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Easy-PressFIT

Assembly Instructions for the PressFIT Modules EasyPIM™ and EasyPACK

Industrial Power

Never stop thinking

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1 General Information

PressFIT is an alternative method for connecting control and load current contacts on IGBT modules to a printed circuit board that complies with the requirements for greater durability, the trend towards higher temperatures, RoHS and – of course – very simple handling.
This contact technology has already been employed for years now in the automotive sector under the most difficult of conditions and with medium-sized currents. The contacts have also been used in the telecommunications sector for some time now for signal transmissions. This type of contact is therefore ideal for use in IGBT modules in which the contacts have to satisfy the requirements for load, control and sense connections.
The press-fit contact for modules in the EconoPIM™ and EconoPACK™ series is an initial development for the technology.
The solution for modules without a base plate is now provided with the Easy PressFIT pin. It should be noted in the case of the Easy PressFIT geometry that it has been used for decades in a wide variety of applications and was able to be adapted for use in the modules.
The Easy PressFIT contact allows solderfree assembly of the EasyPIM™ and EasyPACK modules in the EasyB series. In this assembly technology the module can be mounted on either side of the circuit board.
The electrical and thermal contacts with the circuit board are implemented by means of cold welding. The contacts can be used in standard FR4 printed circuit boards with the tolerances typical of manufacturers.

EasyPIM™ 1B module FP15R12W1T4_B11   EasyPIM™ 2B module FP35R12W2T4_B11

Figure 1: Modules in the EasyB series featuring PressFIT contacts

Easy PressFIT contacts have an area approximately 1.7 mm long that adapts itself to the hole in the printed circuit board during the press-in process. Permanent deformation takes place as a result. This deformation is intended to accommodate the tolerance and provides the basis for the cold welding.
The forces resulting during the press-fitting 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 2 shows various sections and REM images that provide a view of the materials connected together in a gas-tight manner due to the press-in force.

Figure 2: Easy PressFIT contact sections

2 Requirements for Printed Circuit Boards

The PressFIT technology used in the Easy modules has been inspected and qualified by Infineon AG for standard FR4 printed circuit boards with tin (chemically) (IEC 60352-5 + IEC60747-15). If other handling technologies are to be used in the production of printed circuit boards, they would have to be tested, inspected and qualified.

Requirements for the PCB material
Double-sided printed circuit board according to IEC 60249-2-4 or IEC 60249-2-5.
Multilayer printed circuit board according to IEC 60249-2-11 or IEC 60249-2-12.

	min.	typ.	max.
Hole diameter	1.12 mm	1.15 mm	
Copper thickness in hole	> 25 µm		< 50 µm
Metallization in hole			< 15 µm
End hole diameter	0.94 mm		1.09 mm
Copper thickness of conductors	35 µm	70 µm 105 µm	400 µm
Metallization of circuit board	Tin (chemically)		
Metallization of pin	Tin (galvanic)		

Table 1 Requirements for a printed circuit board

In order to ensure that the PressFIT contact sits securely in the printed circuit board, the specification of the hole given in Table 1 must be adhered to.

If the specification of PressFIT holes is limited to just the finished dimension (i.e., the metallized hole), different drill sizes could be used depending on the printed circuit board manufacturer and production philosophy, and also different metallization thicknesses could be provided. This would have the consequence that other results would be obtained that would have to be rejected for quality assurance reasons.

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

With a copper thickness of 25 µm to 50 µm in the hole and a tin 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 compared to, for example, HAL printed circuit boards, this diameter is always higher than the value of 1 mm stated in the standard (IEC 60352-5). The final hole diameter, under consideration of the drilling diameter, copper thickness and tin layer, is typically between 1.02 mm and 1.09 mm.

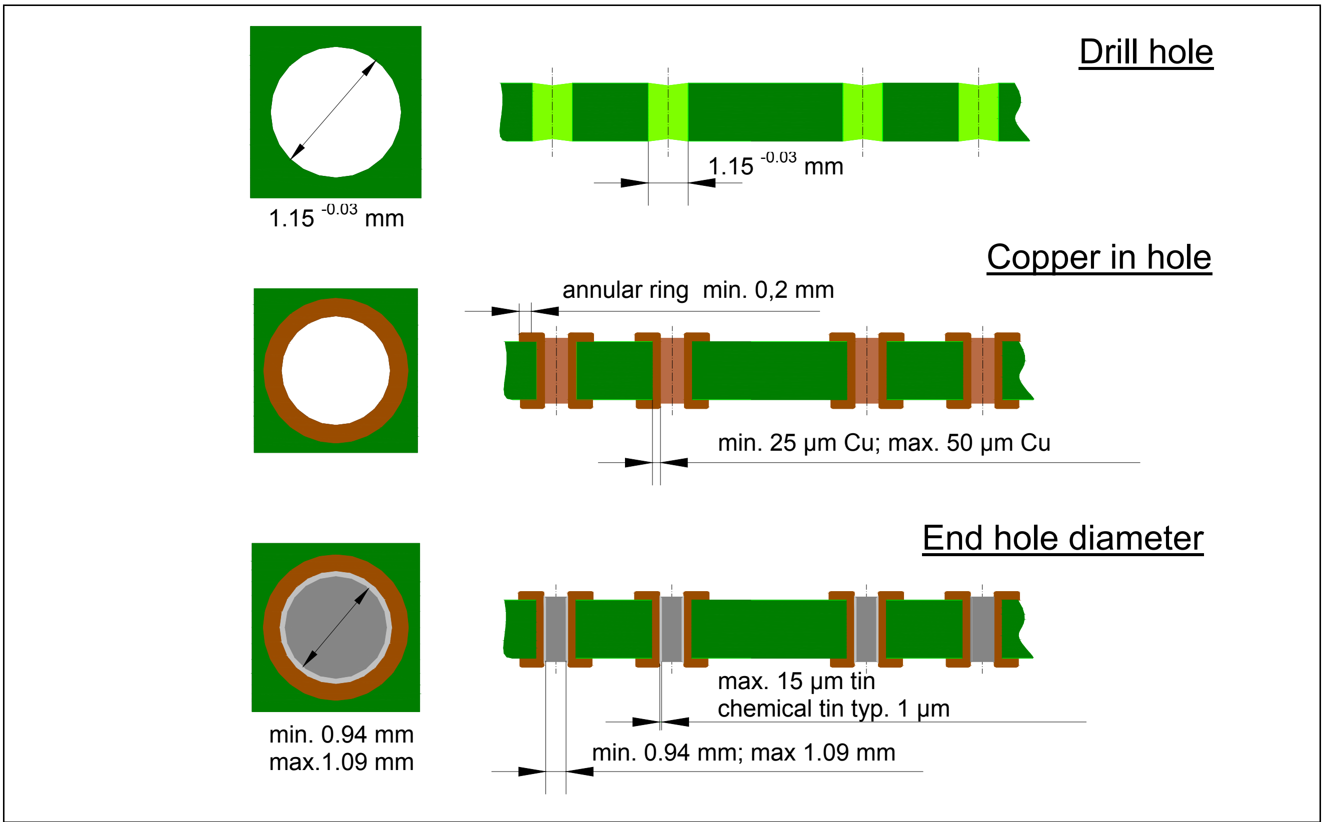


Figure 3 Structure of a printed circuit board

The PressFIT technology is qualified for FR4 printed circuit board material.

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

As with Econo PressFIT modules, a distance of 5 mm from the middle of the pins to other components on the printed circuit board must be observed. The dimensions in the case of Press-tools developed by the user himself must be considered when positioning components.

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

A module that has been pressed in and the contact then pressed out again can no longer be pressed in again. Instead, the module can only be attached in a new printed circuit board by soldering. The plastic deformation of the PressFIT zone does not permit further press-fitting.

3 The Press-In Process

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

The PressFIT module is inserted in a printed circuit board by press-in. The press-fitting can be performed using a simply toggle lever press or a machine. A press-in tool that records the necessary force and the travel distance is to be recommended. Consistent quality is assured in this way. The press-fitting speed should be between 25 mm/min and 50 mm/min according to IEC 60352-5.

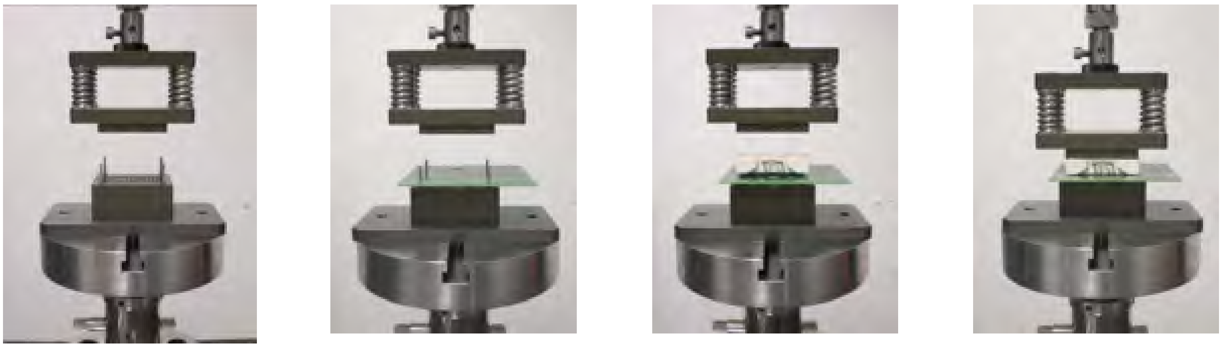
Note than during the press-in process the placement area of the printed circuit board and the pressing area of the pressure plate must be parallel to each other. The pressure plate should be mechanically fixed in position without any play. The module is then pressed into the printed circuit board with a regular movement.

The module pins should penetrate the printed circuit board during press-in until the four standoffs on the module make contact with the board.

Four springs at the upper section of the press-in tool are used to limit the force after the actual real press-in process. This set of springs converts the excess force into spring displacement at the end of the real press-in process. By varying the pretension of the springs the tool can be adjusted to the existing number of pins and the associated press-fitting force. The spring set may be omitted in certain cases by measuring the press-in force and limiting the force applied.

By adhering to the principles stated above, a smooth insertion process for the two components (Easy1B and Easy2B) can be achieved.

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



Step 1	**Step 2**	**Step 3**	**Step 4**
The press is 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 4: Press-In process of an Easy module

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

3.1 Press-In Tools

The following tools that help pressing in and out the module are recommended for the two EasyB Series modules. Figure 5 shows these press tools for the two housing types Easy1B and Easy2B. Each of the tools has two parts. First there is a part that presses against the underside of the module and second, there is a part for holding the printed circuit board in place to be pressed against.

No components can be placed in the mounting areas of the press-fitting tool. This will prevent damage during the press-fitting process.

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

Figure 5: Press-fitting tools for Easy1B (shown left), Easy2B (shown right) and both together (middle figure)

CAD drawings can be requested for both tools. The drawing can be adjusted according to requirement and the tools produced by a manufacturer of choice.

3.2 Press-In Forces

To press a module onto a printed circuit board a force of between approximately 60 N and 80 N must be applied for each pin in the module. The press-in forces vary according to the diameter of the hole in the printed circuit board. If a module has 35 pins – as is the case of the EasyPIM™ 2B, the typical press-in force required is approximately 2.5 kN. All other configurations known today have fewer pins. This means that less press-in force is required for other configurations.

	Min.	Typ.	Max.
Hole diameter		1.15 mm	
Press-In speed		25 mm/min	
Copper thickness in hole	25 µm		50 µm
Typical Press-In force (F) per pin	**60 N**		**80 N**

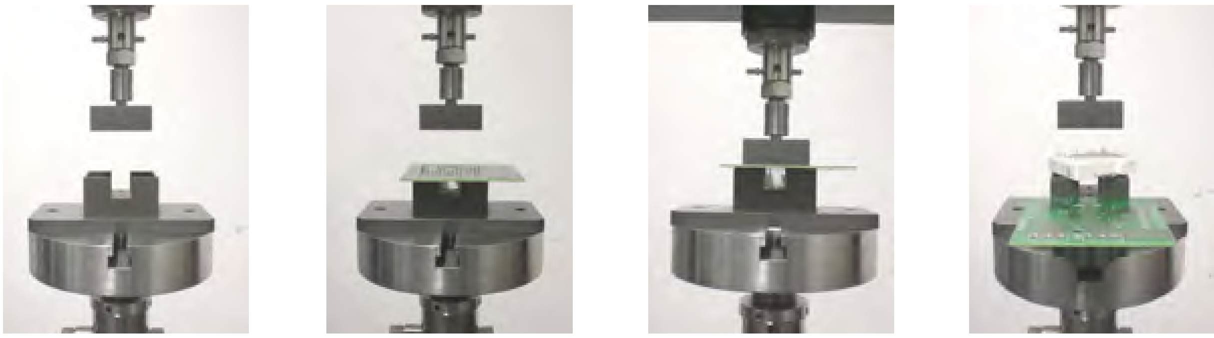
Table 2 Press-In forces per pin

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

4 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 Figures 6 and 7. The printed circuit board is placed with the PressFIT module in the apparatus (tray). Force is applied with the extrusion plate on the PressFIT pins that protrude from the printed circuit board. The press-out tools must be aligned parallel to each other so that the individual components (such as the printed circuit board and module) are not damaged. Once the PressFIT zone has exited the PCB (printed circuit board), the module falls into the tray in the lower part of the tool and is separated from the board.



Step 1:	**Step 2:**	**Step 3:**	**Step 4:**
The press is aligned so that one part of the tool is directly above the other.	The printed circuit board is placed in the extrusion tool with the PressFIT module facing downward.	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.	The printed circuit board and module can be separately removed from the tool.

Figure 6: Extrusion of an Easy module

4.1 Press-Out Tools

The press-out tools consist (as already mentioned above) 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 printed circuit board and serves as a base for the pressing operation.

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

The dimensions of the press-out tool must be considered when designing the printed circuit board so that the components positioned about the module will not be damaged.

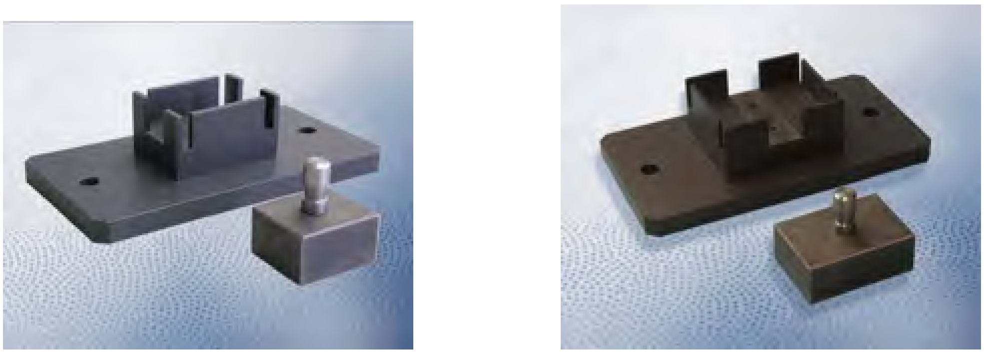


Figure 7: Press-out tools for Easy1B (left illustration) and Easy2B (right illustration) modules

Just as for the press-in tools, CAD drawings can likewise be requested for the extrusion tools. The drawing can be adjusted according to requirement and the tools produced by a manufacturer of choice.

4.2 Press-Out Forces

To press a module out of a printed circuit board a force of between approximately 50 N and 60 N must be applied for each pin in the module. The extruding forces vary according to the diameter of the hole in the printed circuit board.

	Min.	**Typ.**	**Max.**
Hole diameter		1.15 mm	
Copper thickness in hole	25 µm		50 µm
Typical extrusion force (F) per pin	**50 N**		**60 N**

Table 3 Typical extrusion force per pin

5 Quality of PressFIT Contacts

PressFIT is an alternative solution for connecting control and load current contacts on IGBT modules with a printed circuit board.
The requirements for greater durability, the trend towards higher temperatures and absence of lead and – of course – very simple handling are continuously growing.
The PressFIT technology makes it possible for the first time 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 Table3 illustrates the failure rates of different contact technologies.

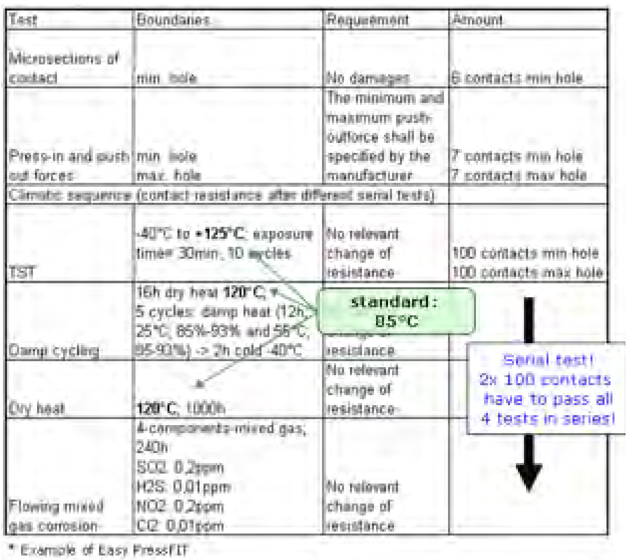
Process		Conductor diameter in mm²	Failure rate λ_{ref} in FIT[1)]	Notes: Standards/guidelines
Solder	manual automatic	–	0.5 0.03	IPC 610[2)], class 2
Wire bonding for hybrid circuits	Al Au		0.1 0.1	28 µm / wedge bond 25 µm / ball bond
Winding		0.05 to 0.5	0.002	DIN EN 60352 – 1 / IEC 60352 – 1 CORR1
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 10^{9} component hours)
2) Acceptance conditions for printed circuit boards

Table 3 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.

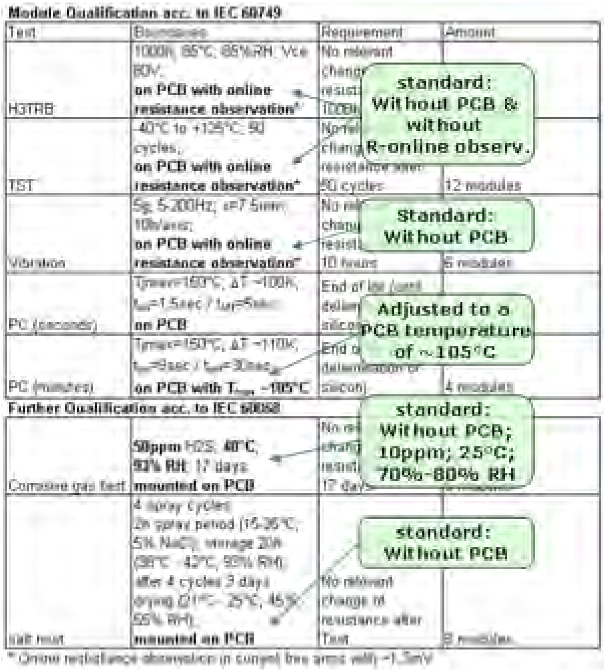
Figure 8 shows a small extract of the various tests. The extract shows that the conditions in the individual tests are to be regarded as considerably stricter than stated in the standards. For example, the significantly higher temperatures or the loads that are up to 5 times greater during a corrosive gas test (H_2S concentration according to the norm: 10 ppm / H_2S concentration in the test: 50 ppm). The green fields show the differences to the less critical requirements according to the norm.



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	[illegible] 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

Single-pin qualification according to IEC 60532-5



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 [illegible]	
TST	-40°C to +125°C; 50 cycles; on PCB with online resistance observation*	No relevant change [illegible] 50 cycles	12 modules
Vibration	5g; 5-200Hz; s=7.5mm; 10h/axis; on PCB with online resistance observation*	No rel[illegible] change [illegible] 10 hours	6 modules
PC (seconds)	Tjmax=150°C; ΔT ~100K; [illegible] on PCB	End of life [illegible]	
PC (minutes)	Tjmax=150°C; ΔT ~110K; [illegible] on PCB with T[illegible] ~105°C	End o[illegible] 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 re[illegible] 17 days	
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 resistance observation in [illegible]

Module qualification according to IEC 60749 and 60068

Figure 8 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.

6 Mounting a PCB to the module

To fix 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 at least slowly turning electric screwdriver 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.

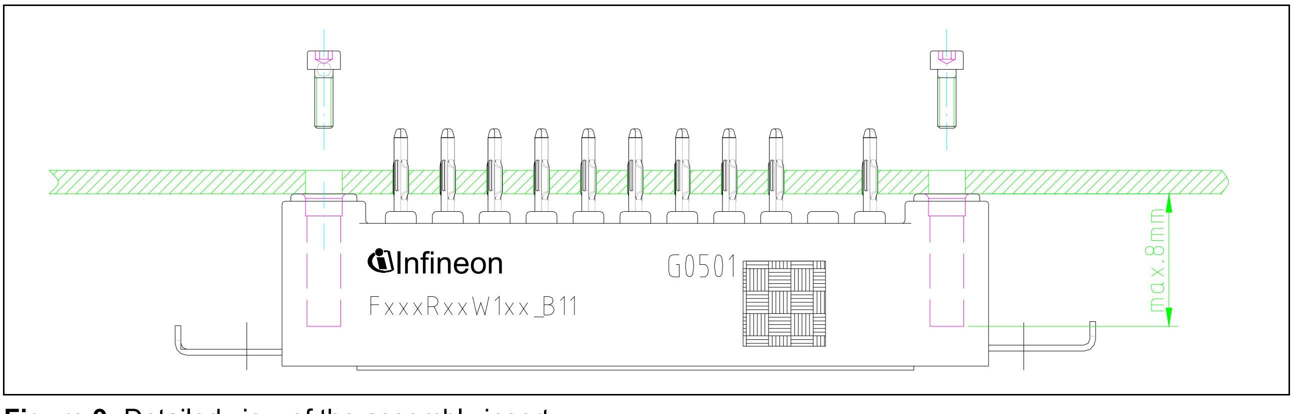


Figure 9: Detailed view of the assembly insert

The effective length of the thread in the stand-off should have a minimum of 4mm 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 plastics will form itself by screwing.

For the choice of the screw length the given PCB thickness has to be taken into account.

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

- Ejot PT WN 1451 K25*10 A2K M_{max}=0,45Nm ±10%
- Ejot DELTA PT WN 5451 K25*8 M_{max}=0,4Nm ±10%
- Metric screws: M2.5*x – for example, M2.5*8 or M2.5*10 depending on the thickness of the printed circuit board 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.

7 Condition of the heat sink for module assembly

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

The condition of the heatsink surface in the area where the module is mounted is of great importance, as this interface between heatsink 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 heatsink, have to be free of degradation and contamination to prevent 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

Attention: 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.

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

8 Applying the Thermal Paste

Due to the individual surface shape (e.g. roughness and flatness) of the heatsink and the module these do not touch across the entire area so that 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 heatsink, 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 does not prevent the metallic contact between module base and heatsink 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 paste, 80 µm thick, should be applied to the module base or to the heat sink according to the module size and used thermal paste. This paste can be applied using either a spatula, a roller or by a silk screen printing. The quantity of thermal paste is sufficient if a small amount of paste is visible around the module after assembling it to the heat sink.

Recommended is the application of thermal paste 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 is achievable 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 paste 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.

9 Assembling the 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 picture 10.

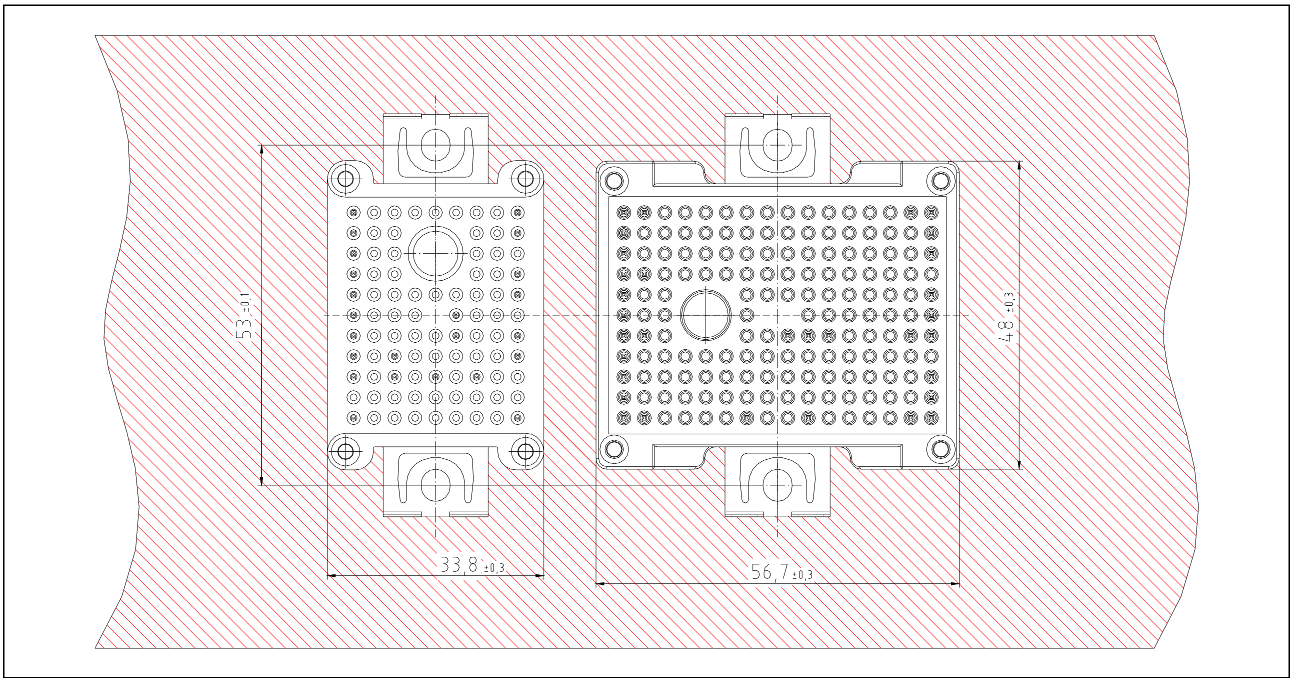
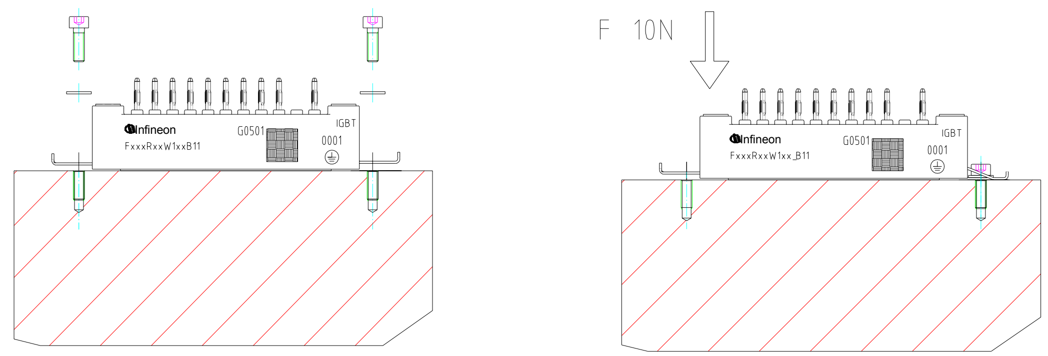


Figure 10: Spacing of the thread holes

Attention: ***If the module is first pressed in to 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 heat sink. 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 11a) 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 11b).

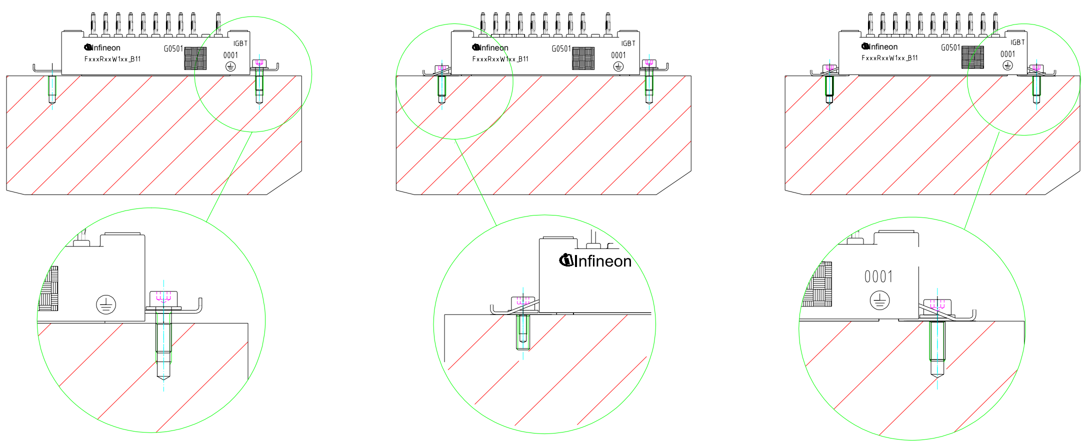


a) Fastening the module by simultaneous screwing in and tightening of the screws.

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

Figure 11: Module fastening options

Alternatively one screw can be applied initially. It is important that the module does not rise up. To prevent this, the first screw has to be loosely tightened to avoid a press force to the clamp (Figure 12a). Afterwards the second screw has to be fully tightened (Figure 12b). Finally the first and still loose screw has to be fully tightened (Figure 12c).



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

Figure 12: Steps for alternative fastening of the module

Table 1 Technical data of the mounting screw

Description	Values
Mounting screw	M4
Recommended mounting torque	M_a = 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

10 System Considerations

If the module is correctly mounted to the heat sink and to the printed circuit board, the screw clamps will apply the necessary pressure. This pressure together with the correct amount of thermal paste will ensure a 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.

Each 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 20N 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:

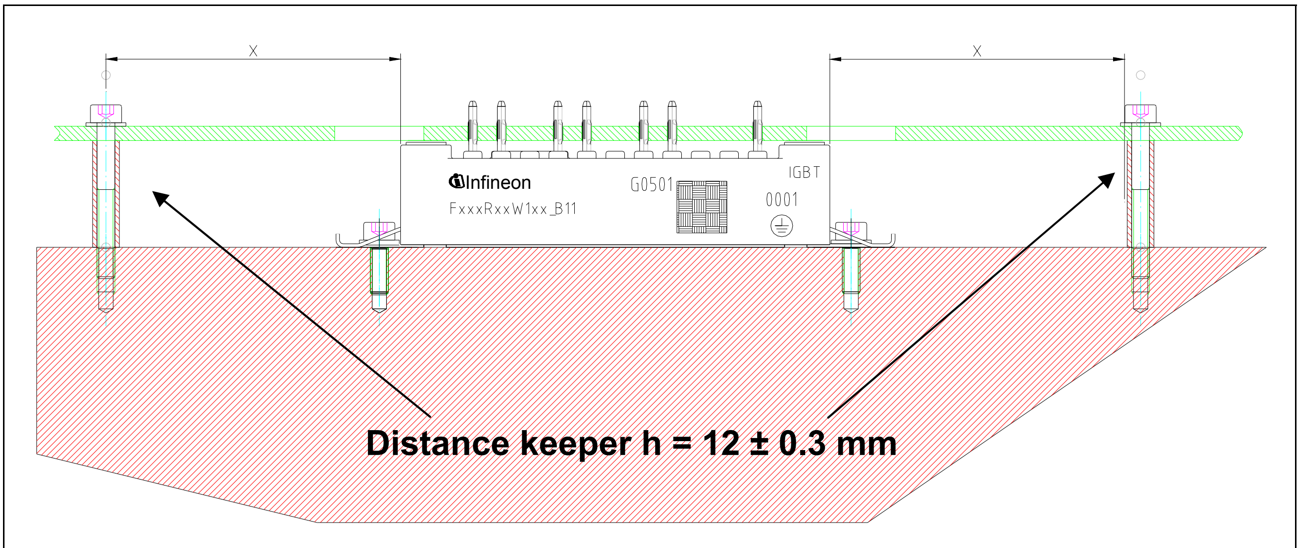


Figure 13: Fixing the printed circuit board

10.1 Module is already pressed into the printed circuit board before mounting

To minimise 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 (Picture 13). In this case, the height tolerance of the spacer should not be larger than the height tolerance of the module (± 0.3 mm).

10.2 Module is pressed into the printed circuit board 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.

11 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 printed circuit board. In order 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.

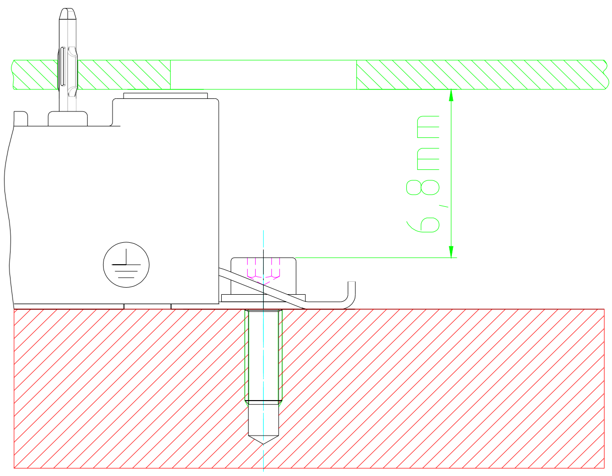


Figure 14: Air path between clip and PCB

The minimum clearance distance between the screw and the PCB depends on the screw itself. The distance will be 6.8 mm with a hexagon socket head screw according to DIN 912, a washer according to DIN 125 and the clamp which can be seen in Pic. 14.

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.

12 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: 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 press-in process as it is recommended for moulded discrete components (e.g. microcontrollers, TO-cases etc.) is not required for Easy B-series modules.

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