

Leapers Semiconductor

Application Note

— **ED3 Power Module** —

V1.4

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1 Product Introduction

1.1 Product Features

- Built-in NTC thermistor
- Low thermal resistance
- 175°C maximum junction temperature
- Low switching losses
- Low conduction losses
- Standard housing
- Insulated baseplate
- High power density
- Press-FIT connection technology

1.2 Circuit Diagram and Outline Drawing

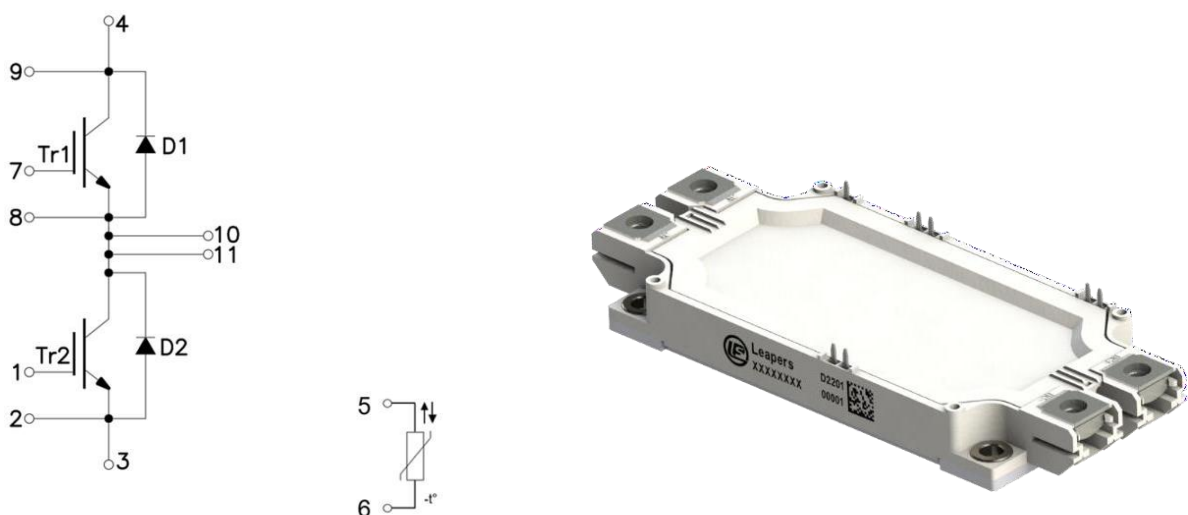
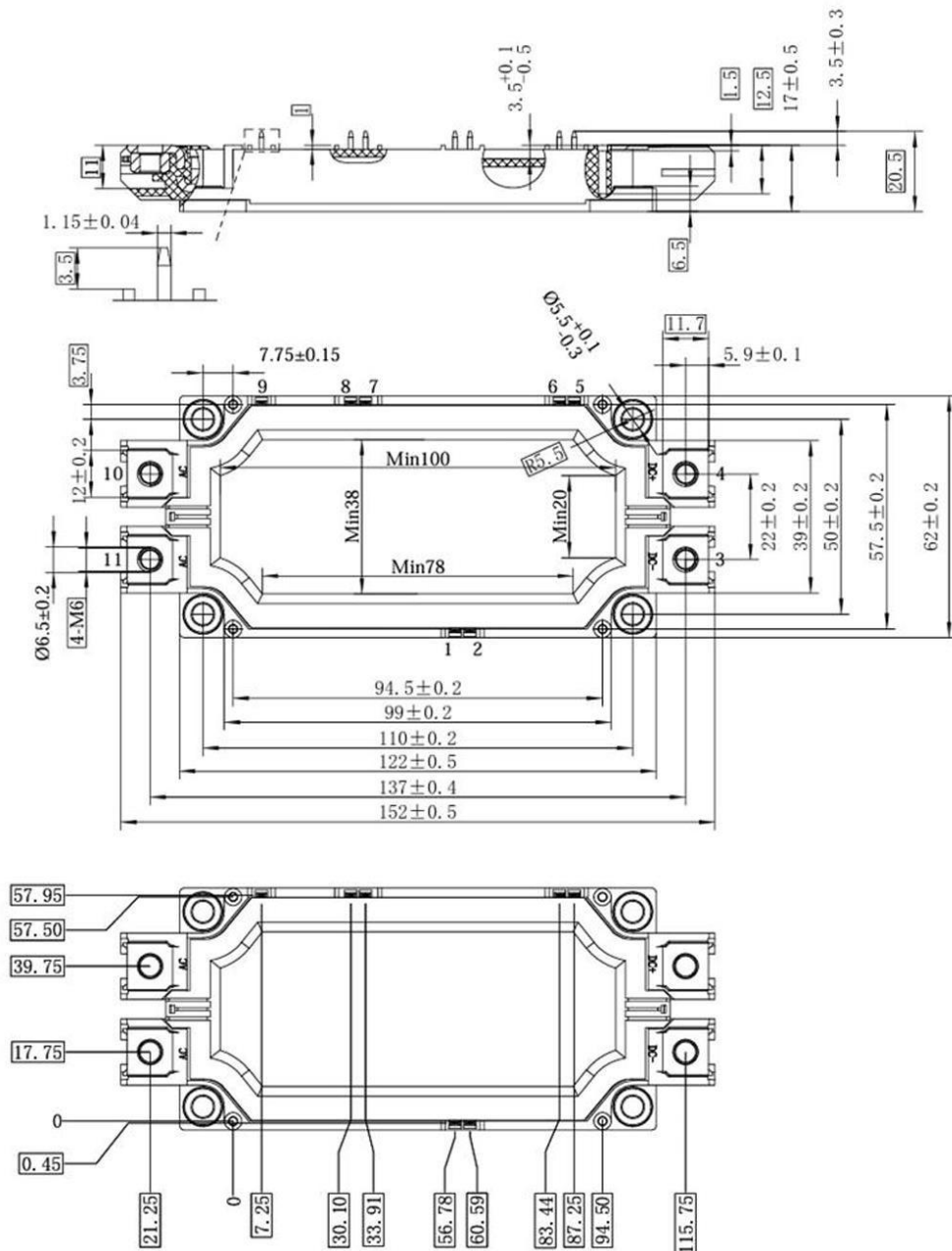


Figure 1: Circuit diagram & Housing

1.3 Detailed Dimensions and Pin Layout



NPW0003_001 A0

Figure 2: Pin configuration

2 Precautions

The gate oxide layer of IGBTs and MOSFETs is only a few tens of nanometers thick and is sensitive to electrostatic discharge (ESD). ESD can cause premature damage or failure of IGBT or MOSFET modules. To prevent premature damage or failure, all delivered products are packaged using appropriate ESD protective materials. When installing or removing modules without ESD protection, please operate in an ESD-protected environment. For details, please refer to ESD installation guidelines such as IEC 61340-5-1 and ANSI/ESD S2020.



Figure 3: ESD warning symbol

3 Installation Instructions

3.1 Recommended Installation Procedure

The installation of the ED3 power module mainly consists of the following steps: Installation of the driver board to the ED3 power module

Installation of the ED3 power module to the heatsink Connection of power terminals to the bus-bar

3.1.1 Installation of the Driver Board to the ED3 Power Module

After soldering, mechanical mounting is recommended to eliminate stress between the module and the PCB. Self-tapping screws can be used through the 4 PCB mounting brackets on the module (refer to Figure 4, Firstack 2FSD0115+ with Leapers ED3 module) to secure the PCB to the module, thereby eliminating stress and enhancing system reliability.



Figure 4: Module PCB mounting brackets

Leapers recommends using self-tapping screws as shown in the figure below. Recommended models: EJOT PT WN1451 K25*10 / K25*9. (Ensure that the effective thread length of the self-tapping screw into the ED3-SiC power module PCB fixing hole is between 4-10mm. Adjustments can be made based on the PCB thickness.)

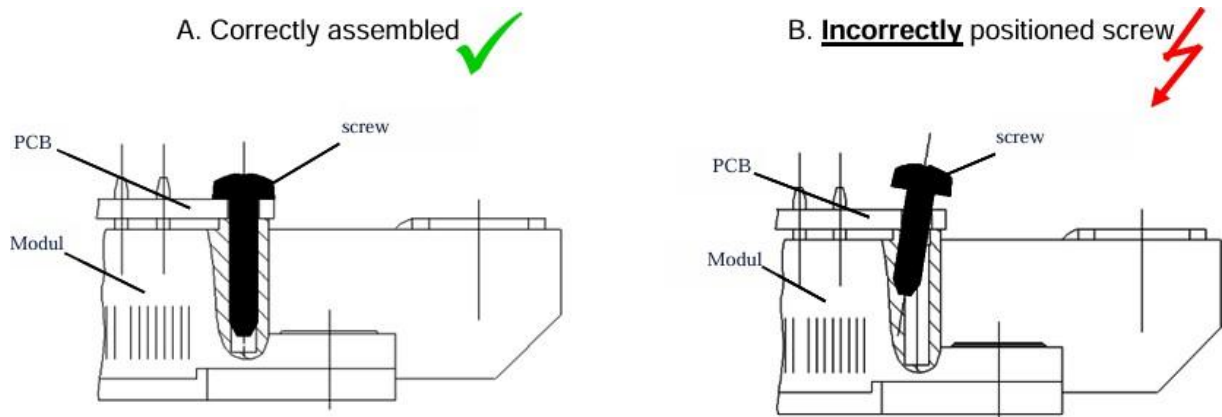


Figure 5: Example of self-tapping screw installation

Installation can be done by hand or using a torque-limited electric screwdriver.

The seating speed of the electric screwdriver should not exceed 300 rpm. The recommended installation torque is $0.45 \pm 10\%$ (Nm).

To ensure the PCB fixing holes of the ED3 power module are not damaged or cracked, the self-tapping screws should be inserted as vertically as possible during installation, as shown in Figure 5.

3.2 PCB Design

It is recommended that the customer's chosen PCB be a standard FR4 PCB with electroless tin plating (IEC60352-5 + IEC60747-15). The PCB material should comply with IEC 60249 standards.

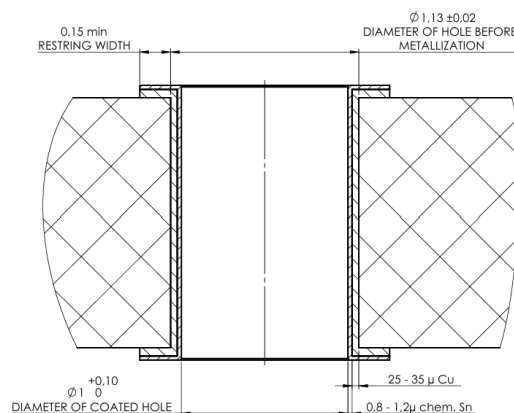


Figure 6: PCB via hole cross-section

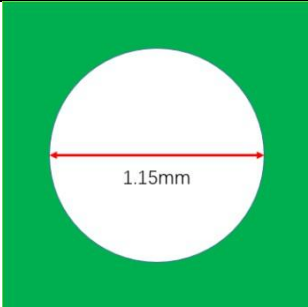
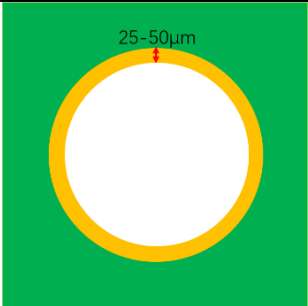
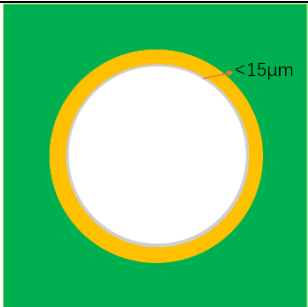
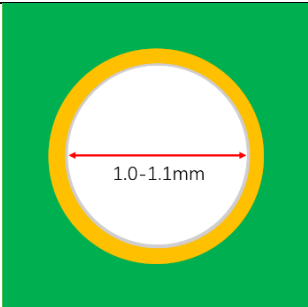
Graphical representation	Parameter	Unit	Typ. Value	Range
	Hole Diameter	mm	1.13	[1.11,1.15]
	Copper Thickness in Hole	µm	30	[25,50]
	Metal Plating in Hole	µm	-	<15
	Pad Diameter*	mm	-	[1.0,1.1]
-	PCB Thickness	mm	1.6	-

Table 1: PCB process requirements

*It should be noted that this diameter is the pad diameter when using the press-fit process. If the customer uses a soldering process, the recommended diameter is $1.55 \pm 0.05\text{mm}$.

During the soldering process, ensure the soldering is reliable and firm, while also avoiding damage to the driver board or ED3 power module housing due to excessive temperature or prolonged soldering time.

According to IEC68-2, the maximum soldering temperature must reach 245°C, and the maximum soldering time should be $\leq 5s$.

3.3 Press-fit

3.3.1 Press-fit Pin

The Press-FIT pins used in Leapers Semiconductor's ED3 modules meet strict press-fit standards and can be connected using either press-fit or soldering methods, offering flexible usage.

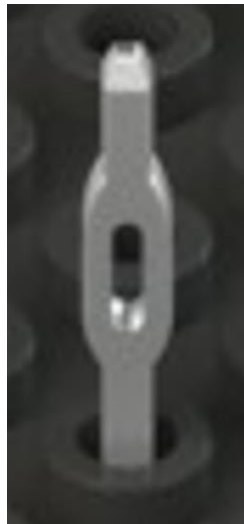


Figure 7: Leapers module Press-FIT pins

For connection reliability reasons, it is not recommended to reuse modules and PCBs that have undergone the Press-FIT process multiple times. For PCBs that have already undergone two module replacements, and for modules that have been pressed once, it is recommended to use soldering for subsequent use to increase connection reliability.

3.3.2 Press-fit Pin Installation

The press-fit connection between the ED3 module and the driver PCB is typically done using a toggle lever press or a dedicated machine. It is recommended to use a dedicated machine that can control pressure value, insertion distance, and insertion speed to ensure good efficiency and press-fit quality.

The design of the upper and lower assemblies should ensure that fragile parts of the ED3 module and the driver PCB (such as electronic components soldered on the PCB, other fragile parts on the board, and the module pins) are not subjected to strong stress that could cause damage.

Recommended press-fit procedure:

- 1) Align the press to ensure the upper and lower parts of the tool are perpendicular to each other;
- 2) Place the PCB and module into the tool. Use tool guide plates for positioning;
- 3) Press the Press-FIT pins of the module into the PCB by moving the upper part of the tool downwards.

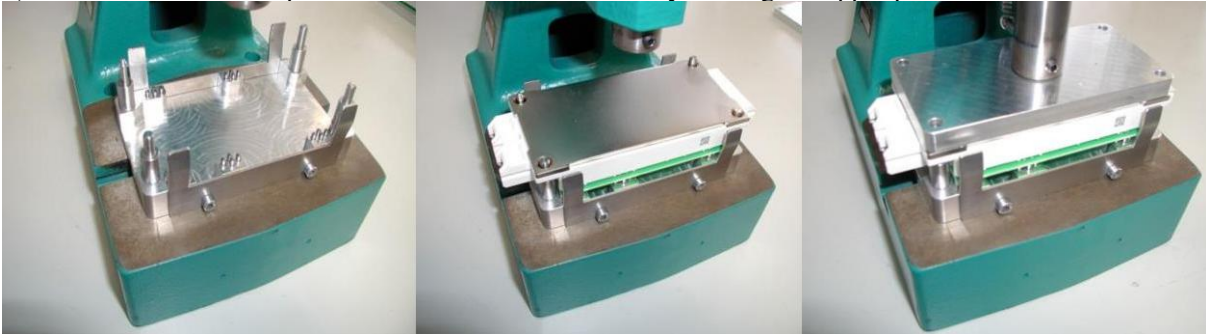


Figure 8: Press-fit procedure steps

Recommended press-in speed:

According to IEC60352-5, the press-in speed should not be lower than 25 mm/min; lower speeds can increase insertion force and cause pin deformation. The maximum recommended press-in speed is 500 mm/min. The recommended press-in speed is 100 mm/min.

Recommended pressure value:

Press-fit is completed only when the pressure applied to each pin in the module reaches 50-80 N (the specific value may vary depending on the driver PCB hole diameter and metal plating thickness). Leapers Semiconductor recommends a typical pressure value of 50 N per pin, with a maximum not exceeding 80 N. For example, for an ED3 7-pin module, the recommended typical pressure is 0.35 KN, with a maximum not exceeding 0.70 KN.

	Minimum	Typical	Maximum
Press-in speed	>25mm/min according to IEC 60352-5 qualification 100 mm/min recommended		
Typical press-in force per pin		50N	<100N
PCB temperature(TG)		125°C	

Table 2: ED3 typical press-in force

3.3.3 Additional PCB Reinforcement

After the press-in process is completed, mechanical methods are recommended to eliminate stress between the module and the PCB.

3.4 Thermal Grease Application

3.4.1 Thermal Grease

Thermal grease is used to fill the gap between the power module and the heatsink. However, due to its poor thermal conductivity, it should be applied as thinly and evenly as possible. Thermal grease is used to fill the gap between the power module and the heatsink. However, due to its poor thermal conductivity, it should be applied as thinly and evenly as possible.

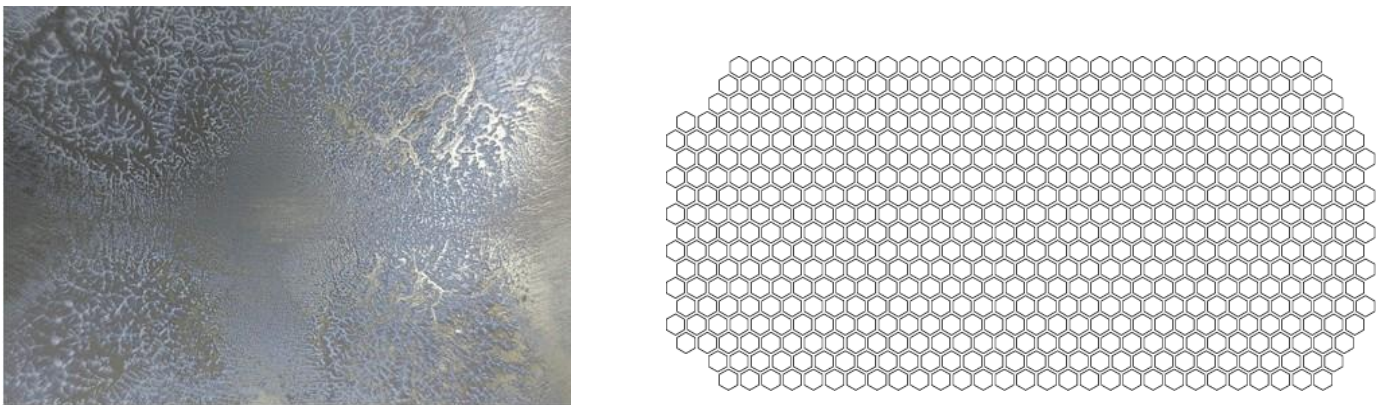


Figure 9: Example of thermal grease distribution and stencil example

3.5 Mounting the Module to the Heatsink

3.5.1 Heatsink

The heat dissipation capability of the heatsink is critical to the performance of the power module. A typical power module heatsink is shown below:



Figure 7: Common ED3 module heatsink

A heatsink for power modules must first have good thermal conductivity; materials with high thermal conductivity should be chosen. Additionally, the heatsink itself needs sufficient mechanical strength to prevent deformation during installation and operation, avoiding additional stress on the ED3 module baseplate.

Among common materials, pure aluminum has high thermal conductivity and is inexpensive, but its low mechanical strength makes it unsuitable for power module heatsinks. The most commonly used materials are aluminum alloys (such as ADC12).

The contact surface between the heatsink and the power module must be smooth, flat, and clean:

- Surface flatness $\leq \pm 50\mu\text{m}/100\mu\text{m}$
- Surface roughness $R_z \leq 10\mu\text{m}$ Furthermore, while ensuring the ED3 module is securely fixed to the heatsink, the thickness of the heatsink at the contact area with the power module should be minimized to reduce thermal resistance and enhance heat dissipation.

3.5.2 Heatsink Screw Installation Parameters

DIN M5 screws with property class 6.8, can be used with washers and spring washers. Installation torque (power module to heatsink):

Recommended minimum torque: 4.0 Nm Typical: 4.5 Nm

Max: 6 Nm

3.5.3 Heatsink Screw Tightening Sequence

Tightening sequence:

To ensure the thermal grease spreads evenly, install the four screws using a cross-pattern: 1-2-3-4.

It is recommended to first tighten the screws with a lower torque (e.g., 0.5-1.0 Nm) in a diagonal cross-pattern. Then, tighten them again in the same order with a higher torque (e.g., 2.0 Nm) using the diagonal cross-pattern. Finally, apply the final installation torque (e.g., 4.5 Nm) following the same order and method.

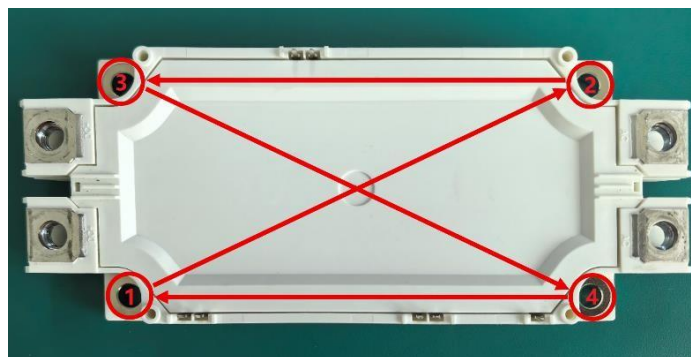


Figure 8: Heatsink screw installation sequence

3.5.4 Other Precautions

If a single module is mounted on a single heatsink, the ED3 power module should be placed as centrally as possible on the heatsink.

If multiple ED3 power modules are mounted on the same heatsink, determine the placement positions based on the power loss of each module. Modules with higher losses should be allocated larger heat dissipation areas.

3.6 Mounting the Module to the Bus-bar

3.6.1 Power Terminal Installation Torque

Similar to mounting the ED3 power module to the heatsink, the connection of the power module's main terminals to the bus-bar recommends using DIN M6 screws with property class 6.8 (with washers and spring washers).

Leapers recommends an installation torque of: 4.5 ± 0.5 Nm.

The effective insertion length of the screw into the module must not exceed the maximum depth of the module's screw hole, which is 10 mm.

It is particularly important to note that although the main terminals of the Leapers ED3 power module are robust, they are not designed to withstand forces in unintended directions. During module installation and use, avoid subjecting the main terminals to additional stress in unintended directions as much as possible. During operation, such stress must be completely avoided.

The maximum allowable stress the Leapers ED3 power module can withstand in various directions is shown in Figure 9:

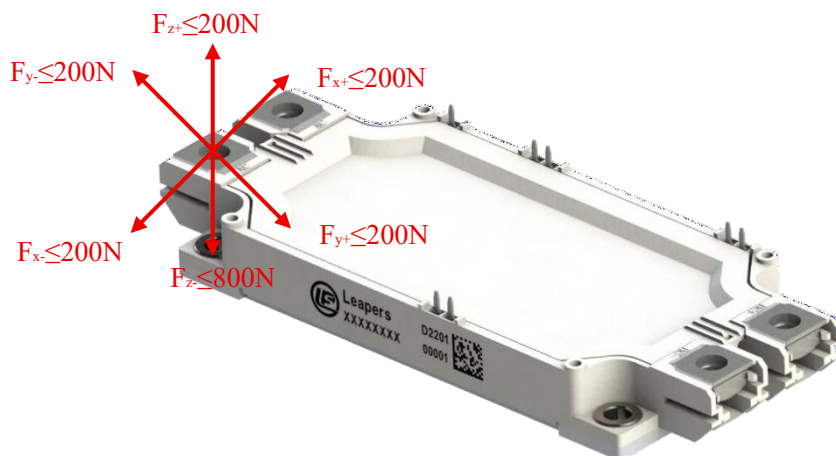


Figure 9: Maximum stress the module can withstand in various directions

3.6.2 Achieving Ideal Stress Relief when Connecting Power Terminals

To achieve the most thorough stress relief when connecting power terminals, it is recommended to use the assembly tools shown in schematic Figure 10 or 11.

Considering all tolerances, the mounting block should be approximately 0.5 mm lower than the height of the power terminal to apply an ideal pre-tension to the power terminal, specifically to avoid harmful permanent force in the Fz+ direction (please refer to Figures 9)

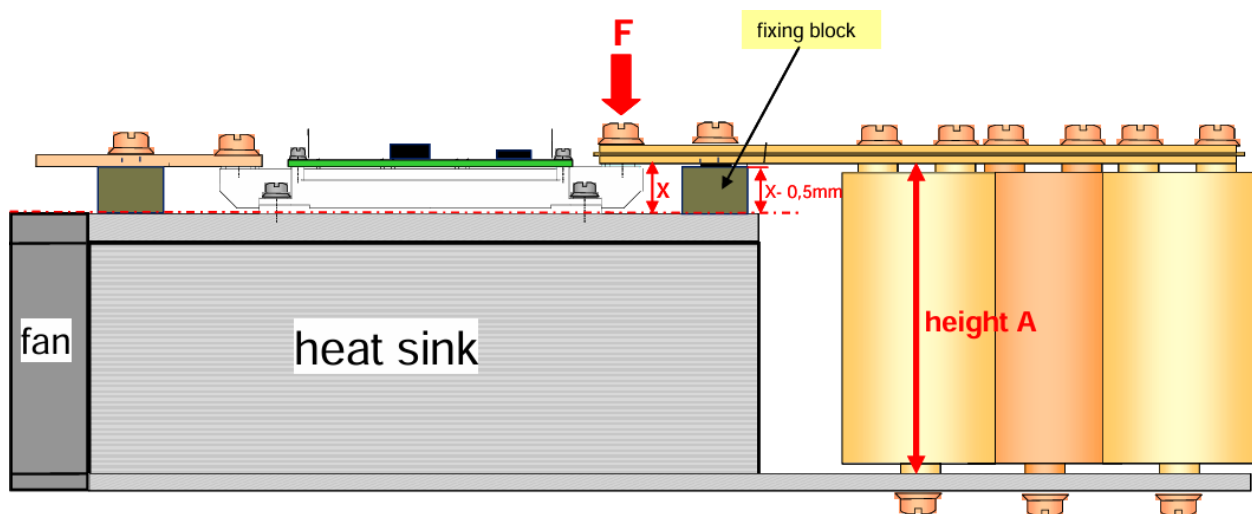


Figure 10: Schematic 1 for achieving ideal stress relief when connecting power terminals

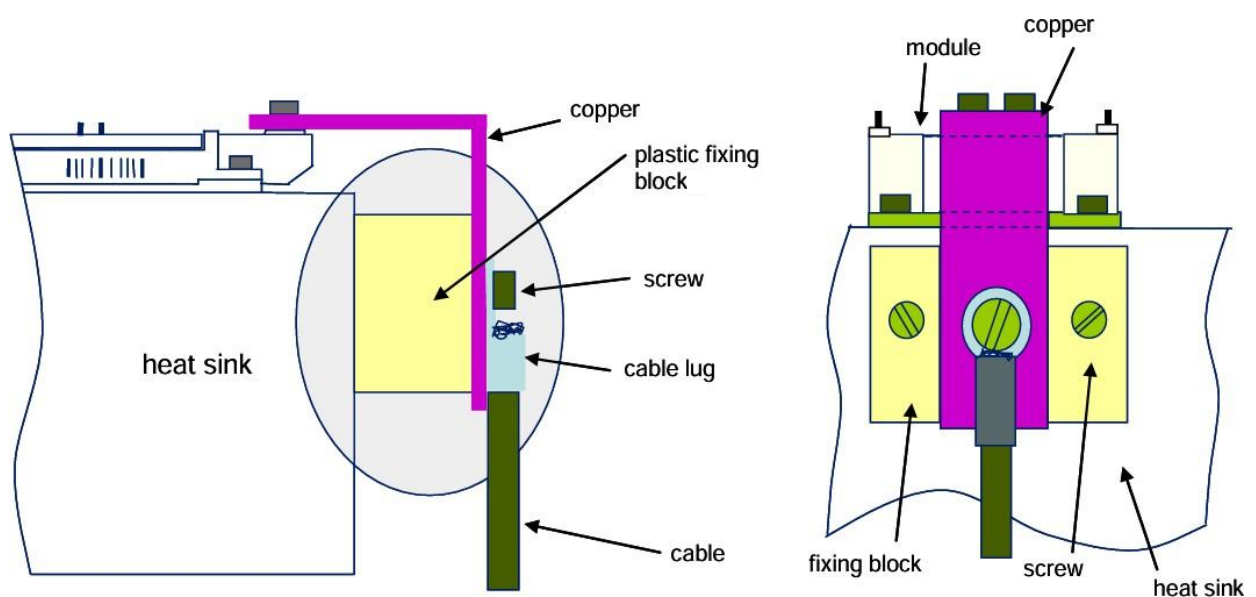


Figure 11: Schematic 2 for achieving ideal stress relief when connecting power terminals

4 Storage and Transportation

During transportation and storage, ED3 modules should be protected from impact and extreme environmental conditions. Although these modules can be stored at temperatures higher than those specified in the data sheet, it is not recommended.

Storage conditions according to TR14 should be followed, with a maximum storage period of 2 years.

If ED3 modules are stored under recommended conditions, no pre-drying treatment is required before assembly.

About this document:

This document is the installation manual for the ED3 power module manufactured by Wuxi Leapers Semiconductor Co., Ltd.

Warning:

Leapers ED3 power modules may contain elements or substances that are harmful to the environment. Improper disposal may cause unnecessary environmental pollution.

For more information, please consult the sales representatives of Wuxi Leapers Semiconductor Co., Ltd.

Disclaimer:

Leapers ED3 power modules manufactured by Wuxi Leapers Semiconductor Co., Ltd. are intended for use in conventional applications as outlined in their data sheet/instruction manual. If customers intend to use them in unconventional applications such as aerospace, life-critical medical devices, etc., they must consult Wuxi Leapers Semiconductor Co., Ltd. and obtain company approval prior to use. The customer shall bear all responsibility for incidents arising from unauthorized use in unconventional applications.

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