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Mounting instructions for IHM and IHV modules

Introduction

This application note should give recommendations regarding the characteristics of different thermal pastes, how a paste could be applied and how modules have to be mounted. The proposals are not binding. In no event the proposals can anticipate and take into account each individual application that is available to or intended by our customers. The application proposals do not replace an assessment by you or your technical department on the suitability of the product for the application that is intended by you. As a result the application proposals will by no means become part of a contractual warranty, unless the applicable supply agreement explicitly stipulates otherwise in writing.

Recommendation for paste layers

Due to the individual surface shapes of module base plates and heat sinks, an air gap in-between these components can never be fully avoided. To dissipate the module losses and to allow a proper heat flow into the sink, all gaps must be filled by thermal paste. An optimum layer thickness displaces all air, but also does not prevent a metal to metal contact where possible.

As a general rule, a paste thickness of 100 µm should be applied if the process is performed manually. Depending on the paste viscosity, deviations from this recommendation are possible (see below).

In the contact area between module and heat sink the following values for roughness R_z and flatness of the heat sink should be kept:

base plate size	surface roughness	flatness
140x 73 mm module:	10-15 µm	< 30 µm
140x130 mm module:	10-15 µm	< 30 µm
140x190 mm module:	≤ 15 µm	< 50 µm

The following quantities represent a guideline of the required amounts of thermal paste for a 100 µm layer:

140x 73 mm module: 1.02 cm^3 = 0.06 in^3
140x130 mm module: 1.82 cm^3 = 0.11 in^3
140x190 mm module: 2.66 cm^3 = 0.16 in^3.

These volumes may be measured by an injection or applied from a tube.

The base plate shape before mounting varies from light concave to convex. This is varified by a bow measurement. During the mounting procedure, a deformation of the pre-bended base plate takes place. To secure and verify a proper shape of the base plate also after mounting, all eupec modules additionally undergo a so-called cavity measurement. Similar to the conditions when mounted on a heat sink, the modules are pressed down to a measuring plate and the cavities at all critical points are measured.

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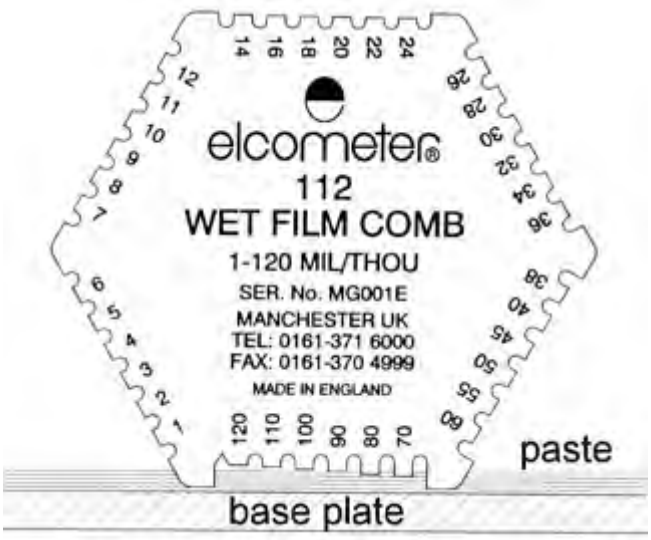
Application of paste: manually or by screen printing

The application of thermal paste is one of most critical steps in the assembly process. It is necessary to achieve an even, homogeneous and reproducible paste layer. Uneven paste layers may lead to stress and cracks in the ceramic insulation.

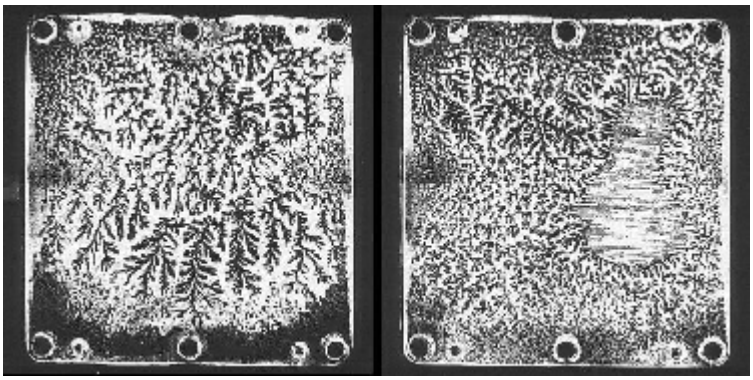
First step should be the cleaning of heat sink and base plate surface with isopropanol or ethyl alcohol. Use a non-fuzzing rag and wear gloves. The contact surface of module and heat sink must be free from damage and contaminations like grease, paste residues or particles. Avoid applying the thermal compound to the the heat sink, because screw holes may be blocked by the paste which may in turn lead to incorrect mounting torques.

The manual application of such a thin layer by using rollers or toothed spatulas is problematic. Homogeneity and reproducibility of the paste thickness is always questionable. A verification of the paste layer thickness can be done by a wet film comb. Place the comb perpendicular to the surface of the heat sink and scrape the comb slowly over it through the thermal paste layer. Wet film combs have teeth of various lengths on their sides. The paste thickness lies between the biggest value of the "coated" or "wet" teeth and the smallest value of the "uncoated" or "dry" teeth.



For qualification and verification of the assembly process, paste prints of dismantled modules should be studied in a training phase. For this apply the thermal paste and assemble the module with the recommended mounting procedure. Allow the paste to flow and fill remaining voids. Depending on their viscosity, this may take up to several hours.

The paste thickness is correct, when - after heating, dismounting and lifting of the modules - a branch-like structure becomes visible on the base plate. A small quantity of thermal compound may be squeezed out laterally when tightening the module to the heat sink. If there are areas without contact (as shown in the picture on the right), the test has to be repeated with more paste.



left:sufficient paste applied
right:partly no contact due to a insuffient amount of paste

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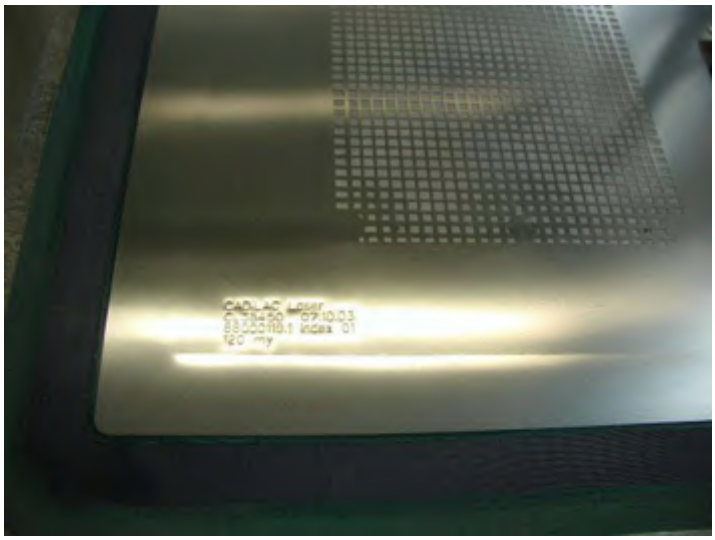
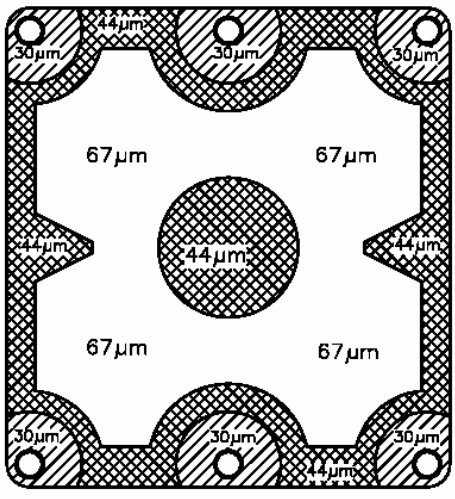
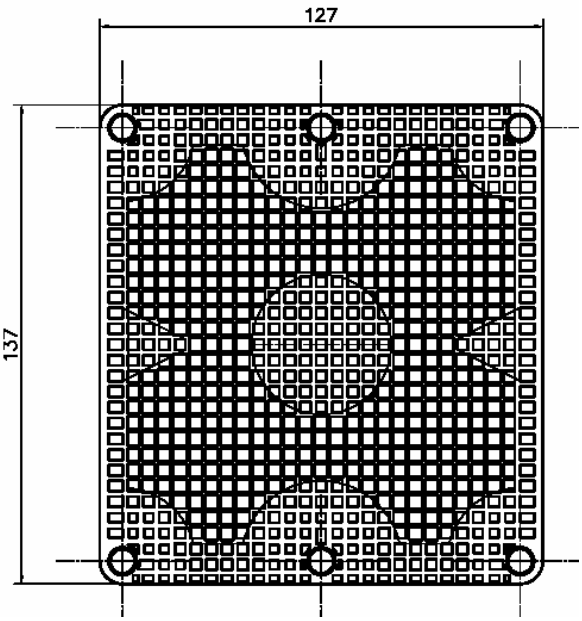
General problem regarding the viscosity of thermal pastes: Low viscous pastes can easily be applied manually. As a drawback there is a tendency, that these materials separate into oil and filler. Thermal contact and long term stability could be questionable and might have to be checked with the manufacturer of the material. According to our experience, high viscous pastes tend to keep their consistency, but an uniform application with roller or spatula could be hard to achieve and time-consuming.

To make use of the favoured high viscous pastes (of course, the process is applicable to all kinds of pastes !) and to overcome the linked handling problem, screen printing of thermal paste has been investigated by eupec.
A standard, unstructured screen delivers a homogenously distibuted amount of paste. To better adapt to the specific shape of mounted AlSiC base plates a special metal jig was developed (see right), which allows to structure the locally applied amount of paste. The drawing of the jig with its notches is shown down to the right, the average distribution of paste thickness is given on the left side of the following drawing:







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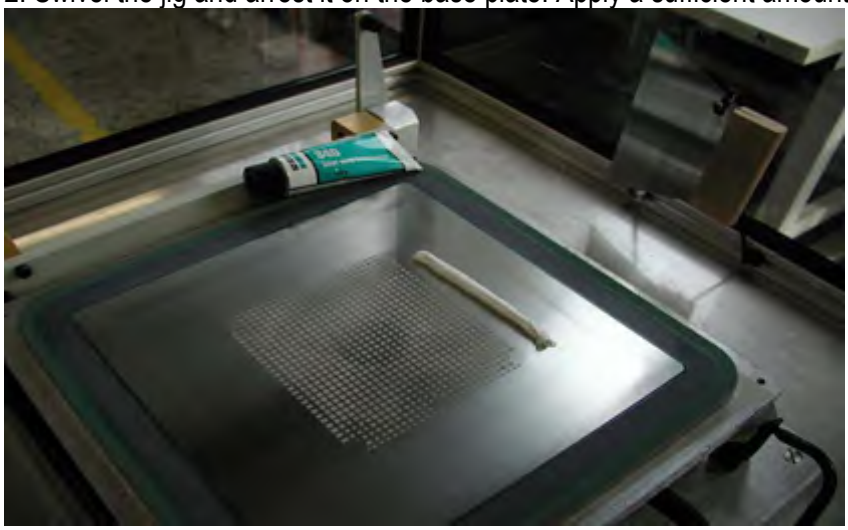
The paste is disposited “where it is needed”. Around the screw holes and in the module center a reduction of the average thickness is implemented. There is less need for migration of paste and less paste remains captured under the module.
A detailed ACAD drawing of the screen as well as a source of supply can be obtained from eupec for the 140x130 mm as well as the 140x190 mm base plate size.

Screen print process and process verification
The paste is directly printed on the AlSiC base plate of the modules. The following pictures show the mechanical set-up and the process of paste application.

1. Clean the metal jig from hardened paste and place the module into the equipment:

2. Swivel the jig and arrest it on the base plate. Apply a sufficient amount of paste:



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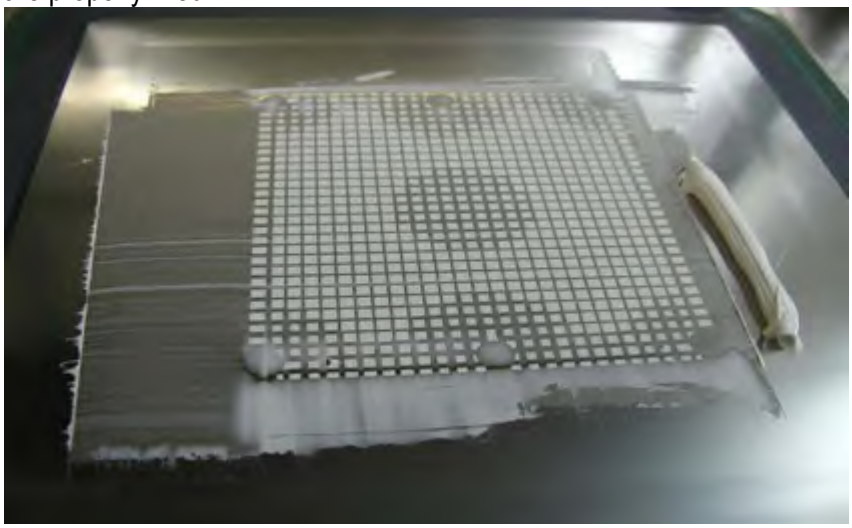
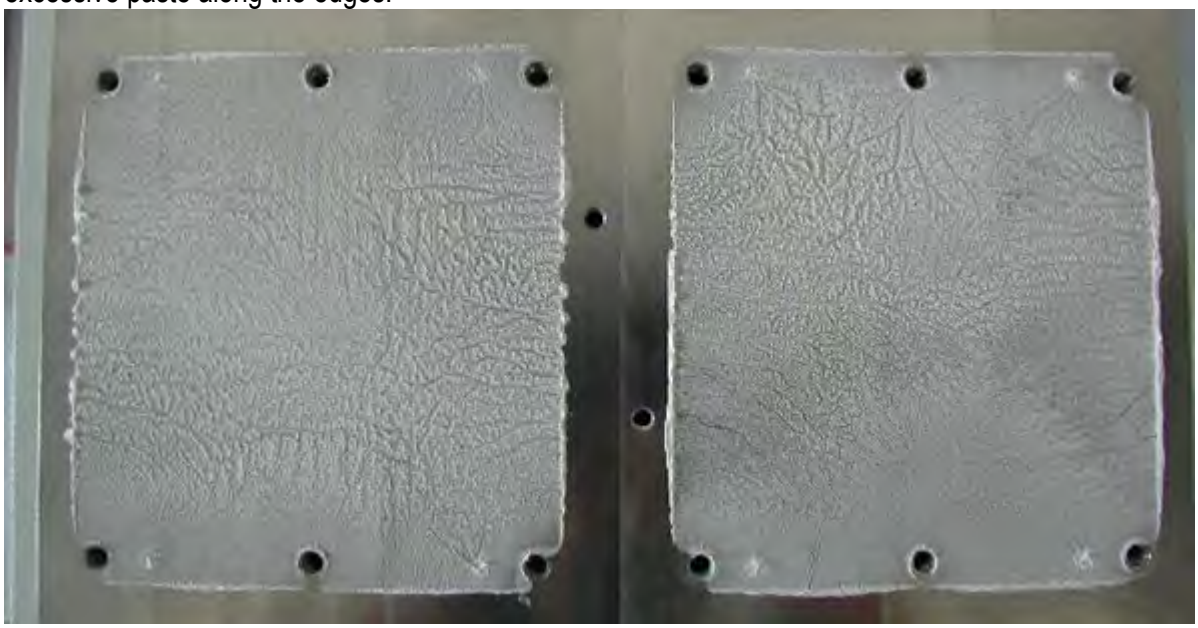
3. Dispense the paste by crosswise moves of a scraper. Make sure, that all notches are properly filled:



4. Finally mount the module to the heat sink according to the mounting instructions. Typical casts which remain on heat sink and module after dismounting are shown hereafter.

The following heat sink shows prints of two modules with a continuous stripe of excessive paste along the edges:



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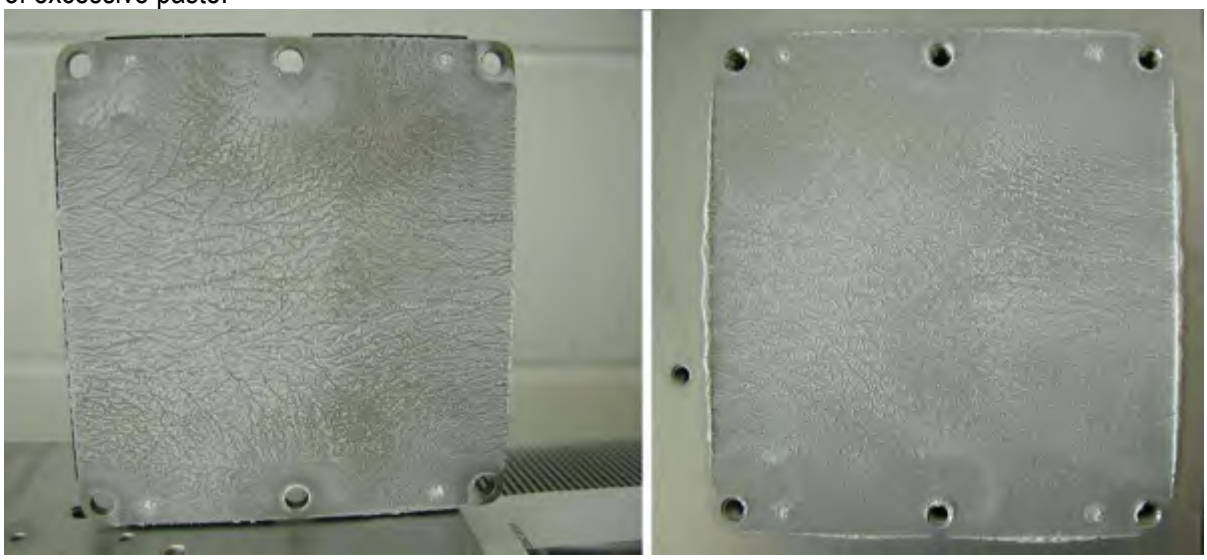
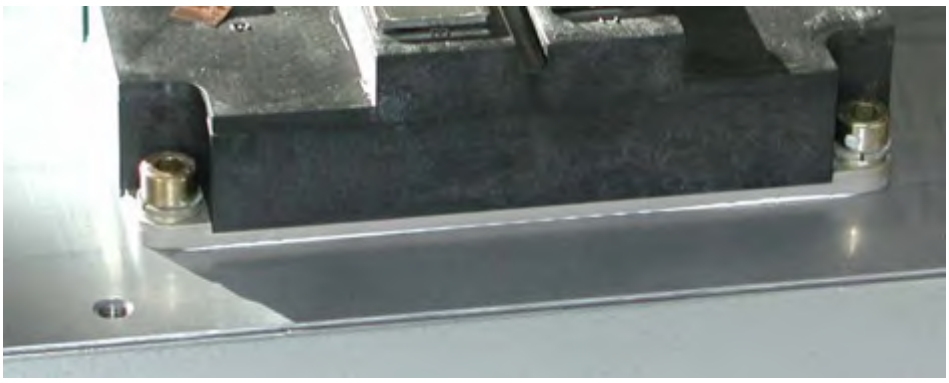
Heat sink with the belonging module, showing a good distribution of paste and a stripe of excessive paste:

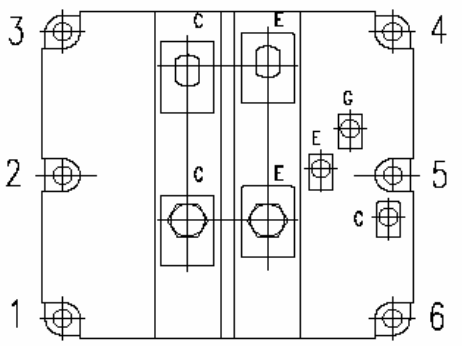


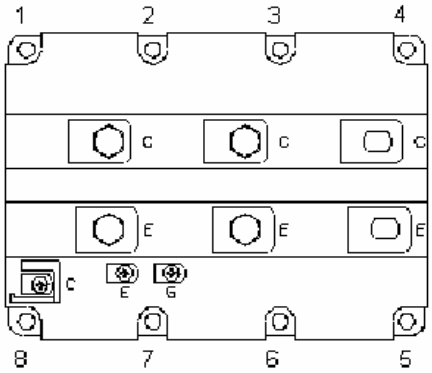
Just after mounting the paste, which is resigning at the edges, shows the structure of the screen. Depending on the paste viscosity a homogenuous stripe of paste should form in a time frame of few minutes (low viscous paste) to several hours (high viscous paste).



Mounting

To avoid unnecessary strain and tension of the base plate, the heat sink has to show sufficient stiffness and has to be handled distortion free during assembly and transport.





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All mounting screws have to be uniformly tightened with the specified mounting torque. A preferrable tool for this is an electronically controlled or at least slow moving electrical screwdriver. The work can also be accomplished manually with the aid of a torque wrench. Due to missing accuracy and precision we advise against the use of pneumatic screwdrivers.
For a good thermal contact to the heat sink we recommend the following procedure of tightening the 6 (or 8) screws of 140x130 (or 140x190 mm) modules after the application of paste and the positioning of the module on the heat sink:

For thermal pastes with low viscosity:

1. Fix module loosely with two diagonal screws e.g. screws # 3 - 6 (or 1 - 5). Press slighly by hand on the module and distribute the paste by a slight rotary motion
2. Tighten the screws with 0.5 Nm±15% in the following sequence:
   screw # 2 - 5 - 3 - 6 - 1 - 4 (or 2 - 6 - 3 - 7 - 4 - 8 - 1 - 5)
3. Tighten the screws with 5 Nm±15% in the same sequence.

For thermal pastes with high viscosity add the following step between 2. and 3.:

2.a Tighten the screws with 2 Nm±15% in same sequence as before. Let the paste flow and fill gaps for at least ½ hour.

This three step procedure must be strictly adhered to for both copper and AlSiC base plate modules to allow the paste to flow and the modules to slowly relax and conform its shape to the heat sink.

The power terminals of the collector as well as the power terminals of the emitter have to have a good electrical and thermal contact. Busbars have to be connected to the module in such a way that no force is applied to them. Their cross sections have to be dimensioned so that a heating up of the module will be avoided.
The auxiliary terminals have to be connected accordingly, observing the common ESD guidelines. No load current is permitted to flow through the auxiliary collector.

Screw dimensions and torque:

mech. mounting:	M6 5 Nm±15%
auxiliary terminals:	M4 2 Nm+5%,-10%
power terminals:	M8 8...10 Nm

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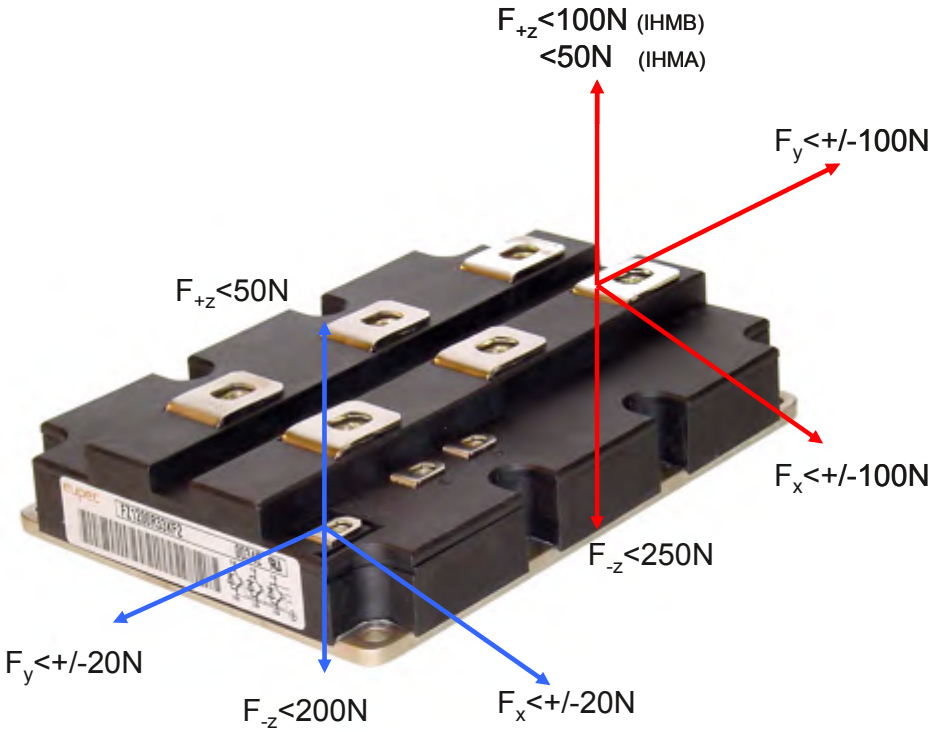
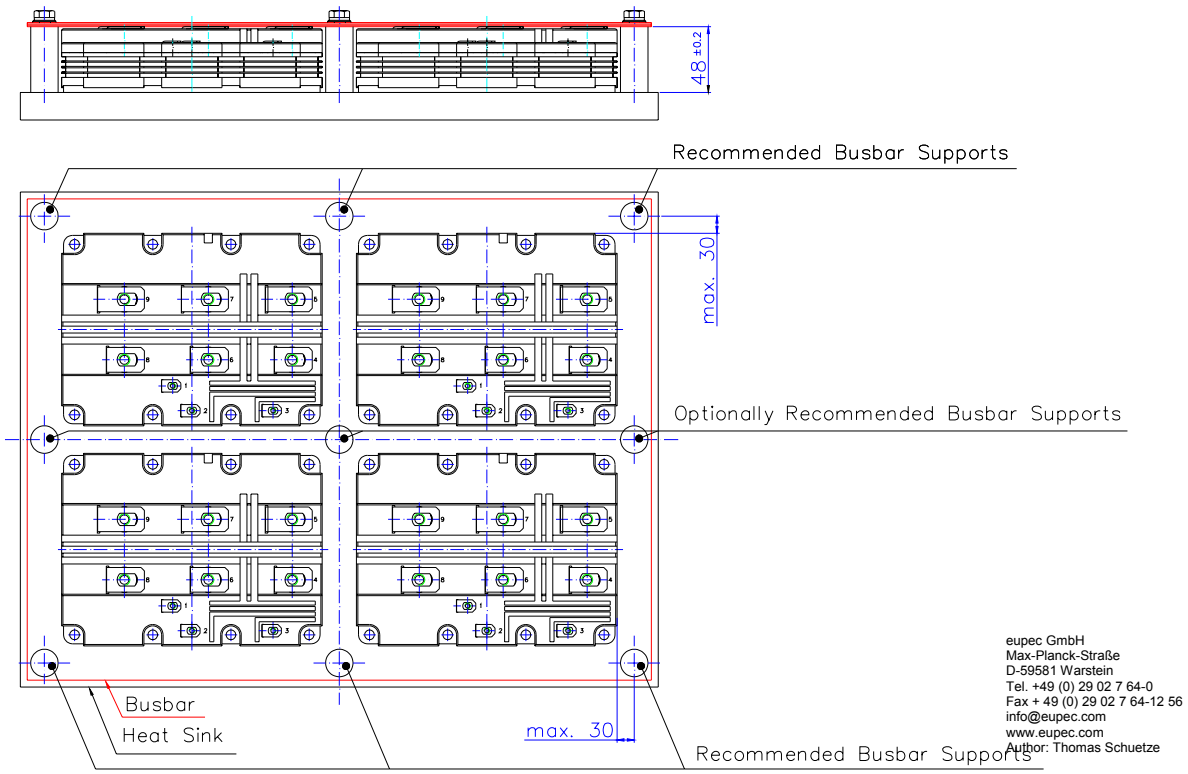
Mounting forces

The busbar should be connected to the main terminals in a way that the specified forces are not exceeded during assembly or in operation.



To avoid dynamic forces onto the module the busbar should be sufficiently supported.



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