an example reflow profile and Table 2 provides soldering parameters.

Figure 6 Reflow profile

Table 2 Reflow parameters

Parameter	Values	Notes
Classification Temperature (T_C)	245°C	Per Section 7.1, Table 2 JEDEC J-STD-020F. Module qualified with 260°C.
Peak allowable temperature (T_P)	255–260°C	Follow solder paste manufacturer guidelines for T_P.
Time above liquidus (TAL)	60-150 seconds	Maximum conditions for the component as defined per JEDEC J-STD-020F. Follow solder paste manufacturer guidelines for TAL.
Liquidus temperature	>217°C	Solder begins to soften at lower temperatures.
Preheat time	95–115 seconds	Preheat time enables flux to activate and etch LGA pads to improve adhesion and solder joint integrity.
Preheat temperature	100–150°C	–
Maximum ramp up rate (T_L to T_P)	3°C/sec	Maximum conditions for the component as defined per JEDEC J-STD-020F. Follow solder paste manufacturers recommendation.
Maximum cooling rate	6°C/sec	Maximum conditions for the component as defined per JEDEC J-STD-020F. Follow solder paste manufacturers recommendation.

The solder paste manufacturer will publish detailed parameters to optimize the reflow process for that particular paste chemistry. These parameters should be used when generating the initial reflow profile for module soldering. The profile should be further optimized for the specific board size, number of layers, copper thickness and mass of adjacent components. Please consult with Infineon if the desired reflow profile exceeds the parameters in Table 2 for T_P, TAL or maximum heating/cooling rates to ensure that the module solder integrity will not be harmed during the attach process.

4.2 Additional guidelines and recommendations

The following guidelines apply at any time the modules are undergoing reflow temperatures during assembly:

- Do not apply pressure to the top of the module during reflow. Module solder joints liquefy during the reflow process and pressure may cause solder or components to move in such a way as to wound or damage the module.
- Keep acceleration or vibration applied to the module to less than 0.5 g once the temperature exceeds 200°C. Beyond this temperature, the module solder joints will be liquidus, and excessive acceleration or vibration could cause parts to fall off.
- To the extent possible, design the reflow process to heat and cool the module uniformly. Depending on other components that can be located in close proximity to the module, this requires a faster or slower belt speed.

5 Post initial attach reflow

5.1 Inspection

Visual inspection of LGA solder joints located in the center of the module is not possible, therefore X-ray inspection is recommended for the pad connections underneath the module. The solder connections must comply with the latest version of IPC-A-610. In addition, given that all module solder connections have liquefied during the reflow, the module should be visually inspected to ensure that the module solder joints remain intact and components mounted to the module have not moved or shifted. If the guidelines in Section 4 are followed, the module solder joints will remain undisturbed following the reflow process. Any signs of solder bridging, bulging, or excessive solder balls (>100um in diameter) indicate that the module has been compromised by the reflow and the process parameters should be reviewed and optimized as needed.

5.2 Subsequent reflows

Infineon modules are qualified for up to three reflows. All three reflows should comply with the parameters shown in Table 2, however following the initial reflow to mount the modules, the subsequent reflows are focused on solder joint preservation rather than solder joint formation.

Modules may be upside down for subsequent reflows to enable double sided board assembly. In an assembly process that includes an upside reflow for modules the following guidelines should be followed.

- TDM22545x modules (5mm height) may be reflowed without support, i.e. no fixturing or glue is required to hold the module in place while being reflowed upside down. In this case, while the module solder joints are liquidus during the process, solder surface tension counteracts the weight of the module and components, holding them in place.
- If support is used during the upside down reflow process, care must be taken to ensure that pressure is not applied to the module, as this may cause solder or components to move. Any force that is applied should not exceed 1.24gf (the approximate weight of the inductor clip) to insure no significant movement occurs during the time joints are liquefied.
- As mentioned in section 4.2, keep acceleration or vibration applied to the module to less than 0.5 g once the temperature exceeds 200°C to minimize component movement.
- While the focus of the reflow profile will be the components being mounted, the ramp and cool down rates of the module during a subsequent reflow should be monitored closely to ensure that module solder connections are not compromised by the process.
- Visual inspection of module solder joints per section 5.1 is recommended following subsequent reflows.
- The module solder joints will not become liquidus at temperatures below 200°C. Any reflow profile that does not expose the module to temperatures above 200°C does not count as a reflow for the module and does not need to follow these guidelines.

5.3 Rework

If needed, a module can be removed from the main board by heating it above 220°C with a hot air gun and then lifting the module off with tweezers. Once removed in this way, the module must be discarded as internal components and solder have likely shifted during this process. During the application of heat above 220°C, ensure that care is taken as to not induce any pressure or movement in adjacent modules during the rework process.

A module may be replaced by cleaning the main board pads, re-printing solder, and repeating the process outlined in this document.

6 Mechanical Considerations and Heatsink Mounting

The module is designed to efficiently conduct the heat away from the silicon dies inside the power stages both from the top side of the module via the copper clips and through the bottom side of the module via the PCB.

As shown in the picture below, the thermal energy can be efficiently extracted from the module by attaching a heat sink or a cold plate on the top side of the module. A thermal interface material (thermal gap pad or thermal putty) between the module and the heat sink/cold plate helps improve the thermal path by reducing the interfacial contact resistances. The thermal interface material datasheets and application notes suggest recommended mounting pressure for lower thermal resistance. Infineon recommends mounting pressure to be ≤100 psi; exceeding this mounting pressure may potentially damage the module and may also cause parametric shifts in performance.

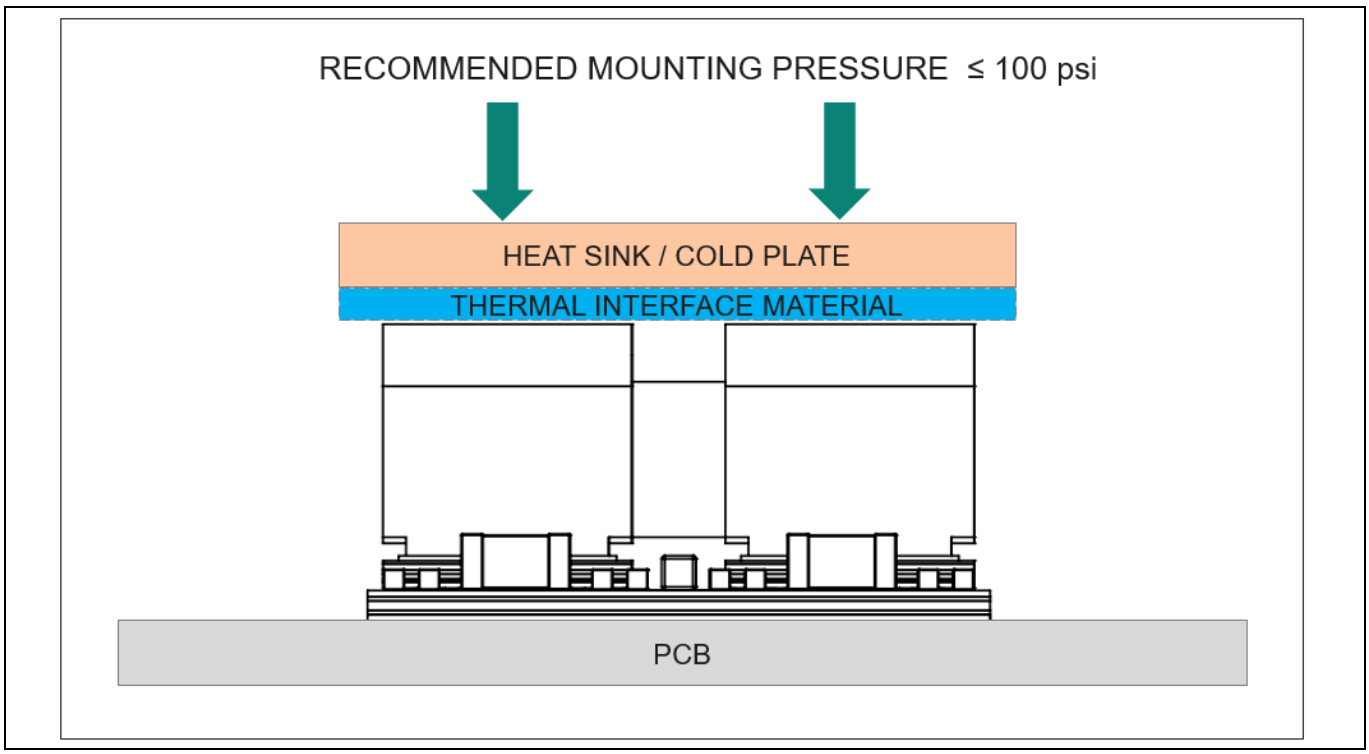

Figure 7 Recommended mounting pressure

If part of the system assembly, Infineon modules should have the heatsink or coldplate mounted to them post reflow. When mounting a heatsink, the following guidelines should be observed.

- Maximum vertical pressure applied to the module should be kept below 100psi.
- Applying force to the module off vertical axis should be avoided. In particular off axis force applied to the inductor body can apply shear stress to the solder joints located under the power stages on the modules, causing fracture, intermittent contact and module failure.
- When applying vertical force to the module, the back side of the customer board should be supported to prevent board deflection. Deflection can cause shear stress to solder joints and cause compromise and failure.

- In double-sided assemblies, the board must be supported when mounting heatsinks or other mechanical components on the opposite side to prevent board deflection damage in the opposite direction.
- Either compliant pads or dispensable Thermal Interface Materials (TIM) can be used to couple module heat to the heatsink. When using a TIM pad, the module tolerance stack should be considered to properly size the pad thickness. When using a dispensable TIM, the dispense method should ensure 100% coverage of the module top surface.
- The metal top surface of the module is at V_{OUT} potential. The mechanical stack should be designed such that no casual contact between grounded heatsinks and top clip is possible in the worst case. Given the low potential of V_{OUT}, most TIMs have sufficient resistance so as to prevent current flow from clip to heatsink. The resistivity of the TIM should be checked to confirm no significant current will flow in the system.

References

[1] Infineon Technologies AG: *TDM22544D webpage*; Available online

[2] Infineon Technologies AG: *TDM22545D webpage*; Available online

Revision history

Document revision	Date	Description of changes
V 1.0	2024-04-19	Initial release
V 1.1	2024-06-04	Section 3.2 added. Recommended stencil design for LG-MLGA-72 Section 6.0 added. Mechanical recommendations
V 2.0	2025-03-31	Updated to include guidelines for subsequent reverse side reflow

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