TN1605

Technical note

# Press-fit ACEPACK power modules mounting instructions

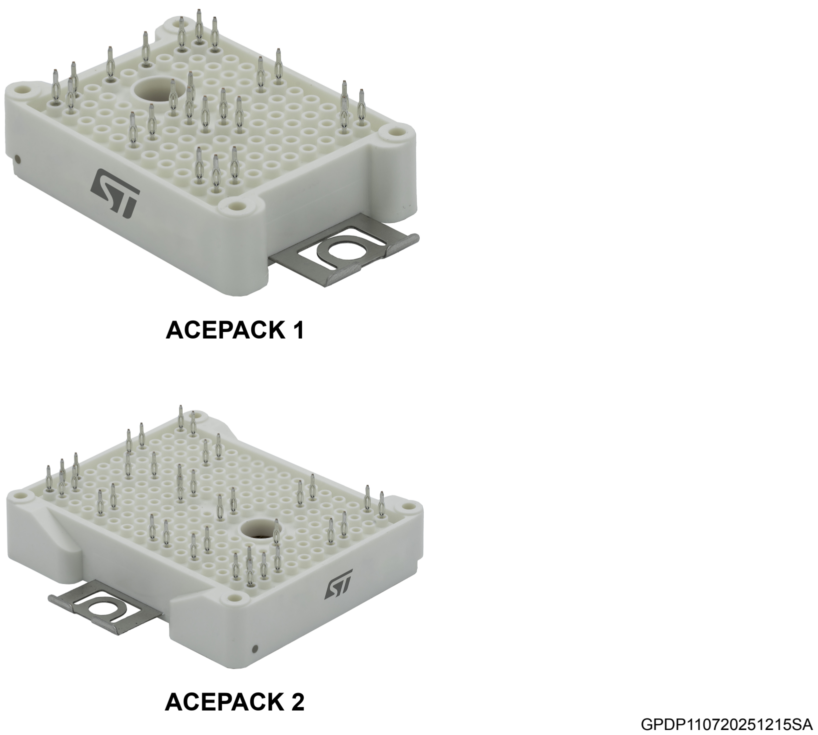
## Introduction

STMicroelectronics introduces the ACEPACK power module family, designed for easy mounting and reliable performance in rugged applications. The available module form factors are ACEPACK 1 with 33.8 mm x 48 mm and ACEPACK 2 with 56.7 mm x 48 mm body dimensions. Various die selections in silicon and silicon carbide substrates can be housed in several configurations.

These modules feature a compact, fully isolated, low profile housing able to integrate very high-power density components in a low junction-to-case thermal resistance DBC. Power modules simplify the design and increase reliability, while PCB size and system costs are optimized.

The following sections provide recommendations for the connection of these modules to a printed circuit board (PCB) and mounting and dismounting methods to achieve adequate connections, reliability, and performance in typical applications.

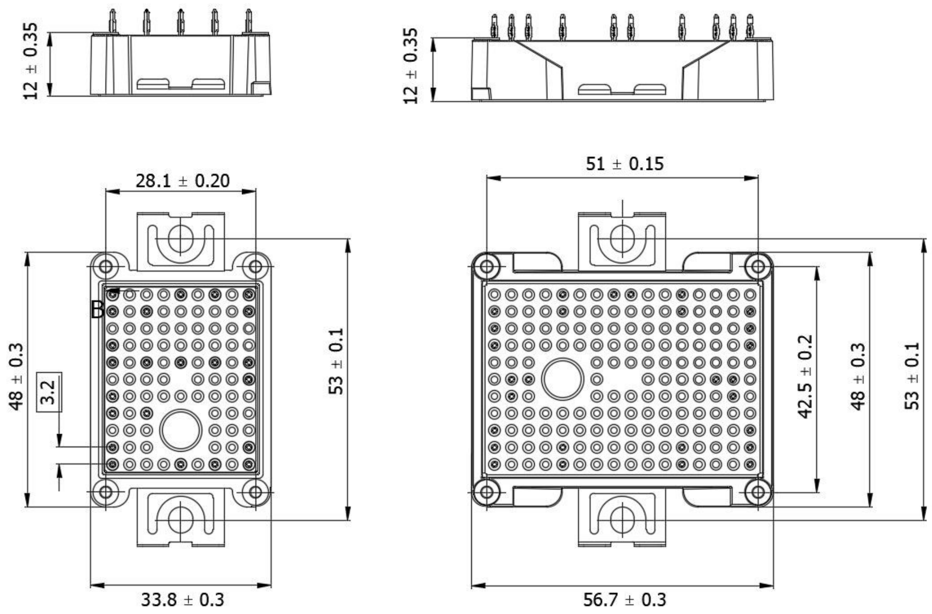
**Figure 1. ACEPACK 1 and ACEPACK 2**



# 1 Key dimensions

For the dimensions for monitoring the ACEPACK 1 and ACEPACK 2 module, refer to Figure 2. Dimensions ACEPACK 1 and ACEPACK 2. The mounting hole size is 53±0.1 mm, while the pin position accuracy is 0.5 mm. For more detailed dimensions, refer to the module datasheet.

**Figure 2. Dimensions ACEPACK 1 and ACEPACK 2**

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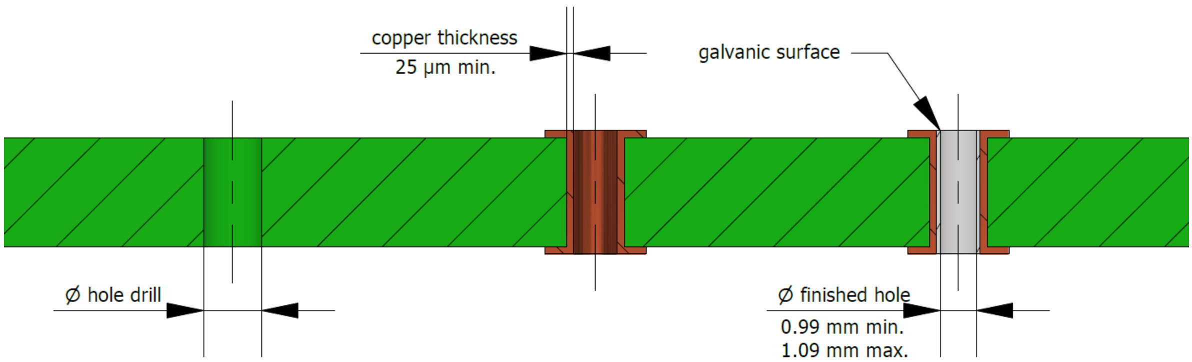
# 2 PCB requirements

The press-fit used in the ACEPACK module has been qualified for standard FR4 printed circuit boards with tin (chemically) (IEC 60352-5 + IEC60747-15). If other handling technologies are used in the production of printed circuit boards, they would have to be tested, inspected, and qualified.

**Figure 3. Plated through holes**




An adequate design of the plated through holes (PTH) of a PCB is essential to obtain good quality press-fit connections. If the finished hole diameter of the PTH is too small, the press-in force through the plated hole may be too high and cause mechanical damage to the pins and the PTH. If the finished hole diameter is too large, it may not form a reliable connection with the pin.

The initial hole diameter prior to plating is important in determining the reliability of press-fit connections. As per the IEC 60352-5 specification, it should be 1.15 mm typical. The thickness of the copper plating applied to the initial hole shall be minimum 25 µm to maximum 50 µm. Then, a surface finish of about 1 µm chemical tin is applied to the hole.

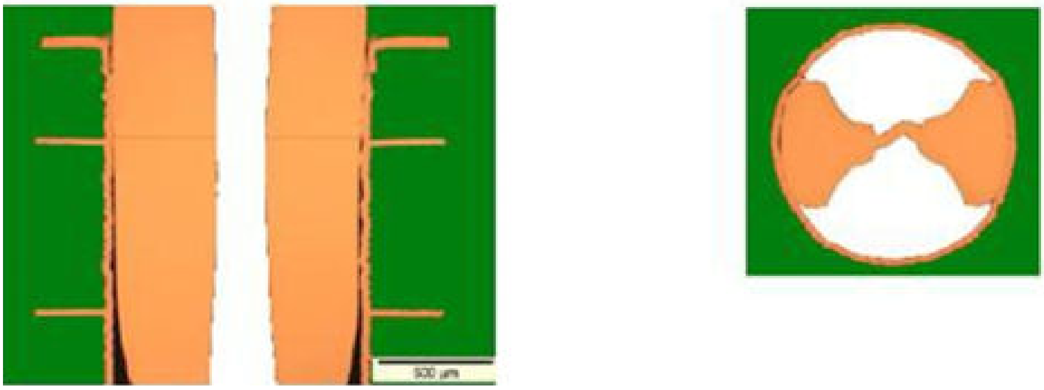
**Table 1. Printed circuit board requirements for press-fit leads option**

| Press-fit leads option | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Hole drill diameter | 1.12 | 1.15 | 1.18 | mm |
| Copper thickness in hole | 25 | | 50 | µm |
| Metallization in hole | | | 15 | µm |
| Finished hole diameter | 0.99 | | 1.09 | mm |
| Copper thickness of conductors | 35 | 70 - 105 | 400 | µm |
| Metallization of circuit board | TIN (chemical) recommended | | | |
| Metallization of pin | Ni / Sn (galvanic) | | | |

Other TIN finish technologies on PCB should be avoided without verification. The HAL plating method is not recommended because of uneven plating on the hole.

The electrical and thermal contacts with the circuit board are implemented by means of cold welding when press-fit pins are used. Permanent deformation takes place as a result of PCB insertion and this deformation is intended to accommodate the tolerance and provides the basis for the cold welding. The resulting forces during the press-fit process ensure that the welded materials on the PCB and pin exhibit a continuously consistent and, unlike other contact technologies, very small electrical contact resistance, see Figure 4. Materials connected in a gas-tight manner due to the press-in force.

**Figure 4. Materials connected in a gas-tight manner due to the press-in force**



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A module that has been pressed in and then pressed out again can no longer be pressed in again. Instead, the module can only be attached to a new printed circuit board by soldering. The plastic deformation of the press-fit zone does not permit further press-fit processes.

# 3 Module mounting process in a PCB

## 3.1 General press-in process

The press-fit process is a cost-effective way to assemble power modules without introducing additional thermal loads. The press-fit connection generates a strong mechanical and a good electrical connection between the module and the PCB.

The press-in assembly procedure must be differentiated for the two cases:

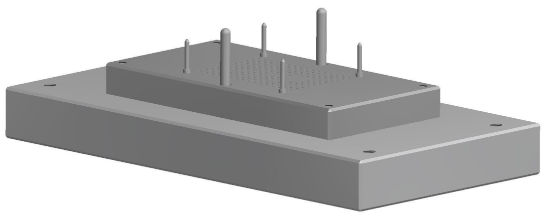
- Single module on PCB.
- Multiple modules on the same PCB.

Generally, a module can be pressed in until the stand-offs (domes) on the four corners of the module touch the PCB.

The figures below show the general process step for the single module case.

The PCB is first placed on the lower press-in tool (step 1) and the module is then aligned to the PCB with the guide pins (step 2). Then, the upper press-in tool can start moving down the module (step 3 - S) until the module domes touch the surface of the PCB (step 4 - S).

**Figure 5. Step 0**



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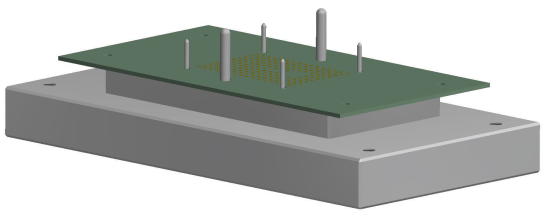
**Step 0:** The bottom plate of the tool with some positioning pins in the four corners to align the PCB and the power module. The two longer pins in the middle align the bottom and the top plates of the tool.

**Figure 6. Step 1**



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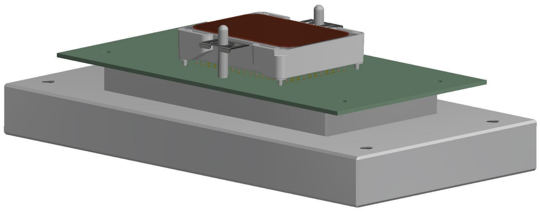
**Step 1**: At the beginning the PCB is placed into the bottom tool. The right alignment is guarantee by the four positioning pins at the corners.

Figure 7. **Step 2**



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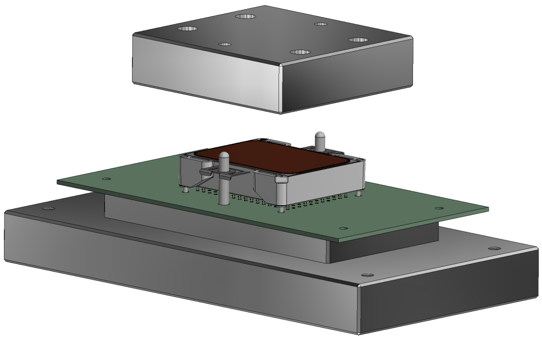
**Step 2**: The module is placed on the positioning elements and press fit pin tips engage into the PCB PTH. The two long pins pass through the holes in the springs of the module.

Figure 8. **Step 3 - S**



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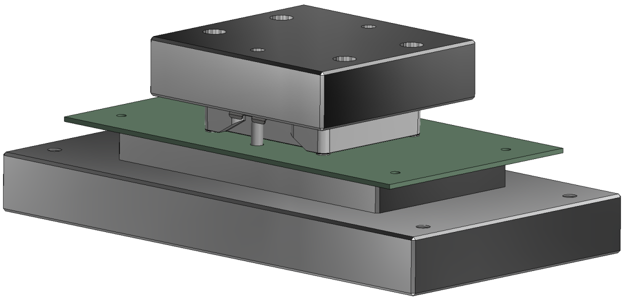
**Step 3 - S**: The flat top plate ensures that at the end of the press-in process the distance between the module and the PCB touch the module, so it is no gap in between.

Figure 9. **Step 4 - S**



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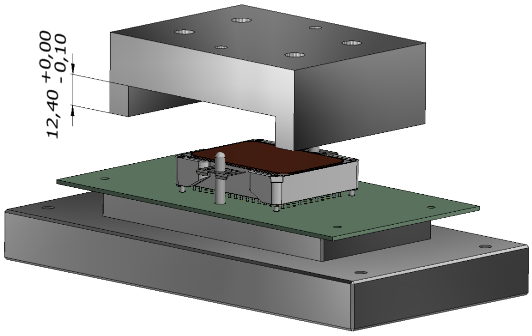
**Step 4 - S**: The pressing process stops by the increasing force between the PCB and the plastic housing domes.

In case of assembly of multiple modules on the same PCB the insertion tool top plate is different and the relevant process step 3 and 4 are shown in figures below.

Figure 10. **Step 3 - M**

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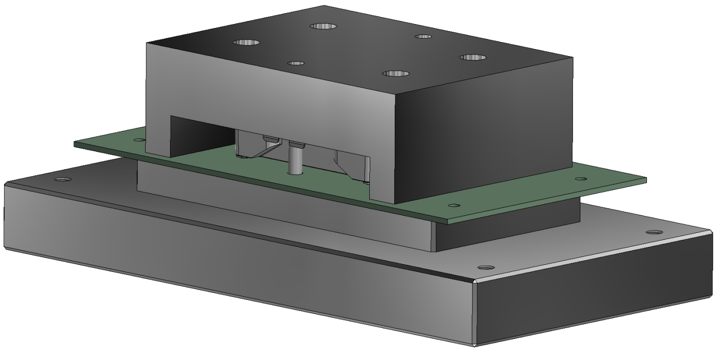
**Step 3 - M**: The shape of the top plate ensures that at the end of the press-in process the distance between the module back side and PCB is 12.40 0/-0.10 mm. The height of the housing is 12.00±0.35 mm, so an air gap between module and PCB is granted (dimensions referred to the Al2O3 substrate).

Figure 11. **Step 4 - M**



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**Step 4 - M**: The pressing process stops by the increasing force between the PCB and the top plate distance keeper.

When multiple modules are assembled on the same PCB and the same heat sink, the height deviations among the modules must be minimized to guarantee adequate contact on the heatsink and avoid mechanical stress on the PCB. In this case, a press-in tool with distance keepers is required to ensure the same distance between the PCB and the top of the modules, as shown in figures above.

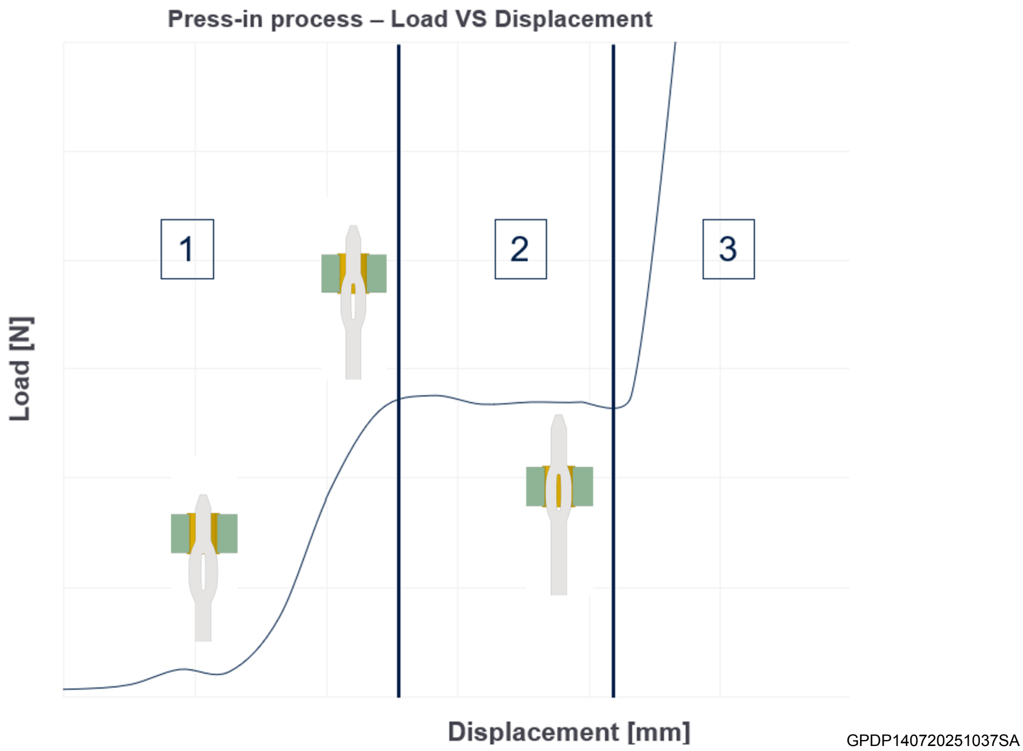
During the process, once the distance keeper contacts the surface of the PCB, the press-in force rises and the press-in process can be stopped, thus preventing direct contact between the case and the PCB. The distance keepers and the other board components should be designed so that no contact among them can occur during the press-in process.

The PCB is first placed on the lower press-in tool (step 1) and the module is then aligned to the PCB with the guide pins (step 2). Then, the upper press-in tool can start moving down the module (step 3 - M) until the distance keepers touch the surface of the PCB (step 4 - M).

## 3.2 Press-in curve example

The press-in process can generally be described by three distinct sections which are depicted in Figure 12. Typical press-in-force profile for insertion with distance keeper. During the first portion of the press-in process, the pins are deformed while being pressed into the PCB through holes. Once the second stage of the process is reached, the module continues to be pressed into its final position, but the force no longer increases because the pins have been deformed to match the PCB hole size. In the third and final stage, the top press-in fixturing tool contacts the PCB and the module can be pressed in no further. At this stage, the fixturing and PCB start to flex, resulting in a steep increase in force with distance relationship. The press-in process should stop before excess force is applied during this stage.

**Figure 12.** Typical press-in-force profile for insertion with distance keeper

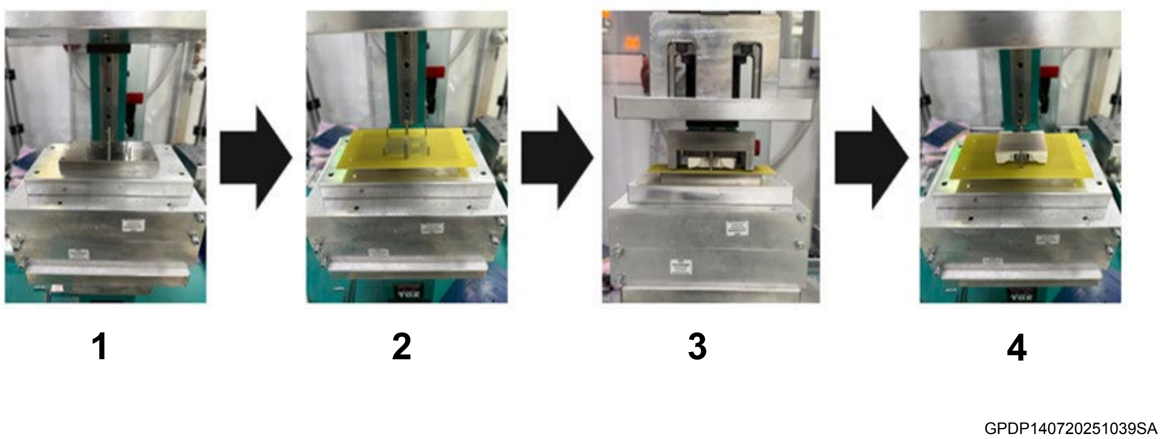



## 3.3 Press-in parameters

A press-in machine as shown in Figure 13. Example of equipment for general press-in process that records the necessary force and the travel distance is recommended to ensure appropriate quality. If possible, monitor the press-in/press-out distance, speed, and force to achieve mechanical stability and high reliability of the press-fit connection:

- The travel distance during the press-in process should be controlled to ensure that the press-fit zone of the pins sits properly in the plated through hole.
- The speed influences the quality of the press-fit connection.

**Figure 13.** Example of equipment for general press-in process



The speed should not be lower than 25 mm/min according to IEC 60352-5. A lower speed can lead to increased press-in forces and deformation of the pins or a non gas-tight connection.

Typical press-in forces vary with the finished hole diameter of the PCB and more in general on the contact area between press-fit pin and plated through hole. Based on the PCB requirements (see Section 2: PCB requirements), the following forces and speeds are recommended:

**Table 2. Press-fit requirements in a printed circuit board**

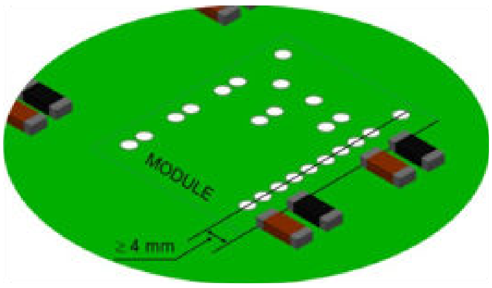
| Press-fit requirements in a printed circuit board | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| Press-in speed | 25 | 100 | | mm/min |
| Press-in force (each pin) | | 60 | 80 | N |

*Note: The maximum applied force per module during pressing should not exceed 4 kN.*

Attention should also be paid to other components like resistors, diodes, or capacitors that need to be assembled on the PCB area next to the ACEPACK module. PCB bending during press-in processes can cause mechanical stress to other PCB components.

It is recommended to leave at least 4 mm between the edge of these components and the middle of the PTH.

**Figure 14. Minimum suggested distance between PTH and components**

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## 3.4 Press-out process

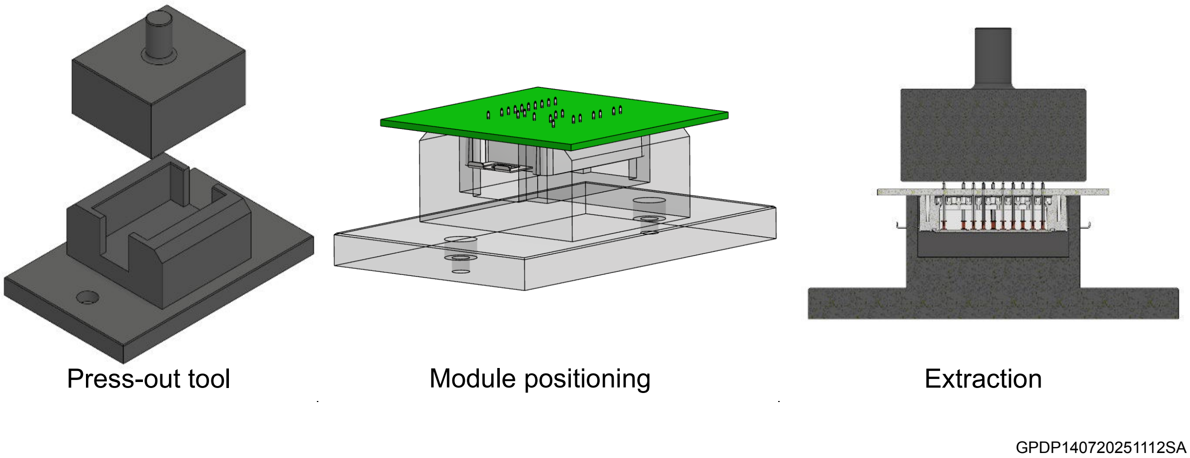
ACEPACK press-fit modules are removed with the appropriate tools as shown in Figure 15. Press-out process.

The press-out tools consist of two parts: the top part presses directly downwards on the module pins; the bottom part holds the PCB during pressing and receives the modules once the press-out is completed.

The force is applied directly touching the pins that protrude from the PCB. The press-out tools must be aligned parallel to each other so that the individual components (such as the PCB and module) are not damaged.

Once the press fit pin-compliant zone is not any more inside the PCB through holes the module falls onto the bottom basement in the lower part of the tool and is separated from the board.

**Figure 15.** **Press-out process**




The press-out tool must be aligned parallel to each other to obtain an equally distributed extrusion process.

The dimensions and shape of the tool must consider not to damage the components positioned around the module during pressing.

The overall press out force depends on the relevant pin out of the product. For the single pin the retention force is typically bigger than 55N.

# 4 Fixing a PCB to the ACEPACK module

**Figure 16.** ACEPACK fixing PCB and cross-section

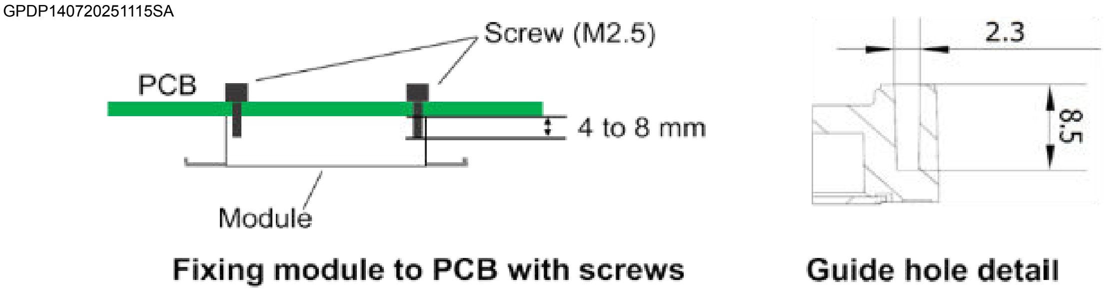
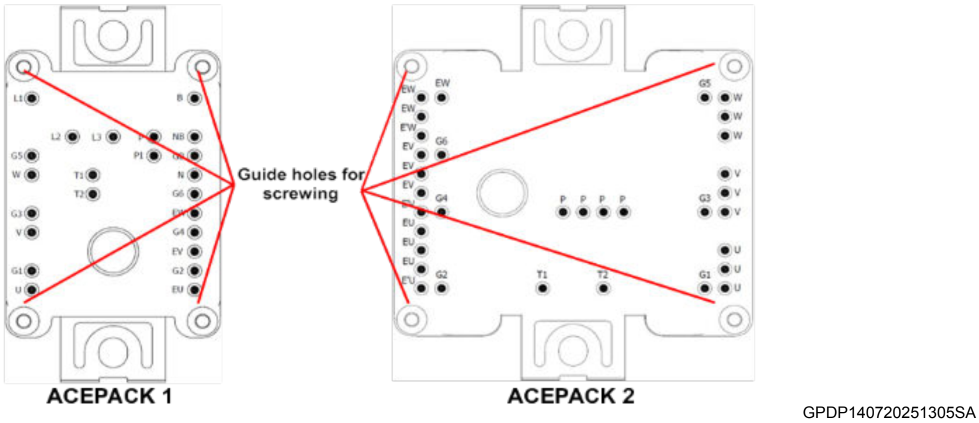



**Figure 17.** Guide hole for the screws in ACEPACK 1 and ACEPACK 2




After the PCB mounting process, it is possible to connect the PCB to the module by screws.

This connection is recommended in case of a single module on the PCB.

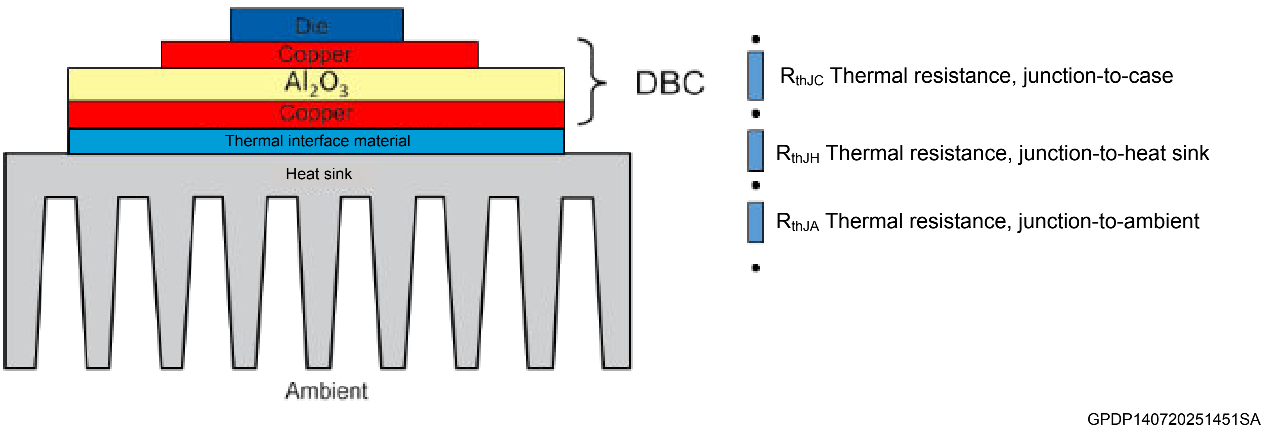
In case of multiple modules assembled in the same PCB the screws must NOT be applied.

Screwing into a plastic cavity is a delicate operation, and care has to be taken to avoid stand-off damage. We suggest using M2.5 x L self-tapping screws, with length L depending on the PCB thickness (screw thread inside guide hole has to be between 4 and 8 mm). The screws self-tap into the stand-off cavity. The vertical position of the screw must also be maintained to prevent lateral insertion. A crosswise sequence for mounting the screws is suggested and the screwdriver should have a slow rotating speed. Typical mounting torque is 0.45 Nm±10% and the screwdriver speed lower than 300 rpm (it is better to avoid pneumatic screwdrivers due to a lack of accuracy in torque).

# 5 Mounting the module to a heat sink

The heat produced by a module must be dissipated to avoid overheating and consequent damage. The thermal performance of a module in combination with a heat sink can be characterized by the sum of all thermal resistances along the thermal path: junction-to-case, case-to-heat sink, and heat sink-to-ambient, as shown in the figure below.

**Figure 18. Dissipation mechanism**




Proper contact between the module substrate and the surface of the heat sink is crucial for managing the overall thermal efficiency of the system. Thermal interface materials (TIMs) are thermally conductive materials used to allow proper matching of the two surfaces and improve heat transfer.

## 5.1 Requirements for a heat sink

In order to maximize heat transfer efficiency, the heat sink contact surface must be flat and clean. The required heat sink surface qualities to achieve good thermal conductivity must be according to DIN 4768-1. Roughness (Rz) should be 10 µm or less and flatness, based on a length of 100 mm, should be 50 µm or less. In particular, the flatness must be less than above value in the module mounting area, including the two clamp screws.

Furthermore, the interface surface of the heat sink must be free of particles and contamination.

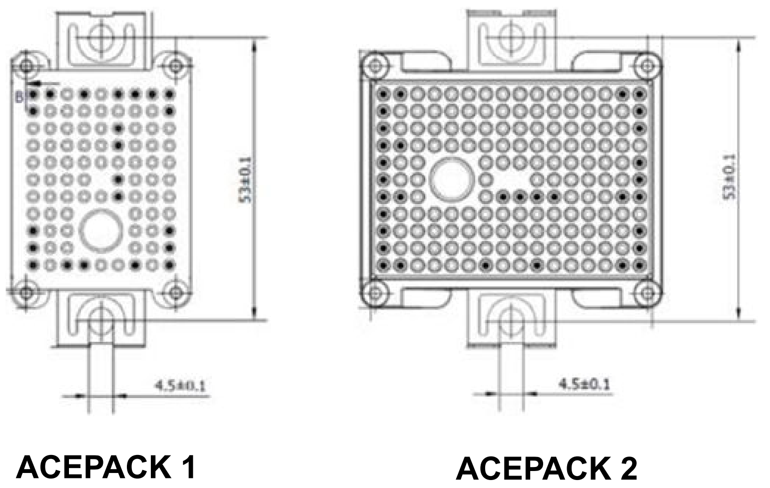
## 5.2 Application of thermal paste

Thermal paste thickness strongly affects the thermal resistivity between the module and the heat sink. An even layer of 80 µm is recommended. Thermal grease quantity is sufficient if a small amount of it can be seen out of the module after the heat sink mounting process.

## 5.3 Heat sink mounting

Heat sink mounting on the modules requires aligning the clamp screw holes of the module with the two thread holes on the heat sink.

**Figure 19.** **Screw clamping zone dimensions**




In the figure below shows one-step and three-step fastening methods.

In the one-step method, the two screws are simultaneously fastened to avoid tilting on one side of the module. Synchronize the two electric screwdrivers to have the same rpm and maximum torque.

In the three-step method:

1. Fasten the first screw only until it touches the screw clamp and does not provoke tilting of the module.
2. Fasten the second screw to the final torque (see Table 3. Technical data of the mounting screw).
3. Fasten the first screw to full torque, securing the module to the heatsink.

**Figure 20.** Module to heat sink fastening method

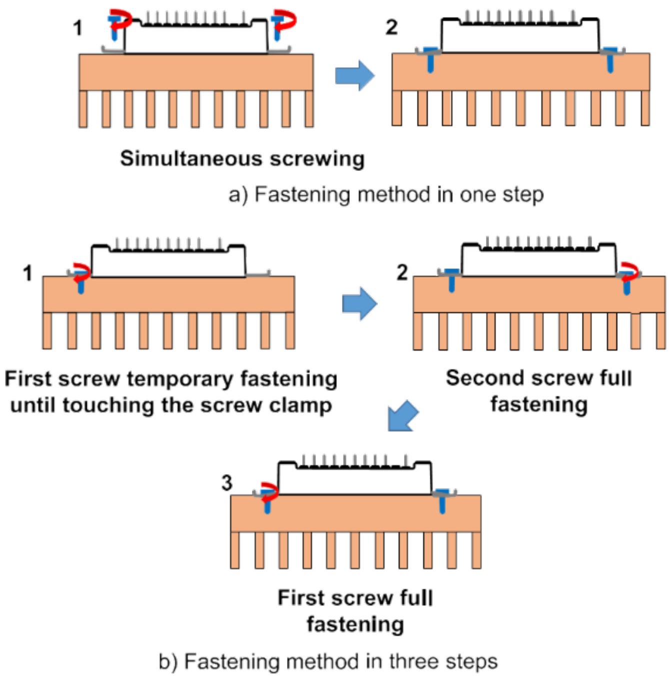



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**Table 3.** Technical data of the mounting screw

| Description | Value |
| --- | --- |
| Mounting screw | M4 |
| Recommended mounting torque | 2.0 - 2.3 Nm |

# 6 Assembly of the PCB and heat sink

After modules are assembled to the PCB and the heat sink, the overall structural integrity needs to be considered to avoid mechanical stress to any of the system components. If the PCB is large and heavy with other components assembled to it, there is some risk that the PCB can bend, creating mechanical stress on the module and the PCB. When multiple modules are applied to the same PCB, height tolerance between modules can result in the mechanical stresses on the board and modules. To reduce stress, space posts should be added on the heat sink to prevent movement of the PCB.

The recommended height of the space posts [H] is 12.40 (0/-0,10) mm for a product with $Al_2O_3$ substrate. The effective distance between center of stand-off and the space post [X] is 50 mm minimum, as shown in the following figure.

In this case the press in process used has to leave the air gap between module and PCB.

The screws must joint the PCB to the space posts. NO screws must be between the module and PCB.

**Figure 21. Assembly procedure when space posts are used**

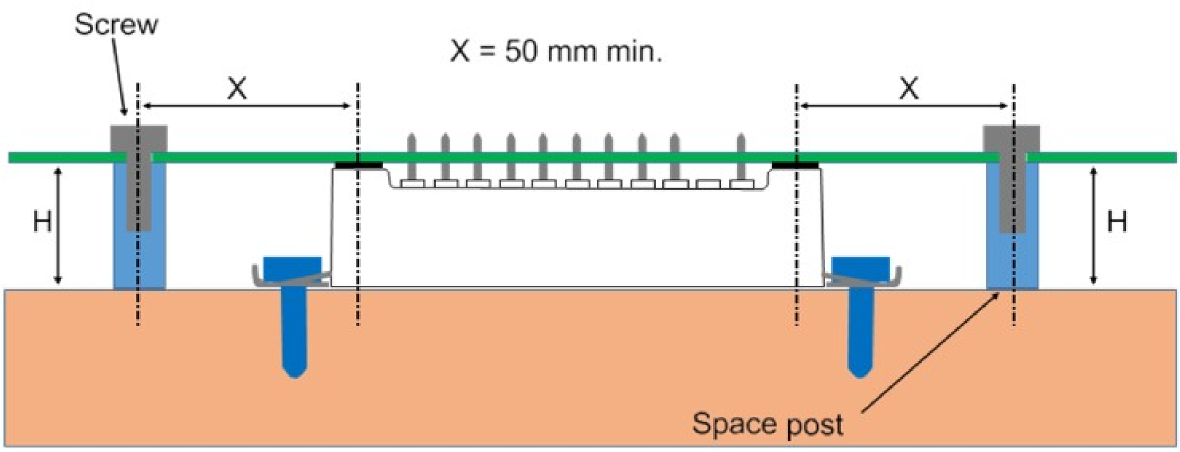
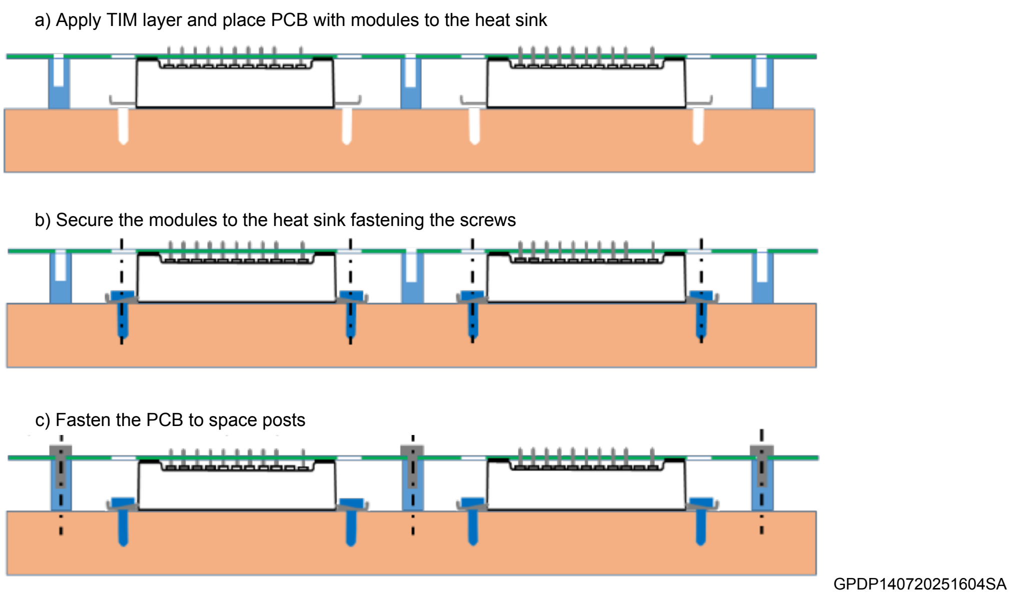


Figure 22. Heat sink mounting shows the overall assembly procedure when space posts are used. First the PCB with the modules is placed onto the heatsink (a). Then the modules are fastened to the heatsink through the screw clamps (b). Finally, the PCB is fixed on the space posts (c).

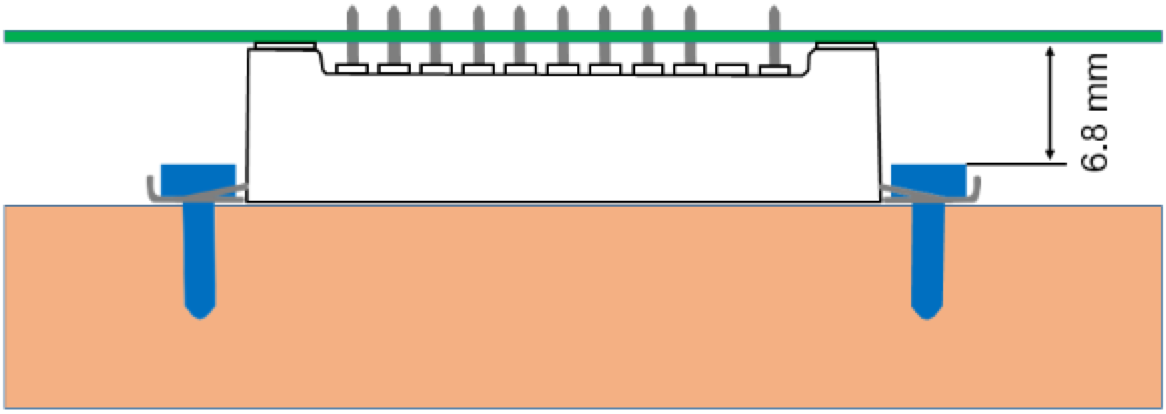
**Figure 22. Heat sink mounting**



# 7 Clearance and creepage distances

When defining the layout of the PCB, application-specific standards, especially regarding clearance and creepage distances, must be considered. This is particularly important for the area of the screw clamp located under the printed circuit board. To meet the respective requirements for clearance and creepage distances, avoid current-carrying devices or through-holes in this area, or apply additional isolation measures such as lacquering.

Figure 23. **Air path between clip and PCB**

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The minimum clearance distance between the screw and the PCB depends on the screw itself. The distance is 6.8 mm with a hexagon socket head screw according to DIN 912, a washer according to DIN 125 and the clamp, see Figure 23. Air path between clip and PCB. The clearance and creepage distances specified in the datasheet are minimum values, irrespective of other devices that may be mounted close to the module.

In any case, the application-specific clearance and creepage distances must be checked and compared with relevant standards and guaranteed through appropriate construction methods, if required.

## Revision history

Table 4. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 29-Jul-2025 | 1 | First release. |

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