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HybridPACK™ 2

General Information and Mounting Instruction

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Attention please!

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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^{TM} 2 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™ 2 dimensions a proposal for designing a driver board can be offered (see Figure 1). The end-hole diameter for the module solder pin connection should be $1{,}35^{-0{,}0}_{+0{,}25}$ mm should be taken.

PLEASE NOTE: The drawing below offers a proposal for solder pin connection based 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.

When designing a driver board which uses connectors (E.g. JST connector type "09HVD6B-EMGF-NR") the geometry and the footprints of the connector must be taken in to account.

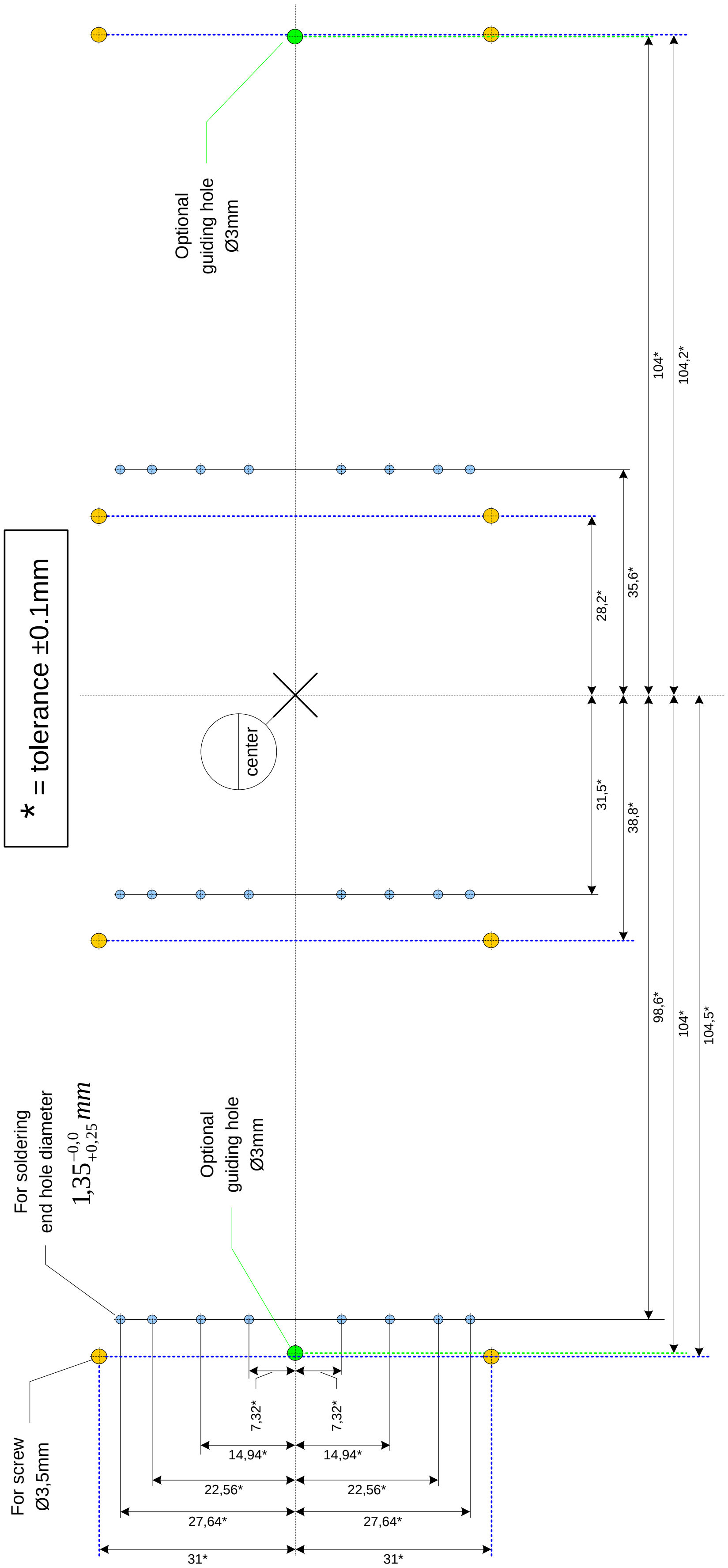

Figure 1 **Proposal for designing a driver board for HybridPACK™ 2 module.**

3 Mounting a Driver Board onto the Module

The driver board could be mounted in two ways: through connectors (strongly recommended) or alternative directly soldering on the top of the module.

When a driver board or module adapter board (PCB) 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 eight 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 3 mm diameter and 10mm length should be used for example type Delta PT 30x10 from EJOT.

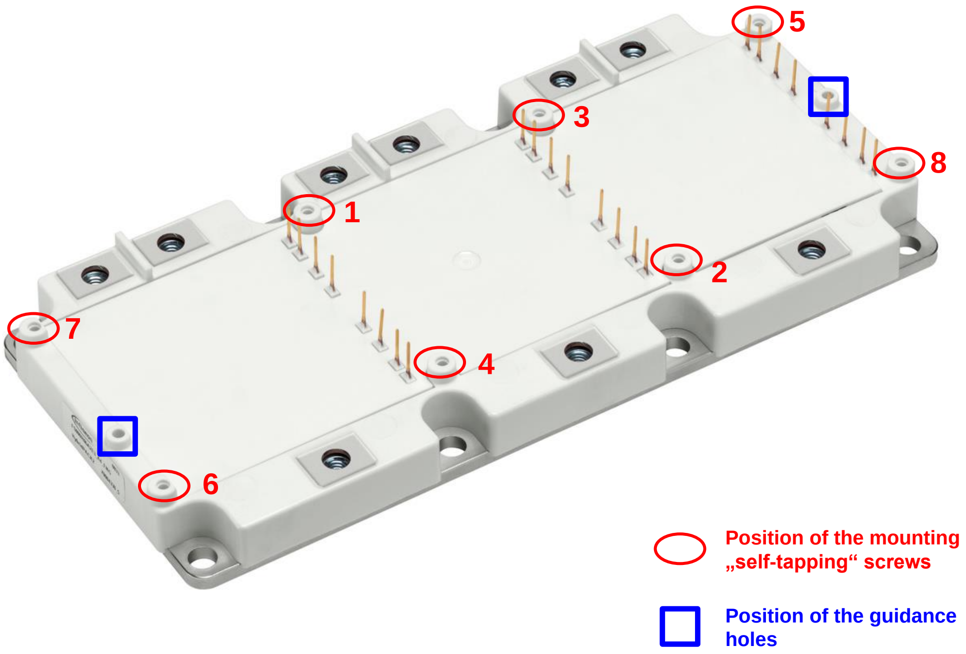

Figure 2 PCB mounting stand-off of HybridPACK™ 2 module.

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 0.9Nm ±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}≤9mm giving consideration to the PCB thickness and the weight of the driver PCB.

The HybridPACK™ 2 offers two guidance holes marked on the Figure 2 with the colour blue. These guidance holes offer assistance by mounting the PCB on the module and allow automated assembly.

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).

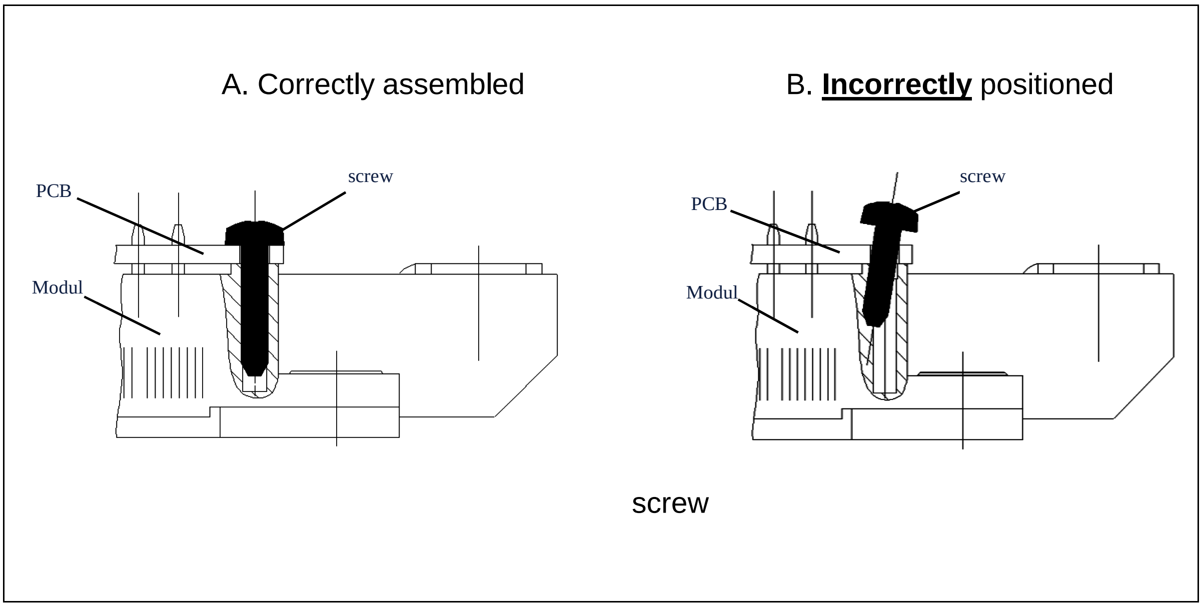

Figure 3 (A) Correctly assembled screw into the mounting stand-off.
(B) Incorrectly positioned screw into the mounting stand-off.

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”.

Instead of directly soldering, the PCB could also be mounted onto the module through connectors. Such electrical connection between PCB and module can use every connector which is designed for a pin cross-section of 0,64 x 0,64 mm, especially JST connector type "09HVD6B-EMGF-NR". The module auxiliary terminals (pin connectors) are designed especially for fitting to the JST connectors (surface and dimensions).

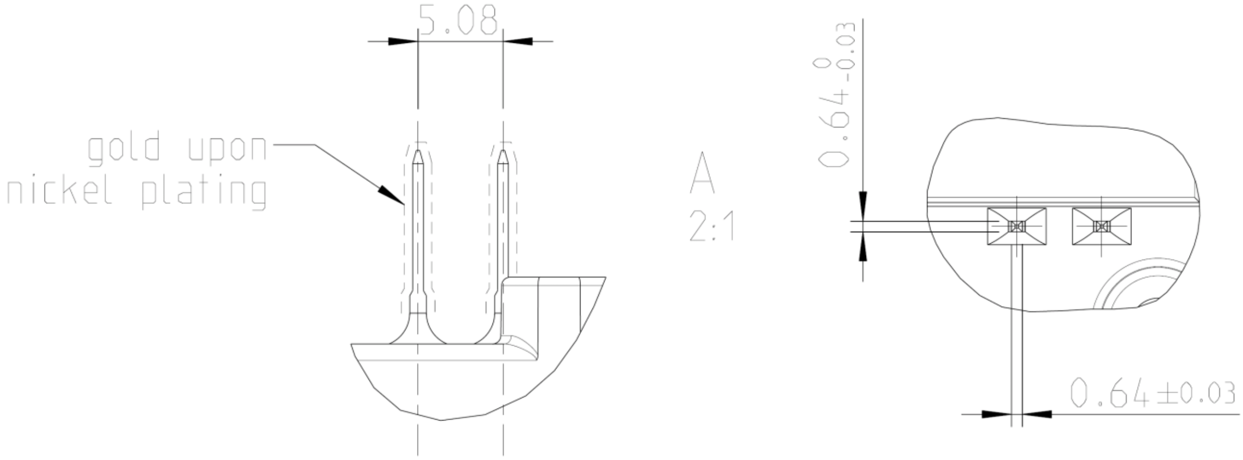

Figure 4 Technical drawing of the HybridPACK™ 2 auxiliary terminals (pin connectors).

The picture above shows the dimension and the structure of the auxiliary terminals. Due to the specific requirements of the JST connector the auxiliary terminals have the following properties:

- The auxiliary terminals are made of 63% IACS (International Annealed Copper Standard) copper material,
- Auxiliary terminals have gold (Au) surface with nickel (Ni) under plating,
- The tensile strength of the auxiliary terminals has to be equal or exceed 530MPa,

4 Application of the Liquid Cooling System

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 (T_{vj_op} = 150 °C) in operation. Therefore, the design of cooling system/heat sink is of great importance to achieve good performance.

HybridPACK™ 2 differs from other power modules because of pin-fin array on the base plate, which makes liquid cooling very effective in sense of thermal performance. The base plate is made of copper (Cu) material with nickel (Ni) plating. The pin fin structure is suitable for cooling fluids like water/ethylenglycol mixture.

PLEASE NOTE: During the mounting process damages of the nickel plating and mechanical deformation of the pin fin structure should be strictly avoided.

As shown in the figure below the pin-fin array is on the module base plate to get maximum heat exchange effect. An O-ring sealing type (202 x 64.2 x 3)mm e.g. from company Trelleborg (part number DRYD001590E768U) should be utilized on the heat sink in order to confirm waterproof of the fluid cooling system. Such O-ring is held in a groove, which surrounds the tray that holds the pin fin array, and this groove should be restricted to the region on the heat sink that corresponds to the region around the pin fin structure see the drawings below. With in this region there should be no contamination, scratches or other base plate damages.

PLEASE NOTE: IFX does not recommend the usage of a silicon gasket or other sealing methods. The usage of sealing methods different then O-ring may cause damage on HybridPACK™ 2 module.

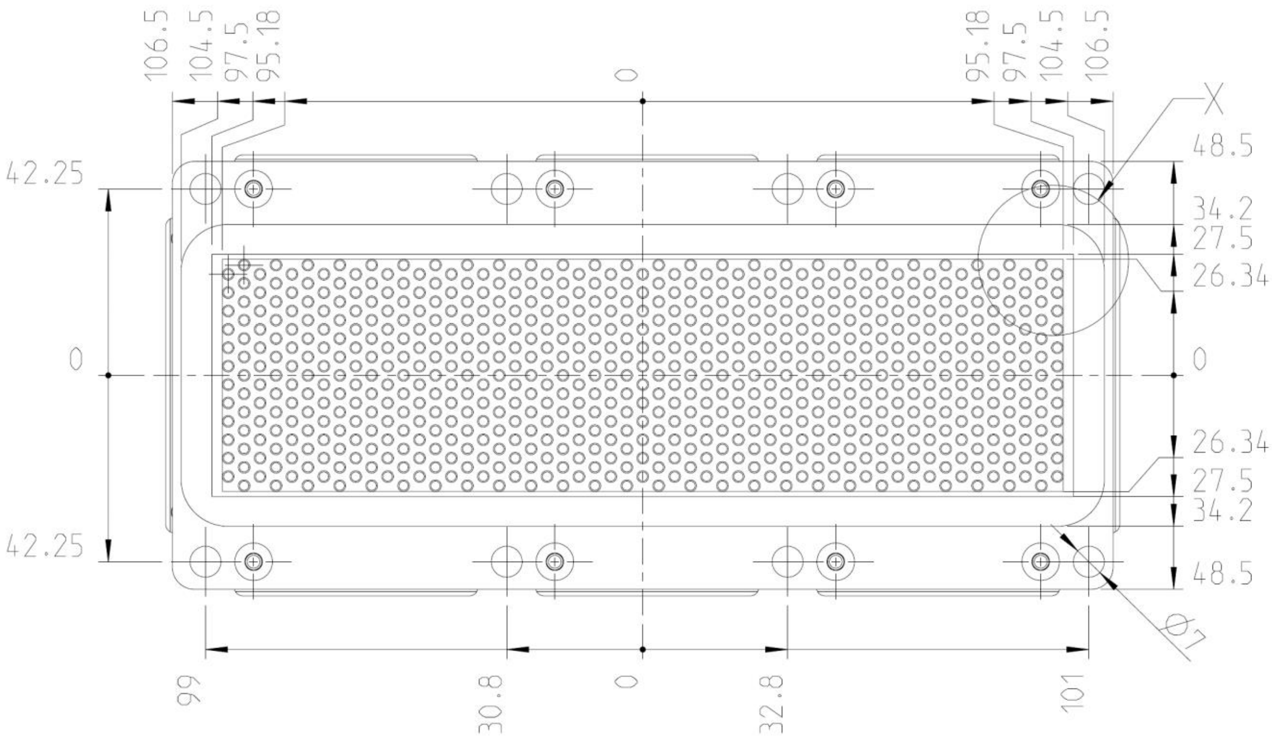

Figure 5 Technical drawing of HybridPACK™ 2 bottom side.

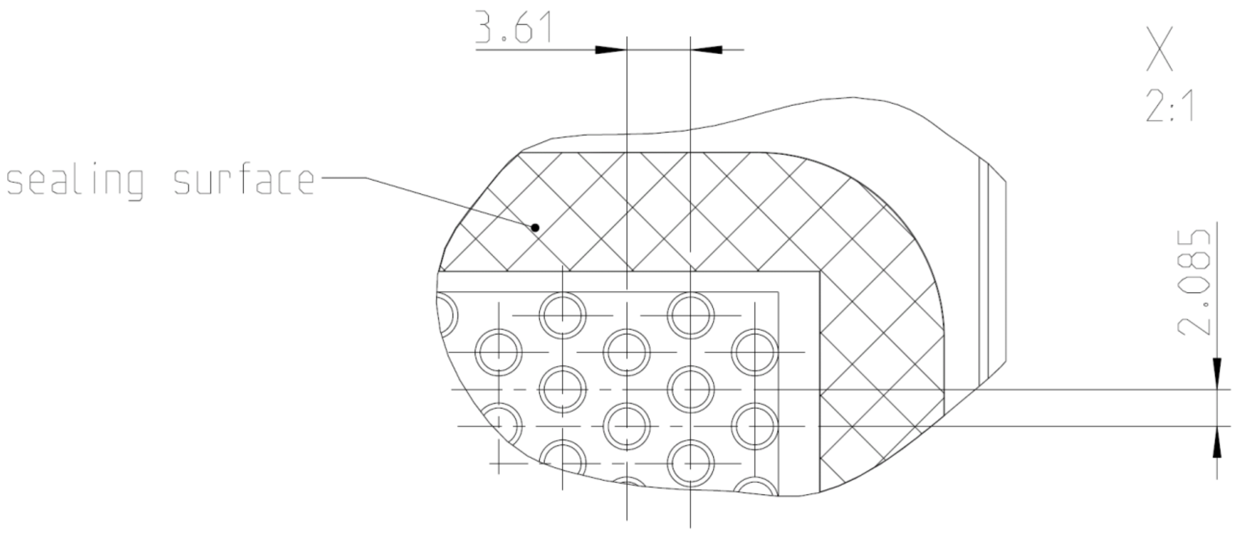

Figure 6 "X"- section Detail drawing of the HybridPACK™ 2 bottom side. The sealing surface corresponds to the O-ring holding groove.

The suggested dimension of the tray holding the pin fin array is depicted in Figure 7a with specified tolerances.

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

PLEASE NOTE: No thermal grease is needed for mounting the HybridPACK™ 2 on the cooler.

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

Surface flatness ≤50µm
Surface roughness Rz ≤10µm
Surface roughness at the sealing surface Ra ≤1.6µm

The heat sink 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 heat sink has to be handled twist free.

An example of fluid cooling system design could be referred to datasheet of HybridPACK™ 2 and Figure 7. This cooling system is designed for O-ring sealing from Trelleborg with part number DRYD001590E768U.

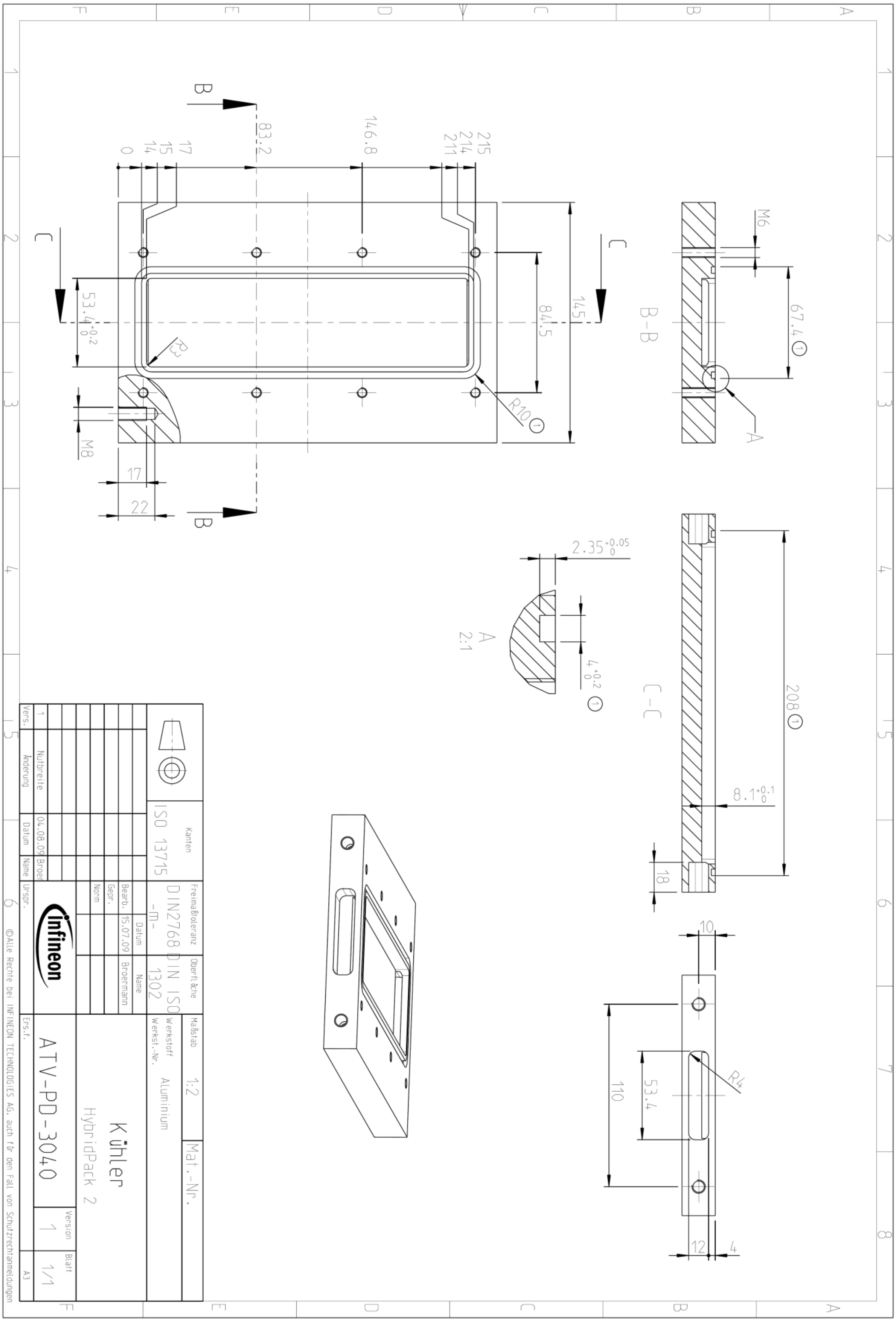

Figure 7 **A design example of fluid cooling system.**

PLEASE NOTE. The heat sink design should be done in such manner in which the cooling fluid has reduced bypass possibility.

The figure below presents the cross section view of HybridPACK™ 2 module and the heat sink. This cross section shows that certain distances have to be minimized so that the cooling fluid can not bypass the pin fin structure. One of the critical places is the border region between the pin fin structure and the heat sink wall shown in the "A" area (represented in the figure below with the black colour). If the distance between the pin fin structure and the heat sink is too big it will offer unwilling path for the fluid. This will eventually decrease the cooling performance. The second critical path is the gap between the pin fin structure and the bottom of the heat sink (represented in the figure below with the red colour). This gap should be minimized as well.

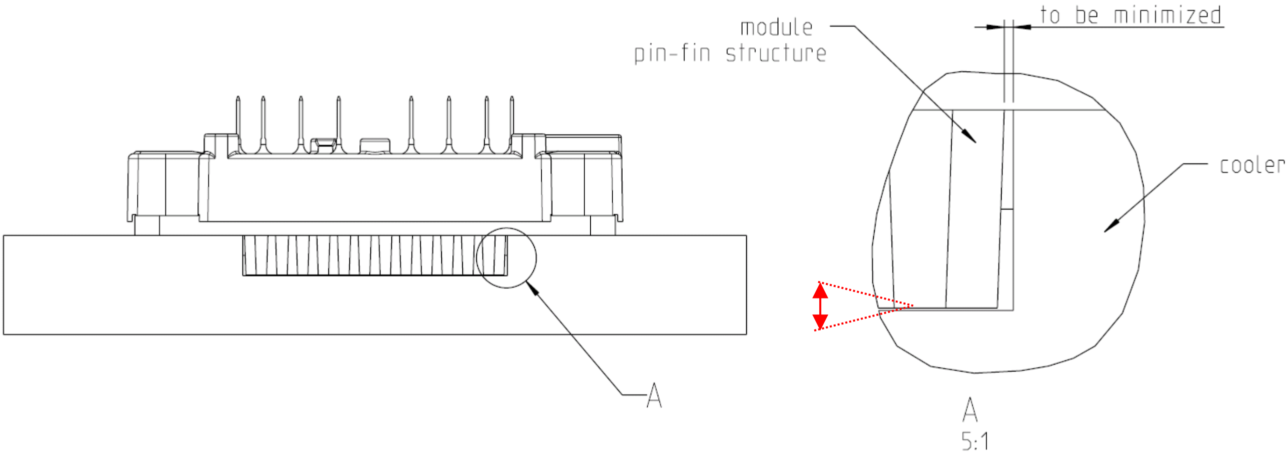

Figure 8 Cross section view of HybridPACK™ 2 and the heat sink. Within the shown area "A" certain distances should be minimized in order to obtain optimized cooling performance.

4.1 Baseplate Surface

A typical appearance of the baseplate surface is a so called "marbling" or "white spots" structure. This structure can be observed after the galvanic nickel and its cleaning process of the baseplates. The roughness of the baseplate, the chemical structure as well as the thickness of the Ni layer is not different to baseplates where this structure is not visible by naked eye. Such an appearance as shown in the Figure 9 is a normal appearance and is no reason for an objection as it does not influence the product performance or quality.

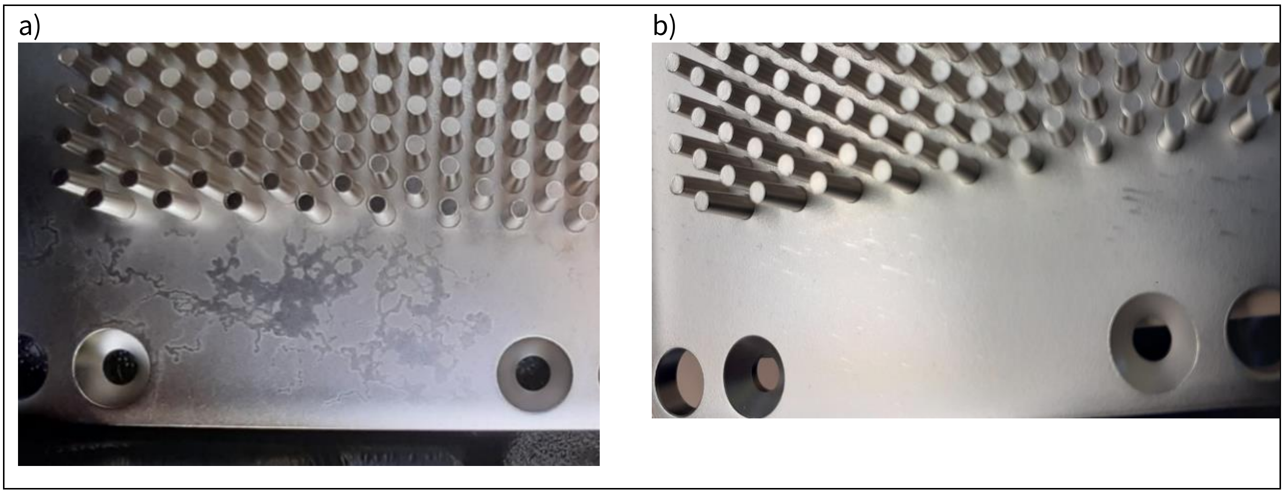

Figure 9 Typical appearance of power module baseplate surface with a "marbling" or "white spots" structure.

5 Screws to Mount the Module to the Heat Sink

To mount the module the following screws are recommended: DIN M6 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 diameter of the used washer is 10mm.

The clearance and creepage distances specified in the HybridPACK™ 2 datasheets are the shortest clearance and creepage distances existing at the unassembled and unconnected module.

When selecting suitable M6 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.

6 Mounting the Module to the Heat Sink

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 M6 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 eight M6 fastening screws with washer (according to DIN 433) and spring washer (according to DIN 127).

1. Place the module onto the heat sink and fix with two screws.
2. Fix the screws with 0.5Nm (hand tight crosswise) in the sequence showed in Figure 10.
3. Tighten the screws with 3Nm – 6Nm in the same sequence (crosswise)

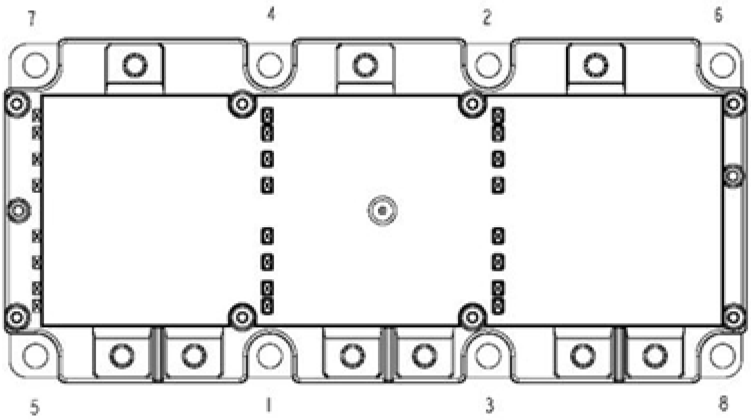

Figure 10 Tightening sequence to mount the module.

7 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}=2.5 Nm to M_{max}=5.0 Nm.

When selecting the screws 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 11.

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

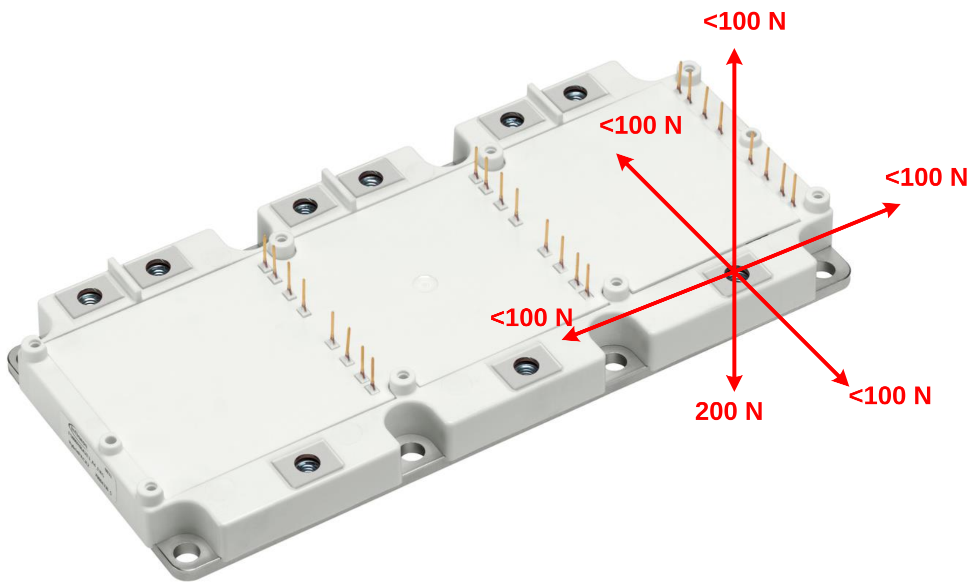

Figure 11 Maximum permissible static pull and push forces at the power terminal of the HybridPACK™ 2.

7.1 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 12, 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.

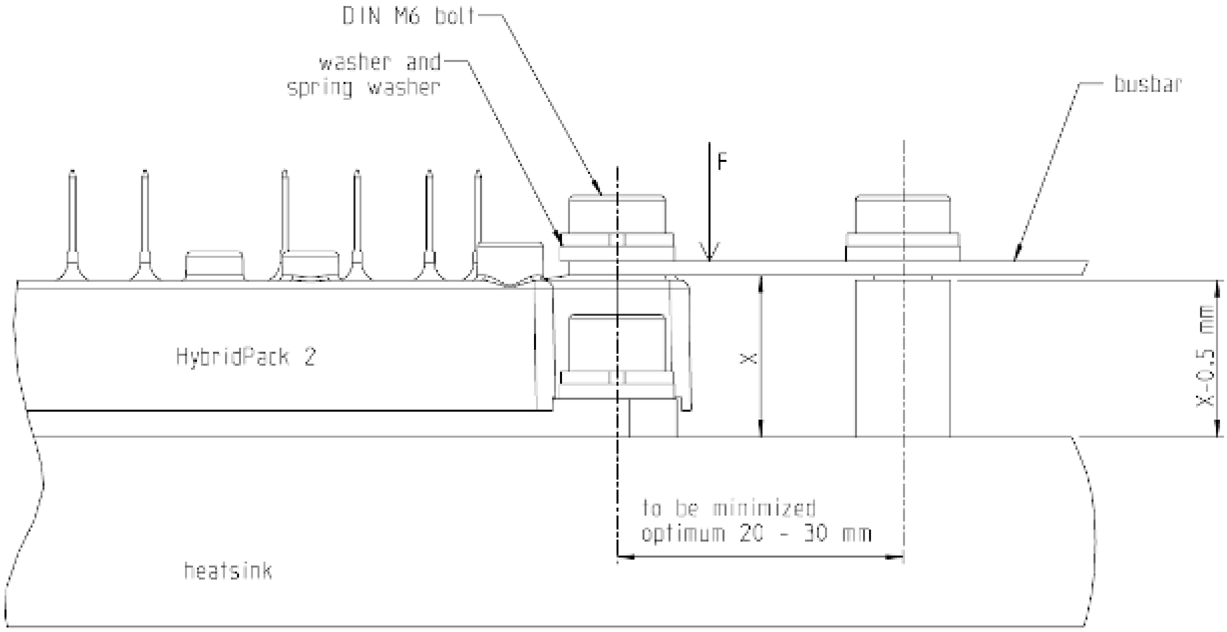

Figure 12 Concept drawing of HybridPACK™ 2 assembly with ideal strain relief

8 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™ 2 modules.

9 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™ 2 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.

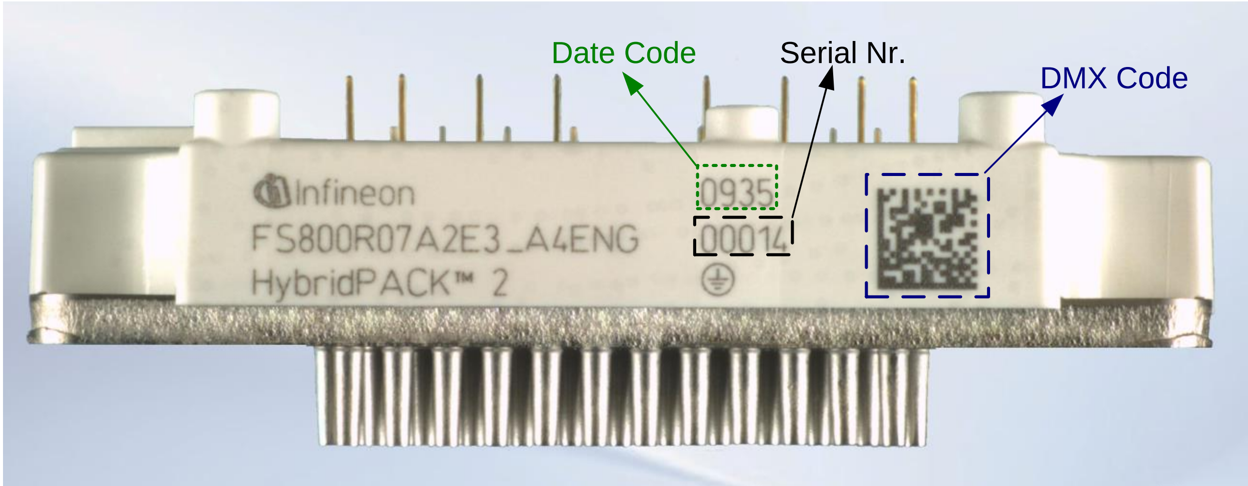

Figure 13 HybridPACK™ 2 picture (side view)

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

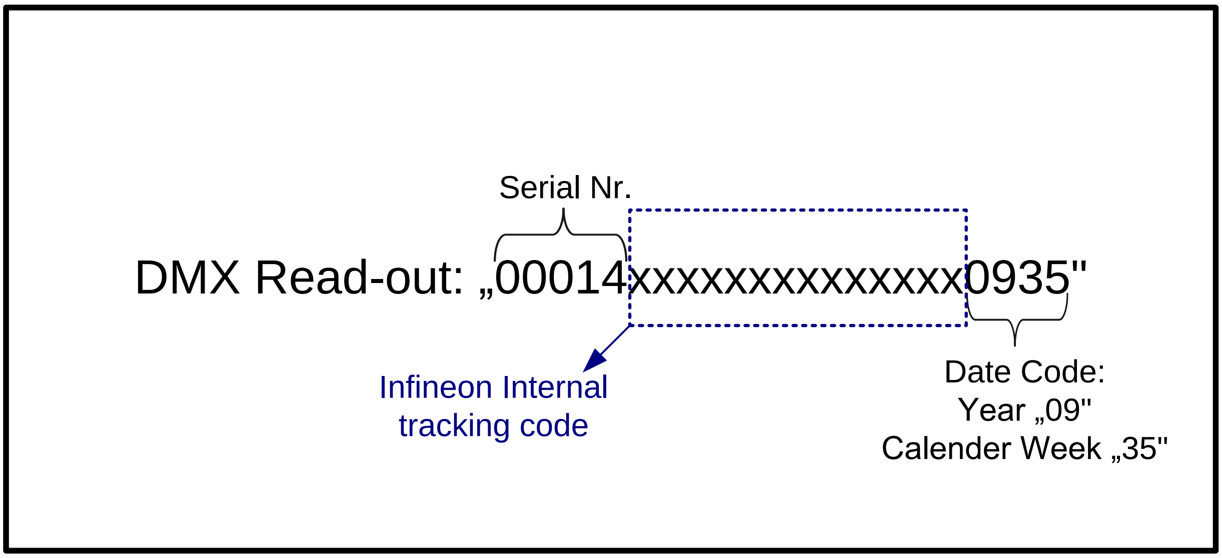

Figure 14 HybridPACK™ 2 DMX Read-out

10 References and Revision History

Revision History			
Date	**Version**	**Changed By**	**Change Description**
2010-08	2.0	Vase Klandjevski (IFAG ATV OPEV AE)	Revision History: ,date (10-08-10) V2.0, Previous Version: V1.0, November 2009 All Pages: Used new template. , Page 4 and 5: Added Chapter " Proposal for Designing a Driver Board" Page 7: Changed name of the JST connector from "09HVD4B-EMGF-SR" to "09HVD6B-EMGF-NR". Page 9: Added comment"IFX does not recommend the usage of a silicon gasket for sealing." Page 11: Changed drawing "A design example of fluid cooling system" Page 14: Updated Figure 11
2020-04	2.1	Denis Weiß (IFAG ATV HP EDT AE)	revised Chapter 4.1