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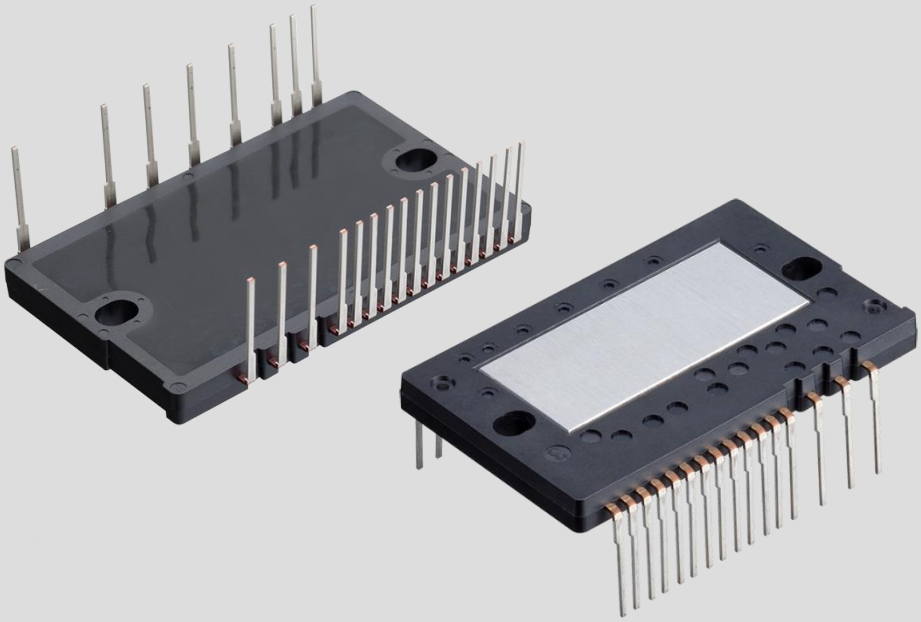


Small IPM (Intelligent Power Module)
P633C, P633A Series
6MBP**XS*06*-50

Mounting Instruction

September 2023

Fuji Electric Co., Ltd.

MT6M15589d

Cautions

This Instruction contains the product specifications, characteristics, data, materials, and structures as of September 2023. The contents are subject to change without notice for specification changes or other reason. When using a product listed in this Instruction be sure to obtain the latest specifications.

The application examples in this note show the typical examples of using Fuji products and this note shall neither assure to enforce the industrial property including some other rights nor grant the license.

Although Fuji Electric Co., Ltd. continually strives to enhance product quality and reliability, a small percentage of semiconductor products may become faulty. When using Fuji Electric semiconductor products in your equipment, be sure to take adequate safety measures such as redundant, flame-retardant and fail-safe design in order to prevent a semiconductor product failure from leading to a physical injury, property damage or other problems.

The products described in this application manual are manufactured with the intention of being used in the following industrial electronic and electrical devices that require normal reliability.

- Compressor motor inverter
- Fan motor inverter for room air conditioner
- Compressor motor inverter for heat pump applications, etc.

If you need to use a semiconductor product in this application note for equipment requiring higher reliability than normal, such as listed below, be sure to contact Fuji Electric Co., Ltd. to obtain prior approval. When using these products, take adequate safety measures such as a backup system to prevent the equipment from malfunctioning when a Fuji Electric's product incorporated in the equipment becomes faulty.

- Transportation equipment (mounted on vehicles and ships)
- Trunk communications equipment
- Traffic-signal control equipment
- Gas leakage detectors with an auto-shutoff function
- Disaster prevention / security equipment
- Safety devices, etc.

Do not use a product in this application note for equipment requiring extremely high reliability such as:

- Space equipment
- Airborne equipment
- Atomic control equipment
- Submarine repeater equipment
- Medical equipment

If you have any question about any portion of this application note, ask Fuji Electric Co., Ltd. or its sales agencies. Neither Fuji Electric Co., Ltd. nor its agencies shall be liable for any injury or damage caused by any use of the products not in accordance with instructions set forth herein.

CONTENTS

This chapter describes the precautions during transportation and storage for the product.

1. Precautions during transportation and storage

- This product must be stored at a normal temperature of 5 to 35ºC and relative humidity of 45 to 75%. If the storage area is very dry, a humidifier may be required. In such a case, use only deionized water or boiled water, since the chlorine in tap water may corrode the leads.
- This product should not be subjected to rapid changes in temperature to avoid condensation on the surface of this product. Therefore store this product in a place where the temperature is steady.
- This product should not be stored on top of each other, since this may cause excessive external force on the case.
- This product should be stored with the lead terminals remaining unprocessed. Rust may cause presoldered connections to fail during later processing.
- This product should be stored in antistatic containers or antistatic shipping bags.
- Under the above storage condition, use this product within one year.

This chapter describes the precautions in unpacking for the product.

2. Precautions in unpacking

1. Removing the pin from the tube

- The products are packaged in tubes that are pinned at both ends.
- Remove the pin on one side to pick out the product from the tube.
- If the pin and the product are in contact with each other when removing the pin, a strong impact might be applied to the product, which may cause deformation or damage to the product terminals. Make a gap between the pin and the product when removing the pin.
- The recoil of removing the pins may cause deformation or damage to the terminals of the product, so remove the pins while holding them.
- If the product falls out from the tube when removing the pins, it may cause a strong impact to the product, causing the product terminals to be deformed or damaged. Remove the pin with the tube opening facing up.
- It is recommended to use a remover (removal jig) to remove the pins. The following shows how to remove the pins using a remover.

A) Make a gap between the pin and the product. (See Fig. 2-1)

Fig. 2-1 Gap between the pin and the product

B) Push the pointed end of the pin with your index finger, and make a gap between the pin and the tube to insert the remover removal part as shown in Fig. 2-2. (See Fig. 2-3)

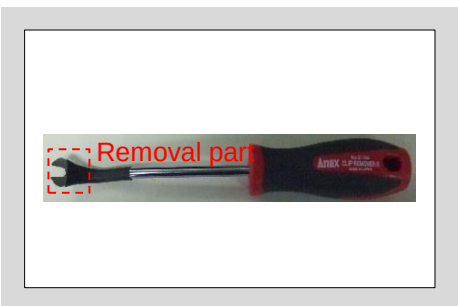


Fig. 2-2 Example of remover (removal jig)

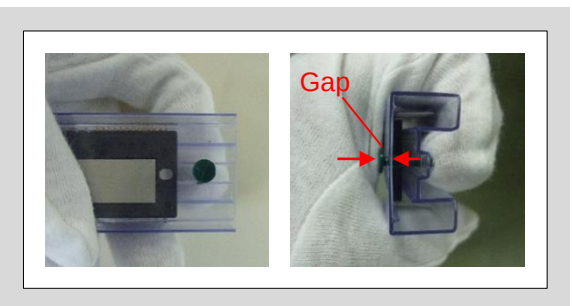


Fig. 2-3 Gap between the pin and the tube

C) Insert the removal part of the remover into the gap between the pin and the tube. (See Fig. 2-4)

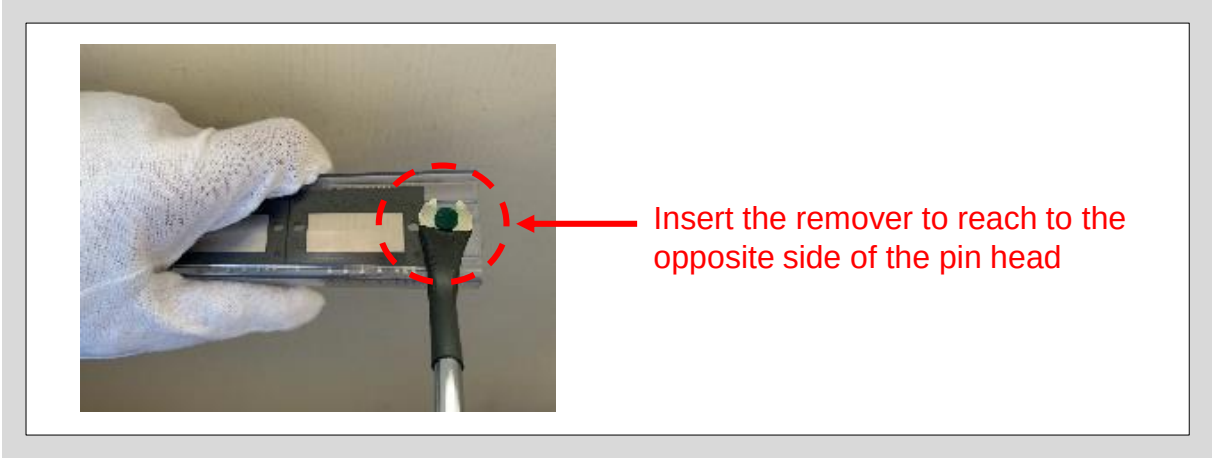


Fig. 2-4 Insert remover

D) Hold the pin with your finger and remove the pin with the tube opening facing up.
(See Fig. 2-5, 2-6)

Fig. 2-5 How to hold the pin

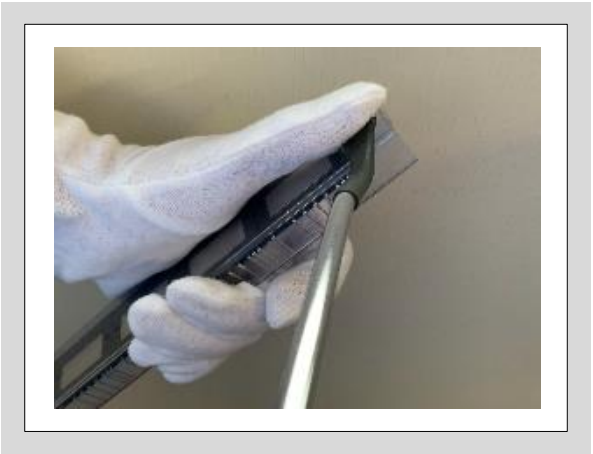


Fig. 2-6 Tube opening orientation

2. Removing the product from the tube

- Since the elements installed in the Small IPM are extremely weak to electrostatic discharge, appropriate ESD countermeasures are necessary in the assembly environment within the range described in the specifications. In particular, when removing it out from the tube, it is most likely to cause electrical damage to the product.
- When removing the product, do not strongly collide the products with each other or bump the product terminals against the tube. A strong impact on the product may cause deforming or damage to the product terminals.

This chapter describes the Through-hole design for PCB attaching to the product.

3. Through-hole design for PCB

Figures 3-1 to 3-4 show examples of recommended Through-hole dimensions and Through-hole layout designs.

- The Through-hole dimensions are the inner diameter after plating (dimension unit: mm).
- If the terminal cross-sectional dimensions / Through-hole clearance is too large, solderability may be impaired. Also, if the land diameter is too large, solder bridges are likely to occur.
- The hole size and land size should be optimized as appropriate, taking into consideration the printed circuit board processing accuracy and mounting method.

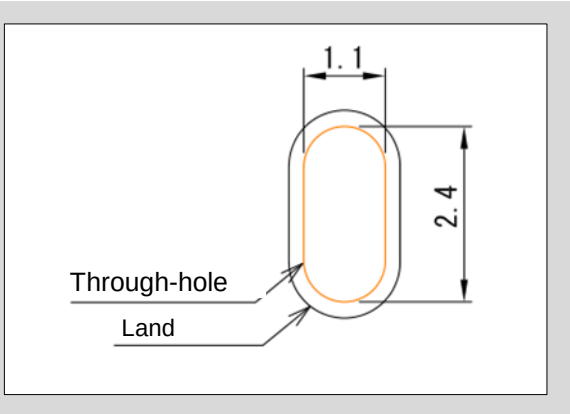


Fig. 3-1 Control side Through-hole dimensions

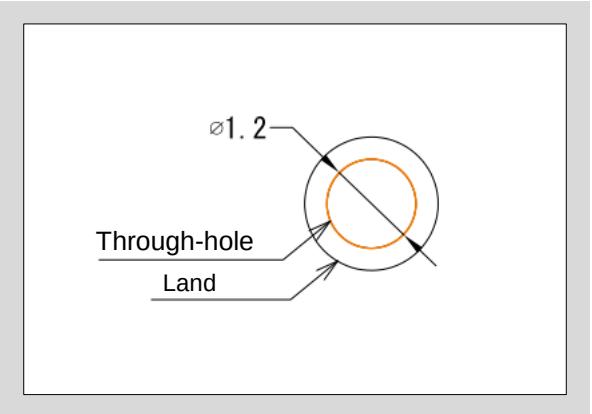


Fig. 3-2 Power side Through-hole dimensions

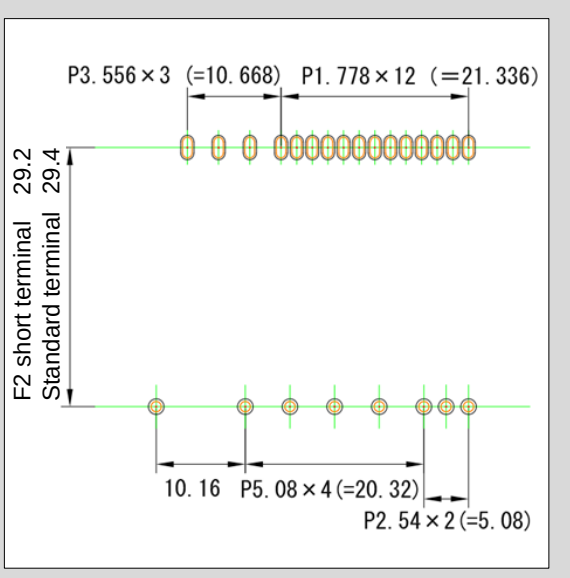


Fig. 3-3 Through-hole layout with standard terminals and short terminals

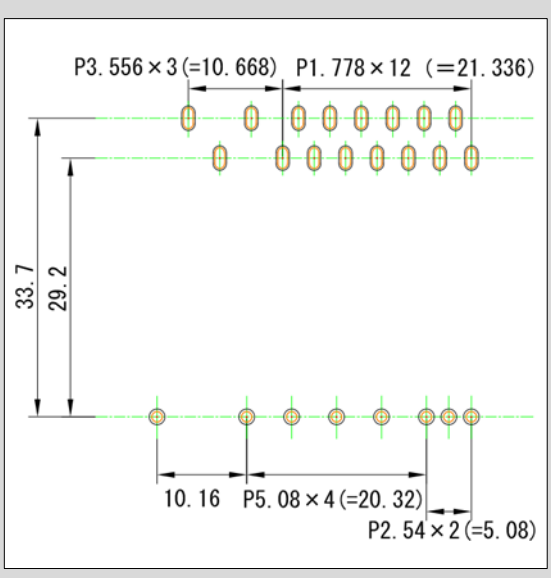
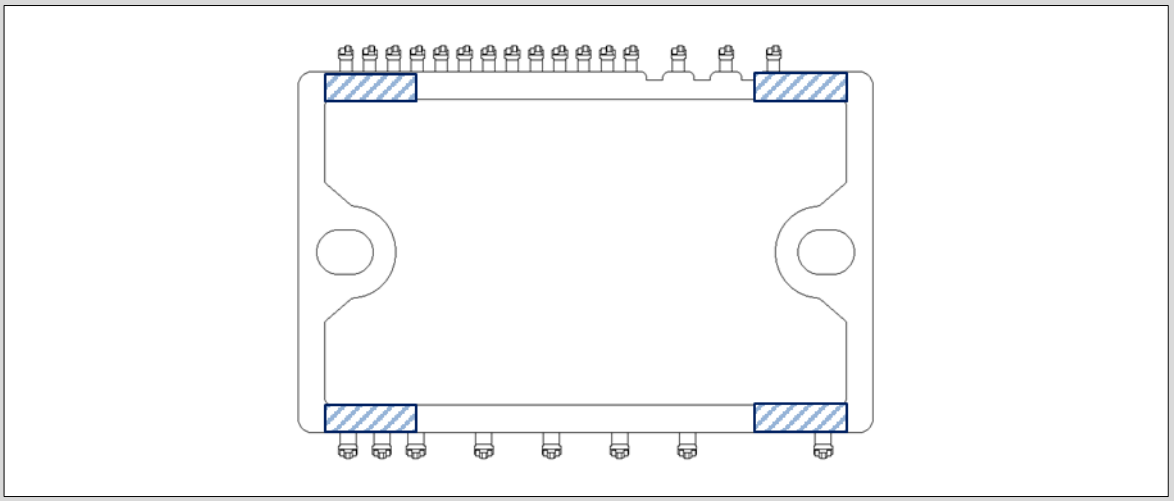


Fig. 3-4 Through-hole layout with zigzag pattern terminal

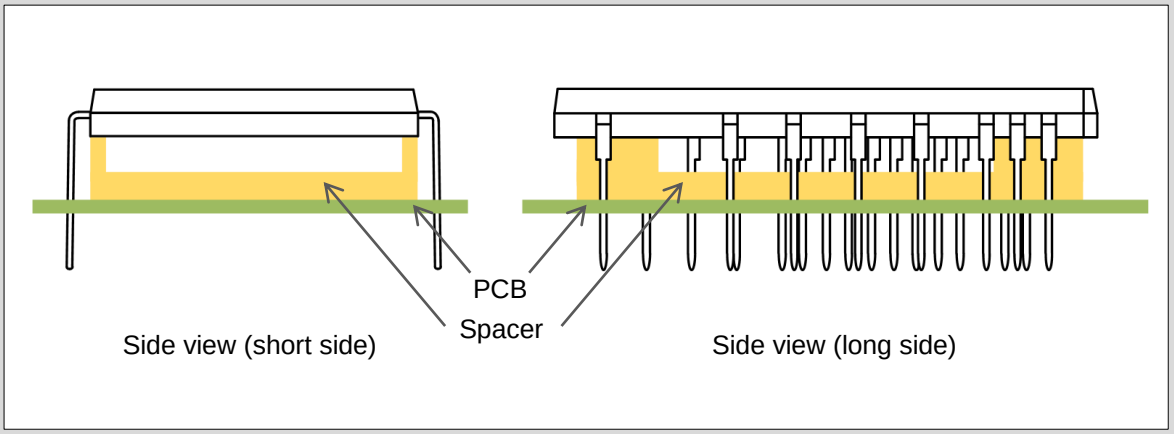
This chapter describes the spacer for PCB attaching to the product.

4. Spacer

- When using spacer between the PCB and the product for alignment during soldering to printed circuit board, it is recommended to support the product at the hatched area as shown in Fig. 4-1.
- Select a spacer material that does not cause contamination or corrosion.



Recommended spacer position



Side view of proposed spacer

Fig. 4-1 Spacer position

This chapter describes the thermal grease application for the product.

5. Application of thermal grease

- It is recommended to apply thermal grease between the product's aluminum base and the heat sink to ensure heat dissipation to the heat sink. If the properties, amount, and application method of the thermal grease is not appropriate, it may result in poor heat dissipation and lead to thermal failure. Table 5-1 shows the recommended thermal grease properties and thickness
- 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 Aluminum base area of product (cm^2) x Density of thermal grease (g/cm^3)

- We recommend using the stencil mask method to control the appropriate thermal grease thickness (Fig. 5-1). The recommended stencil mask pattern is shown in appendix.
- It is recommended to check the spread of thermal grease by removing the product after mounting and check the extent of spreading.
- In the case of liquid cooling, the temperature difference (temperature gradient) between the heat sink temperature and the temperature inside the product becomes large. When mounting the product to heat sink, secure a thermal grease coating amount that can absorb the distortion due to the difference in thermal expansion when the temperature gradient is large.
- In the case of a multiple structure heat sink, the number of fastening parts increases and heat transfer (diffusion) becomes uneven. Therefore, it is necessary to suppress the distortion, such as securing the thermal grease coating amount in consideration of the generated distortion during design.

Table 5-1. Recommended properties of thermal grease

	Unit	Recommended value
Penetration (typ.)	-	328
Thermal conductivity	W/m･K	0.90
Thermal grease thickness	μm	100±30

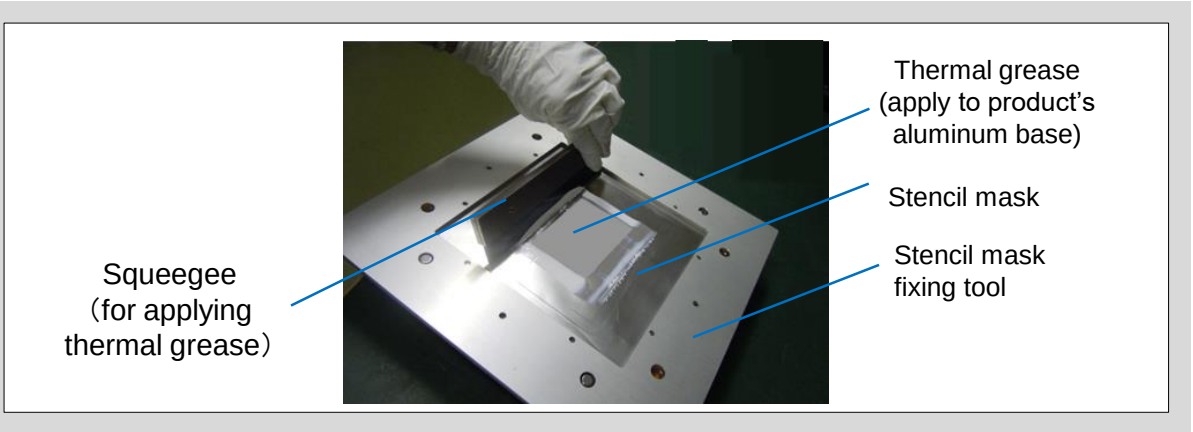


Fig. 5-1 Thermal grease application

This chapter describes the heat sink selection for the product.

6. Heat sink selection

1. Selection

- The junction temperature T_{vj} should not exceed the maximum junction temperature rating for safe operation. Heat sink (cooling device) should be designed to ensures that T_{vj} is always below the maximum junction temperature rating.
- If the IGBT or FWD junction temperature is higher than the maximum junction temperature rating, it might cause damage to the chips. Some types of the products have the overheating (OH) protection function which works when the LVIC chip temperature exceeds the maximum junction temperature rating. However, if the temperature rises too quickly, the OH protection might not work.
- When selecting a heat sink, please verify the chip temperature T_{vj} by measuring T_c at the position shown in Figure 6-1, and calculating the T_{vj} from device power dissipation and thermal resistance. In addition, this product has a built-in temperature sensor, and T_{vj} can be confirmed by the analog voltage that is output according to the LVIC chip temperature. Please use this as a reference when selecting a heat sink.
- For more detailed design, please refer to IGBT Module Application Manual (REH984) and Small IPM Application Manual.
  - P633A Application Manual: MT6M08855
  - P633C Application Manual: MT6M16945

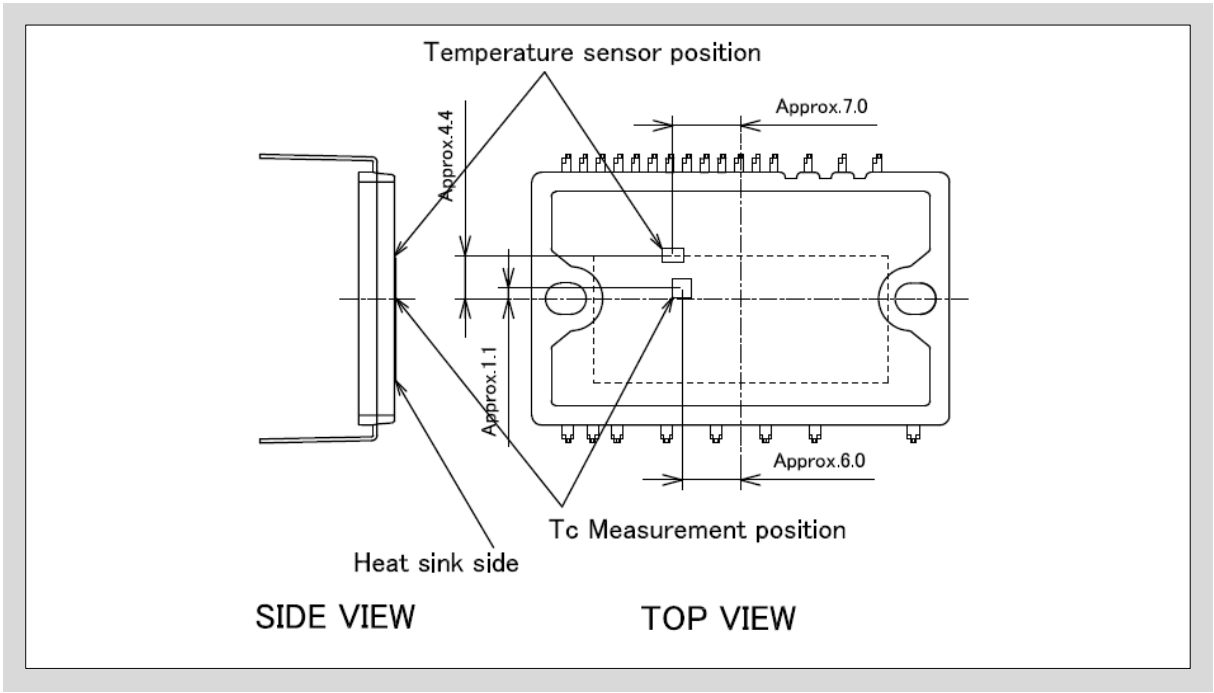


Fig. 6-1 Temperature sensing and T_c measurement points

2. Shape

- As shown in Fig. 6-2, the heat sink flatness should be 0μm/100mm to +100μm/100mm, and the surface roughness (Rz) should be less than 10μm.
- If the heat sink surface is concave, a gap occurs between the heat sink and the product, leading to deterioration of cooling efficiency.
- If the flatness is +100μm/100mm or more, the aluminum base of the product may deform and cracks could occur in the internal isolating substrates.

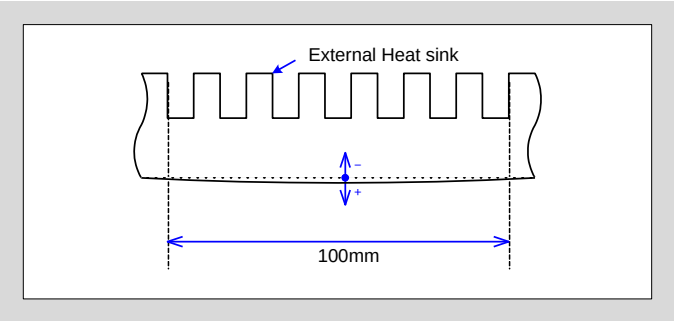


Fig. 6-2 The measurement point of heat sink flatness

3. Mounting (tightening)

- When mounting the product to a heat sink, the following fastening order is recommended. Uneven fastening due to excessive torque might lead to destruction or degradation of the chip.
- Standard: Metric screw JIS B 1111
- Screw length: 8mm
- Screw head shape: Pan shape (head diameter 5.5 mm)
- Material: Stainless
- Use flat washers (JIS B1258 recommended). Washer head type screws can be used as well.
- Avoid using the product to support the load of structure such as heat sink, printed circuit board, etc.
- When mounting this product together with other components to the heat sink, ensure the flatness of the components mounted on the printed circuit board before mounting.

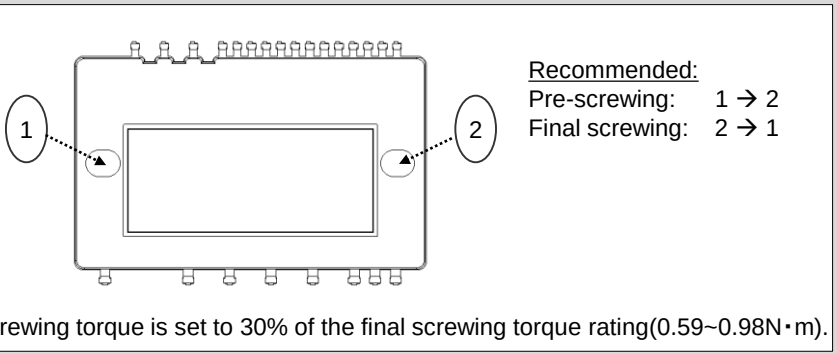


Fig. 6-3 Recommended screw fastening order

This chapter describes the soldering to printed circuit board for the product.

7. Soldering to Printed Circuit Board

- The product's temperature during soldering might exceed the maximum temperature rating. To prevent damage to the product and to ensure reliability, please use the following soldering temperature.

Table 7.1 Soldering temperature and duration

Methods	Soldering Temp. & Time
Dip soldering	260±5°C, 10±1sec

- A stopper is provided on the terminal to prevent the immersion depth of the terminal from coming too close to the product body. Use this stopper to secure the required distance from the printed circuit board and prevent the product body from being immersed in the solder bath during flow soldering.
- It is not recommended to reuse the product after it is removed from the printed circuit board because there is a possibility that the removed product was subjected to thermal or mechanical damage during the removal process.

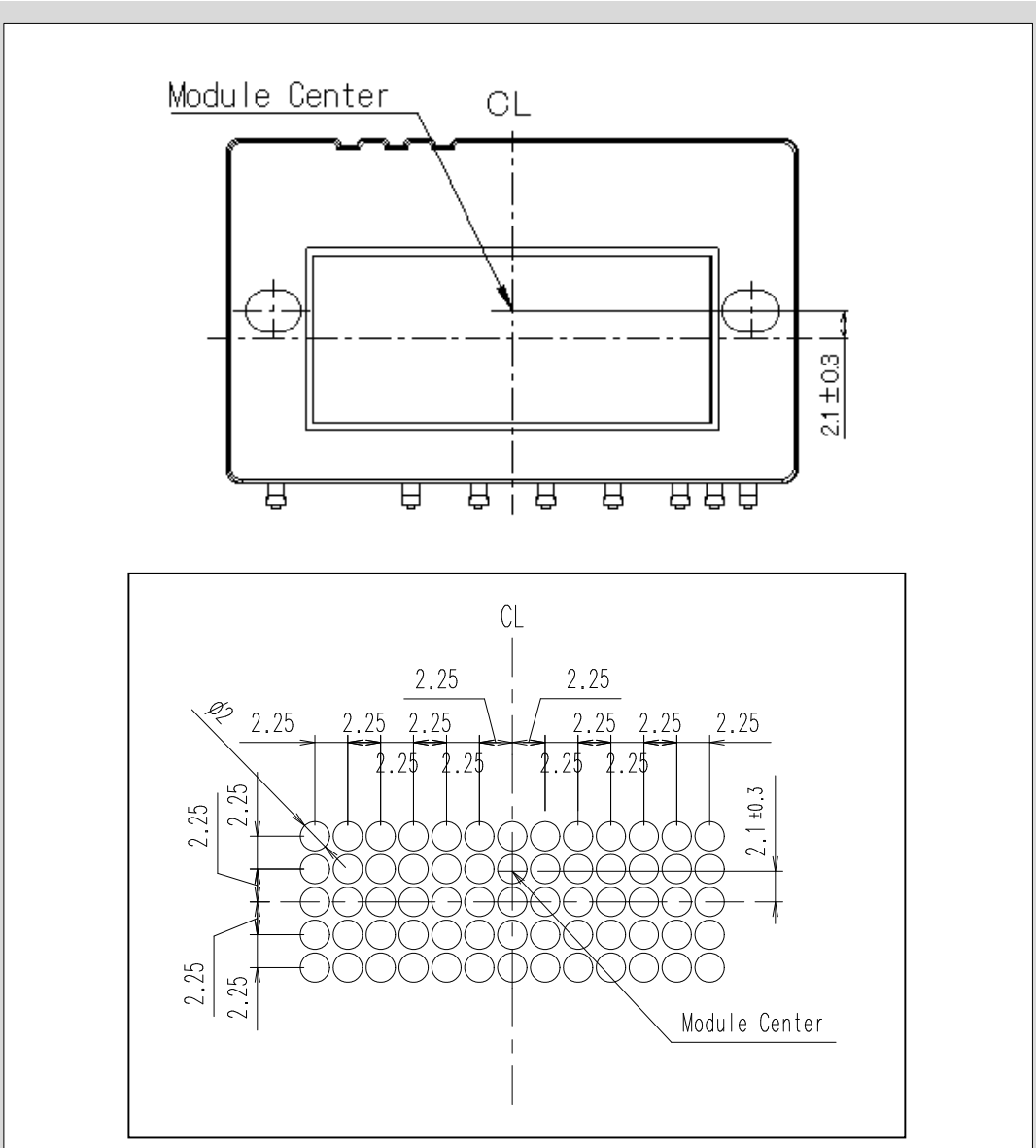
This chapter describes the appendix for mounting of the product.

8. Appendix

1. Stencil mask drawing for thermal grease application (recommended)

Package No. : P633A, P633C

This figure shows the view from the aluminum base surface. Please contact us if you need a dxf file.



※ −·−·−·−·− : Aluminum base centerline

Metal mask thickness : T = 200 μm

(Target grease thickness: T = approx. 100 μm)

Fig. 8-1 Stencil mask drawing for thermal grease application (recommended)

2. Isolation distance of heat sink

- When this product is mounted on a flat heat sink, there is a possibility that discharge will occur between the lead terminals and the heat sink, so the isolation voltage is 1.5 kVrms.
- By ensuring a creepage distance of 2.5 mm or more between the lead terminals and the heat sink, the isolation voltage will be 2.5 kVrms.
- By processing the heat sink as shown in Fig. 8-2, it is possible to secure a clearance distance of 5.08 mm or more in accordance with UL.

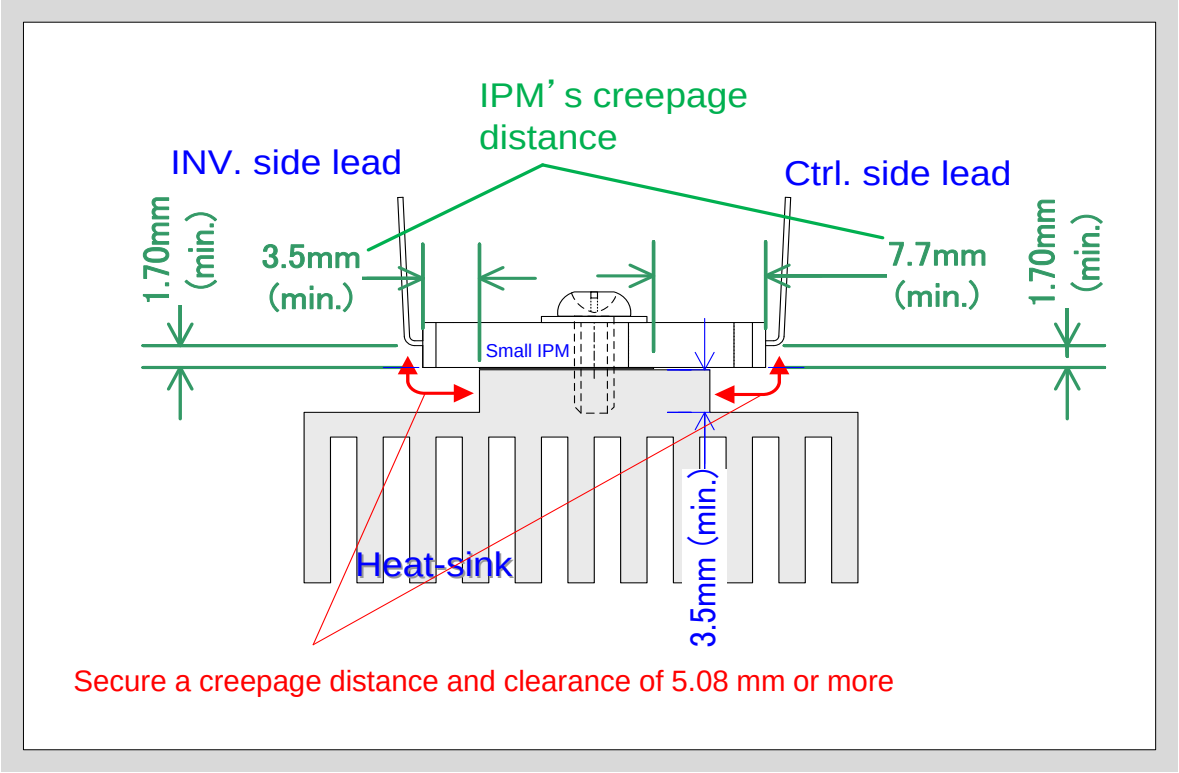


Fig. 8-2 Isolation distance of heat sink