Application Note, V1.0, Nov. 2006

AP2006-09

PrimePACK^{TM}

Mounting Instruction for PrimePACK^{TM} modules

Business Unit

eupec
An Infineon brand

Never stop thinking

Edition 2006-12-08

Published by
Infineon Technologies AG
59568 Warstein, Germany

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AN2006-09		
Revision History:	2006-11	V1.0
Previous Version:	none	

Page	Subjects (major changes since last revision)

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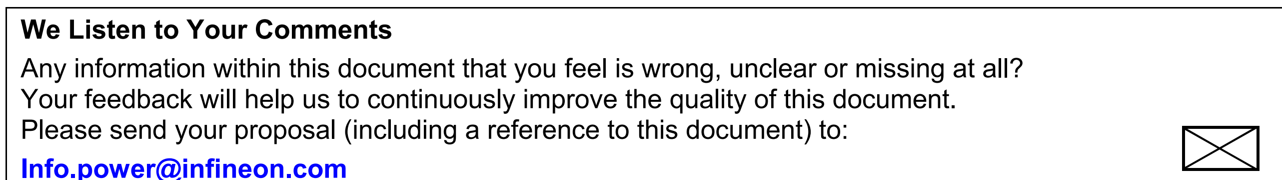

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1 Introduction

Operating of high power modules results in power losses which have to be dissipated via heat sink in order not to exceed the maximum permissible temperature specified in the data sheet during switching in operation ($T_{vj,op}$).
This application note should give you recommendations regarding the characteristics of different thermal pastes, how a paste could be applied and how modules have to be mounted to achieve as good as possible thermal contact between the base plate and the heat sink.

In the second part of the application note you'll find some information and proposals concerning the mounting process of the bus bars to the main terminals of the PrimePACK™ modules.

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2 Recommendation for thermal compound and heat sink surface

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

As a general rule, for PrimePACK™ modules we recommend a typical paste thickness of 50µm if the process is performed manually. Depending on the paste viscosity, deviations from this recommendation are possible (see below).

In our data sheets you can find values for the thermal resistance R_{thCH} which describes the thermal crossover between the base plate of the module and the heat sink. To achieve these values also in your application the contact area between the module and the heat sink should have the following values for roughness Rz and flatness of the heat sink:

base plate size	surface roughness	flatness
172x89 mm module:	< 10µm	< 30µm
250x89mm module:	< 10µm	< 50µm

The following quantities represent a guideline of the required amounts of thermal paste for a 50µm layer. These volumes may be measured by an injection or applied from a tube:

172x89 mm module:	0.77cm^3
250x89mm module:	1.11cm^3

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

3 Manual application of thermal paste

The application of thermal paste is one of the 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 mechanical stress at the base plate and the substrate and inadequate distribution of the thermal resistance between the base plate and the heat sink.

The first step should be the cleaning of the heat sink and the base plate surface with isopropanol or ethyl alcohol. Use a non-fuzzing rag and wear gloves. The contact surface of the module and the heat sink must be free from damage and contaminations like grease, paste residues or particles.

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" tooth and the smallest value of the "uncoated" or "dry" tooth.

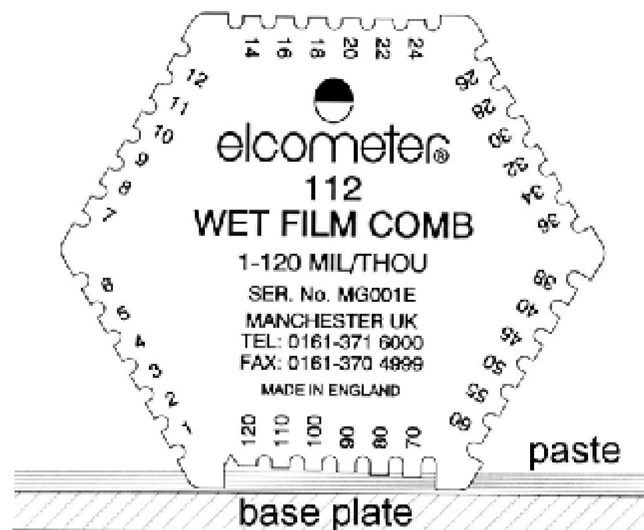

Figure 1 Elcometer, a wet film comb for measuring of the thickness of the thermal paste

For qualification and verification of the assembly process, paste prints of demounted 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, demounting 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 figure 2), the test has to be repeated with more paste.

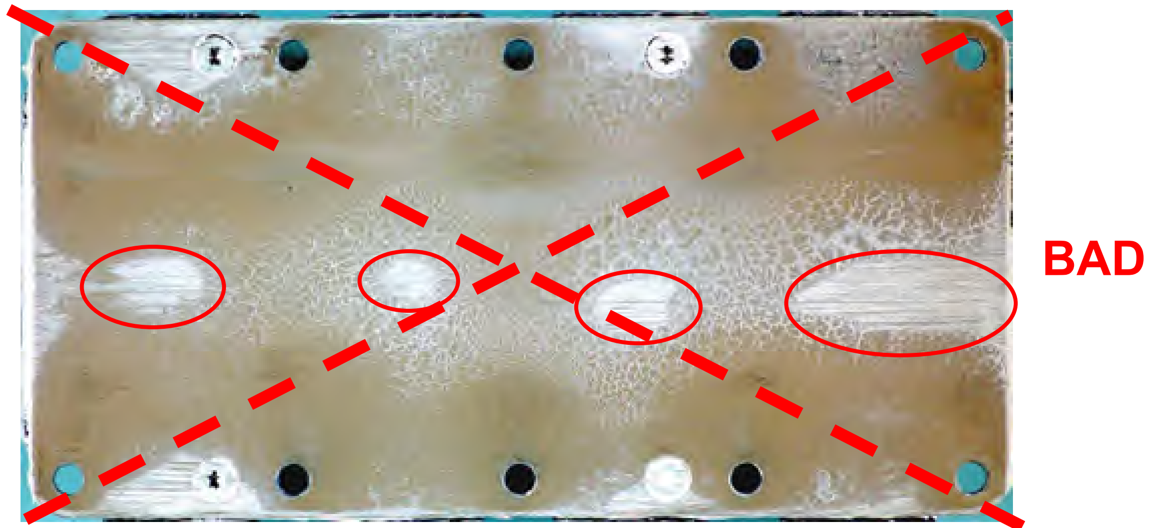

Figure 2 Example of a module base plate after dismounting. Reds marked are areas without contact to the heat sink due to an insufficient amount of thermal paste.

4 Application of thermal paste by screen printing

A general problem regarding the viscosity of thermal pastes is that 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 benefits of high viscous pastes (of course, the process is applicable to all kind of pastes, too) and to overcome the linked handling problem, screen printing for applyig of the thermal paste has been investigated by Infineon. A standard, unstructured screen delivers a homogenously distributed amount of paste. To better adapt to the specific shape of the mounted base plate a special metal jig was developed. It allows to structure the locally applied amount of paste, see figure 3.

Figure 3 Screen print template for PrimePACK^{TM}3 modules

A detailed CAD drawing of the screen as well as a source of supply can be obtained from Infineon for the 172x89 mm as well as for the 250x89 mm base plate size.

4.1 Screen printing process

During the screen printing process the thermal paste is directly applied on the base plate of the module. The following pictures show the mechanical set-up and the process of paste application.

1. At first clean the metal jig from hardened residues of paste or another contamination. Suitable is for example isopropyl or ethylene alcohol.
2. Align of the template and the module, for example place the PrimePACK™ module into a jig shown in figure 4:

Figure 4 Jig for aligning of PrimePACK™2 and PrimePACK™3 modules during screen printing process

3. Swivel the jig and arrest it on the base plate. Apply a sufficient amount of paste.
4. Dispense the paste by crosswise moves of a scrapper or putty knife. Make sure that all notches are properly filled.
5. Finally mount the module to the heat sink according to the mounting instructions.

A typical print image of the base plate after printing of the thermal compound is shown in figure 5.

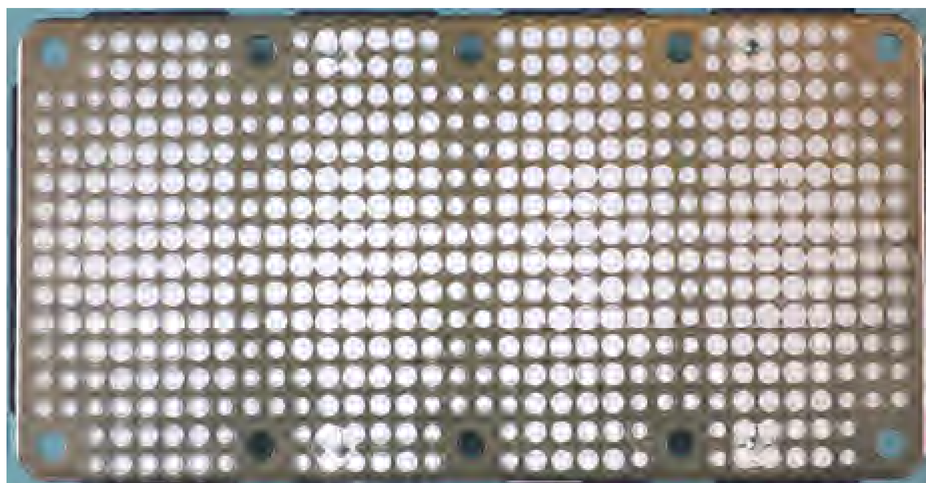

Figure 5 Base plate of the PrimePACK™2 module with applied paste by screen printing before mounting on the heat sink

The paste is disposed “where it is needed”. Around the screw holes and in areas with a high BOW a reduction of the average thickness is implemented.There is less need for migration of the paste and less paste remains captured under the module.

After dismounting of the module from the heat sink a homogeneous and reproducible distribution of the paste is achievable with this process (as shown in figure 6).

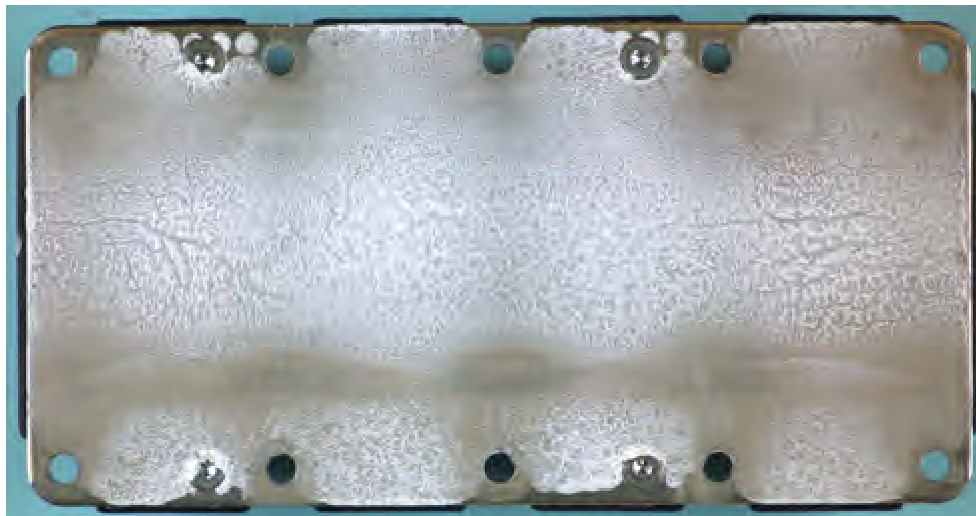

Figure 6 Base plate of the module with applied paste by screen printing after dismounting from heat sink.

5 Mounting of the module to the heat sink

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.

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.

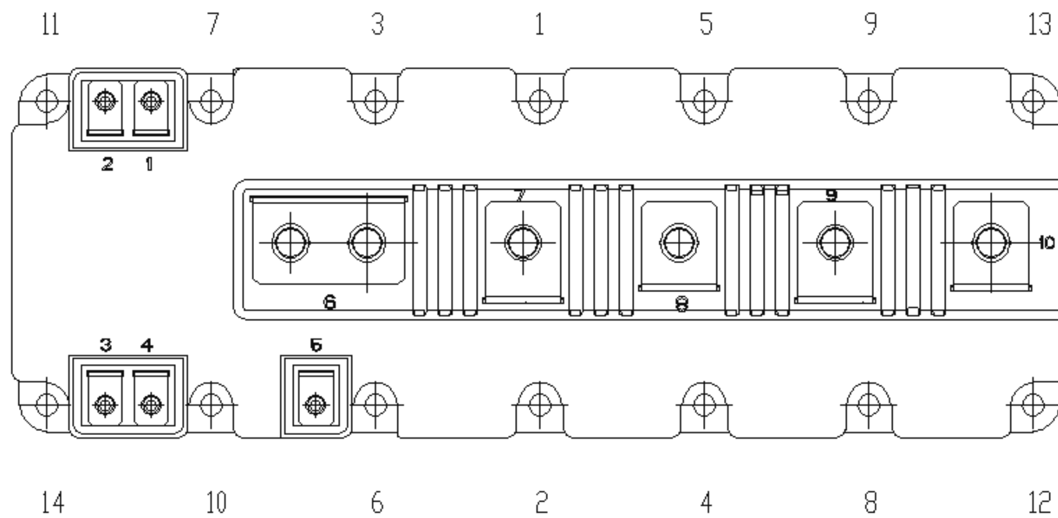

Figure 7 Recommended mounting sequence for PrimePACK^{TM} modules

For a good distribution of the paste - what is necessary for a good thermal contact to the heat sink - we recommend the following procedure of tightening the 10 screws for 172x89mm (or 14 screws for 250x89mm) modules after the application of the paste and the positioning of the module on the heat sink:

1. Fix module loosely with two diagonal screws e.g. screws # 7 – 8 for PrimePACK^{TM}2 (or 11 – 12 for PrimePACK^{TM}3). Press slighly by hand on the module and distribute the paste by a slight rotary motion.
2. Tighten the screws with 6Nm±10% crosswise, like shown in figure 7: 1 – 10 for PrimePACK^{TM}2 and 1 – 14 for PrimePACK^{TM}3.

By using of thermal pastes with high viscosity we recommend to add an additonal step 1.a between 1 and 2:

1.a Tighten the screws with 2Nm±15% in the same sequence as before. By this additional step the thermal compound has the chance to flow and fill the cavities.

6 Connecting the busbars to the main terminals

The power terminals of the collector as well as the power terminals of the emitter have to have a good electrical and thermal contact to the busbars. The cross sections of the busbars have to dimensioned in that way that a heating up of the module will be avoided.

The bus bars have to be connected to the main terminals in that way that the specified forces (shown in figure 8) are not exceeded during assembly or in operation later.

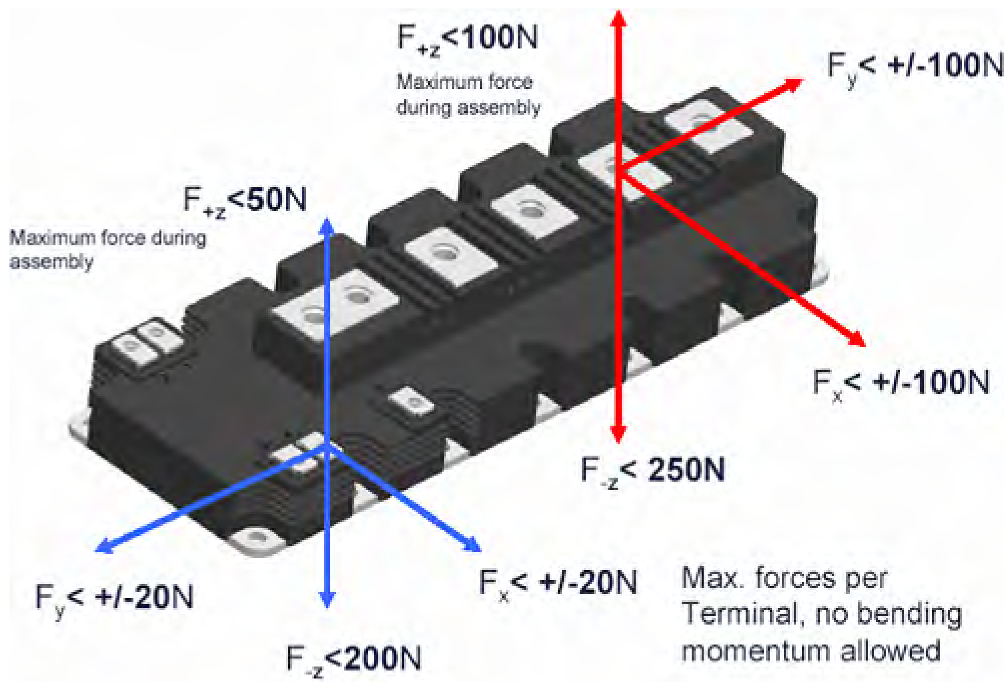

Figure 8 Maximum permissible pull and push forces at the power and auxiliary terminals of the PrimePACK^{TM} modules

The auxiliary terminals have to be connected accordingly, observing the common ESD guidelines. No load current is permitted to flow through the auxiliary collector.

To terminate the power terminals with the best possible strain relief, an assembly according to the concept drawings shown in figure 9 is recommended.

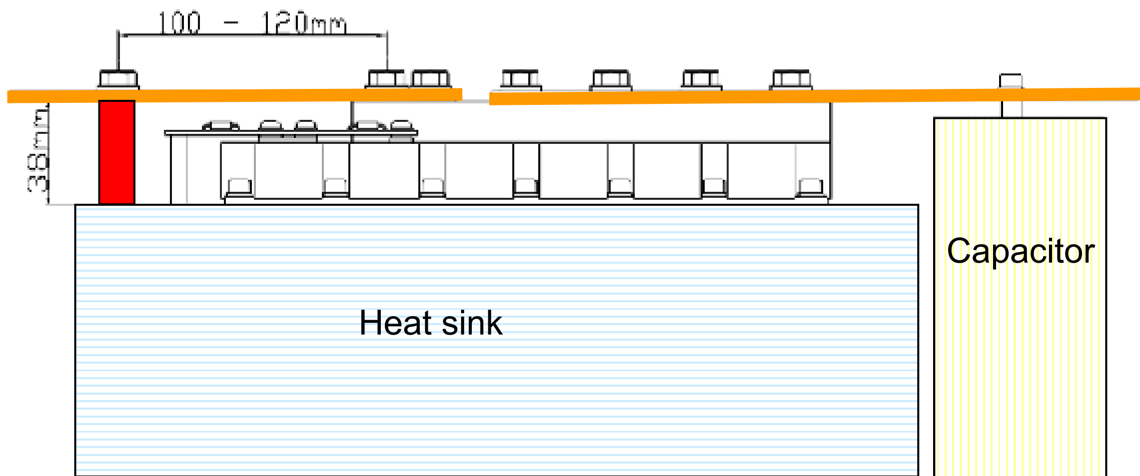

Figure 9 A possible configuration of PrimePACK module with possible strain relief.

Screw dimensions and torques:

mech. mounting, baseplate:	M5	6 Nm±10%
auxiliary terminals:	M4	2 Nm+5%,-10%
power terminals:	M8	8….10Nm

6.1 Remarks

We will offer a suitable set consisting of M4 and M8 screws needed for the mounting of the bus bars to the main terminals and PCB to the auxiliary terminals for PrimePACK™2 and PrimePACK™3 modules. Details concerning the order details for these corresponding sets for PrimePACK™2 and PrimePACK™3 respectively you will find in our Marketing News in the near future.

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