

Mounting Instruction

SEMiX press-fit®



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1. ESD Protection

SEMiX press-fit modules are sensitive to electrostatic discharge (ESD), because discharge of this kind can damage or destroy the devices. SEMiX modules are ESD protected in the shipment box by conductive plastic trays. When handling and assembling the modules it is recommended to wear a grounded wrist strap and to use a grounded workplace. All staff shall be trained for correct ESD handling.

2. General Sequence of Mounting Steps

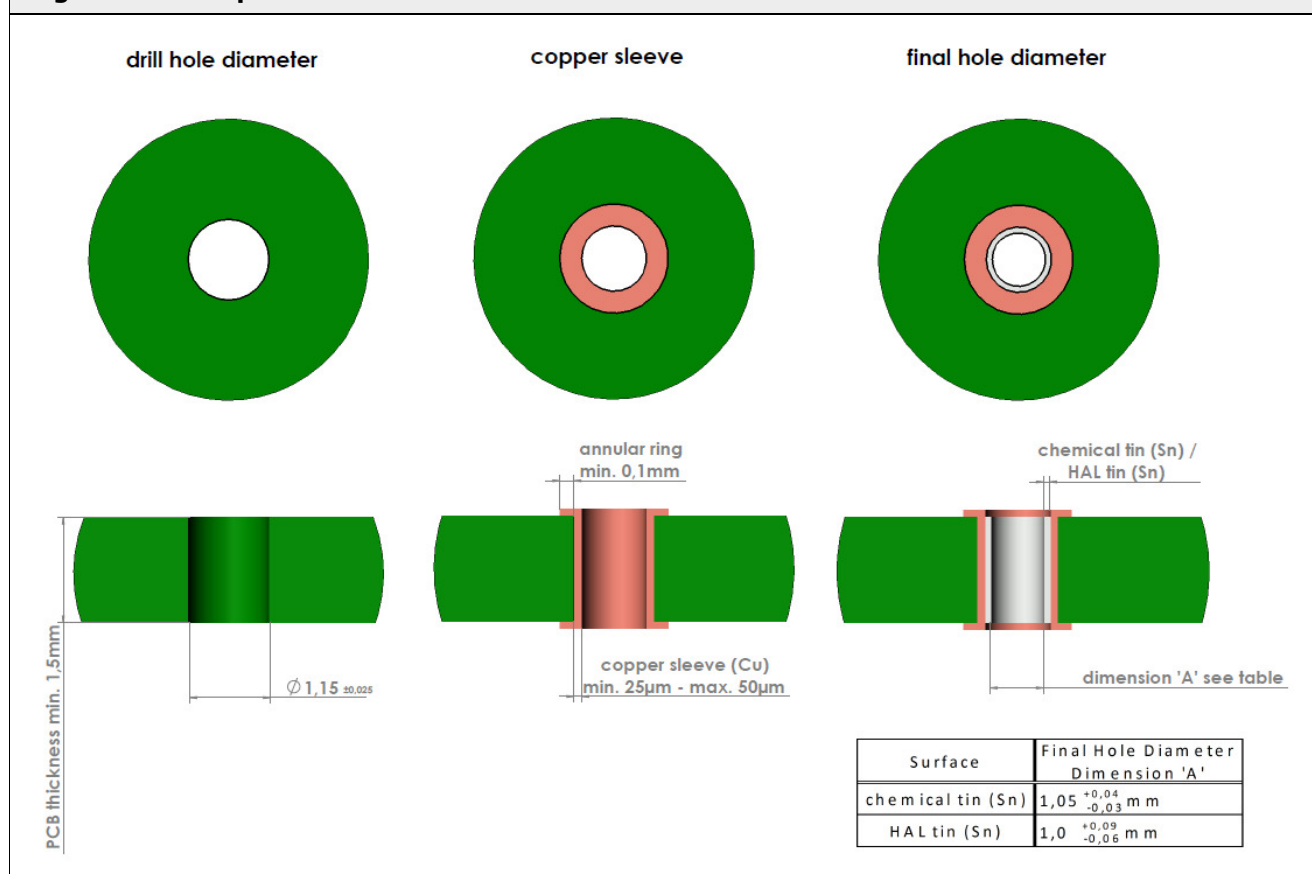
It is recommended to mount the printed circuit board onto the module at first. Second step is the application of thermal paste, in case the option of pre-printed phase-change material is not used. Finally the subassembly of module and driver board is mounted onto the heat sink.

3. Printed Circuit Board Specifications

The following recommendations for printed circuit boards (PCB) do not constitute a complete set of design rules. The responsibility for proper design remains with the user of SEMiX press-fit modules.

- PCB material: FR4
- PCB thickness: min. 1.5 mm
- Specification of holes according to Fig. 1
- Safety zone of 5mm from each pin to any component for the contact areas of the SEMİKRON press-in tool (see chapter 3.1 Press-in Process) or according distance in case an own tool is developed

Figure 1: PCB Specification



4. Mounting the Printed Circuit Board

4.1 Press-in Process

The main principle of the press-in technique is the bigger latitude of the press-in zone than of the PCB hole. By the press-in process a plastic deformation of the pin results, ensuring a gas-tight and low-ohmic resistance. Only small insertion forces are necessary with high holding forces at the same time.

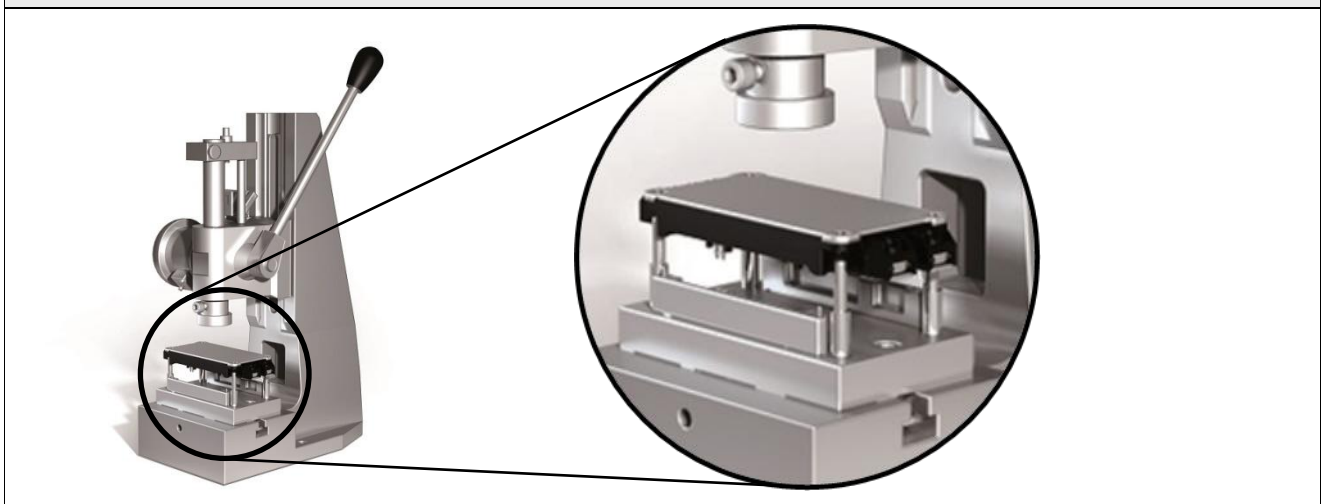
The press-fitting can be done by using a toggle lever press or a machine. SEMİKRON offers 3D CAD models of a suitable press-in tool as design help for a customer's tool (see Fig. 2). These may be requested at the local sales contact. For a constant quality a machine that logs applied force and covered distance is recommended.

During the press-in process the levels of PCB, module and press need to be parallel to each other. Best results are achieved by a continuous movement during the complete cycle.

To press a single pin into the PCB requires a force in the range of 35 N to 70 N. The force depends on the hole diameter. With holes at the lower limit of the specified tolerance (see Fig. 1) or several modules mounted at the same time press-in forces may be higher. The upper limit of the press has to be adjusted to 100 N per pin, to avoid damage of the module respectively the pin.

Standard IEC 60352-5 gives a press-in speed of 25mm/min. As usual production equipment offers speeds from 220 mm/min upwards the recommendation is to use 420 mm/min, where proper results were achieved during tests.

Figure 2: Toggle lever press with press-in tool



4.2 Press-out Process

The tool to disassemble modules from the PCB is similar to the press-in tool. Again 3D CAD models can be provided to assist in development. Same application notes as mentioned above are applicable here. The recommended press-out speed and necessary force are equal to or less than for the press-in process.

A SEMiX press-fit module which was pressed in and then pressed out cannot be pressed in again. The plastic deformation of the press-fit pin does not allow further press-fitting. In this case the module can be connected safely with the PCB by soldering (see section 4.4).

4.3 Additional Fixation

It is necessary to fix the PCB on the module with four additional screws, especially in vibrating applications. SEMİKRON recommends the following type of self-tapping screws:
EJOT-DELTA-PT, WN5451, Torx-Plus, A2K, 2,5x10 mm (www.ejot.de)

When using an electrical screw driver, a screwing speed of 300 rpm and soft torque limitation is recommended, to avoid damage of the housing. SEMİKRON disadvises against pneumatic screw drivers, due

to clutch behavior with torque overshoots. Manual tightening is not allowed, as screwing speed is not sufficient to melt the housing material for forming the thread.

With a speed of 300rpm and the above mentioned screw type, the following torque was defined:

$$M = 0.9 \text{ Nm} \pm 0.1 \text{ Nm}$$

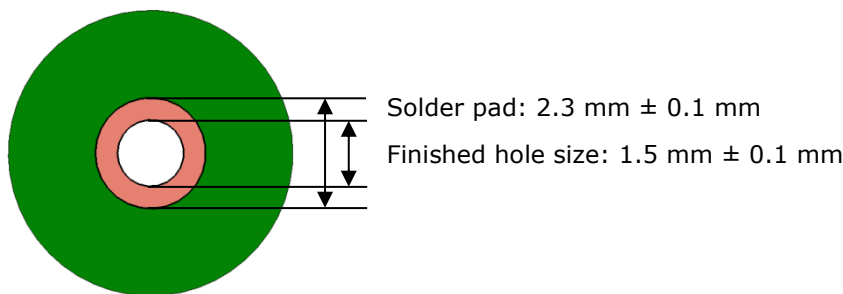
With slower/faster speed the necessary torque for a planar contact of PCB and bearing housing areas might be higher/lower, due to the characteristics of the housing material.

The depth of the screw in the module has to be between min. 6.0 mm and max. 10.0 mm, respectively $8.0 \text{ mm} \pm 2.0 \text{ mm}$. The number of times a driver may be assembled and disassembled strongly depends on the screw surface and mounting torque.

4.4 Soldering

Like mentioned in section 4.2 the PCB needs to be soldered to the module if the module is connected for a second time, i.e. if the press-fit function has already been used. SEMİKRON recommends solder of the type $\text{Sn}_{95,5}\text{Ag}_{3,8}\text{Cu}_{0,7}$ for this. In case the press-fit pin shall be soldered already in first use (e.g. if a module with solder pins is replaced), a different recommendation for the holes than in Fig. 1 is valid (see. Fig. 3).

Figure 3: PCB Specification for soldering the press-fit pin in first use



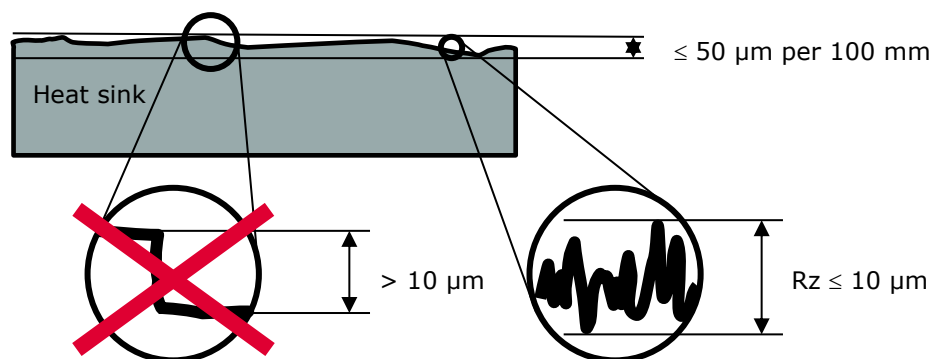
5. Surface Specifications

To obtain the maximum thermal conductivity, the bottom side of the module must be free of grease and particles. It is recommended to clean the mounting surface with lint-free wipes and a fat-dissolving solvent (e.g. isopropyl alcohol). Furthermore, to ensure long-term reliable electrical contacts the press-fit pins have to be kept clean at all times and should never be touched by hand.

The heat sink must fulfil the following specifications (Fig. 4):

- Unevenness of heat sink mounting area must be $\leq 50 \text{ } \mu\text{m}$ per 100 mm (DIN EN ISO 1101)
- Roughness "Rz" $\leq 10 \text{ } \mu\text{m}$ (DIN EN ISO 4287)
- No steps $> 10 \text{ } \mu\text{m}$ (DIN EN ISO 4287)
- The heat sink must be free from grease and particles
- Tap holes must be free of turnings
- It is recommended to clean the surface with lint-free wipes and a fat-dissolving solvent (e.g. isopropyl alcohol)

Figure 4: Heat sink surface specifications



6. Applying Thermal Paste

A thin homogenous layer of thermal paste has to be applied onto the heat sink surface or the bottom side of the module. A layer thickness of 50 µm – 100 µm is recommended and can be determined by using a wet film wheel as shown in Fig. 5. SEMİKRON recommends following pastes:

- silicone paste: P12 from WACKER CHEMIE (www.wacker.com)
- none-silicone paste: HTC from ELECTROLUBE (www.electrolube.com)

Stencil printing is suggested to apply thermal paste, but a hard rubber roll might be suitable as well. Attention has to be paid that no screw holes are polluted by thermal paste.

Further information about applying thermal interface material can be found in *Application Note AN 18-001*.

Figure 5: Wet film wheel



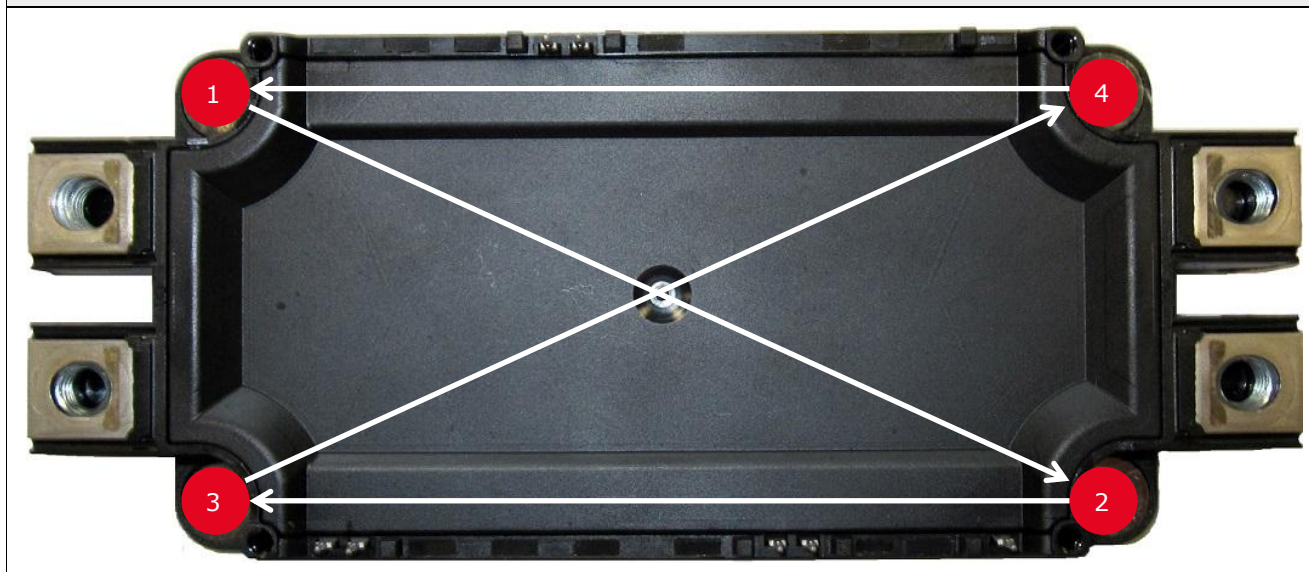
ZWW2102, Zehntner Testing Instruments (www.zehntner.com)

7. Mounting to the Heat Sink

SEMİKRON recommends M5 screws of strength category 8.8. The usage of washers is not necessary. To comply with creepage and clearance distances it is suggested to check the resulting distances according to the relevant standard (EN 61800-5-1) when selecting a screw type (see also chapter 8: Creepage and Clearance Distances).

The SEMiX has to be placed on the matching heat sink area. Then the four screws have to be pre-tightened with max. 1.0 Nm, following a crosswise mounting sequence (Fig. 6). Finally the mounting torque M_s (as given in the data sheet) has to be applied, again crosswise: min. 3.0 Nm and max. 6.0 Nm, respectively $4.5 \text{ Nm} \pm 1.5 \text{ Nm}$.

When using an electrical screw driver, screwing speed has to be limited to a maximum of 300 rpm and soft torque limitation is recommended, to ensure a homogenous distribution of the thermal paste layer. SEMİKRON disadvises against pneumatic screw drivers, due to clutch behavior with torque overshoots.

Figure 6: Crosswise mounting sequence


The optional usage of pre-applied phase-change material does not change the preceding instructions (see also document *Technical Explanation Thermal Interface Materials*).

8. Creepage and Clearance Distances

SEMiX press-fit modules comply with the creepage and clearance distances required in EN 61800-5-1 for the following boundary conditions:

- Maximum peak voltage: 1700V
- Maximum DC-link voltage: 1300V
- Line over-voltage category: 3
- Pollution degree: 2
- Maximum height of operation above sea level: 4000m
- Basic insulation of temperature sensor
- Comparative Tracking Index (CTI) of the housing: Class IIIb ($100 \leq \text{CTI} < 175$)

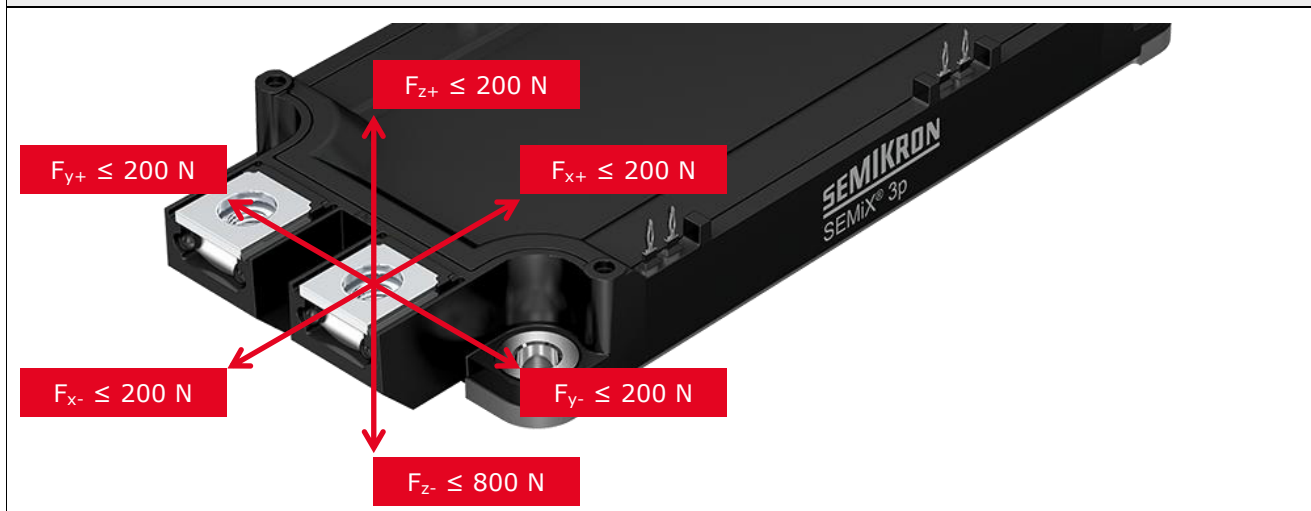
Table 1: Creepage and clearance distances

		EN 61800-5-1	On outside of module
Creepage	Terminal to terminal	13.0mm	13.0mm
	Terminal to base plate	7.1mm	15.0mm
Clearance	Terminal to terminal	2.2mm	10.4mm
	Terminal to heat sink	7.1mm	9.9mm

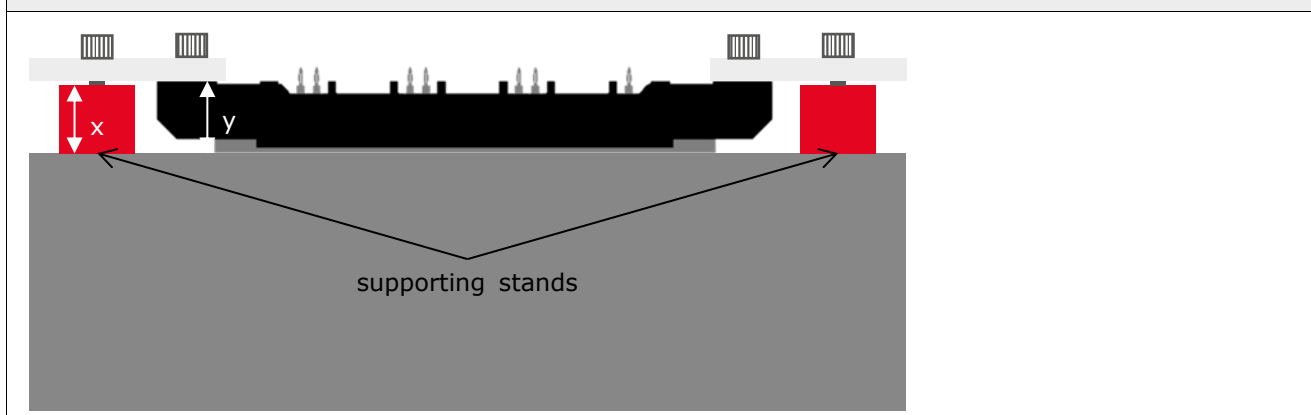
9. Mounting to the Main Terminals

SEMİKRON recommends M6 screws of strength category 8.8. The effective length of the screw in the module has to be between min. 7.0 mm and max. 8.0 mm, respectively $7.5 \text{ mm} \pm 0.5 \text{ mm}$. The mounting torque M_t has to be between min. 3.0 Nm and max. 6.0 Nm, respectively $4.5 \text{ Nm} \pm 1.5 \text{ Nm}$. The driver bit shall be as short as possible to avoid uncontrolled and tilted screwing.

SEMiX is a power module and not part of the mechanical construction. Therefore the maximum mechanical forces on the main terminals (as given in Fig. 7) must not be exceeded throughout the entire mounting process. For the main terminal connections it is better to apply a force in z- direction rather than in z+ direction. The SEMiX module is not meant to secure the DC-link or AC-connection, which is why additional mechanical components (supporting stands) have to be applied there (Fig. 8).

Figure 7: Maximum forces at the main terminals


The height x of the supporting stands should be slightly lower ($\sim 0.5\text{mm}$) than the height y of the power terminals, to bring a loading force to the terminals.

Figure 8: Proposed set-up for stress relief ($x \leq y$)


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