

Fuji 7th Generation IGBT-IPM X Series



Application Manual

Warning:

This manual contains the product specifications, characteristics, data, materials, and structures as of October 2021.

The contents are subject to change without notice for specification changes or other reasons. When using a product listed in this manual, be sure to obtain the latest specifications.

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Cautions

(1) During transportation and storage

Keep locating the shipping carton boxes to suitable side up. Otherwise, unexpected stress might affect to the boxes. For example, bend the terminal pins, deform the inner resin case, and so on.

When you throw or drop the product, it gives the product damage.

If the product is wet with water, that it may be broken or malfunctions, please subjected to sufficient measures to rain or condensation.

Temperature and humidity of an environment during transportation are described in the specification sheet. There conditions shall be kept under the specification.

(2) Assembly environment

Since this power module device is very weak against electro static discharge, the ESD countermeasure in the assembly environment shall be suitable within the specification described in specification sheet. Especially, when the conducting pad is removed from control pins, the product is most likely to get electrical damage.

(3) Operating environment

If the product had been used in the environment with acid, organic matter, and corrosive gas (hydrogen sulfide, sulfurous acid gas), the product's performance and appearance can not be ensured easily.

Chapter 1 Features and structure

| | |
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This chapter describes the features and structure of the X series IPM.

1. Features of the IGBT-IPM

An IPM (intelligent power module) is an intelligent IGBT module combining a built-in control IC which includes a drive circuit and a protection circuit. The X-IPM (X series IPM) has the following features:

1.1 Built-in drive circuit

- Drives the IGBT under the optimized gate control conditions.
- No negative power supply is needed since it has minimum gate impedance between the drive circuit and the IGBT devices.
- Four isolated power supply units are required: one (1) on the lower arm side, three (3) on the upper arm side.

1.2 Built-in protection circuit

- Over current protection (OC), short circuit protection (SC), control power supply under voltage protection (UV), IGBT chips over heating protection (T_{jOH}) and an external alarm signal output (ALM) are integrated.
 - OC and SC are functions to protect the IGBT against breakdown caused by an over current or a load short-circuit. Each IGBT has an on-chip current sensor which can detect the collector current of each IGBT. This feature can protect the IPM module against an over current and a short circuit that may occur in any IGBT.
 - UV is the protective function that works against a drive power supply voltage drop. Control IC for each arm has this function.
 - T_{jOH} provides a high-speed over temperature protection by using an on-chip temperature sensor.
 - ALM sends an alarm signal to the outer peripheral control unit of the IPM when an OC, SC, UV and/or T_{jOH} occur. Additionally the IPM initiates a safe soft stop of the system. *1
- *1 See [Chapter 3 Description of functions] for details of protective functions of each IPM.

1.3 Built-in brake circuit (7in1 IPM)

- A brake circuit can be configured by adding an external resistor that dissipate electric power during regeneration.
- The brake circuit has a drive circuit and protection circuit, similar to the inverter unit.
- In the X series IPM, even when the inverter part of the lower arm detects an abnormality and protection is activated, the brake IGBT can operate independently. Therefore, it is possible to suppress the rise in main power supply voltage due to deceleration resulting from abnormal stop and prevent overvoltage destruction of the product.

1.4 IGBT chips temperature warning output function (specific model)

- The X series IPM has a function that notifies the IGBT chip is overheated by generating a warning signal output when the IGBT chip reaches 150°C or higher. IGBT chips over heating protection (T_{jOH}) operates by stopping the IPM and generate an alarm signal output when the IGBT chip temperature rises above 175°C. However, in the temperature warning output function, the switching operation is continued while the temperature warning signal is generated. By utilizing this function, it is possible to avoid the system from stopping by changing the operating conditions before the IPM is stopped by the over heating protection function.
- In addition, it is possible to prevent a decrease in productivity due to a sudden equipment shutdown.

1.5 RoHS regulatory compliance

- All models of the X series IPM comply with RoHS directive.

2. Part number and lot No.

Table 1-1 shows how to read the part number of the X series IPM.

Table 1-1 How to read the part number ex.) 6MBP50XBA120-50

| 6 | MBP | 50 | X | B | A | 120 | -50 |
|--------------------|-------------------------------------|--------------------|------------------------|---------|--------|------------------------|--------|
| IGBT Switch number | Type of module | Current rating | IGBT Chip generation | Package | Suffix | Voltage rating | Suffix |
| 6: without brake | MBP: Intelligent power module (IPM) | $I_C \times 1$ (A) | X: X series (7th Gen.) | A:P629 | | V_{CES} x1/10 (V) | |
| 7: with brake | | | XR: X series (RC-IGBT) | B:P626 | | | |
| | | | | D:P630 | | | |
| | | | | E:P631 | | | |
| | | | | F:P636 | | | |
| | | | | G:P638 | | | |
| | | | | H:P639 | | | |
| | | | | J:P644 | | | |

Table 1-2 shows how to read the lot No. of the X series IPM.

Table 1-2 How to read the lot No.

| 20 | 1 | 001 |
|-----------------|------------------|---------------|
| Production year | Production month | Serial number |
| 19: 2019 | 1: January | 001~999 |
| 20: 2020 | 2: February | |
| 21: 2021 | : | |
| | 9: September | |
| | O: October | |
| | N: November | |
| | D: December | |

Fig.1-1 shows an example of product indication for X series IPM.

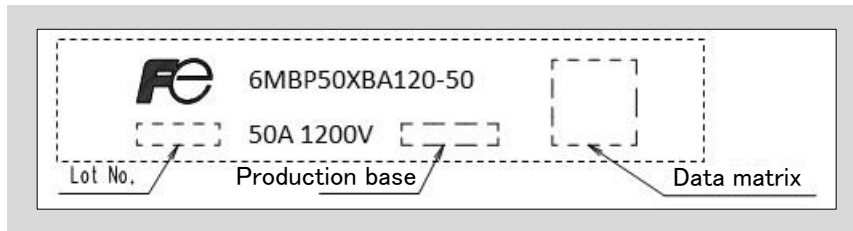


Fig.1-1 Indication ex.)6MBP50XBA120-50

3. Line-up

Table 1-3 650V Line-up

| Package | Pin type | | Screw type | |
|---------|------------------|------------------|------------------|------------------|
| | 6in1 | 7in1 | 6in1 | 7in1 |
| P639 | 6MBP20XRHA065-50 | | | |
| | 6MBP30XRHA065-50 | | | |
| P629 | 6MBP50XAA065-50 | | | |
| | 6MBP75XAA065-50 | | | |
| P626 | 6MBP50XBA065-50 | | | |
| | 6MBP75XBA065-50 | | | |
| | 6MBP100XBA065-50 | | | |
| P644 | | 7MBP50XJN065-50 | | |
| | | 7MBP75XJN065-50 | | |
| P636 | 6MBP100XFN065-50 | 7MBP100XFN065-50 | | |
| P638 | | | 6MBP100XGN065-50 | |
| | | | 6MBP150XGN065-50 | |
| P630 | | | 6MBP100XDA065-50 | 7MBP100XDA065-50 |
| | | | 6MBP150XDA065-50 | 7MBP150XDA065-50 |
| | | | 6MBP150XDN065-50 | 7MBP150XDN065-50 |
| | | | 6MBP200XDN065-50 | 7MBP200XDN065-50 |
| P631 | | | 6MBP250XDN065-50 | 7MBP250XDN065-50 |
| | | | 6MBP200XEN065-50 | 7MBP200XEN065-50 |
| | | | 6MBP300XEN065-50 | 7MBP300XEN065-50 |
| | | 6MBP450XEN065-50 | 7MBP450XEN065-50 | |

Table 1-4 1200V Line-up

| Package | Pin type | | Screw type | |
|---------|------------------|-----------------|--------------------------------------|--------------------------------------|
| | 6in1 | 7in1 | 6in1 | 7in1 |
| P639 | 6MBP10XRHA120-50 | | | |
| P629 | 6MBP25XAA120-50 | | | |
| | 6MBP35XAA120-50 | | | |
| P626 | 6MBP25XBA120-50 | | | |
| | 6MBP35XBA120-50 | | | |
| | 6MBP50XBA120-50 | | | |
| P644 | | 7MBP25XJN120-50 | | |
| | | 7MBP35XJN120-50 | | |
| P636 | 6MBP50XFN120-50 | 7MBP50XFN120-50 | | |
| P638 | | | 6MBP50XGN120-50 | |
| | | | 6MBP75XGN120-50 | |
| P630 | | | 6MBP50XDA120-50 | 7MBP50XDA120-50 |
| | | | 6MBP75XDA120-50 6MBP75XDN120-50 | 7MBP75XDA120-50 7MBP75XDN120-50 |
| | | | 6MBP100XDA120-50 6MBP100XDN120-50 | 7MBP100XDA120-50 7MBP100XDN120-50 |
| | | | 6MBP150XDN120-50 | 7MBP150XDN120-50 |
| P631 | | | 6MBP100XEN120-50 | 7MBP100XEN120-50 |
| | | | 6MBP150XEN120-50 | 7MBP150XEN120-50 |
| | | | 6MBP200XEN120-50 | 7MBP200XEN120-50 |
| | | | 6MBP300XEN120-50 | 7MBP300XEN120-50 |

4. Features of each package

4.1 P639 package (6in1 with lower arm alarm signal output)

- The line-up is 20A to 30A for 650V and 10A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm.
- Main terminals are flat type solder pin and the height is the same as the control terminals.
Therefore, it is possible to solder the main terminals and control terminals to the same PCB.
- Screw size for the heat sink is M4.
- Protective function is applied to the upper arm side, but no alarm signal output function is available.
- The package outline drawing is shown in Figure 1-2.

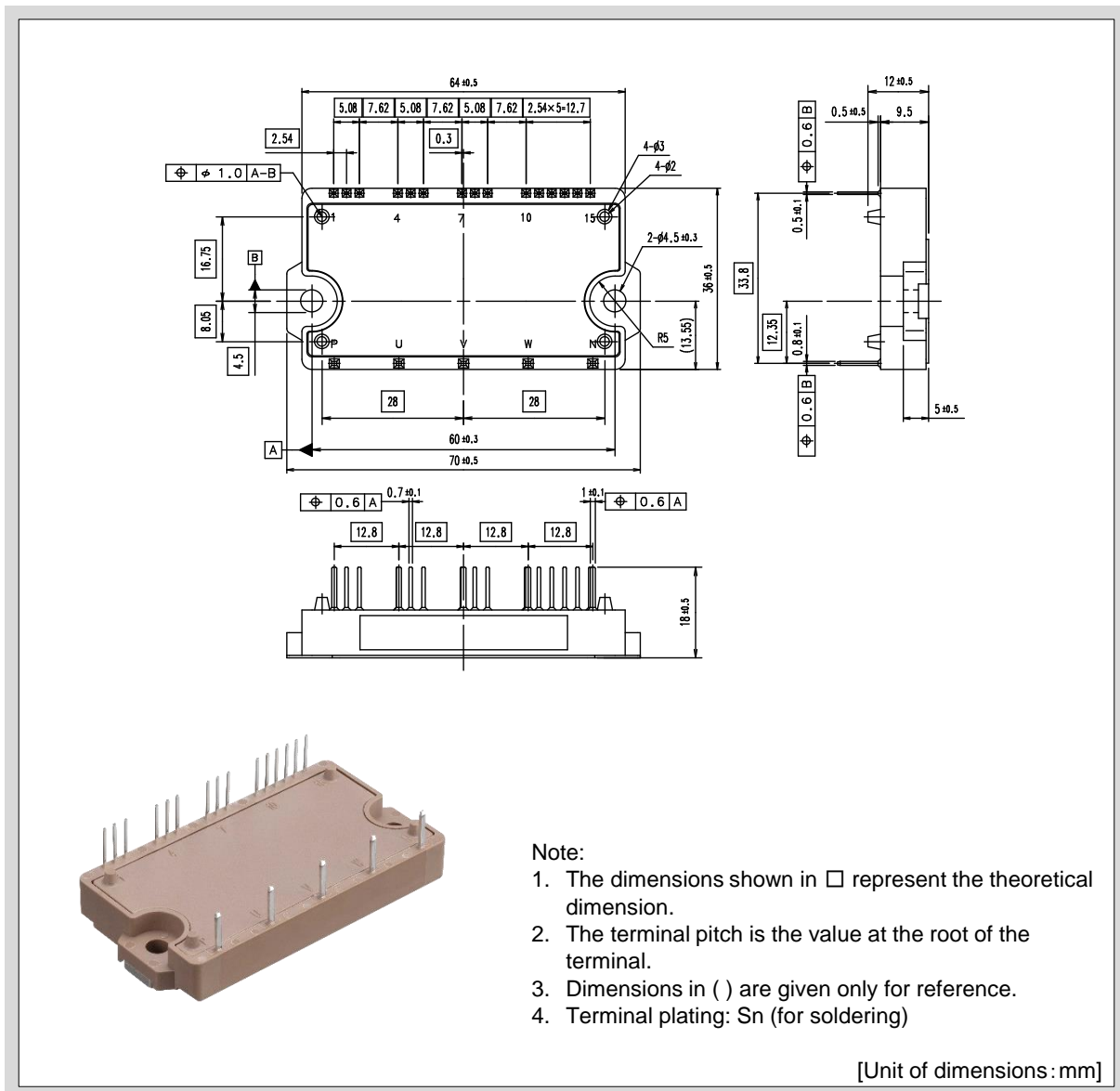


Fig.1-2 Package outline drawing (P639)

4.2 P629 package (6in1 with lower arm alarm signal output)

- The line-up is 50A to 75A for 650V and 25A to 35A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm.
- Main terminals are flat type solder pin and the height is the same as the control terminals. Therefore, it is possible to solder the main terminals and control terminals to the same PCB.
- Screw size for the heat sink is M4.
- Compatible mounting dimensions with the R-IPM series P619 package.
- Protective function is applied to the upper arm side, but no alarm signal output function is available.
- The package outline drawing is shown in Figure 1-3.

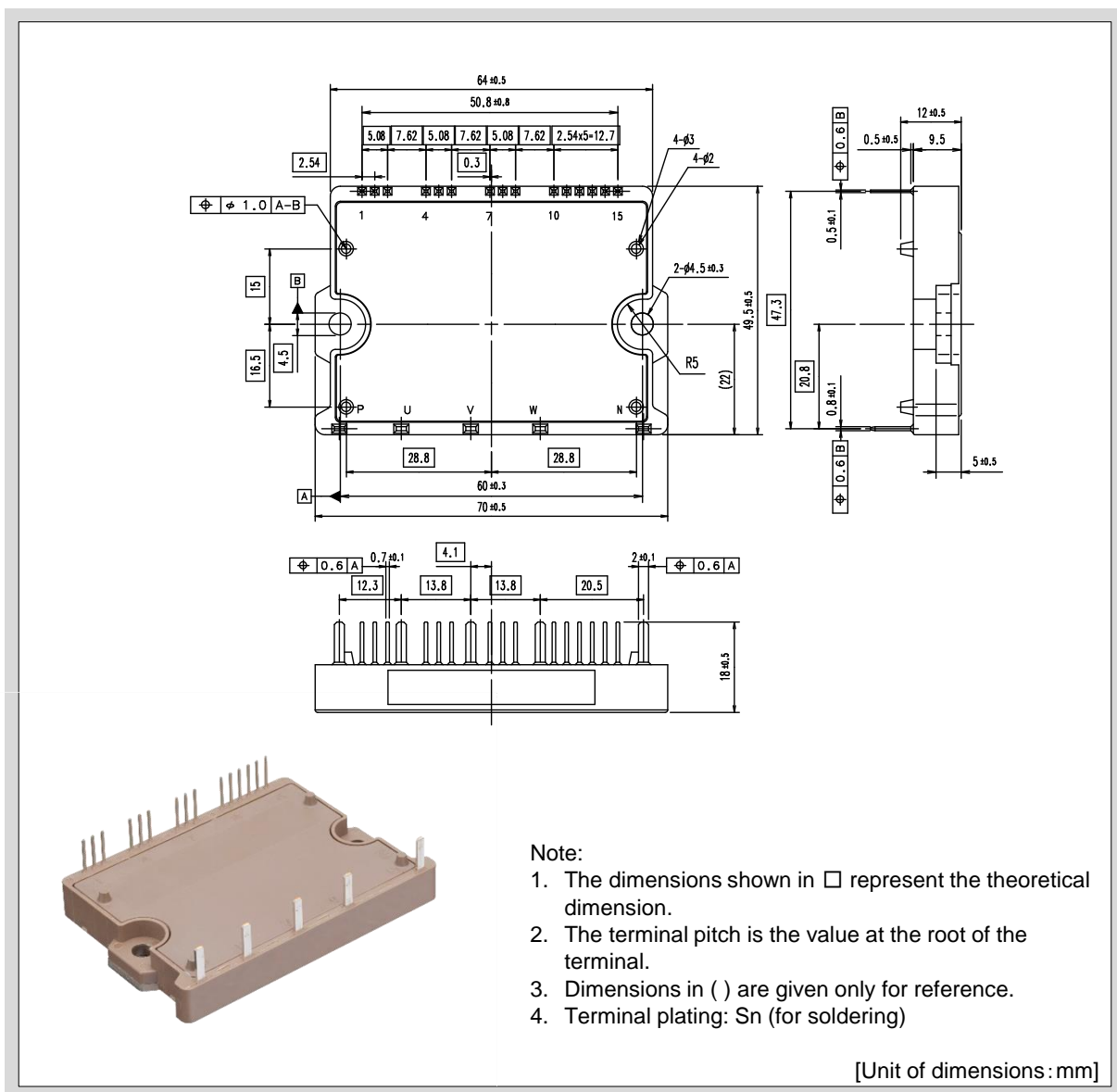


Fig.1-3 Package outline drawing(P629)

4.3 P626 package (6in1 with upper and lower arm alarm signal output)

- The line-up is 50A to 100A for 650V and 25A to 50A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm.
- Main terminals are flat type solder pin and the height is the same as the control terminals.
- Therefore, it is possible to solder the main terminals and control terminals to the same PCB.
- Screw size for the heat sink is M4.
- The package outline drawing is shown in Figure 1-4.

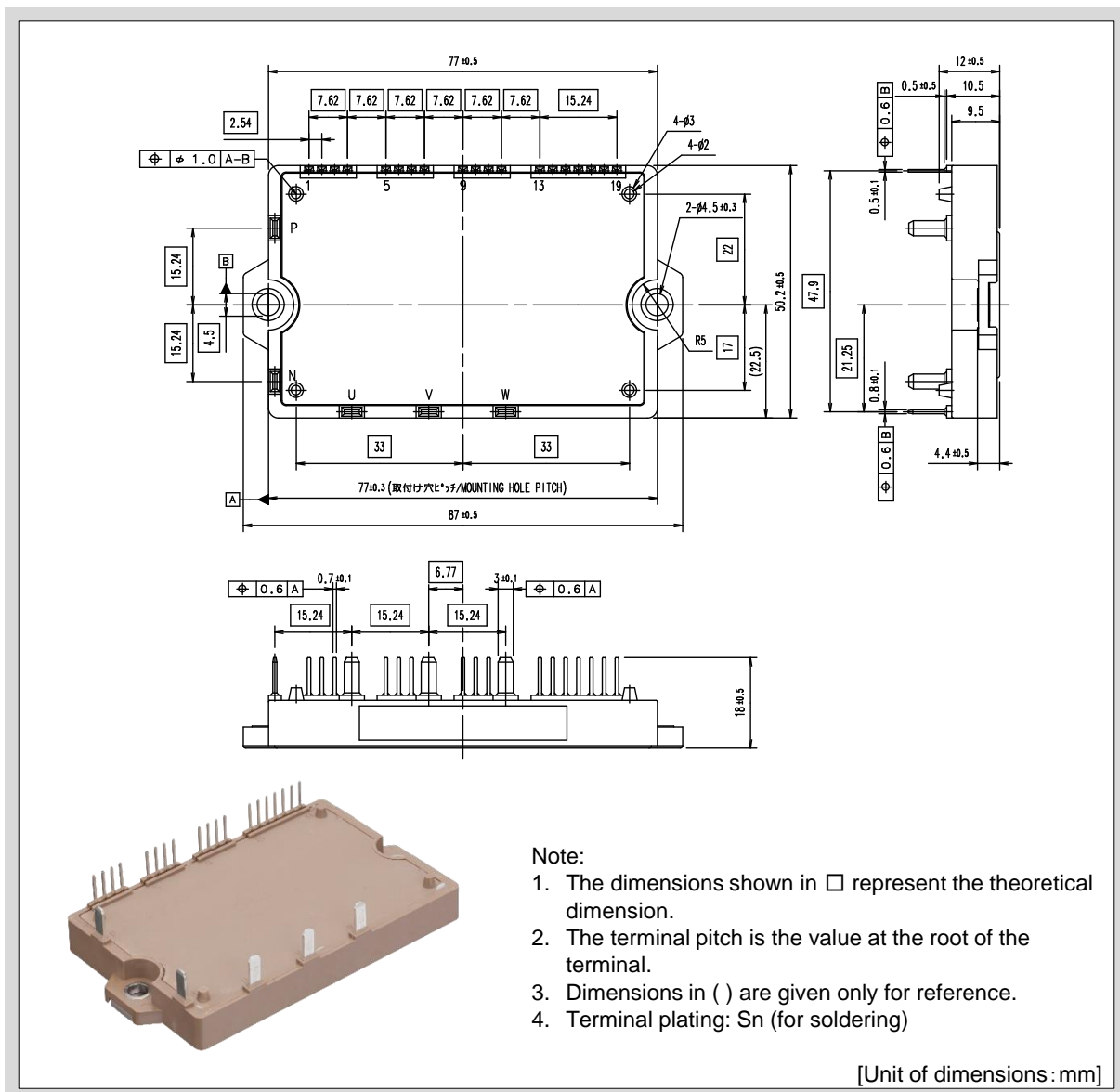


Fig.1-4 Package outline drawing (P626)

4.4 P644 package (7in1 with upper and lower arm alarm signal output)

- The line-up is 50A to 75A for 650V and 25A to 35A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm.
- Main terminals are flat type solder pin and the height is the same as the control terminals. Therefore, it is possible to solder the main terminals and control terminals to the same PCB.
- Screw size for the heat sink is M4.
- The package outline drawing is shown in Figure 1-5.

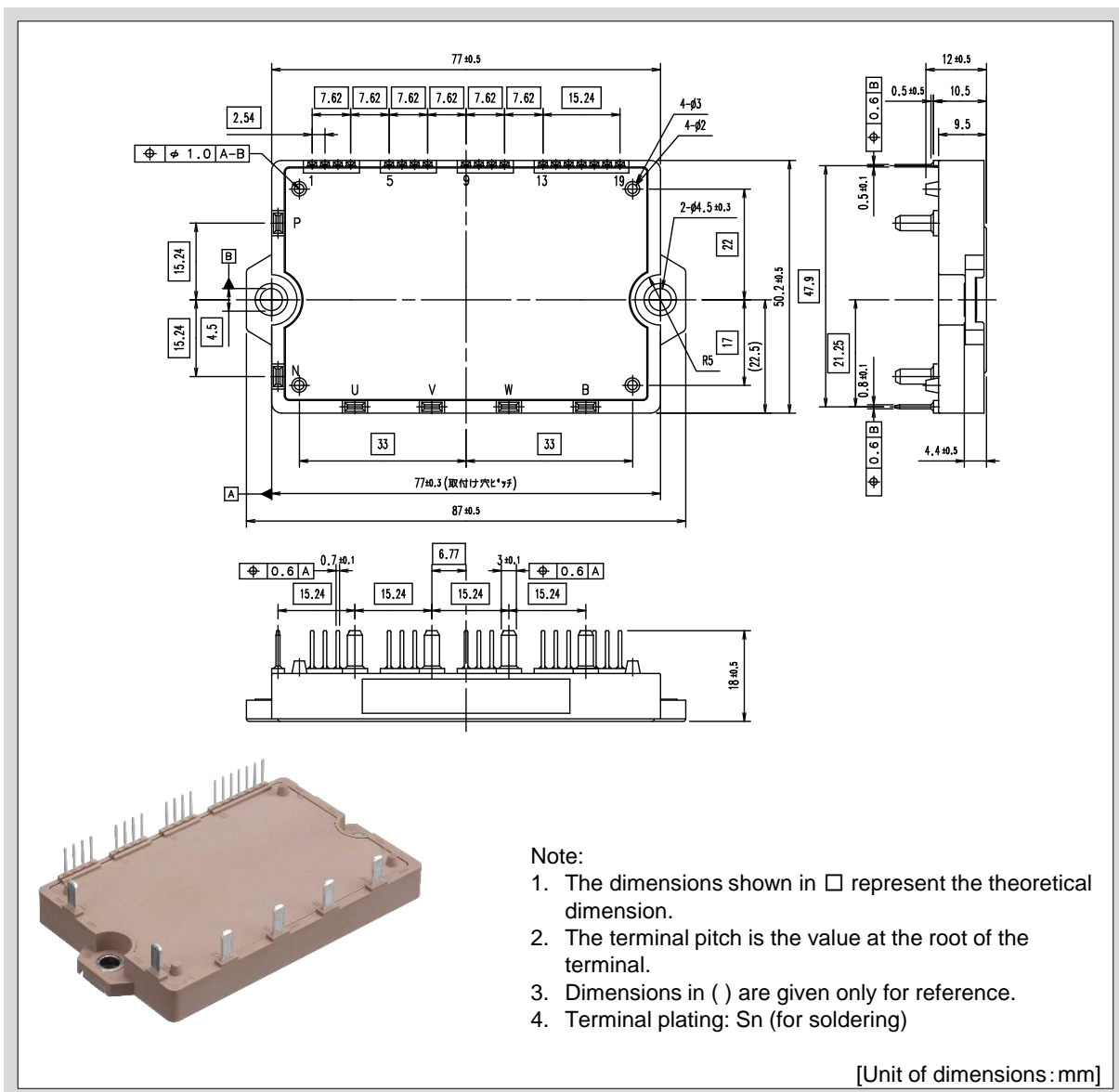


Fig.1-5 Package outline drawing (P644)

4.5 P636 package (6in1/7in1 with upper and lower arm alarm signal output)

- The line-up is 50A to 100A for 650V and 25A to 50A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm.
- Main terminals are flat type solder pin and the height is the same as the control terminals. Therefore, it enables to solder the main terminals and control terminals to the same PCB.
- Screw size for the heat sink is M4.
- Two types of protrusions with different heights are provided on the upper surface of the lid. The height from the base surface to the device control printed board can be selected from 17.0 mm and 18.5 mm. Refer to Figure 1-18.
- The package outline drawing is shown in Figure 1-6.

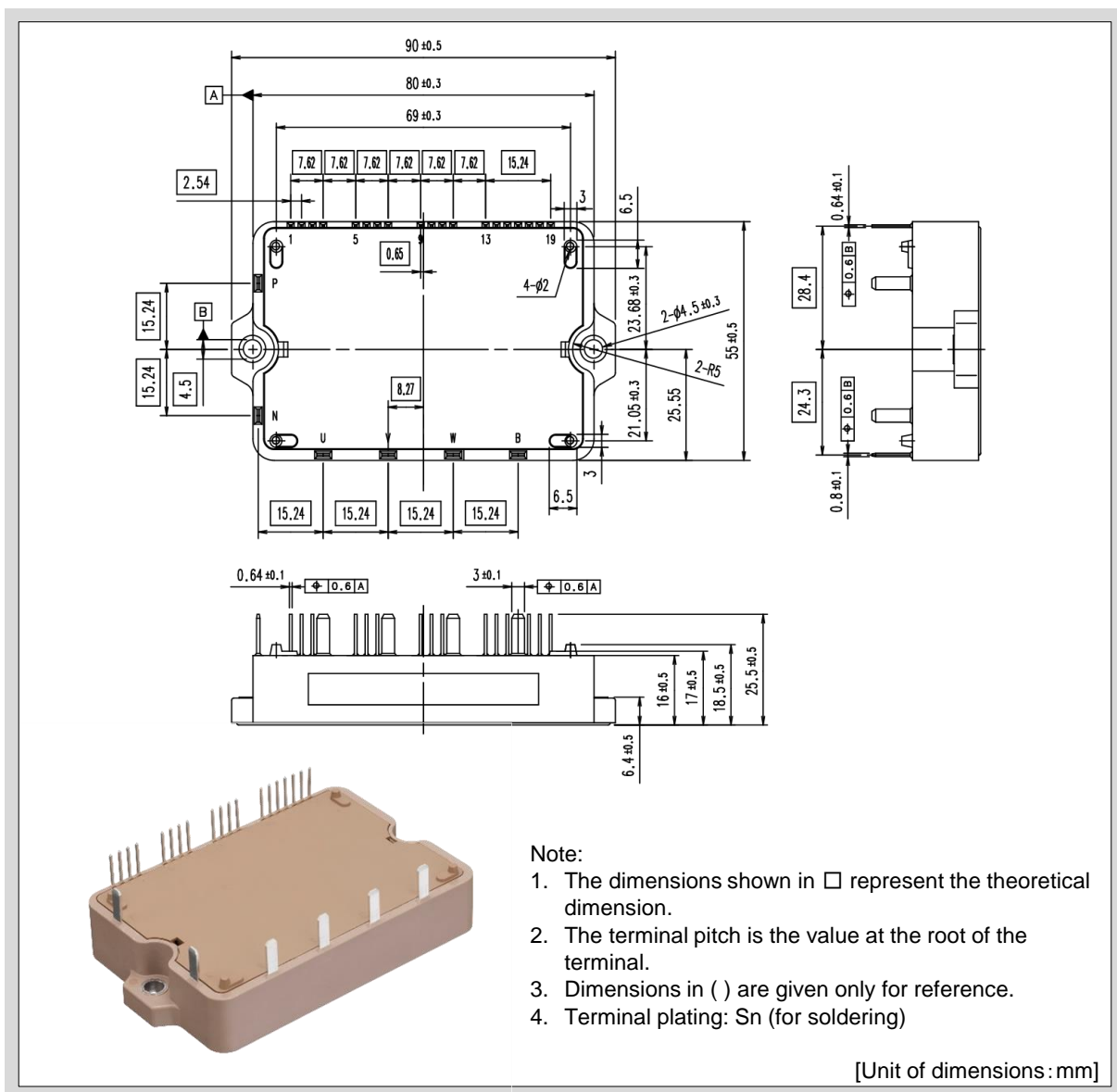


Fig.1-6 Package outline drawing(P636)

4.6 P638 package (6in1 with upper and lower arm alarm signal output)

- The line-up is 50A to 150A for 650V and 25A to 75A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm and can be connected with general-purpose connectors and soldering.
Guide pins make it easy to insert connectors for printed circuit boards.
- Main terminals are M4 screws.
- Screw size for the heat sink is M4 common with the main terminals.
- All electrical connections are done with screws and connectors, thus no soldering is required and easy to remove.
- The package outline drawing is shown in Figure 1-7.

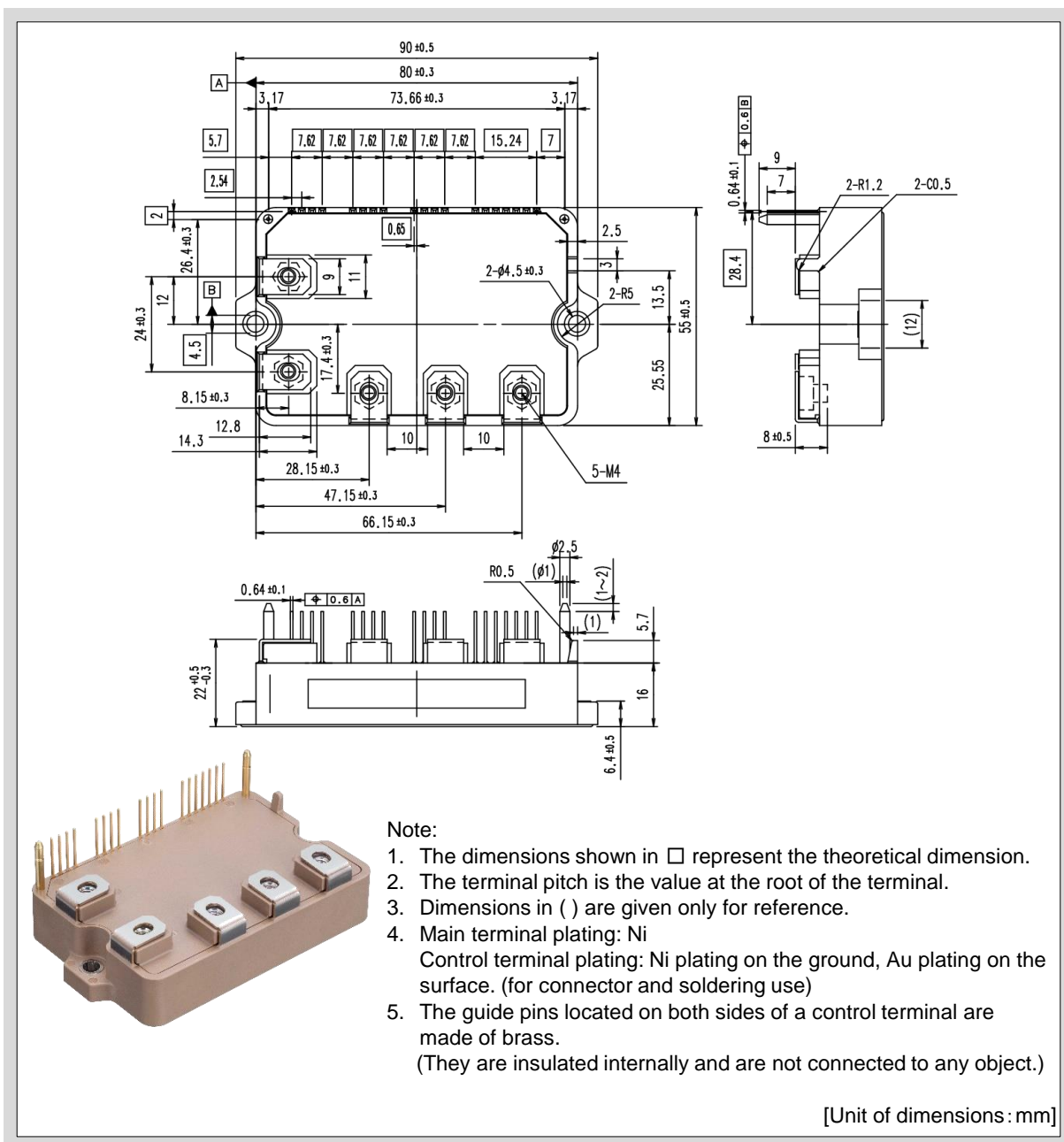


Fig.1-7 Package outline drawing (P638)

4.7 P630 package (6in1/7in1 with upper and lower arm alarm signal output)

- The line-up is 50A to 250A for 650V and 25A to 150A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm and can be connected with general-purpose connectors and soldering.
Guide pins make it easy to insert connectors for printed circuit boards.
- Main terminals are M4 screws.
- Screw size for the heat sink is M4 common with the main terminals.
- All electrical connections are done with screws and connectors, thus no soldering is required and easy to remove.
- The package outline drawing is shown in Figure 1-8.

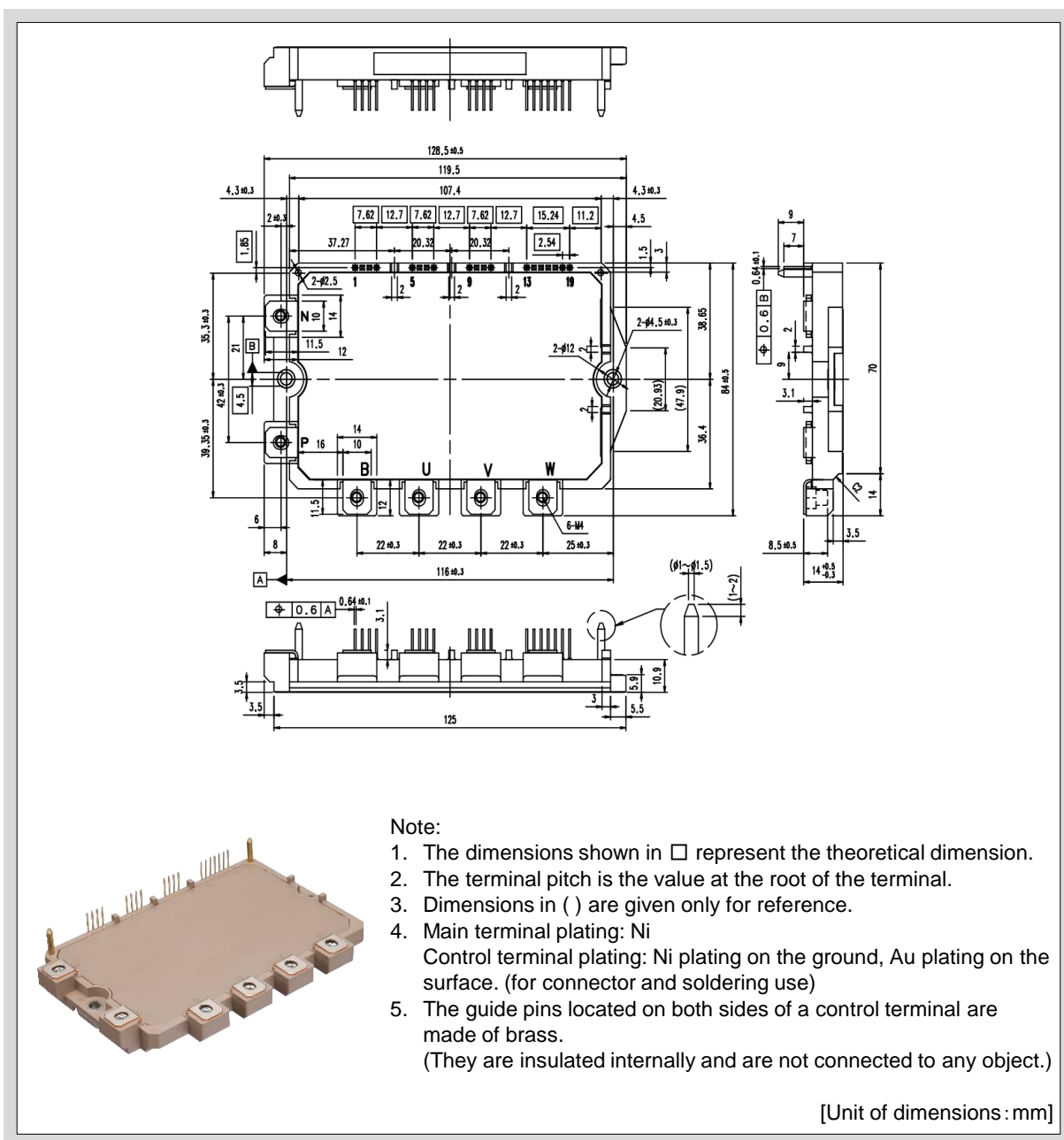


Fig.1-8 Package outline drawing (P630)

4.8 P631 package (6in1/7in1 with upper and lower arm alarm signal output)

- The line-up is 200A to 450A for 650V and 100A to 300A for 1200V.
- Terminal pitch of the control terminals is standard 2.54 mm and can be connected with general-purpose connectors and soldering.
- The main power input (P1, P2, N1, N2), brake input (B), and output terminals (U, V, W) are located close to each other, making main wiring easy. The P1 and P2, N1 and N2 terminals are internally connected.
- The main terminals are M5 screws, allowing high current connections to be made securely.
- Screw size for the heat sink is M5 common with the main terminals.
- All electrical connections are done with screws and connectors, thus no soldering is required and easy to remove.
- Compatible with R-IPM series P612. (Excluding the control terminal part)
- The package outline drawing is shown in Figure 1-9.

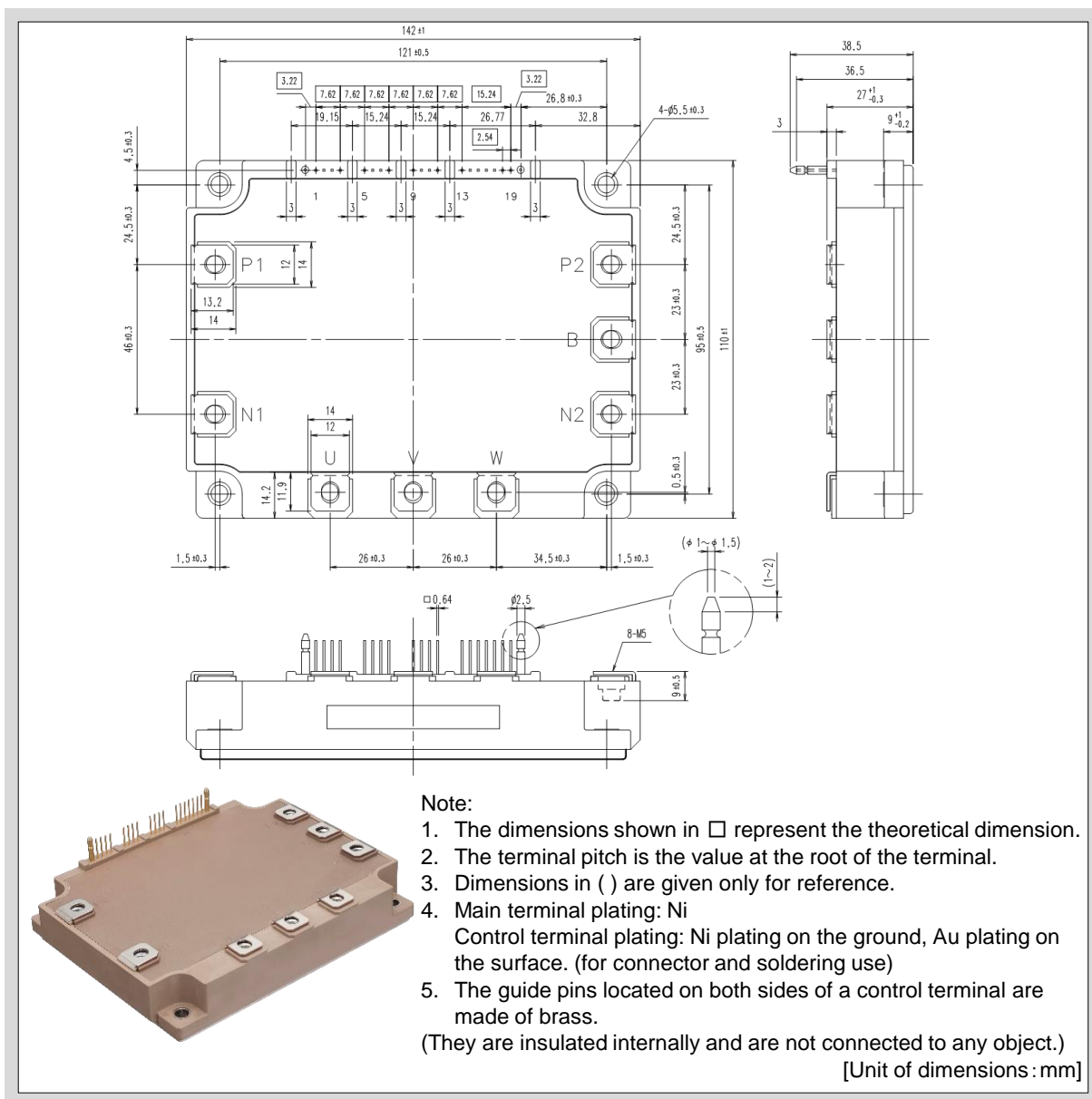


Fig.1-9 Package outline drawing (P631)

5. Structure

The structural components for each package are shown in Figure 1-10 to Figure 1-16.

* These figures are for material explanation only and do not show the exact dimensions or layout.
In addition, they do not indicate all the parts used in the products.

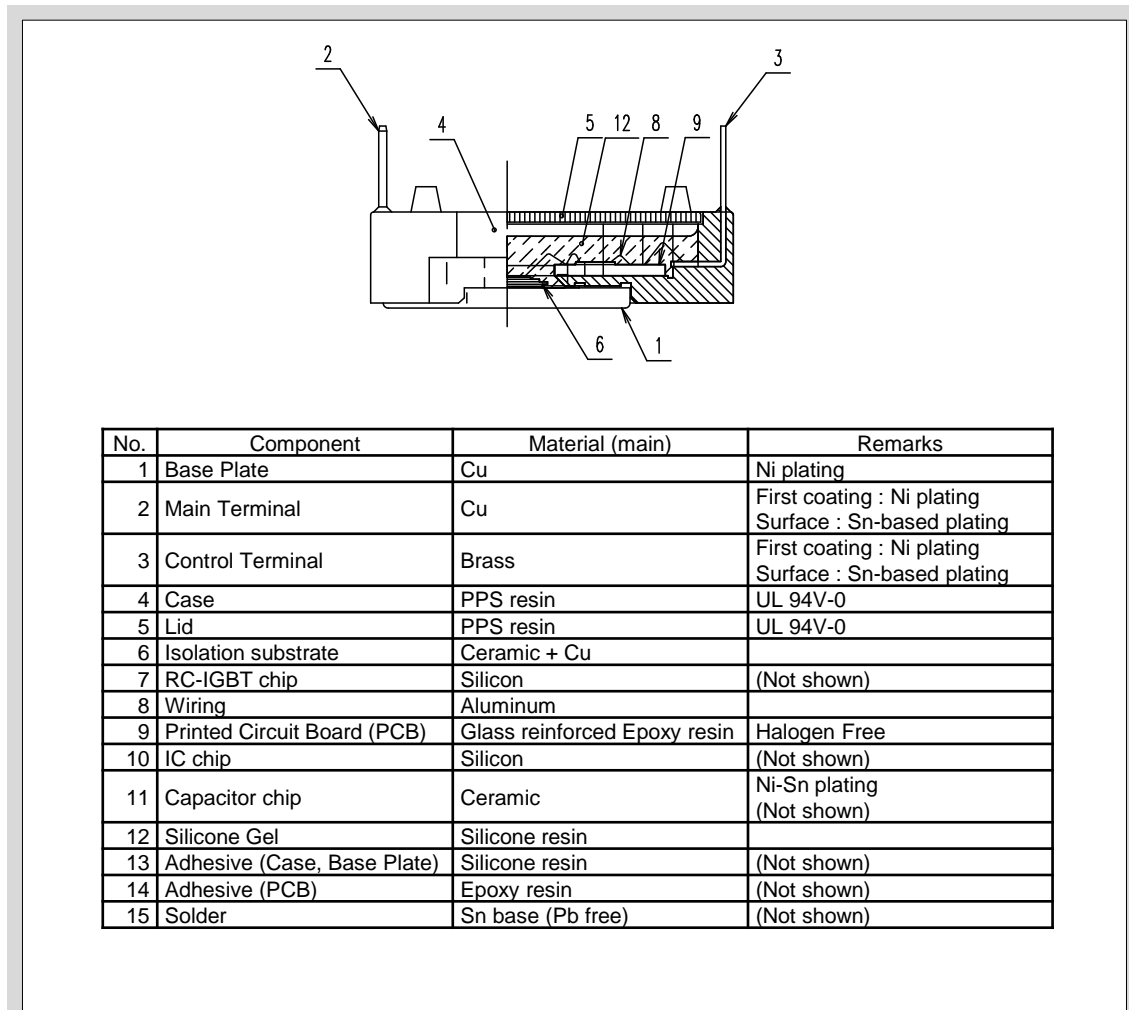
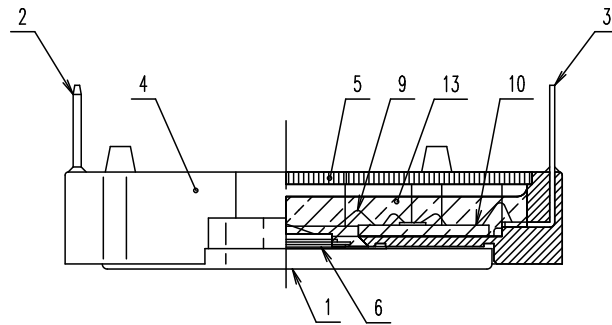
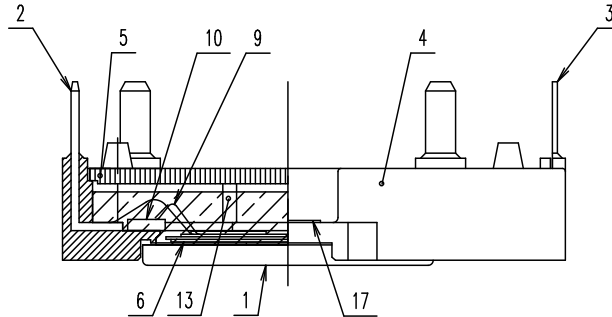


Fig.1-10 Structure and materials (P639)



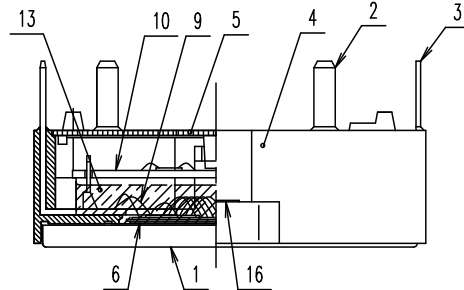
| No. | Component | Material (main) | Remarks |
|-----|-----------------------------|------------------------------|--|
| 1 | Base Plate | Cu | Ni plating |
| 2 | Main Terminal | Cu | First coating : Ni plating Surface : Sn-based plating |
| 3 | Control Terminal | Brass | First coating : Ni plating Surface : Sn-based plating |
| 4 | Case | PPS resin | UL 94V-0 |
| 5 | Lid | PPS resin | UL 94V-0 |
| 6 | Isolation substrate | Ceramic + Cu | |
| 7 | IGBT chip | Silicon | (Not shown) |
| 8 | FWD chip | Silicon | (Not shown) |
| 9 | Wiring | Aluminum | |
| 10 | Printed Circuit Board (PCB) | Glass reinforced Epoxy resin | Halogen Free |
| 11 | IC chip | Silicon | (Not shown) |
| 12 | Capacitor chip | Ceramic | Ni-Sn plating (Not shown) |
| 13 | Silicone Gel | Silicone resin | |
| 14 | Adhesive (Case, Base Plate) | Silicone resin | (Not shown) |
| 15 | Adhesive (PCB) | Epoxy resin | (Not shown) |
| 16 | Solder | Sn base (Pb free) | (Not shown) |

Fig.1-11 Structure and materials (P629)



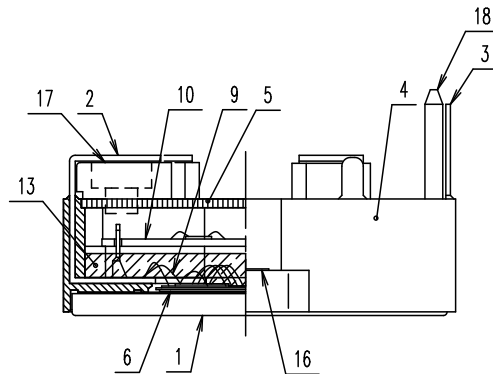
| No. | Component | Material (main) | Remarks |
|-----|-----------------------------|------------------------------|--|
| 1 | Base Plate | Cu | Ni plating |
| 2 | Main Terminal | Cu | First coating : Ni plating Surface : Sn-based plating |
| 3 | Control Terminal | Brass | First coating : Ni plating Surface : Sn-based plating |
| 4 | Case | PPS resin | UL 94V-0 |
| 5 | Lid | PPS resin | UL 94V-0 |
| 6 | Isolation substrate | Ceramic + Cu | |
| 7 | IGBT chip | Silicon | (Not shown) |
| 8 | FWD chip | Silicon | (Not shown) |
| 9 | Wiring | Aluminum | |
| 10 | Printed Circuit Board (PCB) | Glass reinforced Epoxy resin | Halogen Free |
| 11 | IC chip | Silicon | (Not shown) |
| 12 | Capacitor chip | Ceramic | Ni-Sn plating (Not shown) |
| 13 | Silicone Gel | Silicone resin | |
| 14 | Adhesive (Case, Base Plate) | Silicone resin | (Not shown) |
| 15 | Adhesive (PCB) | Epoxy resin | (Not shown) |
| 16 | Solder | Sn base (Pb free) | (Not shown) |
| 17 | Ring | Stainless steel | |

Fig.1-12 Structure and materials (P626, P644)



| No. | Component | Material (main) | Remarks |
|-----|-----------------------------|------------------------------|--|
| 1 | Base Plate | Cu | Ni plating |
| 2 | Main Terminal | Cu | First coating : Ni plating Surface : Sn-based plating |
| 3 | Control Terminal | Brass | First coating : Ni plating Surface : Sn-based plating |
| 4 | Case | PPS resin | UL 94V-0 |
| 5 | Lid | PPS resin | UL 94V-0 |
| 6 | Isolation substrate | Ceramic + Cu | |
| 7 | IGBT chip | Silicon | (Not shown) |
| 8 | FWD chip | Silicon | (Not shown) |
| 9 | Wiring | Aluminum | |
| 10 | Printed Circuit Board (PCB) | Glass reinforced Epoxy resin | Halogen Free |
| 11 | IC chip | Silicon | (Not shown) |
| 12 | Capacitor chip | Ceramic | Ni-Sn plating (Not shown) |
| 13 | Silicone Gel | Silicone resin | |
| 14 | Adhesive (Case, Base Plate) | Silicone resin | (Not shown) |
| 15 | Solder | Sn base (Pb free) | (Not shown) |
| 16 | Ring | Stainless steel | |

Fig.1-13 Structure and materials (P636)



| No. | Component | Material (main) | Remarks |
|-----|-----------------------------|------------------------------|--|
| 1 | Base Plate | Cu | Ni plating |
| 2 | Main Terminal | Cu | Ni plating |
| 3 | Control Terminal | Brass | First coating : Ni plating Surface : Au plating |
| 4 | Case | PPS resin | UL 94V-0 |
| 5 | Lid | PPS resin | UL 94V-0 |
| 6 | Isolation substrate | Ceramic + Cu | |
| 7 | IGBT chip | Silicon | (Not shown) |
| 8 | FWD chip | Silicon | (Not shown) |
| 9 | Wiring | Aluminum | |
| 10 | Printed Circuit Board (PCB) | Glass reinforced Epoxy resin | Halogen Free |
| 11 | IC chip | Silicon | (Not shown) |
| 12 | Capacitor chip | Ceramic | Ni-Sn plating (Not shown) |
| 13 | Silicone Gel | Silicone resin | |
| 14 | Adhesive (Case, Base Plate) | Silicone resin | (Not shown) |
| 15 | Solder | Sn base (Pb free) | (Not shown) |
| 16 | Ring | Stainless steel | |
| 17 | Nut | Fe | Trivalent chromate treatment |
| 18 | Guide pin | Brass | |

Fig.1-14 Structure and materials (P638)

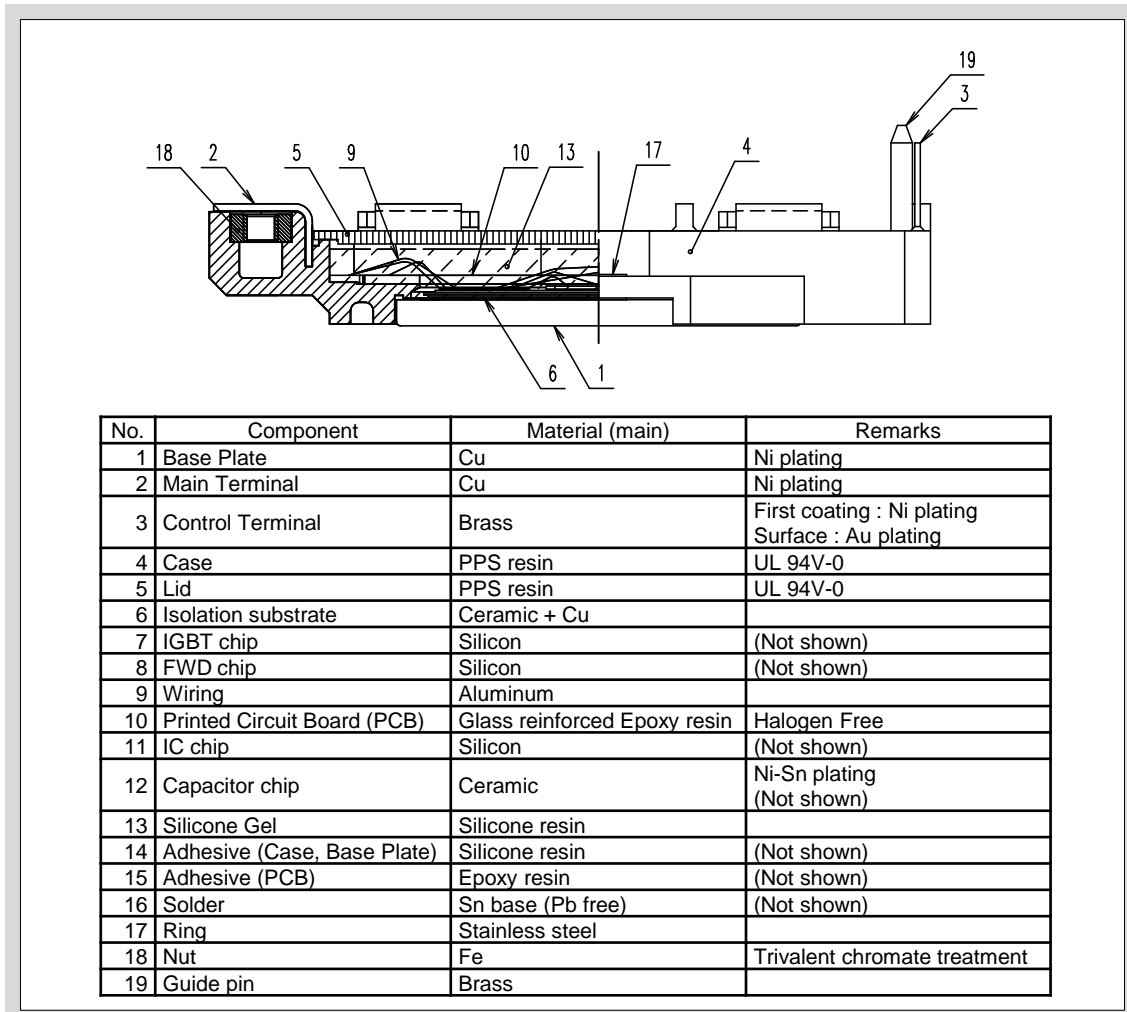
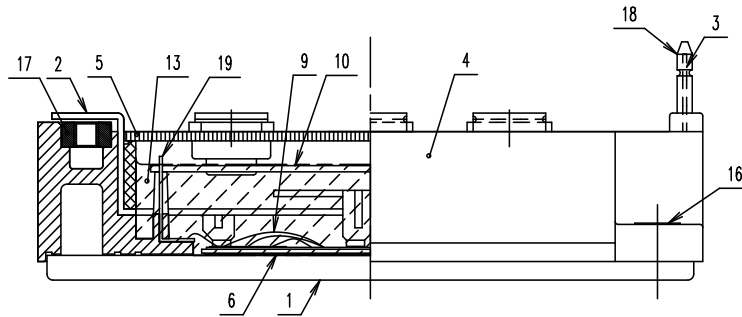


Fig.1-15 Structure and materials (P630)



| No. | Component | Material (main) | Remarks |
|-----|-----------------------------|------------------------------|--|
| 1 | Base Plate | Cu | Ni plating |
| 2 | Main Terminal | Cu | Ni plating |
| 3 | Control Terminal | Brass | First coating : Ni plating Surface : Au plating |
| 4 | Case | PPS resin | UL 94V-0 |
| 5 | Lid | PPS resin | UL 94V-0 |
| 6 | Isolation substrate | Ceramic + Cu | |
| 7 | IGBT chip | Silicon | (Not shown) |
| 8 | FWD chip | Silicon | (Not shown) |
| 9 | Wiring | Aluminum | |
| 10 | Printed Circuit Board (PCB) | Glass reinforced Epoxy resin | Halogen Free |
| 11 | IC chip | Silicon | (Not shown) |
| 12 | Capacitor chip | Ceramic | Ni-Sn plating (Not shown) |
| 13 | Silicone Gel | Silicone resin | |
| 14 | Adhesive (Case, Base Plate) | Silicone resin | (Not shown) |
| 15 | Solder | Sn base (Pb free) | (Not shown) |
| 16 | Ring | Stainless steel | |
| 17 | Nut | Fe | Trivalent chromate treatment |
| 18 | Guide pin | Brass | |
| 19 | Internal Terminal | Brass | Ni plating |

Fig.1-16 Structure and materials (P631)

- Main terminals of IPM (screw type)

The structure of the main terminal is shown in Figure 1-17:

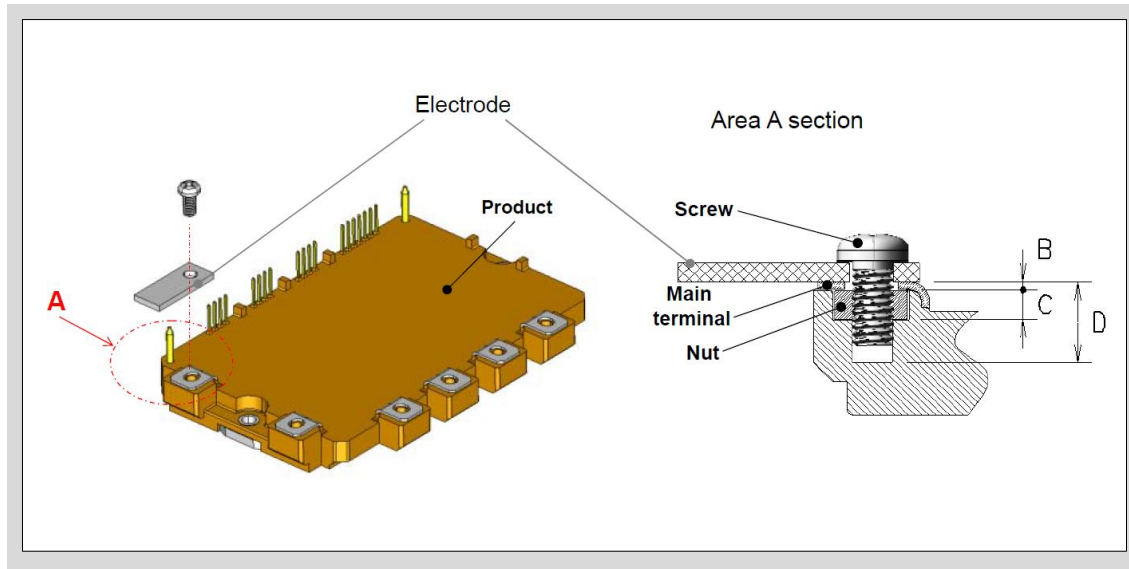


Fig.1-17 IPM main terminal structure (Example: P630)

Table 1-5 IPM main terminal specifications

| Package | Screw standard | Terminal tab thickness (B) | Nut depth (C) | Screw hole depth (D) |
|---------|----------------|----------------------------|---------------|----------------------|
| P638 | M4 | 0.8 | 3.5 | 8.0 ± 0.5 |
| P630 | M4 | 0.8 | 3.5 | 8.5 ± 0.5 |
| P631 | M5 | 1 | 4 | 9.0 ± 0.5 |

[Unit : mm]

- Guide pins of IPM

The guide pins located on both sides of control terminal portions of P638, P630 and P631 are made of brass. They are insulated internally and are not connected to any object.

- Height of the protrusion on lid of P636
P636 package has two types of protrusions with different heights (2.5 mm and 1.0 mm) on the lid. The PCB height can be set to 18.5 mm or 17.0 mm by utilizing these protrusions.

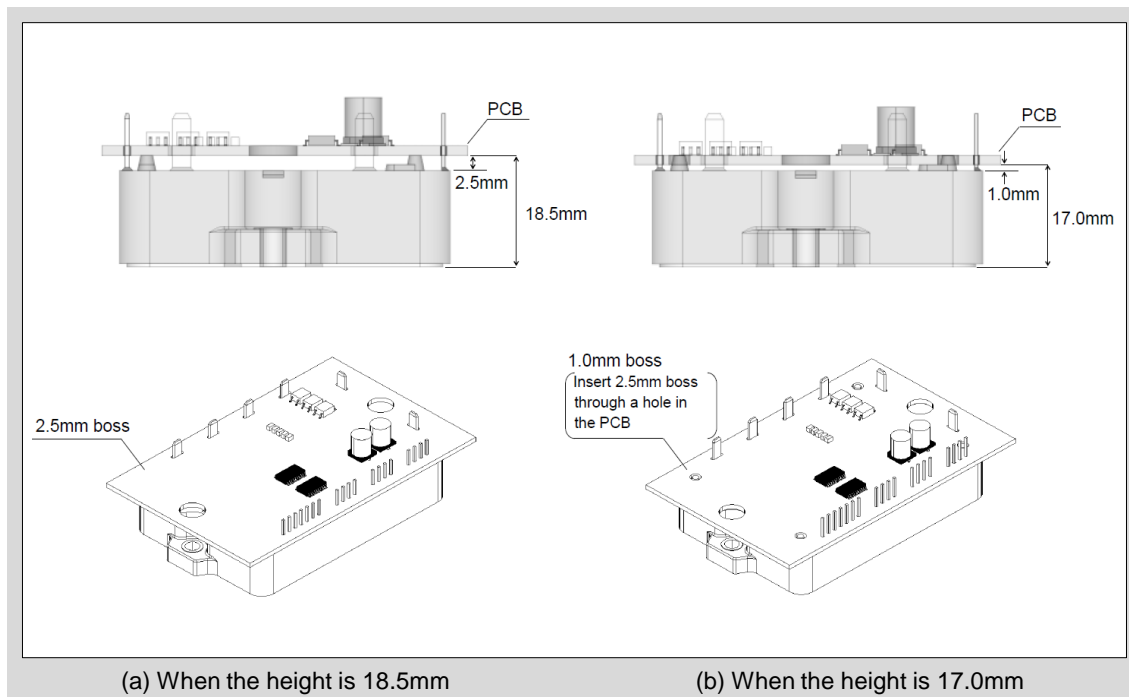


Fig.1-18 Selecting from two different protrusion heights