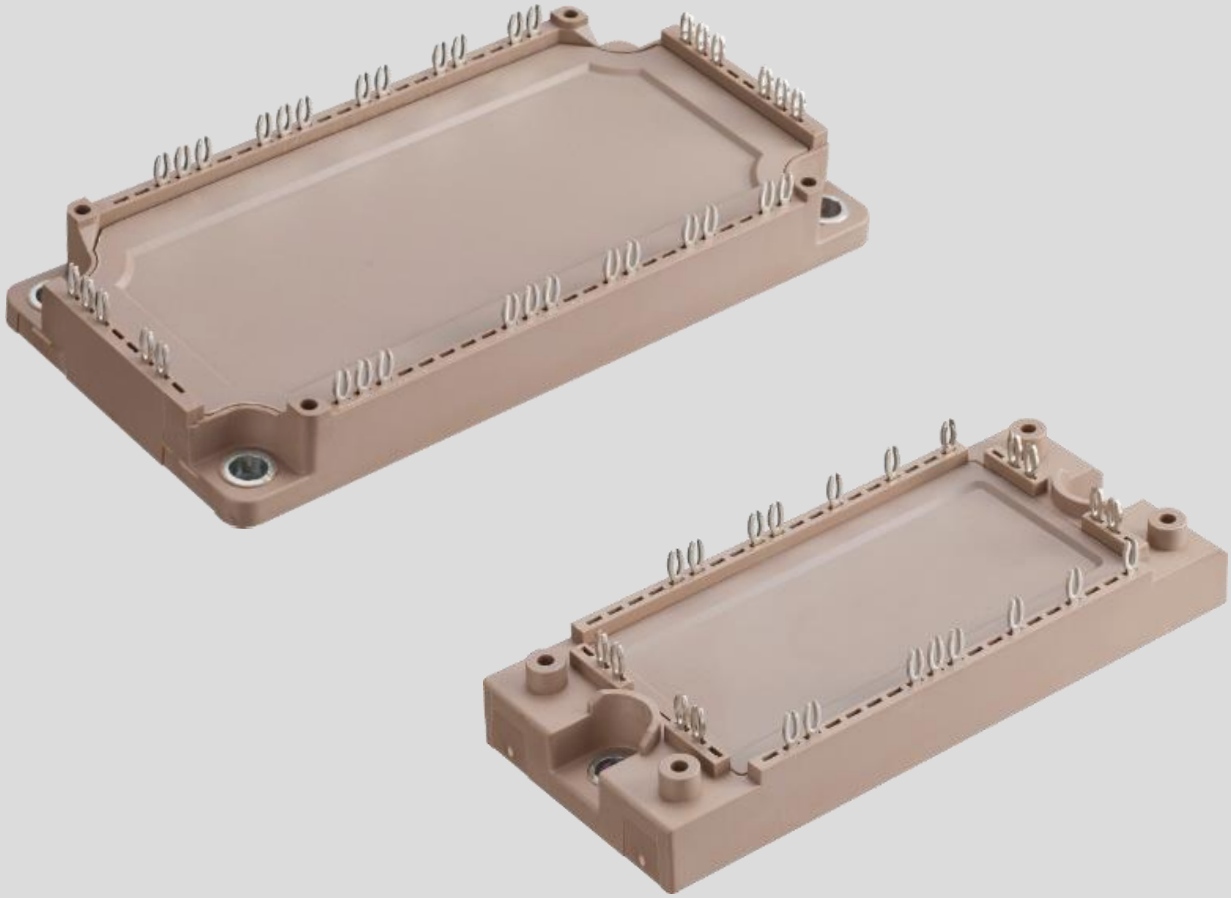
Fuji Electric
Innovating Energy Technology



Fuji Industrial IGBT Module
Press Fit Type
EconoPIM™ (M721, M722)
EconoPACK™ (M647, M648, M1202)

Mounting Instruction

Dec. 2023

Fuji Electric Co., Ltd.

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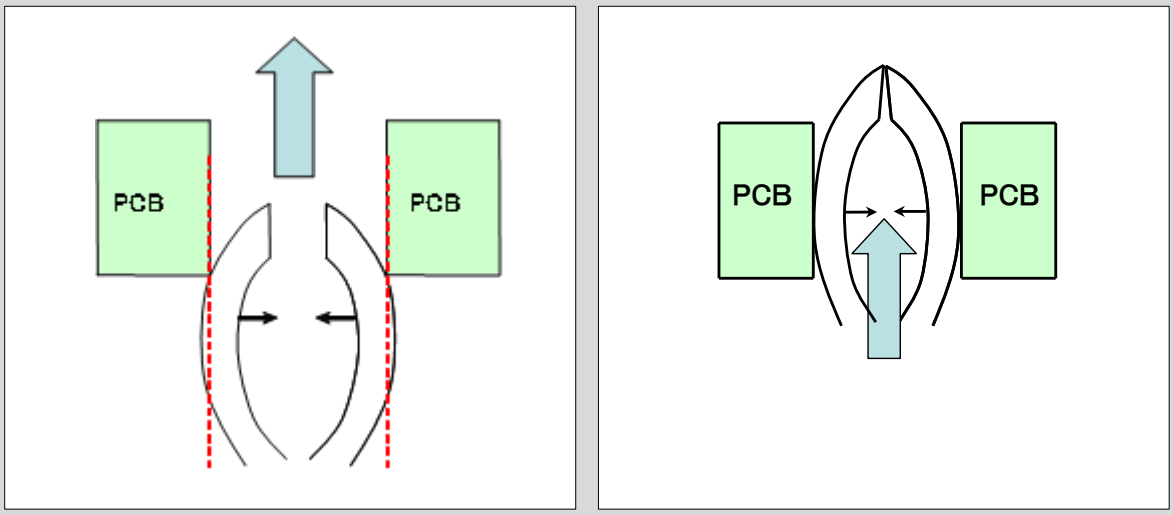
1. Scope of application

This document describes how to safely mount and use press fit type of EconoPIM™ and EconoPACK™ products for the following part numbers shown in Table 1.
Press fit type : Products that can be mounted solder less to printed circuit board (PCB)

Press fit terminals have the characteristic shape shown in Fig.1(a). When the press fit terminal is pressed into the PCB, contact pressure is applied from both sides of the terminals, and they were deformed and inserted as shown in Fig.1(b). The deformation pressure makes it possible to mount the product on the PCB solderless.

When handling the product, in addition to the contents described in this document, please check the Warning and Caution in the product specification too.

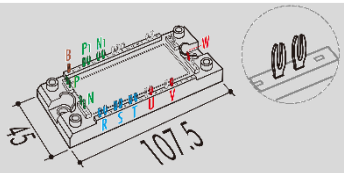
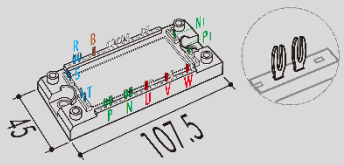
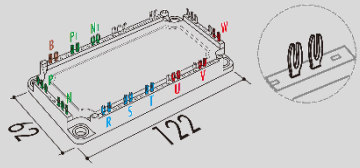
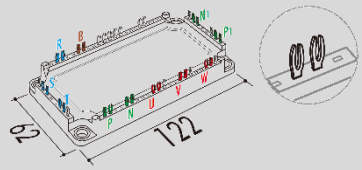
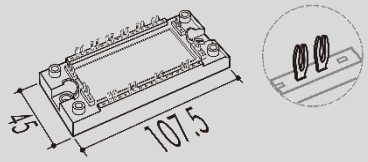
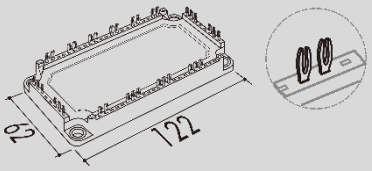
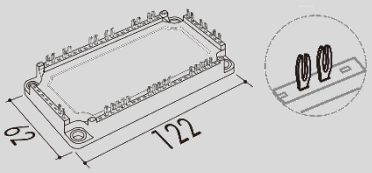


(a) Terminal shape before the press-in process (b) Terminal shape after the press-in process

Fig.1 Terminal shape before and after the press-in process to the printed circuit board

The target part numbers of this mounting instruction are as follows.

Table 1 Scope of application of this mounting instruction

Applicable model			Package outlines
Package name	Series	Part number	
M721	X series	7MBRxxxXWA065-xx 7MBRxxxXWA120-xx 7MBRxxxXWE120-xx	
	V series	7MBRxxxVW120-xx	
	X series	7MBRxxxXYA065-xx 7MBRxxxXYE065-xx 7MBRxxxXYA120-xx 7MBRxxxXYE120-xx	
	V series	7MBRxxxVY060-xx 7MBRxxxVY120-xx	
M722	X series	7MBRxxxXXA065-xx 7MBRxxxXXA120-xx 7MBRxxxXXE120-xx	
	V series	7MBRxxxVX120-xx	
	X series	7MBRxxxXZA065-xx 7MBRxxxXZA120-xx 7MBRxxxXZE120-xx	
	V series	7MBRxxxVZ060-xx 7MBRxxxVZ120-xx	
M647	X series	6MBIxxxXWE120-xx	
	V series	6MBIxxxVW-060-xx 6MBIxxxVW-120-xx	
M648	X series	6MBIxxxXXA120-xx 6MBIxxxXXE120-xx 6MBIxxxXRXE120-xx	
	V series	6MBIxxxVX-060-xx 6MBIxxxVX-120-xx 6MBIxxxVX-170-xx	
M1202	V series	12MBIxxxVX-120-xx	

2. Mounting the module to printed circuit board

2-1. Requirements for printed circuit board

Table 2 and Fig.2 show the recommended specifications of a printed circuit board (PCB).

The recommended specifications in Table 2 is evaluated based on IEC60352-5. When using a PCB other than the recommended specifications, evaluation is required.

< Requirements for the PCB material >

Double-sided PCB in accordance with IEC 60249-2-4 or IEC 60249-2-5.

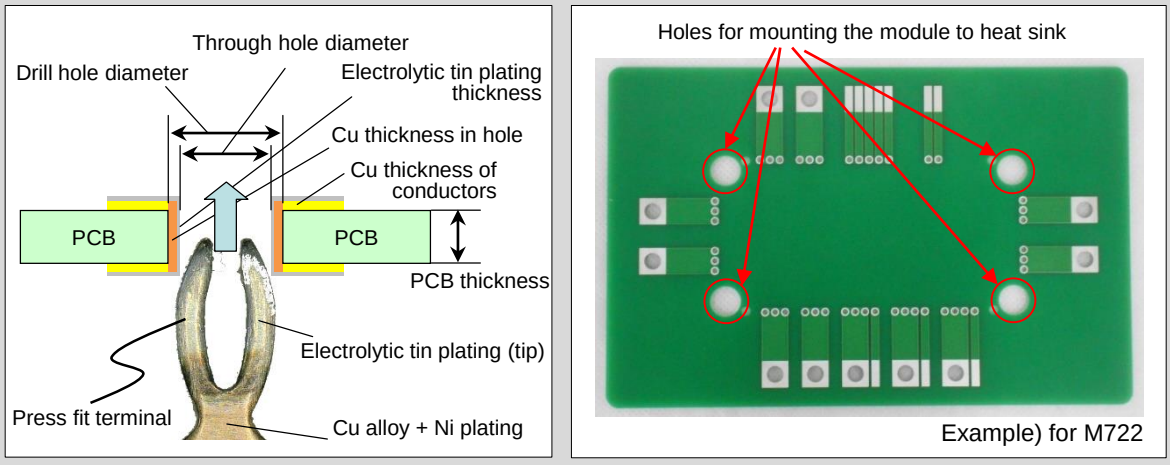
Multilayer PCB in accordance with IEC 60249-2-11 or IEC 60249-2-12.

For example, the through hole diameter should be in the range of 2.14mm to 2.29mm with properly Sn/Cu plated sidewall. If the diameter is too small, problems such as damage to the terminals and PCBs may occur during the press-in process. On the other hand, if the diameter is too large, a gap will be created between the terminal and the PCB, causing problems such as vibration and shock, resulting in reduced reliability.

In addition when mounting the module to the heatsink after mounting the PCB, holes for module mounting are required on the PCB. (Fig. 2 (b)) These holes for mounting can be used as a guide pin hole for the module fixing tool when inserting the module into the PCB.

Table 2 Requirements for a printed circuit board

	Min.	Typ.	Max.
Drill hole diameter	-	2.35mm	-
Through hole diameter	2.14mm	2.20mm	2.29mm
Cu thickness in hole	25μm	-	-
Electrolytic tin plating thickness	-	-	15μm
Cu thickness of conductors	35μm	70um, 105μm	-
PCB thickness	1.6mm	2.0mm	-
PCB material	FR4		



(a) PCB cross section and each dimension

(b) Holes for mounting the module(lower tool)

Fig.2 Recommended specification of a printed circuit board

2-2. Notes when mounting components on a printed circuit board

For press fit products, it is recommended that components be mounted in an area at least 5mm away from the center of the press-fit terminals because the PCB near the press-fit terminals may be deformed during the press-in process. Also, design the press-in/press-out tool to be used in such a way that it does not affect the components.

2-3. The press-in and press-out process of printed circuit board

This section describes the procedure of the press-in and press-out process of PCB.

Table 3 shows the recommended press speed and load (average per terminal) during the press-in and press-out process for the minimum and maximum PCB through-hole diameters.

Table 3 Recommended press speed and load

Through hole diameter of PCB		2.14mm(Min.)	2.29mm(Max.)
Press-in process	Recommended press speed	25mm/min	
	Recommended load (Average load per terminal)	Typ. 93N	Typ. 74N
Press-out process	Recommended load (Average load per terminal)	Typ. 45N	Typ. 49N

If the press-in force is too low, there will be issues with the contact between PCB and the module terminals. On the other hand, if the press-in force is too high, it can damage the PCB and other mounted components.

Therefore, it is recommended to use dedicated machine and tools for the press-in and press-out process. Fig.3 shows a photo of the press machine (example).

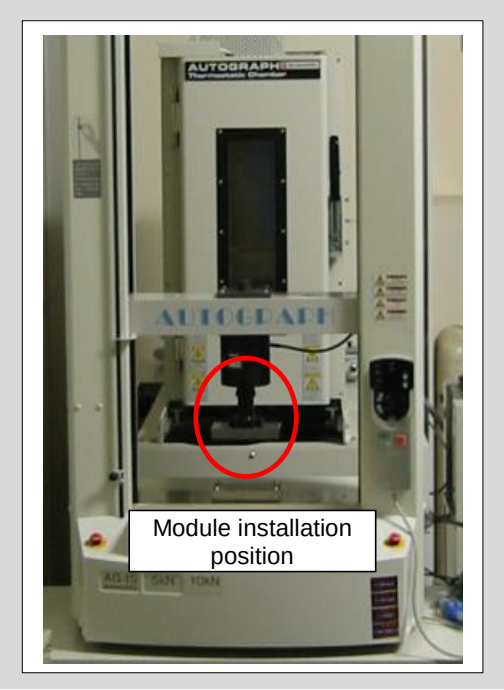


Fig.3 Example of press machine

2-3-1. Press-in / press-out tool

During press-in/press-out of the PCB, use a tool for press-in/press-out to ensure that the press-fit terminals and through holes are not misaligned. Examples of a press-in tool is shown in Fig.4 and a press-out tool is shown in Fig.5.(example for M722 and M648)

Please refer to the appendix for the actual tool dimensions.

During the press-in process, pass the lower tool guide pins through the hole for the guide pins of the PCB.

In the example of Fig.4, the module mounting holes are used as guide pin holes.

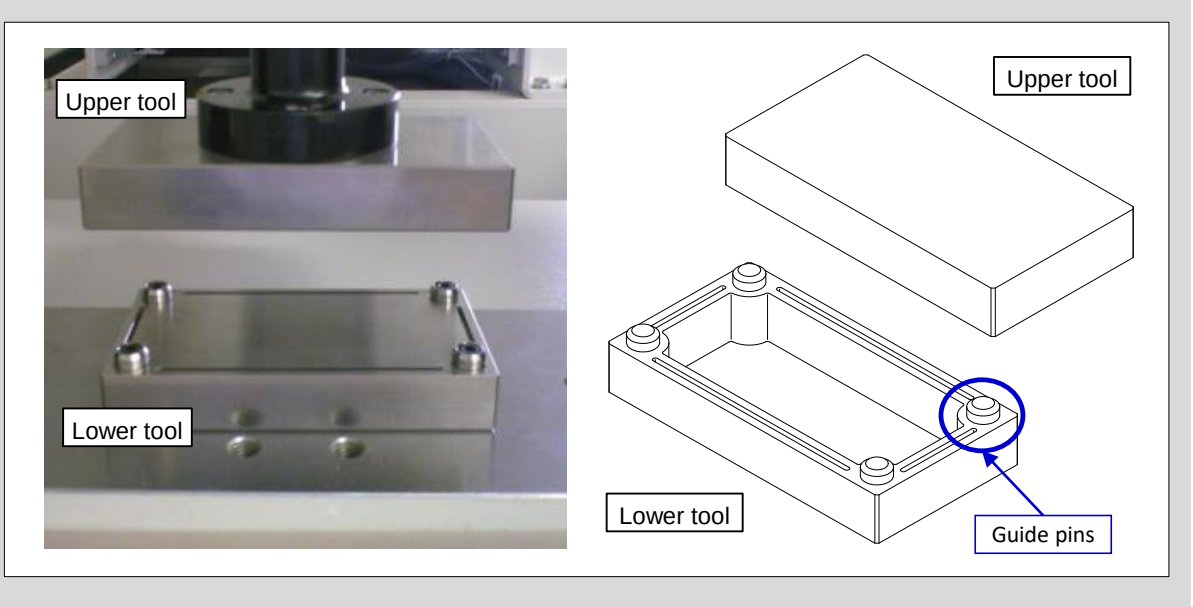


Fig.4 Recommended press-in tool

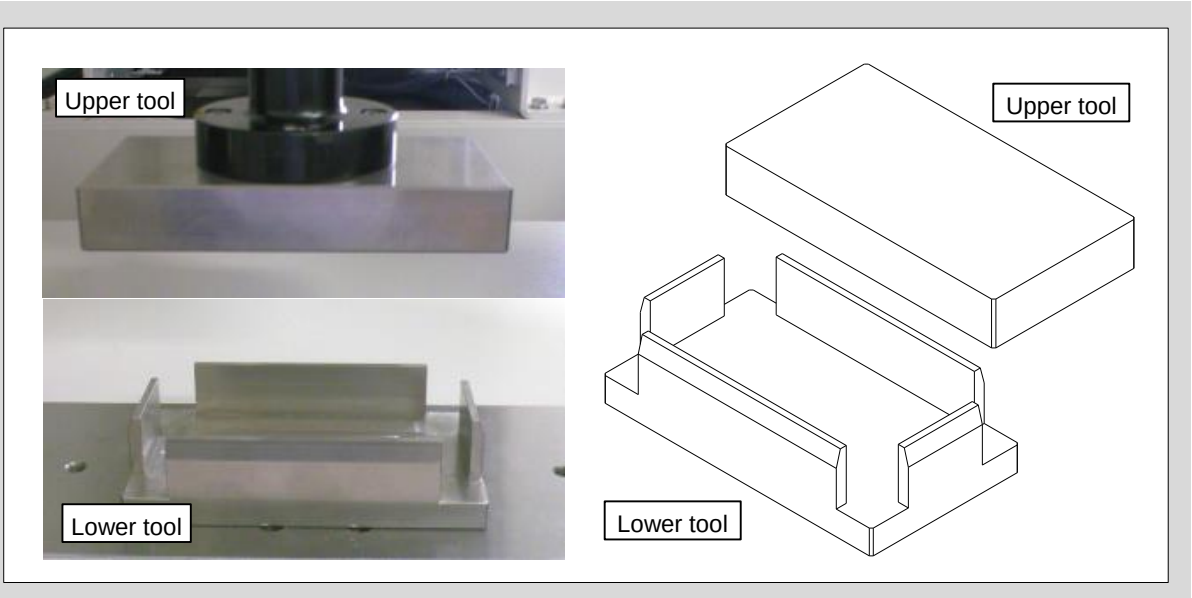
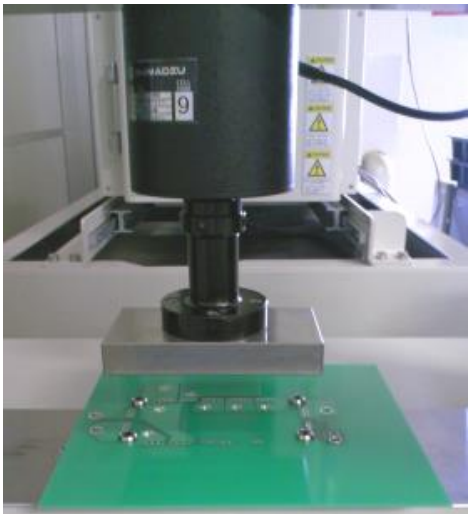


Fig.5 Recommended press-out tool

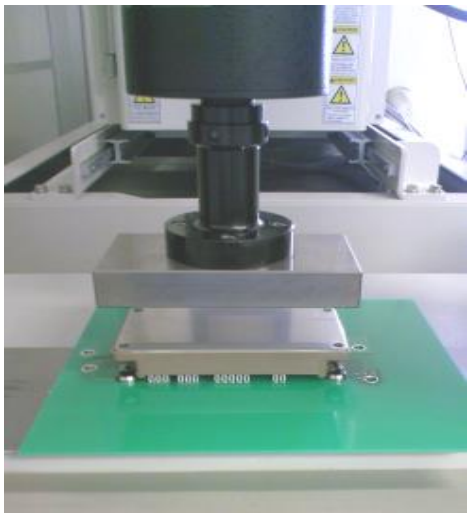
2-3-2. Example of press-in process

Fig.6(a)-(d) show the example of press-in process.
Please refer to section 2-3 for the recommended speed and load.

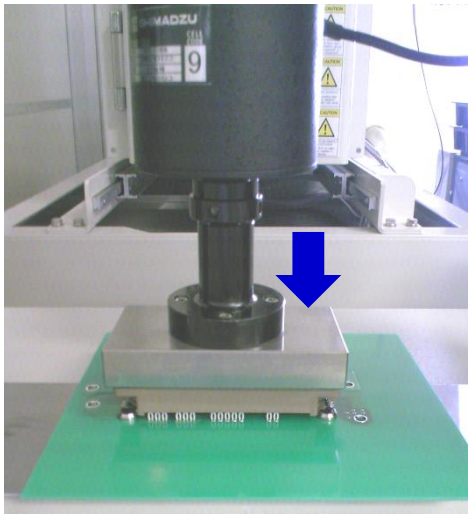
(a) Set the press-in upper tool and lower tool on the press machine.



(b) Set the PCB by aligning the PCB hole for the guide pins with the guide pins of the lower tool.



(c) Set the module by aligning the terminals of the module with the through holes of the PCB.

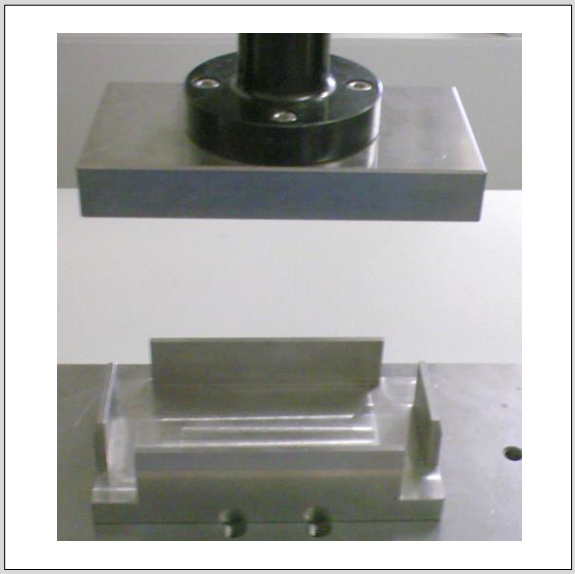


(d) Press the module with the recommended speed and load.

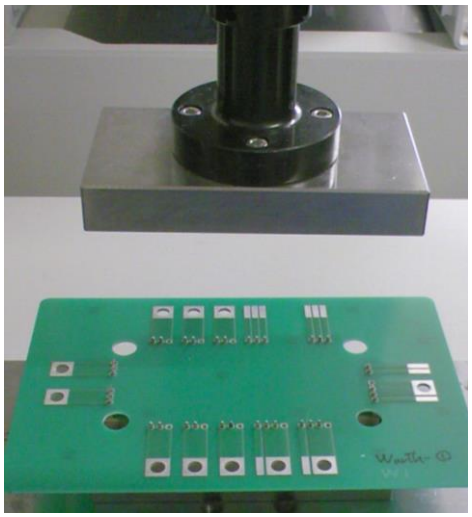
Fig.6 Example of press-in process

2-3-3. Example of press-out process

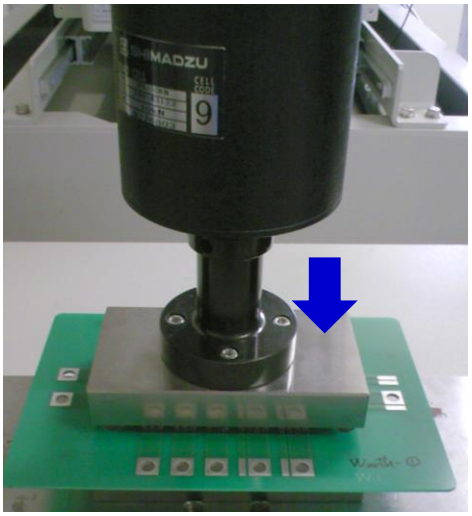
Fig.7(a)-(d) show the example of press-out process.
Please refer to section 2-3 for the recommended load.



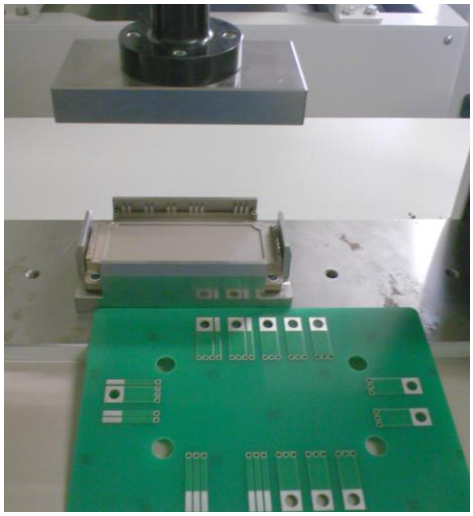
(a) Set the press-out upper tool and lower tool on the press machine.



(b) Set the PCB mounted module on the lower tool.



(c) Press the terminals of the module with the upper tool.



(d) The module is removed from the PCB and drops onto the lower tool.

Fig.7 Example of press-out process

2-4. Soldering the module to the printed circuit board after press-out

It is possible to reuse a module after press-out. Remove the PCB carefully. However, since the press-fit terminals after press-out is deformed compared with the unmounted state, please solder the contact part of the press-fit terminals and PCB when remounting.

The recommended conditions for soldering the module to the PCB are shown below.

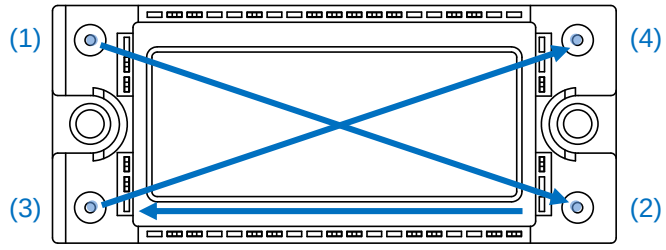
Terminal temperature : 245±5ºC
Time : 5±0.5sec

The recommended soldering temperature is defined as “terminal temperature”. This is different from the preset temperature of the soldering equipment. Please set the temperature of the soldering equipment according to the heat capacity of your PCB. Also, make sure that the resin temperature below the module terminal during soldering does not exceed 260ºC.

2-5. Screw tightening to printed circuit board

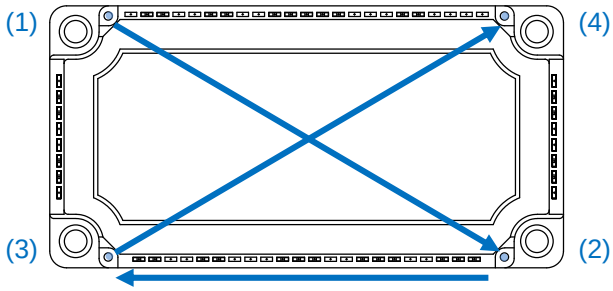
This section describes the screwing method when mounting the PCB to the product.

1. Use M2.5 self-tapping screws to fix the product to PCB.
2. To fix the module with even force, first perform temporary tightening. Fig.8 shows the tightening torque and sequence.
3. Perform final tightening in the same sequence as temporary tightening. The final tightening torque should be within the range shown in Fig.8.



	Tightening torque	Tightening sequence
Temporary tightening	Make sure the screws go straight in	(1)→(2)→(3)→(4)
Final tightening	0.4～0.5 N･m	(1)→(2)→(3)→(4)

(a) Screw tightening torque and screw tightening sequence (M721, M647)

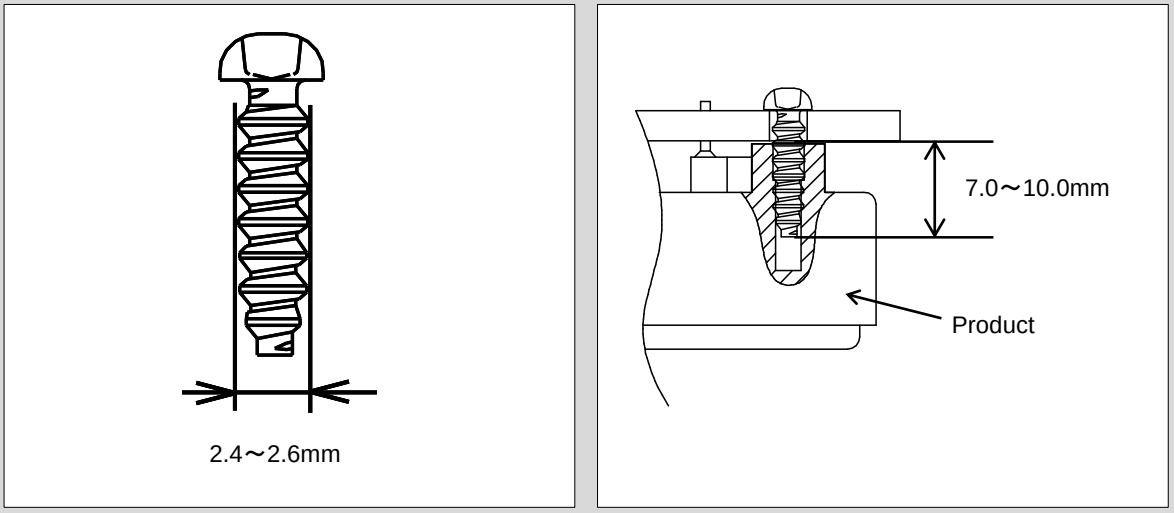


	Tightening torque	Tightening sequence
Temporary tightening	Make sure the screws go straight in	(1)→(2)→(3)→(4)
Final tightening	0.4～0.5 N･m	(1)→(2)→(3)→(4)

(b) Screw tightening torque and screw tightening sequence (M722, M648, M1202)

Fig.8 Screw tightening torque and screw tightening sequence

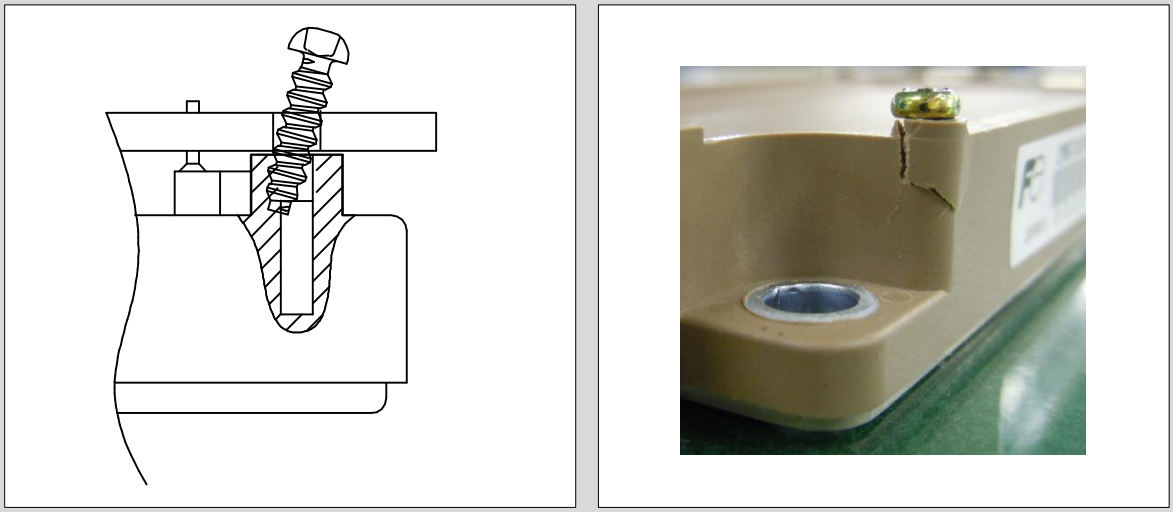
4. As shown in Fig.9, use screws with a diameter of 2.4 to 2.6 mm and a length of 7.0 to 10.0 mm from the underside of the PCB.
5. Manual screwing is recommended. When using an electric screwdriver, optimize the parameters such as tightening conditions to avoid mechanical damage. Check that the product is not damaged after tightening. Also, the screwing speed should not exceed 300 rpm. It may result in mechanical damage as shown in Fig.10.



(a) Recommended screw dimension (diameter)

(b) Recommended screw dimension (length) and mounting image

Fig.9 Recommended screw dimensions and mounting image



(a) Example of screw in tilted state

(b) Example of mechanical damage

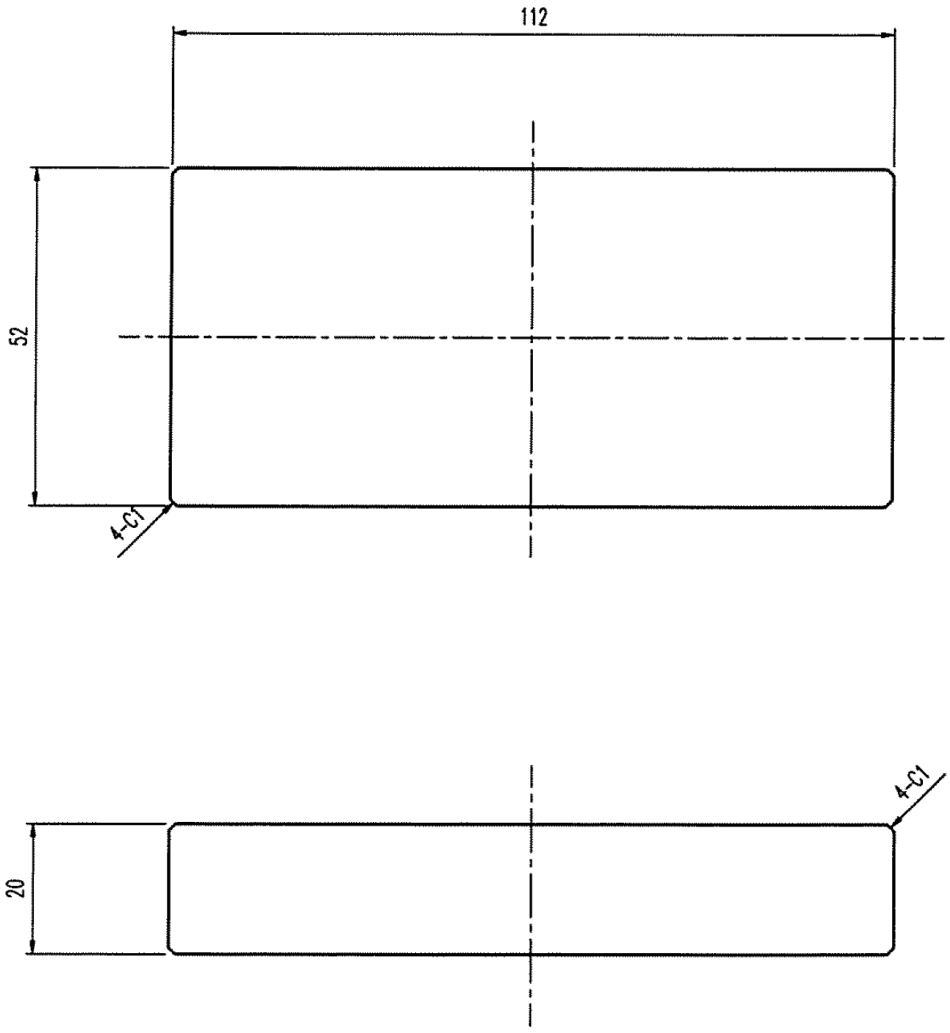
Fig.10 Poor example of screw tightening

Appendix : Press-in / press-out tool drawing

Appendix 1. For M721 and M647

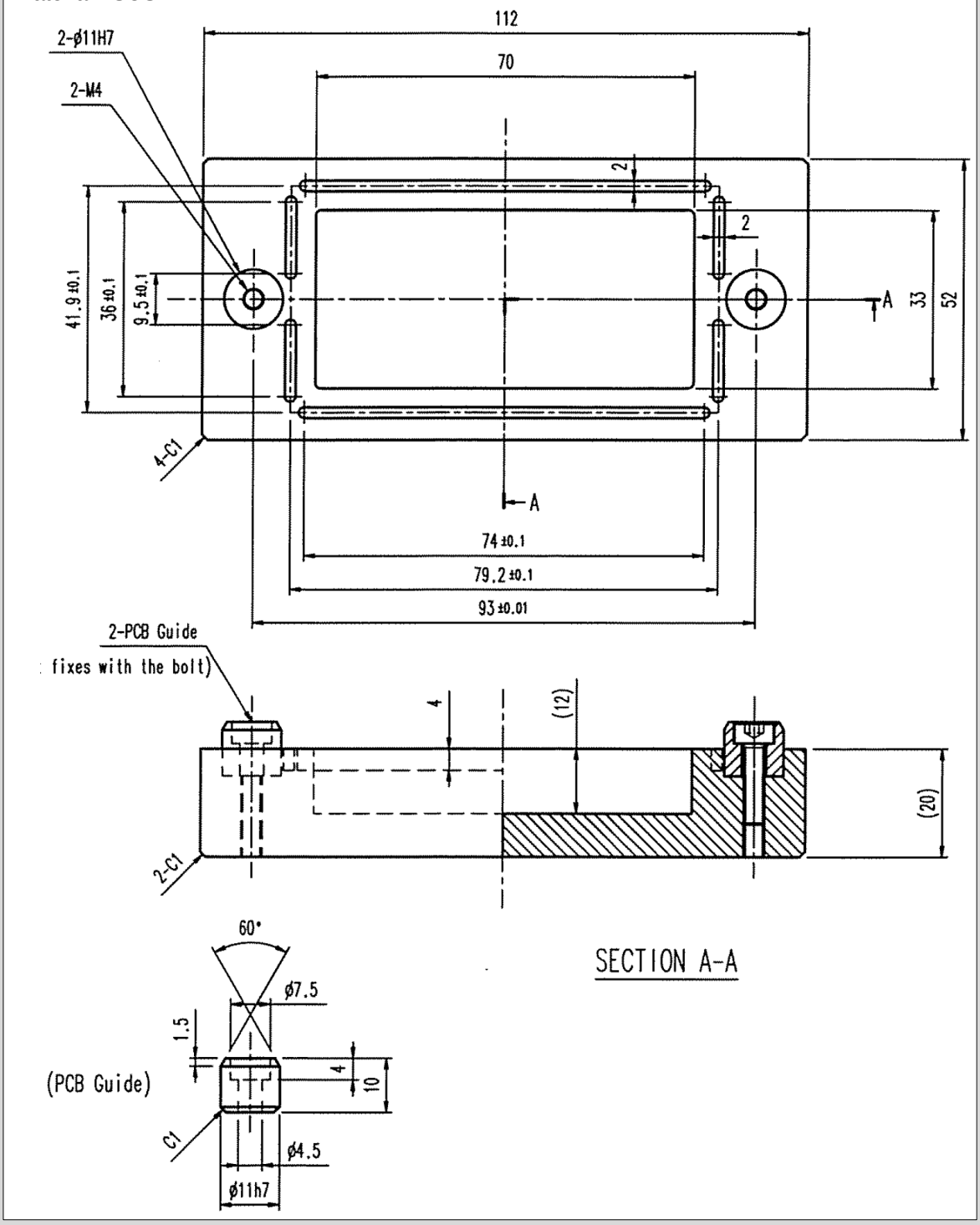
Appendix 1-1. Press-in upper tool (M721, M647)

Unit : mm
Material : SUS



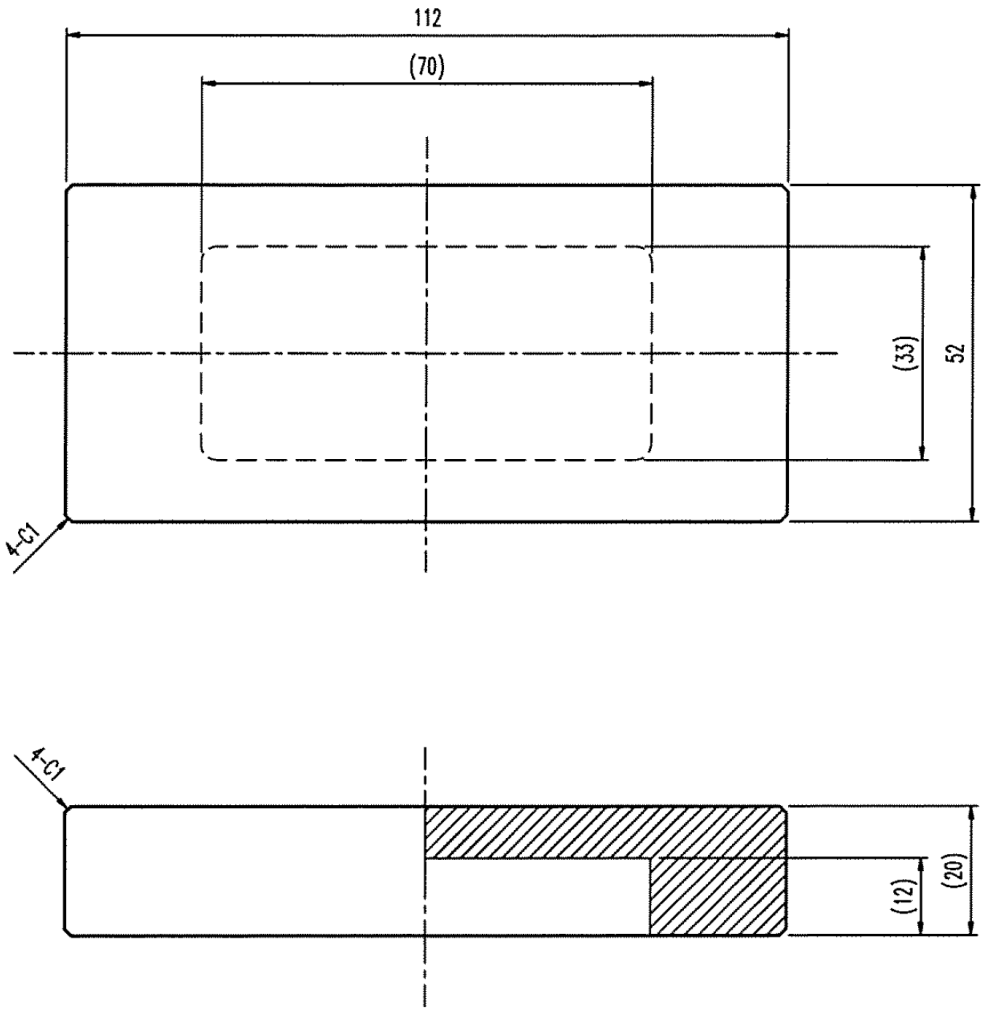
Appendix 1-2. Press-in lower tool (M721, M647)

Unit : mm
Material : SUS



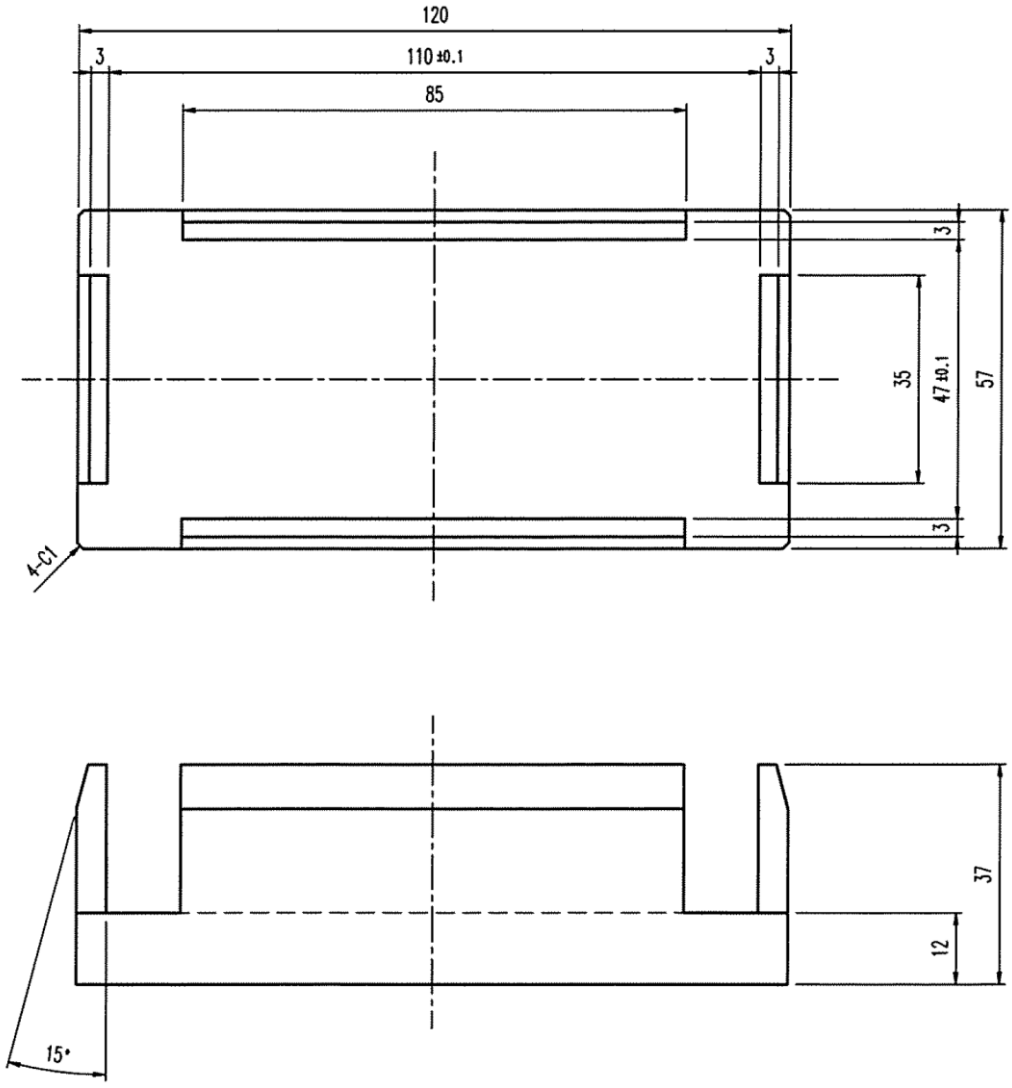
Appendix 1-3. Press-out upper tool (M721, M647)

Unit : mm
Material : SUS



Appendix 1-4. Press-out lower tool (M721, M647)

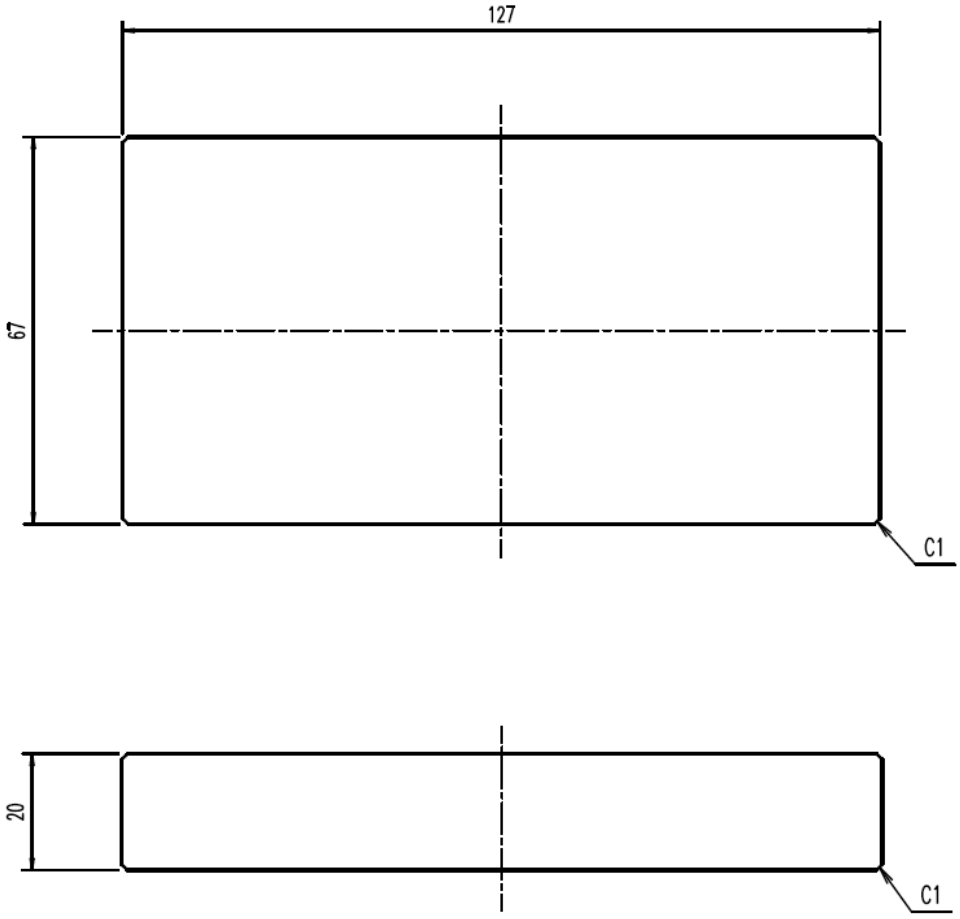
Unit : mm
Material : SUS



Appendix 2. For M722, M648 and M1202

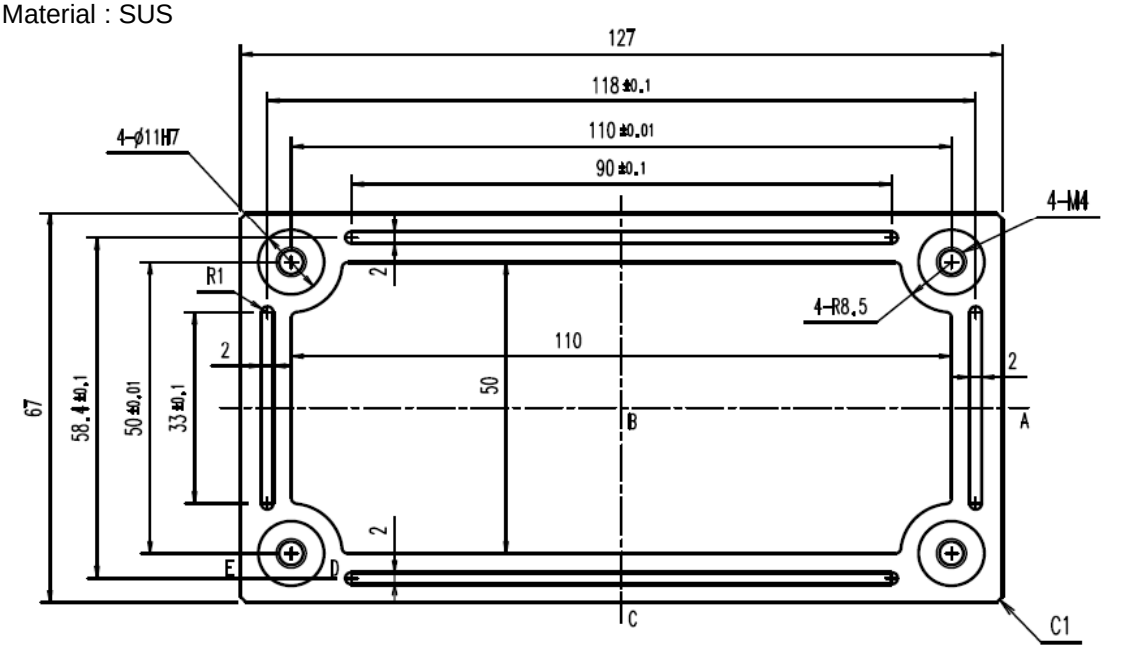
Appendix 2-1. Press-out upper tool (M722, M648, M1202)

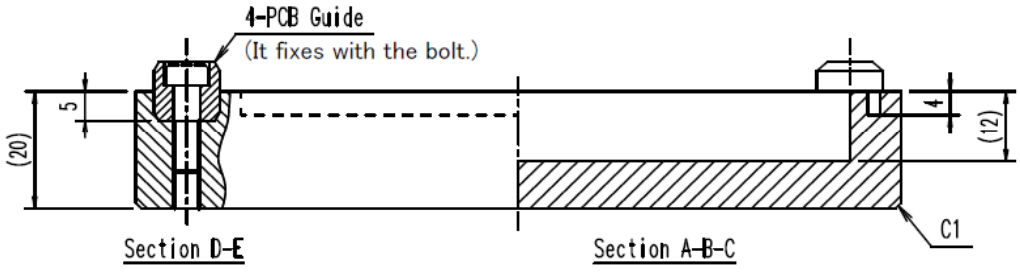
Unit : mm
Material : SUS

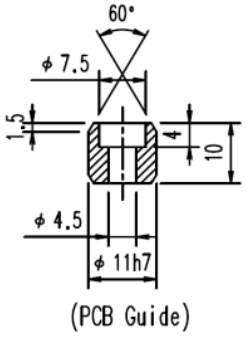


Appendix 2-2. Press-in lower tool (M722, M648, M1202)

Unit : mm
Material : SUS

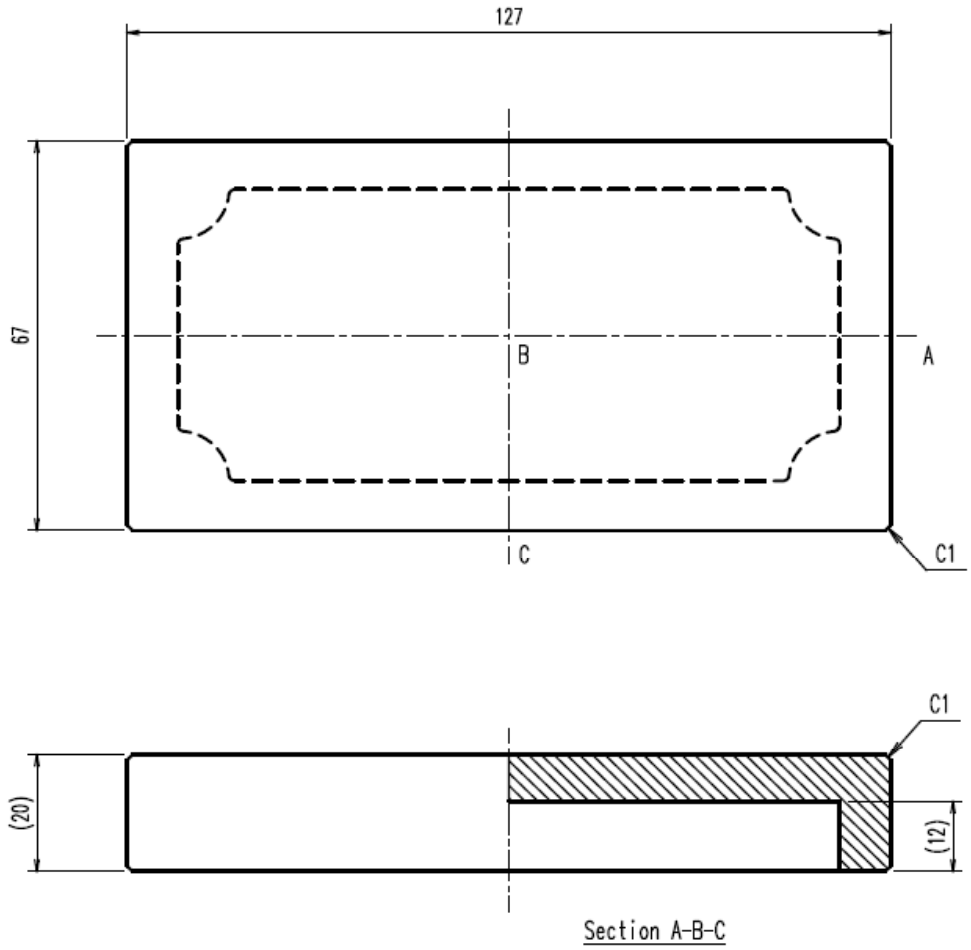






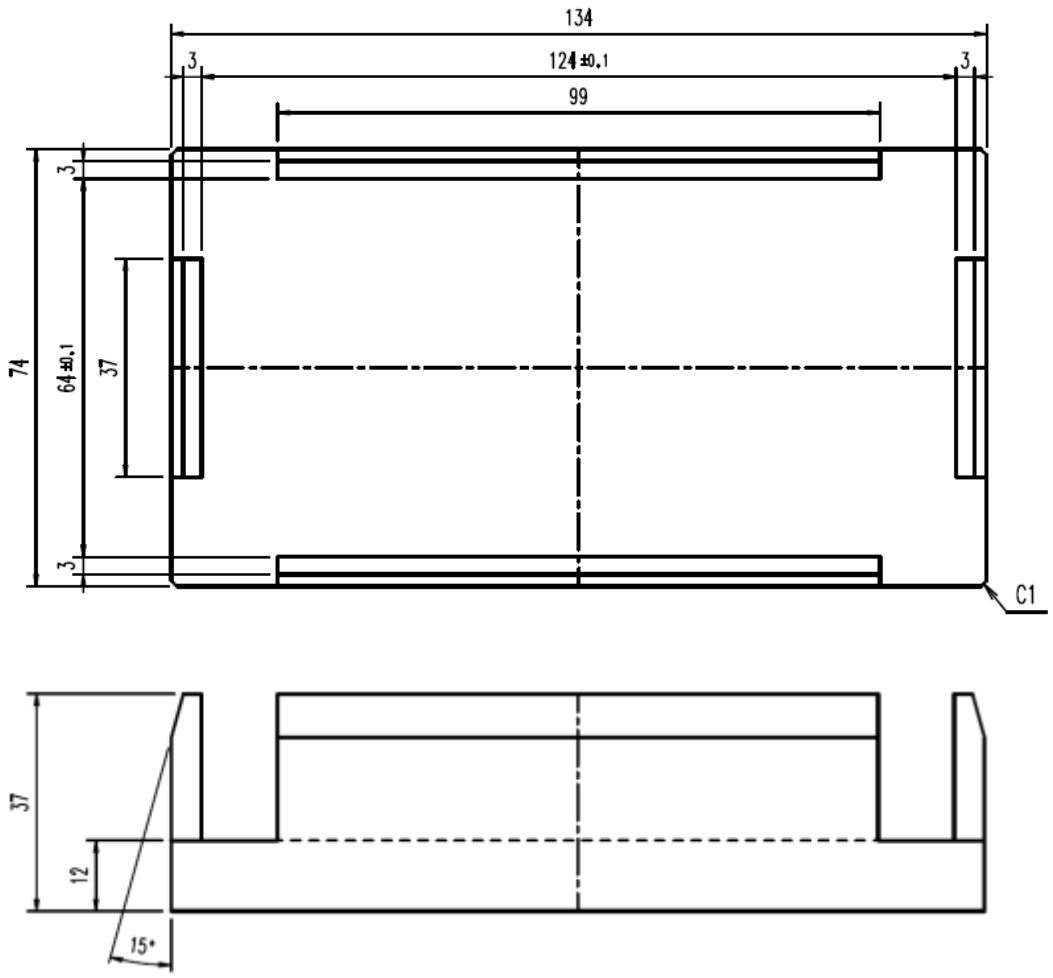
Appendix 2-3. Press-out upper tool (M722, M648, M1202)

Unit : mm
Material : SUS



Appendix 2-4. Press-out lower tool (M722, M648, M1202)

Unit : mm
Material : SUS



3. Mounting to heat sink

3-1. Surface conditions of heat sink

Design the heat sink so that the following surface conditions are satisfied. If the roughness and flatness do not satisfy the conditions, it may cause an increase in contact thermal resistance, or insulation failure due to package cracking.

1. The surface roughness(R_z) of the heat sink should be 10μm or less.
2. The surface flatness of the heat sink should be 50μm or less in absolute value per 100mm, taking the straight line connecting the center points of the two screw mounting holes as reference. Here, "+" (plus) is defined when the heat sink has a convex shape, and "-" (minus) is defined when the heat sink has a concave shape. If both shapes exist, the sum of the absolute values of the maximum and minimum values should be 50μm or less.

* The flatness must satisfy the above value within the entire module mounting area including the two screw clamps.

Fig.11 shows the definition of surface roughness and flatness of the heat sink.

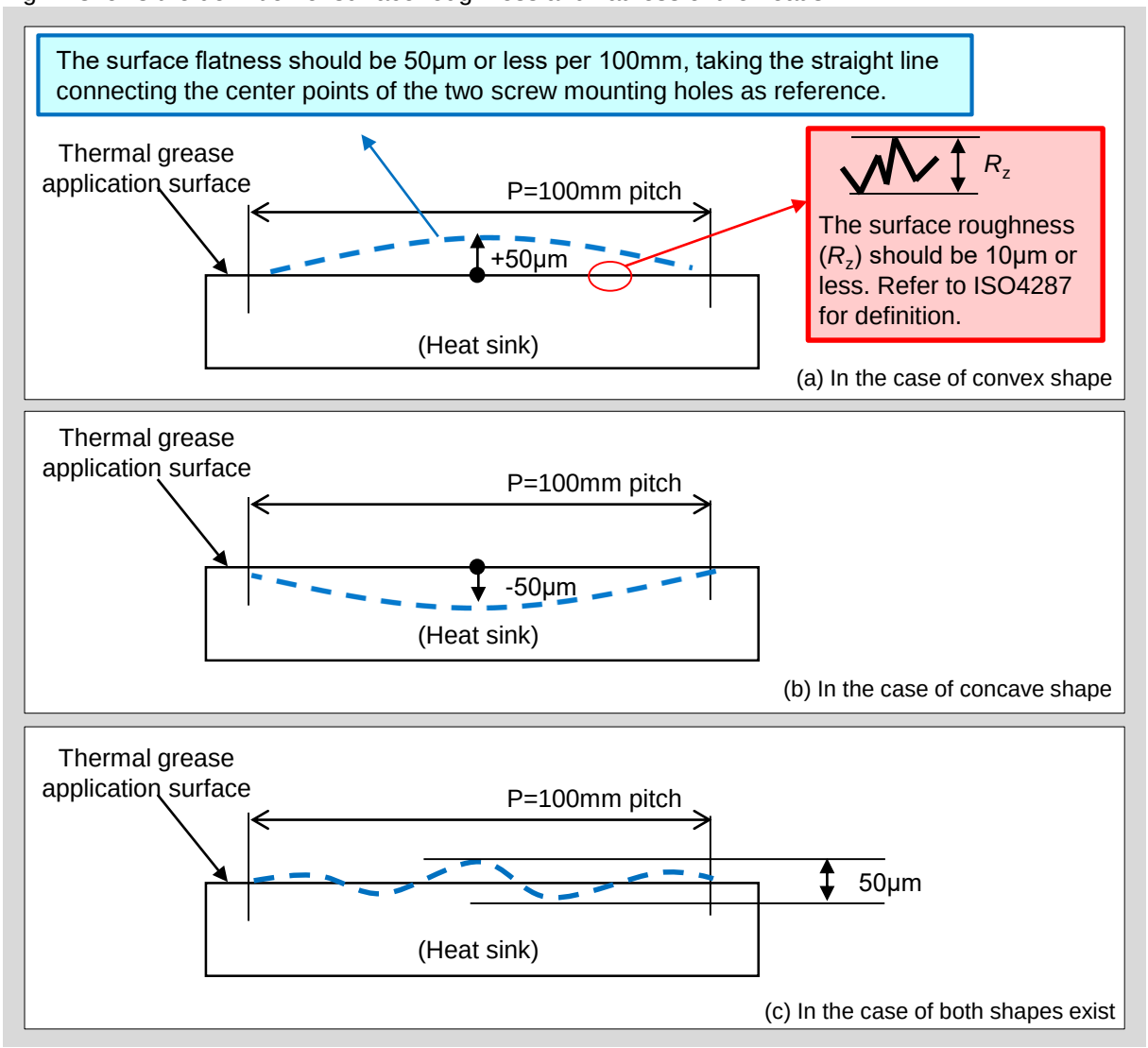


Fig.11 Heat sink surface flatness and roughness

3-2. Application of thermal grease

Thermal grease must be applied between the product mounting surface and the heat sink to ensure heat dissipation from the product to the heat sink. Thermal grease should be applied to the mounting surface of the product.

Improper thermal grease characteristics, application amount, and application method can lead to thermal breakdown due to deterioration of heat dissipation caused by thermal grease not spreading sufficiently throughout the product, or to a reduction in product life due to degradation or depletion of thermal grease during high temperature operation or temperature cycling. Pay attention to the selection and application method of the thermal grease.

Assuming that the thickness is uniform, the required amount (weight) of thermal grease can be calculated from the following formula.

Thermal grease weight (g) x 10^4	=	Thermal grease thickness (μm)	x	Base plate area of module (cm^2)	x	Density of thermal grease (g/cm^3)

The stencil method of application is recommended to control proper thickness (Figure 12). The recommended stencil mask pattern (Table 4) can be provided upon request.

The spreading of thermal grease can be checked by removing the product after mounting. Make sure that the thermal grease is well spread over the entire product mounting surface.

When applying thermal grease, should check not only the spread of the thermal grease over the entire surface of the product, but also the heat dissipation of the product.

Fuji Electric confirmed that the spreading which is not a problem in actual use using ELECTROLUBE's HTC thermal grease with our specified stencil masks and heat sinks of the shape described in our specifications. Table 5 shows typical characteristics of HTC thermal grease.

Additionally, the use of phase change thermal interface material and thermal sheet may cause excessive stress on the product as described below.

- Phase change thermal interface material :

When the grease solidifies, its hardness increases significantly compared to normal thermal grease. If there is a step between the fastening points due to the grease, the product may be subjected to excessive stress at the step when fastening the product. To reduce product stress during fastening, consider measures such as increasing the fastening torque in stages, fastening while heating and softening the grease. After the grease softens and spreads, the tightening torque may decrease. Consider measures such as retightening within the specified torque range or using spring washers.

- Thermal sheet :

If there is a step between the fastening points due to the sheet, the product may be subjected to excessive stress at the step when fastening the product. Please consider placing the sheet over the entire backside of the product, including around the heat sink fastening screw holes.

The above explanation shows the basic concept of thermal grease, but when using it, customer is responsible for making the decision to apply it with sufficient application verification.

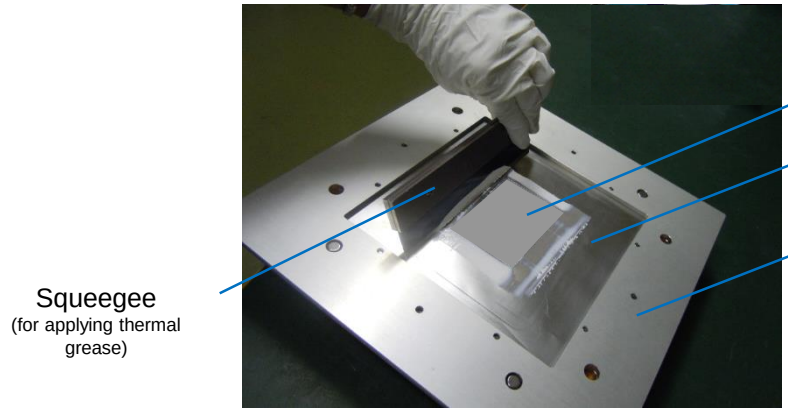


Fig.12 Thermal grease application

Table 4 Recommended stencil mask pattern and module package number

Stencil mask pattern	Module package number
Type A	M721,M647
Type B	M722, M648, M1202

Table 5 Typical characteristics of HTC thermal grease and recommended thickness

	Unit	Value
Viscosity (23deg.C, 1RPM)	Pa･s	202 ~ 205 *
Thermal conductivity	W/m･K	0.9 *
Average thickness after spreading	μm	100 +/- 30

* Excerpt from HTC Technical Data Sheet

3-3. Screw tightening the module to heat sink

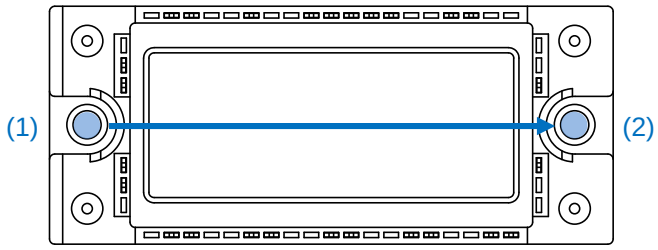
This section describes how to tighten the screws when mounting the module to heat sink.

1. Use M5 screws to fix the module to heat sink.
2. To fix the module with even force, first perform temporary tightening with 0.5N･m. Fig.13 shows the tightening sequence.
3. Perform final tightening in the same sequence as temporary tightening. The final tightening torque should be within the following range. V-series: 2.5 ~ 3.5 N･m, X-series: 2.5 ~ 6.0 N･m.

Fuji Electric conducts quality verification using the following screws and washers.

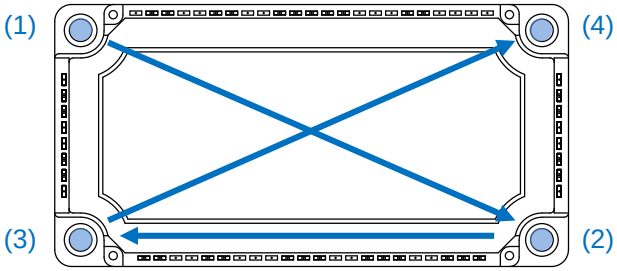
M5 bolt with built-in washer, Strength class 10.9 with black oxide film

(Spring washer dimensions : JIS1251, Flat washer dimensions : JIS1256)



	Tightening torque	Tightening sequence
Temporary tightening	0.5±0.1 N･m	(1)→(2)
Final tightening	V series : 2.5 – 3.5 N･m X series : 2.5 – 6.0 N･m	(1)→(2)

(a) Screw tightening torque and screw tightening sequence (M721, M647)



	Tightening torque	Tightening sequence
Temporary tightening	0.5±0.1 N･m	(1)→(2)→(3)→(4)
Final tightening	V series : 2.5 – 3.5 N･m X series : 2.5 – 6.0 N･m	(1)→(2)→(3)→(4)

(b) Screw tightening torque and screw tightening sequence (M722, M648, M1202)

Fig.13 Screw tightening torque and screw tightening sequence

3-4. Fixing the printed circuit board to heat sink

This product enables current to flow through contact between the through hole part of the PCB and the press-fit terminals. In order to secure the PCB safely and ensure contact reliability against vibrations, etc., it is recommended that the PCB be structurally reinforced by fixing it to the heat sink with spacers, screws, etc., as shown below.

Fig.14 shows the spacer height for fixing the heatsink and PCB.

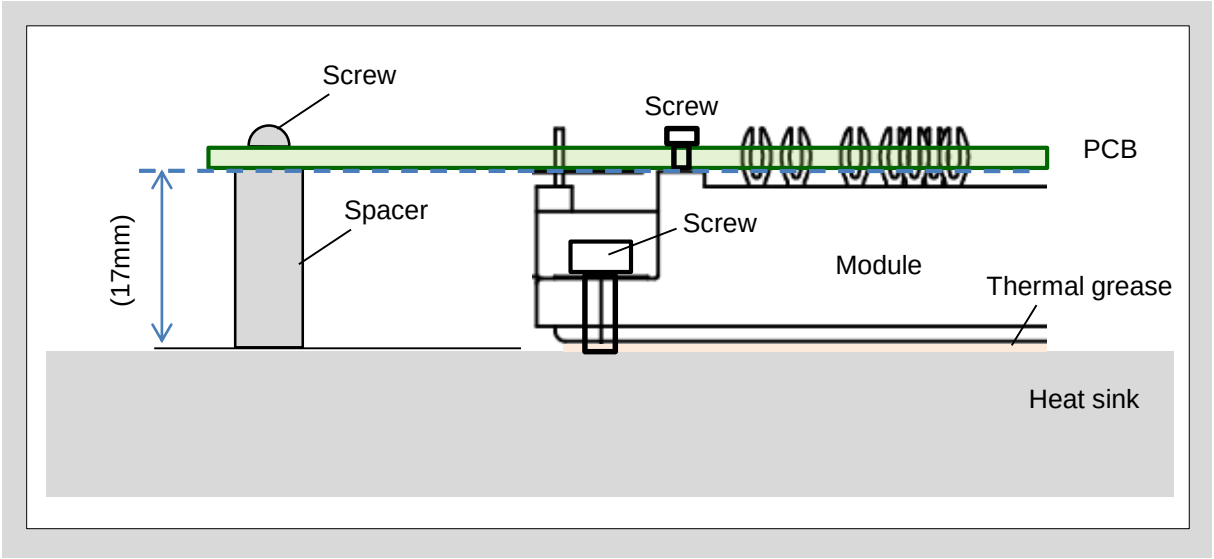


Fig.14 Fixing the printed circuit board to heat sink

4. Warning

(1) If the printed circuit board is not suitable, the terminals temperature may exceed the storage temperature. Use the terminals within the range of storage temperature.

(2) If longer screws than the allowable length described in this manual are used, the product may be damaged, causing ground faults and poor insulation. In that case, Fuji Electric Co., Ltd. Is not responsible for the matter.

(3) In any environment containing acids, alkalis, organic substances, corrosive gases (hydrogen sulfide, sulfurous acid gas, etc.) and corrosive liquids (cutting fluid, etc.), this product may oxidize or corrode, resulting in poor contact, disconnection, short circuit, ground fault, etc. In such cases, avoid using this product as it may cause malfunctions. In the unlikely event that a short circuit or ground fault occurs, there is secondary risk of smoke, fire, or explosion, etc. If this product is used under conditions containing these corrosive substances, Fuji Electric Co., Ltd. is not responsible regardless of the conditions (temperature, humidity, concentration, etc.).

(4) This product is not designed for use in a dusty environment. When used in an environment where dust is generated, heat dissipation may deteriorate due to clogging of the heat sink, and short circuits or ground faults may occur due to leaks between terminals or creeping discharge. (even if the dust is insulating materials such as fiber, leakage may occur due to moisture absorption.)

(5) When this product is pressed into the printed circuit board, if there are foreign objects between the product and the press-in tools, the isolation substrate of the product may be damaged and may cause isolation failure. Therefore, take measures against foreign objects during the press-in process.

This manual does not describe all applications and mounting conditions. Therefore, it is necessary to evaluate under actual usage conditions and confirm the mechanical characteristics, electrical characteristics, thermal characteristics, lifetime, etc.
The order in which CONTENTS is described in this manual does not indicate the order in which the products should be mounted. Please consider and decide the installation process.
The applications described in this manual are illustrative of typical applications using Fuji Electric's semiconductor products. This manual do not warrant or grant licenses for the enforcement of industrial property rights or other rights.

5. Storage and transportation notes

5.1 Storage

(1) Please manage the storage location so that the temperature is 5 to 35°C and the humidity is 45 to 75%. If more than a year has passed since the product was manufactured under these storage conditions, confirm that the terminal solderability is not deteriorated before mounting.
(2) Avoid exposure to corrosive gases and dust.
(3) Rapid temperature changes may cause condensation on the product surface. Therefore, store products in a place with minimal temperature changes.
(4) During storage, it is important that nothing be placed on top of the products, since this may cause excessive external force on the case.
(5) Store products with unprocessed terminals. Corrosion may form causing processed connections to have high contact resistance or potential solder defects in later processing.
(6) Use only antistatic containers for storing products in order to prevent ESD damage.

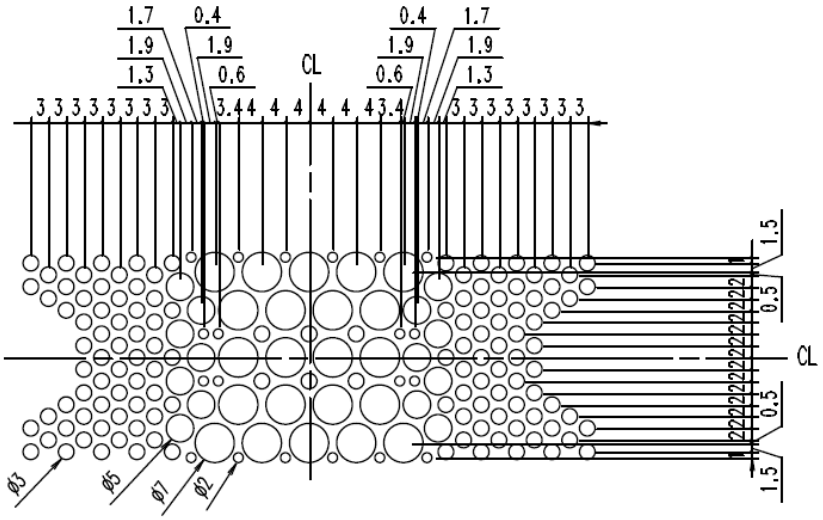
5.2 Transportation

(1) Do not drop or cause impact to the products which could otherwise cause mechanical stress.
(2) When transporting several products in the same box or container, provide sufficient ESD padding between the products to protect the terminals and to keep the products from shifting.

6. Stencil mask drawing

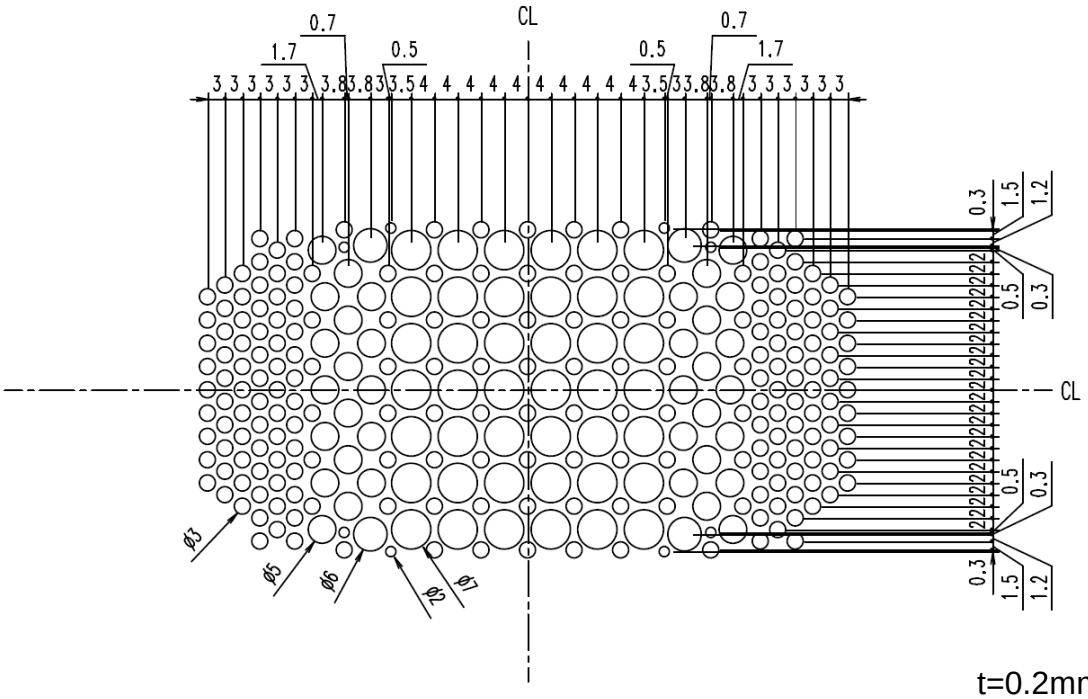
Stencil mask drawing for thermal grease application (recommended)
If you would like to obtain the following data, please contact our sales department.

Type A : M721, M647



t=0.2mm

Type B : M722, M648, M1202



t=0.2mm

Warning:

The contents in this manual (product specifications, characteristics, data, materials, structure, etc.) are as of December 2023. The contents are subject to change without prior notice due to changes in product specifications or for other reasons. When using a product described in this manual, please obtain the product's latest specification and check the data.