# Handling and Mounting Instructions for SiCPAK™ Power Modules

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# 1 Introduction

This application note covers the recommended PCB design and mounting guidelines for Navitas' SiCPAK™ Series power modules. Special attention should be paid to the process of inserting the module into the PCB and the design of the PCB on which the module will be crimped. Failure to adhere to proper module insertion procedures and PCB design may result in press-fit pin damage or module housing damage, making the module unsuitable for use. It is recommended that you follow the instructions outlined in this document to ensure safe and reliable operation of the SiCPAK™ series modules. SiCPAK™ F and G are shown in Figure 1. For the exact dimensions of each product, please refer to the module's datasheet on the Navitas website. It is recommended that you follow these instructions to ensure safe and reliable operation of the SiCPAK™ series power modules.


Figure 1. SiCPAK™ F(Left) and SiCPAK™ G(Right) Images

## 1.1 Key Dimensions

The key dimensions for mounting SICPAK™ F and SICPAK™ G modules are shown in Figure 2 below. The pin pitch is 3.20 mm± 0.3 mm, and the distance between the mounting holes is 53 mm± 0.1 mm. For more information on dimensions and tolerances for designing hardware for these systems, refer to the module datasheet.

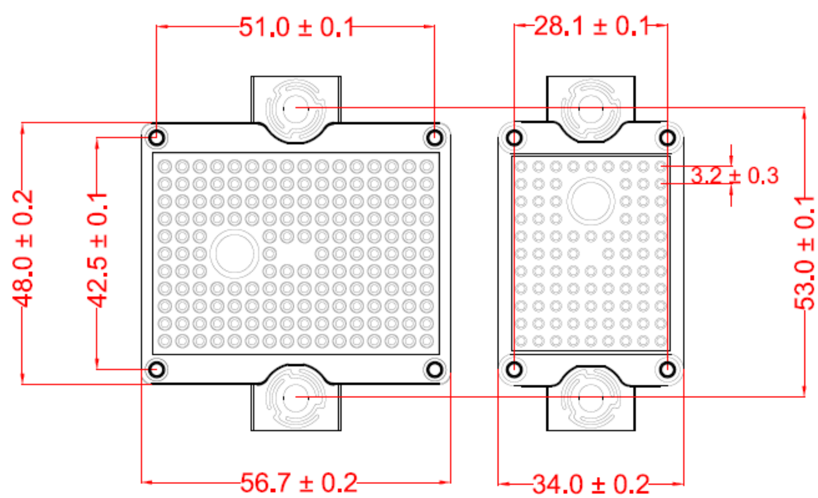



Figure 2. Key Dimensions of SiCPAK™ G and F

### 1.2 Press-fit Pin

SiCPAK™ power modules adopt press-fit contacts, eliminating the need for soldering or the use of fastening hardware to attach module terminals to PCBs. The press-fit contacts of the SiCPAK™ power module are shown in Figure 3. The press-fit contact method facilitates the assembly process and provides a cold-welded connection to provide excellent mechanical and electrical performance.

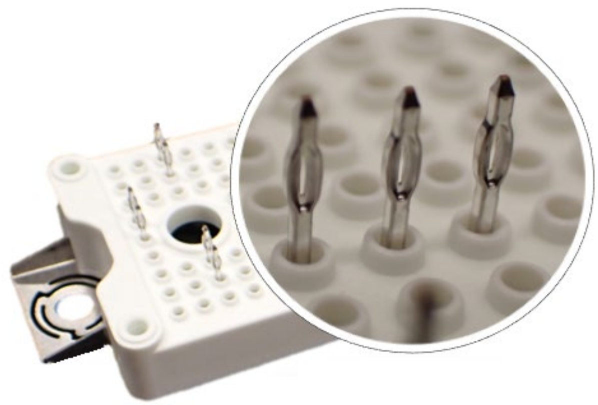


Figure 3. Typical appearance of Press-fit pin

### 1.3 Handling

Care must be taken not to exert force on the bottom of the housing while the substrate is not supported. The substrate and the module housing are not firmly attached to each other, and the substrate may be pushed out of the housing when force is applied to the housing as shown in Figure 4. For the same reason, no force should be applied to the pins of the module. In all real-world applications, the housing and board positions are fixed relative to each other, and these precautions do not cause problems.

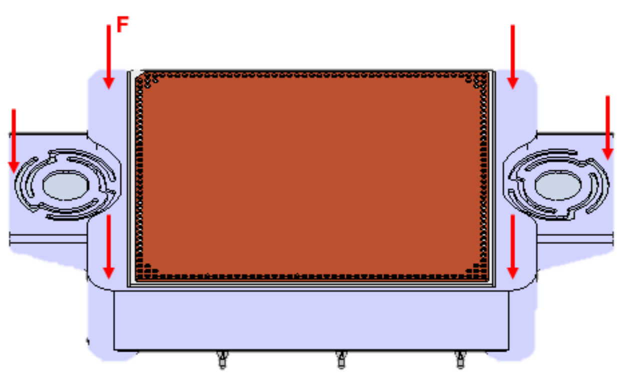



Figure 4. Forces on the housing during module handling should be avoided to prevent a substrate push-out

## 2 PCB Requirements

When properly designed and inserted, the module pins and PCB holes form a cold welding, providing high reliability. The PCB hole recommendations for SiCPAK™ modules are detailed in Table 1 and clarified in Figure 5. To ensure this high reliability connection, FR4 PCBs must comply with IEC 60352-5 and IEC 60747-15. In addition, double-sided PCBs must meet IEC 60249-2-4 or IEC 60249-2-5, while multilayer PCBs must meet IEC 60249-2-11 or IEC 60249-2-12. Users can use a variety of drill sizes to modify the copper thickness and metallization thickness to get the correct finish hole diameter, but Navitas has not conducted extensive reliability or connection quality testing to validate these PCB specification modifications. Press-fit pins are designed to be inserted into PCBs with a maximum thickness of 2 mm. Exceeding the maximum PCB thickness will reduce the ability to crimp modules using the recommended procedure.

Table 1. PCB Requirements for EON Press-fit Pins

| | Min. | Typ. | Max. |
|---|---|---|---|
| Initial Drilled Hole Diameter Ø [mm] | 1.12 | 1.15 | |
| Cu Thickness in the Hole [µm] | 25 | | 50 |
| Sn Thickness [µm] (Chemical Tin) | | | 15 |
| Final Hole Ø [mm] | 1.02 | | 1.09 |
| Annular ring [µm] | 200 | | |
| Thickness of Conductive Layer [µm] | 35 | 70−105 | 400 |
| Board Thickness [mm] | 1.6 | | |

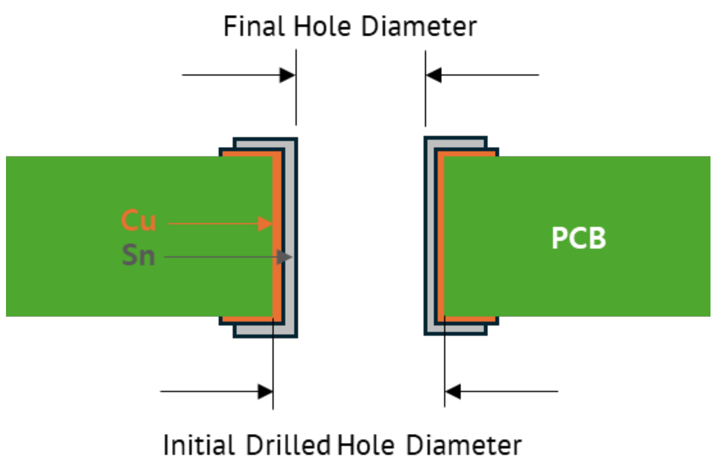



Figure 5. Recommended PCB Structure

Navitas recommends 1.05 ± 0.05 mm for the typical end hole diameter. Customers are not advised to specify PCB pin holes by end hole diameter alone. Even though the customer gets the same end hole diameter, achieving that diameter through different combinations of drill hole sizes and processes may not meet the specification. The specifications provided to the PCB manufacturer should include all the information listed in Table 1, especially the drill diameter.

The recommendation still applies that holes in the PCB should be drilled during manufacturing with a drill size of 1.15 mm and should not be milled. Experience has shown that drilled hole diameters of 1.12 mm and 1.15 mm are obtained considering the run-out tolerance of the spindle after drilling due to shrinkage of FR4 material.

PCB fabricated complying to the above standards allows SiCPAK™ series modules to be pressed in up to 3 times. It is recommended to replace the PCB after removing the third module from the PCB. It is also recommended to solder the module pins to the PCB, once press out the module after pressing into the PCB may reduce the press-fit function. When removing a module from the PCB, it should be avoided if possible as the pins may be damaged. A module can be press-fit up to twice before it needs to be replaced.

To safeguard the module from high temperatures, we recommend reflowing the PCB before pressing the module onto it, especially if other components require reflow soldering. For PCBs adhering to these guidelines, crucial dimensions must be upheld to guarantee the press-fit connection's reliability remains intact post-reflow. Should the press-fit occur prior to heatsink mounting, the PCB requires a clearance hole at the center of the mounting screw position for screw head passage (see Figure 6). Conversely, mounting the module on the heatsink before pressing it into the PCB eliminates the need for this clearance hole, though it might complicate the press-fit process itself.

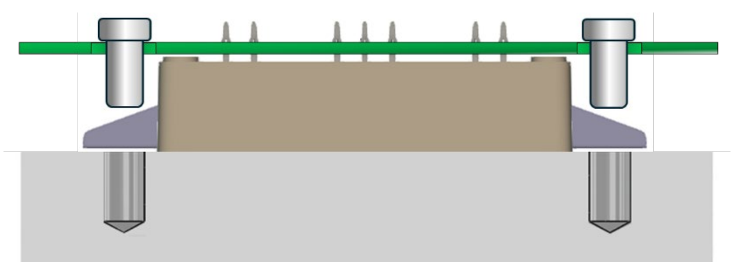


Figure 6. Module with cross-sectional view of heatsink and PCB with module mounting screws

# 3 Heatsink and TIM Requirements

To get the most out of your module, it's crucial to mount it on a heatsink. This is because the module and heatsink surfaces, while appearing flat, have tiny imperfections. These create microscopic air pockets when they're pressed together, which are poor conductors of heat. To solve this, you need to fill those tiny gaps with a thermally conductive material. This material helps heat flow efficiently from the module to the heatsink. To ensure the best possible heat transfer, it's recommended to use a heatsink with a roughness of 10 µm or less and a flatness of 50 µm or less per 100 mm. These specifications minimize the empty spaces, ensuring optimal thermal contact and significantly improving the module's ability to dissipate power.

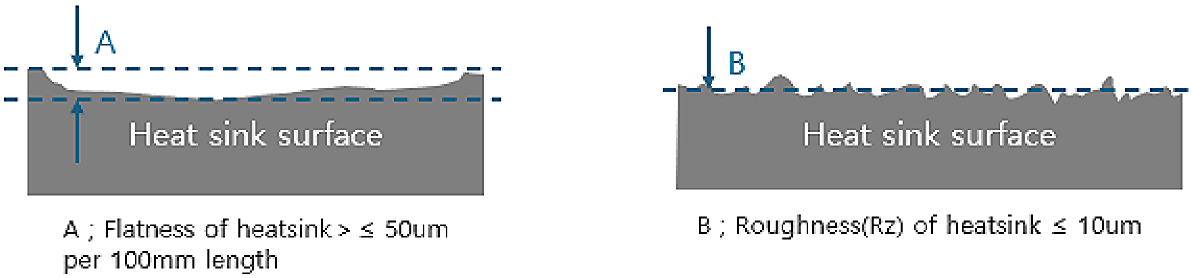



Figure 7. Heatsink Requirements

Apply a thin layer of thermal interface material (TIM) to either the module's copper base or the heat sink's mounting surface. This TIM layer should ideally fill all gaps between the two contact surfaces while still allowing them to touch. While several application methods exist, we recommend using a 5 mil thick stencil (contact your local Navitas sales manager for design specifications). Once the TIM is applied, attach the module base plate to the cold plate as detailed in section 6.

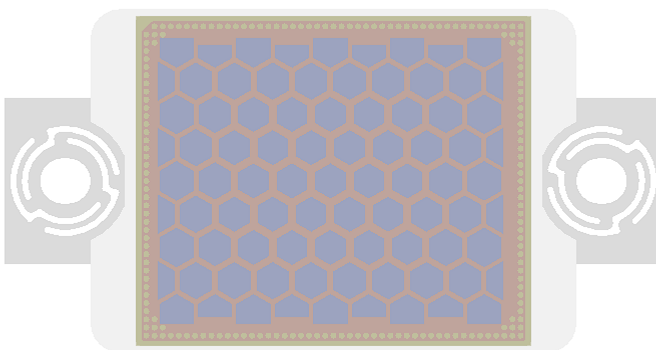


Figure 8. SICPAK™ F with stencil print TIM layer

### 3.1 Modules with Pre-applied Thermal Interface Material

In addition to the standard variants, customers can now purchase all SICPAK™ F and SICPAK™ G modules (see Figure 9) with TIM pre-applied. This frees customers from all the headaches associated with the TIM application process.

Figure 9. SICPAK™ G module (left) and SICPAK™ F module (right) with TIM layers pre-applied

### 3.2 Properties and Features of PCM pre-applied modules

Navitas Pre-Applied TIM Modules use Honeywell PTM6000SPM paste as the thermal interface material. It is designed to minimize thermal resistance at interfaces and maintain extremely stable performance validated through reliability testing required for long product life applications. Based on a robust polymer PCM structure, this material exhibits excellent wetting properties during typical operating temperature ranges, resulting in very low surface contact resistance. Characteristics PTM6000SPM are summarized in Table 2.

Table 2. Material Characteristics of PCM

| Physical Properties | Unit | PTM6000-SPM |
|---|---|---|
| Thermal Conductivity | W/m.K | 4.4 |
| Thermal Impedance @ no shim | cm2. ˚C/W | 0.07 |
| Specific Gravity | g/cm3 | 2 |
| Viscosity | Pa.s @25℃ | 200 |
| Volume Resistivity | Ohm.cm | $2.1x10^{14}$ |
| Thickness Range | mm | NA |

The stencil pattern dimensions of SiCPAK™ F are illustrated in Figure 10. The pattern has a final thickness of 80~100um ranges. Customers can request pattern drawings via Navitas local sales.

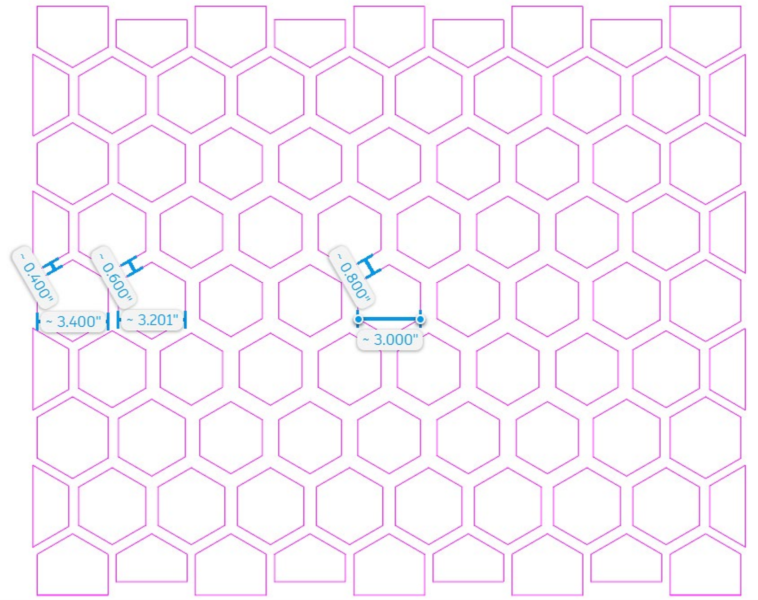



Figure 10. SiCPAK™ F PCM pattern

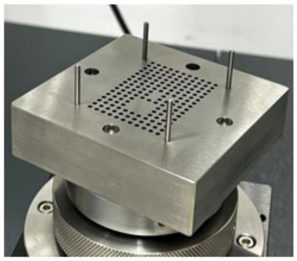
# 4 Press-in Process

## 4.1 General press-in process

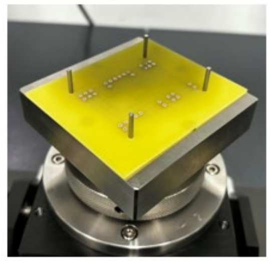
To ensure consistent joint quality, it is recommended that the module be pressed into the PCB using a machine, press, and/or fixture. It is also recommended that the press force and travel of the press tool used be monitored and recorded. While the purpose of the machine or press is to provide a consistent clamping force, the fixture also serves to secure the PCB in place while ensuring that the force used to mount the module is perpendicular to the module board. Additionally, the press fixture provides a solid stop for the PCB to stop in, providing consistent clamping depth.

The press-in process can be performed before or after the module is mounted on the heatsink, but it is generally recommended to do the press-in process first, as it simplifies the press-fit procedure and fastening requirements. However, this recommendation usually requires that the PCB have holes for placing and tightening the mounting screws, as shown in Figure 6.

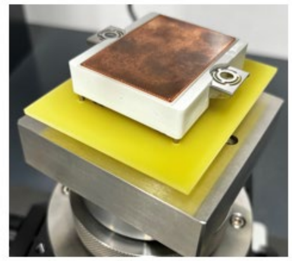
The recommended procedure for press-in a single module to a PCB is shown in Figure 11. First, place the lower fixture in the press under the press ram. The PCB should then be aligned and placed on the lower fixture. After ensuring that the PCB position is fixed, the pins on the module should be aligned with the corresponding holes on the PCB. The surface of the tool that applies the force to the PCB should be parallel to the PCB and the module substrate. The module can be pushed into the PCB in a smooth and even manner to the desired depth, or until the PCB contacts the four standoffs on the top surface of the module.



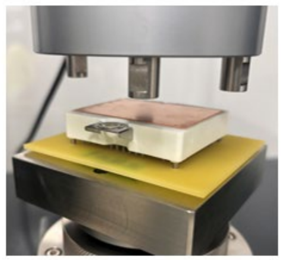
1.
Lock the fixture onto the pressure mechanism base



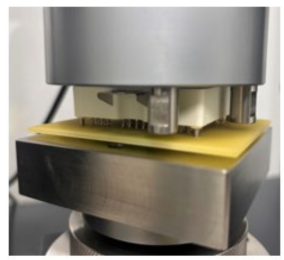
2.
Align the PCB alignment holes with the bottom fixture and place



3.
Align the module mounting holes and place the module onto the PCB



4.
Top clamp is pressed down on the module, and the four pins that need to be avoided touch the module.



5.
Press the top fixture of the press down until it contacts the PCB

Figure 11. Example recommended press-in process for single module

## 4.2 Press-in process parameters

The press-in force is related to the retention force and the quality of the press-fit connection (electrical resistance and reliability). The Press in speed for standard tests is between 25-50 mm/min according to IEC 60352-5. A Press in speed of under 25 mm/min can lead to increased press-in forces and a deformation of the pins, or to a connection that is not gas-tight. But the recommended speed is 100 mm/min since speeds of 450 mm/min are common in automated assembly lines. The maximum force that must be applied to the module is 4 kN, but the typical force per pin required to press the module against a properly designed PCB is between 60 N and 120 N. The press-fit process for SiCPAK™ series modules can generally be divided into three sections, shown in Figure 12. In the first part of the press-fit process, the pins are slightly deformed while being squeezed into the PCB holes. When the second step of the process is reached, the module will continue to be pressed into its final position, but the force will no longer increase because the pins have been deformed to fit the PCB hole size. In the third and final step, the top press-fit fixing tool comes into contact with the PCB and the module can no longer be pressed. At this stage, the fixture and PCB begin to bend, which increases the force rapidly with the distance relationship. At this stage, the press-fit process must be stopped before excessive force is applied.

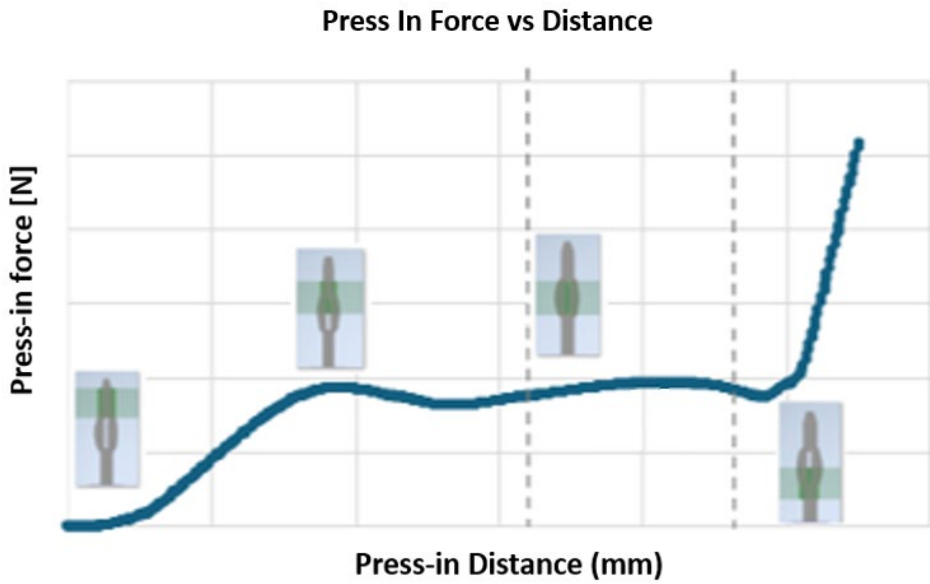


Figure 12. Typical press-input profiles of SiCPAK™ series modules

### 4.3 Press-in tool construction

You can request the CAD files for the fixture shown in Figure 13. This fixture has two parts: one holds the PCB, and the other presses down on the module's bottom, also providing a solid backstop.

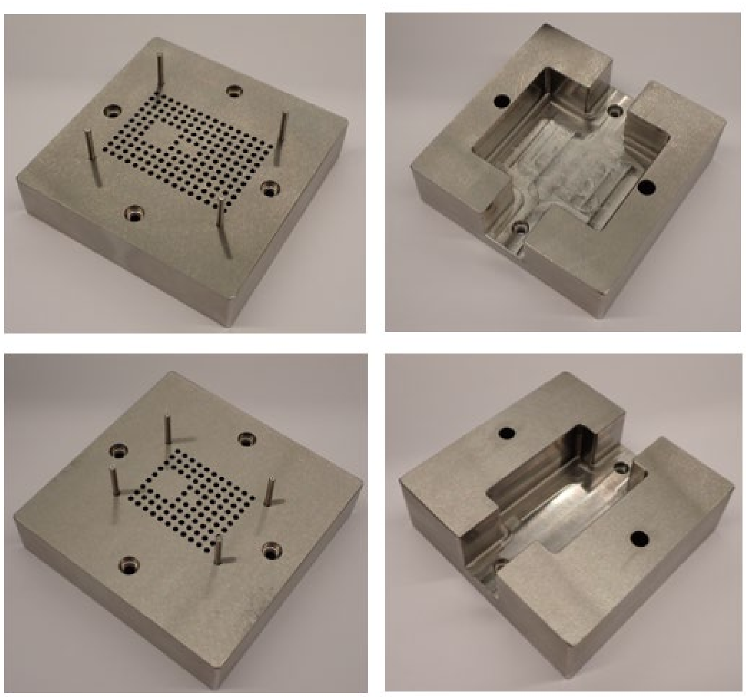


Figure 13. Press-in fixture for SiCPAK™ F(Bottom) and G(Top)

## 4.4 Press-in process and tools for modules with pre-applied TIM(Thermal Interface Material)

If the module is attached to the heatsink before the PCB assembly, standard mounting procedures (as described in Section 4) apply, even for modules with pre-applied thermal interface material (TIM). However, if the module is attached to the PCB before heatsink assembly, a specialized press-in tool is necessary to protect the PCM layer during the process. Minor damage to the TIM layer from the press-in jig is acceptable and won't affect the system's thermal performance. Figure 14 illustrates a TIM spacer (PCM is a type of TIM). For 2D or 3D CAD drawings of jigs, please contact your local Navitas sales manager.

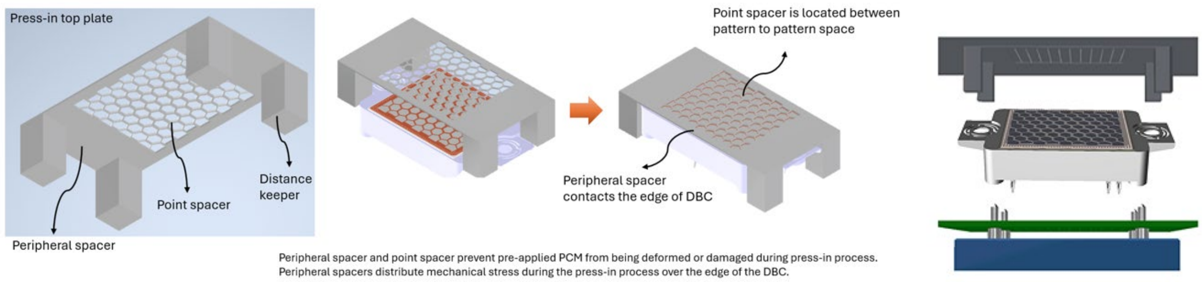



Figure 14. Sequence of press-in process (with TIM spacer) and
Description of TIM Spacer (Example for SiCPAK™ F)

## 4.5 Auxiliary Mounting on PCBs

For enhanced mechanical stability, optional screws can be tightened into the module's stand-offs, providing strain relief for the PressFIT contact between the module and the PCB. The PCB can be attached to the module using the four mounting holes in each corner of the module. These holes are compatible with the following self-tapping screws, which should be at least 4 mm and no more than 8 mm penetration.

- Ezot PT WN1451 K25 , Mounting torque = 0.45 Nm ±10%
- Ezot Delta PT Un5451 K25, Mounting torque = 0.4 Nm ±10%
- Metric Screws ; M2.5 x L, depending on PCB thickness

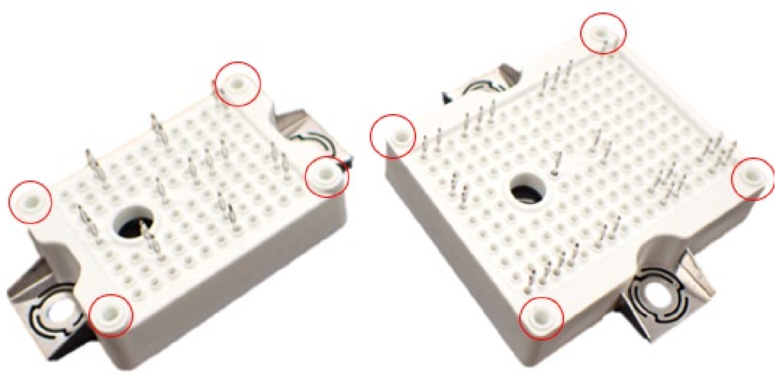


Figure 15. SiCPAK™ PCB Mounting Holes

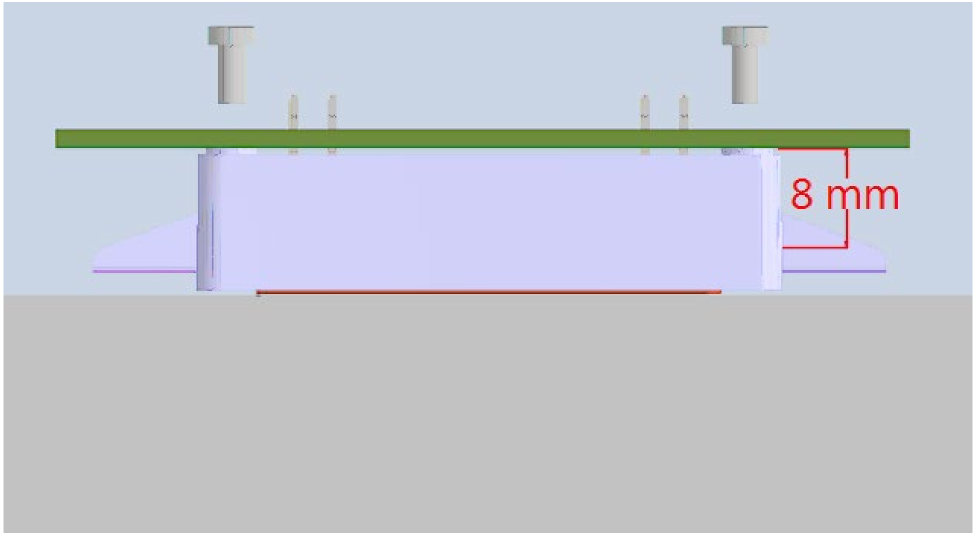
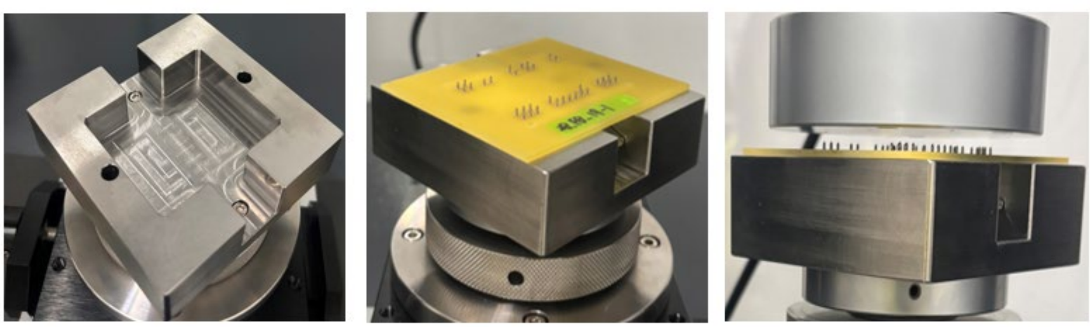



Figure 16. PCB Mounting Hole Penetration Depth

# 5 Press-out Process

## 5.1 Press-out process

To safely remove the module from the PCB, using specialized pressing tools and fixtures is recommended, similar to the press-fit process. The press-out procedure involves a flat plate applying direct pressure to the top of the module's pins while the PCB is held securely. This action pushes the module's pins out of the PCB, as illustrated in Figure 17. The pressing operation should be smooth and consistent, with each pin requiring a force greater than 40 N. Figure 18 provides an illustration of this press-out method.



1. Lock the fixture onto the pressure mechanism base

2. PCB with pressed in module is placed on the fixture

3. Press ram with top fixturing piece presses down until it contacts the PCB

Figure 17. Examples of recommended press out processes

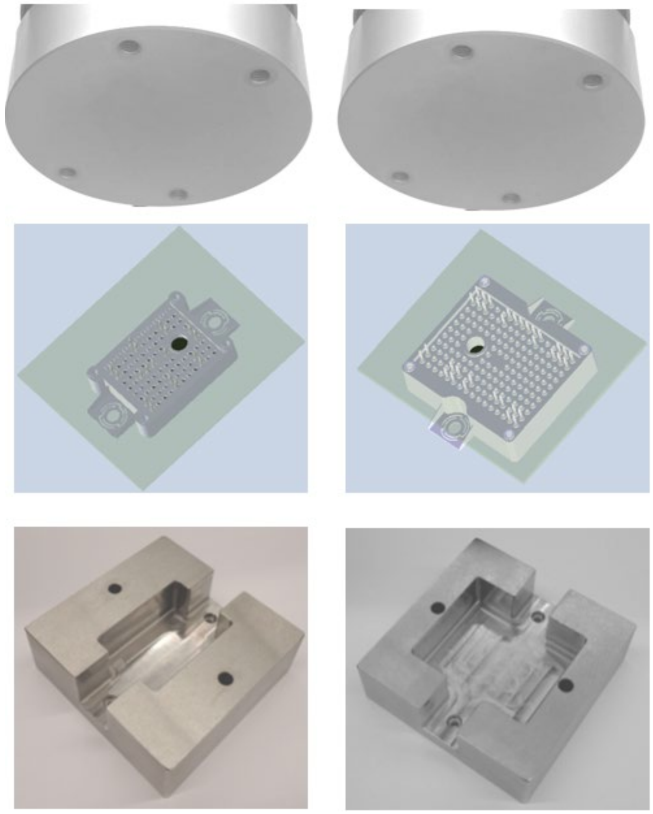


Figure 18. Press-out process - SICPAK™ F module (left) and SICPAK™  G module (right)

### 5.2 Press-out tool

Press-out fixtures for SiCPAK™  series modules consist of a flat press used to press the pins of the module and a support used to secure the PCB in a fixed position while providing a position for the module to fall off after the press-out process is complete. The fixture is shown in Figure 19. A 3D step file of the fixture is available upon request.

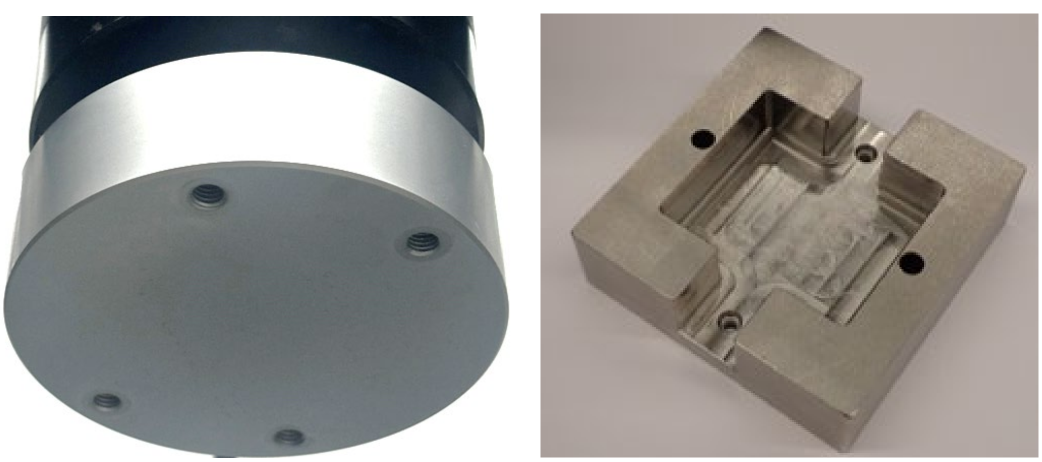


Figure 19. Press-out fixtures - flat press (left) Support (right)

## 6 Mounting Modules on the Heatsink

To attach the module, utilize the two M4 screws located at the mounting positions depicted in Figure 20. It is crucial that the module's mounting surface achieves full contact with the heatsink, as illustrated in Figure 21. Should any instability be observed during mounting, it is advised to clean and then reapply fresh Thermal Interface Material (TIM). A mounting torque of 2 to 2.3 Nm is recommended. Users must ensure the mounting tab is centered within the mounting hole before selecting one of the specified installation procedures. Mounting screw specifications are detailed in Table 3.

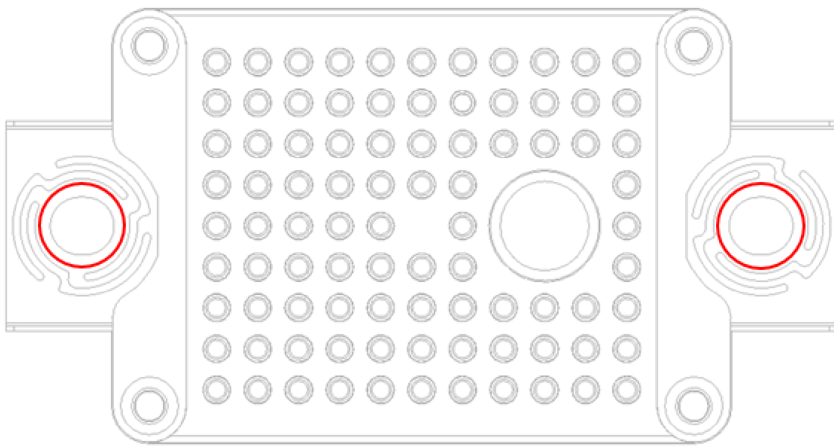


Figure 20. M4 Screw Mounting Position on SICPAK™ F Module

Method 1: Insert both screws and tighten them at the same time (Fig. 21).
Method 2: Hold the module in place relative to the heatsink with a force of about 10 N, then tighten the mounting screws (Fig. 22).
Method 3: Insert one screw and tighten until the screw touches the mounting tab without bending. Then insert the second screw and tighten to the module's recommended mounting torque (2 – 2.3 Nm). Finally, tighten the first screw to the module's recommended mounting torque (Fig. 23).

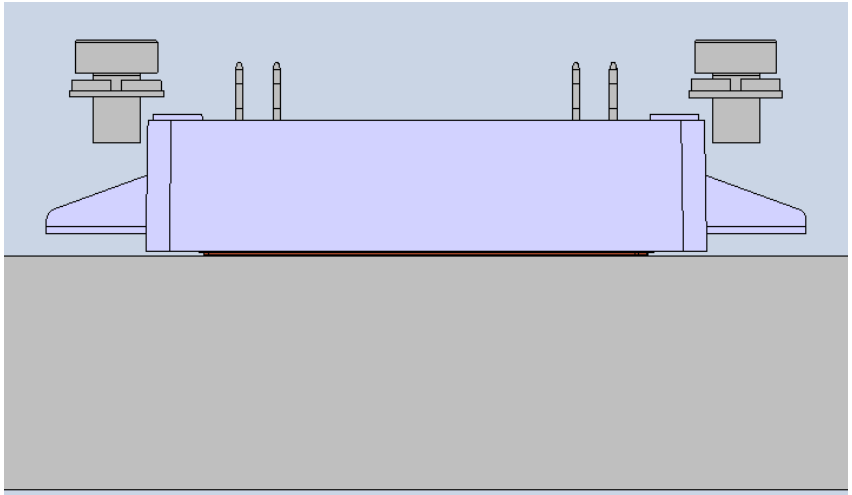


Figure 21. Mounting method 1

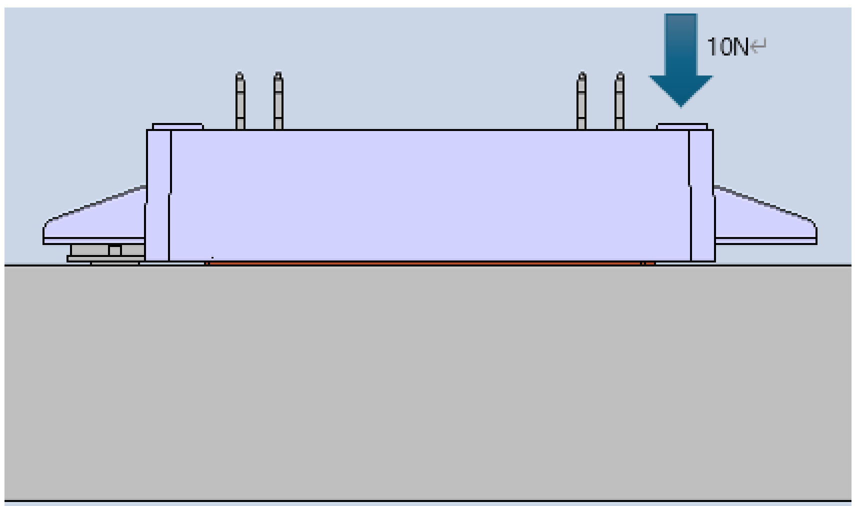



Figure 22. Mounting method 2

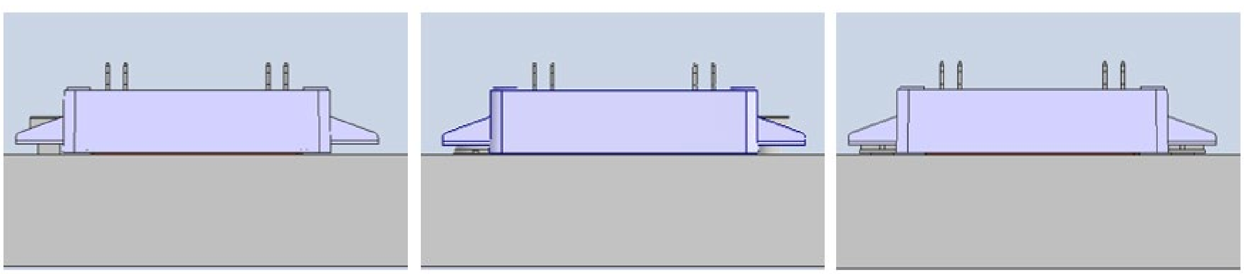


Figure 23. Mounting method 3

Table 3. Mounting Screw Requirements

| Description | Values |
|---|---|
| Mounting Screw | M4 |
| Recommended Mounting Torque | Ma=2.0~2.3Nm |
| Aluminum alloy not hardened | 6.4 mm |
| Aluminum alloy hardened | 4.8 mm |
| Aluminum cast alloy | 8.8 mm |
| Washer (DIN) 125 | D=9 mm |

# 7 System Considerations

To prevent damage, a module's individual pins can withstand an upward pulling force of up to 6N, while the entire module can handle a maximum of 20N. Consequently, designers are required to incorporate supplementary mechanical stress relief to mitigate external forces on the module pins. One effective strategy involves securing the PCB to a separate structure affixed to the heat sink. At this juncture, proper alignment of the pin and housing is critical, and the PCB must be positioned 12mm above the heat sink's surface, as depicted in Figure 24. When integrating a module into a heat sink prior to its final mounting, the PCB-to-heat sink bolt should be situated at least 5cm from the module's periphery to minimize forces on the module pins. Conversely, if the module is installed within a heat sink and subsequently pressed against the PCB, the bolt should be located as close to the module as system constraints permit.

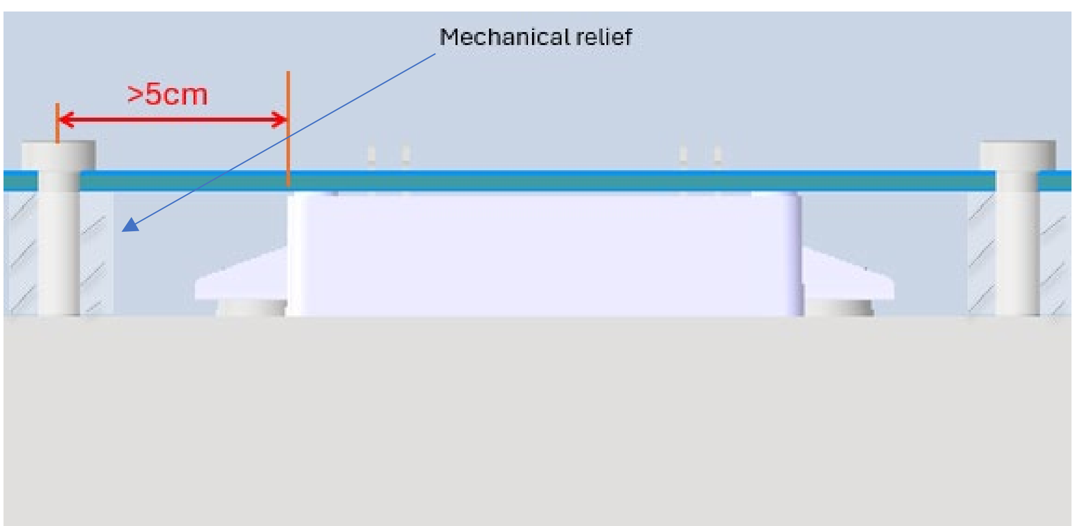



Figure 24. PCB Mechanical Relief

When the module is correctly installed (pressed in), there should be a small 0.29mm gap between the PCB and the module. This happens because the distance from the module's copper bottom to the PCB's bottom should be 12.29mm, while the ideal mechanical support for the PCB is 12mm tall. This setup creates a slight downward force from the PCB onto the module, which is good, though not strictly required. Crucially, the PCB's mechanical support must *not* pull the module upwards, as this can negatively impact its thermal performance by detaching it from the heatsink. Therefore, if the press-fit process results in a distance less than 12.29mm, the PCB's mechanical support height needs to be reduced. For systems with multiple modules sharing a heatsink and PCB, the PCB's mechanical support and the module's height tolerance must be carefully considered at each support point. These support points should be symmetrical for power modules. Lastly, if a gap exists between the PCB and the module housing, avoid screwing the PCB directly onto the module using mounting holes, as this can cause the heatsink to exert upward force on the module.

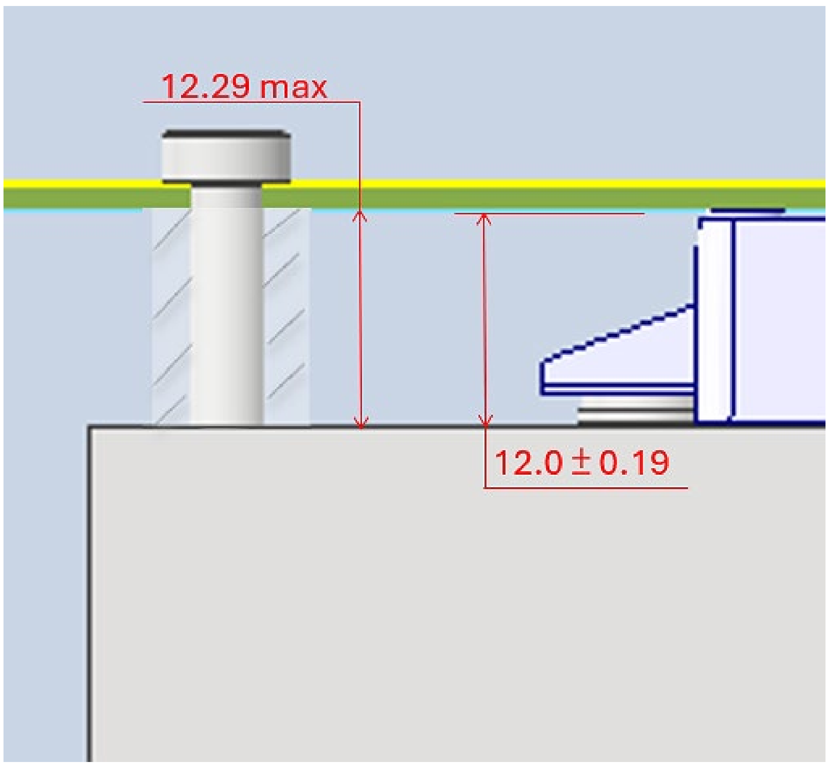



Figure 25. Air gap indicating no PCB mounting screws required

## 7.1 Mounting Multiple Modules

In applications that involve several modules, the optimal method to avoid tolerance stacking is to initially insert all modules into the PCB at the specified height H (refer to Figure 26). Next, apply the TIM to the module following the procedure outlined in Section 3. Afterward, position the assembled PCB with the module onto the heat sink and secure the module to the heat sink using the technique suggested in Section 6. This entire procedure is illustrated in Figure 26. If all modules are mounted onto the heat sink first and then pushed into the PCB, it may slightly alter the module height and exert unnecessary pressure on the terminals of certain modules. Furthermore, the suggested method does not necessitate a minimum distance of 5 cm between the module and the PCB support.

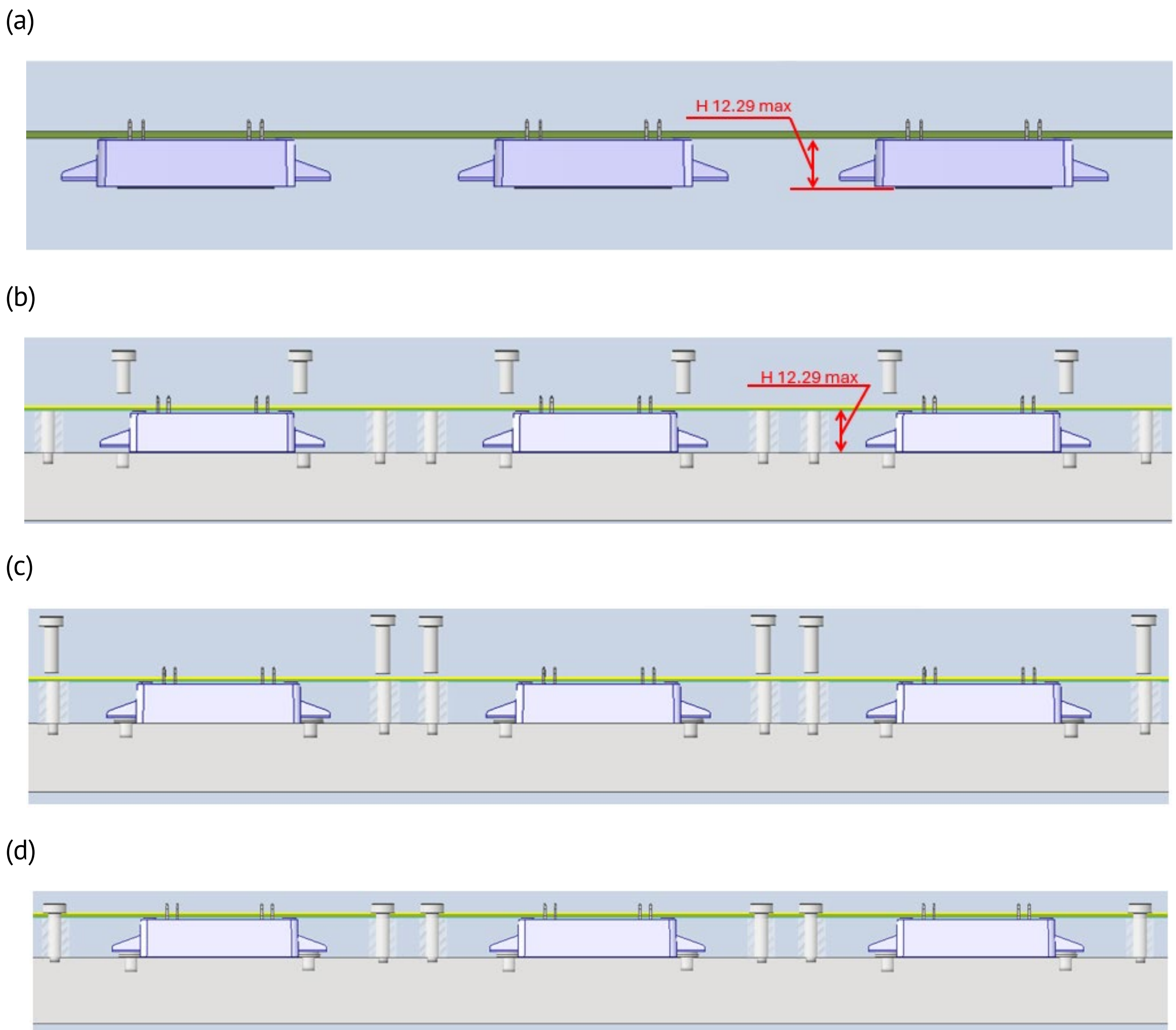



Figure 26. Multiple Module Tolerance Considerations and Assembly Sequence

### 7.2 Creepage and Clearance Considerations

To meet most application-specific standards, specific creepage and clearance distances are essential. This includes the distance from the top of the mounting screw head to the bottom of the PCB, which varies with the screw chosen. For SiCPAK™ modules utilizing DIN 912 M4 hexagon socket head screws and DIN 125 M4 washers, this distance is 6.8 mm (see Figure 27). Failing to account for this can lead to violations of many creepage and clearance standards when placing through-holes or other current-carrying devices on PCBs above screw heads.

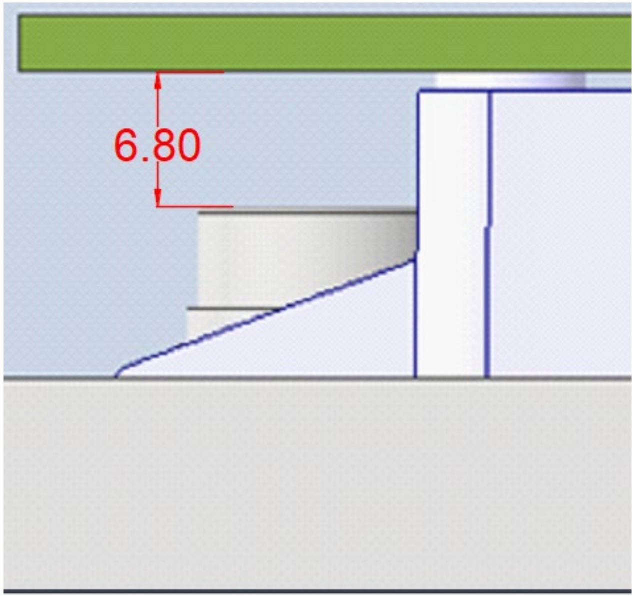



Figure 27. Special creepage and clearance considerations

# 8 Handling of Modules with Pre-applied PCM

## 8.1 Transportation and Storage

Extreme thermal and mechanical shocks should be avoided while transporting and storing the module. The tray box is designed to prevent direct contact with the PCM layer of the module board. PCM pre applied modules should be stored in this tray box as shown in Figure 28. Table 4 shows the optimal storage conditions. It is not recommended to store PCM pre-applied modules above phase change temperature (45℃).

Figure 28. PCM pre-applied modules in a Tray Box

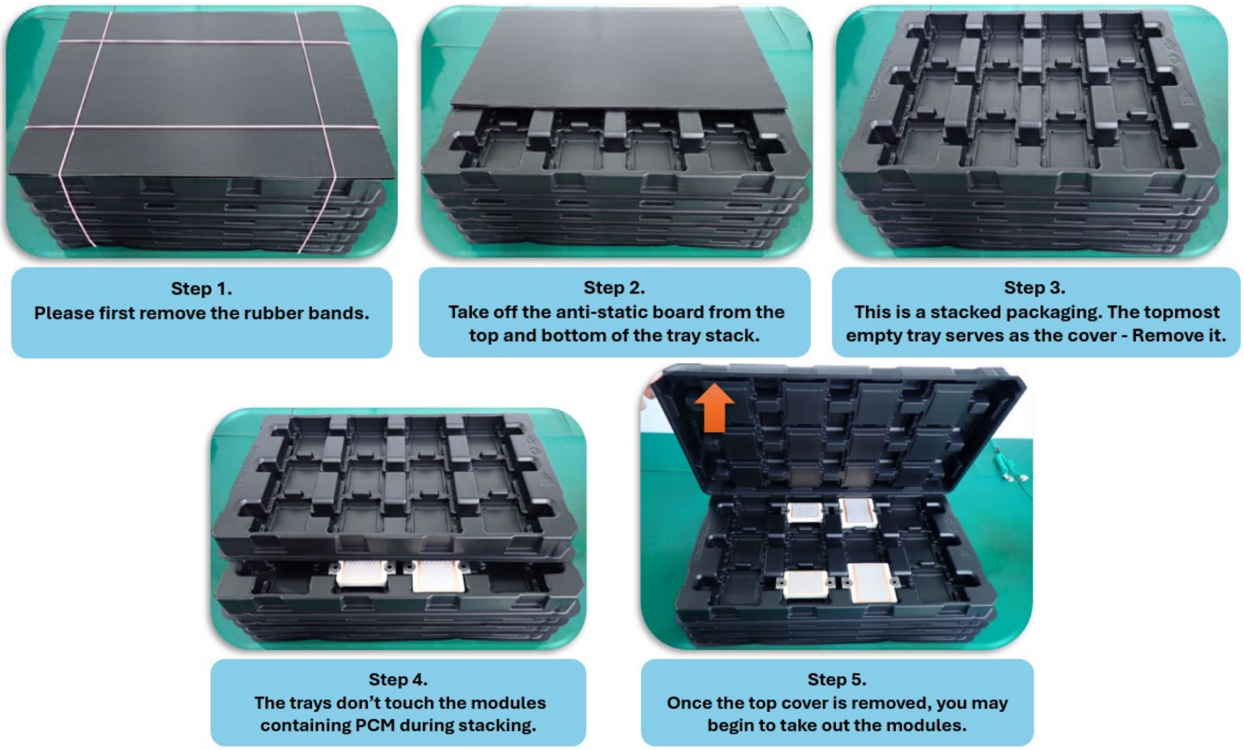



Figure. 29 Recommended Opening procedure of Tray box

Table 4. Recommended Transport and Storage Conditions

| | |
|---|---|
| Storage Temperature | 10 –40℃ |
| Humidity Conditions | 10 < RH < 55% |
| Storage Duration | Max. 12 months |

## 8.2 Management

The PCM print layer should be treated as a functional area of the module and protected from damage or removal during handling or mounting. PCM pre-applied modules are shipped in a tray box with a tightly closed lid. It is recommended to carefully open the covers side by side to avoid mechanical damage to the PCM layer. During the assembly process, care should be taken not to touch the PCM layer directly. If the PCM layer is contaminated or more than 10% of the total print area is damaged, it is recommended that you remove the PCM layer according to the instructions provided below and apply thermal grease instead.

## 8.3 Disassemble and rework

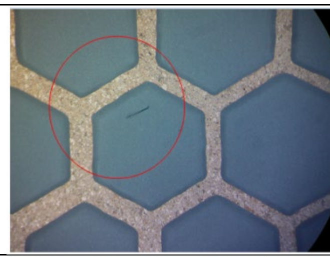
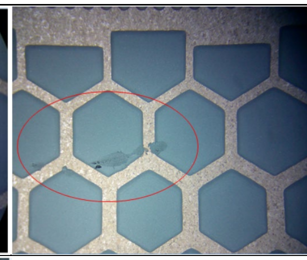
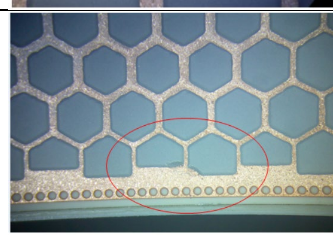
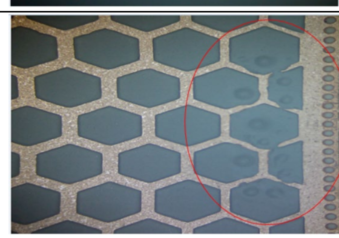
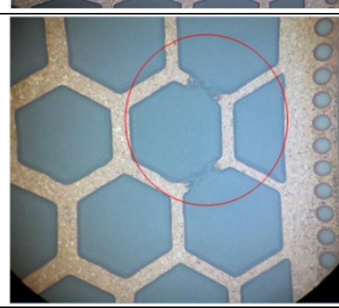
In the event of a failure or rework, the module may need to be disassembled. For rework before module operation, a standard PCB/heatsink disassembly process can be applied. If the module is operated and the PCM has already melted and distributed, the bonding strength between the heatsink and the module is strong, and the module may not be easily removed from the heatsink. In such cases, it is recommended to use a knife to separate the module or apply a little heat

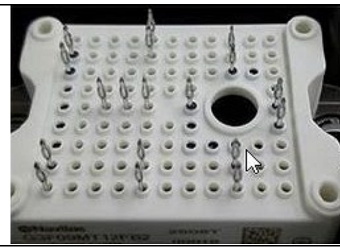
(45-60℃) to melt the PCM again to easily separate the module. Use a soft plastic scraper to remove the PCM layer from the back of the module and the heat sink. To remove any remaining PCM residue, we recommend using a microfiber cloth.

## 9 Example of Acceptable Part Variations

Minor variations in the PCM layer are permissible and won't impact thermal performance. Table 5 provides examples of these acceptable printing deviations. However, the heatsink surface and the module's backside (including the PCM layer) must be free of foreign particles to avoid ceramic damage. Also, potting resins in pin holes do not affect module performance.

Table 5. Example of Acceptable Parts

| | |
|---|---|
| 1) Scratches on PCM pattern |   |
| 2) Peel off |  |
| 3) Air bubble |  |
| 4) Pattern Bridge |  |

| | | |
|---|---|---|
| 5) Potting resin on pin holes |  | |

## Additional Information

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Contact: info@navitassemi.com