SEMIKRON
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Mounting Instruction
SKiM®4&5

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Prepared by:	Matteo Santoro
Approved by:	S. Hopfe, W. Obermaier

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1. Related Documents

- Datasheet of SKiM power modules
- Technical Explanations SKiM4/5
- Technical Explanation Pre-applied Thermal Paste

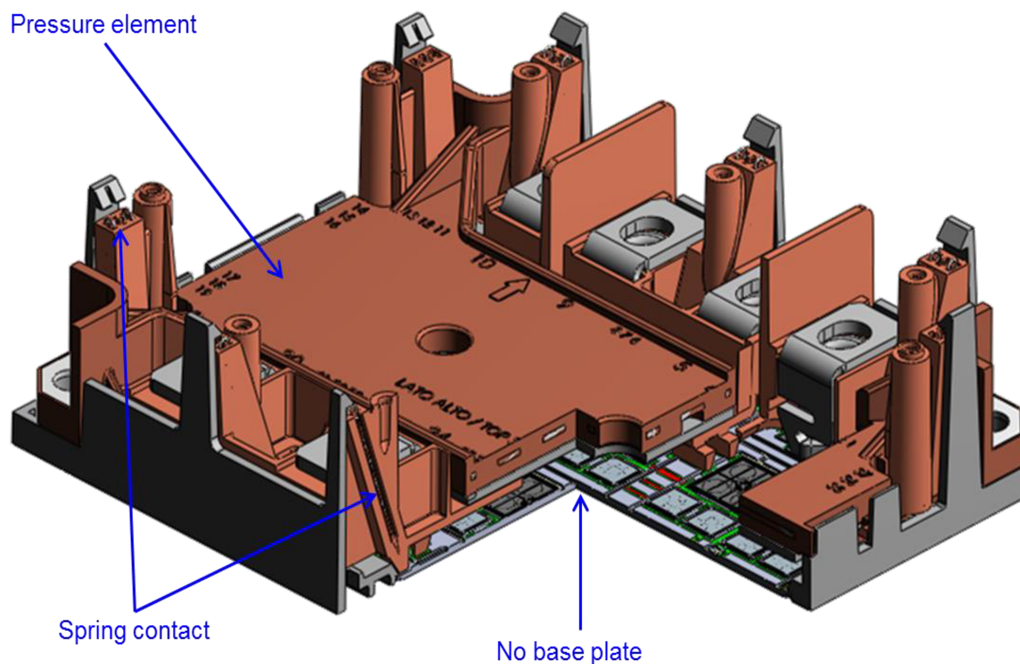
All documents are available on the SEMIKRON internet page.

2. Introduction

The SKiM product family features highly reliable baseplate-less modules specifically designed to meet Customer's needs in terms of shock and vibration stability, as well as high temperature capability and service life.

The concept of baseplate-less design is to achieve a good thermal contact in the active area of the DCB-substrate (Al_2O_3 or AlN) close to the dies by an implemented pressure contact system (SKiiP technology). This pressure contact system is activated by mounting the module onto the heat sink. During this process, the spring contact system is activated and assures a close contact between the heat sink and the module.

Figure 1: Cross-sectional view of SKiM4



3. ESD Protection

In IGBT modules electrostatic discharge can damage or destroy the sensitive MOS structure of the gate. For this reason all SKiM modules are ESD protected by a dedicated cover during assembling process, storage and transport.

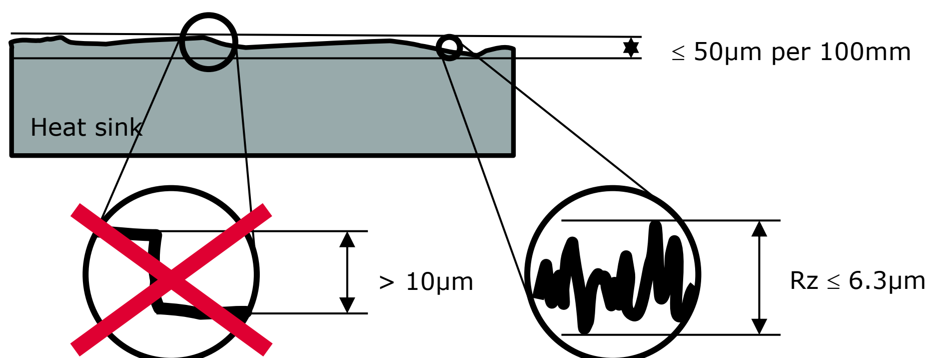
When handling and assembling SKiM4 and SKiM5 modules it is recommended that a conductive grounded wristlet is worn and a conductive grounded workplace is used. All staff shall be suitably trained for correct ESD handling.

4. Surface Specification

To obtain the maximum thermal conductivity of the module, heat sink and module must fulfil the following specifications.

4.1 Heat sink

Figure 2: Heat sink surface specifications



- Heat sink must be free from grease and particles
- Unevenness of heat sink mounting area must be ≤ 50 µm per 100 mm (DIN EN ISO 1101)
- Roughness (Rz) ≤ 6.3µm (DIN EN ISO 4287)
- No steps > 10µm (DIN EN ISO 4287)

4.2 Mounting surface

The mounting surface of the SKiM module must be free from grease and all kind of particles. Fingerprints or discolorations on the bottom side of the DBC (Figure 3) do not affect the thermal behaviour and cannot be rated as a failure criteria.

Due to rework or a second cleaning process, there might be imperfections on the bottom surface of the DBC. An imperfection of the surface does not affect the thermal behaviour (Figure 4).

Figure 3: SKiM bottom surface discolorations

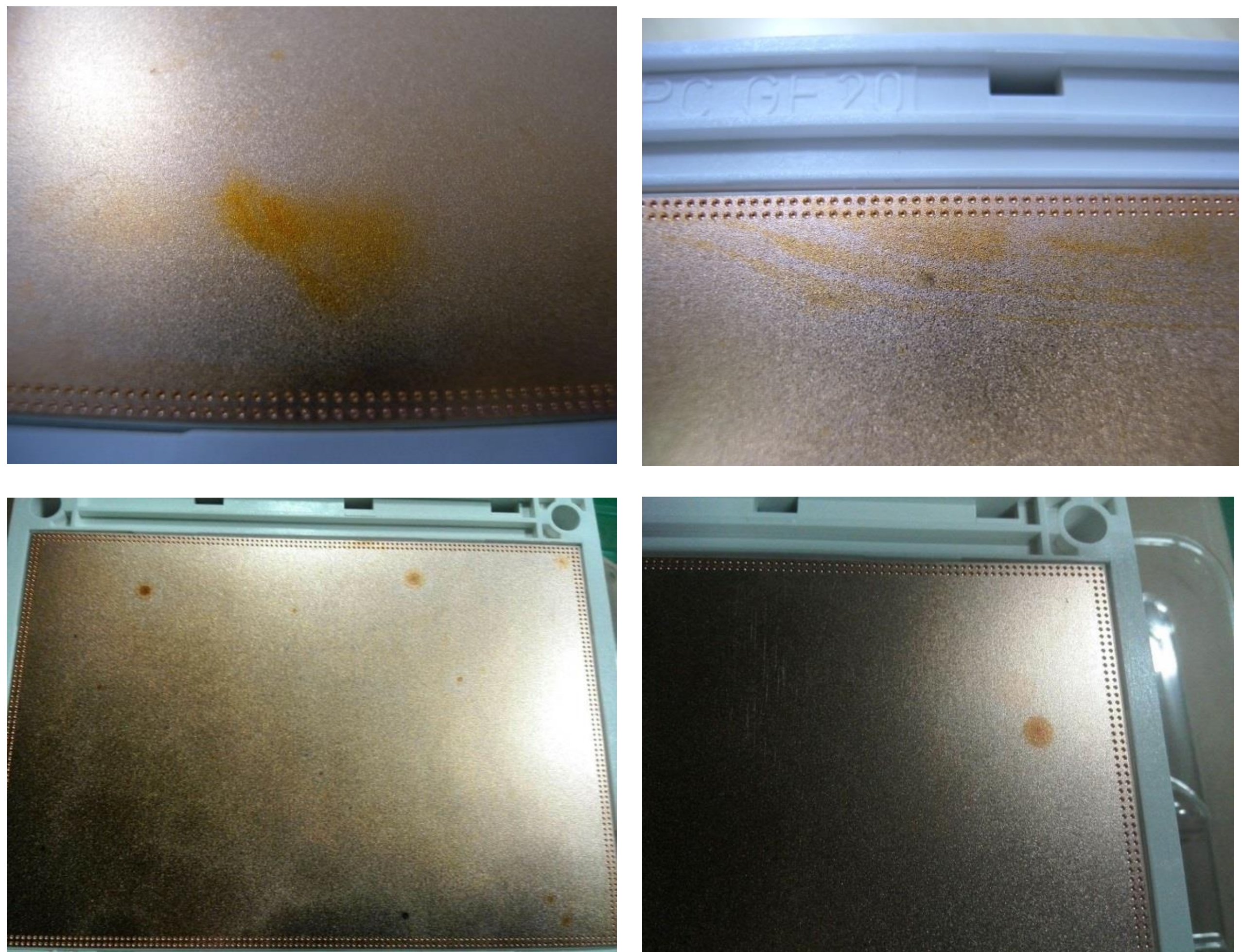


Figure 4: SKiM bottom surface after rework

Due to the manufacturing process, the bottom side of the SKiM may exhibit scratches, holes or similar marks. The following figures are defining surface characteristics, which do not affect the thermal behaviour. Distortions with higher values as specified can be rated as failure.

The SKiM bottom surface must in any case comply with the following specification (Figure 5 to Figure 7).

Figure 5: Scratches on the SKiM surface

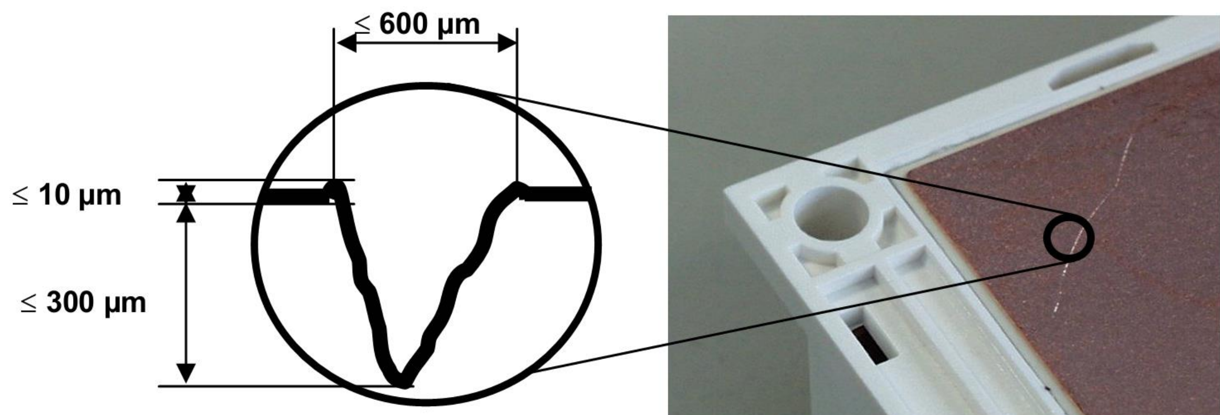


Figure 6: Etching hole (hole down to substrate level) in the SKiM bottom surface

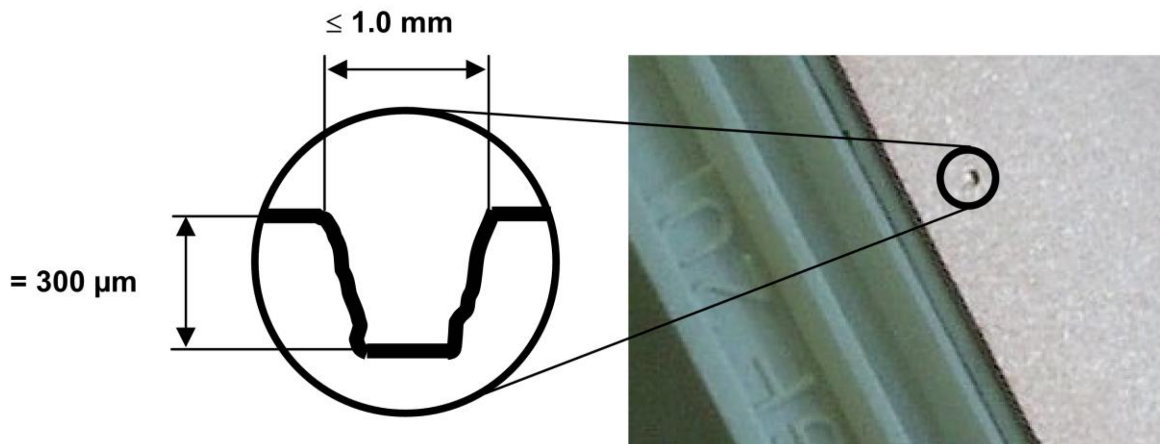
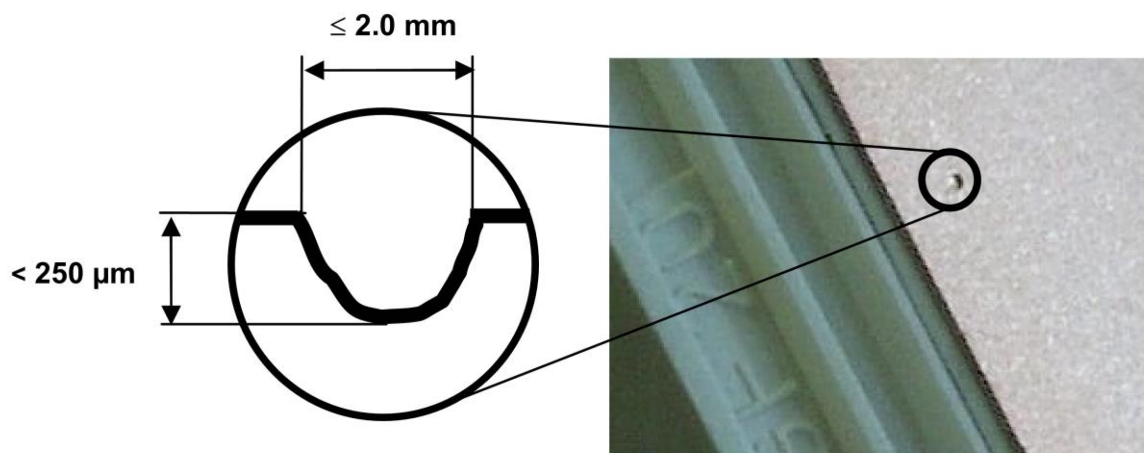


Figure 7: Etching hole (hole NOT down to substrate level) on the SKiM bottom surface



5. Assembly

5.1 Application of thermal paste

A thin layer of thermal paste should be applied to the heat sink surface or module bottom surface. SEMIKRON recommends screen printing for applying the thermal paste. The screen printing process offers reproducibility and accuracy of the thickness of the paste. The following values are valid for the resulting continuous layer thickness of thermal paste and recommended for „Silicone Paste P 12" from WACKER CHEMIE applied with screen printing process:

SKiM4:	between 40µm and 50µm
SKiM5:	between 40µm and 50µm

SEMIKRON has a special process for automatic paste printing which grants tolerance of 45µm ± 5µm (Figure 8) . For information on the qualification of SEMIKRON's thermal paste printing process please contact SEMIKRON.

If not using modules with pre-applied thermal paste by SEMIKRON it is the customer's responsibility to qualify his own paste printing process as deviations from the recommended process may impact reliability or technical performance of the modules.

Figure 8: SEMIKRON automated printing machine

Applying paste by a hard rubber roller might be applicable but usually needs to be handled with extra care for acceptable results. In any case a thickness check should be done to verify the thermal paste thickness.

SEMIKRON recommends the gauge from ZEHNTNER called “Wet Film Wheel” as shown in Figure 9 for thickness check and to measure the paste thickness in four different points near the corner of the module.

Figure 9: Wet film wheel type ZWW2102

Lower thickness of thermal paste (e.g. from 20µm to 30µm for AlN DBCs) might also be possible but this is not a standard for SEMIKRON. The reliability of the different thickness must be measured for equal distribution of the paste across the entire copper area of the module and by monitoring the Rth values to make sure given datasheet can be met.
An example for correct application of thermal paste on SKiM4 heatsink is shown in Figure 10.

When the module is mounted according to SEMIKRON specifications with 50µm of paste, thermally cycled and dismounted again, no voids can be observed in the thermal paste print out either on the heatsink (Figure 11, left) or on the module (Figure 11, right). Please note that the printing images of heatsink and module must both be observed: areas with lower thickness of thermal paste on the heatsink may go together with areas of higher thickness on the module and vice versa. This is not faulty as long as the total thickness is within the specified range.

Figure 10: Heatsink view after application of thermal paste

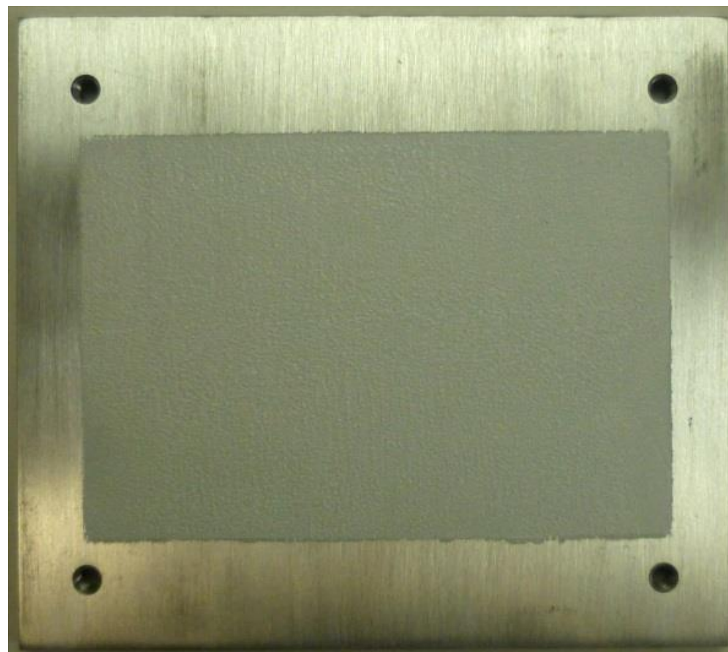
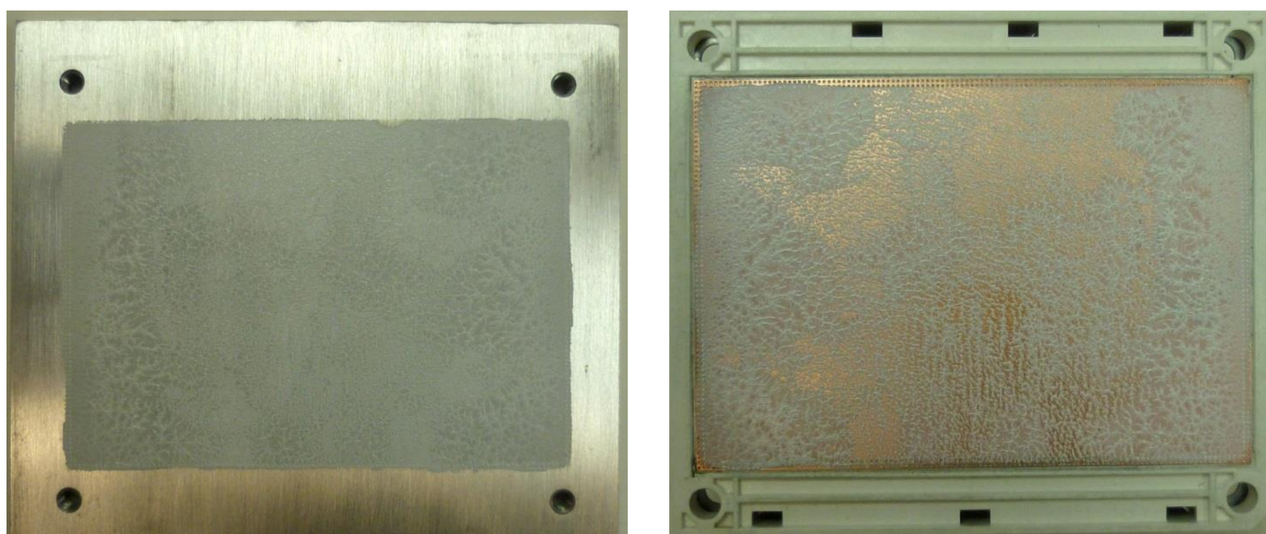


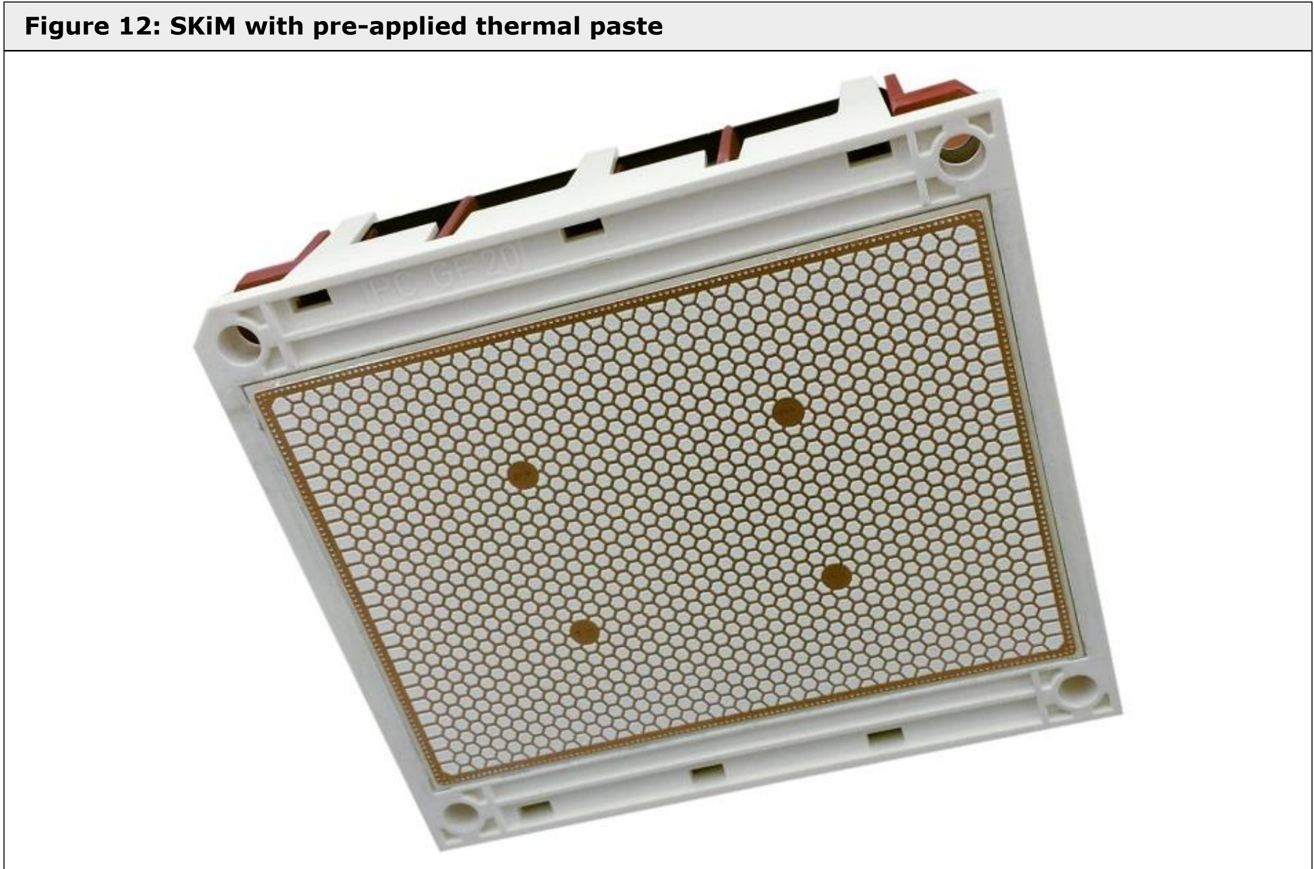
Figure 11: Example for a good distribution of thermal paste after assembly, thermal cycling an disassembly



5.2 Pre-applied thermal paste

SEMIKRON offers SKiM®4&5 power modules with pre-applied Wacker P12 (silicone-based) thermal paste.

Figure 12: SKiM with pre-applied thermal paste



The thermal paste is applied to the modules by SEMIKRON prior to shipment for eliminating the critical process step from the customer's manufacturing process.
Further advantages of pre-applied thermal paste are:

- Efficient, reproducible, and controllable module assembly process
- Optimum thickness of thermal paste layer leading to lower thermal resistance
- High degree of process reliability using an automated and monitored screen-printing process

For further technical details please **refers to the Technical Explanation Thermal Interface Material** available in the SEMIKRON web site

5.3 Mounting the SKiM

After applying the thermal grease, the SKiM4 or SKiM5 module can be placed on to the appropriate heat sink area.

After the module has been positioned on the heat sink, the screws need to be inserted and pre-tightened, applying a torque of 0.5Nm.

Manual pre-tightening for SKiM5 shall be performed following the numerical sequence highlighted in Figure 15, and manually pre-tighten each screw with tool. This will help module to reach mechanical stability and keep plastic parts in place in the final tightening.

SEMIKRON recommends to use the following M5 screw (according to DIN EN ISO 898-1):

Strength of screw : "8.8"
Tensile strength : Rm = 800N/mm²
Yield point : Re = 640N/mm²
Washer : suitable for thread M5 (according to ISO 7092)

After the pre-tightening of the module SEMIKRON recommends a waiting time of 1-2 minutes until the module reaches mechanical stability before tightening the screws to the final mounting torque as shown in Table 1.

Table 1: Torque specification for heat sink fixing

Module	Minimum torque	Maximum torque
SKiM4	2Nm	3Nm
SKiM5	2Nm	3Nm

Final tightening is to be performed crosswise following mounting sequence of Figure 14. Torque wrenches with automatic release are strongly recommended.

As to power screw drivers, an electric power screw driver is recommended. With pneumatic systems, the behaviour of the clutch can lead to a shock and torque overshoot which would damage the SKiM module.

SEMIKRON recommends to limit the screwing speed to a maximum value of 200 revolutions per minute (rpm).

Pre-tightening and final tightening must be performed crosswise. Examples for crosswise mounting order of SKiM4 and SKiM5 are shown in Figure 13 and Figure 14.

When using an electrical screw driver, screwing speed has to be limited to a maximum of 200 rpm and soft torque limitation is recommended, to ensure a homogenous distribution of the thermal paste layer.

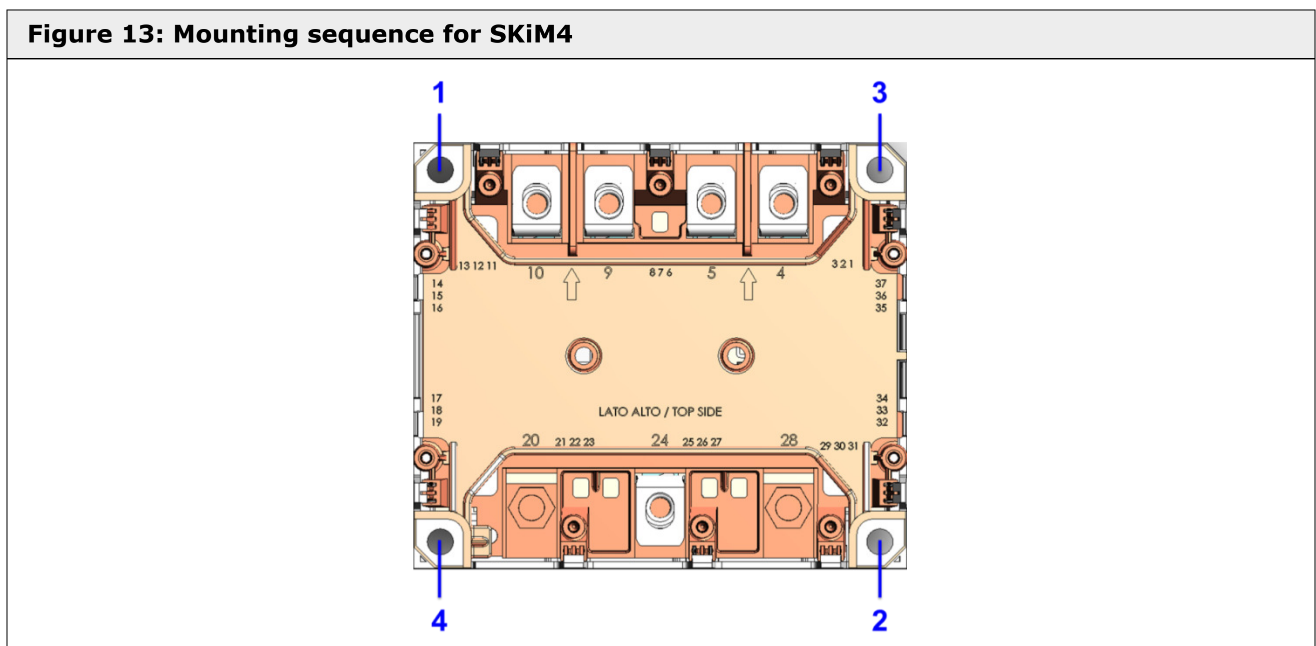


Figure 13: Mounting sequence for SKiM4

Figure 14: Mounting sequence for SKiM5

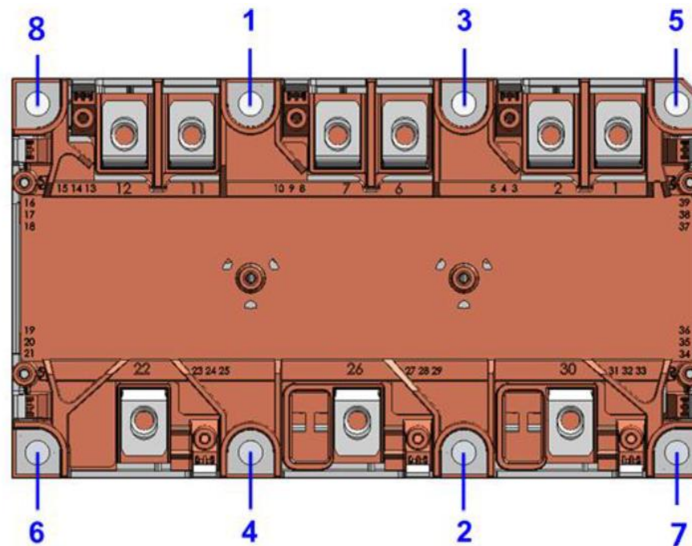
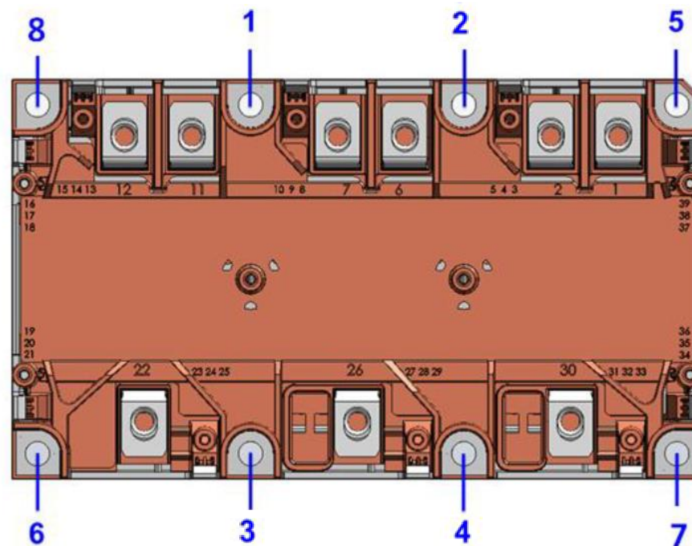


Figure 15: Alternate Mounting sequence for SKiM5



During the assembly process the thermal paste will spread evenly, meaning that reliable and homogeneous thermal contact is achieved. The R_{th} values given in the datasheets will be reached after 3-4 thermal cycles during which the heatsink temperature must be cycled between 10°C and 80°C. This effect shall be considered for first electrical high power operation.

5.4 DC bus-bar mounting

The functionality of the pressure contact system can be disturbed by too high pulling forces on main terminals, resulting in malfunction of the module.

SEMIKRON recommends the following M6 screw (according to DIN EN ISO 898-1)

Strength Designation	: “8.8”
Tensile strength	: Rm = 800N/mm²
Yield point	: Re = 640N/mm²

Washer : not required

The screws have to be tightened to the final mounting torque according to Table 2.

Table 2: Torque specification for terminal mounting		
Module	Minimum torque	Maximum torque
SKiM4	4Nm	5Nm
SKiM5	4Nm	5Nm

The maximum immersion depth of the screws for SKiM4 and SKiM5 may not exceed 9mm and subsequent tightening of the screws is not allowed.

For the maximum allowed pulling forces per terminal on SKiM4 and SKiM5 modules refer Figure 16 and Table 3.

Figure 16: Terminal pulling forces

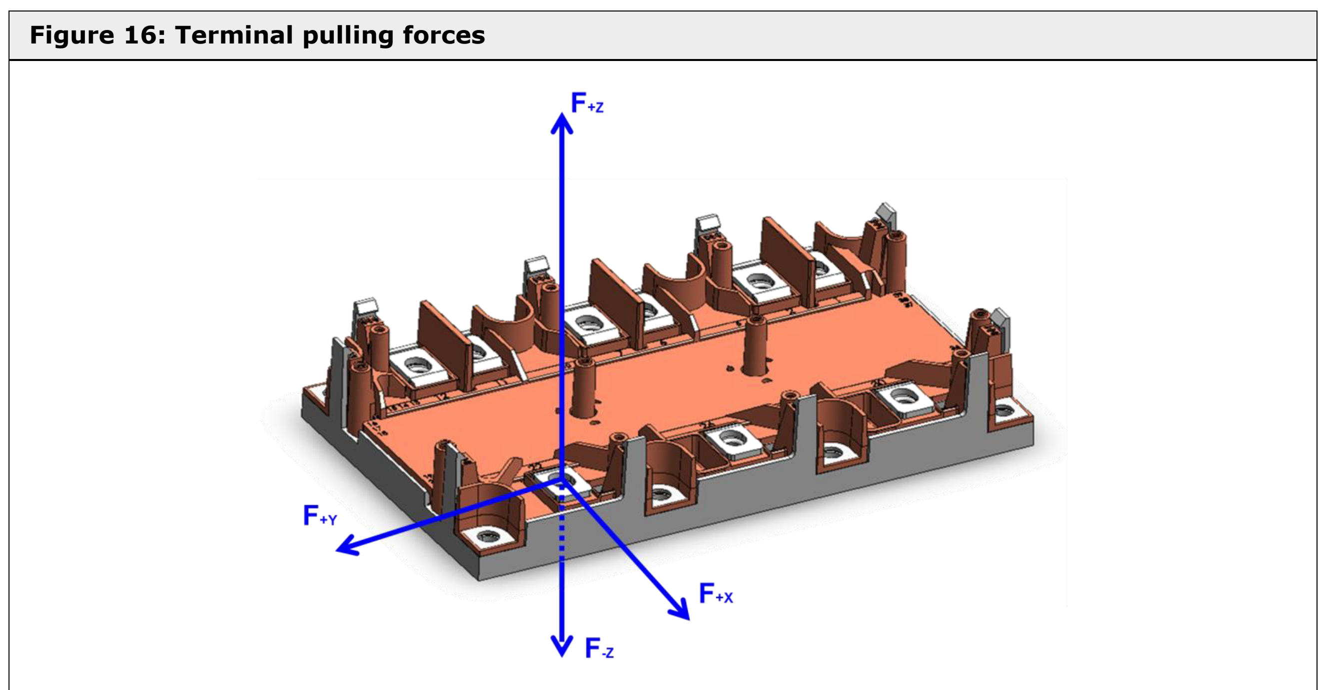
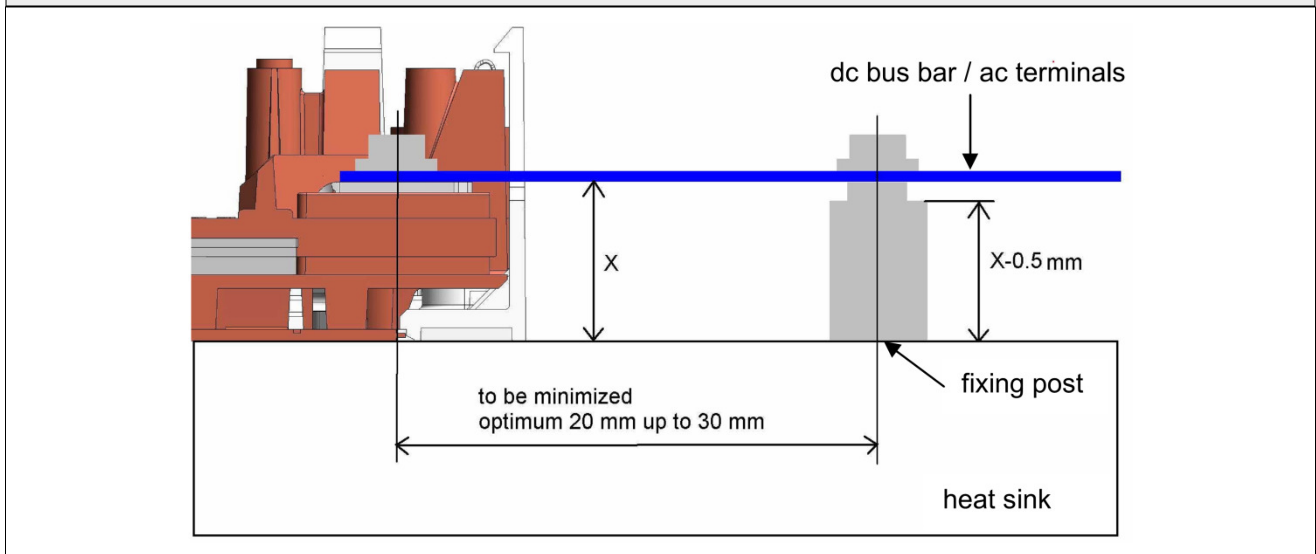


Table 3: Maximum pulling forces per terminal	
Force direction	Maximum force
F_{+X}	< 100N
F_{+Y}	< 100N
F_{+Z}	< 100N

Note: In order to avoid damages to the module SEMIKRON recommends not to apply pulling forces along F_{+Z} direction. To avoid those pulling forces it is recommended to reduce the height of the fixing post be 0.5mm regarding the minimum terminal height (see Figure 17).

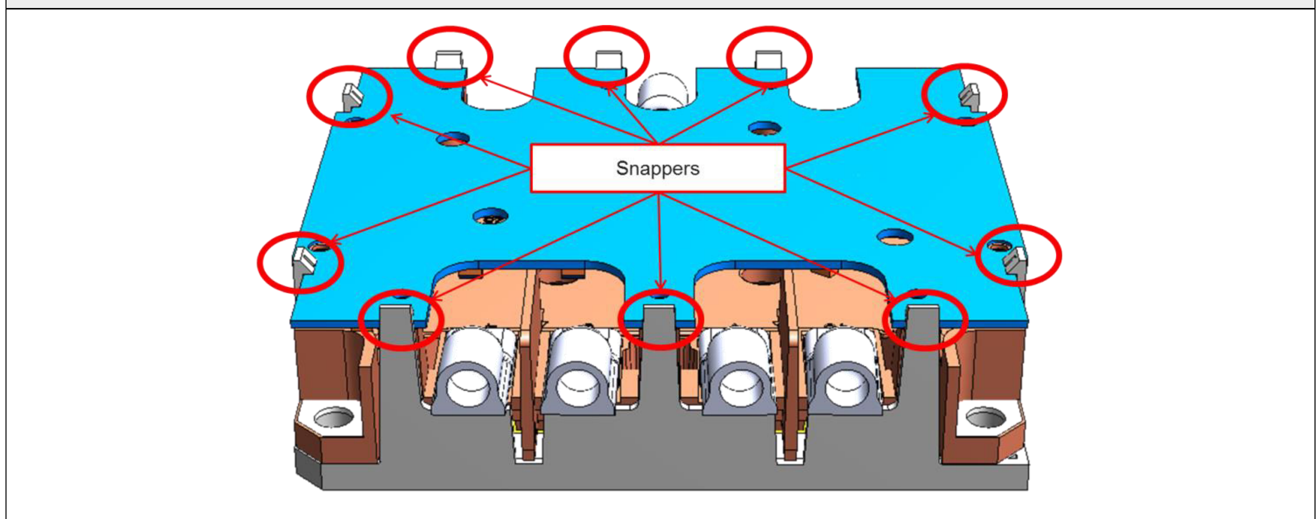
Figure 17: Recommended DC bus-bar assembly scheme



5.5 Printed Circuit Board (PCB) assembly

A printed circuit boards (PCBs) can easily be mounted onto the SKiM module by snapping all snappers as shown in Figure 18.

Figure 18: PCB assembly on the SKiM



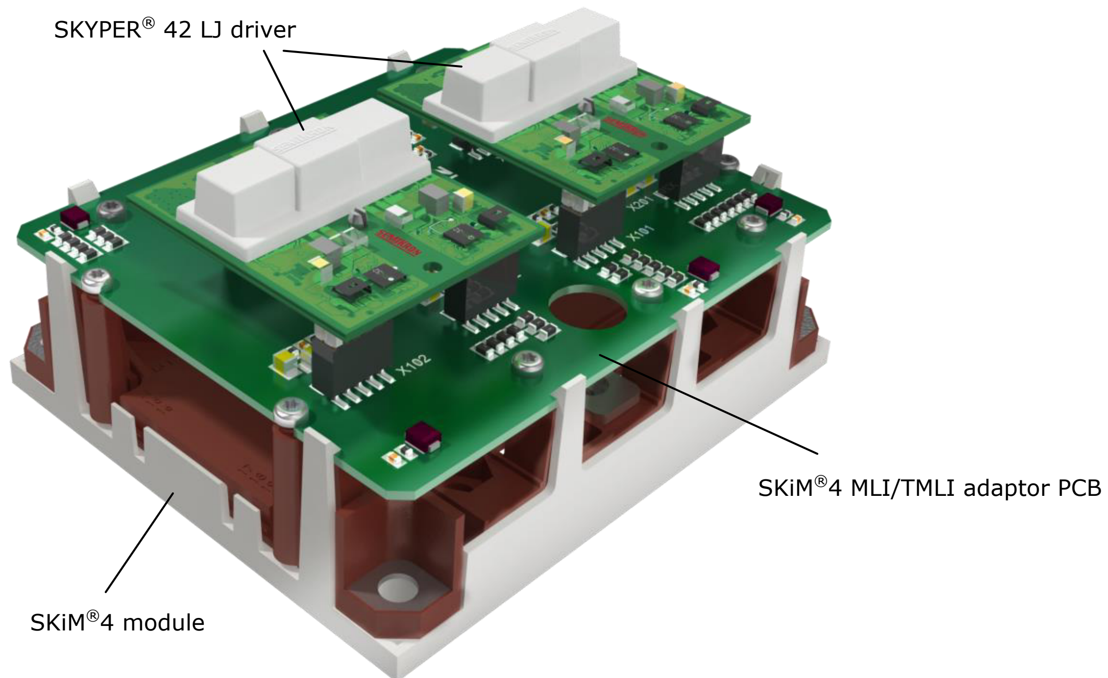
To test the SKiM4 MLI and TMLI the following application boards have been developed:

- L5063101 – SKYPER® 42 LJ
- 45120701 – PCB MLI driver adaptor
- 45121301 – PCB TMLI driver adaptor

The application boards respect all required clearance and creepage distances but are not further qualified as they are intended for prototyping only and not for series production.

The complete assembly scheme is shown in Figure 19.

Figure 19: SKiM4 driver assembly



To avoid damages of the spring contacts during the assembly of the PCB adapter, it is recommended not to make lateral movements of the board respect for the module. For this reason it is recommended to maintain the PCB aligned to the module using guiding pins (Figure 20) temporarily located in the posts shown in Figure 21.

The procedure to assemble the PCB using the guiding pins is the following:

1. screw the 2 guiding pins into 2 diagonally opposite screw holes;
2. place the PCB on top of the SKIM4 module, so that the guide pins go through 2 holes in the PCB;
3. press the PCB down along the guide pins until all snap hooks have snapped over the edge of the PCB;
4. screw down all other screws and finally replace the guiding pins with screws.

In this way the PCB cannot move during assembly and the landing pads for the springs will be in the exactly right position.

The P/N of the guiding pins is 41076090.

Figure 20: Guiding pins for SKiM4

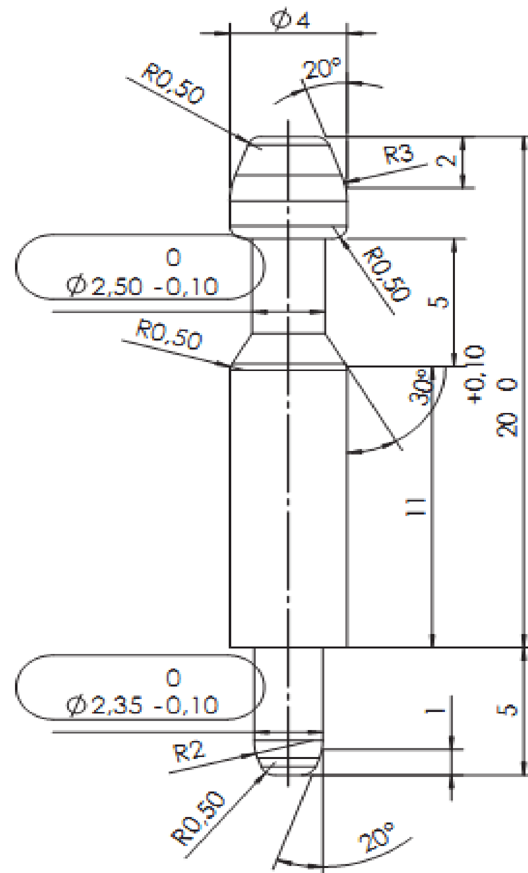


Table 4 specifies the minimum and maximum torque values for the PCB mounting screws.

Table 4: Torque specification for PCB mounting

Module	Minimum torque	Maximum torque
SKiM4	0.7Nm	0.9Nm
SKiM5	0.7Nm	0.9Nm

Figure 21: SKiM4 positions for guiding pins

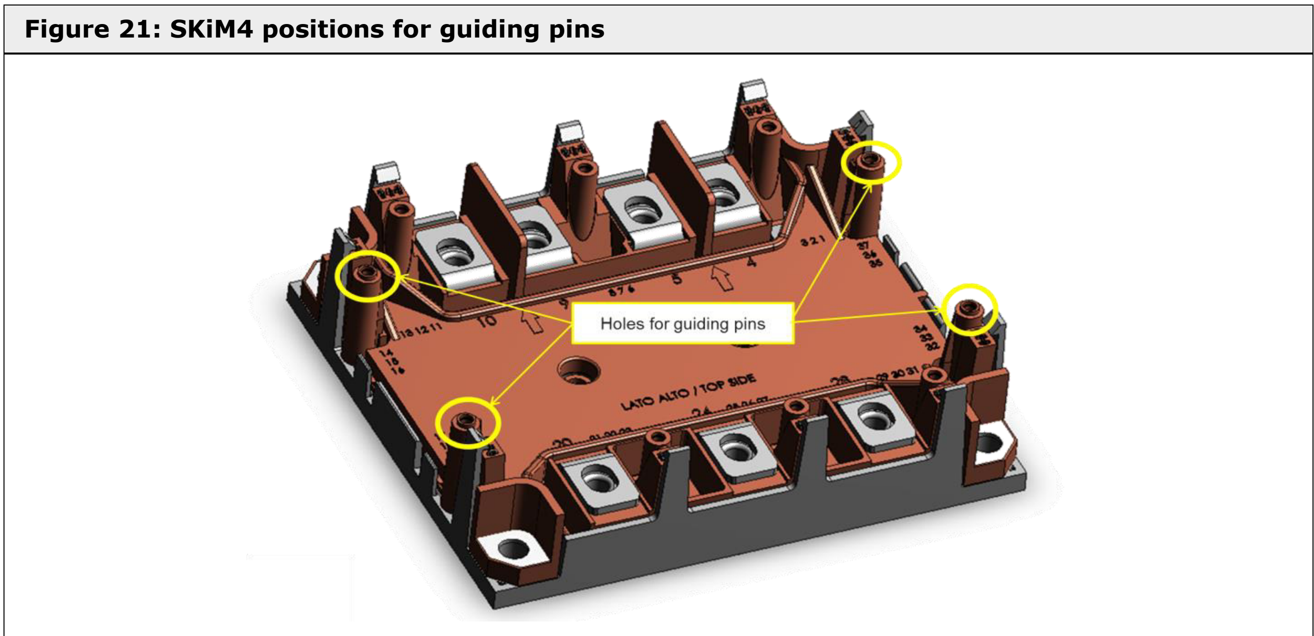
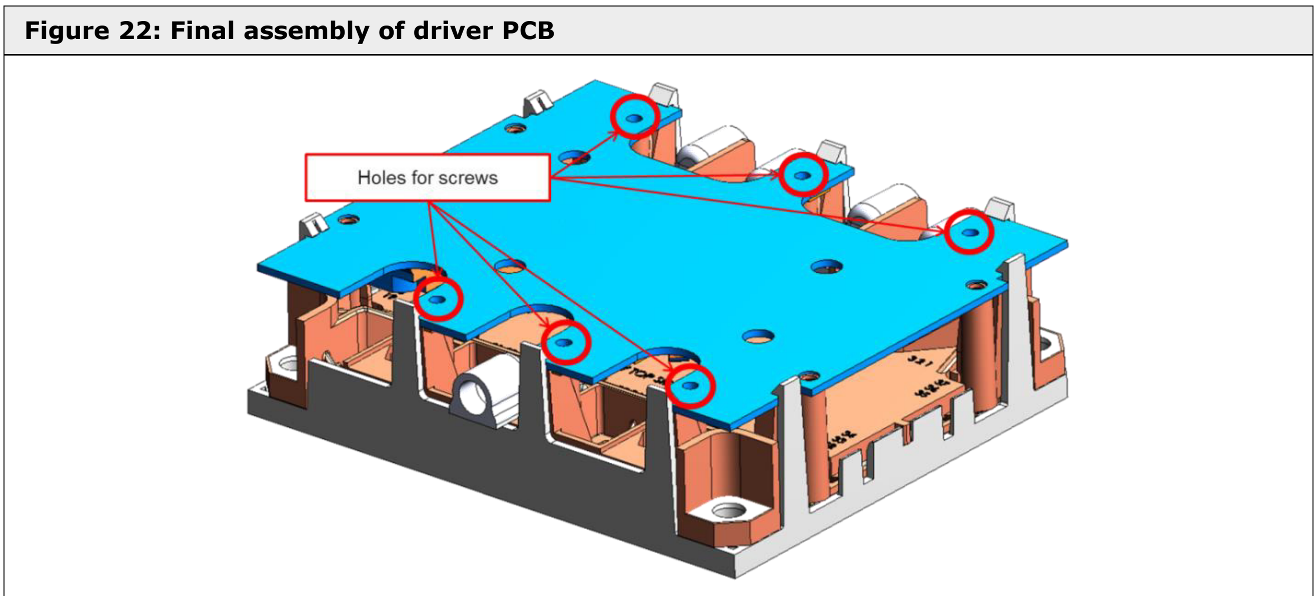


Figure 22: Final assembly of driver PCB



Once fixed on the Module the PCB can be removed and replaced only once. Fastening the self-tapping screws more than twice in the same hole may compromise the mechanical stability.

To fix the PCB onto the module SEMIKRON recommends the usage of the following screw:

- Screw: EJOT PT WN1452 K30x8 (self-tapping type)
- Screw head: the design can be chosen by the Customer

The recommended screws may be supplied by *EJOT Verbindungstechnik GmbH*:

- Web site: http://www.ejot.de
- E-mail: info@ejot.de

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Symbols and Terms

Letter Symbol	Term

A detailed explanation of the terms and symbols can be found in the "Application Manual Power Semiconductors" [2]

References

[1] www.SEMIKRON.com
[2] A. Wintrich, U. Nicolai, W. Tursky, T. Reimann, "Application Manual Power Semiconductors", ISLE Verlag 2011, ISBN 978-3-938843-666

HISTORY

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SEMIKRON INTERNATIONAL GmbH
P.O. Box 820251 • 90253 Nuremberg • Germany
Tel: +49 911-65 59-234 • Fax: +49 911-65 59-262
sales.skd@semikron.com • www.semikron.com