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HybridPACK™ 1

General Information and Mounting Instruction

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1 Introduction

The operation of high power modules results in power losses, which have to be dissipated via a heat sink so that the maximum permissible temperature specified in the data sheet will not be exceeded. Therefore, the mounting process of power modules is vital, because it affects the module's thermal performance and furthermore its reliability, which is critical for automotive applications.

This application note, gives mounting instructions for HybridPACK™ 1 module with recommendations how to screw the module, assemble the PCB and mount the module onto the heat sink.

Please also note that ground straps should be worn while working with the components and valid ESD safety instructions should be followed at all time, since IGBT modules are electronic-static sensitive components. In addition, maximum permissible values in the product datasheet and application notes are absolute limits which generally, even for short times, may not be exceeded as this may lead to destruction of the component. Moreover, this application note cannot cover every type of application and condition. Hence, the application note cannot replace a detailed evaluation and examination by you or your technical divisions of the suitability for the targeted applications. The application note will, therefore, under no circumstances become part of any supplier agreed warranty, unless the supply agreement determines otherwise in writing.

2 Proposal for designing a driver board

Based on the HybridPACK™ 1 dimensions a proposal for designing a driver board can be offered (see Figure 1). The end-hole diameter for the module solder pin connections should be $1{,}8^{-0{,}0}_{+0{,}5}$ mm.

PLEASE NOTE: The drawing below offers a proposal for a driver board and therefore it is not binding. Detailed evaluation and examination by you or your technical divisions must be done in order to verify the suitability of this proposal.

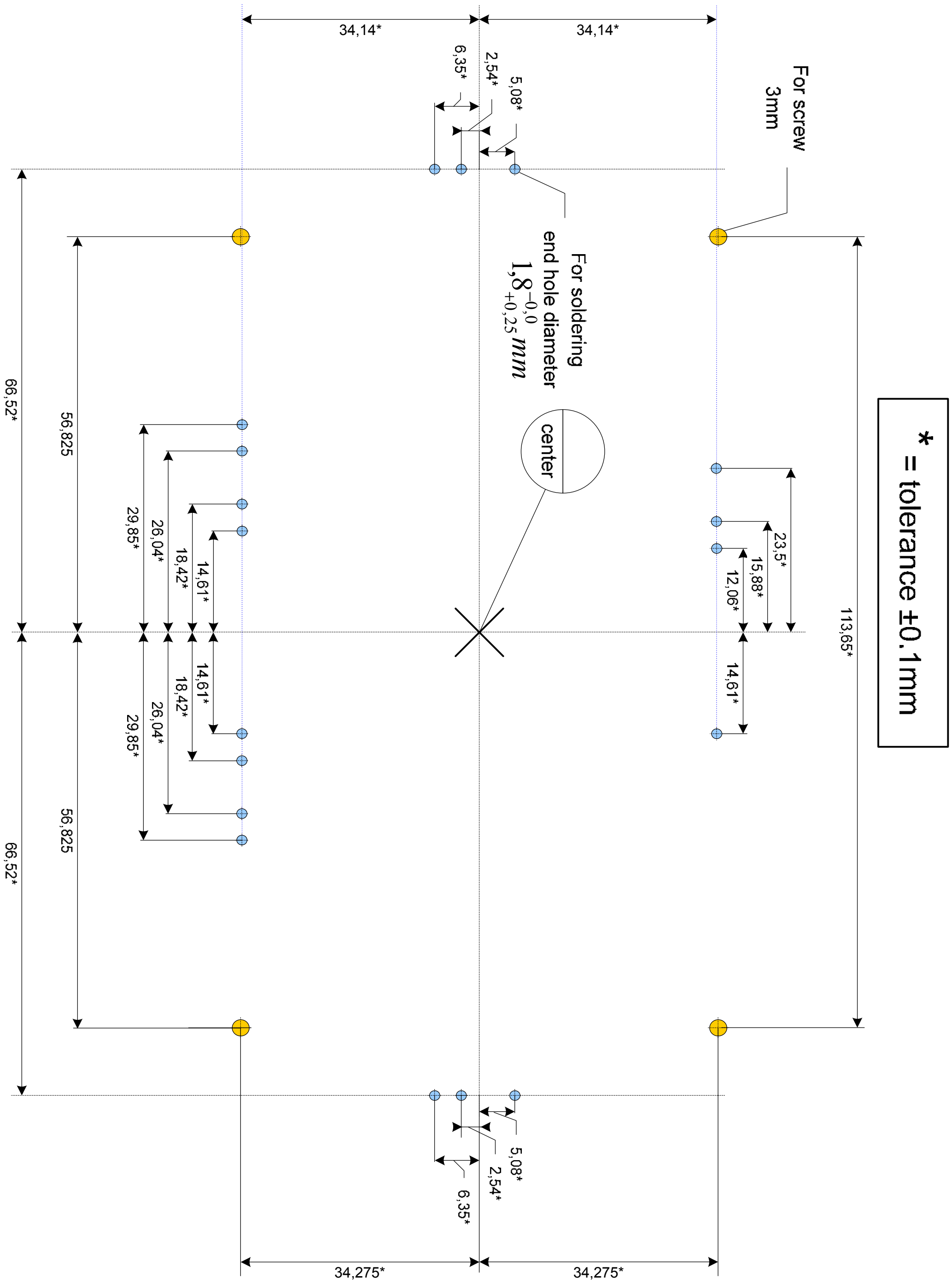

Figure 1 Proposal for designing driver board for HybridPACK™ 1 module.

3 Mounting a driver board onto the module

The driver board could be mounted by direct soldering on the top of the module.

When a driver board or module adapter board (Printed Circuit Board) is soldered directly on top of the module, the contact joints (=solder connections) between PCB and module auxiliary contacts should be mechanically relieved as much as possible. Relieve of the contact points is carried out by mounting the PCB directly onto the module at the four mounting stand-offs (Figure 2) using self-tapping (thread forming) screws or similar assembly material. The length of the used self-tapping screws is depended on the PCB thickness. Example: For mounting a PCB with 1.6mm thickness a self-trapping screw with 2,5 mm diameter and 8mm length should be used, for example type Delta PT 25x8 WN 5451 from EJOT.

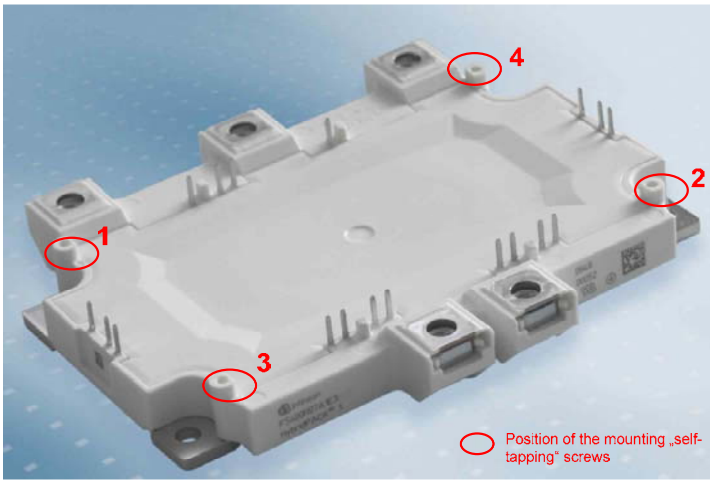

Figure 2 PCB mounting stand-off of HybridPACK™ 1 module.

The screws should be mounted in the sequence showed in Figure 2. The initial 1.5mm of the mounting stand-off serve as guidance only and cannot take any force. The thread in the plastics will form itself by driving in the screws. Apart from manually driving the screws into the mounting stand-offs, an electronically controlled or at least slowly turning electric screwdriver (≤300rpm) is a preferred aid (due to the lack of accuracy we do not recommend the use of pneumatic screwdrivers). The maximum applied force (M_{max}) is 0.4Nm ±10%. The effective length of the screw thread entering the mounting stand-off should be of a minimum length of l_{min}≥6mm and a maximum length of l_{max}≤8mm giving consideration to the PCB thickness and the weight of the driver PCB.

To avoid damage or splitting of the stand-off, straight insertion of the screw into the stand-off has to be observed during assembly (Figure 3).

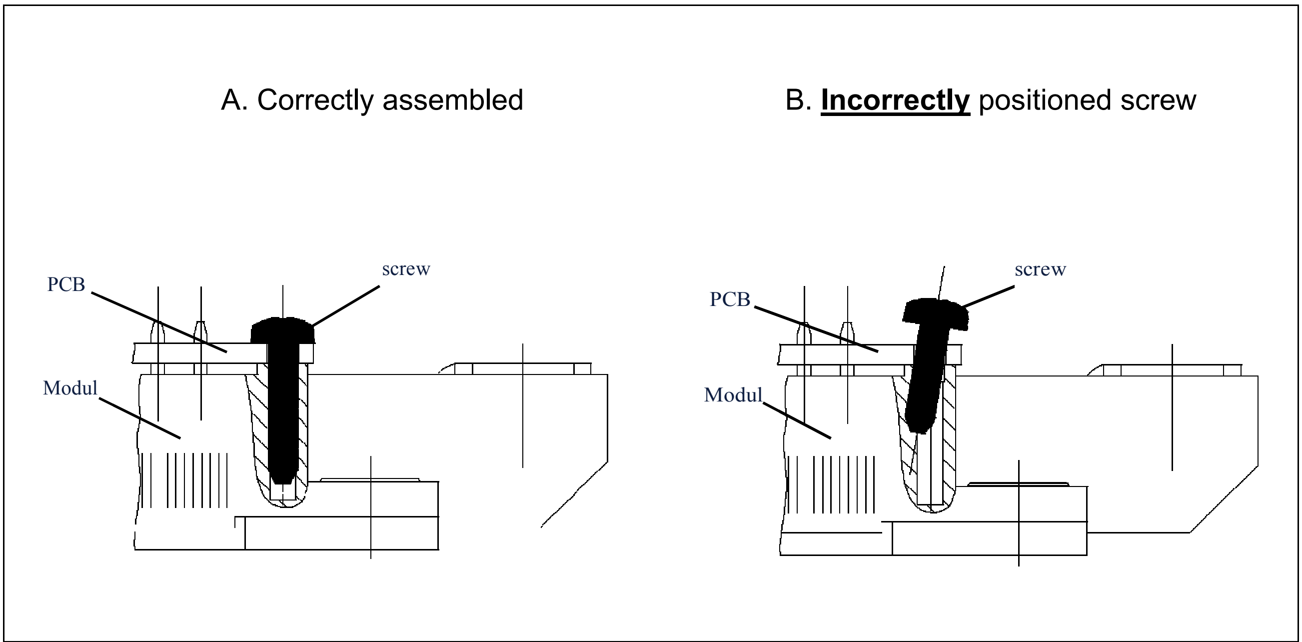

Figure 3 (A) Correctly assembled screw into the mounting stand-off. (B) Incorrectly positioned screw into the mounting stand-off.

The recommended screws and torques are based on laboratory tests. Depending on screws and tools used, it may be necessary to adapt the assembly process accordingly.

After mounting the PCB the solder process (manual soldering, selective soldering or wave soldering) may begin. When adhering to this sequence of assembly, the mechanical strain to the solder points can be minimised.

During the entire soldering process, care needs to be taken that neither a too high soldering temperature nor a too long process time at the auxiliary pins overheats the plastic case and thus deforms it.

According to IEC 68 section 2, a maximum solder temperature of T=260°C for a maximum process time of t_{max}≤10s has to be observed during the solder process.

Further information regarding solder processes can be referred to the application note AN2005-06 “Soldering Econo und Easy modules”.

4 Condition of the heatsink for module assembly

The power loss occurring in the module has to be dissipated in order not to exceed the maximum permissible temperature specified in the datasheet during switching operation (T_{vj_op} = 150 °C). Therefore, the design of cooling system/heat sink is of great importance to achieve good performance.

The condition of the heatsink surface in the area where the module is mounted has a decisive influence on the heat transfer of the entire system.

The contact surfaces, the base plate of the module and the surface of the heatsink have to be free of degradation and contamination and should be cleaned with a fresh, lint free cloth.

The contact surface of the heatsink should not exceed the following values referenced to a length of L=100mm:

Surface flatness ⩽50µm
Surface roughness Rz⩽10µm

The heatsink has to be of sufficient stiffness for the assembly and the subsequent transport in order not to exert additional straining or pulling forces to the base plate of the module. During the entire assembly process the heatsink has to be handled twist free.

5 Application of the thermal compound

Due to the individual surface shape of the module baseplate and the heatsink, these do not touch across the entire area so that a certain punctiform separation between the two components cannot be avoided.

To dissipate the losses occurring in the module and to achieve a good heat flow into the heatsink, all localised cavities have to be filled with thermal compound. When using a heat conductive paste, a homogenous application needs to be assured.

A well applied layer will fill all cavities and at the same time does not prevent the metallic contact between baseplate and heatsink surface. A compound should be selected which shows permanently elastic features in order to assure a continuously favourable heat transfer resistance. The paste should be applied in a way that no screw holes are contaminated so that bolt torques are not degraded.

Common rollers or fine toothed spatulas can be used to apply the thermal compound. The layer thickness of the grease should typically be 50µm to 100µm on the baseplate of the module.

The manual application of the heat conductive paste with a constant layer thickness in the µm-region may be problematic. The homogeneity and reproducibility of the layer thicknesses is always questionable. Generally the application is sufficient when after tightening the module a small quantity of surplus paste is squeezed out around the sides of the module see Figure 4.

For qualification and verification of the assembly process, the imprint of disassembled modules should be checked in a training phase.

For this, the thermal compound is to be applied according to the mounting notes. The layer thickness of the paste is correct if after heating up, unbolting and carefully lifting off the module, a branch-like structure can be seen on the baseplate as in Figure 5.

In addition, it is possible to check the layer thickness of the thermal compound after application with the aid of a wet film comb.

As a guideline for the required amount of thermal compound for a homogenous layer thickness of 100µm, a volume of V=0.73cm3 results from a HybridPACK™ 1 module with a baseplate size of 57mm*128mm. These volumes can be measured with the aid of a syringe or applied from a tube.

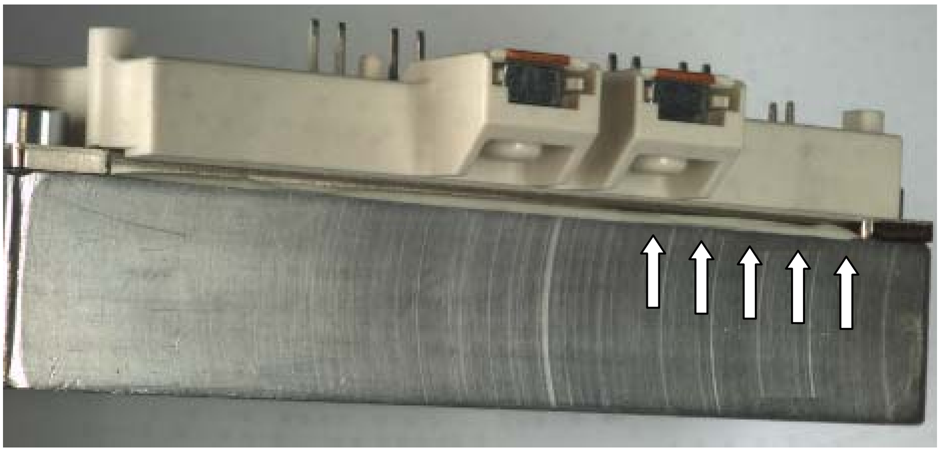

Figure 4 Mounted HybridPACK™ 1 module with thermal compound squeezed out at the side

Recommendable is the application of thermal compound by a screen print process. Apart from an optimised and module specific distribution of the heat conductive paste, a homogenous and reproducible layer thickness application is achievable with this procedure.

Figure 5 Print image of a disassembled HybridPACK™ 1 with branch-like structure of the thermal compound

5.1 Screen print template

Contrary to conventional methods of paste application, this procedure applies the thermal compound only to areas where it is required.

To begin with, a surface scan of the base plate was used to determine the quantity of thermal compound required. For this purpose the HybridPACK™ 1 was scanned twice along the baseplate. There are two profiles obtained from this scanning: “Profile Line1” - blue line and the “Profile Line2” - black line.

Figure 6 shows the baseplate profile of a mounted HybridPACK™ 1 module (FS400R07A1E3).

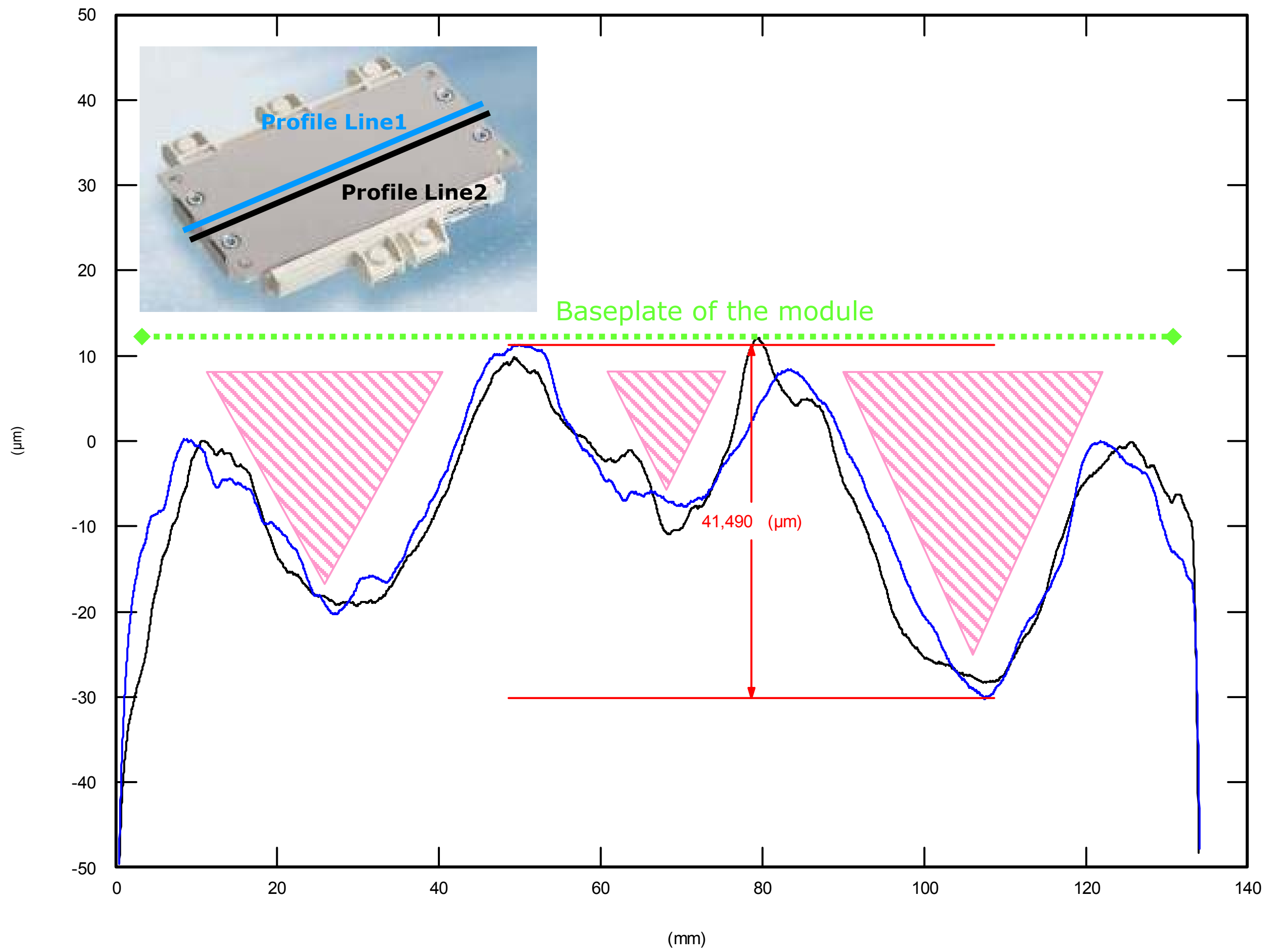

Figure 6 Baseplate profile of a mounted HybridPACK™ 1 module FS400R07A1E3).

Typically the unevenness of this base plate is around 40µm.

The green line shows the location of the baseplate. The end points of the green line represent the start and end point of the baseplate. The pink areas below the baseplate of the module show the areas where the HybridPACK™ 1 has no direct thermal contact to the heat sink.

These cavities need to be filled with thermal compound. To determine the required paste the surface scan is divided into a grid. For each raster point the sufficient amount of paste is to be determined. The result of this procedure shows the screen print template (see Figure 7).

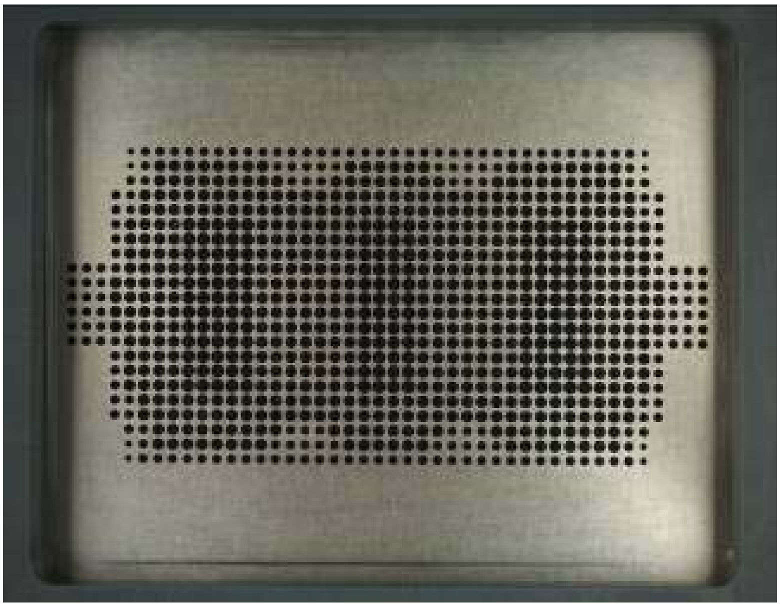

Figure 7 Screen print template for an HybridPACK™ 1 module

The corresponding drawing for a module type is available. A CAD drawing of this screen may be ordered via your sales partner.

Further notes regarding the application of screen print templates for the application of thermal grease can be found in the application note ”AN2006-02 Application of screen +print templates.pdf”.

5.2 Screen print template for an HybridPACK™ 1 baseplate

On the picture below a screen print template for an HybridPACK™ 1 baseplate can be found. Please use the recommended screen print template for applying the thermal compound.

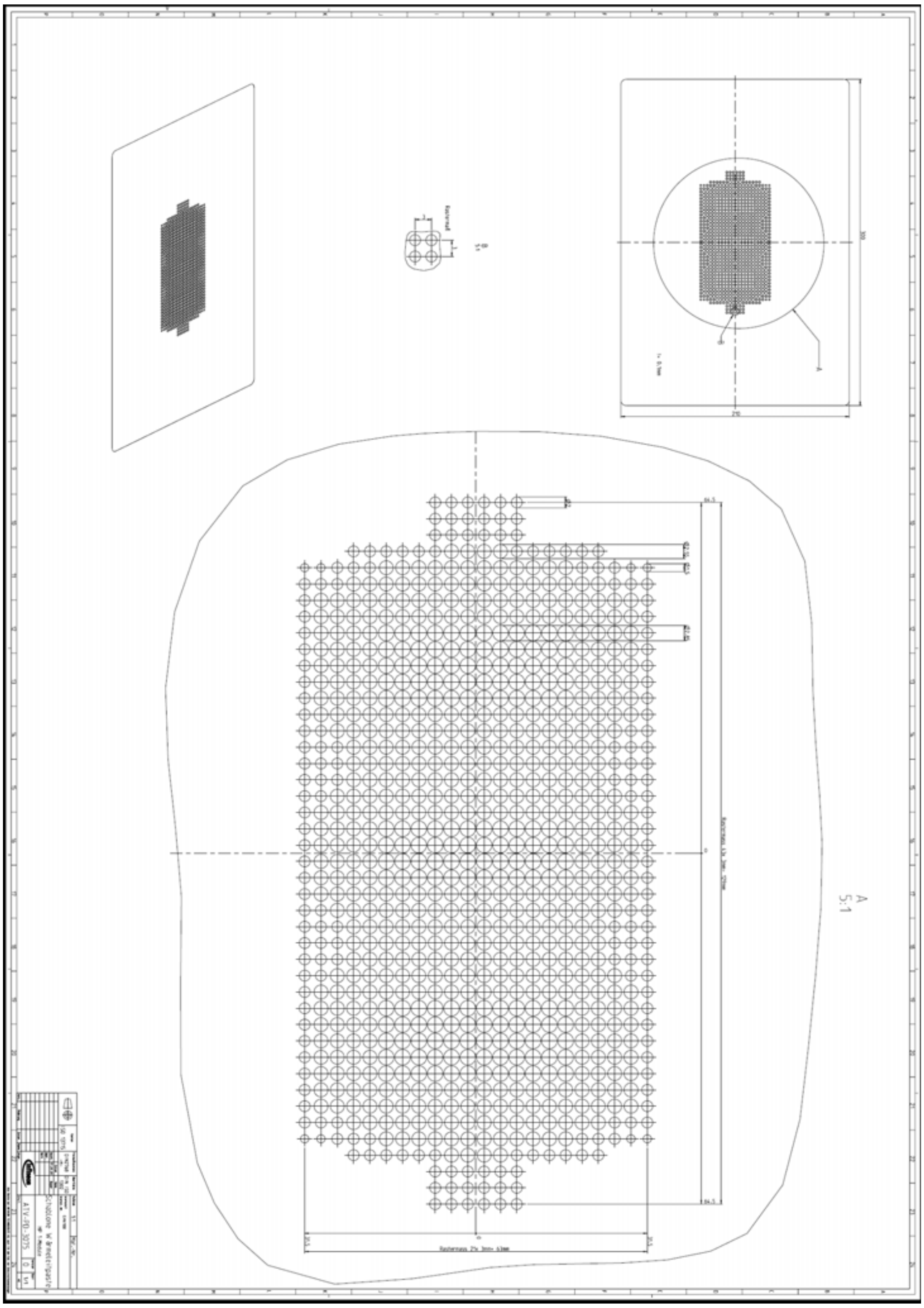

Figure 8 Screen print template for an HybridPACK™ 1 baseplate

6 Screw to mount the module to the heatsink

To mount the module the following screws are recommended: DIN M5 screws which comply at least with class 6.8 (for example, according to DIN 912 (ISO4762), ISO 7380, DIN 6912 and DIN 7984) in combination with a suitable dented edge washer and spring washer (for example, according to DIN 433 or DIN 125) or the combination of both the “dented edge washer”.

The clearance and creepage distances specified in the HybridPACK™ 1 datasheets are the shortest clearance and creepage distances existing at the unassembled and unconnected module.

When selecting suitable M5 screws, washers and spring washers to mount the module, it is recommended to consider the resulting clearance and creepage distances between the power terminal and the nearest bolt head or washer during the development phase.

7 Mounting the module to the heatsink

The clamping force of the module resulting from the assembly process to the heat sink depends on the torque applied and the condition of the heat sink material. The following torque values specified in the datasheet result from steel screws in aluminium heat sinks with a dry M5 thread and their typical friction factors of μ_G=0.2~0.25 (μ_G=friction coefficient thread in heat sink):

$$M_{min}=3Nm \text{ to } M_{max}=6Nm.$$

For a good thermal contact to the heat sink the following procedure is recommended when tightening the four M5 fastening screws with washer (according to DIN 433) and spring washer (according to DIN 127).

1. Place the module with the thermal compound applied onto the heatsink and fix with two screws

2. Fix the screws with 0.5Nm (hand tight crosswise) in the sequence showed in Figure 9.

3. Tighten the screws with 3Nm – 6Nm in the same sequence (crosswise)

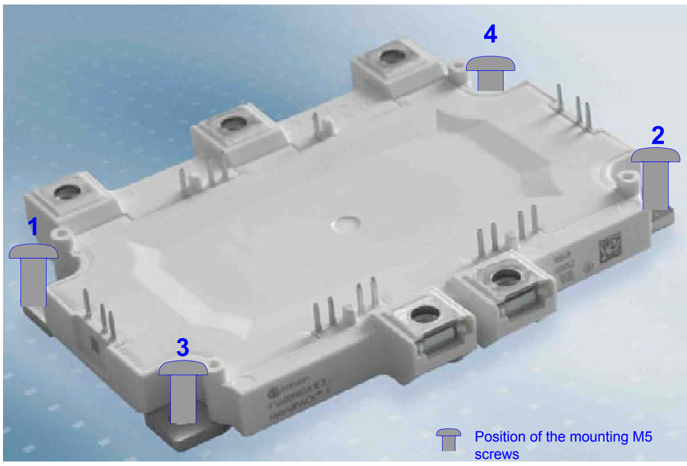

Figure 9 Tightening sequence to mount the module.

When using thermal compound, it may be necessary depending on the type of paste to check the tightening torques of the fastening screws for the correct value after a heat-up test. When using thermal foils instead of heat conductive paste, it is recommended to definitely perform this additional check.

PLEASE NOTE: The torques given within this application notes are valid only when using thermal compound. Own tests and measurements with the heat conductive foils envisaged are absolutely necessary!

When selecting the heat conductive paste or heat conductive foil, the thermal contact and long-term stability should be considered and discussed with the manufacturer.

8 Connecting the bus bars to the power terminals

The DC power side should be connected with a laminated DC bus bar in order to keep the switching overvoltage as low as possible by minimising the stray inductance. Adherence to the maximum permissible voltage at the power terminals and at the IGBT chip is to be assured according to the RBSOA data in the datasheet.

For the connection of the power terminals DIN M6 screws are required which comply at least with class 6.8, in combination with a suitable washer and spring washer or complete combination screws. These should be tightened with the recommended torque of M_{min}=3.0 Nm to M_{max}=6.0 Nm.

When selecting the bolt length the layer thickness of the connected parts has to be subtracted from the total length of the screws. The effective length of engagement into the module thread may not exceed the maximum specified depth of 10mm.

The connected parts have to be mounted to the power terminals in such a way that the specified static forces are not exceeded during assembly or later in operation, as shown in Figure 10.

PLEASE NOTE: The values of the specified forces refer only to static forces. No oscillation (swinging) forces are allowed here.

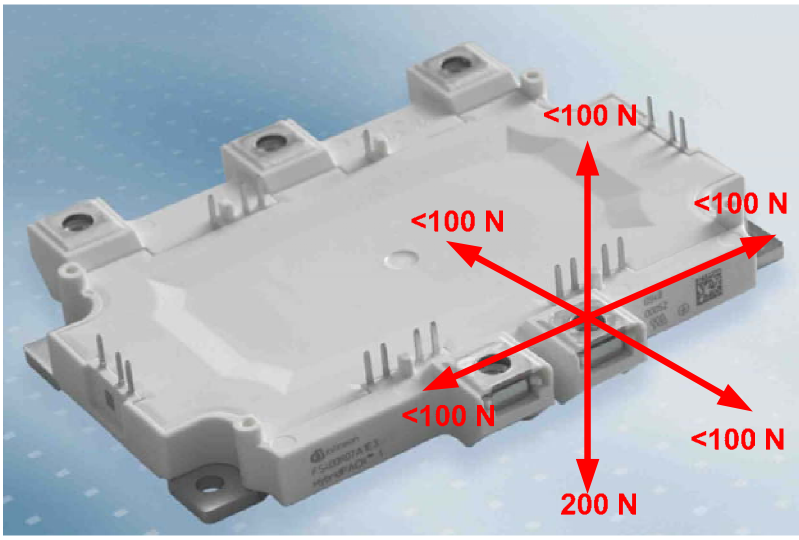

Figure 10 Maximum permissible static pull and push forces at the power terminal of the HybridPACK™ 1.

8.1 Connecting the power terminals with ideal strain relief

To connect the power terminals with the best possible strain relief, a recommended assembly schematic is shown in Figure 11, in which a bus bar is connected to the power terminals in such a way that only a low force is applied to them, even during shock or vibration conditions. The power terminals can withstand the force F best in the direction from the terminal to the base plate. Force to other directions has to be avoided. This has also to be considered in the tolerance of the bus bar.

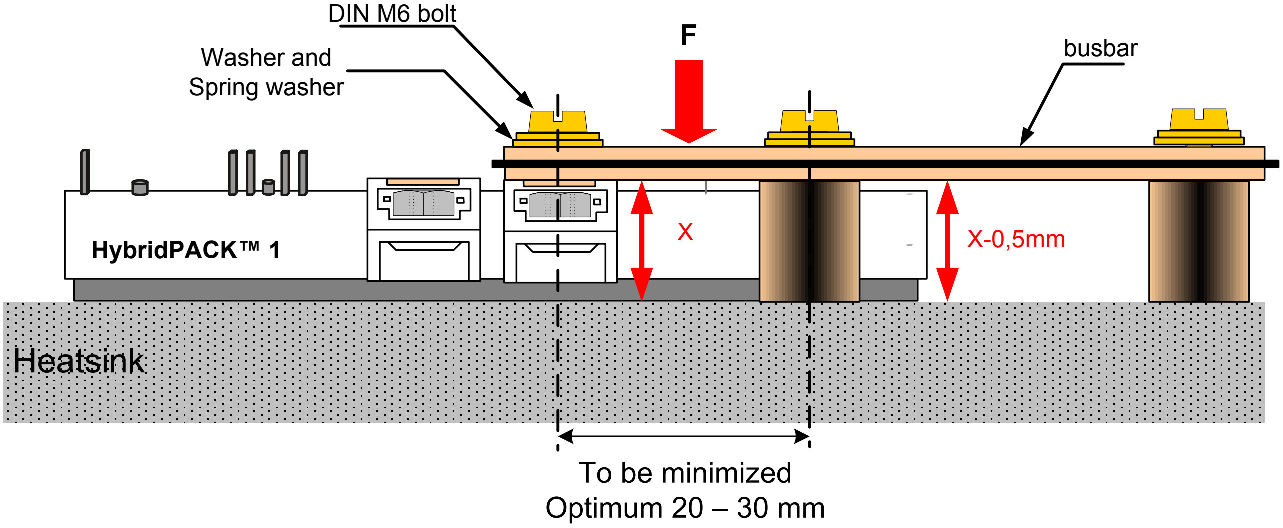

Figure 11 Concept drawing of HybridPACK™ 1 assembly with ideal strain relief

9 Storage and transport

Storage of the module at the temperature limitations specified in the datasheet is possible but not recommended.

The recommended storage conditions according to IEC60721-3-1, class 1K2 should be assured for the recommended storage time of max. 2 years.

Max. air temperature: T_{maxair}=+40°C
Min. air temperature: T_{minair}=+5°C
Max. relative humidity: 85%
Min. relative humidity: 5%
Condensation: not permissible
Precipitation: not permissible
Iceing: not permissible

Pre-drying of the case prior to the solder process, which is recommended for moulded discrete components (e.g. microcontrollers, TO-cases etc.), is not required for HybridPACK™ 1 modules.

10 Data Matrix (DMX) part marking

Infineon Technologies as a part of the electronic industry, is making gains by using Data Matrix part marking to transform the way of tracing HybridPACK™ products, both through the manufacturing process, and throughout the entire life of that product or component. Total traceability means dramatic improvements to process and quality control.

Data Matrix is a two-dimensional code which is machine readable with conventional 2D reader or scanner. The readers are capable of reading low contrast marks, damaged codes and even codes on severely compromised surfaces. On the picture below the side view of HybridPACK™ 1 is depicted. From this picture, the marking of the module can be seen together with the Data Matrix (DMX) - Code, Date Code and the Serial Nr.

Figure 12 HybridPACK™ 1 picture (side view)

When DMX-Code of the module depicted in above has been read out with a conventional scanner, then the following characters will be shown:

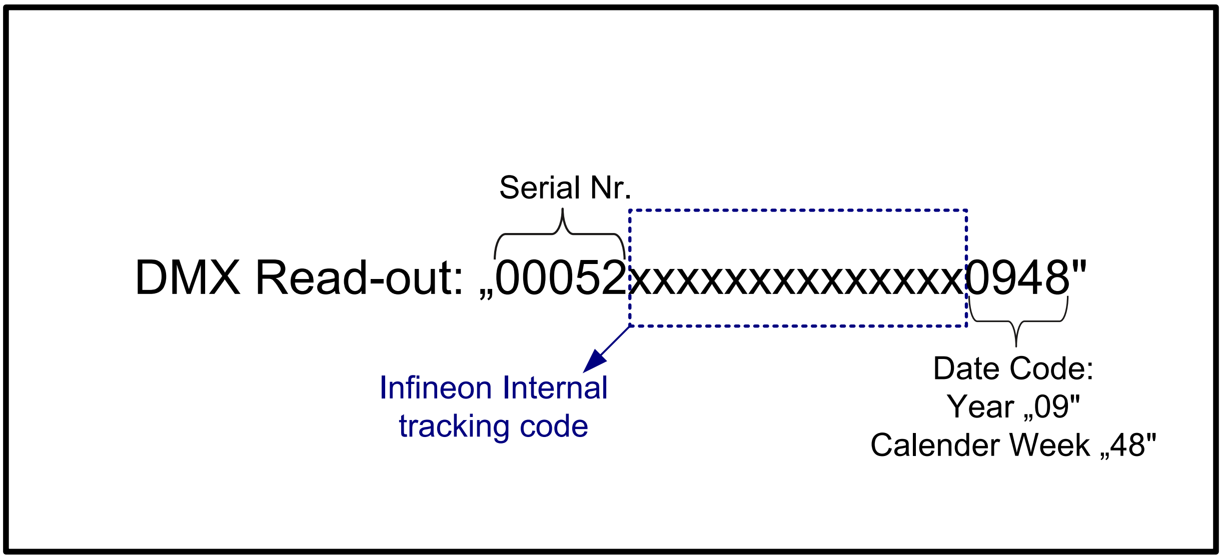

Figure 13 HybridPACK™ 1 DMX Read-out

7 References

The referenced application notes and datasheet can be found at http://www.infineon.com

[1] Infineon Application Note AN2005-06 “Soldering Econo und Easy modules

[2] Infineon Application Note, AN2006-02 “Application of screen +print templates.pdf”

[3] Infineon Datasheet FS400R07A1E3 and FS200R07A1E3