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Mounting Instructions for modules with DBC base

Application Note

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Version Rev.03

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1 General Information

Part of power modules failed due to improper mounting methods, especially for the modules with DBC base (e.g. B2, B3, B9, A1, C7 package).

The DBC directly contacts the heat sink for the modules with DBC base when mounted on the heat sink, because the modules do not have a heat-dissipating copper base plate. The DBC ceramic is a brittle material, so the wrong installation causes the DBC to be subjected to stress and mechanical damage, thereby reducing the lifetime of the module. Proper installation can effectively improve the module's work safety, reliability and longevity.

This mounting instruction is based on the many years of experience of NanJing SilverMicro Electronics. It mainly introduces the two types of the modules with DBC base installations, hard and soft. This mounting instruction is also applicable to other series of modules with DBC base.

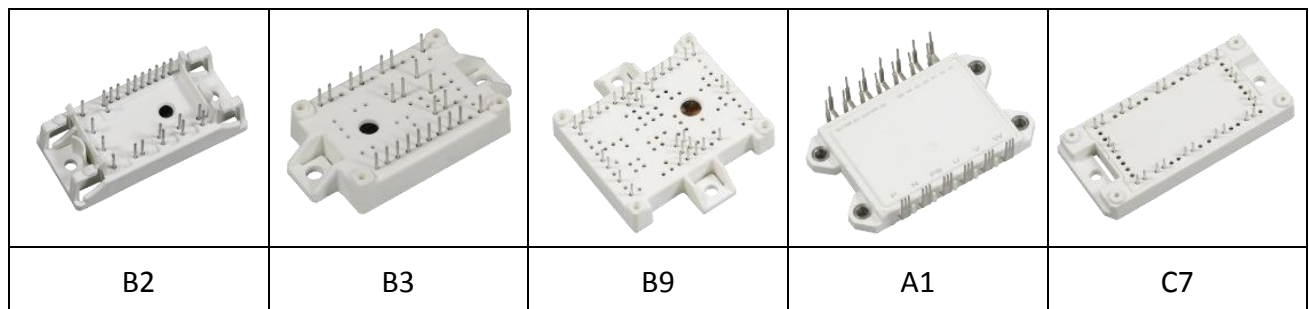


Fig 1 Typical hard-linked modules with DBC base

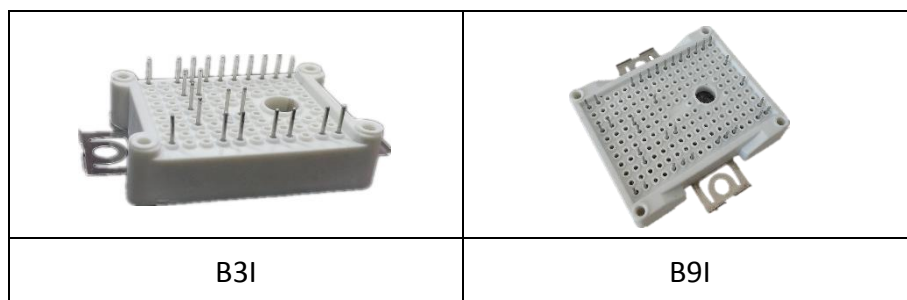


Fig 2 Typical soft-linked modules with DBC base

Fig 1 and Fig 2 show typical hard-linked and soft-linked modules with DBC base, respectively. The soft-linked module has stainless steel shrapnel, when the module is mounted on the heat sink, the stress can be absorbed by the shrapnel, thus reducing the mechanical stress on the DBC ceramic during installation.

2 Recommended Mounting Order

Basically, we recommend the mounting order as below for the modules with DBC base:

1. Applying the thermal paste
2. Assembling the module on the heat sink
3. Mounting the PCB to the module
4. Fixing the PCB and the heat sink
5. Soldering the module to the PCB

For B3/B3I, B9/B9I, A1, C7 package, recommended mounting order can be followed. For the B2 package, the module must be mounted on the PCB first, and the hooks on the module must be matched. Therefore, according to the way of Fig 3, holes should be left on the PCB.

Note: In order to facilitate after-sales maintenance, it is recommended to add the PCB through-holes to make it easier to remove the module. The size of the holes is determined by the size of the screwdriver, screws, and washers.

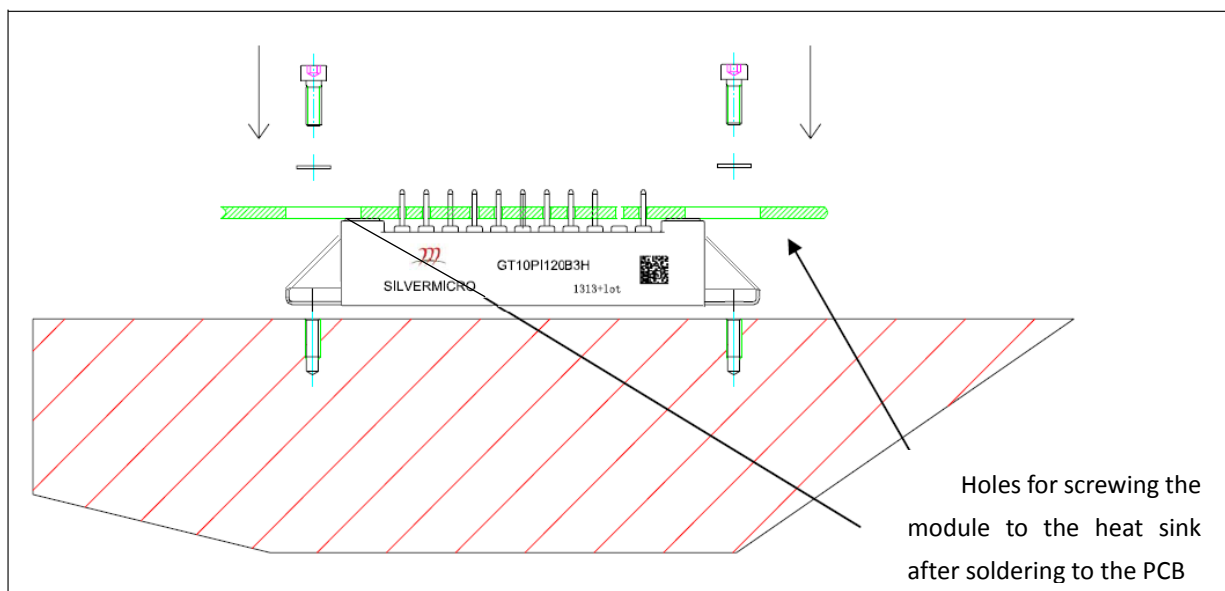


Fig 3

3 Use of thermal paste

Due to the curvature of the DBC mounting surface, furthermore the DBC mounting surface and the surface of the heat sink are not completely flat, if the two are in direct contact, there will be an air gap, which increases the thermal resistance and affects the heat transfer from the module to the heat sink. Therefore, when installing the module, it is necessary to apply thermal grease to fill the air gap between the DBC copper layer and the heat sink, so that the surface of the heat sink has good contact with the module to form good heat conduction.

3.1 The thickness of thermal paste

Since the bottom plate of module is a ceramic copper-clad substrate, it is basically brittle. Therefore, during the mounting process, the deformation of the bottom plate must be controlled within 50 μm to ensure that the intermediate ceramic layer does not break. Therefore, the mounting torque of the modules with DBC base becomes smaller, and the extrudability of the thermal grease in the module mounting process is deteriorated, so the ideal thickness of the thermal grease layer needs to be controlled within a small range.

The recommended thickness of the thermal grease is 80-120 μm . If the thickness of the thermal grease is too small, there will be an air gap between the module and the heat sink. The temperature rise of the module is too large. The thickness of the thermal grease is too large to make the thermal resistance of the silicone grease layer. Too large to increase the thermal resistance of the entire module.

The ideal state is to fill all the gaps while preventing direct metal contact between the base plate and the heat sink surface.

3.2 Applying the thermal paste

The thermal paste can be applied using either a spatula, a roller or by a silk screen printing. It is recommended to apply thermal paste by stencil printing. The advantages of stencil printing are as

Mounting Instructions for modules with DBC base

follows:

- Thermal paste will only be applied to the area to be coated, which is highly efficient
- The thickness of thermal paste is controllable and the printing consistency is good
- Excess thermal paste can be scraped off and used for the next printing, reducing the loss of thermal paste

The pattern printed on the stencil is similar to the honeycomb. The printing and coating effects of our installation test are shown in the figure below. (The thickness of the stencil used in the installation test is 120um. After the module is installed, the thermal paste is spread out and the effective thickness is 80um.)

Mounting Instructions for modules with DBC base

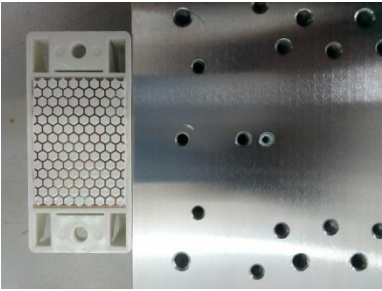
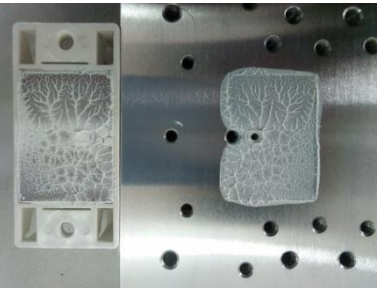
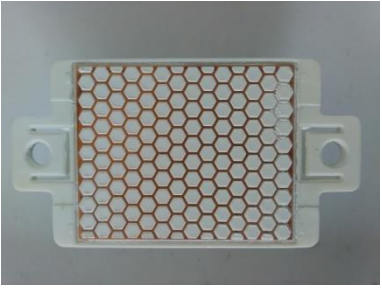



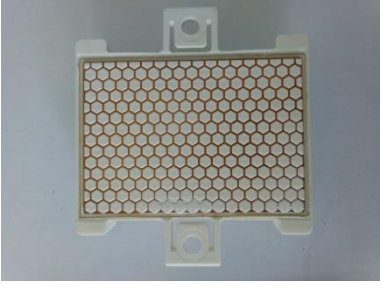

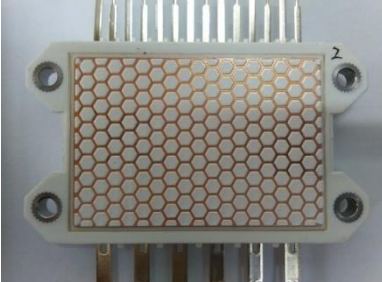

Package	After printing	After mounting
B2		
B3		
B3I		
B9		
A1		

Fig 4 Printing and coating effects

Mounting Instructions for modules with DBC base

3.3 Single printing quantity

In order to ensure the effect of printing, the quantity of modules for single printing should not be too much. The recommended quantity of single printings is shown in the table below.

Package	Recommended single printing qty
B2	12
B3/B3I	12
B9/B9I	9
A1	12
C7	9

3.4 Printing Process

Step 1. Prepare stencil and fixture

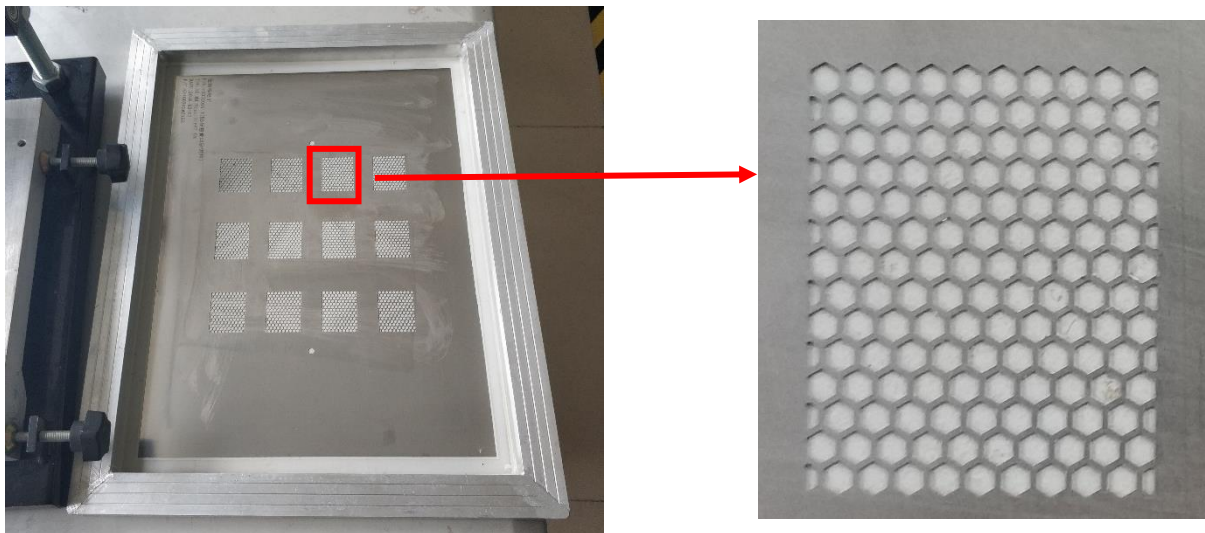


Fig 5

It is recommended to clean the stencil after each printing to avoid the residue affecting the printing effect.

Mounting Instructions for modules with DBC base

Step 2. Put the stencil and module into the fixture

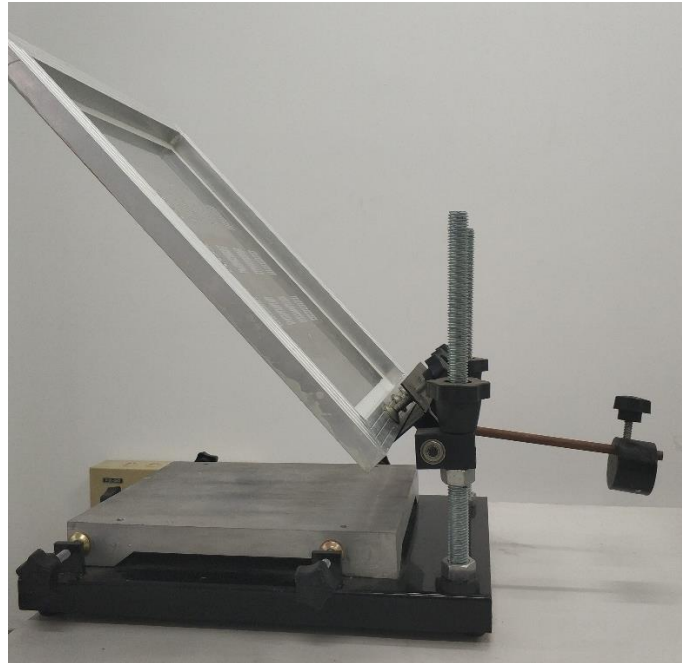


Fig 6

The stencil and the printing fixture are matched, and the stencil opening corresponds to the following modules one by one.

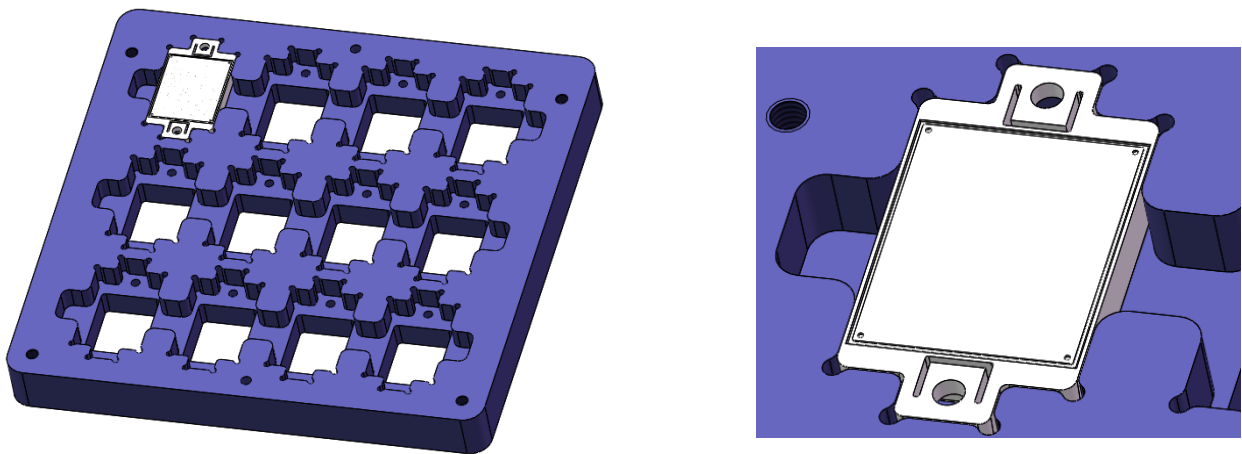


Fig 7 Fixed module tooling

Mounting Instructions for modules with DBC base

Step 3. Printing thermal paste

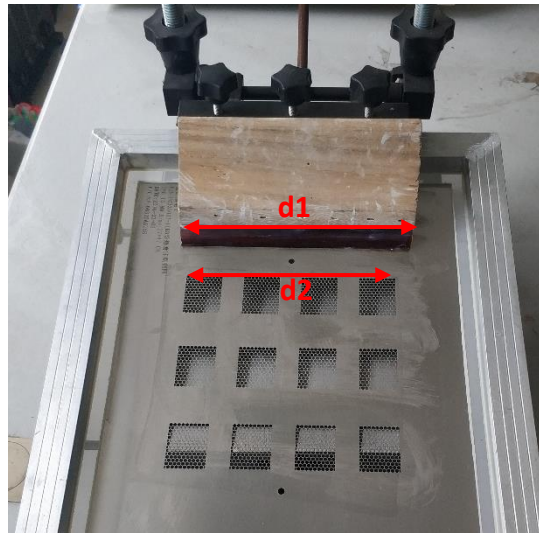


Fig 8

It is recommended to use a scraper to print thermal paste to the bottom of the module. The width of the scraper should be greater than the print width ($d1 > d2$).

4 Assembling the module on the heat sink

4.1 Heat sink requirements

The power loss in the module is dissipated by the heat sink and must not exceed the maximum junction temperature T_j mentioned in the data sheet during operation.

When heat is transferred to the contact surface of the module and the heat sink, the area where the module contacts the surface of the heat sink is particularly important.

The surface of the module and heat sink must be free of degradation and contamination, with the goal of preventing additional mechanical stress from being applied to the module and additionally increasing thermal resistance.

Heat sink requirements:

Roughness: $\leq 10 \mu\text{m}$

Flatness: $\leq 50 \mu\text{m}$

Note: The flatness of the heat sink should not exceed the above values. This area includes the entire module mounting area and the part that is in contact.

4.2 Assembling hard-linked module on the heat sink

The module is mounted to the heat sink and screws can be selected according to the instructions in the data sheet. Refer to the pre-tightening torque and tightening torque recommended in the table below.

Package	Screw	Pre-tightening torque (N·m)	Tightening torque (N·m)
B2	M4	0.5~0.75	0.75~1.2
B3	M4	0.5~0.75	0.75~1.2
B9	M4	0.5~0.75	0.75~1.2
A1	M3	0.5~0.75	0.75~1.2
C7	M4	0.5~0.75	0.75~1.2

Mounting Instructions for modules with DBC base

When the module is mounted on the heat sink, be aware that the mounting holes on the module are precisely aligned with the screw holes on the heat sink. This mounting surface must be kept clean and free of contamination.

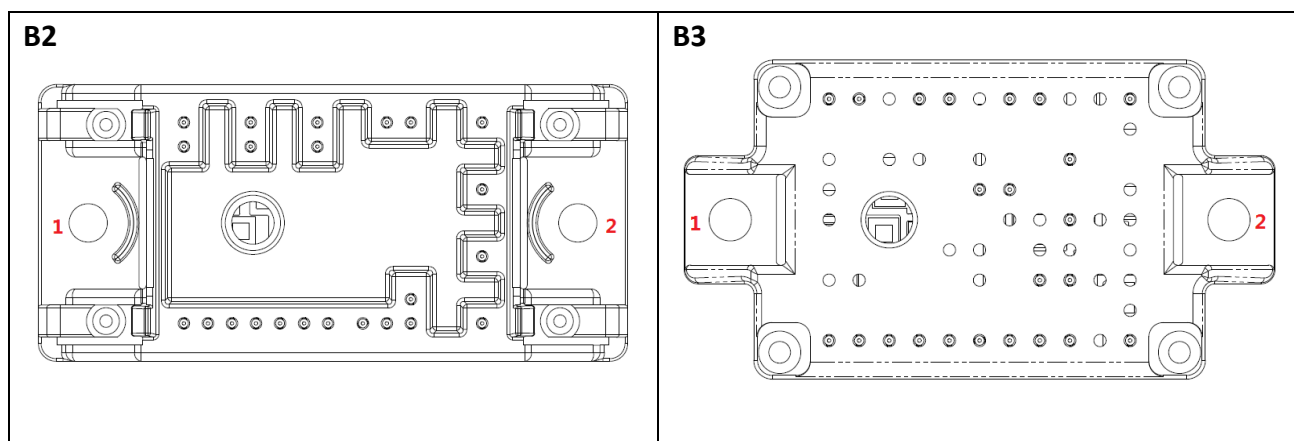
When the position of the module is fixed, the screws should be tightened in the direction of diagonal symmetry, and then tightened first and then tightened. When tightening the screws, be careful not to suddenly force the module DBC to withstand large stresses. After the module is locked, a small amount of silicone grease is spilled around the bottom, which proves that the coating effect is good.

For modules with four mounting holes, it is recommended to tighten in the order of 1→2→3→4 when pre-tightening, and in the order of 4→3→2→1 when tightening.



Fig 9 The module with 4 mounting holes

For the modules with two mounting holes, after the position of the module is fixed, it is also pre-screwed and then tightened.



Mounting Instructions for modules with DBC base

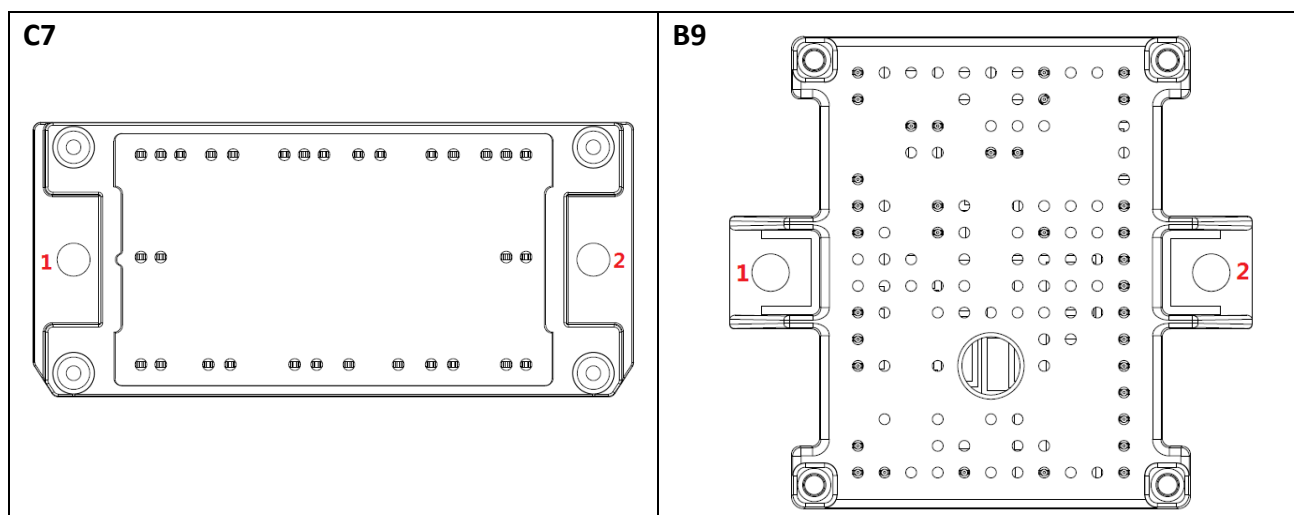


Fig 10 The modules with 2 mounting holes

4.3 Assembling soft-linked module on the heat sink

For soft-linked modules, the tightening torque is slightly larger than the hard-linked module. It is recommended to use washers. Refer to the pre-tightening torque and tightening torque in the table below.

Package	Screws	Pre-tightening torque (N·m)	Tightening torque (N·m)
B3I	M4	0.5~0.75	2.0~2.3
B9I	M4	0.5~0.75	2.0~2.3

It is recommended to install an M4 flat washer with thickness of 0.3-0.5mm. The washer is made of stainless steel or galvanized iron. First align the module with the mounting hole, then screw in the first screw and gently screw it on. Do not apply force on the spring, then screw in the second screw, pre-screw, then fully tighten, and finally the first A still loose screw is fully tightened.

Mounting Instructions for modules with DBC base

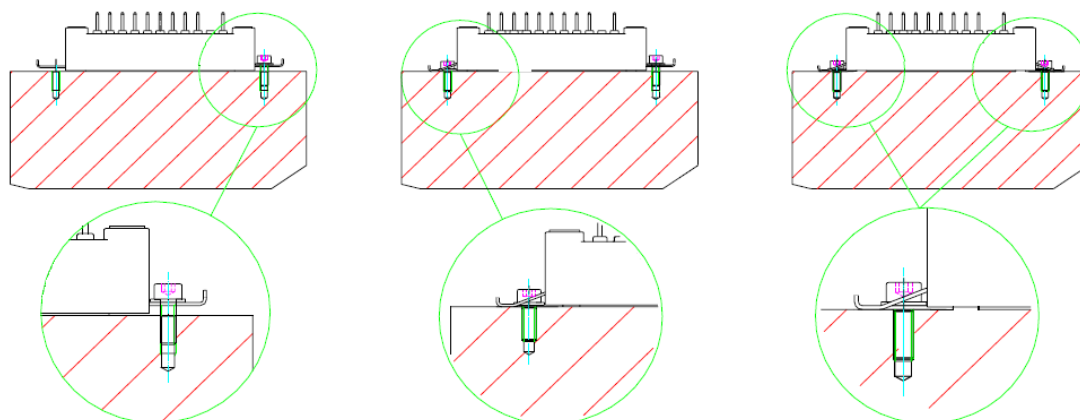


Fig 11

5 Mounting the PCB to the module

The installation between the module and the PCB requires the selection of the appropriate installation method according to the module itself. The following three cases are listed. Other modules with DBC base are similar, and the customer can judge according to the actual application module.

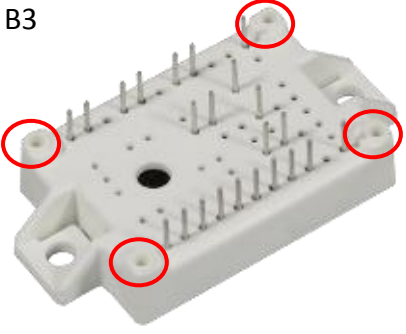


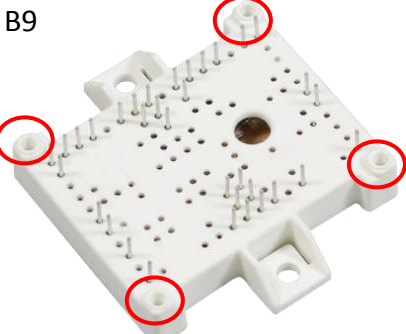
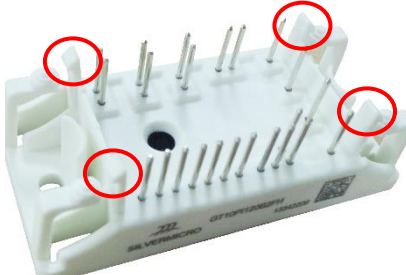
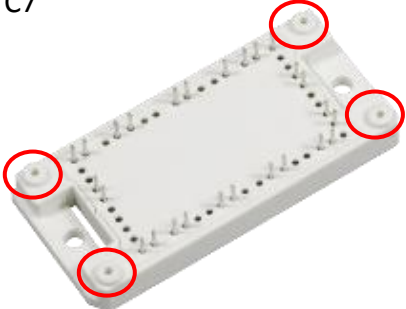
B3/B3I, B9/B9I, C7	B2	A1
PCB mounting holes on the module housing, mounted by self-tapping screws	There is a hook on the module housing, and the hook is matched with the PCB hole through the hook	No other installation, just solder the terminal to the PCB
B3 	B2 (2-clip) 	A1 
B9 	B2 (4-clip) 	
C7 		

Fig 12

Mounting Instructions for modules with DBC base

5.1 Mounted by self-tapping screws

First insert the terminals on the module into the PCB, then screw on the 4 corners of the module. For a safer installation, the recommended installation tool is a low-speed electric screwdriver with a speed of $n \leq 300$ rpm. Due to the lack of precision, we do not recommend the use of a pneumatic screwdriver or a manual screwdriver. The recommended screws and torques are shown in the table below.

Package	Recommended screw	Recommended torque
B3/B3I, B9/B9I	M2.5 x 8	0.4N·m
C7	M2.5 x 6	0.4N·m

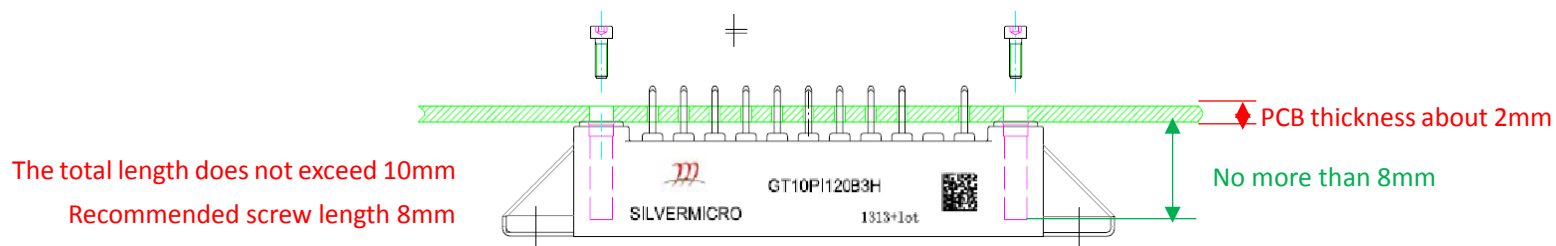


Fig 13

In order to select the length of the screw, the thickness of the PCB must be calculated. If the thickness of the PCB is 2mm, then at least 2mm of the screw depth can ensure the PCB reliability. As shown in the figure, for B3/B3I, B9/B9I modules, the depth of the screwing module is up to 8mm, otherwise there is a risk of damaging the casing.

It should also be noted that the screw is only used for guiding at the first 1.5mm of the mounting screw, so do not use too much force. When the screwing is continued, the thread of the plastic housing will naturally form.

In order to avoid damage or cracking of the casing, please pay attention to see if there is any inclination when driving the screw into the threaded hole.

Mounting Instructions for modules with DBC base

5.2 Mounted by hook

This section mainly introduces the B2 module and PCB installation. The B2 module can be divided into 2-clip and 4-clip according to the number of hooks. There are two ways to install, one is manual pressing, and the other is automatic pressing using a pressing fixture.

5.2.1 2-clip mounting by hand

Insert the module pins into the PCB and clip in the module. Burrs are not allowed on the PCB-cutouts.

The necessary force for pushing the clips is:

- 12 N in case of 17 mm modules/side
- 40 N in case of 12 mm modules/side

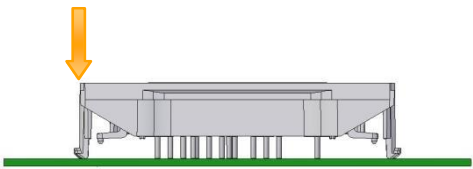

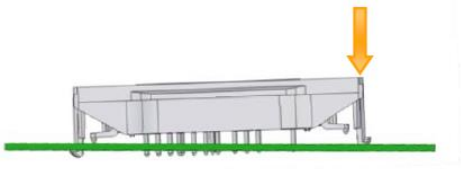
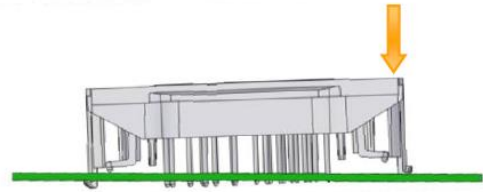

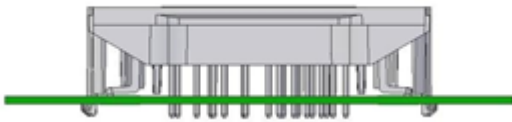
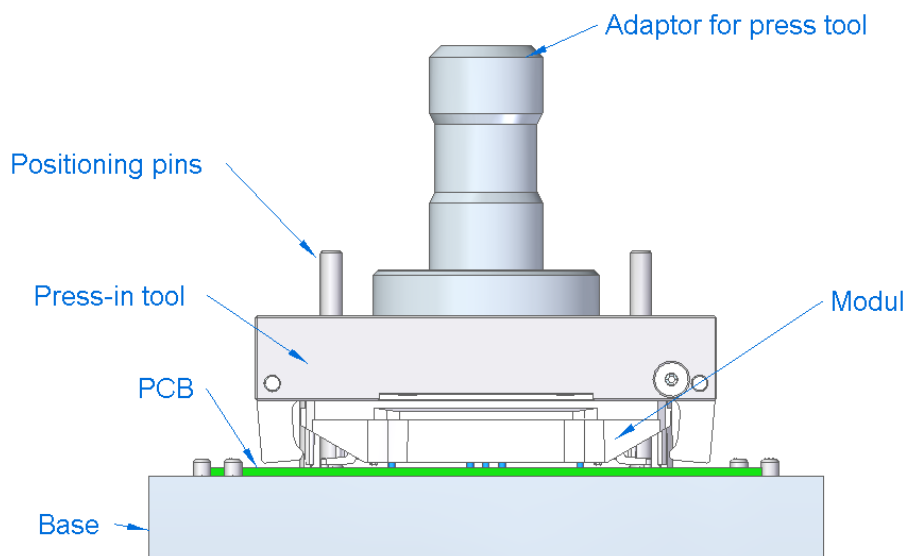
12mm module	17mm module
1. Insert the module pins to the PCB and press one arbitrary side of the module gently as shown below until two clips of that side are locked.	
	
2. Press the other side to lock the remaining two clips as shown on the figure below	
	
3. The mounted module on PCB	
	

Fig 14 Hand mounting steps

Mounting Instructions for modules with DBC base

5.2.2 2-clip mounting with clip-in tool



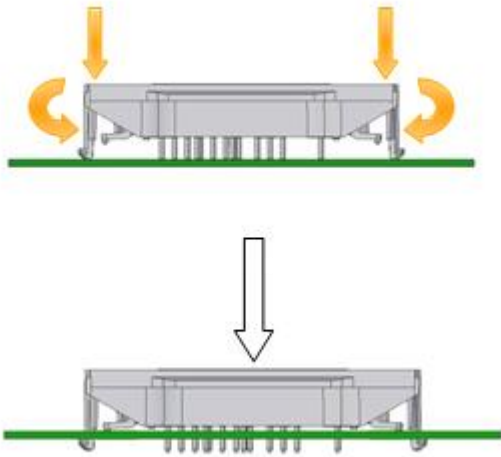
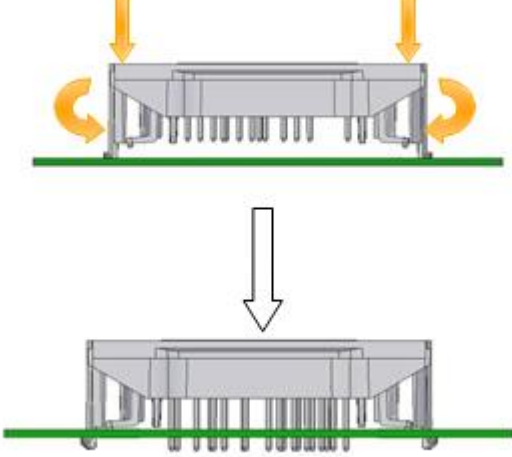
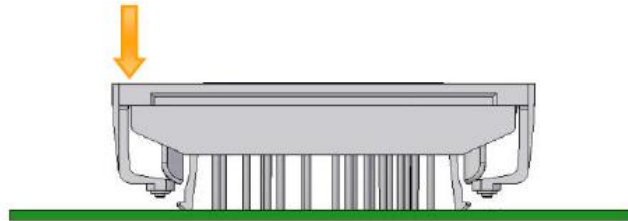
12mm module	17mm module
Mounting operation by clip-in tool	
	

Fig 15 Mounting operation provided by the clip-in tool

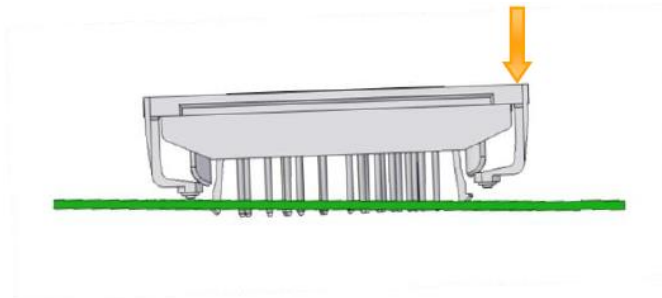
Mounting Instructions for modules with DBC base

5.2.3 4-clip mounting by hand

1. Insert the module pins to the PCB and press one arbitrary side of the module gently as shown below until two clips of that side are locked



2. Press the other side to lock the remaining two clips as shown on the figure below



3. The mounted module on PCB

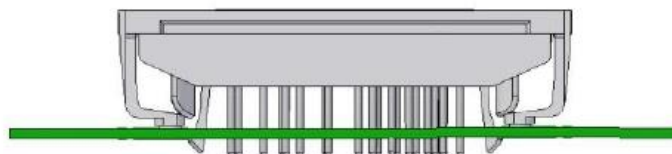


Fig 16 Hand mounting operation for 4 clip module

5.2.4 4-clip mounting with clip-in tool

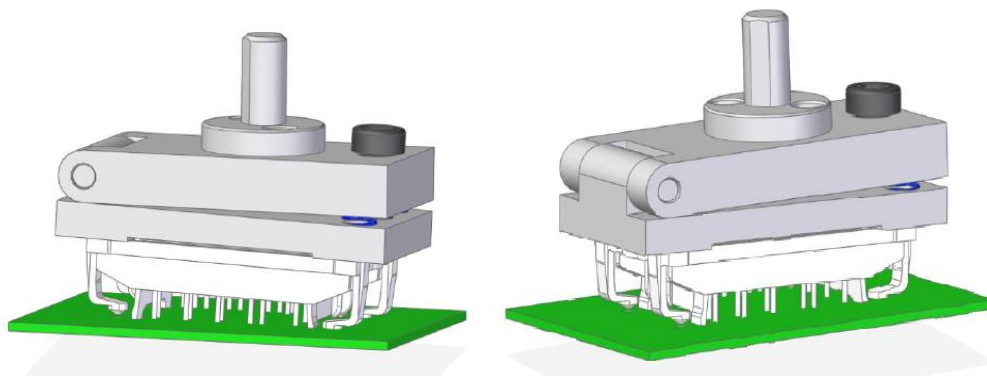


Fig 17 Clip-in tool

Mounting Instructions for modules with DBC base

5.2.5 Permitted deformations of the clips and springs

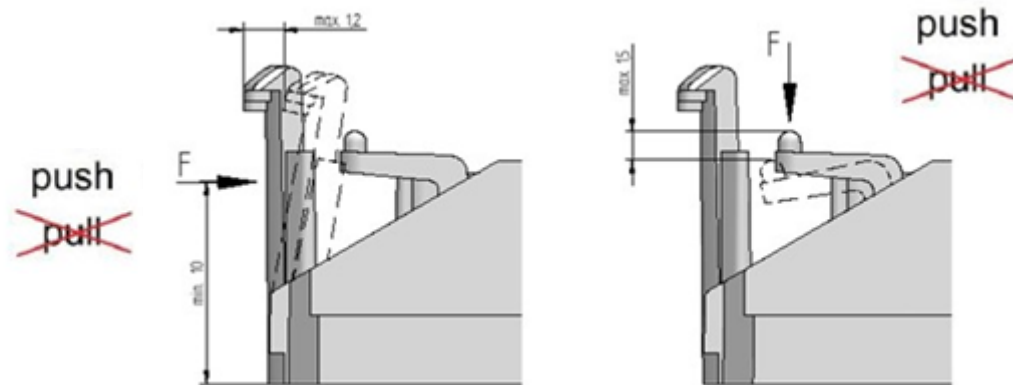


Fig 18 12mm module, permitted deformation of the clips and springs

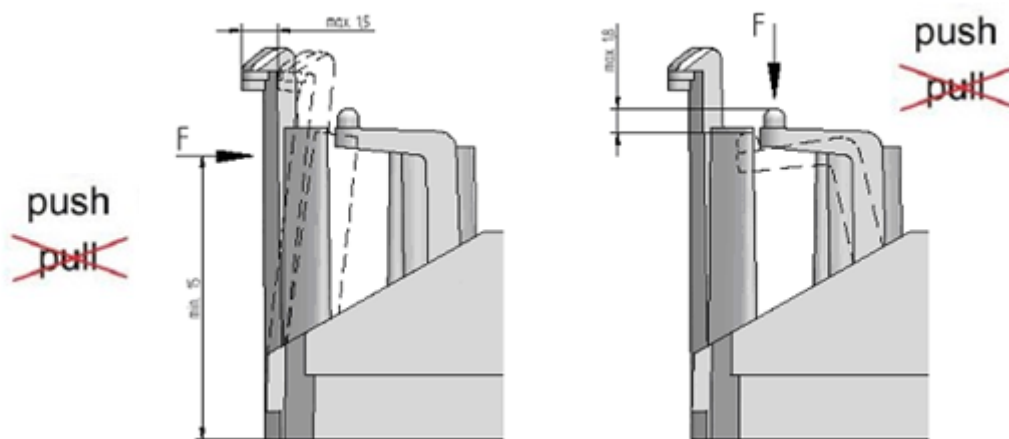


Fig 19 17mm module, permitted deformation of the clips and springs

Maximum allowable force and displacement on the clip and springs:

Housing	Clip		Spring	
	max. force	max. displacement	max. force	max. displacement
12mm	70N	1.2mm	20N	1.5mm
17mm	20N	1.5mm	20N	1.8mm

6 Fixing the PCB and the heat sink

Between the PCB and the heat sink, the heat sink is mainly connected by four screws and four positioning guide posts, as shown in Fig 20.

Note 1: In order to see this figure more clearly, this figure omits the PCB, and the PCB and module are already installed.

Note 2: At this point, the module and the heat sink are tightened

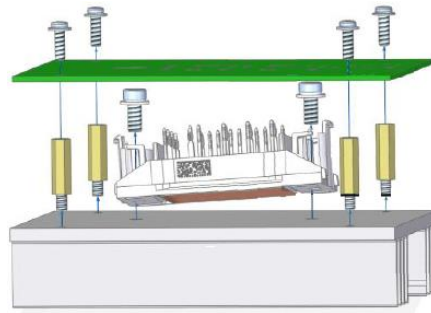


Fig 20 Fixing the PCB and the heat sink

1. First tighten the four positioning guide posts on the heat sink
2. Then precisely align the four positioning holes on the PCB board with the screw holes on the positioning guidepost
3. Tighten the 4 screws diagonally

For the A1 module, follow a similar approach,

1. First tighten the four positioning guides on the heat sink
2. Then align the terminal hole on the PCB board with the terminal of the module, and press the PCB board down slowly until the PCB board is in contact with the terminal step position, and cannot be further pressed in. At this time, the four positioning holes and the guide on the PCB board Align the screw holes on the column
3. Screw the PCB board to the heat sink and tighten the 4 screws diagonally.

The role of the positioning guide post is to ensure the vertical of the screw and the surface of the heat sink, and to avoid damage to the PCB during installation.

Mounting Instructions for modules with DBC base

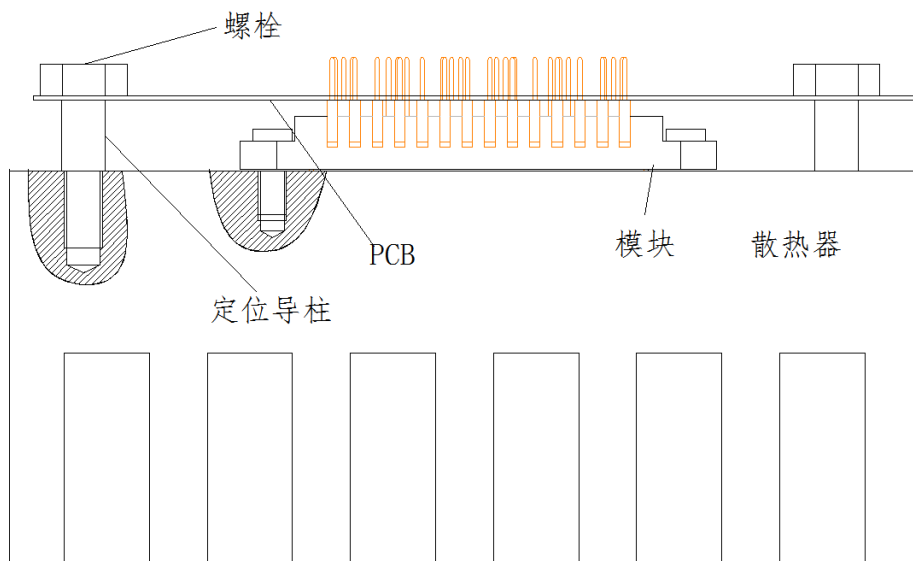


Fig 21 A1 Module installation diagram

7 Recommendation for soldering

Plated through holes should exhibit a vertical solder fill of 75 %, with a fully formed fillet on the solder side and evidence of 75 % wetting on the component side lead, barrel and pad.

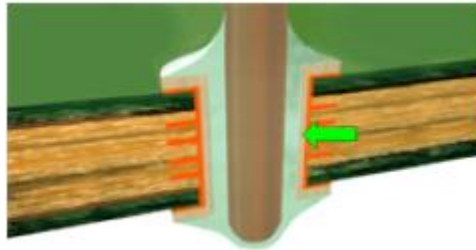


Fig 22 Plated through hole, good soldering

Recommended soldering temperature: 350°C~400°C

8 Revision History

Date	Revision	Notes
/	Rev.01	Initial release
2019/3/27	Rev.02	<ol style="list-style-type: none">1. Add hard-linked and soft-linked2. Add printing thermal paste3. Add mounting the module on the PCB4. Add mounting the PCB to the heat sink
2019/5/30	Rev.03	<ol style="list-style-type: none">1. Section 4.3, update the tightening torque from 1.0~1.5 N·m to 2.0~2.3 N·m