# Mounting Instructions for Modules EMIPAK-1B, EMIPAK-2B Series

*By Kevin Liu*

This application note introduces Vishay's EMIPAK modules and discusses the assembly and PCB issues involved in their use.

EMIPAK modules are designed to provide reliable performance in rugged 15 A to 150 A applications. A single housing is used to integrate power components, providing higher power density. Various die selections are available in several configurations. An integrated thermal sensor is also included.

Fig. 1 - Example of EMIPAK-1B Module

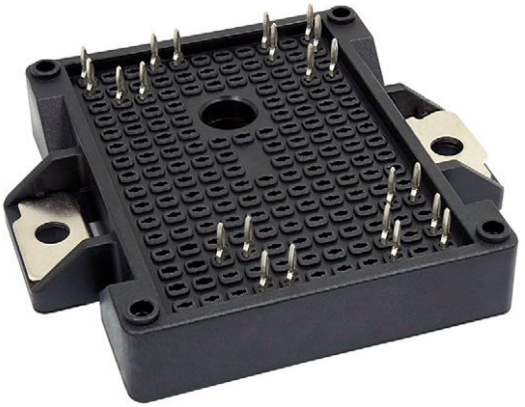

Fig. 2 - Example of EMIPAK-2B Module

## INTRODUCTION

Vishay's EMIPAK-1B and EMIPAK-2B modules are distinguished by these key features:

- Fully isolated
- Compact and easy to mount
- PressFit pins locking technology. Patent # US.263.820.B2
- Low profile package suitable for assembly on PCB
- Low junction-to-case thermal resistance

Important factors in the assembly process are:

- Heat sink design
- PCB design
- Power leads size/area
- Distance from adjacent heating parts
- Protection against electrostatic discharge (ESD)

Recommendations for each of these items and requirements for mounting EMIPAK modules to the PCB are discussed in the following sections.

## ESD PROTECTION

IGBT, MOSFET, and diode modules are sensitive to ESD. All EMIPAK modules are ESD-protected during shipment with an antistatic tube. Anyone handling or working with the modules during the assembly process must wear a conductive grounded wristband.

## HEATSINK SPECIFICATION

The contact surface of the heat sink must be flat, with a recommended tolerance of < 0.03 mm (< 1.18 mils) and a levelling depth of < 0.02 mm (< 0.79 mils), according to DIN/ISO 1302. In general, a milled or machined surface is satisfactory if prepared with tools in good working condition. The heat sink mounting surface must be clean, with no dirt, corrosion, or surface oxide. It is very important to keep the mounting surface free from particles exceeding 0.05 mm (2 mils) in thickness.

APPLICATION NOTE

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

## MODULE MOUNTING SURFACE

The mounting surface of EMIPAK modules must be with no particles. Discolorations or polished copper layer can be present as results of overall assembly process of the device; they do not have impact on thermal dissipation and on device performances in final applications, therefore are considered just as cosmetic imperfection (see below figures as examples).

Fig. 3 - Example of discoloration

Fig. 4 - Example of discoloration

Fig. 5 - Example of discoloration

Slightly scratch also do not have impact on thermal dissipation and on device performances (Fig. 6 as example).

Fig. 6 - Example of scratch

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

## MOUNTING OPERATIONS

Inspect the module to ensure that the contact surface of the base is clean, and that there are no lumps or bulges on the baseplate that could damage the base or reduce heat transfer across the surfaces.

Make a uniform coat on the heat sink mounting surfaces or on module baseplate with a good quality thermal compound, or direct application with screen printing technique is recommended. The test conditions for thermal resistance values on the datasheet specify a uniform layer of thermal compound with a thickness in the range of 0.08 mm (3.1 mils) to 0.1 mm (4 mils). The thermal conductivity of the compound should be not less than 0.5 W/mK.

Bolt the module to the heat sink using the two fixing holes. An even amount of torque should be applied for each individual mounting screw. An M4 screw should be used with lock washers. A torque wrench, accurate in the specified range, must be used to achieve optimum results when mounting the module. The first mounting screw should be tightened to one third of the recommended torque; the second screw should then be tightened to the same torque. Full tightening of both screws can then be completed applying the recommended torque (see data in bulletins). Over-tightening the mounting screw may result in deformation of the package, which would increase the thermal resistance and damage the semiconductors. After a period of three hours, check the torque with a final tightening in opposite sequence to allow the spread of the compound.

Due to the limited distance between the screw head and the top side of the device, it is suggested to design the PCB with the conductive tracks and / or components in position to achieve the required level of clearance / creepage required by the customer's application, and maybe also adding an extra insulation coating.

If the module needs to be removed from the PCB, the first step is to unscrew it from the heat sink, followed by gentle movement of the module to separate it from the heatsink. Thermal grease will remain both on the heatsink surface and the bottom baseplate surface.

## PRESSFIT TO PCB

To contact EMIPAK-1B and EMIPAK-2B pins to the PCB, the solder-free PressFit method can be used, which offers the major advantage is the eliminating solder reflow and its related temperature profile.

The majority of standard FR4 PCB boards can be used with no special requirement in terms of dimension and number of layers. Vishay tested both FR4 125 and FR4 180 PCB models.

EMIPAK pins have been designed with the size and shape required to fit into the PCB holes during the assembly process. The typical pin eyelet size is 1.2 mm (47 mils) wide and 0.64 mm (25.2 mils) thick.

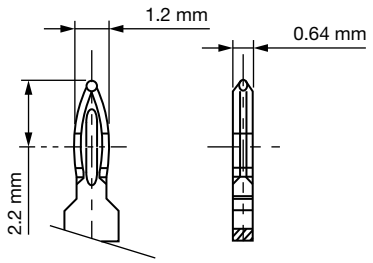


Fig. 7 - Example of pins

The contact between the pin and PCB hole will result in a very low contact resistance (less than 500 mΩ) Double-sided or multilayer PCBs according to IEC 60249 can be used.

As per IEC 60352-5 the PCB material should be defined with following specifications;

- PCB hole diameter: 1.12 mm to 1.15 mm (44 mils to 42.9 mils)
- Copper thickness in hole: 25 µm to 50 µm (0.98 mils to 1.96 mils)
- Metallization in hole: < 15 µm (0.59 mils)
- End hole diameter (after hole plating): 0.94 mm to 1.09 mm (37 mils to 42.9 mils)
- Copper thickness of conductors: 35 µm to 400 µm (1.37 mils to 15.74 mils), typical 70 µm to 105 µm (2.75 mils to 4.13 mils)
- Metallization of circuit board: tin (chemical)
- Metallization of pin: tin (galvanic)

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

Due to the wide variety of PCB construction methods and designs available on the market, there are multiple solutions that might be adopted by EMIPAK module end users. Vishay strongly suggests adhering to the specifications described above, which have been used to test and qualify EMIPAK press-fit pin solutions. In principle, other methods to get tin plating, like HAL, might be used if they can guarantee the needed tolerances in layer thickness.

We do not recommend reusing an EMIPAK device after it has been de-mounted from the PCB. However tests conducted during qualification showed no degradation of the press-fit pin contact or variation of the needed press-in force after three cycles (mount / de-mount) of the same module on three different PCBs with 25 mm/min insertion speeds. If an EMIPAK module must be reused, we suggest soldering the connecting pins.

On the other hand it is possible to utilize the same PCB after de-mounting from the EMIPAK module up to three times. The tests conducted during qualification showed no degradation of the PCB hole contact and variation of the needed press-in and pull-out forces after three cycles (mount / de-mount) of different modules on the same PCB with 25 mm/min (1 inch/min) insertion speed. However, special attention must be taken to avoid pin damage and bending during the mount / de-mount process.

## PRESS-IN

Based on the results of the qualification tests we suggest mounting the EMIPAK module on the PCB with the following conditions:

Insertion speed in the range: 25 mm/min to 50 mm/min (1 inch/min to 2 inch/min) as suggested also in IEC 60352-5

- Minimum force to press-in each pin is 35 N.
- Maximum force to press-in each pin is 90 N.
- Therefore, the press-in force for a 20 pin EMIPAK module should be in the range 0.7 kN to 1.8 kN.

The press-in procedure using a semiautomatic machine is illustrated below.

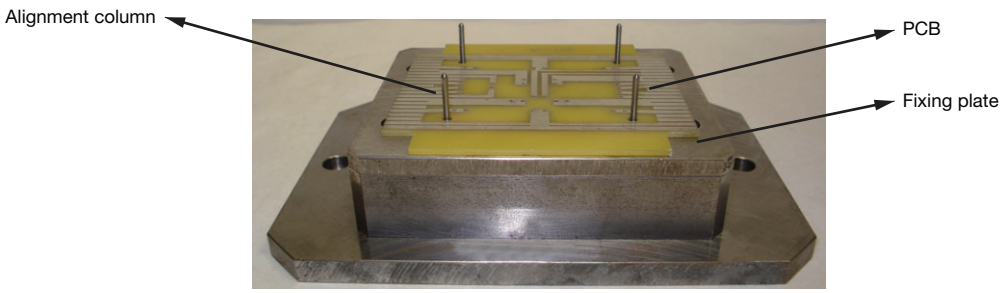


Fig. 8 - Step 1: Put the PCB on the assistant tool

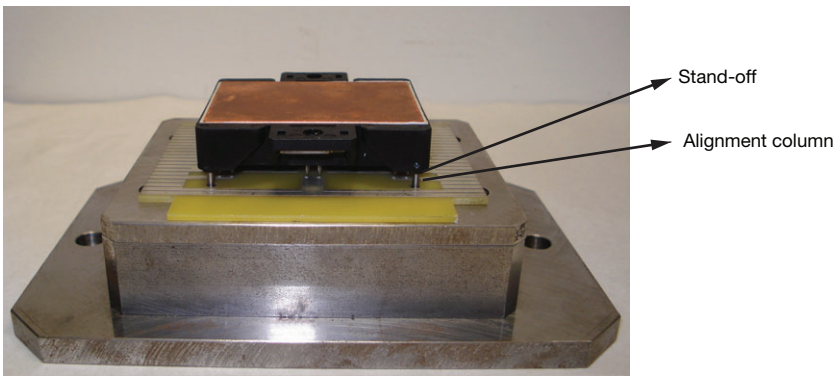


Fig. 9 - Step 2: Put the EMIPAK module on the PCB and make sure the alignment column is aligned into stand-off.

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

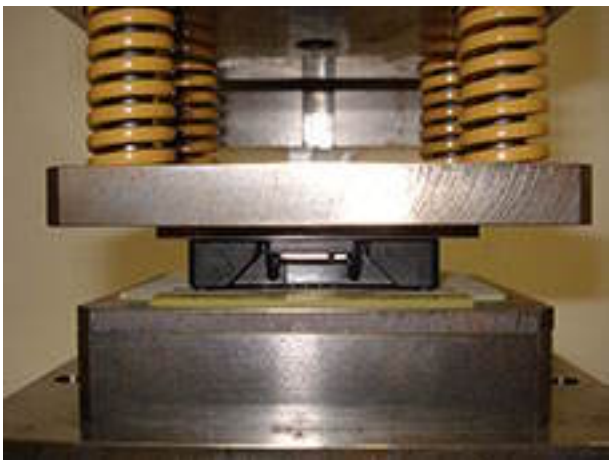

Fig. 10 - Step 3: Start the semiautomatic machine to press the pressfit module into the PCB, making sure there is no gap between the stand-off and the PCB.

Fig. 11 - Step 4: Stop the machine and press-in is finished

## PRESS-OUT

The force to be applied in order to press-out the single pin is at least 20 N. Therefore, the force needed to press-out a 20-pin EMIPAK module is 0.4 kN.

To press-out the EMIPAK module from the PCB, we suggest using the tool and pushing directly by contacting the pin's edge. It is not recommended to remove the device from the PCB by pulling the baseplate. The press-out setup tool is illustrated below.

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

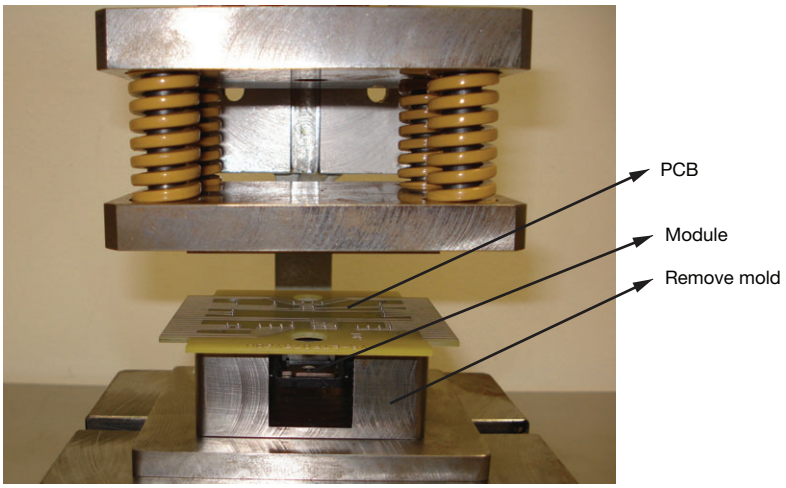


Fig. 12

**MOUNTING A PCB TO THE MODULE** (Single Module)

The EMIPAK module housing has been designed with four stand-off lids. They can be used to tighten the PCB to the module body by adding screws. Fig. 13 shows a schematic of a PCB connected to an EMIPAK through screws tightened into the module's stand-offs. 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 10 self-tapping screws, in accordance with the PCB thickness, to avoid touching the bottom surface of the stand-off cavity. The screws will self-thread into the stand-off cavity. The vertical position of the screw must also be maintained to prevent lateral insertion. We also suggest mounting the screws in a crosswise sequence. Fox example, if the fixing holes are 1, 2, 3, and 4 in a clockwise or counter-clockwise sequence, then we suggest mounting the screws by the sequence 1 and 3, then 2 and 4. In addition, the screwdriver used should have a slow rotating speed. Typical mounting torque is 0.45 Nm ± 10 %. Do not exceed 1 Nm to avoid screw / plastic damage.

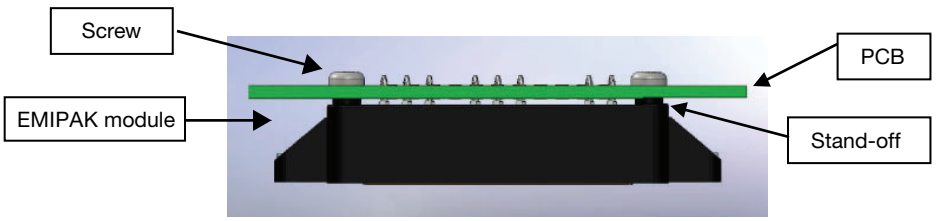


Fig. 13

In applications where one single module is used in each system, the following alternative process flows are both suitable:

a) First press-in the module to the PCB, then mount the module on the heatsink

b) Mount the module on the heatsink, and then press-in the PCB to the module.

In process A, it is suggested to use spacers to keep adequate distance between the PCB and heatsink. The spacers should be positioned at least 5 cm (2 inches) far from the modules in order to reduce the forces applied to the module pins.

In process B, the spacers can be closer to the module.

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

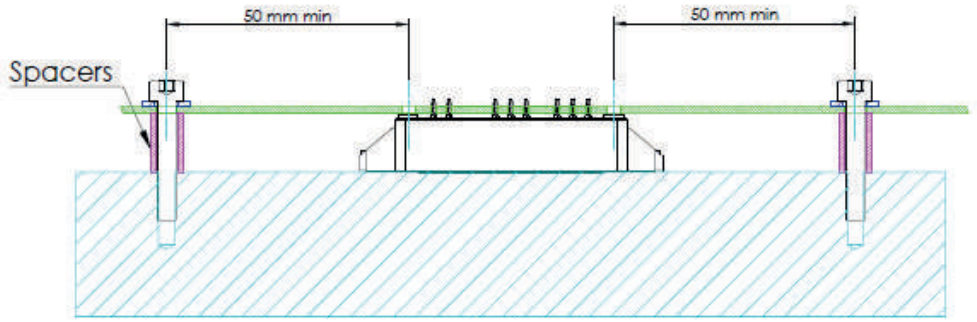


Fig. 14

## PRESS-IN TOOLS

The pin-to-PCB press-in operation has been defined and validated by using the tools shown in Fig. 15. We suggest adopting a similar approach when selecting the press-in to be installed at the end user manufacturing floor.

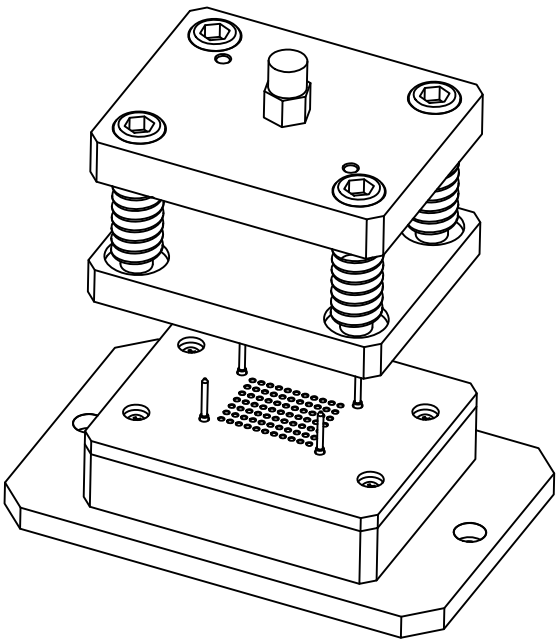

Fig. 15 - The tool for PCB module press-in

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

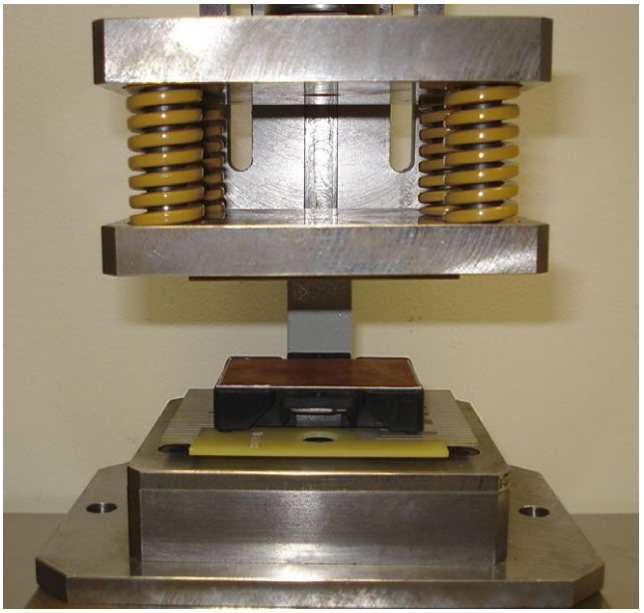

Fig. 16 - Photo of the tool for PCB module press-in

The bottom side of the press tool keeps the PCB fixed, while the top side moves and applies force directly onto the module baseplate.

## MOUNTING A PCB TO THE MODULE (Multiple Modules)

Special settings have to be prepared when simultaneously mounting more than one EMIPAK module on the same PCB.

The following process flow is recommended:

a) Press-in modules to PCB

b) Mount modules to the heatsink

c) Connect the spacers

## PRESS-IN TOOLS

The pin-to-PCB press-in operation can be performed adopting a similar approach of that of a single module, but the press-in tool has to leave an air gap between the PCB and module stand-off and avoid contact between the two parts. In such a way the press-in tool compensates the modules' height tolerance, levelling all modules. Therefore a height of 12.4 mm - 0 mm + 0.05 mm (488 mils - 0 mils + 1.97 mils) is suggested.

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

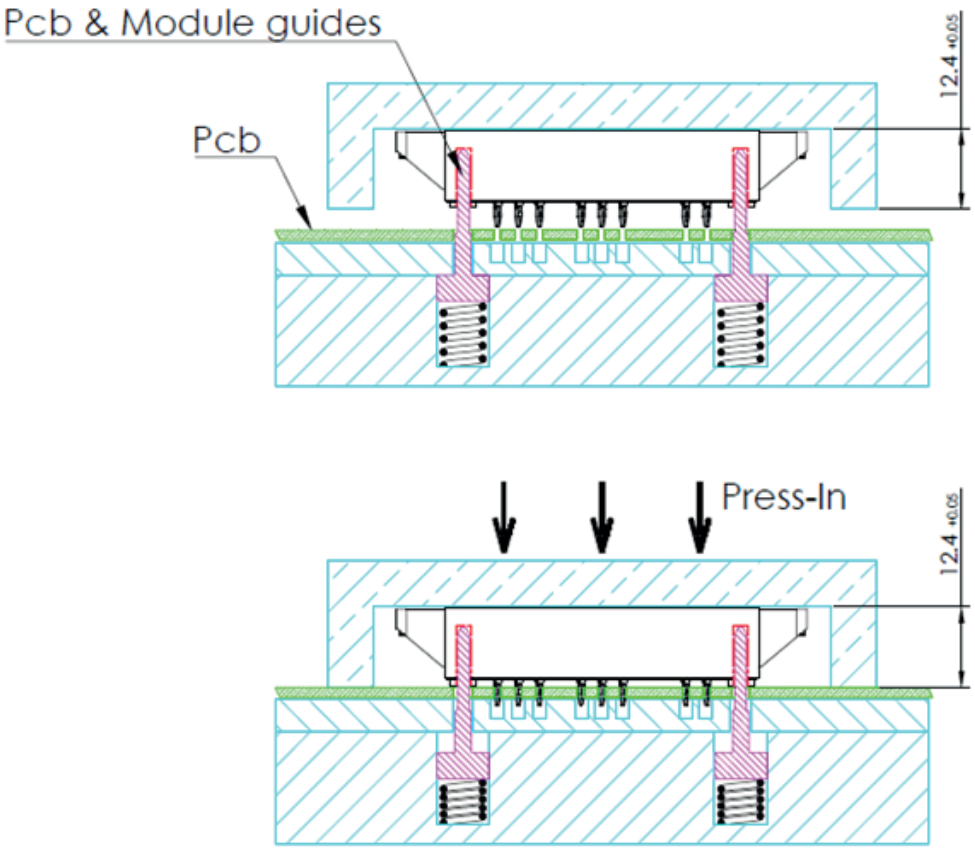


Fig. 17 - Press-In

## MOUNTING TO THE HEATSINK AND CONNECTION OF SPACERS

Thanks to the above press-in method description, the spacers can be placed close to the modules as needed.

# Mounting Instructions for EMIPAK-1B and EMIPAK-2B Modules

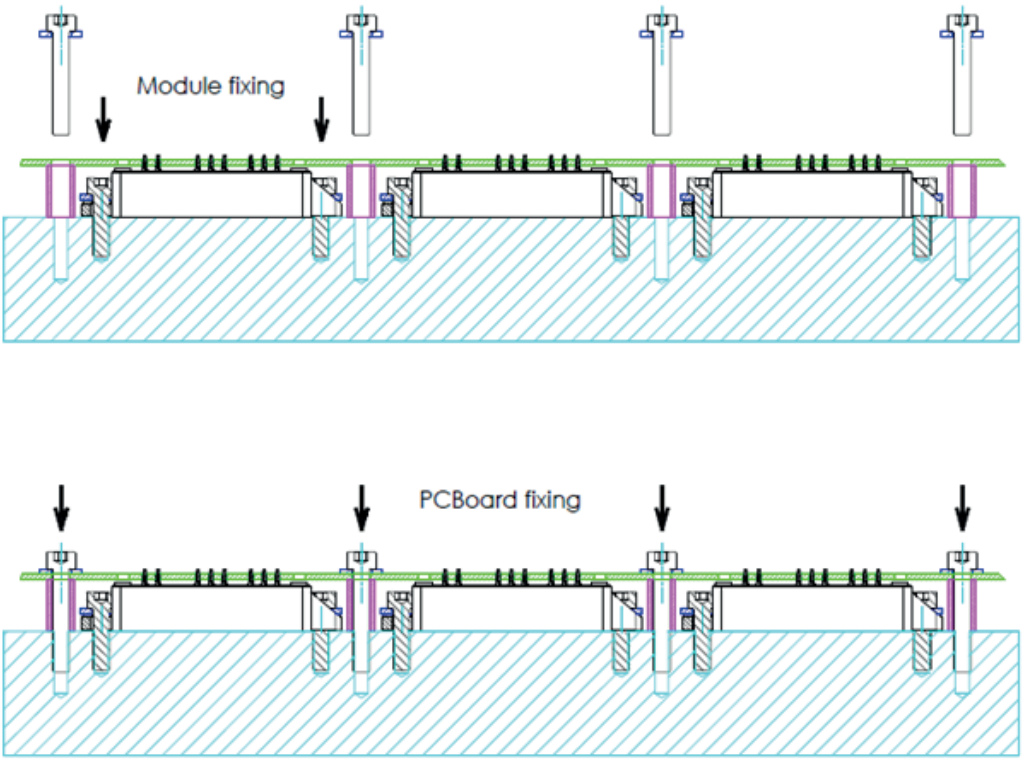


Fig. 18 - Module and PCB fixing

## SOLDER TO PCB

As an alternative method, the device pins can be soldered to the PCB. The PCB must be designed with appropriate tolerances on its hole diameters. Soldering operations must be done so as to avoid inducing any mechanical stress from pulling or tensioning the module pins. The module stand-off can be used to help align the PCB and keep proper distance. EMIPAK modules can be soldered to the PCB using hand iron or wave soldering processes. To prevent overheating of the device, we suggest that soldering time not exceed 8 s to 10 s at a temperature of 260 °C. The mounting of the module on the heatsink can be done either before or after soldering the module pins onto the PCB.

In case of removal of the module from the PCB, the first step involves unscrewing the heatsink and PCB. Gentle movement of the module will allow for separation from the heatsink, and thermal compound is expected to remain either on the heatsink surface or on the bottom baseplate surface.

## END OF LIFE MODULE WASTE DISPOSAL RECOMMENDATION

Corporate social responsibility is more and more important for the environment protection, Vishay is certified by ISO 140001 and Vishay modules are always compliant with the Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive.

We recommend that the end of life modules (include components of the modules) shall be segregated by hazardous and collected in a labeled container (refer to CER code # 16.02.16) which should be put in a designated place.