Power Module Application Notes

Contents

1. Product application example of configuration

Examples of power supply configurations using a wide variety of combinations of power modules and on-board power supply units lineups will be introduced with layout sketches.

2. Parallel Operation example of configuration

Some products equally shares current by connecting each PC terminal of power module in parallel.
In this chapter, basic cautions, warnings and connections in parallel operation will be explained.

2-1 **Introduction**
2-2 **Precaution in parallel operation**
2-3 **Example of parallel operation**
2-4 **Example of N+1 redundant operation**

3. Power module conduction cooling design

For power modules with aluminum boards, conduction cooling design is necessary. Conduction cooling design (including selection of heat sink and fan setting) should be made based on the input/output conditions and temperature environment in use so that the temperature of the power module base plate stays within the allowed range of temperatures.
In this chapter, the conduction cooling design by forced air cooling with heat sink will be explained.

3-1 **Conduction cooling design (explanation and examples)**
3-2 **Standard heat sinks (refer also to the quick reference below.)**

4. Power module mounting method

The power module with aluminum board should be fastened to the printed circuit with screws and soldered.. Instructions on how to do that will be described.

4-1 **Board mounting method**
4-2 **Heat sink mounting method**
4-3 **About vibration resistance**
4-4 **Recommended soldering conditions**
4-5 **Recommended cleaning conditions**
4-6 **About storage condition and duration**

* Our standard heat sinks -- quick reference

No.	Module type name	Heat sink type name
1.	PH50S, PH75S	HAA-041
2.	PH75F, PH100S	HAA-062
3.	PH150S	HAA-072
4.	PH100F, PH150F, PH300S, PF500A	HAA-083
5.	PH300F, PH600S, PF1000A	HAA-146
6.	PAH50S, PAH75S, PAH100S, PAH150S, PAH200S, PAH300S, PAH350S, PAH450S, PAH75D, CN200A110, PH300A280	HAH-10T, HAH-10L, HAH-15L
7.	PAF400F, PAF450F, PAF500F, PAF600F, PAF700F, PFE300SA, PFE500SA, PFE700SA	HAF-10L, HAF-15L, HAF-15T
8.	PFE500F	HAL-F12T
9.	PFE1000F, PFE1000FA	HAM-F10T
10.	CN30A110, CN50A110, CN50A24, CN100A110, CN100A24 PH50A280, PH75A280, PH100A280, PH150A280	HAQ-10T

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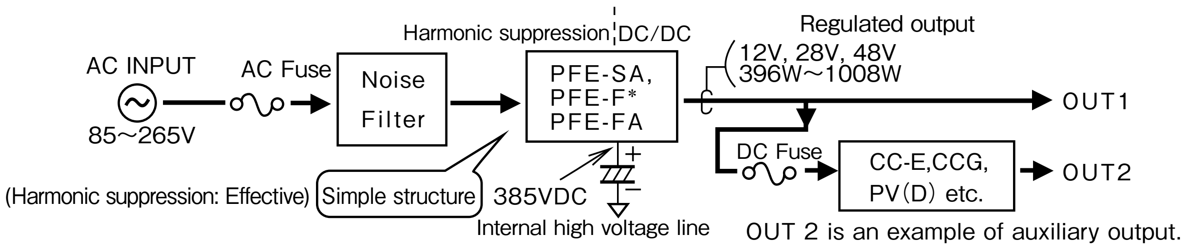
1. Product application example of configuration

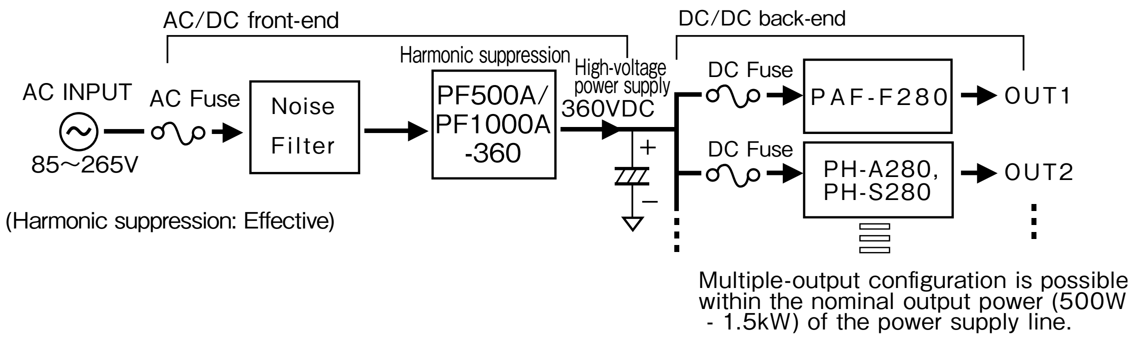
Example 1: 500W AC/DC power supply

All the DC/DC converters referred to in this page are of insulation type.

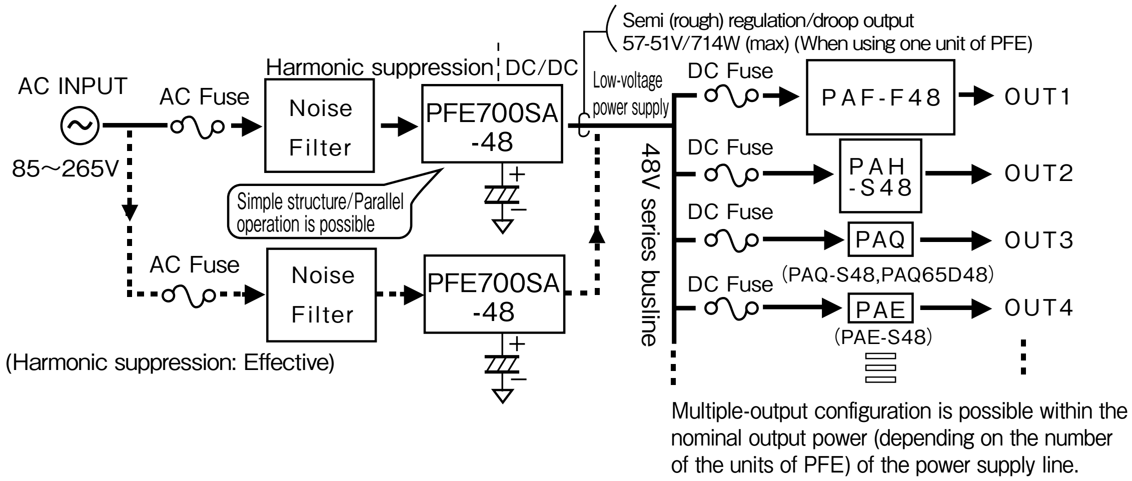


*PFE-F and PFE-FA are possible output power reinforcement (kW order) by parallel operation.

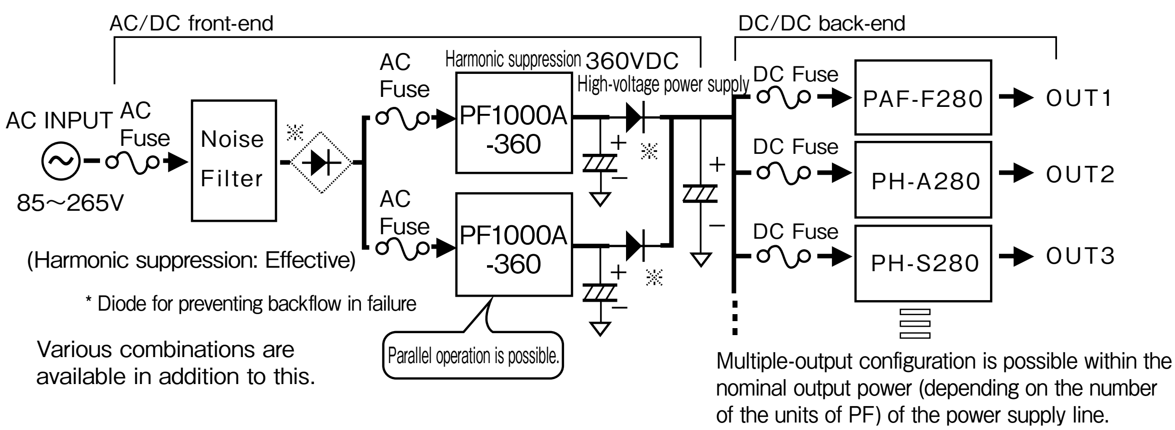
Example 2: 500-1500W AC/DC power supply (high voltage power feeding / multiple outputs)



Example 3: 700W or over AC/DC power supply(low voltage power feeding / multiple outputs)

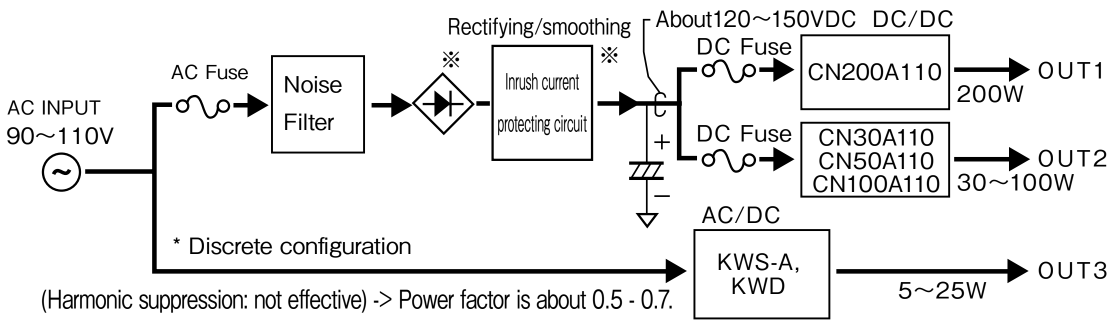


Example 4: High power (kW class) N+1 parallel redundancy AC/DC power supply (high voltage power feeding / multiple outputs)

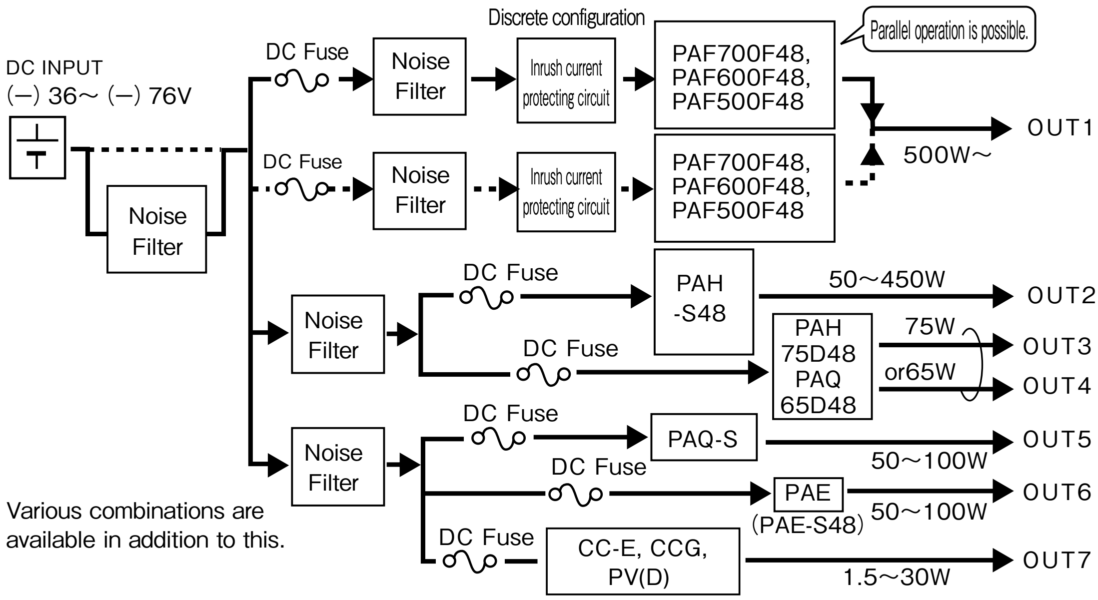


Example 5: Domestic (Japan) use AC/DC power supply

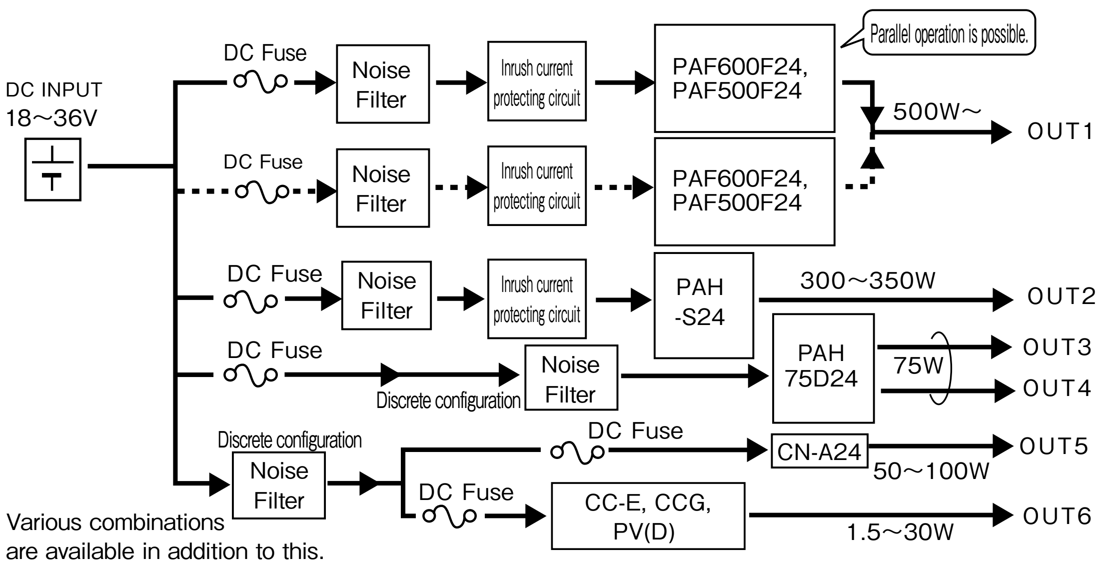
All the DC/DC converters referred to in this page are of insulation type.



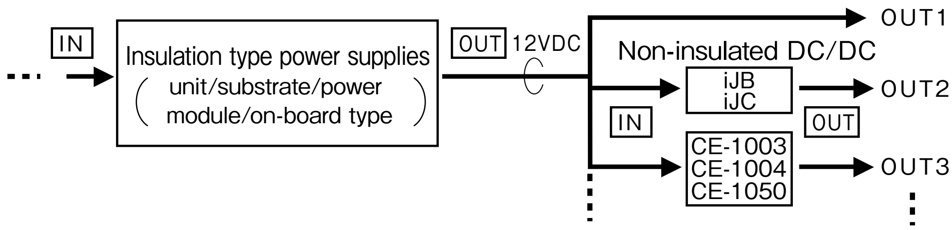
Example 6: Communication/industry use -- 48V DC/DC power supply



Example 7: Communication/industry use -24V DC/DC power supply



Example 8: Usage of insulated/non-insulated power supply

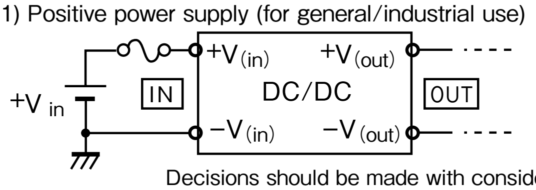


Example 9: Input/output connections for insulated DC/DC converter

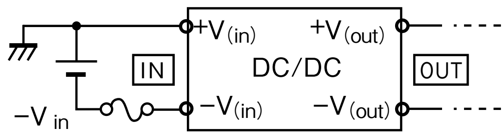
In this section, conceptual diagrams of the use of insulation type DC/DC converters will be introduced. Refer to the respective pages for each product, because some external parts may be needed or some names of terminals may differ depending on the product.

(1) Location for fuse to be inserted

1) Positive power supply (for general/industrial use)



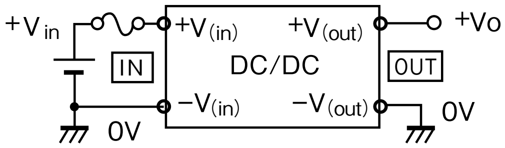
2) Negative power supply (for communication)



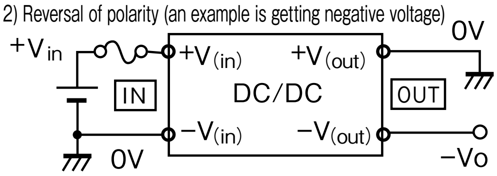
Decisions should be made with consideration to safety in the connection conditions after the fuse is blown out when a problem has occurred.
The explanation of each product is based on the positive power supply.

(2) Application as the non-insulated power supply

1) Voltage conversion with homopolarity

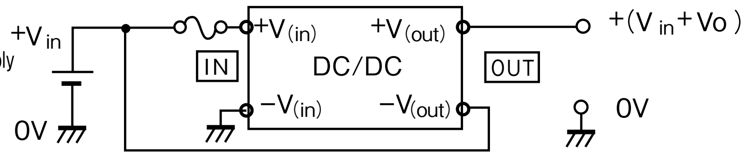


2) Reversal of polarity (an example is getting negative voltage)

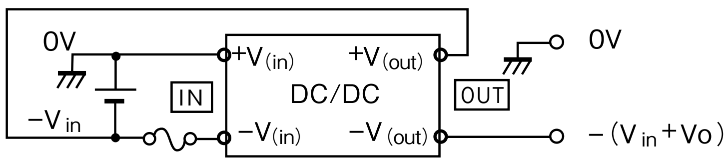


3) Use of output voltage for input line in series

A. Layering to positive power supply

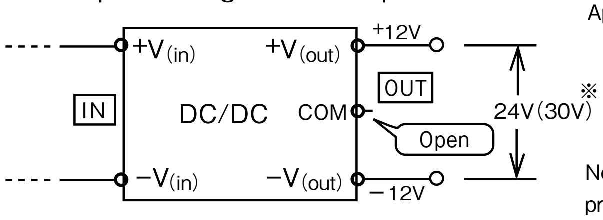


B. Layering to negative power supply



In the insulation type DC/DC converter, by connecting the input and output mutually like above, application as the non-insulated power supply is possible. Other connections are also possible in addition to this.

(3) Use of bipolar voltage in dual outputs



Applicable products

KWD, CC-Dx-E, PSD, PVD
Combination with (1) / (2) above are also possible.
* Variability function is to be used for some products

Note) This application is not available for the following products: CE, PAH75D, PAQ65D

2. Parallel Operation example of configuration

2-1 Introduction

Some products equally shares current by connecting each PC terminal of power module in parallel.
There are 2 different parallel operations as follows.

(1) Parallel Operation
When load current can not be supplied by only a unit of power module, the output can be enhanced. Also, the reliability of the system can be improved to derate the output power.

(2) N+1 Parallel Redundant Operation
For power supply system required high reliability, it is possible to improve the reliability of the system by using N+1 units for load of N units.
In parallel operation with N+1 units, even though one of the power modules is failed, performance of the system can be maintained for the other units cover for the failure power module and share the load current.

2-2 Precaution in parallel operation

Basic cautions and warnings in parallel operation are as follows.

- Available to use in identical model (same output power and voltage.).
- Attach a common mode choke coil at input of each power module.
- Adjust within accuracy of output voltage of each model.
- For the maximum load current, refer to clause of "Parallel Operation" of instruction manual of each model.
- Ground of PC terminal (signal ground) is -S or COM terminal. Inhibit to use as power line.
- Use same length and size of output load wire between power modules in parallel operation and loads.
- If IOG and AUX terminals are used, read its explanation in the manual.
- When the distance between power modules is too long, current balance might get worse due to switching noise. As countermeasure, please connect a ceramic capacitor (about 0.01 to 0.1 uF) between PC and signal ground terminal of each power module.

2-3 Example of parallel operation

(a) Parallel connection to enhance the output and to improve the reliability

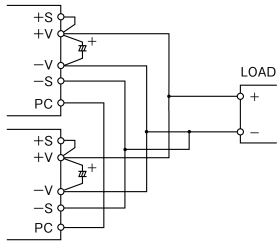


Figure2-1 : Parallel Operation

(b) Parallel Operation with programmed output voltage

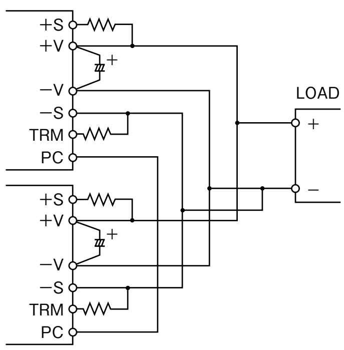


Figure2-2 : Parallel Operation with Programmed Output Voltage

(c) Parallel Operation with adjustable output voltage

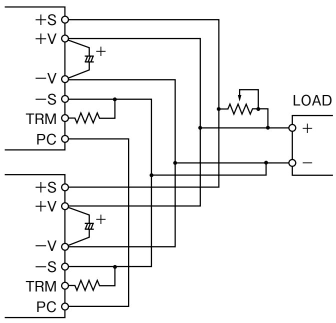


Figure2-3 : Parallel Operation with adjustable voltage

(d) Parallel operation when the output voltage is adjusted by applying voltage externally

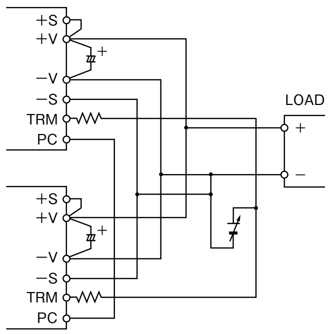


Figure 2-4 : Parallel Operation which is possible to adjust output voltage by external applied voltage

2-4 Example of N+1 redundant operation

(a) N+1 Redundant connection

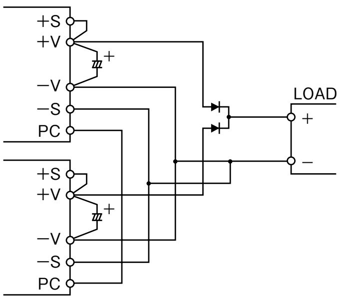


Figure2-5：N+1 Redundant Operation

(b) Redundant Operation with programmed output voltage

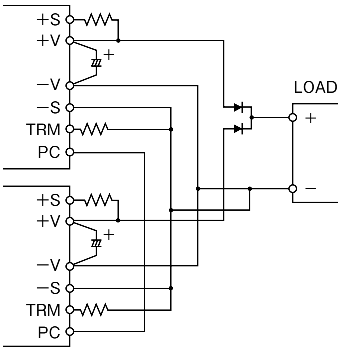


Figure2-6：N+1 Redundant Operation with programmed output voltage

(c) Redundant operation with adjustable output voltage

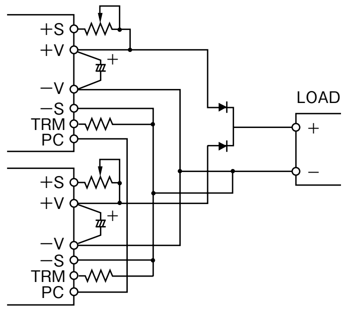


Figure2-7：N+1 Redundant Operation with adjustable output voltage

(d) Redundant operation when the output voltage is adjusted by applying voltage externally

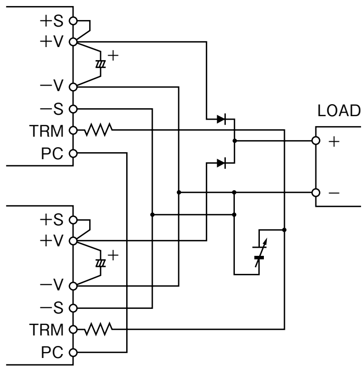


Figure2-8：N+1 Redundant Operation which is possible to adjust the output voltage by external applied voltage

Note) Please do sufficient evaluation on actual products when applying N+1 redundant or parallel operation.

3. Power module conduction cooling design

3-1 Conduction cooling design

The power modules become usable under the condition that the temperature of the base plate in use is kept under the allowed temperature value. The system reliability is dominated by the temperature of the base plate in use.
We will explain about the power module conduction cooling designing process by using an example with "PAF600F280-48". Figure 3-1 is the flow chart of the conduction cooling design.

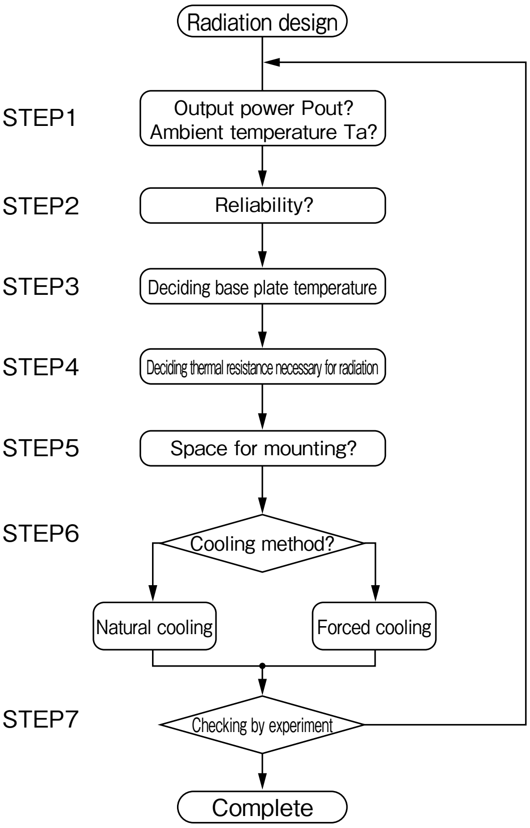


Figure 3-1 Flow chart of conduction cooling design

●STEP 1

Decide the output power (Pout) and the ambient temperature (Ta) of the power module to be used.

Model: PAF600F280-48
Pout = 500(W) (83% load)
Ta = 50(℃)

(Hereinafter, a designing example with an actual device will be indicated inside the frame.)

●STEP 2

Decide the base plate temperature with consideration of the required reliability.
Use the table 3-1 (Temperature and usage of base plates) as a measuring stick.

Usage	Base plate temperature	Reliability level
Devices for public use Devices with drone control systems	70℃ or lower	Highest
General industrial devices Devices in production facilities	80℃ or lower	Relatively high
General electronic devices	85℃ or lower	Ordinary

Table 3-1 Temperature and usage of base plates

●STEP 3

Here, the base plate temperature is supposed to be set to "Ta = 80℃ or lower", assuming that the device is for general industrial use.

●STEP 4

Decide the necessary thermal resistance of the heat sink.

(1) Find the internal power consumption.

$$Pd=\frac{1-\eta}{\eta}\times Pout=Pout\times\left(1-\frac{1}{\eta}\right)\quad\cdots\text{(Expression 3-1)}$$

Pd : Internal power consumption (W)
Pout : Output power (W)
η : Efficiency

Then, the efficiency can be found by the expression below.

$$\eta=\frac{Pout}{Pin}\times 100\quad\cdots\cdots\cdots\text{(Expression3-2)}$$

η : Efficiency (%)
Pout : Output power (W)
Pin : Input power (W)

Efficiency differs depending on the input voltage and output current. As well, efficiency differs by the type of power module. Refer to the data of each type of module. Figure 3-2 shows a typical example of the case in "PAF600F280-48".
Note that the internal power consumption should be decided with 1-2% allowance against the efficiency value calculated using the characteristic of efficiency in output current.

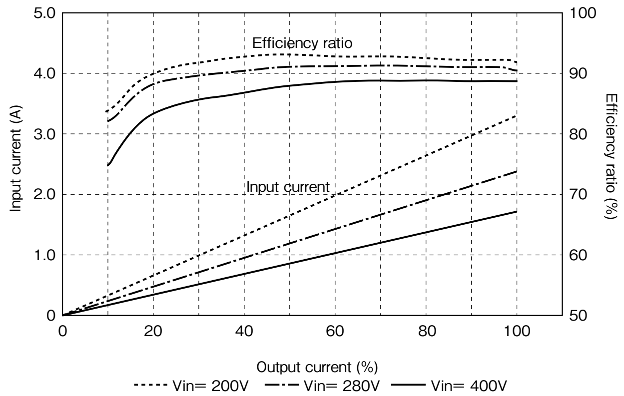


Figure 3-2 PAF600F280-48 efficiency characteristics

> Efficiency is found by using Figure 3-2. In this example, efficiency is to be found in the condition of operating PAF600F280-48 with 280VDC nominal voltage. The efficiency achieved by 280VDC input voltage and 83% output current is found to be 91% from Figure 3-2. By adding an allowance of 1% to this value,
>
> Efficiency η = 90%
> By this, the internal power consumption is found to be
>
> $$Pd=500\times\left(\frac{1}{0.9}-1\right)$$
> $$=56(W)$$

(2) Find the necessary thermal resistance of the heat sink.

θbp-a=(Tp − Ta)／Pd (Expression 3-3)

θbp-a : Thermal resistance(℃ /W) (between base plate and air)
Pd : Internal power consumption(W)
Ta : Ambient temperature(℃)
Tp : Base plate temperature(℃)

The thermal resistance of the heat sink can be found by the expression below.

θhs-a= θbp-a− θbp-hs (Expression 3-4)

θhs-a : Thermal resistance between heat sink and air (℃ /W)

θbp-hs : Contact thermal resistance(℃ /W) (between base plate and heat sink)

Contact thermal resistance means the thermal resistance of the contact surface between the power module base plate and the heat sink. Use silicone grease or others to reduce the contact thermal resistance.
Fasten the heat sink to the power module by using screws, as indicated in a separate section.

The recommended screw-tightening torque in fastening the power module is 0.54Nm.

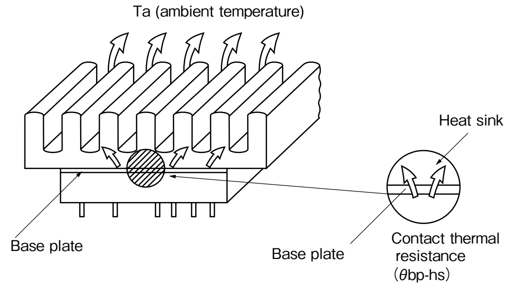


Figure 3-3 Contact thermal resistance

●STEP 5

> In this example, the thermal resistance between the base plate and air is
>
> θbp-a = (80-50)/56
> = 0.54(℃ /W)
>
> And, the thermal resistance of the heat sink in the condition of 0.2℃/W contact thermal resistance (θbp-hs), is found to be
>
> θhs-a = 0.54-0.2
> = 0.34 (℃ /W)

Next, check the size of the physically available heat sink space when mounting the power module.

> In this example, assume that the available mounting space of the module is 70(W) x 60(H) x 125(D) mm.
> As the size of the main unit of PAF600F is 61(W) x 12.7(H) x 117(D) mm,
> a space of approximately 70(W) x 47(H) x 125(D) mm (approximately $4.1x10^5mm^3$) can be assigned for the heat sink.

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●**STEP 6**

Study the cooling method appropriate for the mounting space.

(1) **Natural air cooling**

Find the approximate value of the heat sink volume which ensures the thermal resistance found in Step 4, to be required in natural air cooling, based on Figure 3-4 (Relationship between envelope volume of heat sink and thermal resistance). The characteristics shown in Figure 3-4 are for typical aluminum heat sinks with proper fin spacing (if the spaces are too narrow, ventilation resistance becomes large, reducing the amount of heat discharge). The envelope volume means the volume enclosed by the outline of the heat sink. The envelope volume value to be found here should be the approximate volume of the heat sink required in natural air cooling. Note that the thermal resistance value differs depending on the shape of the heat sink, so refer to data provided by heat sink manufacturers for details to make decisions.

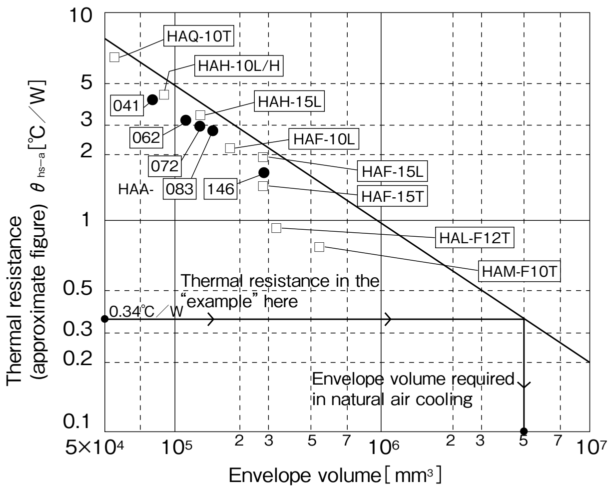


Figure 3-4 Relationship between envelope volume of heat sink and thermal resistance (in natural air cooling)

Also, the thermal resistance data provided by heat sink manufactures is, in most cases, the one in the condition with vertical mounting. Be aware that the cooling efficiency will be considerably reduced in the condition with horizontal mounting. If the selected heat sink can be accommodated by the mounting space, go to Step 7.

If not, study the forced air cooling.

(2) **Forced air cooling**

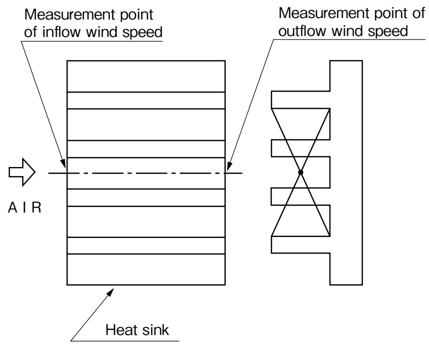
When forced air cooling is employed, the heat discharge ability of the heat sink improves and becomes several times higher than with natural air cooling.

The heat discharge design by forced air cooling is not easy because the air flow in the case cannot be even.

The uneven air flow is caused by the disturbance in air flow generated by the fan due to the complicated shape/structure of the case and mounted components located in the case. The calculation methods are introduced in various literature, but they are not practically usable because of too many conditions to be applied.

Here, the method of measuring wind speed in a mock-up of the case and estimating the thermal resistance will be introduced.

First, create a mock-up of the case with consideration to the shape of the case, number of fans and their locations to be attached, how the wind blows to the heat sink, mounted components around the heat sink, and other factors of mechanical design. Then, activate fans and measure the inflow and outflow speed of wind into/from the heat sink by using a wind meter. The measurement points should be the center of the heat sink as shown in Figure 3-5 (Measurement point of wind speed). Estimate the thermal resistance value by using the average value of the inflow and outflow speed of wind as the heat sink's thermal resistance characteristic in * Standard heat sink for



$$\text{Average wind speed} = \frac{\text{inflow wind speed} + \text{outflow wind speed}}{2}$$

Figure 3-5 Measurement point of wind speed

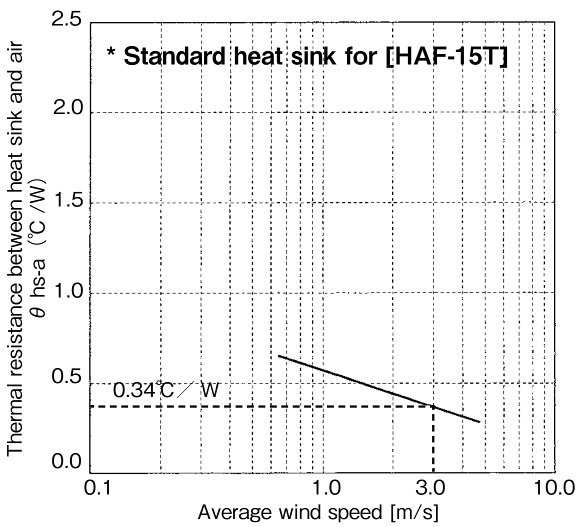


Figure 3-6 Heat sink's thermal resistance characteristic in wind speed

Estimate the thermal resistance value by using the heat sink's thermal resistance characteristic in wind speed, based on the measured wind speed value.

Check if this thermal resistance value comes under the thermal resistance value found in Step 4. If necessary thermal resistance is not ensured, change the characteristics of fans or modify the mechanism of the case so that the

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necessary thermal resistance value is ensured.

The envelope volume required in the case of using natural air cooling should be calculated. It is found to be 5.2 x 10^6mm^3 or over based on Figure 3-4.
The mounting space cannot accommodate this volume, as the available space for the heat sink is approximately 4.1 x 10^5mm^3. Consequently, forced air cooling should be adopted. In this case, one of our standard heat sinks (HAF-15T) should be adopted to fit the available mounting space.
Based on Figure 3-6 "Heat sink's thermal resistance characteristic in wind speed", a wind speed of approximately 3m/s or over is necessary to attain 0.34℃ /W or lower thermal resistance value. Confirm that the necessary wind speed value is ensured by measuring the wind speed using a mock-up.

●**STEP 7**

Conduct experiments to check if the designed performance is actually attained. The base plate temperature can be estimated by the expression below.

$$Tp = Ta + Pd \times \theta bp\text{-}a$$
$$= Ta + Pd\,(\theta bp\text{-}hs + \theta hs\text{-}a) \quad \text{(Expression 3-5)}$$

Tp：Base plate temperature(℃)
Ta：Ambient temperature(℃)
Pd：Internal power consumption(W)
θbp-a：Thermal resistance(℃/W) (between base plate and air)
θbp-hs：Contact thermal resistance(℃/W) (between base plate and heat sink)
θhs-a：Thermal resistance of the heat sink(℃/W) (between heat sink and air)

In the experiment, confirm that the base plate temperature value is under that decided in Step 3. If there are no problems, the design is complete. If the performances in the experiment do not satisfy the designed values, re-design the device.
For PAF600F280-48, measure the base plate temperature at the center of the base plate. If it is impossible due to the structure of the heat sink or other factors, measure the base plate temperature at the nearest point from the center of the base plate as possible. (The measurement point may differ depending on the model.)

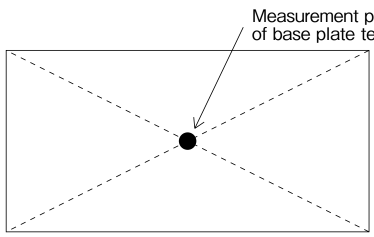


Figure 1-7 Measurement point of base plate temperature

Implement an experiment with an actual device in which PAF600F280-48 is mounted. Measure the base plate temperature in the same conditions as in actual use (Pout=500W, Ta=50℃). Confirm that the measured base plate temperature is kept at 80℃ or lower. This completes the design.

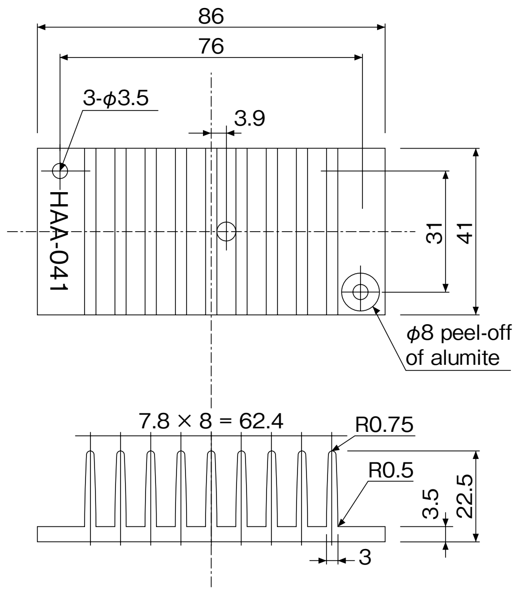
3-2 Standard heat sinks

We have prepared standard heat sinks for each package of our power modules.
Note that the indicated thermal resistance values are those in the condition where silicone grease is applied.

(1) Heat sink for [T41] (HAA-041)

Dimensions：86(W)×41(D)×22.5(H)mm
Modules to be applied to: PH50S/75S

[Appearance diagram]] Material：Alminium (black alumite treatment)



[Cooling characteristics]
〈Natural air cooling〉 Thermal resistance: Approximately 3.9 (℃/W)

〈Forced air cooling〉

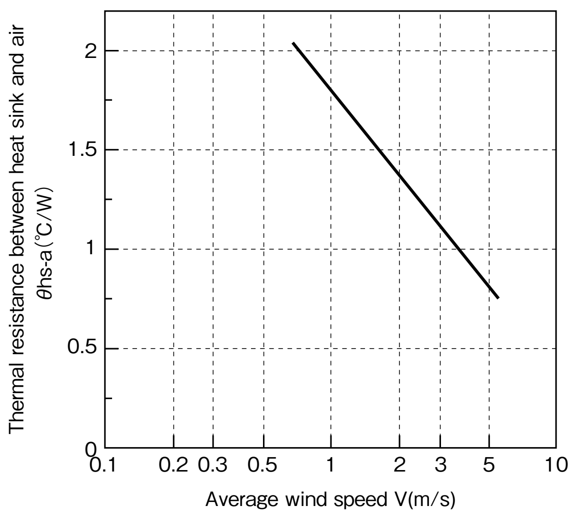


Figure 3-8 Thermal resistance characteristic in wind speed for the heat sink prepared for [T41]

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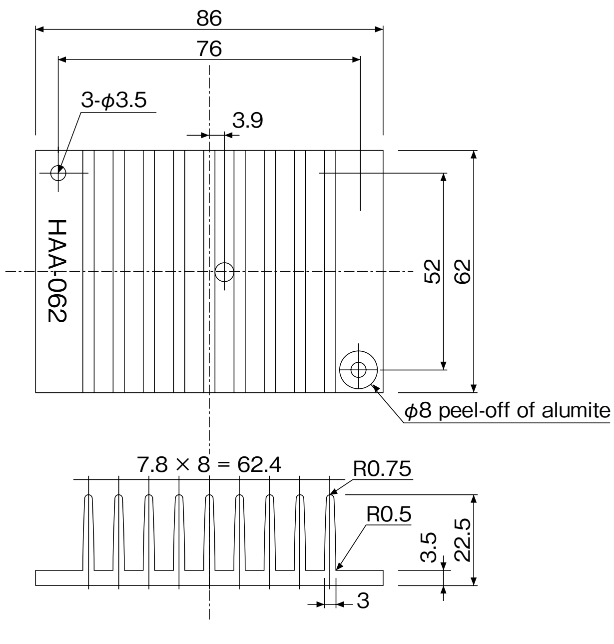
(2) Heat sink for [T62] (HAA-062)

Dimensions: 86(W) x 62(D) x 22.5(H) mm
Modules to be applied to: PH75F/100S

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance: Approximately 3.2 (℃ /W)

(Forced air cooling)

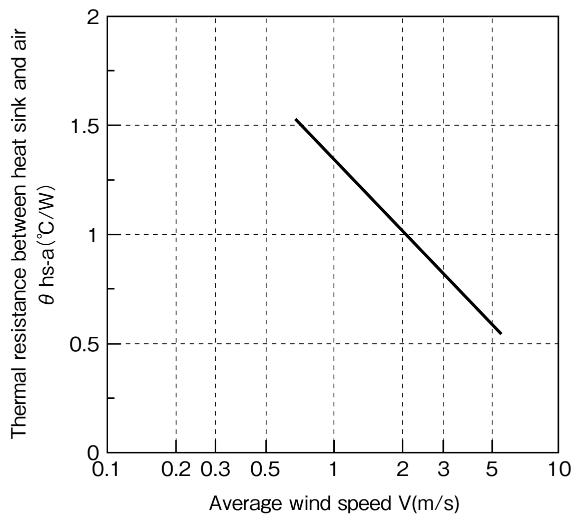
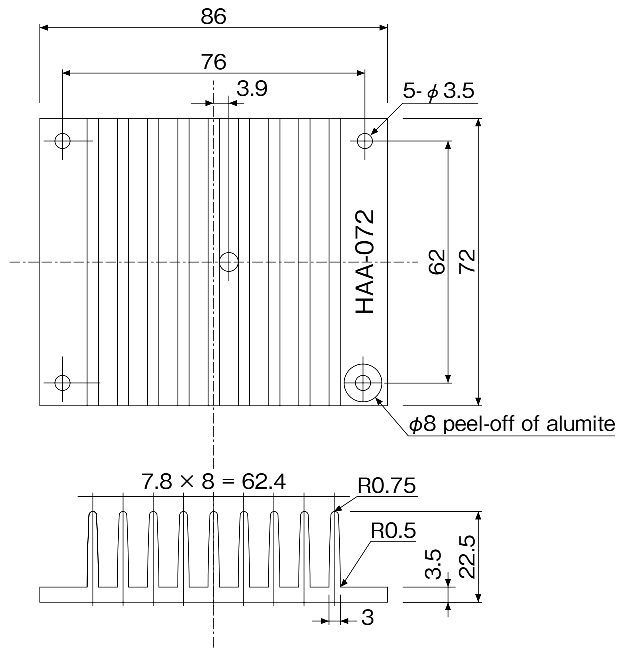


Figure 3-9 Thermal resistance cahracteristc in relation to wind speed for the heat sink prepared for [T62]

(3) Heat sink for [T72] (HAA-072)

Dimensions: 86(W) x 72(D) x 22.5(H) mm
Modules to be applied to: PH150S

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance: 3.0 (℃ /W)

(Forced air cooling)

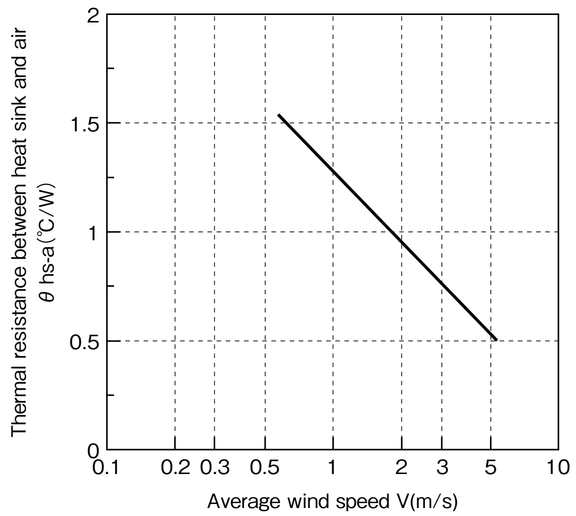
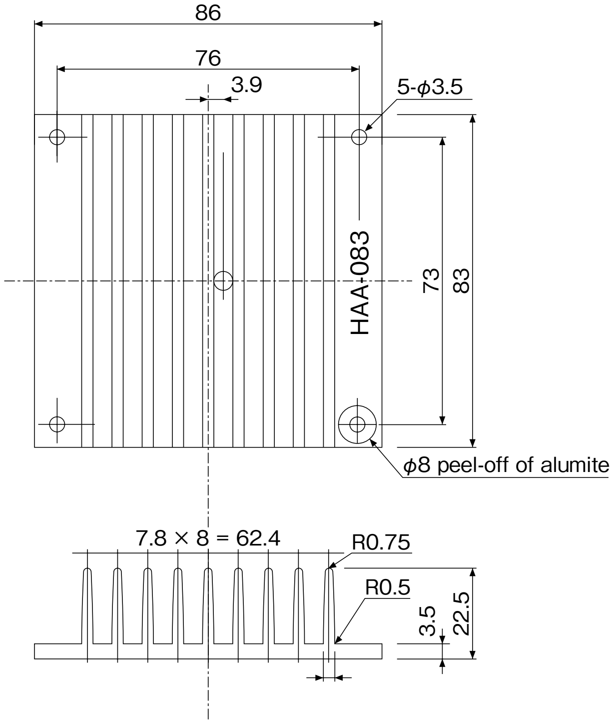


Figure 3-10 Thermal resistance cahracteristc in relation to wind speed for the heat sink prepared for [T72]

(4) Heat sink for [T83] (HAA-083)

Dimensions: 86(W) x 83(D) x 22.5(H) mm
Modules to be applied to: PH150F/PH100F/PF500A/PH300S

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance: 2.7 (℃ /W)

(Forced air cooling)

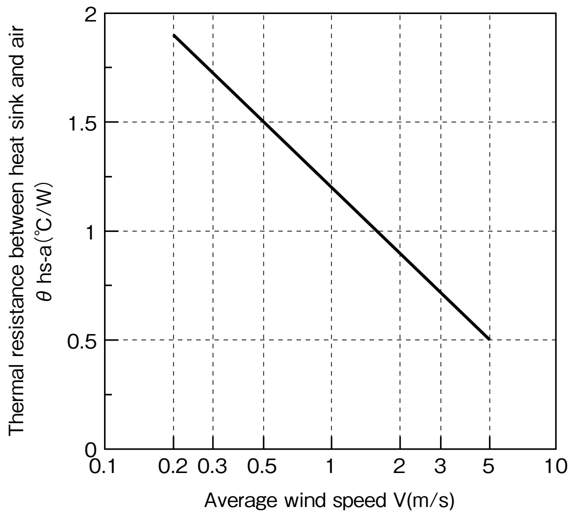
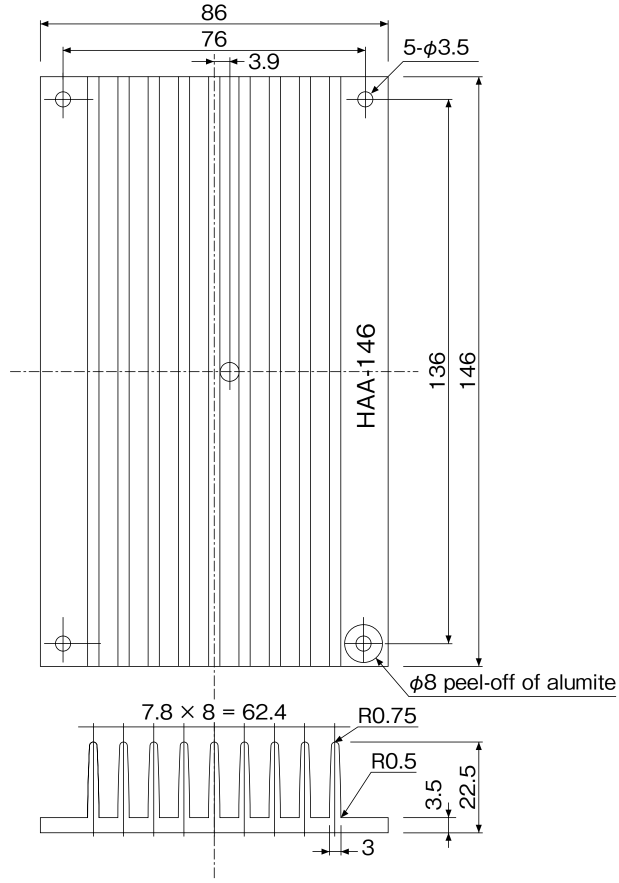


Figure 3-11 Thermal resistance characteristic in relation to wind speed for the heat sink prepared for [T83]

(5) Heat sink for [T146] (HAA-146)

Dimensions: 86(W) x 146(D) x 22.5(H) mm
Modules to be applied to: PH300F/PF1000A/PH600S

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance: Approximately 1.7 (℃ /W)

(Forced air cooling)

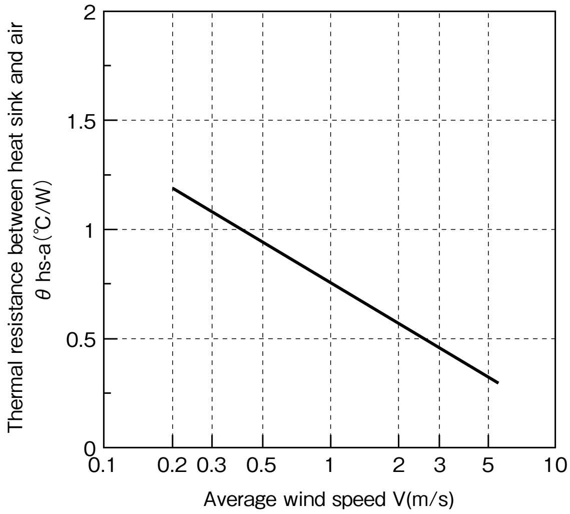


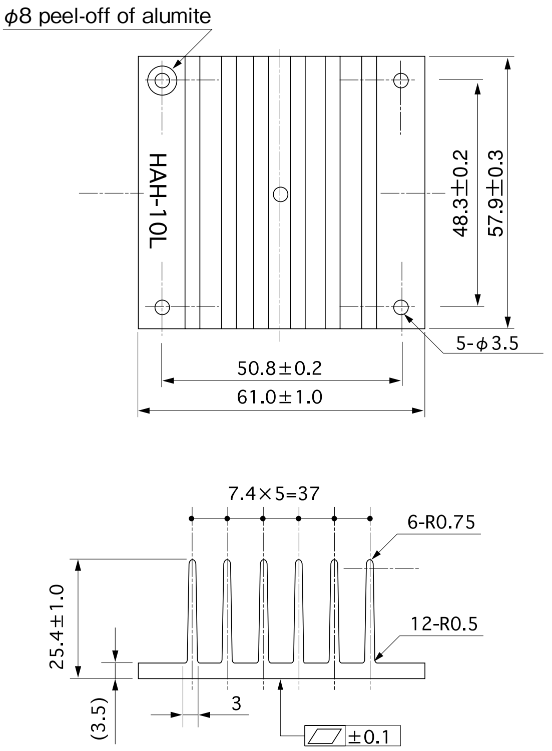
Figure 3-12 Thermal resistance characteristic in relation to wind speed for the heat sink prepared for [T146]

TDK-Lambda

(6) Heat sink for Half Brick ①(HAH-10L)

Dimensions: 57.9(W) x 61(D) x 25.4(H) mm
Modules to be applied to: PAH/PAH75D series
CN200A110/PH300A280

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance: Approximately 4.6 (℃ /W)

(Forced air cooling)

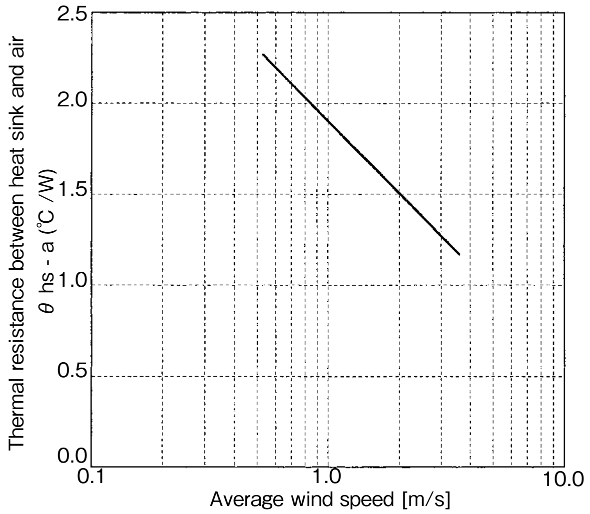
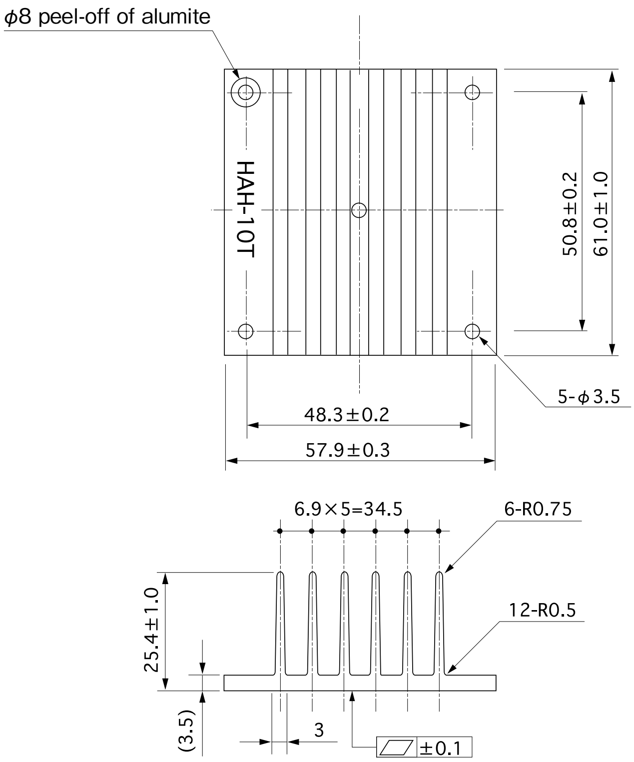


Figure 3-13 Thermal resistance characteristic in relation to wind speed for the heat sink prepared for [HAH-10L]

(7) Heat sink for Half Brick ②(HAH-10T)

Dimensions: 57.9(W) x 61(D) x 25.4(H) mm
Modules to be applied to: PAH/PAH75D series
CN200A110/PH300A280

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance: Approximately 4.5 (℃ /W)

(Forced air cooling)

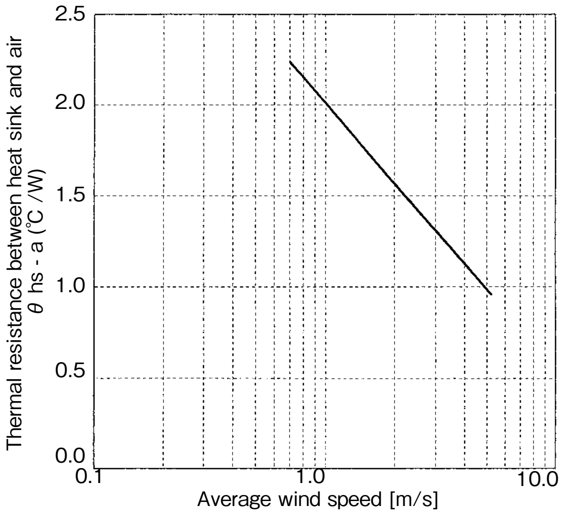


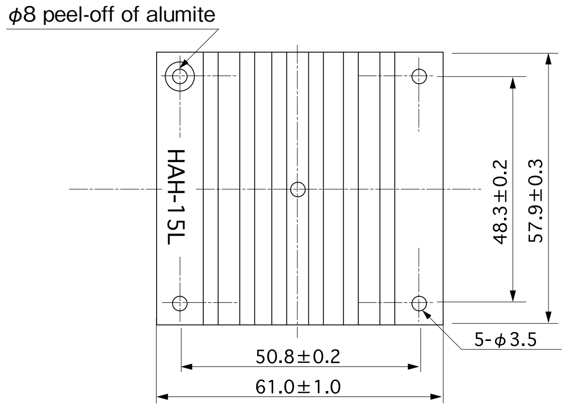
Figure 3-14 Thermal resistance characteristic in relation to wind speed for the heat sink prepared for [HAH-10T]

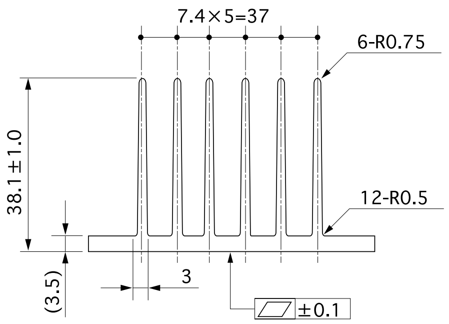
Power module Application notes

(8) Heat sink for Half Brick ③(HAH-15L)

Dimensions: 57.9(W) x 61(D) x 38.1(H) mm
Modules to be applied to: PAH/PAH75D series
CN200A110/PH300A280

[Appearance diagram] Material: Alminium (black alumite treatment)





[Cooling characteristics]
(Natural air cooling) Thermal resistance: Approximately 3.4 (℃ /W)

(Forced air cooling)

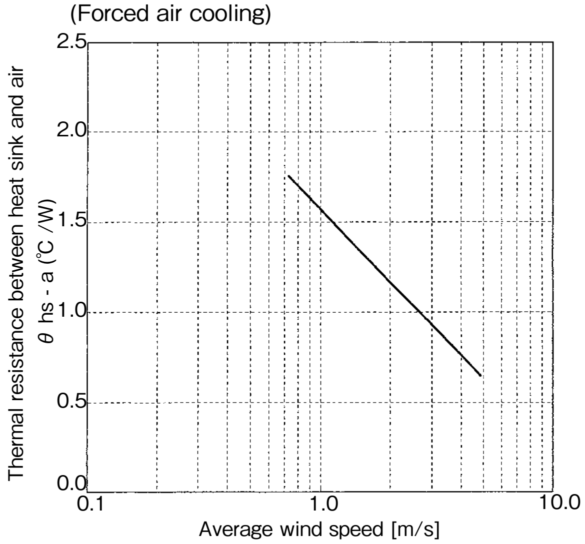
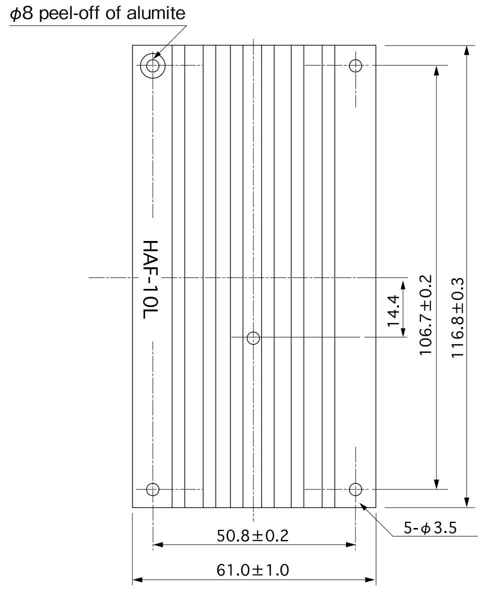


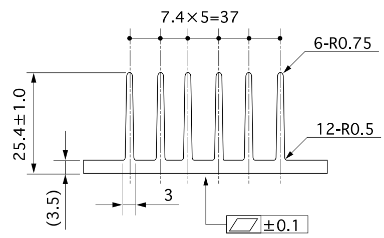
Figure 3-15 Thermal resistance cahracteristc in relation to wind speed for the heat sink prepared for [HAH-15L]

(9) Heat sink for Full Brick ①(HAF-10L)

Dimensions: 116.8(W) x 61(D) x 25.4(H) mm
Modules to be applied to: PAF series, PFE-SA series

[Appearance diagram] Material: Alminium (black alumite treatment)





[Cooling characteristics]
(Natural air cooling) Thermal resistance: Approximately 2.2 (℃ /W)

(Forced air cooling)

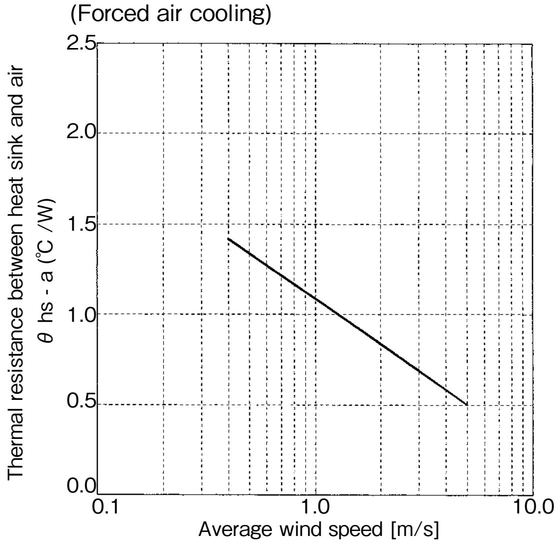


Figure 3-16 Thermal resistance characteristic in relation to wind speed for the heat sink prepared for [HAF-10L]

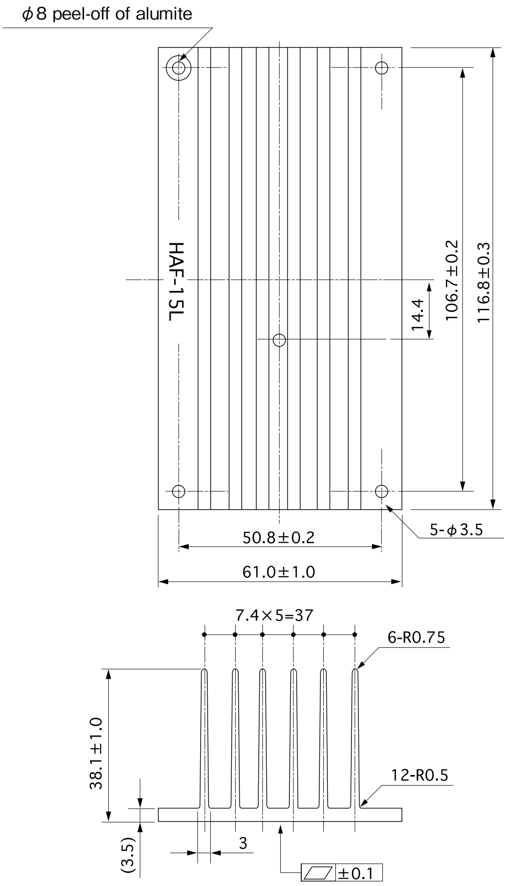
Power module
Application notes

(10) Heat sink for Full Brick ②(HAF-15L)

Dimensions: 116.8(W) x 61(D) x 38.1(H) mm

Modules to be applied to: PAF series, PFE-SA series

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]

(Natural air cooling) Thermal resistance: Approximately 1.9 (℃ /W)

(Forced air cooling)

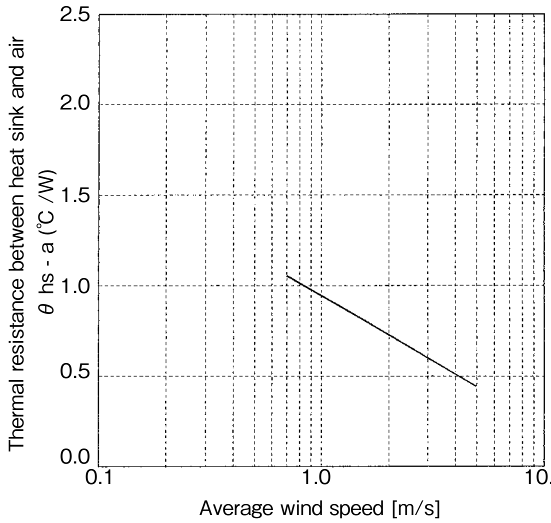


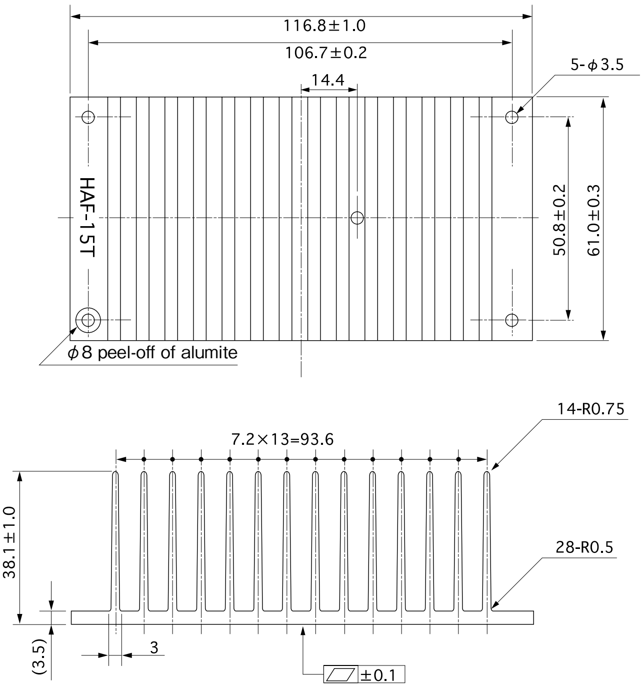
Figure 3-17 Thermal resistance cahracteristc in relation to wind speed for the heat sink prepared for [HAF-15L]

(11) Heat sink for Full Brick ③(HAF-15T)

Dimensions: 116.8(W) x 61(D) x 38.1(H) mm

Modules to be applied to: PAF series, PFE-SA series

[Appearance diagram] Material: Alminium (black alumite treatment)



[Cooling characteristics]

(Natural air cooling) Thermal resistance: Approximately 1.5 (℃ /W)

(Forced air cooling)

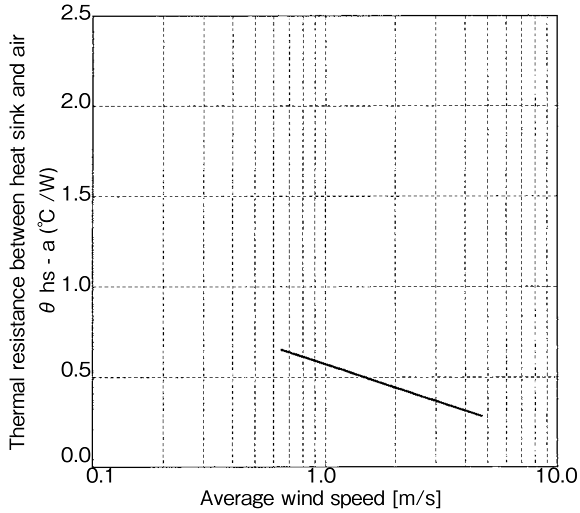
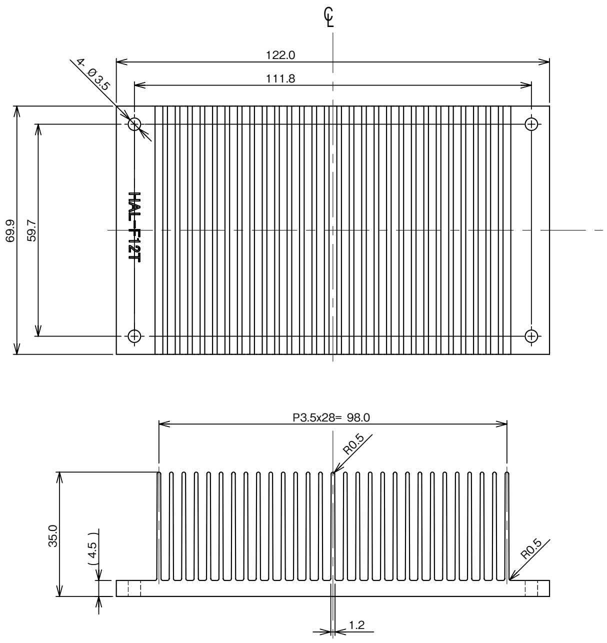


Figure 3-18 Thermal resistance cahracteristc in relation to wind speed for the heat sink prepared for [HAF-15T]

(12) Heat sink for PFE500F (HAL-F12T)

Dimensions : 122 (W) × 35 (H) × 69.9 (D) mm
Modules to be applied to : PFE500F

[Appearance diagram] Material : Alminiuum (Non-surface treatment)

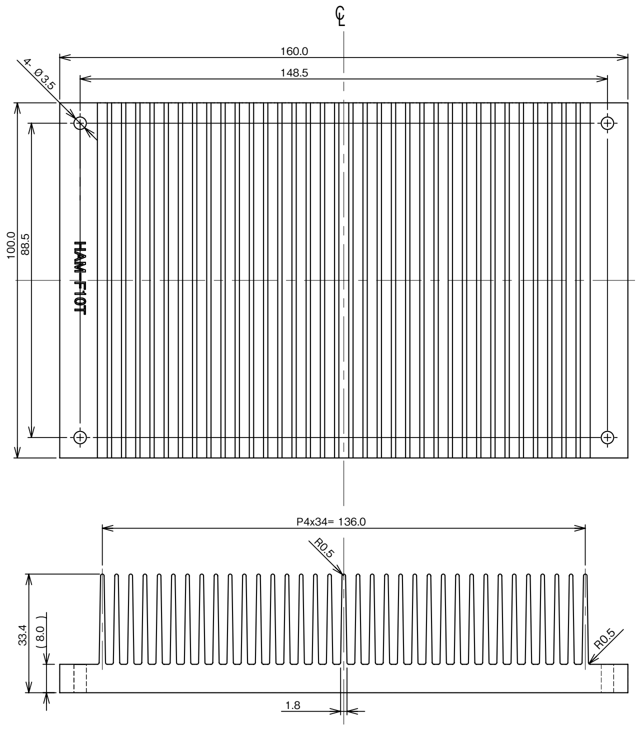


[Cooling characteristics]
〈Natural air cooling〉 Thermal resistance:0.97 (℃ /W)
〈Forced air cooling〉 Refer to chart below.

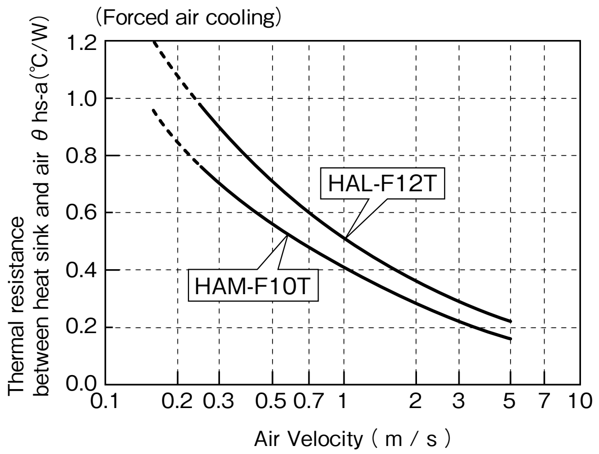
(13) Heat sink for PFE1000F(A)(HAM-F10T)

Dimensions : 160 (W) × 33.4 (H) × 100 (D) mm
Modules to be applied to : PFE1000F, PFE1000FA

[Appearance diagram] Material : Alminiuum (Non-surface treatment)



[Cooling characteristics]
〈Natural air cooling〉 Thermal resistance:0.78 (℃ /W)
〈Forced air cooling〉 Refer to chart below.

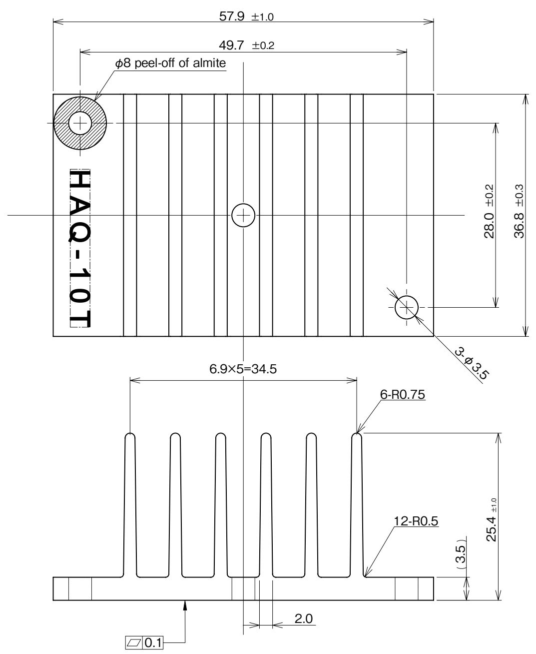


When using, please make a hole in the center of a heat-sink, and confirm base plate temperature of PFEs.

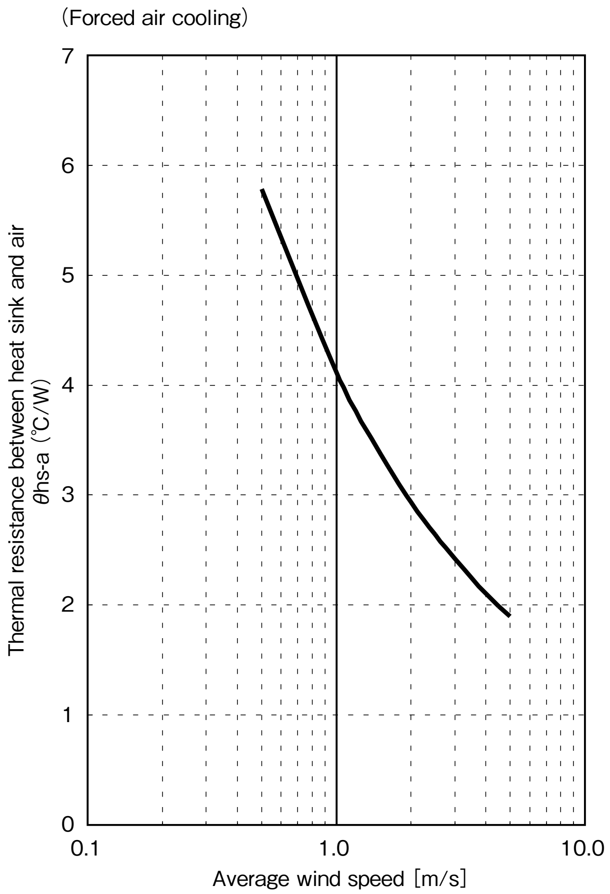
(14) Heat sink For 1/4 Brick (HAQ-10T)

Dimensions : 57.9(W)×25.4(H)×36.8(D)mm
Module to be applied to : CN30A110, CN50A110, CN100A110, CN50A24, CN100A24
PH50A280, PH75A280, PH100A280, PH150A280

[Appearance diagram] Material : Alminium (black alumite treatment)



[Cooling characteristics]
(Natural air cooling) Thermal resistance : Approximately 7.5 (℃ /W)



Power module
Application notes

4. Power module mounting method

4-1 Board mounting method

Mount the power module onto the printed circuit by following the instructions in Figure 4-1.

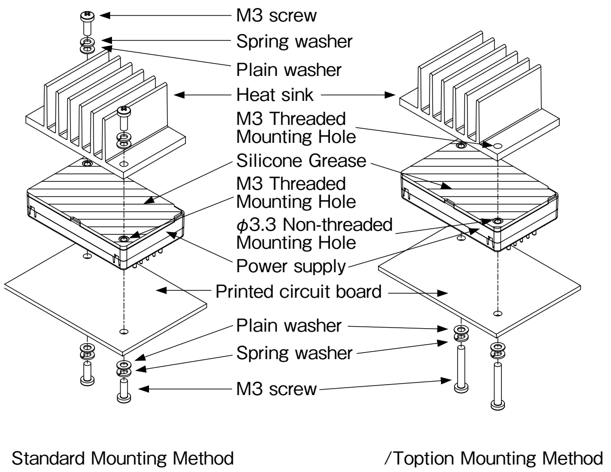


Figure 4-1 Mounting printed circuit board and heat sink

(1) Method to fixing on printed circuit board

To fix a power module onto printed circuit board, use M3 screws and mount it to the M3 threaded holes of the power module. (The number of the mounting holes is either 2 or 4, which depends on the package size.) The recommended screw-tightening torque is 0.54Nm.

(2) Mounting holes (/T option is ϕ3.3 non-threaded mounting hole)

Mounting holes of the power module are connected to the base plate. Connect base plate to FG (Frame Ground) by using this mounting holes.

(3) Mounting holes on printed circuit board

Decide the diameters of holes/lands on the printed circuit board by referring to the respective sizes shown below.

Types	PH50 - PH300F	PH300S	PH600S	PAH/PAF /PFE	PAH75D	CN30- CN100A	CN200A
Input terminal pin	ϕ 2.0mm	←	←	ϕ 1.0mm	←	ϕ 1.0mm	←
Hole diameter	ϕ 2.5mm	←	←	ϕ 1.5mm	←	ϕ 1.5mm	←
Land diameter	ϕ 5.0mm	←	←	ϕ 3.5mm	←	ϕ 2.5mm	←
Output terminal pin	ϕ 2.0mm	←	□0.08in	ϕ 2.0mm	ϕ 1.0mm	ϕ 1.5mm	ϕ 2.0mm
Hole diameter	ϕ 2.5mm	←	□2.8mm	ϕ 2.5mm	ϕ 1.5mm	ϕ 2.0mm	ϕ 2.5mm
Land diameter	ϕ 5.0mm	←	□5.0mm	ϕ 5.0mm	ϕ 3.5mm	ϕ 3.5mm	ϕ 5.0mm
Signal terminal pin	ϕ 0.6mm	ϕ 0.8mm	←	ϕ 1.0mm	←	ϕ 1.0mm	←
Hole diameter	ϕ 1.0mm	ϕ 1.2mm	←	ϕ 1.5mm	←	ϕ 1.5mm	←
Land diameter	ϕ 2.0mm	ϕ 2.4mm	←	ϕ 3.5mm	←	ϕ 2.5mm	←
Mounting tap (FG)	M3	←	←	←	←	←	←
Hole diameter	ϕ 3.5mm	←	←	←	←	←	←
Land diameter	ϕ 7.0mm	←	←	←	←	←	←

For locations of holes, refer to the appearance diagram of each module.

(4) Recommended material of printed circuit board

Regarding material of board, the double-sided through hole glass epoxy board is recommended (thickness to be 1.6mm or more, copper foil thickness to be 35 μ m or more).

(5) Output pattern width

Regarding the output pattern, when a current of from several to dozens of amperes flows here, if the board pattern width is too thin, the voltagae drops and this causes the board to be heated. The relationship between current and pattern width varies depending on the board material, thickness of conductor, and increase of allowed temperature of pattern, etc. An example in the case with the glass epoxy board and 35 μ m copper foil thisckness is shown in Figure 4-2.

For example, to assure the condition that 5A of current flows while the rise in temperature is kept within 10℃ , the pattern width should be 4.2mm or over for 35 μ m copper foil thickness. (In general, "1mm/A" can be noted as a reference.)

Also note that the characteristics shown in Figure 4-2 are merely an example and differ depending on the board manufacturer. Be sure to check for each case in designing.

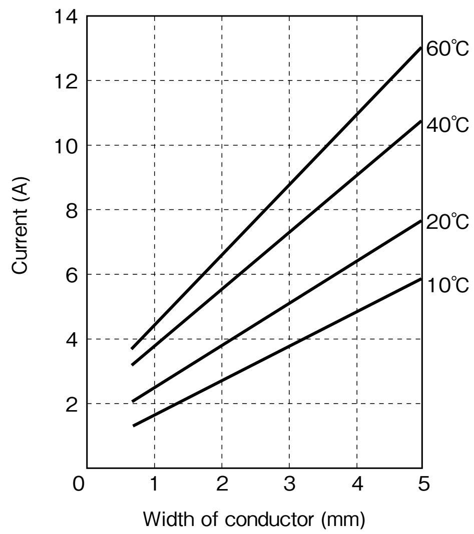


Figure 4-2 Characteristics of the relationship between current capacity and width of conductor, for 35 μ m copper foil thickness

4-2 Heat sink mounting method

(1) Method of fixing heat sink

(1-1) Standard model

To fix the heat sink onto power module, use M3 screws and mount it to the M3 threaded holes at the base plate side. (The number of the mounting holes is either 2 or 4, which depends on the package size.)

The recommended screw-tightening torque is 0.54Nm.

(1-2) /T option model

To fix the heat sink onto power module, use M3 screws those are the same screws for mounting

power module onto printed circuit board.
When mounting the heat sink, be sure to use grease or sheet for discharging heat between the heat sink and the base plate, in order to reduce contact thermal resistance and enhance efficiency in discharging heat. Also, be sure to use a heat sink which does not have warpage, so that the base plate and the heat sink make contact firmly.

(2) Mounting holes on heat sink
Decide the diameter of the mounting holes on the heat sink by referring to the sizes shown below.

Hole diameter: ϕ 3.5mm

4-3 About vibration resistance

The specification value of vibration resistance for the power module is the one in the condition where only the power module is mounted onto the printed circuit board.
If a large-size heat sink should be used, fasten the heat sink not only to the power module but also to the case of the device, in order for overload not to be applied to the power module and the printed circuit board.

4-4 Recommended soldering conditions

Soldering should be conducted under the conditions shown below.
(1) Dip soldering
…………………260℃ , within 10 seconds
Pre-heat conditions
…………………110℃ , 30-40 seconds or less
(2) Soldering iron
…………………350℃ , within 3 seconds
Soldering time changes according to heat capacity of soldering iron, pattern on printed circuit board, etc. Please confirm actual performance.

4-5 Recommended cleaning conditions

Recommended cleaning conditions after soldering are shown below. Consult us for cleaning methods in conditions other than shown below.

(1) Recommended cleaning fluid
- IPA (isopropyl alcohol)

(2) Cleaning method
Clean the unit with a brush so that the cleaning fluid does not intrude into inside of the power supply unit. Also, be sure to dry the cleaning fluid.

4-6 About storage condition and duration

About the storage of the power module, we recommend the following.

(1) Storage condition
Temperature: 5 ~ 30℃
Humidity : 40 ~ 60%RH

(2) Storage duration
Please store the products less than 1 year after the delivery is made. For the product which storage duration are longer than 1 year, please check the solderability and if the leads are rusty before they are used.