Automotive EasyPACK™ Power Modules

Assembly Instructions for the EasyPACK™ Automotive

About this document

This Application Note provides a guideline on how to use and implement Automotive EasyPACK™ power modules with PressFIT connection technology. The values and recommendations in this document should not be considered as datasheet values.

Scope and purpose

The Automotive EasyPack™ power module is a simple to use power module in combination with a printed circuit board. It is an indirectly cooled power package, where the thermal pad is mounted onto the cooler and the signal pins, as well as the power pins, are connected to a printed circuit board. In comparison to other power module solutions on the market, the output currents of the Automotive EasyPack™ power module are routed to the load via a printed circuit board.

Within this document, you will find mounting recommendations and assembly instructions of the Infineon Automotive EasyPack™ power module as well as information on the PressFIT technology.

This application note applies to the following products:

Product Type	SP or number	Status
F4-50R07W1H3_B11A	SP000931906	Production
F4-75R07W1H3_B11A	SP001050464	Production
FS50R07W1E3_B11A	SP000865118	Production
FS75R07W2E3_B11A	SP000865130	Production
FF200R08W1P2_B11A	SP005595082	Sampling
FF300R08W2P2_B11A	SP005424885	Production
FF08MR12W1MA1_B11A	SP002314006	Production

Table 1: Infineon EASY Products

Product not listed? Please ask your Infineon Sales Representative

Intended audience

This document is intended for all technical experts using Infineon Automotive EasyPACK™ modules in various automotive applications

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1. General information

The Automotive EasyPack™ package platform is an indirect cooled power module design for usage with **P**rinted **C**ircuit **B**oard (PCB) technology. Qualified according to AQG324 the automotive EasyPack™ is the ideal package to withstand the harsh environment of the automotive market and at the same time to outmatch the quality expectations of Infineon's automotive customers. The EasyPack™ modules meet requirement to satisfy RoHS category.

The main advantages of the Automotive EasyPack™ power modules are the simplicity of its usages, the wide range of applications and the very high flexibility. Flexibility in terms of the many different technologies which can be used inside the Automotive EasyPack™ power modules as well as the possibility to host many different power topologies in one Automotive EasyPack™.

As shown in Figure 1, Automotive EasyPack™ power modules are available in two different sizes, the EASY1B and the EASY2B.

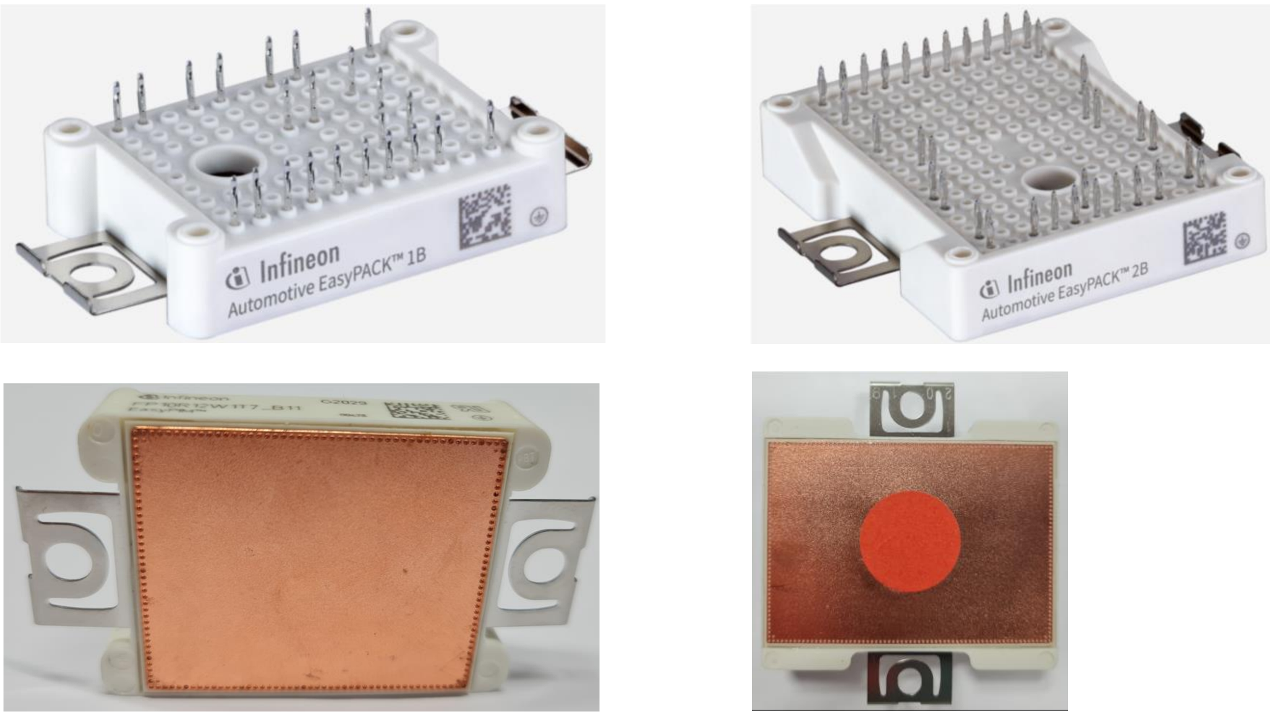


Figure 1. Automotive EasyPack™ EASY1B and EASY2B

2. Construction of the Automotive EasyPack™

Mosfets, IGBTs, diodes, and other technologies are soldered on a DCB substrate (**D**irect **C**opper **B**onded). The substrate is the carrier for the different technologies and provides besides the good thermal conductivity also the isolation between the cooler and the semiconductors.

A stiff plastic frame with two mounting clamps pushes the substrate to the cooler. The plastic frame itself is designed to accomplish a very planar and smooth transition between the cooler and the heat sink of the substrate.

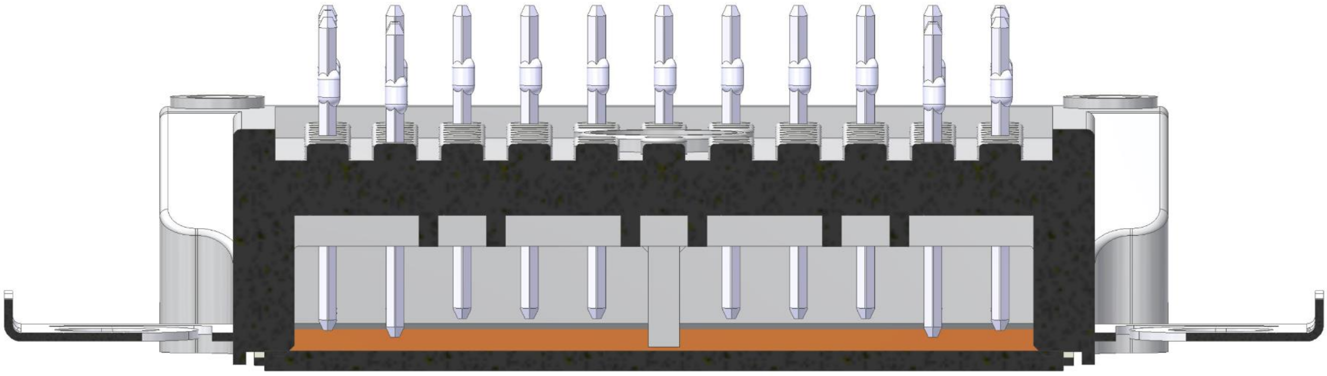


Figure 2. Construction of an Automotive EasyPack™

The mechanical pressure on the substrate comes from the housing of the automotive EasyPack™ pushing the substrate towards the cooler. The sealing rope and the gel are only providing isolation to the package, but no mechanical bonding between the substrate and the housing.
Pulling the housing in the opposite direction breaks the power module and the DCB including the chips may slip out of the housing.

Pins are connected to the substrate. Applying pressure to the pins and at the same time a pressure to the housing in the opposite direction, pushed the substrate out of the housing.

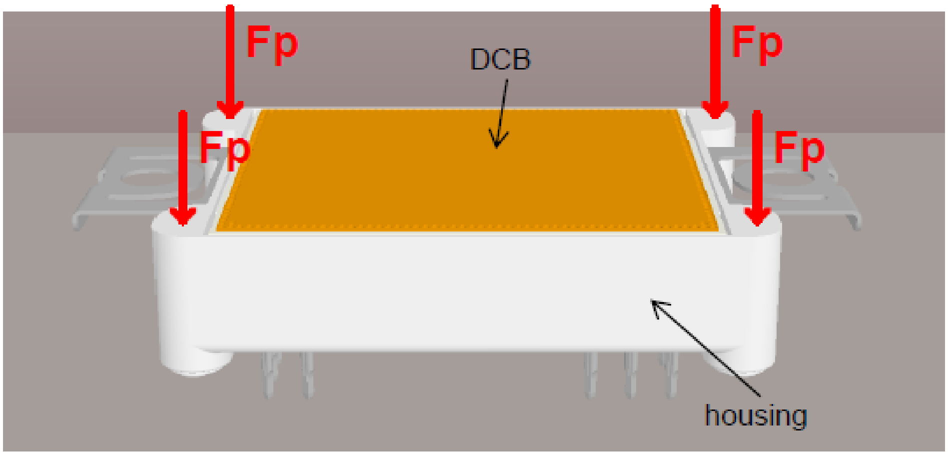


Figure 3. Forces to remove the housing from the substrate

<u>Please note:</u> During handling processes avoid forces that might push out the DCB out of the housing of the Automotive EasyPack™.

3. Connection to the Printed Circuit Board

Control- and load pins of the automotive EasyPack™ are realized with press-fit technology. Press-fit technology is a well-established and field-proven connection technology in the automotive industry for many years. Press-fit pins eliminate the need for soldering and therefore they cut down process time and costs by gaining flexibility in the board design at the same time.

There are two types of press-fit pins; this solid pin having a defined press-in zone and the compliant pin having an elastic press-in zone. The Infineon Automotive EasyPack™ is using solid press-fit pins.

4. Mounting of the Automotive EasyPACK™ on the Cooler

Mounting of the Automotive EasyPACK™ 1B/2B Modules on the cooler is very easy, fast, and reliable. This will save system cost, mounting time and provides a highly reliable result. Figure 4. Shows Automotive EasyPach™ 1B and 2B and a magnified view of the PressFIT Pins.

Figure 4. Modules in the Automotive EasyPACK™ B series featuring PressFIT contacts

Automotive EasyPACK™ PressFIT contacts have an area of approximately 1.7 mm^2 that adapts itself to the holes in the PCB during the press-in process. The plastic is deformed as a result. This deformation is intended to accommodate the tolerance and provides the basis for the cold welding.

The forces resulting during the PressFIT process ensure that the welded materials on the PCB and pin exhibit a continuously consistent – and, unlike other contact technologies – very small electrical contact resistance (approximately 0.05 mΩ). Figure 5 shows various sections and SEM images that provide a view of the air-tight bonded materials resulting from the press-in force.

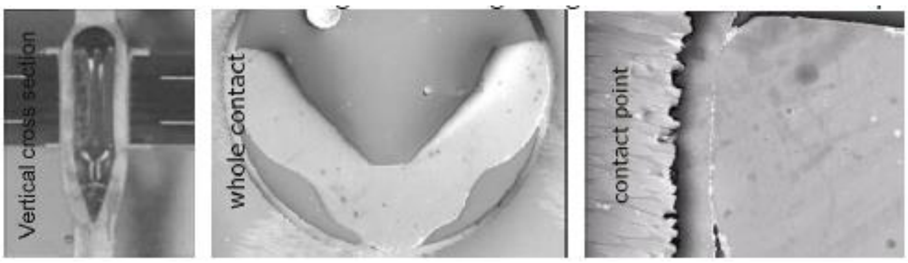


Figure 5: Automotive EasyPACK™ PressFIT contact sections

This application note gives mounting instructions for the Automotive EasyPACK™ module with recommendations on 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 electrostatic-sensitive components. 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.

5. General information on power module handling

This section describes forces on module housing: DCB push-out.

The power module is not designed to withstand forces on the module housing as shown in the example of Figure 6. The module pins are located here on a flat table. Forces on the module housing (Fp) are pushing the

DCB out of the housing. Therefore, forces (Fp) on the module housing have to be avoided during handling. Please note that this is a different case compared to the normal press-in process, where the DCB is fully supported in the press tool, and the press-in forces affect the DCB and not the housing.

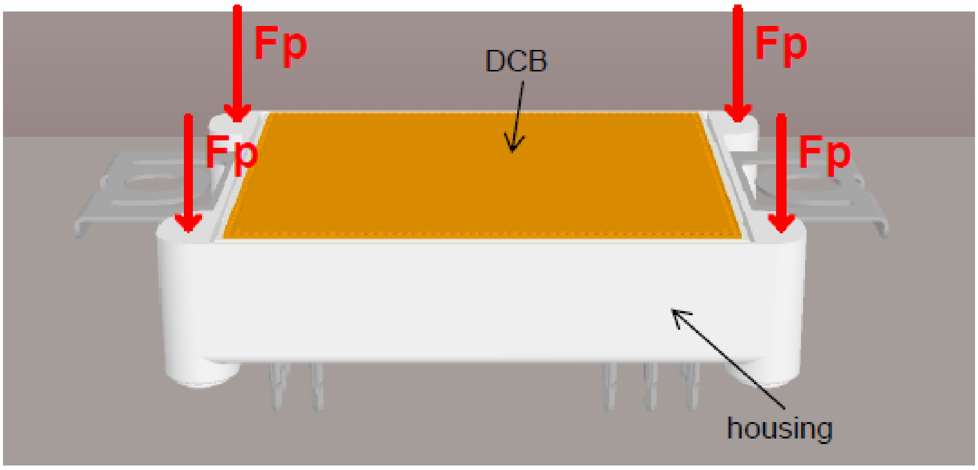


Figure 6. Forces on the housing during module handling should be avoided to prevent a push-out of the DCB

6. Requirements for printed circuit boards

The press-fit technology used in the Automotive EasyPACK™ is designed based on IEC 60352-5 for standard FR4 printed circuit boards with immersion tin plating. The PCB material must be compliant with IEC 60249-2-4 or IEC 60249-2-5 for double-sided printed circuit boards and IEC 60249-2-11 or IEC 60249-2-12 for multilayer printed circuit boards.

The requirements for the PCB are in Table 1. In case the requirements are not met, there is a risk of a not gas-tight signal pin connection or of pin and/or PCB via damage. The recommendations for the PCB for the X-pin holes are in Table 2.

Please note that the press-fit hole specifications are only valid for assembled PCBs. In case of unassembled PCBs, e.g. for testing purposes, it is recommended to perform a standard reflow solder process before starting the power module assembly process.

No	Description	unit	min.	typ.	max.	Remarks and known common mistakes
1	Drill tool diameter	mm	1.12	1.15		Wrong drill tool applied. Specify clearly the press-fit hole positions and required drill tool size to the PCB manufacturer
2	Copper thickness in hole	um	25		50	In case the via metallization is lower than specification, the risk is a damaged/cracked via.
3	End hole diameter	mm	0.99		1.09	End hole diameters lower than spec may lead to increased press-in forces and may damage the pins. Larger holes than spec may lead to low press-in forces

4	Copper thickness of conductors	um	35	70 105	400	No results are available for thinner or thicker copper layers.
5	Hole to hole pattern tolerance	um			±100	In typical PCB manufacturing hole to hole pattern is lower than ±80um.
6	Recommended PCB thickness	mm		1.6		Target value with +/-10% thickness tolerance
7	Metallization of circuit board		Immersion Tin (Sn chemically)			Immersion tin has a typical 1-5 um metallization in the hole. Other metallization types should be avoided can lead to strong deviation in press-in forces. For E.g. HAL leadless shows high variations in press-in forces and the risk is a not gas-tight pin connection, which can fail over application lifetime. PCB with ENIG plating can lead to increased press forces due to hard surface and this PCB type was not tested at Infineon module qualification tests.
8	Metallization of pin		Ni/Sn (galvanic)			The Sn plated pin with nickel under layer avoids potential whisker growth out of the upper galvanic tin layer.

Table 1. Requirements for a PCB

No	Description	unit	min.	typ.	max.	Remarks
1	End hole diameter X-Pin	mm		5.9		The hole should be drilled with a 6.0 mm drill tool and not milled in order to avoid additional unnecessary hole position tolerances.
2	End hole diameter Y-Pin1	mm		5.4		The hole should be drilled with a 5.5 mm drill tool and not milled in order to avoid additional unnecessary hole position tolerances.
3	Hole to hole pattern tolerance	um			±100	Plated holes are preferred in order to achieve a minimum “X-pin hole” to “Pressfit hole” pattern tolerance.

Table 2. Recommendations for the printed circuit board X-pin holes

In order to ensure that the PressFIT contact sits securely in the PCB, the specification of the hole given in Table 2 must be adhered to. Experience has shown that PCB hole diameter should be significantly larger than the module frame element for a seamless assembly process. The given relatively large hole diameters in the PCB is the best compromise between Module and PCB alignment and the necessary play during this assembly step.

The specified relatively large hole sizes avoid an unnecessary rotation of the PCB with respect to the signal pin coordinate system.

If the specification of PressFIT holes is limited to only the finished dimension (i.e., the metalized hole), different drill sizes could be used depending on the PCB manufacturer and production philosophy, and also different metallization thicknesses could be provided. This would lead to results that would have to be rejected for quality assurance reasons. The end hole diameter is a function of the drill hole, the copper thickness, and the metallization in the hole.

The recommendation still applies that the hole in the PCB is to be drilled during manufacturing with a drill size of 1.15 mm, and should not be milled. Experience has shown that a final hole diameter between 1.12 mm and 1.15 mm is obtained under consideration of the runout tolerances of the spindles after drilling due to the shrinking of the FR4 material.

With a copper thickness of 30 µm to 50 µm in the hole and a thin layer of about 1 µm for tin applied chemically, an end hole diameter is obtained as the test dimension. Due to the thinner tin layer thickness, this diameter is always higher than the value of 1 mm stated in the standard (IEC 60352-5). The final hole diameter, considering the drilling diameter, copper thickness, and a chemical tin layer, is typically between 1.02 mm and 1.09 mm.

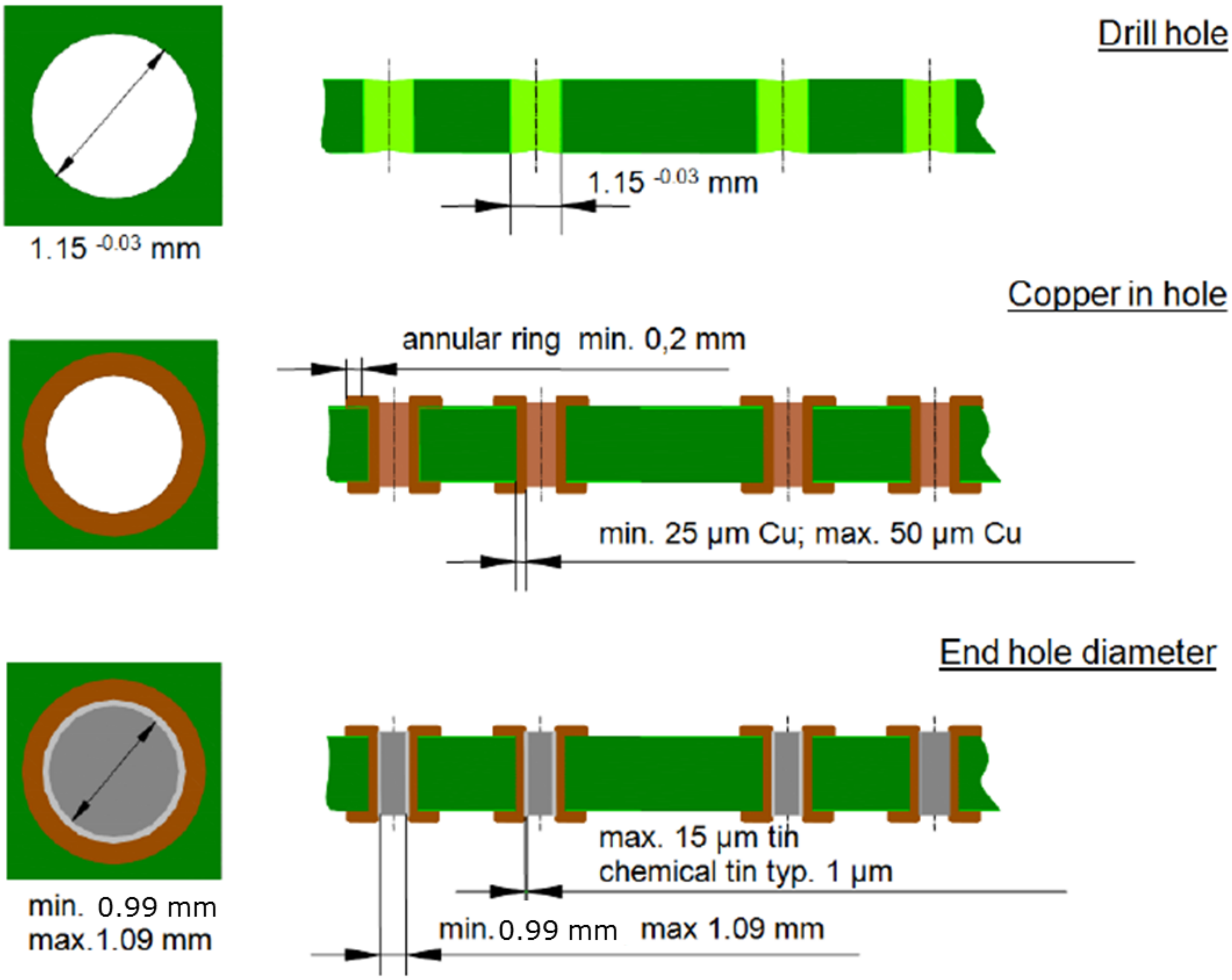


Figure 7. Structure of a PCB Different dimensions compared with DC6i

The PressFIT technology is qualified for FR4 PCB material.

After a reflow soldering process is carried out on a PCB, the module can be pressed into the board without difficulty. The retention forces of the press-fitted pins are not diminished.

Depending on the applied press tools, a certain distance from the middle of the pins to other components must be observed. A distance of 5 mm is recommended, similar to Infineon's Econo PressFIT power modules.

A PressFIT module can be replaced up to two times. This means that a PCB can be used in total three times. Correct handling of the components is essential.

A module that has been pressed in, and the contact pressed out again, can no longer be pressed back in again. Instead, the module can only be attached to a new PCB via soldering. The plastic deformation of the PressFIT area does not permit a further PressFIT process.

Tolerance of PCB hole pattern is suggested to be kept within:

⌖	⌀0.1

7. The press-in Process

This section deals with the necessary press-in forces and tools for the modules.

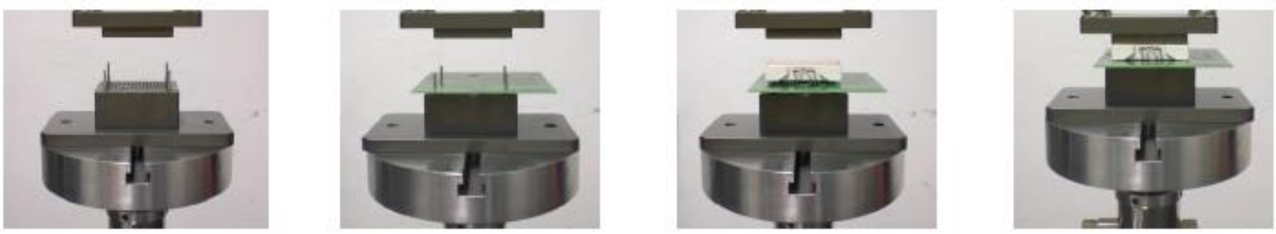
The PressFIT module is inserted into a PCB by pressing it in. PressFIT can be performed using a toggle lever press or a machine. A press-in tool that records the necessary force and the travel distance is recommended. Consistent quality and reproducibility is assured in this way. The PressFIT speed should not be lower than 25 mm/min according to IEC 60352-5. A lower PressFIT speed can lead to increased press-in forces and to deformation of the pins, or a non-gas-tight connection.

Note that during the press-in process, the placement area of the PCB and the pressing area of the pressure plate must be parallel to each other. The pressure plate should be mechanically fixed in position without any tolerance. The module is then pressed into the PCB in a regular motion.

The module pins should penetrate the PCB during press-in until the four stand-offs on the module, or optional distance keepers as described in chapter 16, make contact with the board.

By adhering to the principles stated above, a smooth insertion process for the two components can be achieved.

The following illustrations show the press-in process as it is implemented in the laboratory.



a)	b)	c)	d)
The press in aligned so that one part of the tool is directly above the other.	The printed circuit board is placed on the tool and held in place by the pins on the tool.	The module is placed on the tool and positioned using the pins on the tool.	The module contacts are pressed onto the printed circuit board by pressing the upper tool part downwards.

Figure 8. Press-in process of an Automotive EasyPacK™ module

Attention! It is recommended to protect the underside of the IGBT module against damage during the press-fitting process.

7.1. Press-in tools

The following tools that help to press the modules in and out are recommended for the Automotive EasyPACK™ B Series modules. Figure 9 shows these pressing tools for the two housing types, Automotive EasyPACK™ 1B and Automotive EasyPACK™ 2B.

Each of the tools has two parts. The first part presses against the underside of the module, and the second part holds the PCB in place to be pressed against.

No components can be placed in the mounting areas of this special type of press-fitting tool. This prevents damage during the press-fitting process.

When press-fitting multiple modules onto a PCB, arrange the press-in tool in such a way that the modules are on the same level after pressing. In this way, the modules can be mounted on the heat sink with a good thermal connection.

Figure 9. Press-fitting tools for Automotive EasyPACK™ 1B (shown left), Automotive EasyPACK™ 2B (shown right)

The drawing can be adjusted according to different requirements (e.g. module pinning and topside assembly of other parts) and the tools produced by a manufacturer of choice.

7.2. Press-in forces and speed

To press a module onto a PCB, a force of between approximately 60 N and 100 N must be applied for each pin in the module. The press-in forces vary according to the diameter of the hole and copper metallization in the PCB.

Table 3 shows the PressFIT speed and the maximum PressFIT force per pin.

No	Description	unit	min.	typ.	max.	Remarks
1	Press-in speed	mm/s	>25	100		according to IEC 60352-5 qualification
2	Max allowed press force per pin	N	60	85	<100	

Table 3. PressFIT speed and forces per pin

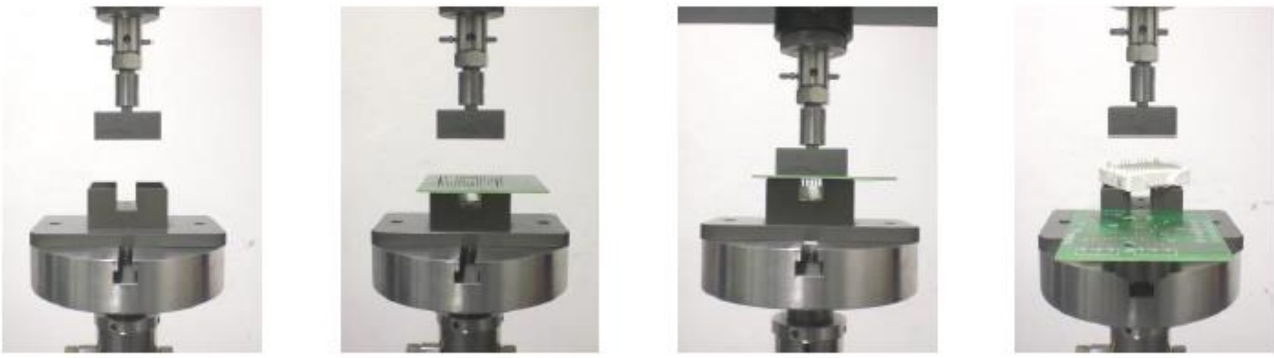
Attention! The maximum applied force per module for Automotive EasyPACK™ during pressing should not exceed 4 kN.

The press-fitting speed should not be lower than 25 mm/min according to IEC 60352-5. Infineon recommends a press-in speed of about 100 mm/min. The typical press-in speed for automated assembly lines is up to 450 mm/min.

7.3. The press-out process

This section deals with the necessary press-out forces and tools for the modules.

PressFIT modules are removed with the appropriate tools as shown in Figure 10 and Figure 11. The PCB is placed with the PressFIT module on the device tray. Force is applied with the extrusion plate on the PressFIT pins that protrude from the PCB. The press-out tools must be aligned parallel to each other so that the individual components (such as the PCB and module) are not damaged. Once the PressFIT zone has been lifted from the PCB, the module falls onto the tray in the lower part of the tool and is separated from the board.



Step 1:

The press is aligned so that one part of the tool is directly above the other.

Step 2:

The printed circuit board is placed in the extrusion tool with the PressFIT module facing downward.

Step 3:

The module contacts are extruded from the printed circuit board by pressing the upper tool part downwards. The module falls into the tray of the lower tool.

Step 4:

The printed circuit board and module can be separately removed from the tool.

Figure 10. Extrusion of an Automotive EasyPACK™ module

7.4. Press-out tools

As already mentioned above, the press-out tools consist of two parts. The upper part of the tool presses directly downwards on the module pins. The lower part of the tool holds the module with the PCB, and serves as a base for the pressing operation.

The disassembly tools must be aligned parallel to each other to obtain an equally distributed extrusion process.

The dimensions of the press-out tool must be considered when designing the PCB so that the components positioned around the module will not be damaged.

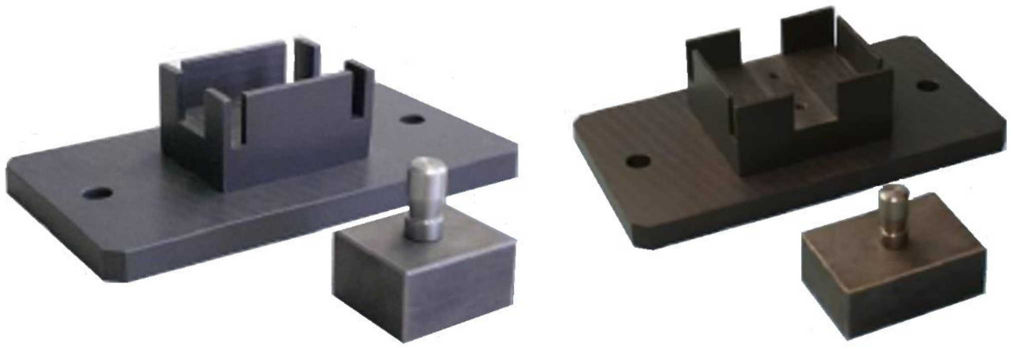


Figure 11. Press-out tools for Automotive EasyPACK™ 1B (left) and Automotive EasyPACK™ 2B (right) modules

The drawing can be adjusted according to requirements and the tools produced by a manufacturer of choice.

7.5. Press-out forces

To press a module out of a PCB, a force of approximately >40 N has to be applied for each pin in the module. The extruding forces depend mainly on the diameter of the hole in the PCB.

7.6. Quality of PressFIT contacts

PressFIT is an alternative solution for connecting control and load current contacts on IGBT modules with a PCB.

The requirements for greater durability, the trend towards higher temperatures and absence of lead, and, of course, very simple handling, are continuously growing.

As an advanced technology on the market, the PressFIT makes it possible to improve reliability up to a factor of 100 compared to manually soldered contacts and other contact types. The results of the reliability analyses in the Siemens norm SN 29500-5 demonstrate the factor.

The assembly process is simple and consequently saves time and money. The process is reliable, and system reparability is ensured.

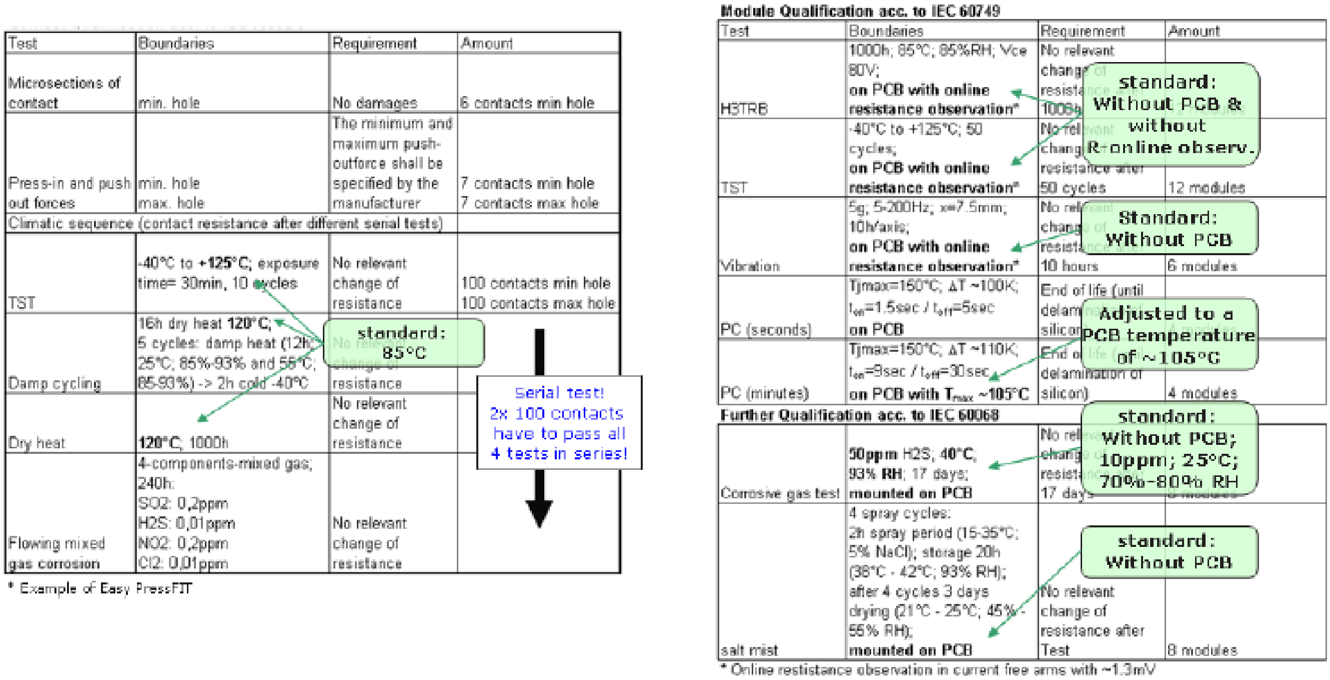
An extract from the Siemens norm SN 29500-5 / Edition 2004-06 Part 5 shown in Table 4 illustrates the failure rates of different contact technologies.

Process	Conductor diameter in mm²	Failure rate λ ref in FIT1)	Notes: Standards/guidelines
Solder manual Automatic	_	0.5 0.03	IPC 6102), class 2
Wire bonding for hybrid circuits Al Au		0.1 0.1	28 μ m / wedge bond 25 μ m / ball bond
Winding	0.05 to 0.5	0.002	DIN EN 60352 – 1 / IEC 60352 – 1 CORR1
Crimping manual Automatic	0.05 to 300	0.25	DIN EN 60352 – 2 / IEC 60352 – 2 A 1+2
Clips	0.1 to 0.5	0.02	DIN 41611 – 4
PressFIT	0.3 to 2	0.005	IEC 60352 – 5
Insulation piercing connectors	0.05 to 1	0.25	IEC 60352 – 3 / IEC 60352 – 4
Screws	0.5 to 16	0.5	DIN EN 60999 – 1
Terminals (spring force)	0.5 to 16	0.5	DIN EN 60999 – 1
1) 1 FIT = 1 x 10-9 1/h; (one failure per 109 component hours) 2) Acceptance conditions for PCBs			

Table 4. Failure rates for various contact technologies Siemens norm SN 29500-5 / edition 2004-06 Part 5

The PressFIT contact has been qualified in accordance with the usual standards for IGBT modules at Infineon.

Figure 12 shows a small extract of the various tests. The extract shows that the conditions in the individual tests are to be regarded as considerably stricter than stated in the standards. For example, in a corrosive gas test, the temperatures in the scope of the individual test are 15 K higher than the condition in the standard. And the H2S concentration is five times higher than the conditions according to the norm. The green fields show the test conditions according to the norm, which is less critical than in the individual tests.



Test	Boundaries	Requirement	Amount
Microsections of contact	min. hole	No damages	6 contacts min hole
Press-in and push out forces	min. hole max. hole	The minimum and maximum push-outforce shall be specified by the manufacturer	7 contacts min hole 7 contacts max hole
Climatic sequence (contact resistance after different serial tests)			
TST	-40°C to **+125°C**; exposure time= 30min, 10 cycles	No relevant change of resistance	100 contacts min hole 100 contacts max hole
Damp cycling	16h dry heat **120°C**; 5 cycles: damp heat (12h; 25°C; 85%-93% and 55°C; 85-93%) -> 2h cold -40°C	No relevant change of resistance	
Dry heat	**120°C**; 1000h	No relevant change of resistance	
Flowing mixed gas corrosion	4-components-mixed gas; 240h: SO2: 0,2ppm H2S: 0,01ppm NO2: 0,2ppm Cl2: 0,01ppm	No relevant change of resistance	

* Example of Easy PressFIT

Module Qualification acc. to IEC 60749

Test	Boundaries	Requirement	Amount
H3TRB	1000h; 85°C; 85%RH; Vce 80V; **on PCB with online resistance observation***	No relevant change of resistance after 1000h	12 modules
TST	-40°C to +125°C; 50 cycles; **on PCB with online resistance observation***	No relevant change of resistance after 50 cycles	12 modules
Vibration	5g; 5-200Hz; x=7.5mm; 10h/axis; **on PCB with online resistance observation***	No relevant change of resistance after 10 hours	6 modules
PC (seconds)	Tjmax=150°C; ΔT ~100K; t_{on}=1.5sec / t_{off}=5sec **on PCB**	End of life (until delamination of silicon)	4 modules
PC (minutes)	Tjmax=150°C; ΔT ~110K; t_{on}=9sec / t_{off}=30sec **on PCB with T_{max} ~105°C**	End of life (until delamination of silicon)	4 modules

Further Qualification acc. to IEC 60068

Test	Boundaries	Requirement	Amount
Corrosive gas test	**50ppm** H2S; **40°C**; 93% **RH**; 17 days; **mounted on PCB**	No relevant change of resistance after 17 days	8 modules
salt mist	4 spray cycles: 2h spray period (15-35°C; 5% NaCl); storage 20h (38°C - 42°C; 93% RH); after 4 cycles 3 days drying (21°C - 25°C; 45% - 55% RH); **mounted on PCB**	No relevant change of resistance after Test	8 modules

* Online restistance observation in current free arms with ~1.3mV

Single-pin qualification according to IEC 60532-5

Module qualification according to IEC 60749 and 60068

Figure 12. Extract from qualification test

Further details on the individual tests can be found in various publications, such as "Reliability of PressFIT connections" at www.infineon.com.

8. Mounting a PCB to Module

For mounting a PCB onto the module, additional screws can be used if desired. These screws will be tightened into the stand-offs of the module.

An electronically controlled, or slowly turning electric screwdriver, with n ≤ 300 rpm, is the preferred mounting tool.

Due to the lack of accuracy, we do not recommend the use of pneumatic screwdrivers or manual screwdrivers.

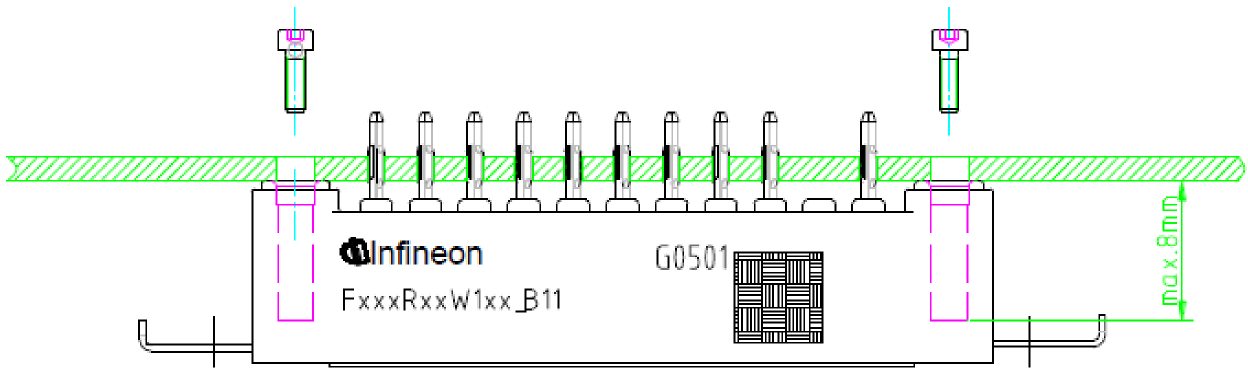


Figure 13. Detailed view of the assembly insert

The effective length of the thread in the stand-off should have a minimum of 4 mm and a maximum length of 8 mm.

The initial 1.5 mm of the mounting stand-off serves as guidance only and cannot take any force. The thread in the plastic will form during the screwing process.

For the choice of the screw length, the given PCB thickness has to be considered.

The following screws are tested to fix the PCB to the module:

- Ejot PT WN 1451 K25*10 A2K Mmax=0,45 Nm ±10%
- Ejot DELTA PT WN 5451 K25*8 Mmax=0,4 Nm ±10%
- Metric screws: M2.5*x – for example, M2.5*8 or M2.5*10 depending on the thickness of the PCB used

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

9. Condition of the heatsink for Module assembly

The power loss occurring in the module has to be dissipated via heat sink in order not to exceed the maximum permissible temperature T_{vjop} specified in the datasheets during operation.

The condition of the heat sink surface in the area where the module is mounted is of great importance, as this interface between heat sink and module is of decisive influence on the heat transfer of the entire system.

The contact surfaces, the surface below the module, and the surface of the heat sink have to be free of degradation and contamination to preventing excess mechanical stress to the module as well as an increase in thermal resistance.

Heat sink requirements:

Roughness: ≤ 10 µm

Flatness based on a length of 100 mm: ≤ 50 µm

Note 1: The flatness of the heat sink should not exceed the values listed above. This area includes the entire module mounting area as well as that of the clamps.

Note 2: If the layer of thermal grease applied is too thick, e.g. as a consequence of cavities, the thermal resistance R_{th} between module and heat sink will increase.

10. Applying thermal grease

Due to the individual surface shape (e.g. roughness and flatness) of the heat sink and the module, the lower surface of the module and the surface of the heat sink do not touch across the entire area. Therefore, a certain localized separation between the two components cannot be avoided.

To dissipate the losses occurring in the module and to achieve a good flow of heat into the heat sink, all localized cavities have to be filled with a 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 will still allow the metallic contact between module base and heat sink surface. A compound should be selected which shows permanently elastic features in order to assure a continuously favorable heat transfer resistance.

Before the module is mounted onto the heat sink, an even layer of thermal grease, 80 µm thick for Automotive EasyPACK™ 1B/2B, is recommended to be applied to the module base or to the heat sink according to the module size and the thermal grease used. This grease can be applied using either a spatula, a roller, or silk screen printing. The quantity of thermal grease is sufficient if a small amount of grease is visible around the module after assembly to the heat sink.

The recommendation is to apply the thermal grease by means of a screen print process. Apart from an optimized and module-specific distribution of the heat conductive paste, a homogenous and reproducible layer thickness can be achieved with this procedure. If a screen print process is used, the layer thickness could be reduced to values under the above-mentioned numbers. The size of the module and the viscosity of the thermal grease are important factors in this case.

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 silk-screen.

11. Assembling the Automotive EasyPack™ 1B/2B module on the heat sink

The module is mounted onto the heat sink using M4 screws. It is also possible to use an additional flat washer. The heat sink has to be provided with threaded holes as shown in Figure 14.

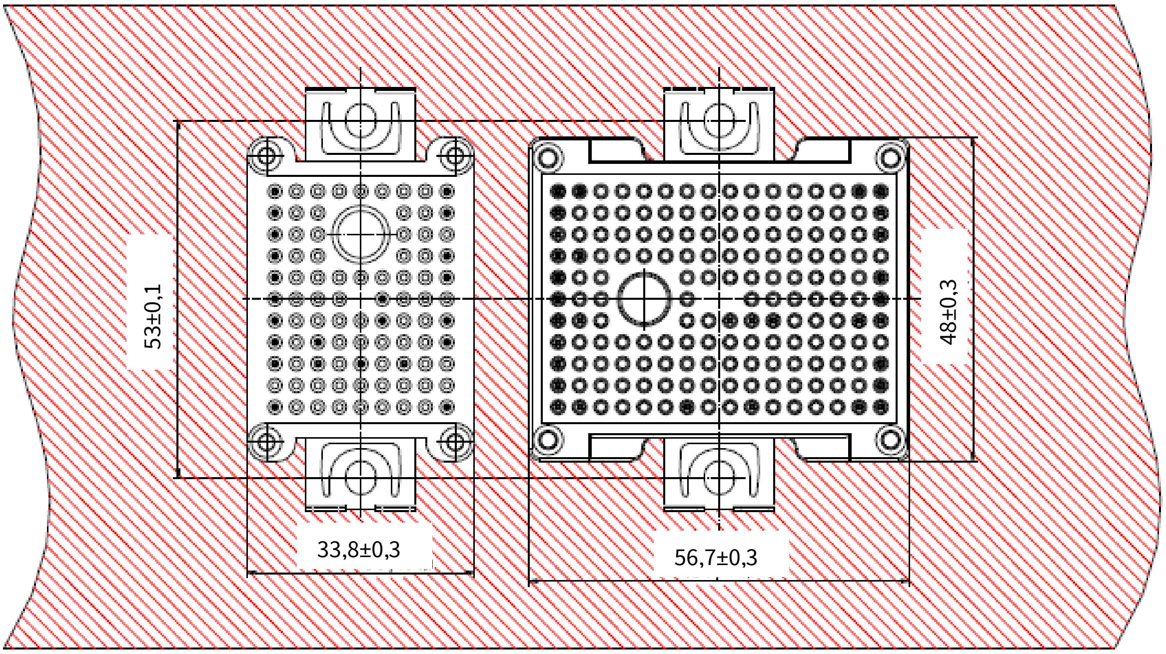
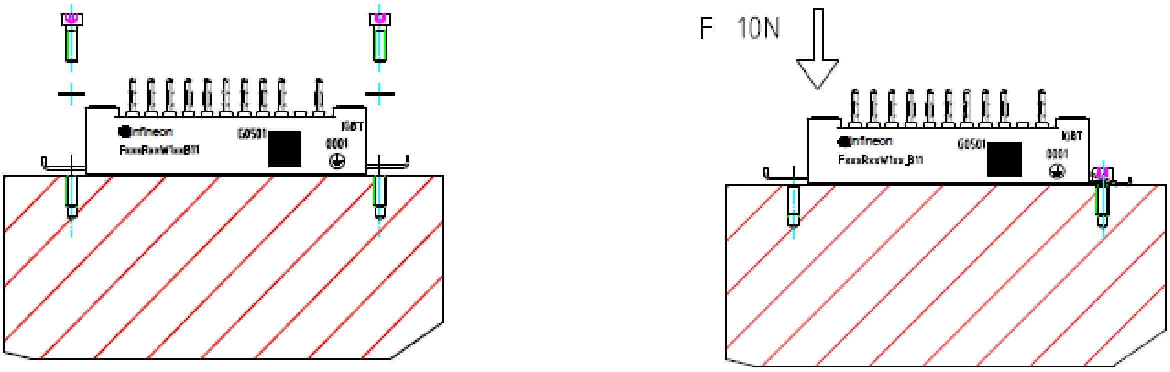


Figure 14. Spacing of the threaded holes

Note: If the module is first pressed into the PCB, or if a later disassembling of the module is desired, the PCB must contain suitable through-holes. The hole size depends on the screwdriver size or the screw's head diameter or washer.

The module should be positioned onto the heat sink in such a way that the holes of the screw clamps are exactly above the threaded holes of the heatsink. The mounting surface must be clean and free of contamination.

The module can be fastened by screwing in and tightening both screws at the same time (Figure 15a) or by holding down the module during the mounting process with a force of approximately 10 N so that the module cannot rise up (Figure 15 b) and tightening the screws one after another, following the instruction in Figure 16.

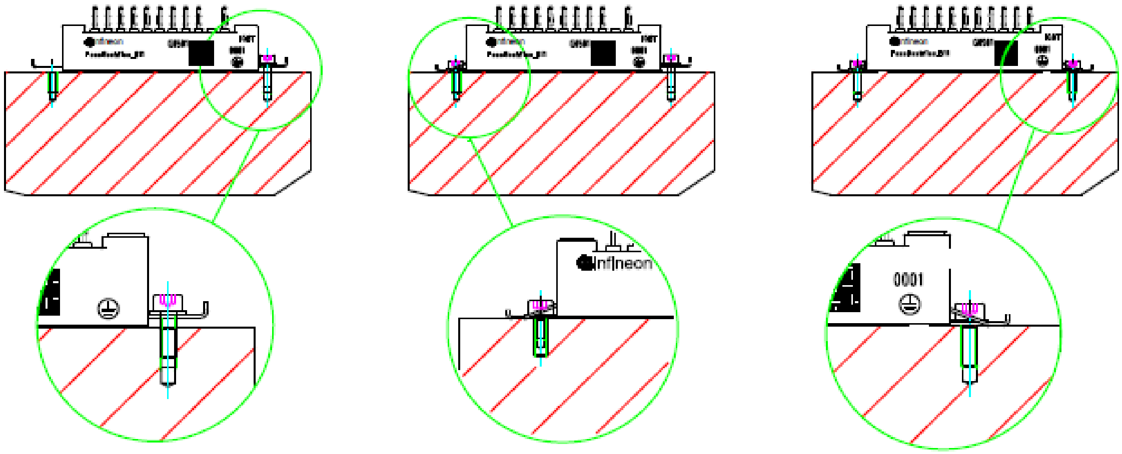


a) Fastening the module by simultaneous screwing in and tightening of screws.

b) Fastening the module while holding down the module during screwing.

Figure 15. Module fastening options; a) simultaneous screwing b) non-simultaneous screwing using force

Alternatively, one screw can be applied initially. It is important that the module does not lift up. To prevent this, tighten the first screw loosely to avoid a press force to the clamp (Figure 16 a). Then, tighten the second screw completely (Figure 16 b). Finally, tighten the first screw completely (Figure 16 c).



a) Step 1 b) Step 2 c) Step 3

Figure 16. Fasten the module by tightening both screws without force

Description	Values
Mounting screw	M4
Recommended mounting torque	Ma = 2.0 – 2.3 Nm
Recommended thread engagement for screws with property class 4.8 to 6.8 for different materials	
Aluminium cast alloy Aluminium alloy hardened Aluminium alloy not hardened	2.2 x d = 8.8 mm [1)] 1.2 x d = 4.8 mm [1)] 1.6 x d = 6.4 mm [1)]
Washer acc. to DIN 125	D = 9 mm

[1)] As per technical literature

Table 5. Technical data of the mounting screw

12. System considerations

If the module is correctly mounted to the heat sink and to the PCB, the screw clamps will apply the necessary pressure. This pressure, together with the correct amount of thermal grease, will ensure low thermal resistance and an optimal thermal flow between the module and the heat sink. Since the PCB is connected to the module by pressed-in pins only, suitable measures have to be taken to ensure that vibrations are kept at a minimum. Any possible movement between the terminals and the module case has to be avoided. Every single pin may only be subjected to a maximum press and pull force of 6 N vertical to the heat sink. The overall pulling force to the module of 20 N must not be exceeded. The compressive force could be 10 times higher than the possible pulling force. A low compressive load to the module is preferred. Therefore, the circuit board should additionally be fixed to the heat sink at a position close to the module. Two options are possible:

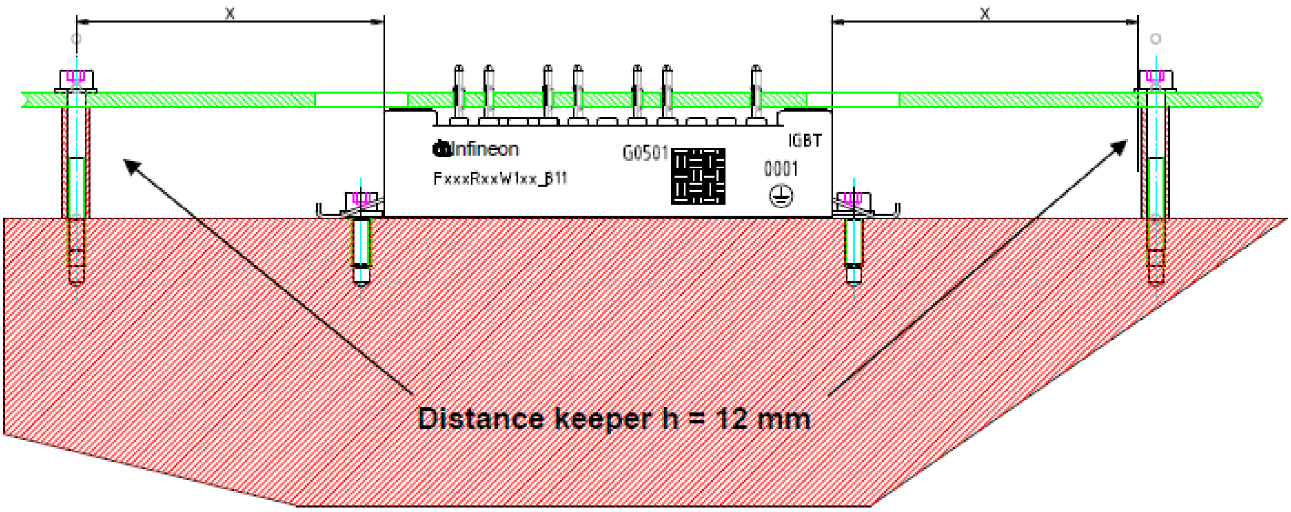


Figure 17. Fixing the PCB

13. Module is already pressed into the PCB before mounting

To minimize the forces that are applied to the pins of a module, it is recommended to keep a distance of at least x = 5 cm from the module's outer edges (Figure 17).

14. Module is pressed into the PCB after mounting

In this case, no mechanical stress will occur. Therefore, it is allowed to place the distance keeper as close as possible x ≤ 5 cm to the module.

15. Clearance and creepage distances

When defining the layout of the PCB, application-specific standards, mainly regarding clearance and creepage distances, have to be considered. This is particularly important for the area of the screw clamp, which is located under the PCB. To meet the respective requirements regarding clearance and creepage distances, current-carrying devices or through-holes in this area should be avoided, or additional isolation measures like lacquering must be taken.

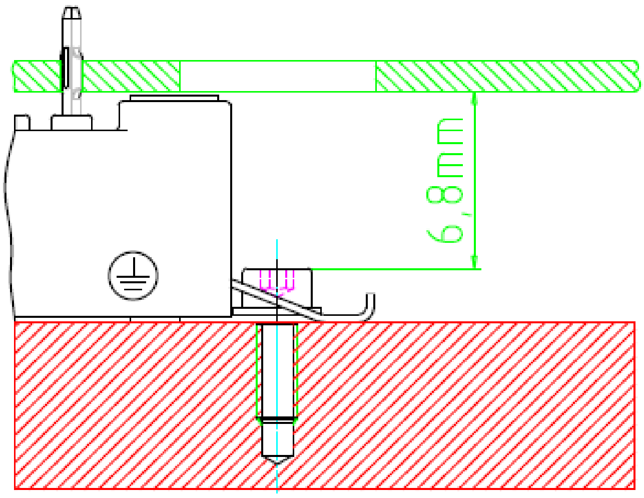


Figure 18. Air path between clip and PCB for Automotive EasyPACK™ 1B and Automotive EasyPACK™ 2B packages

The minimum clearance distance between the screw and the PCB depends on the screw itself. For Automotive EasyPACK™ 1B/2B packages, the distance will be 6.8 mm with a hexagon socket head M4 screw according to DIN 912.

The clearance and creepage distances specified in the datasheet are minimum values irrespective of other devices that would be mounted close to the module.

In any case, the application-specific clearance and creepage distances have to be checked and compared to relevant standards and guaranteed by suitable constructive means, if required.

16. Multi-modules and automotive application

An increasing number of applications require the mounting of several power modules on the PCB. Furthermore, new power module applications, like automotive hybrid electrical vehicles and full electric vehicles (H)EV, have high requirements on vibration and mechanical shock robustness. In such applications, the height tolerance of the modules has to be considered in the mounting concept in order to avoid a mechanical deformation of the PCB or unwanted forces on the modules and PressFIT pins.

Please note that the following instructions shall be regarded as additional information to the general mounting instructions. The chapter focuses on mounting concepts of the module, considering height tolerance. General recommendations like PCB requirements, press speed, heat sink requirements, etc. are unaffected by the following instructions.

16.1. Modules' press-in process on the PCB

Figure 19 shows the press-in process of the power modules on the PCB. This process is quite similar to that of chapter 7.

Figure 19 a shows the bottom side of the press tool with guiding domes, which are useful for pre-alignment. In Figure 19 b, the PCB is placed into the press tool, whereby the correct placement is obtained by the guiding domes of the press tool.

Figure 19 c demonstrates the press-tool with the PCB ready for module assembly.

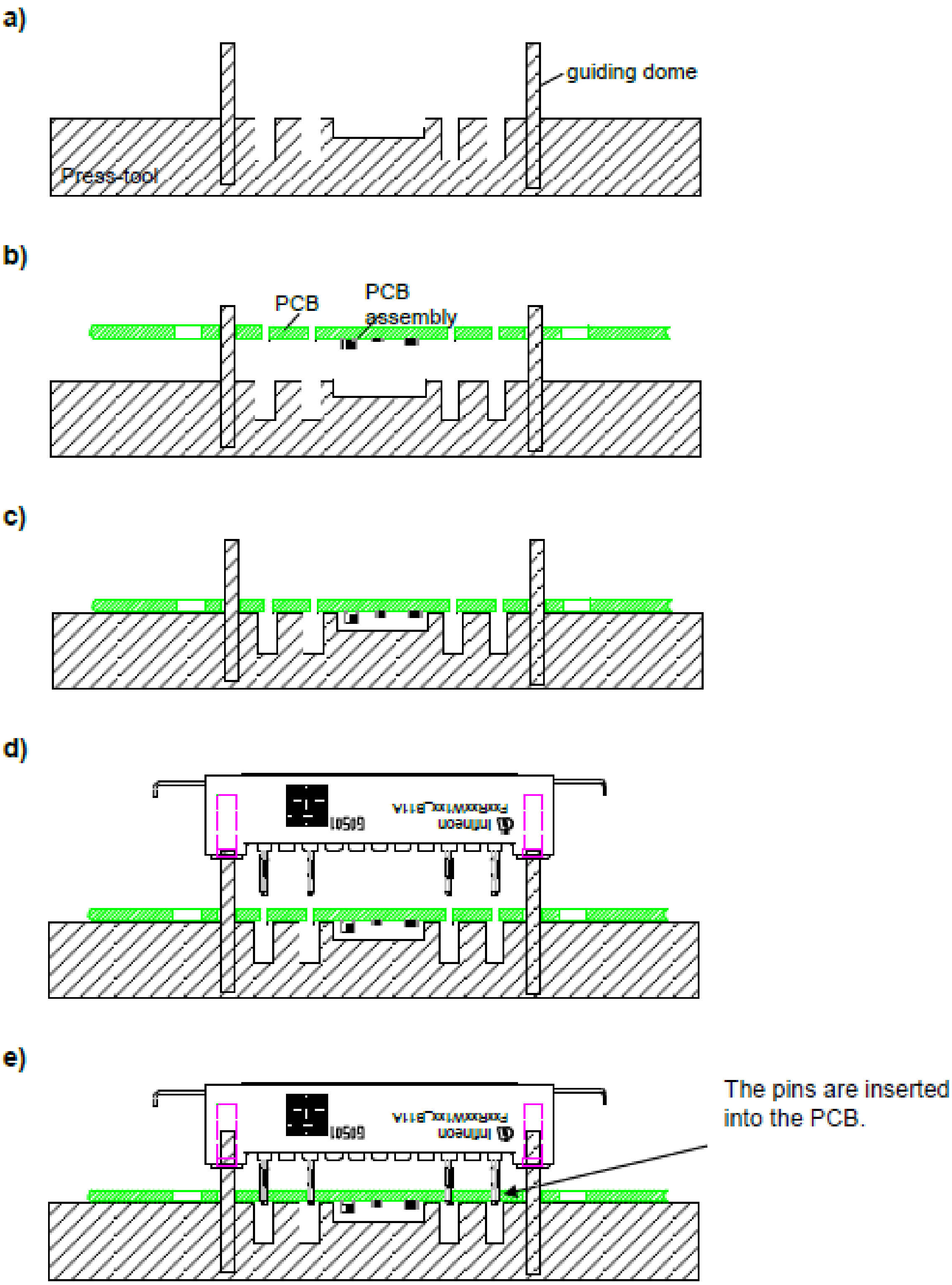
In Figure 19 d, the module is placed on the guiding elements. The module is released and the module pins are inserted into the PCB.

Figure 19 e shows the state where the module pins are inserted into the PCB. The module is now placed flush with the press-tool, and the pin touches the PCB at the beginning of the active press zone, which starts at about 2.5 mm from the pin top. If the module is not flush with the press tool or pins are not inserted (module about 2.5 mm higher than the normal case shown here), then mounting should be corrected before the pins are damaged in the later press-in process.

In Figure 19 f the top press tool with the distance keeper is illustrated.

Figure 19 g shows the controlled path-force press-in process. The pressing process stops by the increasing force between the PCB and this distance keeper. It is correct if the press-in process is stopped before the PCB is on the module housing. Thus, the distance of the module backside to the PCB is independent of the module height.

Please note: It is possible to press the module tighter to the PCB than the maximum 12.45 mm. This will increase the overlapping zone in the active press zone (contact area: pin to PCB). Please do not forget to lower the fixing elements of the cooling system (Figure 19 b) accordingly if the modules are pressed tighter to the PCB! The value (H) of Figure 19 b must not be higher than the module-to-PCB height of Figure 19 a! A force of the PCB on the module in the direction of the cooling system is uncritical and is desired, as it improves the thermal contact.


a)
guiding dome
Press-tool
b)
PCB
PCB assembly
c)
d)
e)
The pins are inserted into the PCB.

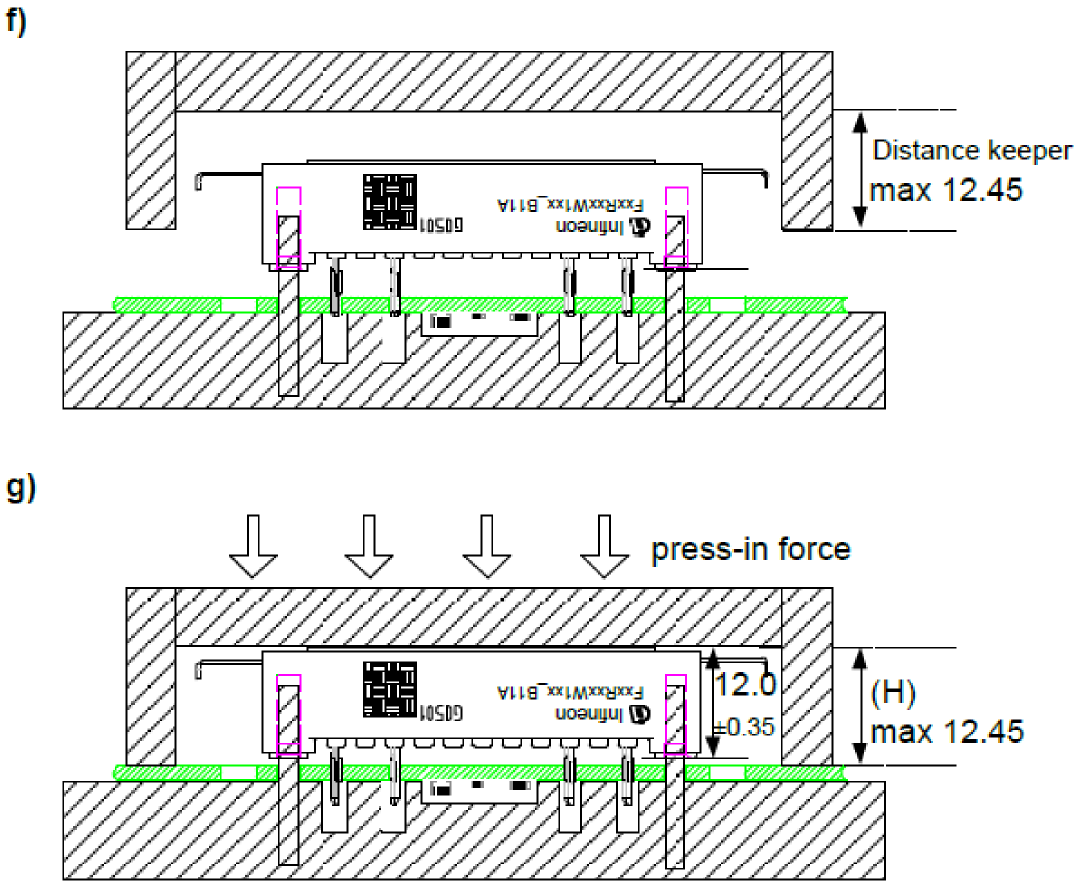


Figure 19. Press-in of the power modules (drawing not true to scale)

16.2. Modules and PCB mounting on the heat sink

After the power module is pressed into the PCB (see Figure 20 a), the PCB with the module has to be mounted to the cooling system. Please see Chapter 9 and 10 for more information on the heat sink and thermal grease requirements, and how the grease should be applied to the system. Figure 20 b-d show the mounting process with an example of three power modules pressed into the PCB. However, the illustrated concept can also be applied with a different number of modules or a single-module application. Figure 20 b shows the process where the PCB with the pre-assembled modules is placed on the cooling system and the modules are fixed with screws via the spring clamp of the Automotive EasyPACK™ module. Please refer to Chapter 11 for detailed information on the assembly of the modules on the heat sink. It is important to mount the modules before the PCB is fixed to the cooler!

Figure 20 c shows the fixing of the PCB to the heatsink. As the height tolerance of the module is quasi compensated in the pressing process, the fixing points for the PCB can be close to the power modules. This is an advantage compared to the concept in chapter 13 where >=5 cm distances have to be maintained between the module and distance keepers.

The position of the distance keepers should be designed symmetrically around the power module(s).

Figure 20 d shows the final system assembly.

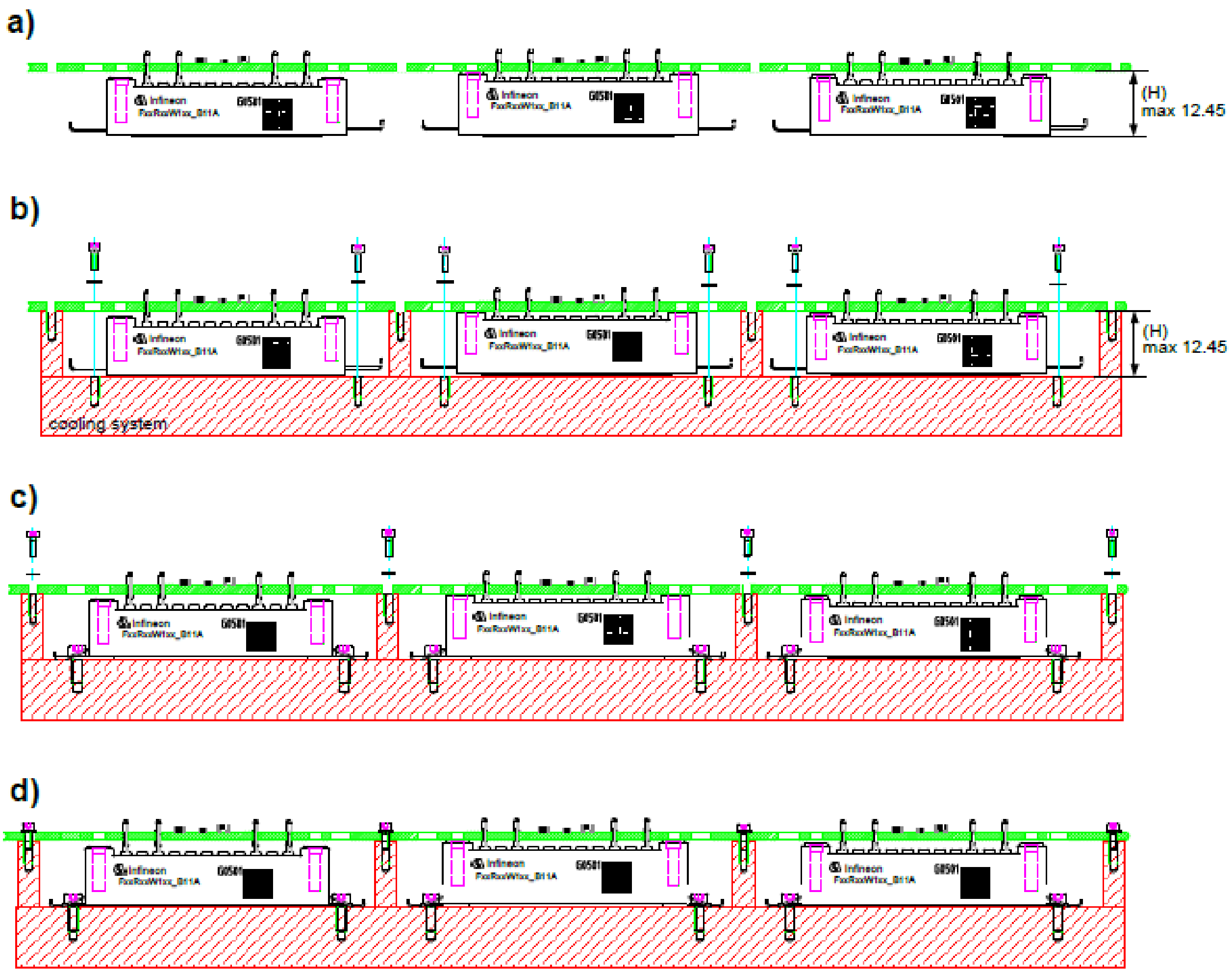


Figure 20. Mounting example of the PCB and module to the cooling system (drawing not true to scale)

Figure 21 shows a zoom of the final system assembly. Depending on the height of the module, a small air gap remains between the module and PCB.

As the value (H) of Figure 20 b must not be higher than the module-to-PCB height of Figure 20 a, it is ensured that no pull forces are applied to the power modules, which would be critical in consideration of the thermal contact between module and heat sink.

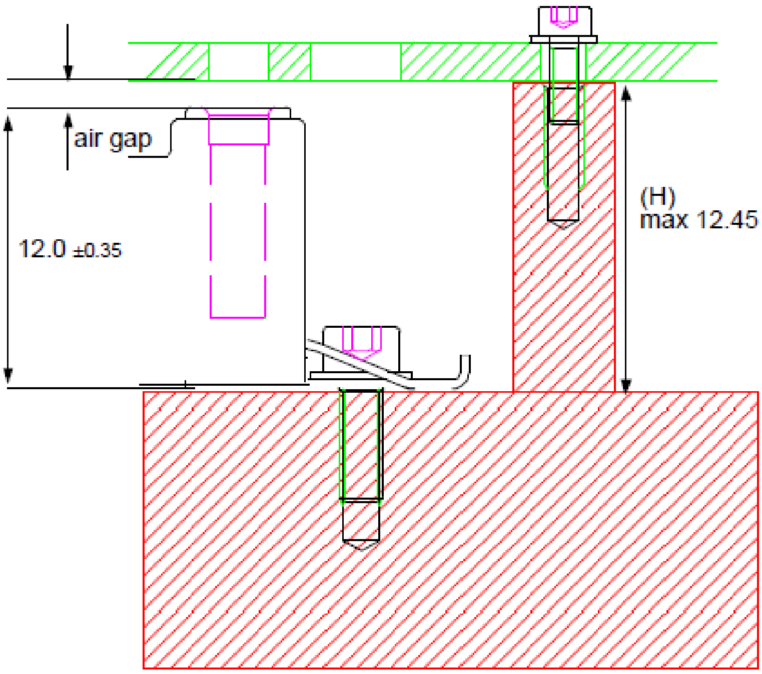


Figure 21. Zoom illustration of final system assembly (drawing not true to scale)

Please note that using this press concept with a remaining air gap does not allow the PCB to be screwed down to the stand-offs (guiding holes) as shown in chapter 8.

Please note that for a single module application, the PCB is screwed to the module. However, in case of more module in parallel, the modules are screwed to the heatsink, and the PCB and the distance keepers are tightened via screws as shown in Figure 20.

17. Storage and Transport

During transport and storage of the modules, extreme forces through shock or vibration have to be avoided as well as extreme environmental influences.

Storage of the modules at the limits of the temperature 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: Tmaxair=+40°C

Min. air temperature: Tminair=+5°C

Max. relative humidity: 85%

Min. relative humidity: 5%

Condensation: not permissible

Precipitation: not permissible

Icing: not permissible

Pre-drying of the power module prior to the press-in process (as is recommended for molded discrete components, such as microcontrollers, TO-cases, etc.) is not required for the Automotive EasyPACK™ power modules.

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Edition <2021-09-07>

Published by

Infineon Technologies AG

81726 Munich, Germany

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Email: WAR-IGBT-Application@infineon.com

Document reference

AN 2009-01