Fuji IGBT Module
Mounting instruction

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e-Front runners

Fuji Electric Co., Ltd.

PressFIT IGBT module mounting instruction
section-1 press-in/push-out

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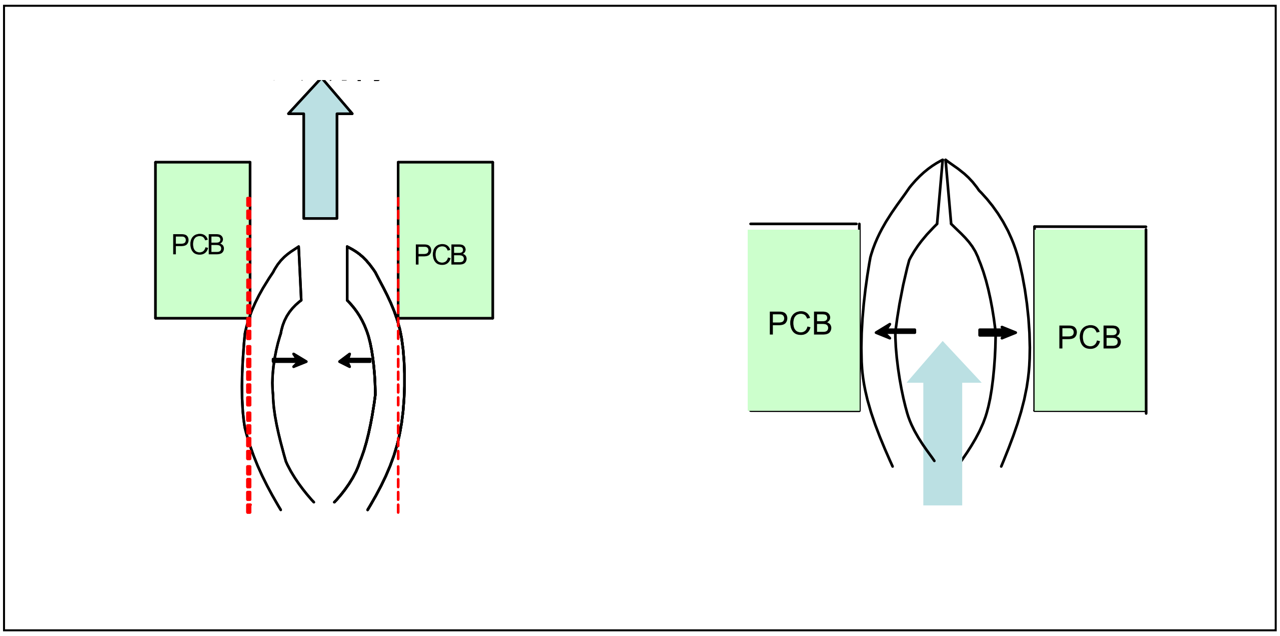
1 General Information

This application note describes the recommended PCBs specification and mounting / un-mounting advises of Fuji Electric (here in after Fuji) Press FIT IGBT modules.

This application note cannot cover every type of application and/or conditions. Therefore, Fuji PressFIT modules, which are used out of these suggestions on PCB and mounting process, will not have any warranty and/or guarantee under any circumstances. We recommend you or your technical partners to confirm throughout electro-mechanical evaluation in practical applications.

The PressFIT module provides solder less mounting onto PCB with low resistive stable contact. A PressFIT pin before insertion has opened shape as shown in Fig.1. After press-in processes, which are described in later section, the pin is closed by the contact pressure from both sides (Fig.2). During the press-in process, mechanical deformation of pin and materials of the PCB hole sidewall form cold-welding joints, it is possible to have low resistivity and stable contact with this new technology.

This application note describes a basic idea of the mounting restricted area of PCBs.
An individually consultation is needed about a detailed alimentation of the mounting restriction area.



2 Requirements on PCBs

This chapter describes the PCB recommendation for the Press FIT modules. PCB should have been designed within criteria in the Table1. For example, through hole diameter should be a range of 2.14mm to 2.29mm with properly Sn/Cu plated sidewall as described in the figure. When it smaller, mechanical issue in the press-in process would be found, on the other hands, if it bigger, shock and vibration and/or contact reliability may have concerns.

These results were experimentally obtained based from IEC60352-2. The evaluation is separately needed if PCBs which have out of these parameters.

PCB should have holes for guide pins of press-in tools with a specific position, hole diameter so that press-in lower and upper tool contact first and absorb the insertion force to protect PCB and its surface mounted devices from mechanical stress during press-in process.

<Recommended specification of PCB>

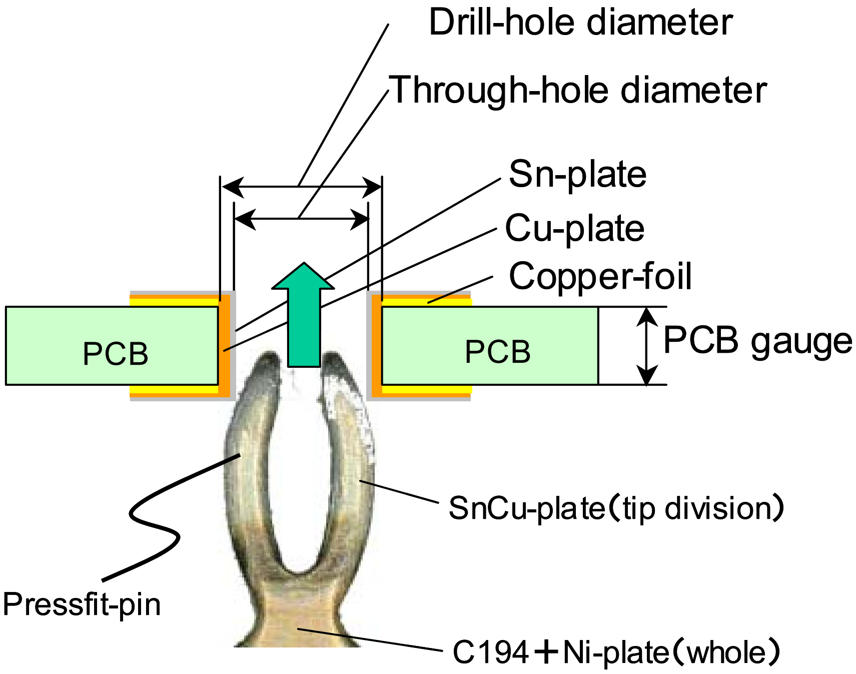


Table1. Recommended PCB specification

	min	typ	max
drill hole diameter	-	2.35mm	-
through hole diameter	2.14mm	2.2mm	2.29mm
Copper plating thickness in the hole	>25um	-	-
Metallisation in the hole	-	-	<15um
Copper gauge of the circuit board tracks	35um	70um 105um	-
PCB gauge	1.6mm	2.0mm	-
PCB material	FR4		

3 Mounting process and removing process

The procedure for mounting process and removing process of PressFIT module are described in this section. PressFIT module should be inserted within a specific range of mounting speed and force. If mounting force were below the limit, the module would have issue in low resistive and stable contact. On the other hand, mechanical damage on PCB and other parts mounted on the surface would be expected if too much press-in force.

When press-in, we recommend using the equipment as shown in Fig.3 to have accurate control in force control. We also recommend using specific press-in and push-out tools provided in the latter section with drawings.

Recommended press-in force and speed, push-out forces are described in the Table 2. Typical forces for each pin are also indicated in the table. Press-in speed of 25mm/min is also recommended to have good contact.

It is possible to remove a module from PCB and re-press-in to the PCBs again, however, we recommend soldering all pins for the modules that are not 1st-press-in, in order to avoid risk of mechanical damage during push-out process.

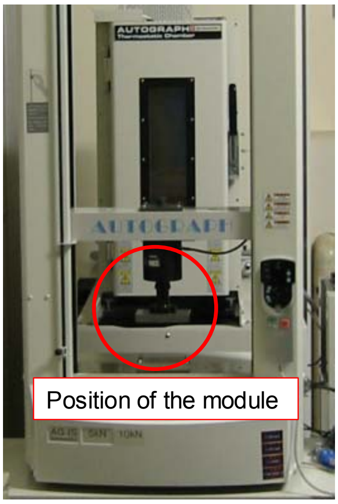


Fig.3 Press device picture

4 Example of Press-in and Push-out tools

Figures 4(a)-(d) are: (a) Photograph press-in toolset, (b) example of physical dimension (drawings) of press-in tools, (c) Push-out tools photo, (d) Push-out tool drawing examples

PCB-Guide in press-in lower tool works as mechanical stopper. Press-in lower and upper tool contact first and absorb the insertion force to protect PCB and its surface mounted devices from mechanical stress during press-in process. The height should be adjusted with the board thickness and press-in equipment.

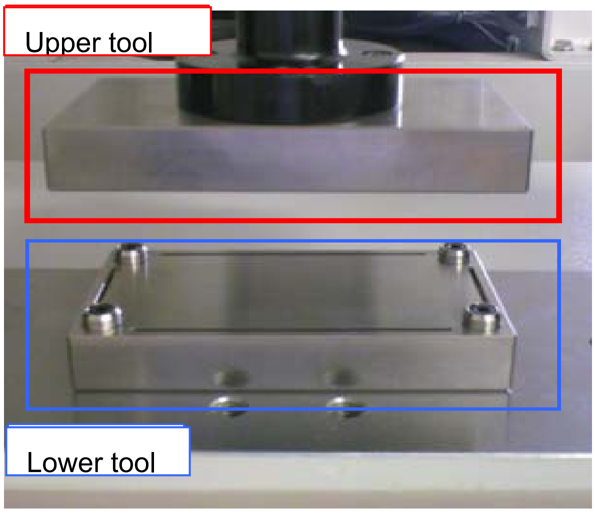


Fig.4(a) press-in tool set

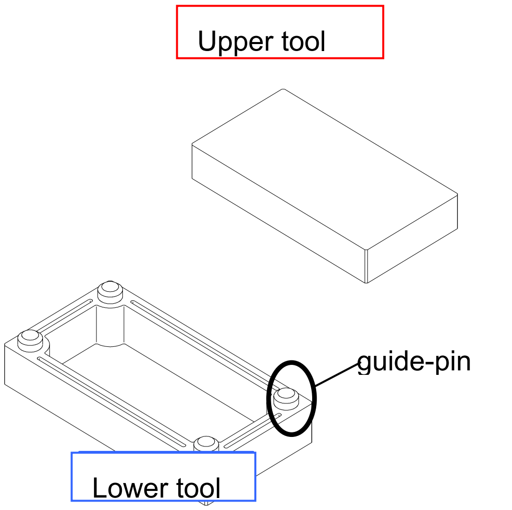


Fig.4(b) press-in tool drawing example

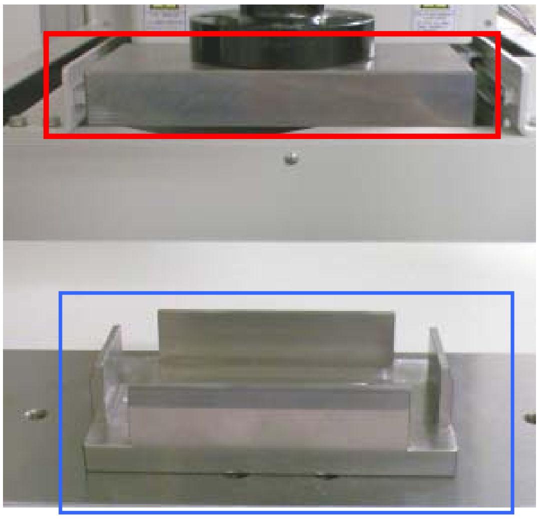


Fig.4(c) push-out tool set

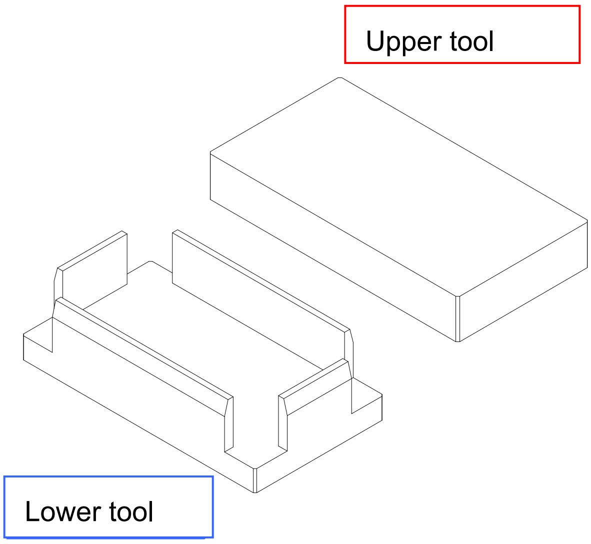
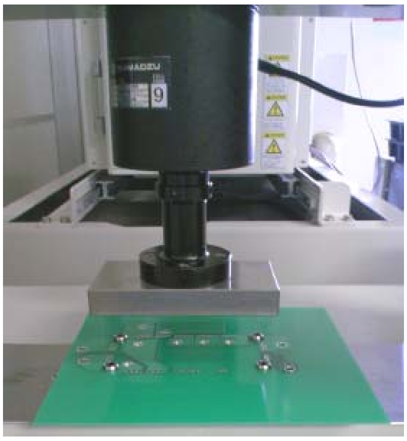


Fig.4(d) push-out tool drawing example

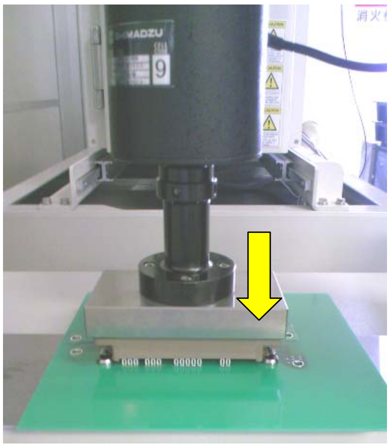
5 Example of mounting process of the module into the PCBs; Press-in



1 Set the lower and upper tools.

2 Place PCB on the lower tool to fit the PCB-guides.

3 Set the module upside down.

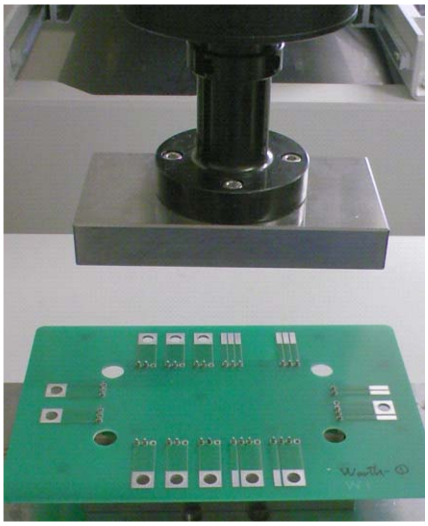


4 Press the module base plate by pressing equipment with recommended force and speed.

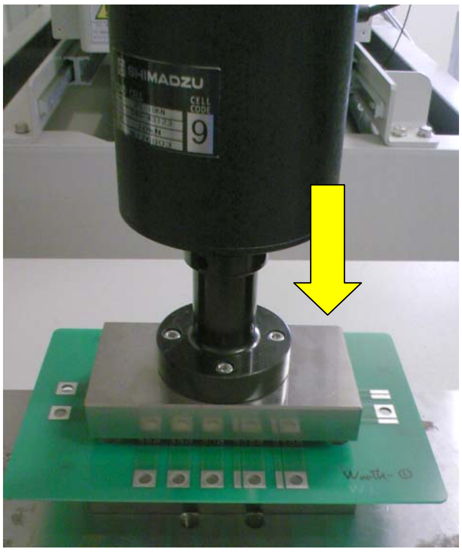
6 Example of removing process of a module from PCBs; Push out

1 Set the lower and upper tools
2 Set the PCB with module.
3 Push the top of the press-fit pins with recommended force.
4 Set the module upside down
5 The module and PCB will be separated and module will be dropped in the lower push-out tool.

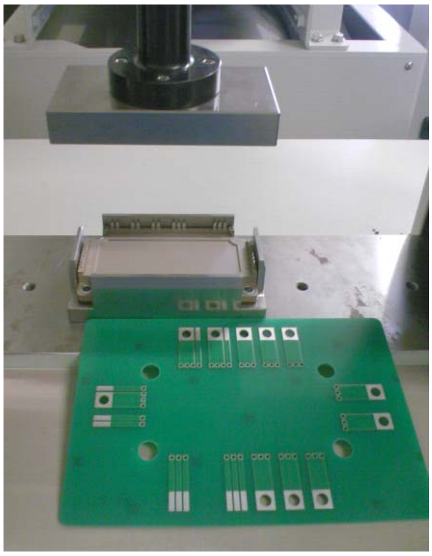
1 Set the lower and upper tools



2 Set the PCB with module



3 Push the top of the press-fit pins with recommended force

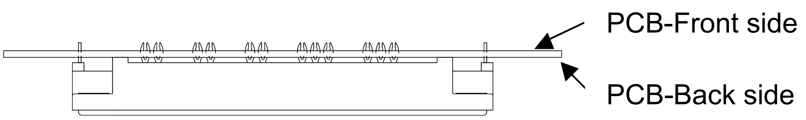


5 The module and PCB will be separated

Fig.6 Push out process

7 Restriction of mounting area of PCB surface components

In order to avoid risk of mechanical damage of other components mounted on PCB surface, we recommend reserving specific area, which would have high strain during press-in and/or push-put process. Figures 8 and 9 are restricted area for PCB front-side and backside, respectively. Basically, we recommend reserving 5mm in distance from the center of pins.



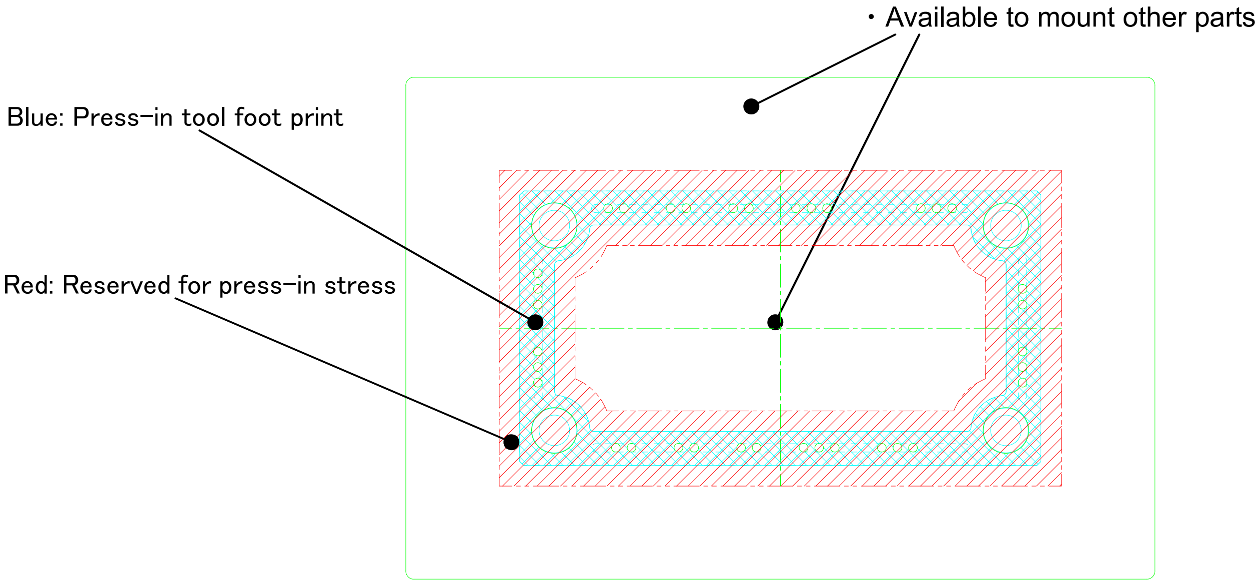


Fig.8 PCB designing recommendation (Front side)

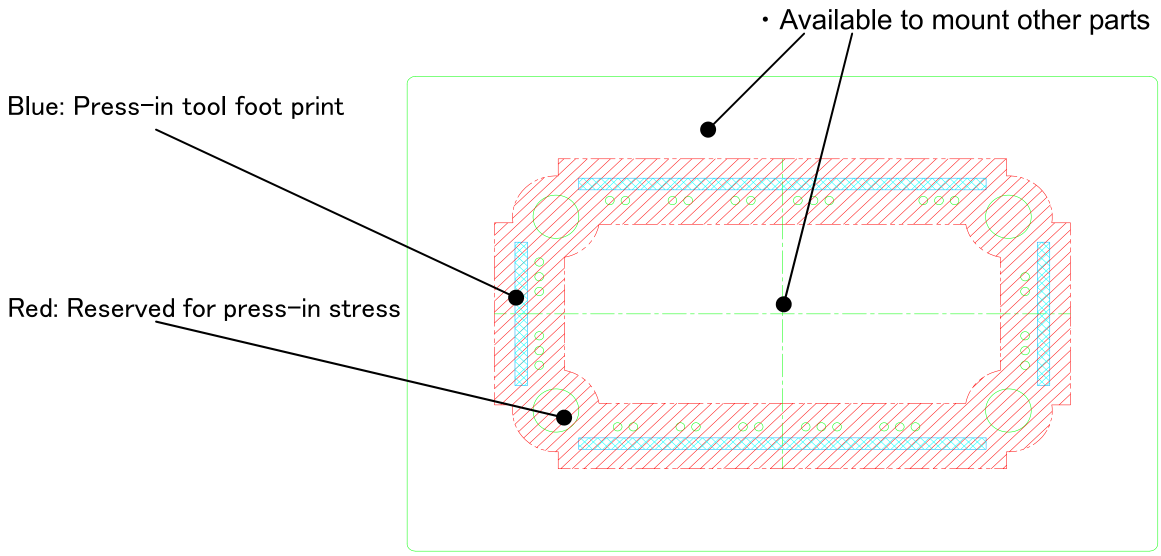


Fig9. PCB-Back side (Back side)

8 Press-in and push-out force

Recommended press-speed and the load (average a pin) of mounting process is shown at the under Table 2 shows the press-in speed and the press-in forces per pin in case of a small hole diameter (2.14mm) and a big diameter (2.29mm).

On the other hands, Table 3 shows push-out forces typical per pin in case of a small hole diameter and a big diameter.

Table2. In case of Mounting process

Hole diameter	2.14mm(min)		2.29mm(max)
Press-in speed	25mm/min		
Press-in Forces typical per pin	93N		74N

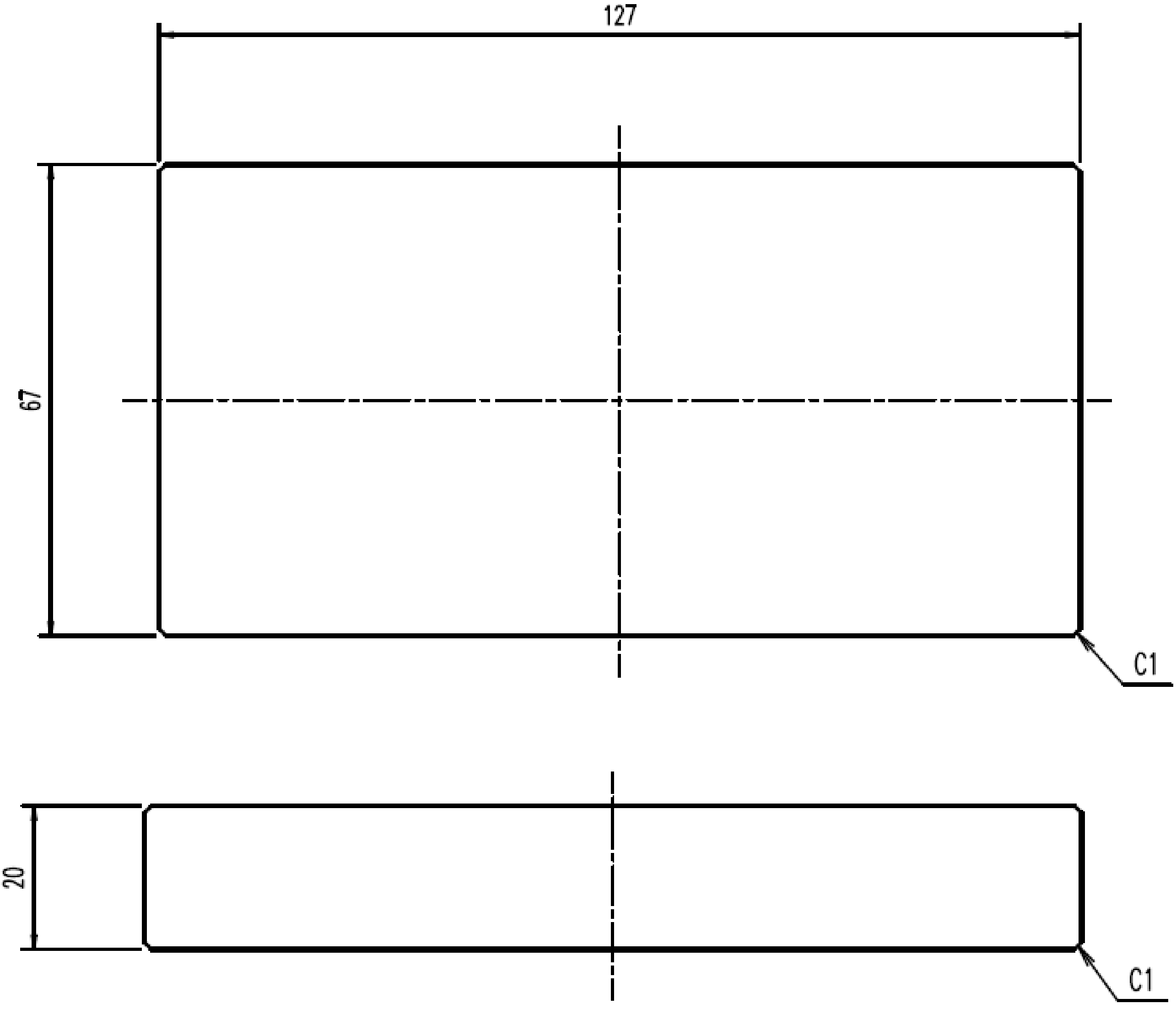
Table3. In case of Removing process

Hole diameter	2.14mm(min)		2.29mm(max)
Push-put Forces typical per pin	45N		49N

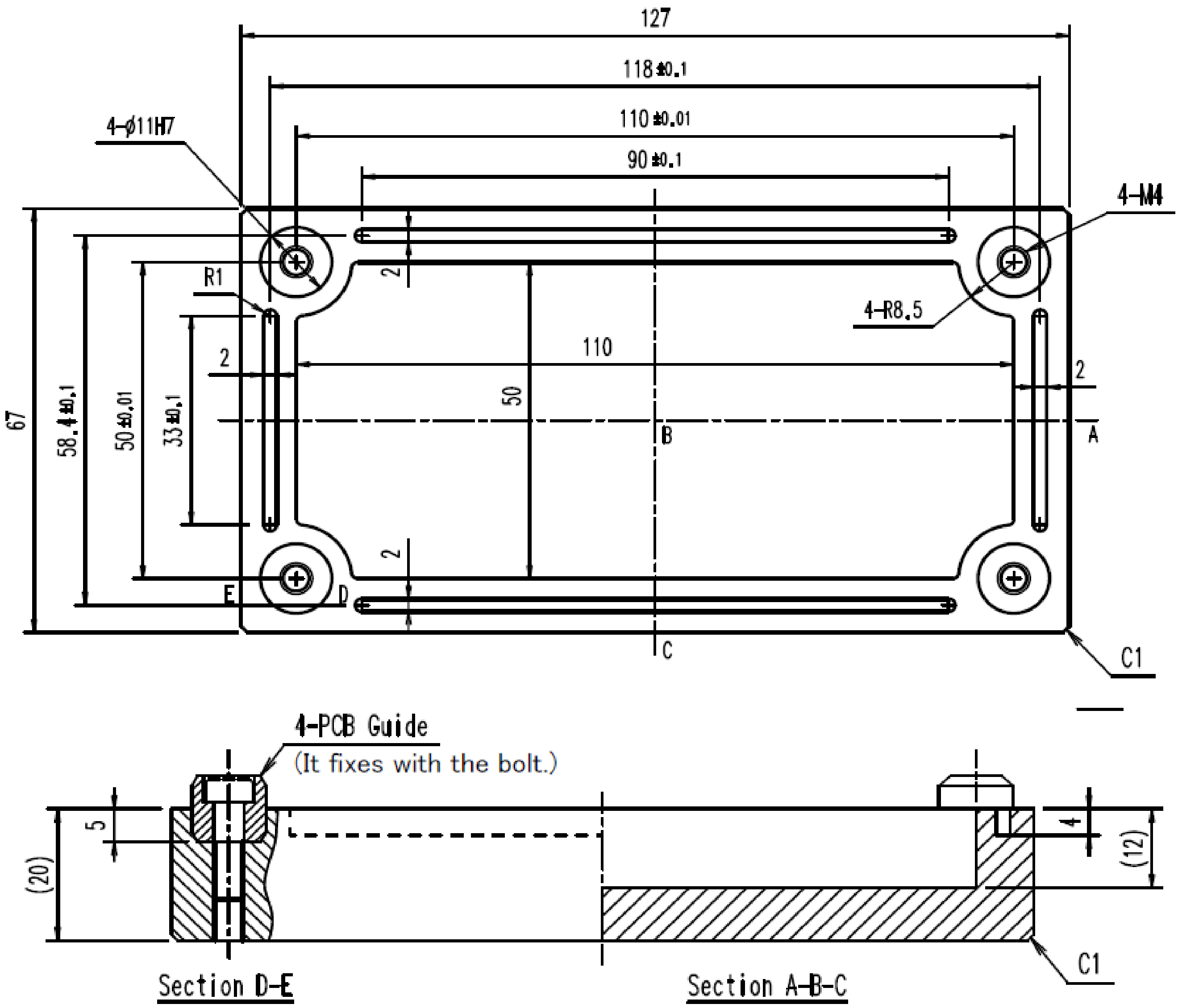
9 Drawings of recommended Press-in tool

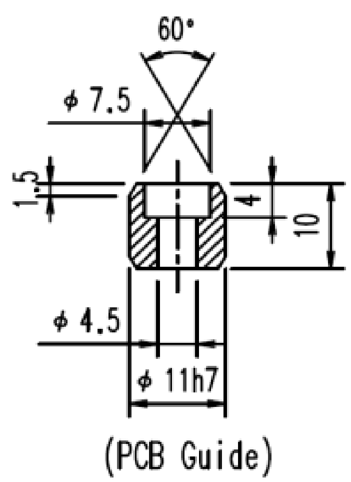
Press-in tool (upper)

Unit:mm



Press-in tool (lower)
Unit:mm
Metarial:SUS



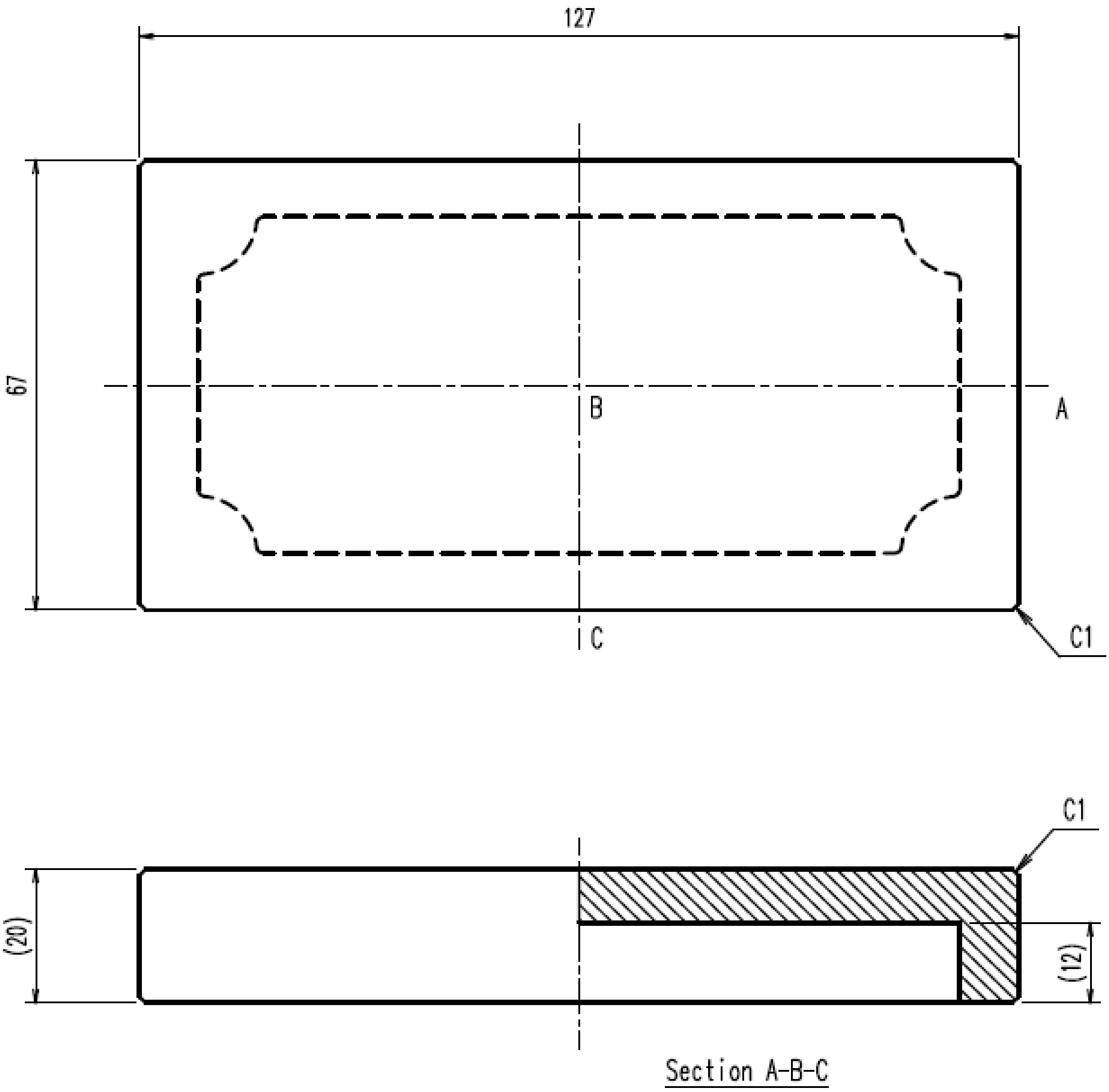


10 Drawings of recommended Push-out tool

Push-out tool (upper)

Unit:mm

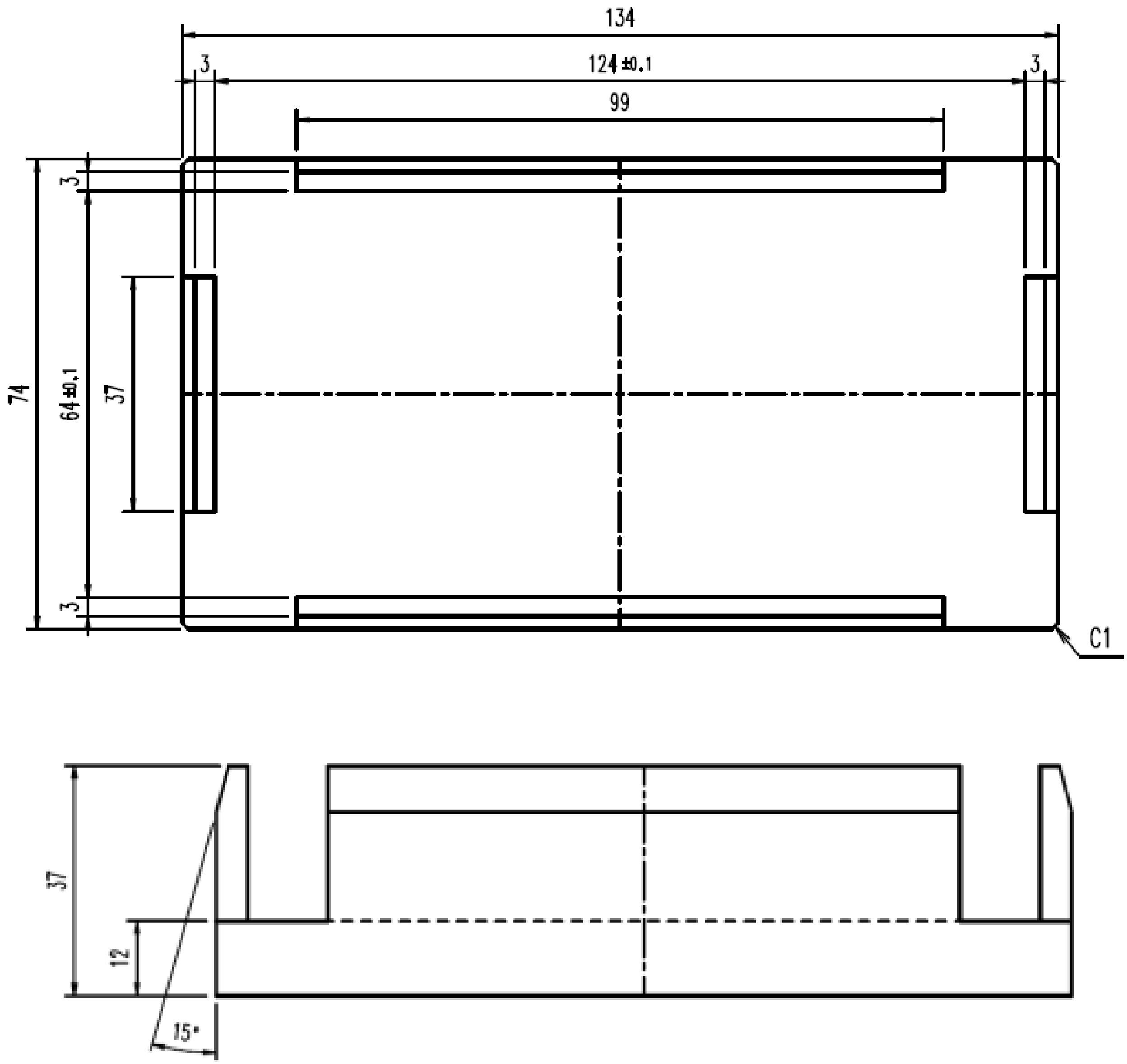
Metarial:SUS



Push-out tool (lower)

Unit:mm

Metarial:SUS



Mounting instruction for M260 package
(V-series spring contact module)

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This section provides information how to mount IGBT modules of M260 package, so called DualXT(Spring).

This mounting instruction is available for type name(s) of 2MBI XXX VJ- XXX -5X .
(X is number of 0~9.)

1 Mounting IGBT modules_

This section presents how to mount M260 package, so called “DualXT(Spring)”.

1.1 Mounting on heat sink

The thermal resistance between IGBT module base plate and heat sink depends on module location, thermal properties of heat sink and cooling methods. In general, each system has different heat sink properties such as thermal conductivity and cooling fan, this section focuses on module location on heat sink. Followings should be taken into account in IGBT module mounting process since thermal resistance varies according to the position of the mounted modules:

- ✓ IGBT modules should have thermally optimized layout on heat sink according to the mechanical-thermal design so that the modules have good heat spread to minimize the thermal resistance.
- ✓ The distance between IGBT modules should be optimized based on the mechanical-thermal design and the estimated total power dissipation for each module to avoid the thermal coupling effect between modules mounted on the next

1.2 Heat sink surface finishing (module mounting area)

The mounting surface of the heat sink should be finished to the roughness of 10μm or less. A warp based on a length of 100mm should be 50μm or less. If the surface of the heat sink does not have enough flatness, the modules may have unexpected increase in the contact thermal resistance (Rth(c-f)). If the heat sink flatness does not match the above requirements, the high stress in the DCB on the modules may result high voltage insulation failure.

1.3 Thermal grease pasting

Thermal grease between heat sink and module base plate is strongly recommended to reduce the contact thermal resistance. Screen-printing, rollers and spatulas are typical method of thermal grease pasting, however, stencil mask is recommended when target grease thickness is less than 100μm.

Table 1 Recommended properties of thermal grease

Items	Recommendation
Penetration (typ.)	>= 338
Thermal conductivity	>= 0.92 W/m.K
Thermal grease thickness	100μm +/- 30μm

*1 The thermal desistance between the heat sink and the module depends on the thermal grease properties and thickness. We strongly recommend customer to check contact interface after mounted to confirm if the interface has good thermal grease spreading. Also we recommend checking the thermal interface conditions after thermal cycling if the thermal grease has low viscosity.

*2 Stencil mask pattern electric data and recommended method are also available on request.

1.4 Mounting procedure

Mounting procedures onto heat sink are described.

(a) Minimum and maximum torque for mounting M5 screws indicated (1)-(4) in the picture on the right are:
Minimum: 2.5Nm
Maximum: 3.5Nm

(b) Pre-torque is recommended with 1/3 of the final torque with sequence (1) - (2) - (3)-(4) in Fig.1

(c) Final torque must be within specified force of 2.5 to 3.5 Nm with sequence (1) - (2) - (3)-(4)

(d) To comply the creepage and clearance distance, the total height of screw and washer must not exceed 6.0mm.

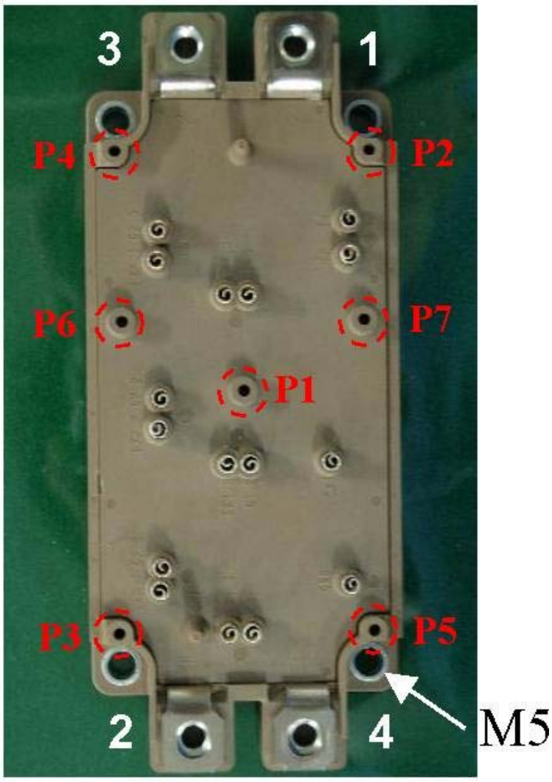


Fig.1Mounting holes 1-4 in M260 modules

1.5 PCB mounting procedure

PCB mounting processes are described.

(a) Minimum and maximum torque for mounting M2.6 self tapping screws indicated P1 to P7 in Fig.1:
Minimum : 0.4Nm
Maximum: 0.6Nm

(b) Pre-torque is recommended with 1/3 of the final torque with sequence P1-P2-P3-P4-P5-P6-P7 in Fig.1.

(c) Final torque must be within specified force of 0.4 to 0.6Nm with sequence P1-P2-P3-P4-P5-P6-P7 in Fig.1.

Maximum screw rotation speed is 300 rpm.

1.6 Electrostatic Discharge (ESD) protection

If excessive static electricity is applied to the control terminals, the devices can be broken. Some countermeasures against static electricity is necessary.

2 Connecting main terminals

2.1 Bus bar connection

- Screw M6
- Screw length Bus bar thickness + (7 to 9mm)
- Screw torque Minimum 3.5Nm / Maximum 4.5Nm
- Maximum terminal temperature 100°C

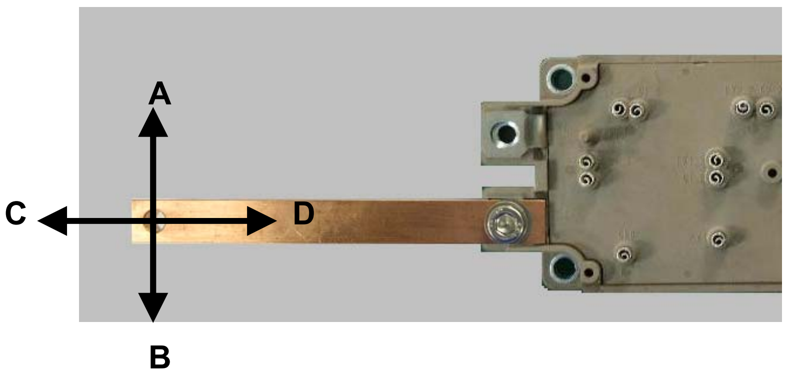
<Important notes>
Special care should be taken when mounting bus bar to IGBT main terminals so that the terminals do not have excess forces. The principle of a lever sometimes makes the moment of force much bigger than expected especially when installing to long bus bar. In addition, the terminals may have seriously damages when the module is fixed with miss alignment in position between the module terminal and bus bar holes. Well alignment to the module terminals and bus bar holes are recommended to reduce mechanical stress.

2.2 Maximum force vectors from bus bar

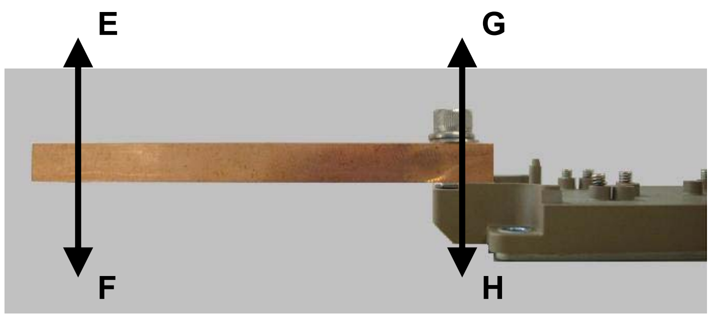
Maximum vectors and definitions are described in the table below.

Vector	Strength*
A	5 Nm
B	3 Nm
C	500 N
D	500 N
E	5 Nm
F	5 Nm
G	500 N
H	1000 N

*) Strength in the table is the mechanical capability for the short period in mounting process.



(a) Horizontal direction



(a) Vertical direction

Fig.2 Vector descriptions from bus bar

2.3 Clearance and creepage distance

In order to establish good isolation voltage, it is recommended for the IGBT application to have both clearance and creepage distance for the main terminal design as defined (a) and (b) in Fig.3 should be longer than minimum value of :

Clearance distance	9.5mm
Creepage distance	14.0mm

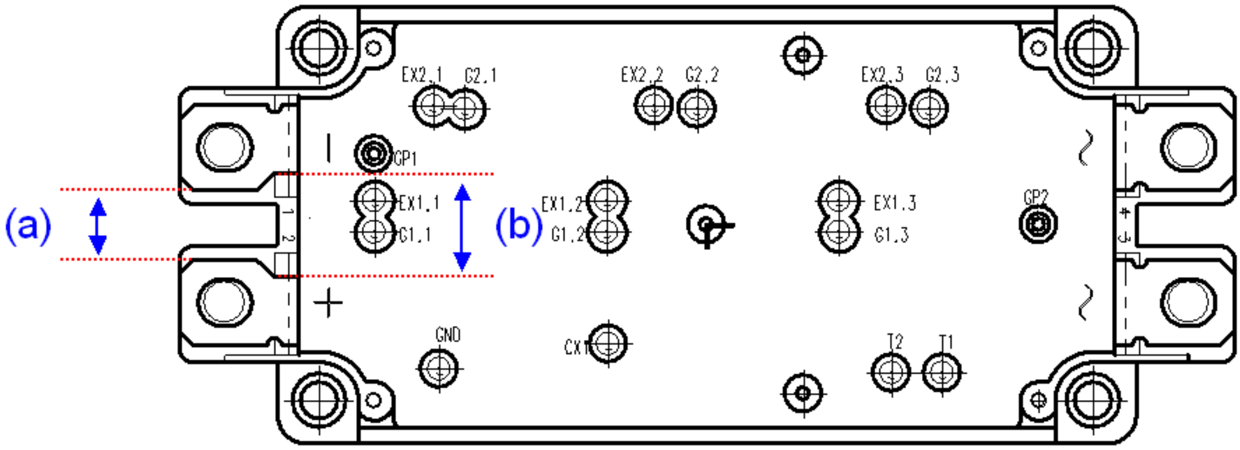
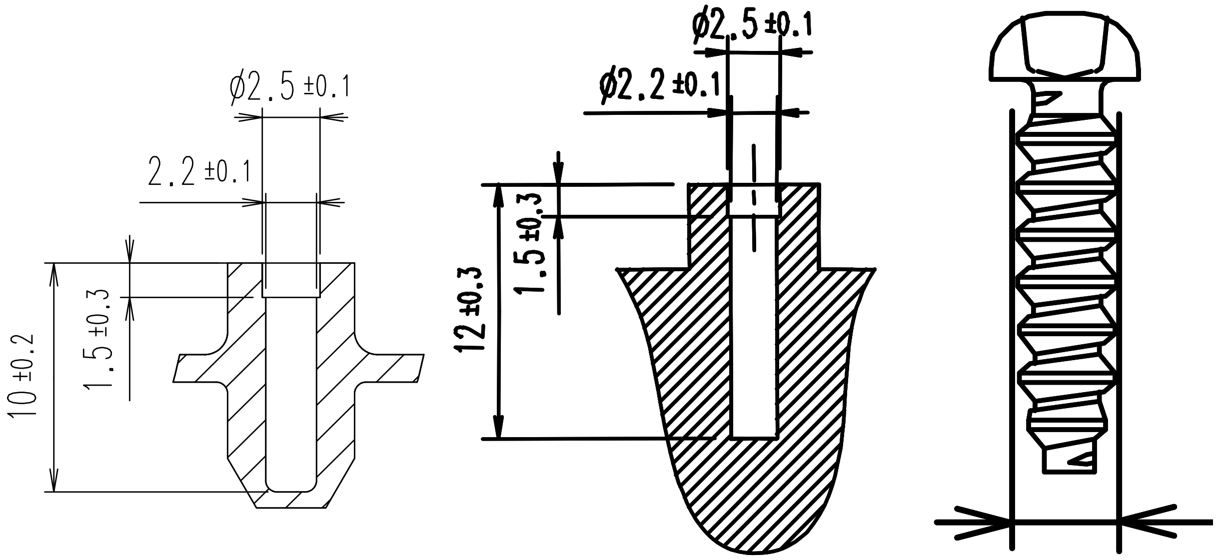


Fig. 3 Clearance and creepage distance for IGBT main terminals

3 Suggestions when mounting onto PCB

3.1 Recommended screws

As mounting holes for PCBs have step holes with diameter of 2.2mm and 2.5mm, screws with diameter of 2.4 to 2.6mm are recommended. Figures below shows recommended screw types and length. Self-tapping screws are recommended. In Japan, M2.6 screws are recommended.



(a) Hole for PCB; P1, P6 and P7 in Fig.1

(b) Holes for PCB; P2, P3, P4 and P5 in Fig.1

(c) recommended screw

Fig.4 PCB screw holes and recommended screw cross section

3.2 Screw length

5.0mm to 8.5mm + PCB thickness length screws are recommended to mount PCBs.

Recommended mounting torque is 0.4~0.6Nm, screws should be placed vertically. If screws are tightened with angles as shown in Figs.5 and 6, the pads on PCB and control terminals on IGBT modules may have loose electrical contact, which may have risk of module failure in worst case.

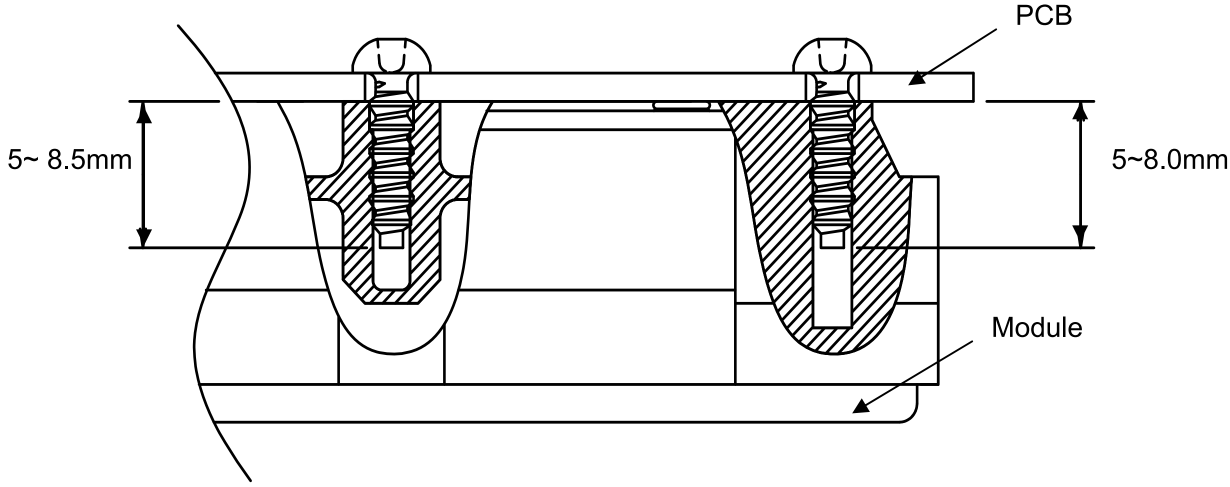


Fig.5 P1/P6/P7 hole cross sectional image of screw

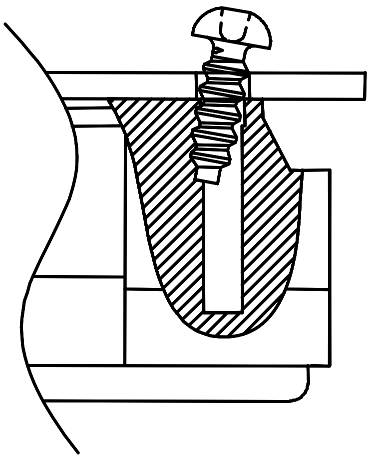


Fig.6 Bad example of screw tightened with angular position

3.3 How to mounting PCB screws

Manual tighten of PCB screw is preferable. However, if other tools such as electric drivers or other automated methods are used, parameter optimization and confirmation is recommended in practical installation process by customer so that IGBT module does not have mechanical damage by automatic screw process.

3.4 Example of mechanical damage with not recommended screw and/or process

PCB mounting is recommended by the methods above.

In case, not recommended screws and/or methods are used in IGBT installation process, it may have a risk of mechanical damage as shown in Fig.7. Screw types and process advanced confirmation is desirable.

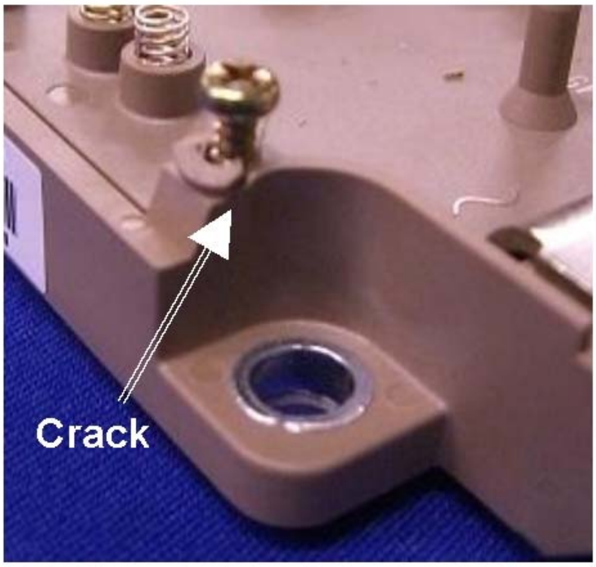


Fig.7 Mechanical damage example of IGBT module

4 Degradation of spring

4.1 H2S Gas exposure

Spring resistance may degrade in H2S Gas atmosphere. Initial spring contact resistance is around 100mΩ. It is increasing by H2S Gas exposure (please refer to Fig.8). Recommendation of total exposure is under 5000 [ppm Hr] which can control contact resistance under 500mΩ. Fig.9 shows photo of springs at initial and 1000ppm Hr. Even spring color change to yellowish at 1000ppm Hr , contact resistance is not increase. Life time of the spring can be calculating by expression (1).

Life time of spring = 5000 / H2S Gas density [Hr] ---- (1)

For example, H2S Gas density of normal atmosphere is around 0.005 ppm. Life time of the spring is 5000/0.005 = 1000000Hr = 114 year in normal atmosphere.

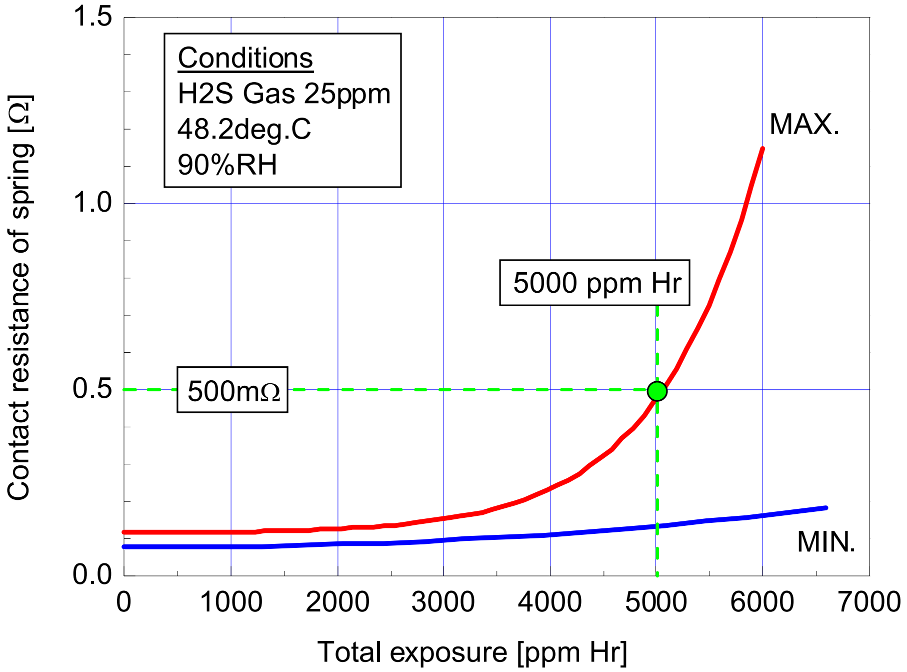
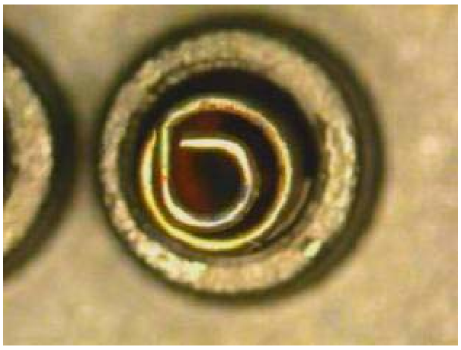


Fig.8 Contact resistance degradation (H2S Gas exposure)

(a) initial



(b) At 1000 ppm Hr

Fig.9 Spring discoloration (H2S Gas exposure)

4.2 SO2 Gas exposure

Spring resistance may degrade in SO2 Gas atmosphere. Initial spring contact resistance is around 100mΩ. It is increasing by SO2 Gas exposure (please refer to Fig.10). Recommendation of total exposure is under 1750 [ppm Hr] which can control contact resistance under 500mΩ . Fig.11 shows photo of springs at initial and 500ppm Hr. Even spring color change to yellowish at 500ppm Hr , contact resistance is under 500 mΩ . Life time of the spring can be calculating by expression (2) .

Life time of spring = 1750 / SO2 Gas density [Hr] ---- (2)

For example, SO2 Gas density of normal atmosphere is around 0.01 ppm. Life time of the spring is 1750/0.01 = 175000Hr = 20 year in normal atmosphere.

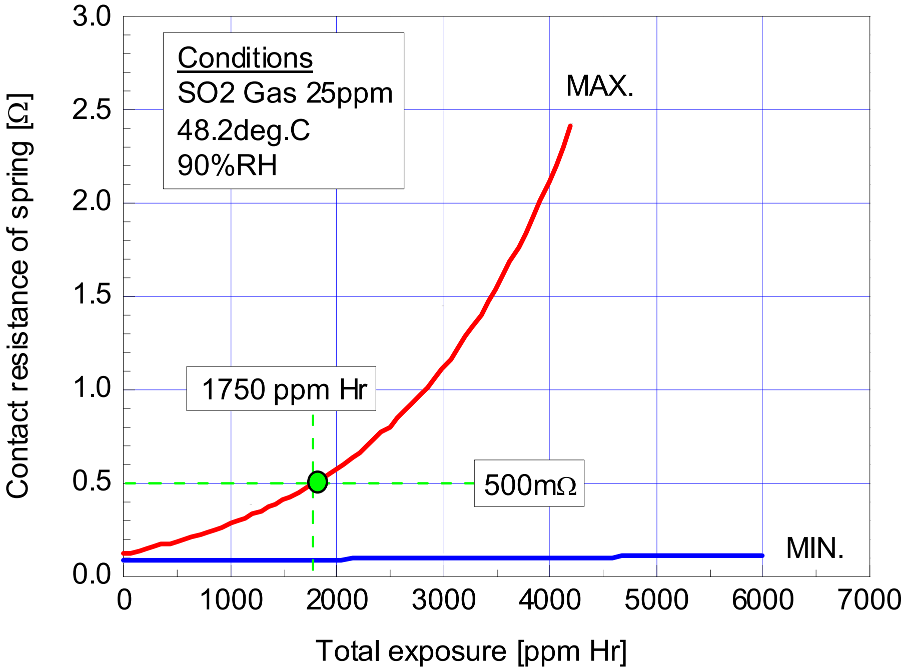
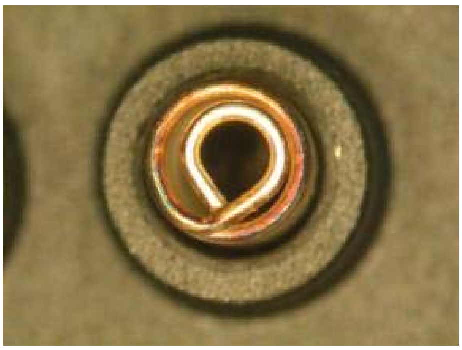


Fig.10 Contact resistance degradation (SO2 Gas exposure)

(a) Initial



(b) At 500ppm Hr

Fig.11 Spring discoloration (SO2 Gas exposure)

4.3 Spring color degradation by storage

Spring color may change black or yellowish, which is depended on by storage condition. Even spring color is change, the contact resistance of spring is under 500 mΩ if customer keeps storage condition which is defined by expression (1) and (2) of section 4.1 and 4.2. Table 2 shows contact resistance of initial and color degraded spring. Spring color degradation has not always influence for degradation of contact resistance.

Table 2 Example of color degradation of spring

Initial	Color degraded spring	
Contact resistance = 98mΩ 	94mΩ 	78mΩ 
	97mΩ 	84mΩ 

FUJI IGBT Modeules U Series
Mounting Instructions ECONOPACK™+

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This manual describes the recommended method to install and use ECONOPACK™+ safely.

Note: ECONOPACK™+ is a registered trademark of Infineon Technologies AG, Germany

1 Mounting

1.1 Colling fin mounting

Since thermal resistance varies according to the position of the mounted modules, pay attention to the following points:

a. When mounting only one module, position it in the center of the cooling fin in order to minimize the thermal resistance.

b. When mounting several modules, determine the individual positions on the cooling fin according to the amount of heat that each module generates. Leave more space for modules that generate more heat.

1.2 Cooling fin surface finishing (module mounting area)

The mounting surface of the cooling fin should be finished to the roughness of 10μm or less and a warp based on a length of 100mm should be 50μm or less. If the surface of the cooling fin is not flat enough, there will be a sharp increase in the contact thermal resistance (Rth(c-f)). If the flatness of the cooling fin does not meet the above requirements, the mounted module will experience extreme stress on the DBC substrate possibly destroying its insulating barrier.

Roughness: 10μm max:
Flatness of the cooling fin: 50μm max. (based on a length of 100mm)

1.3 Thermal compound application

To reduce the contact thermal resistance, we recommend applying thermal compound with screen printing, rollers or spatulas between the cooling fin and the base plate of the module. Recommended thickness of the compound is approx.100μm.

Recommended thermal compound for your reference

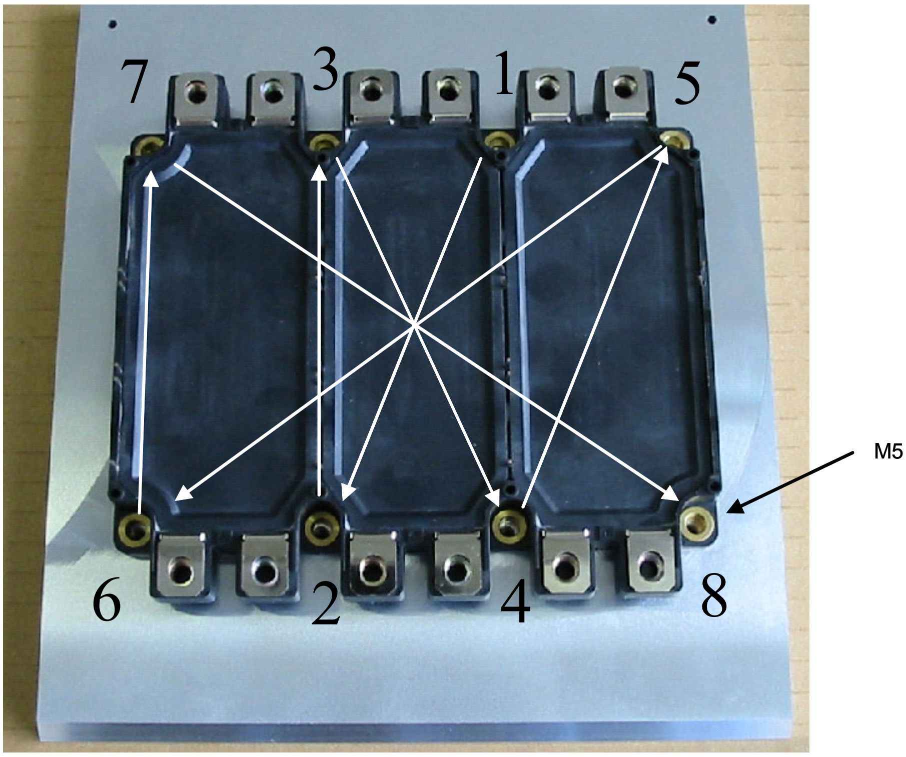
Penetration (typ.)	338 min.
Thermal conductivity	0.92 W/m·k min.
Thickness of the compound	100μm±30μm

Note:

1) The contact thermal resistance is dependent on the compound's efficiency and thickness. The thickness of the compound could be lessened if the warp of the cooling fin could be reduced. Use the above table as a reference to decide the thickness of the compound being used.
2) Confirm the expansion of the compound when the module is installed with high viscosity compound. On the other hand, note that low viscosity compound may flow out due to the temperature cycle.

1.4 Mounting procedure

1) Recommended tightening torques: 3 to 6 N•m (M5)
2) Initial: Torque 0.5 to 1.0 (N•m), sequence (1)-(2)-(3)-(4)-(5)-(6)-(7)-(8)
3) Final: Full specified torque (3 to 6 N•m), sequence (1)-(2)-(3)-(4)-(5)-(6)-(7)-(8)



1.5 ESD

If excessive static electricity is applied to the control terminals, the devices could be broken. Some countermeasures against static electricity is necessary. Refer to the Chapter 3-2 of the Application Manual (REH984).

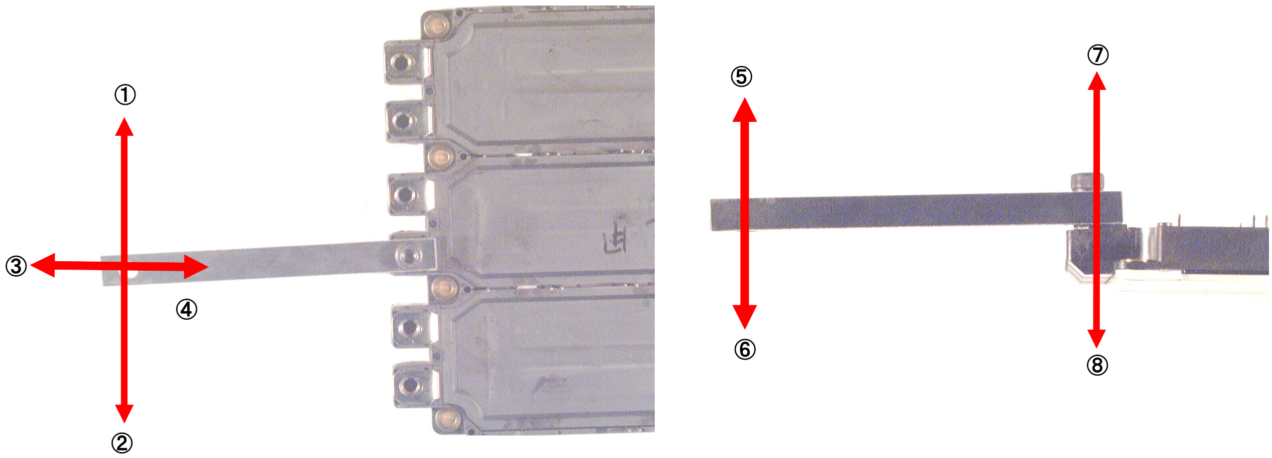
2 Main terminal connection

2.1 Bus bar connection

1) Screw: M6
2) Screw length: Bus bar thickness + (7mm to 9mm)
3) Tightening torque: 3 to 6 [N•m]
4) Allowable terminal temperature: 100°C max.

Note:
In case of connecting a bus bar to the main terminal, avoid excessive force to a terminal part.
Especially, the applied force at the opposite end of the copper bar will act as much bigger to the terminal part, because the moment force is proportional to the copper bar length.
Moreover, if a screw will be tightened when there is position gap between a terminal and a copper bar, stress will be generated continuously in the terminal part, and becomes the cause of damage.
Fasten the screw so that position gap does not occur.

2.2 Limitation of forces for the mounted conductors



Force direction	①	②	③	④	⑤	⑥	⑦	⑧
Strength*	5N•m	3N•m	500N	500N	5N•m	5N•m	500N	1000N

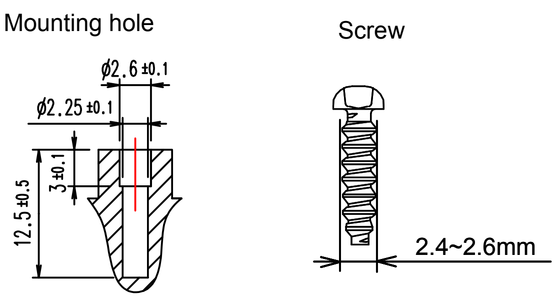
* Strength for a short time during mounting

3 PCB fixed on the module

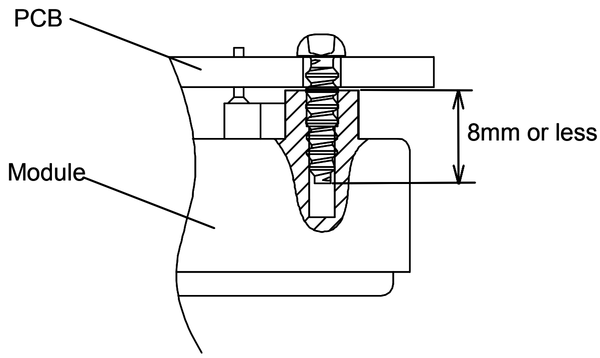
3.1 Fixing by screws

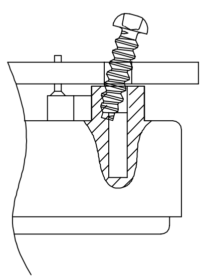
The hole diameters are 2.25mm and 2.6mm.
Therefore, a diameter of 2.4-2.6mm is recommended.

1. Screw type: Self tapping screw
   (In Japan, M2.6 self tapping screw)



2. Screw length : PCB thickness +(5mm to 8mm)

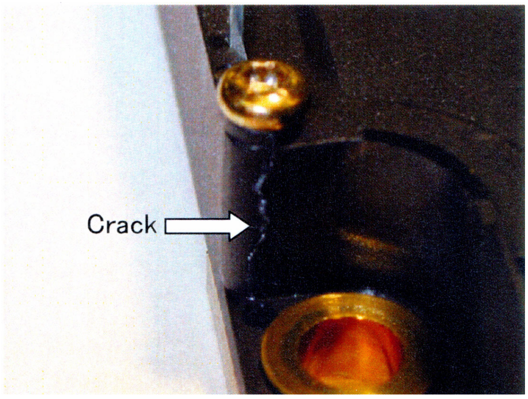




Note : Recommended tightening torque: 0.4 +/- 0.05 N•m
(Make installation of the screw perpendicular to the module.)

3. Recommended tightening method: Hand tightening

Note : If high speed tightening tool is used, the module case might be damaged. Confirm the tightening torque of the high speed tightening tool in advance.



Note : The case might break if screws beside the above recommendation are used.
Confirm the screws before using them.

3.2 Soldering pin-terminals

1) Plating of pin terminal: Sn/Cu (lead-free plating)
2) Recommended soldering method: Flow soldering or hand soldering
3) Soldering conditions

a. Flow soldering
Pre heat: 125°C max.
Post heat: 265°C/11s max.

b. Hand soldering (by soldering iron)
Iron tip temperature: 410°C max.
Soldering time: 5s/terminal max.

FUJI IGBT Modeules U Series
Mounting Instructions 2MBI400U(4)H-120

CONTENTS **Page**

This manual describes the recommended method to install and use 2MBI400U(4)H-120 safely.

1 Mounting

1.1 Mounting on heat sink

Since thermal resistance varies according to the position of the mounted modules, pay attention to the following points:

a. When mounting only one module, position it in the center of the heat sink in order to minimize the thermal resistance.

b. When mounting several modules, determine the individual positions on the heat sink according to the amount of heat that each module generates. Leave more space for modules that generate more heat.

1.2 Heat sink surface finishing (module mounting area)

The mounting surface of the heat sink should be finished to the roughness of 10µm or less and a warp based on a length of 100mm should be 50µm or less.

If the surface of the heat sink is not flat enough, there will be a sharp increase in the contact thermal resistance (Rth(c-f)). If the flatness of the heat sink does not meet the above requirements, the mounted module will experience extreme stress on the DBC substrate possibly destroying its insulating barrier.

Roughness: 10µm max.

Flatness of the heat sink: 50µm max. (based on a length of 100mm)

1.3 Thermal compound application

To reduce the contact thermal resistance, we recommend applying thermal compound with screen printing, rollers or spatulas between the heat sink and the base plate of the module. Recommended thickness of the compound is approx.100µm.

Recommended thermal compound for your reference

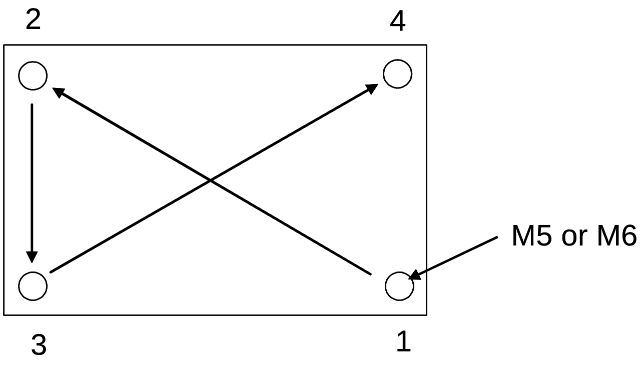
Penetration (typ.)	338 min.
Thermal conductivity	0.92 W/m·k min.
Thickness of the compound	100µm±30µm

Note:

1) The contact thermal resistance is dependent on the compound's efficiency and thickness.
   The thickness of the compound could be lessened if the warp of the heat sink could be reduced.
   Use the above table as a reference to decide the thickness of the compound being used.
2) Confirm the expansion of the compound when the module is installed with high viscosity compound. On the other hand, note that low viscosity compound may flow out due to the temperature cycle.

1.4 Mounting procedure

1) Recommended tightening torques: 2.5 to 3.5 N•m (M5 or M6)
2) Initial: Torque 0.5 to 1.0 (N•m), sequence (1)-(2)-(3)-(4)
3) Final: Full specified torque (3.5 N•m), sequence (1)-(2)-(3)-(4)



1.5 ESD

If excessive static electricity is applied to the control terminals, the devices could be broken. Some countermeasures against static electricity is necessary. Refer to the Chapter 3-2 of the Application Manual (REH984).

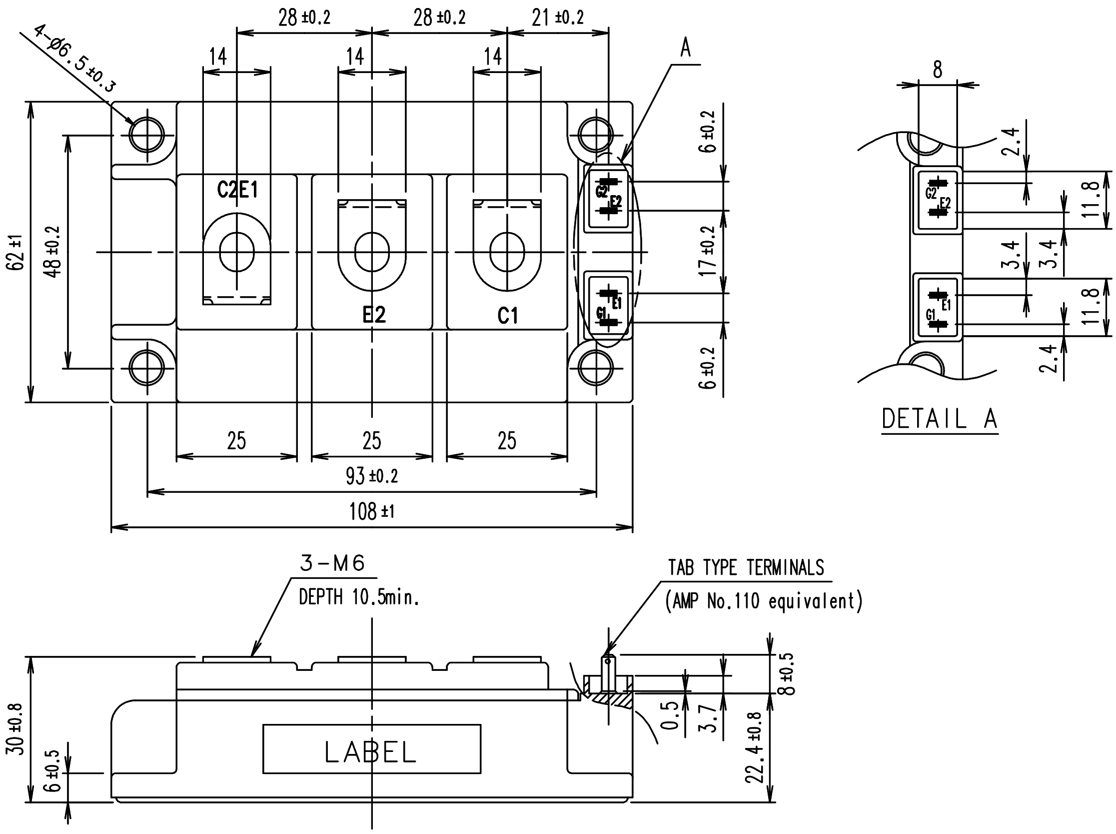
2 Main terminal connection

2.1 Bus bar connection

1) Screw: M6
2) Screw length: Bus bar thickness + (7.5mm to 9.5mm)
3) Tightening torque: 3.5 to 4.5 [N•m]
4) Allowable terminal temperature: 100°C max.
5) Allowable terminal pull force: 40N max.

Note:
In case of connecting a bus bar to the main terminal, avoid excessive force to a terminal part.
Especially, the applied force at the opposide end of the copper bar will act as much bigger to the terminal part, because the moment force is proportional to the copper bar length.
Moreover, if a screw will be tightened when there is position gap between a terminal and a copper bar, stress will be generated continuously in the terminal part, and becomes the cause of damage.
Fasten the screw so that position gap does not occur.

3 Dimensions



WARNING

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   - Medical equipment

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