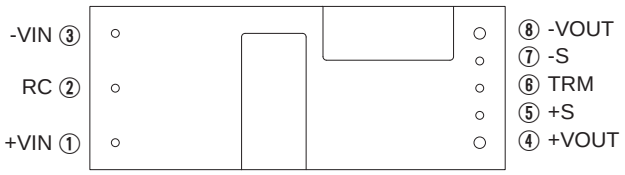
Basic Characteristics Data

Model	Circuit method	Switching frequency [kHz]	Input current	Rated input fuse	Inrush current protection	PCB/Pattern			Series/Redundancy operation availability	
						Material	Single sided	Double sided	Series operation	Redundancy operation
CQHS250	Full-bridge converter	140	✻1	–	–	glass fabric base, epoxy resin		Multilayer	Yes	✻2
CQHS300	Forward converter	250	✻1	–	–	Aluminum	Yes		Yes	✻2
CQHS350	Forward converter	250	✻1	–	–	Aluminum	Yes		Yes	✻2

✻1 Refer to Specification.
✻2 Refer to Instruction Manual.

1 Pin Configuration

● CQHS250



● CQHS300/CQHS350

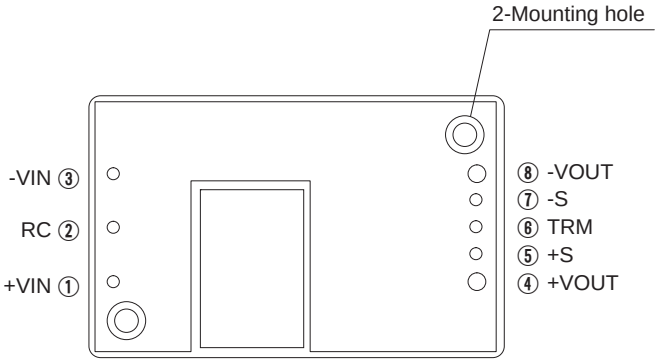


Fig.1.1 Pin configuration (bottom view)

Table 1.1 Pin Assignment

No.	Pin Name	Function
①	+VIN	+DC input
②	RC	Remote ON/OFF
③	-VIN	-DC input
④	+VOUT	+DC output
⑤	+S	+Remote sensing
⑥	TRM	Adjustment of output voltage
⑦	-S	-Remote sensing
⑧	-VOUT	-DC output
–	Mounting hole	Mounting hole

No.	Pin Name	Reference
①	+VIN	3.1 "Wiring input pin "
②	RC	4.4 "Remote ON/OFF "
③	-VIN	3.1 "Wiring input pin "
④	+VOUT	3.2 "Wiring output pin "
⑤	+S	4.5 "Remote sensing "
⑥	TRM	4.6 "Adjustable voltage range "
⑦	-S	4.5 "Remote sensing "
⑧	-VOUT	3.2 "Wiring output pin "
–	Mounting hole	6.1 "Mounting method "

2 Connection for Standard Use

■The power module needs input and output connection as shown in Fig.2.1 or Fig.2.2.

Reference: 3 "Wiring Input/Output Pin"
6.5 "Derating"

■Short the following pins to turn on the power supply.
-VIN↔RC, +VOUT↔+S, -VOUT↔-S

Reference: 4.4 "Remote ON/OFF"
4.5 "Remote sensing"

■Only DC voltage can be applied to CQHS Series. Applying AC voltage will damage the power module.

● CQHS250

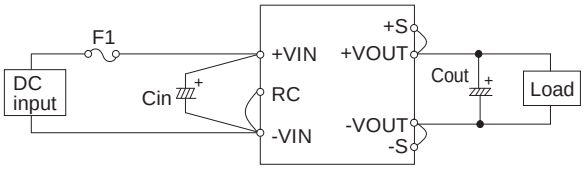


Fig.2.1 Connection for Standard Use (CQHS250)

● CQHS300/CQHS350

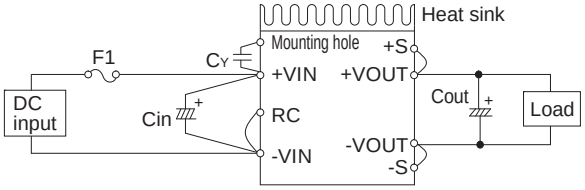


Fig.2.2 Connection for Standard Use (CQHS300/CQHS350)

Table 2.1 External components

No.	Symbol	Component	Reference
1	F1	Input fuse	3.1(1) "External fuse"
2	C_Y	Primary decoupling capacitor	3.1(2) "Noise Filter/Decoupling Capacitor"
3	Cin	External capacitor on the input side	3.1(3) "External capacitor on the Input"
4	Cout	External capacitor on the output side	3.2 "Wiring output pin"
5	—	Heat sink	6.5 "Derating"

3 Wiring Input/Output Pin

3.1 Wiring input pin

(1) External fuse

■The input circuit of CQHS Series does not come with a built-in fuse. In order to protect the power module, a normal-blow fuse should be installed to +VIN.

■When multiple modules get input voltage from a single front-end power supply, a normal-blow fuse must be installed to each module.

Table 3.1 Recommended fuses (Normal-blow type)

Model	CQHS25048	CQHS30048	CQHS35048
Rated current	15A	20A	20A

(2) Noise Filter/Decoupling Capacitor

■An appropriate filter must be used if conformance to the conducted noise regulation is required or if surge voltage may be applied to the unit. Please consult us for more details.

● CQHS300/CQHS350

■A decoupling capacitor Cy must be used to reduce the line noise on the input line and stabilize the power module operation (Fig. 2.2). Note that resonance and inductance from the input line filter may cause the power module to become unstable.

■Install a decoupling capacitor Cy of at least 4700 pF as close to the input pins as possible (within 50mm of the pins).

■If the total capacitance of the decoupling capacitor exceeds 15000 pF, the specified isolation voltage between input and output may not be satisfied. In this case, either reduce the capacitance of the decoupling capacitor at the input or install a decoupling capacitor to the output.

(3) External capacitor on the Input

■An external capacitor Cin must be installed between +VIN and -VIN to reduce line noise and stabilize the power module operation (Fig. 2.1 and Fig.2.2).

〔Capacitance CQHS250/300/350 : at least 68μF×2
CQHS250
Ta=-20 to +85℃ Electrolytic or Ceramic capacitor
Ta=-40 to +85℃ Ceramic capacitor
CQHS300/CQHS350
Tc=-20 to +100℃ Electrolytic or Ceramic capacitor
Tc=-40 to +100℃ Ceramic capacitor〕

■The capacitor must be installed less than 50mm of the power module. As ripple current will flow through this capacitor, pay attention to the ripple current rating of the capacitor.

■If the power module is to be turned ON/OFF directly with a switch, inductance from the input line will induce a surge voltage several times that of the input voltage and it may damage the power module. Make sure that the surge is absorbed, for example, by connecting an electrolytic capacitor between the input pins.

(4) Input Voltage Range/Input Current Range

■Keep the input voltage ripple within the specification below. Output ripple voltage will increase as these values increase.

〔Ripple voltage CQHS250/300/350 : less than 4Vp-p〕

■Make sure that the peak input voltage stays within the specified input voltage range of the power module.

■Choose a front end power supply that can supply enough current Ip (Fig. 3.2) for starting up the power module.

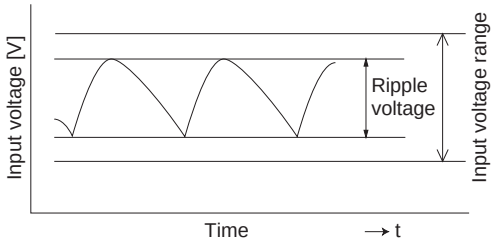


Fig.3.1 Input Voltage Ripple

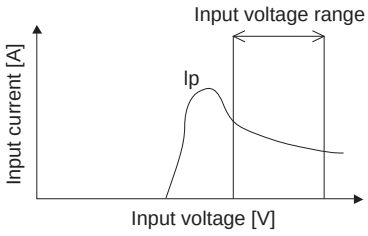


Fig.3.2 Input Current Characteristics

(5) Reverse Input Voltage Protection

■Avoid applying reversed-polarity voltage to the power module as it will damage the power module. To protect the power module from reversed polarity voltage, installing an external diode as shown in Fig. 3.3 is recommended.

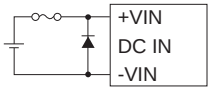


Fig.3.3 Reverse Input Voltage Protection

3.2 Wiring output pin

■Install an external capacitor Cout between +VOUT and -VOUT to increase stability of output (Fig. 2.1 and Fig.2.2).
Recommended capacitance of Cout is shown in Table 3.2 and Table 3.3.

■Choose a high frequency type electrolytic capacitor for Cout. Output ripple and rise time will be influenced by the capacitor's ESR and ESL and the wiring impedance.

■As ripple current will flow through capacitor Cout, pay attention to the ripple current rating of the capacitor.

■Install capacitor Cout as close to the power module as possible (within 50mm).
This is useful for reducing radiated noise and increasing stability of the power module operation.

■When the capacitance of external output capacitor Cout is high, it may unstabilize the operation of power supply, so please refer to Table 3.2 and Table 3.3 for the value of the external capacitor Cout.

Table 3.2 Capacitance Values for External Output Capacitor Cout [μF] (CQHS250)

Output voltage(V)	Recommended capacitance Ambient temperature			Maximum capacitance
	Ta=-40~-20℃	Ta=-20~0℃	Ta=0~+85℃	
32	470	470	220	2200
50	330	100	100	1000

Table 3.3 Capacitance Values for External Output Capacitor Cout [μF] (CQHS300/CQHS350)

Output voltage(V)	Recommended capacitance Base plate temperature			Maximum capacitance
	Tc=-40~-20℃	Tc=-20~0℃	Tc=0~+100℃	
32	470×2	470×2	470	3300
50	330×2	330	330	2200

■The specified ripple and ripple noise are measured by the method introduced in Fig. 3.4 and Fig.3.5.

● CQHS250

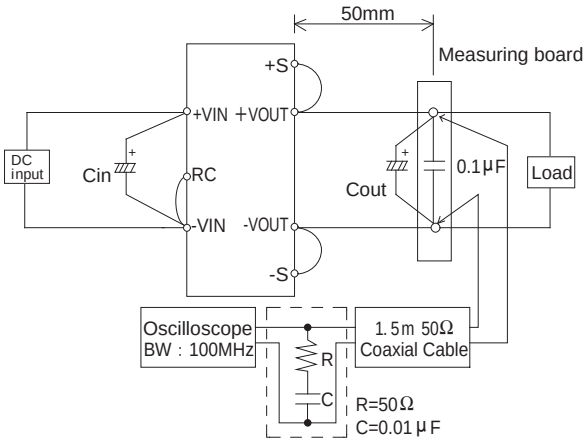


Fig.3.4 Method of Measuring Output Ripple and Ripple Noise (CQHS250)

● CQHS300/CQHS350

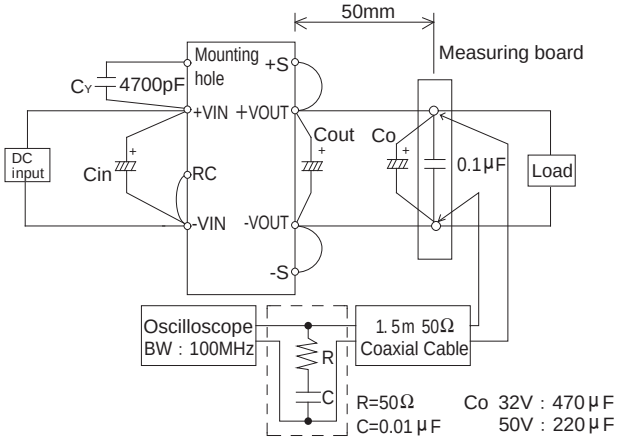


Fig.3.5 Method of Measuring Output Ripple and Ripple Noise (CQHS300/CQHS350)

4 Function

4.1 Overcurrent protection and Low voltage protection

■Overcurrent protection is built-in and comes into effect at over 105% of the rated current.
Overcurrent protection prevents the unit from short circuit and overcurrent condition.

■The DC output will be shut down, when the output voltage drops under the output voltage adjustment range (low voltage protection).

■Recovery from the protection is accomplished by applying 5VDC or less input for at least 1 second, or toggling remote ON / OFF signal for at least 1 second.

4.2 Overvoltage protection

■The overvoltage protection circuit is built-in. The DC input should be shut down if overvoltage protection is in operation.

■Recovery from the protection is accomplished by applying 5VDC or less input for at least 1 second, or toggling remote ON / OFF signal for at least 1 second.

Remarks :
Please note that devices inside the power supply might fail when voltage more than rated output voltage is applied to output pin of the power supply. This could happen when the customer tests the overvoltage performance of the unit.

4.3 Thermal protection

■Over Temperature Protection (OTP) is built in. If the temperature of PCB exceed 120℃ (CQHS250) or the base plate temperature exceed 100℃ (CQHS300/CQHS350). OTP will work, causing the output voltage to drop.

■Recovery from the protection is accomplished by applying 5VDC or less input for at least 1 second, or toggling remote ON / OFF signal for at least 1 second, after the unit should be cool down.

● -N (CQHS250)

■Option "-N" means the output voltage of the power module will be recovered automatically when the fault condition (such as OCP, OVP or OTP) is corrected.

4.4 Remote ON/OFF

■The remote ON/OFF function is incorporated in the input circuit and operated with RC and -VIN. If positive logic control is required, order the power module with "-R" option.

Table 4.1 Remote ON/OFF Specifications (CQHS250)

	ON/OFF logic	Between RC and -VIN	Output voltage
Standard	Negative	L level(0 - 1.0V) or short	ON
		H level(4.0 - 7.0V) or open	OFF
Optional -R	Positive	L level(0 - 1.0V) or short	OFF
		H level(4.0 - 7.0V) or open	ON

■When RC is at low level, a current of 0.1mA typ will flow out. When Vcc is used, keep it within the following rage:
4 ≦ VCC ≦ 7V.
When remote ON/OFF is not used, short RC and -VIN.

Table 4.2 Remote ON/OFF Specifications (CQHS300/CQHS350)

	ON/OFF logic	Between RC and -VIN	Output voltage
Standard	Negative	L level(0 - 1.2V) or short	ON
		H level(3.5 - 7.0V) or open	OFF
Optional -R	Positive	L level(0 - 1.2V) or short	OFF
		H level(3.5 - 7.0V) or open	ON

■When RC is at low level, a current of 0.5mA typ will flow out. When Vcc is used, keep it within the following rage:
3.5 ≦ VCC ≦ 7V.
When remote ON/OFF is not used, short RC and -VIN.

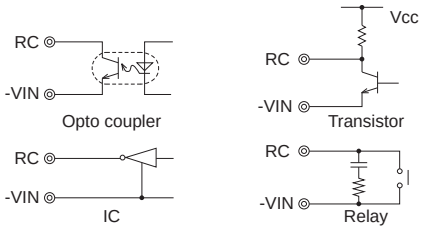


Fig. 4.1 RC Connection Example

4.5 Remote sensing

(1) When Remote Sensing is Not Used

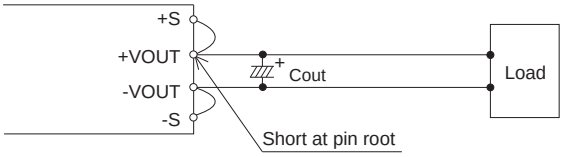


Fig. 4.2 When Remote Sensing is Not Used

■When remote sensing is not used, make sure +VOUT and +S are shorted, and that -VOUT and -S are shorted as well.

■Keep the patterns between +S and +VOUT and between -S and -VOUT as short as possible. Avoid a looping pattern. If noise enters the loop, the operation of the power module will become unstable.

(2) When Remote Sensing is Used

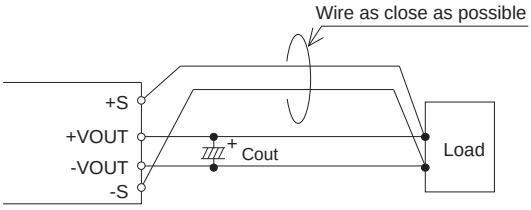


Fig. 4.3 When Remote Sensing is Used

■Using remote sensing with long wires may cause output voltage to become unstable. Consult us if long sensing wiring is necessary.

■Sensing patterns or wires should be as short as possible. If wires are used, use either twisted-pair or shielded wires.

■Use wide PCB patterns or thick wires between the power module and the load. Line drop should be kept less than 0.3V. Make sure output voltage from the power module stays within the specified range.

■If the sensing patterns are shorted by mistake, a large current may flow and damage the pattern. This can be prevented by installing fuses or resistors close to the load.
As wiring or load impedance may generate oscillation or large fluctuations in output voltage, make sure enough evaluation is given in advance.

4.6 Adjustable voltage range

(1) Output voltage adjusting

■Output voltage is adjustable by the external potentiometer.

■When the output voltage adjustment is used, note that the over voltage protection circuit operates when the output voltage sets too high.

■If the output voltage drops under the output voltage adjustment range, note that the Low voltage protection operates.

■By connecting the external potentiometer (VR1)and resistors (R1,R2),output voltage becomes adjustable, as shown in Fig.4.4, recommended external parts are shown in Table 4.2.

■The wiring to the potentiometer should be as short as possible.
The temperature coefficient becomes worse, depending on the type of a resistor and potentiometer. Following parts are recommended for the power supply.
Resistor·····Metal film type, coefficient of less than ±100ppm/℃
Potentiometer····Cermet type, coefficient of less than ±300ppm/℃

■When the output voltage adjustment is not used, open the TRM pin respectively.

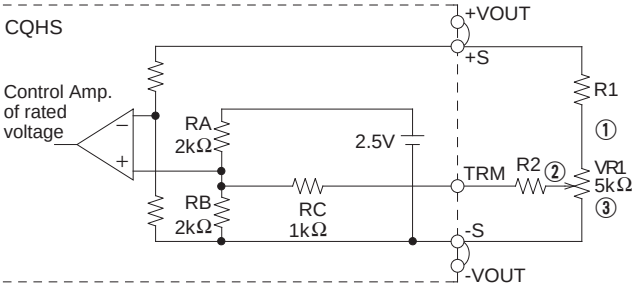


Fig. 4.4 Output voltage control circuit

Table 4.2 Recommended Values of External Resistors

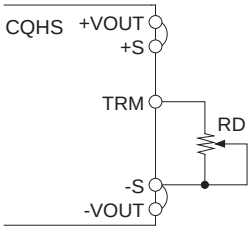
No.	VOUT	Adjustable range			
		VOUT±5%		VOUT±10%	
		R1	R2	R1	R2
1	32V	51kΩ	11kΩ	51kΩ	6.2kΩ
2	50V	82kΩ		82kΩ	

(2) Output voltage decreasing

■By connecting the external resistor(RD), output voltage becomes adjustable to decrease.
The external resistor(RD) is calculated the following equation.

$$RD=\left(\frac{100\%}{\Delta\%}-2\right)[k\Omega]$$

$$\Delta\%=\frac{V_{OR}-V_{OD}}{V_{OR}}\times 100$$



V_{OR} :Rated output voltage[V]
V_{OD} :Output voltage needed to set up[V]

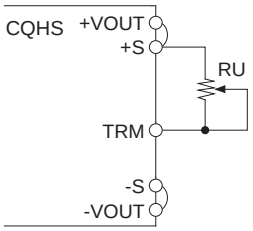
Fig. 4.5 Connection for output voltage decreasing

(3) Output voltage increasing

■By connecting the external resistor (RU), output voltage becomes adjustable to increase.
The external resistor (RU) is calculated the following equation.

$$RU=\left(\frac{V_{OR}\times(100\%+\Delta\%)}{1.225\times\Delta\%}-\frac{(100\%+2\times\Delta\%)}{\Delta\%}\right)[k\Omega]$$

$$\Delta\%=\frac{V_{OU}-V_{OR}}{V_{OR}}\times 100$$



V_{OR} :Rated output voltage[V]
V_{OU} :Output voltage needed to set up[V]

Fig. 4.6 Connection for output voltage increasing

(4) Intput voltage derating

■When the input voltage is 36 - 40VDC , the output voltage adjustment range becomes as shown in Fig. 4.7.

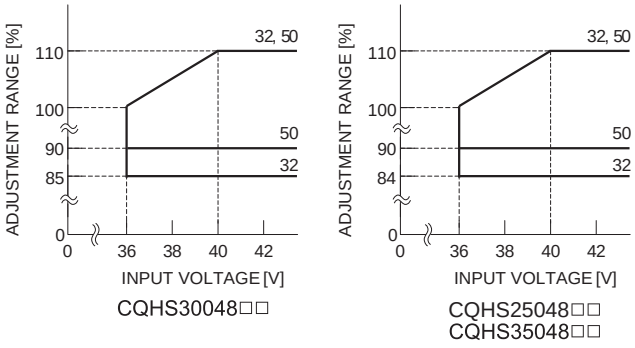


Fig. 4.7 Output voltage adjustment range

(5) Output current derating (CQHS3504832)

■When the output voltage adjust less than rated output voltage, the output current range becomes increasing as shown in Fig. 4.8.

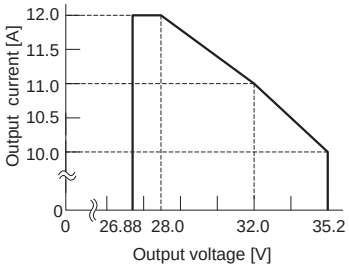


Fig. 4.8 Output Current derating curve (CQHS3504832)

4.7 Withstanding Voltage / Isolation Voltage

■When testing the withstanding voltage, make sure the voltage is increased gradually. When turning off, reduce the voltage gradually by using the dial of the hi-pot tester. Do not use a voltage tester with a timer as it may generate voltage several times as large as the applied voltage.

5 Series and Parallel Operation

5.1 Series operation

■Series operation is available by connecting the outputs of two or more power supplies, as shown below. Output current in series connection should be lower than the lowest rated current in each unit.

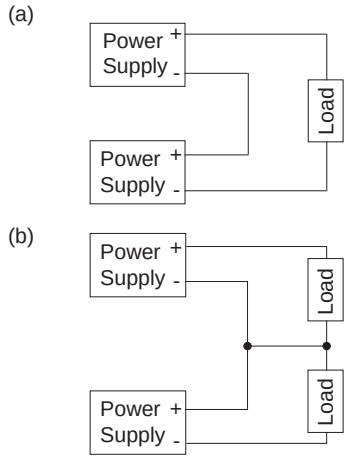


Fig. 5.1 Examples of series operation

5.2 Redundancy operation

■Parallel operation is not possible.

■Redundancy operation is available by wiring as shown below.

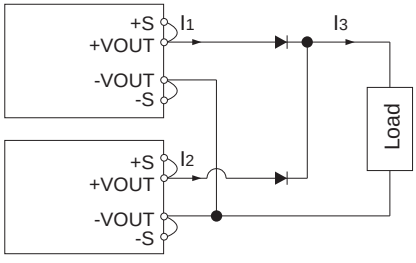


Fig. 5.2 Example of Redundancy Operation

■Even a slight difference in output voltage can affect the balance between the values of I_1 and I_2.

Please make sure that the value of I_3 does not exceed the rated current of a power supply.

$I_3 \leqq$ the rated current value

6 Implementation · Mounting Method

6.1 Mounting method

■When multiple power modules are used side by side, position them with sufficient spaces to allow adequate air ventilation so that the temperature of each power module will remain within the temperature range shown in the derating curves.

■Do not pass the DC input pattern underneath the power module as this will increase conducted noise. Place the DC input pattern away from the power module.

Do not pass the DC output pattern underneath the power module as this will increase output noise. Place the DC output pattern away from the power module.

■High frequency noise is radiated from the power module. When mounting the power module on a PCB, leave a copper pattern on the PCB to let it act as a shield and connect this pattern to the mounting hole.

● CQHS250

■Avoid placing pattern layout in hatched area shown in Fig.6.1 to insulate between pattern and power supply.

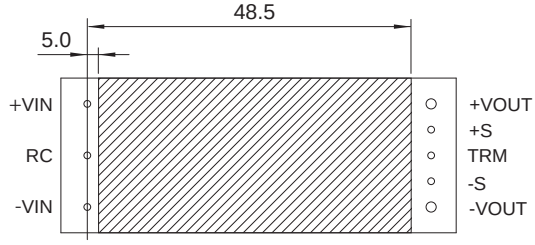


Fig.6.1 Prohibition area of pattern layout (top view)

● CQHS300/CQHS350

■Soldering CQHS series with printed board must be done under the flat condition by using the mounting hole and fixing with the screw.

If CQHS series is inclined and it's mounted, the insulation of the internal components and printed board might not be kept.

■When a heat sink cannot be fixed on the base plate side, order the power module with "-T" option. A heat sink can be mounted by affixing a M3 tap on the heat sink.

Please make sure a mounting hole will be connected to a grounding capacitor C_Y.

Table 6.1 Mounting Hole Configuration

	Mounting hole
Standard	M3 tapped
Optional : -T	ϕ3.4 thru

6.2 Stress onto the pins

■Applying excessive stress to the input or output pins of the power module may damage internal connections. Avoid applying stress in excess of that shown in Fig. 6.2 and Fig.6.3.

■Input and output pins are soldered onto the internal PCB. Do not bend or pull the leads with excessive force.

● CQHS300/CQHS350

■As unexpected stress may be applied to the pins, set the diameter of the PCB mounting hole at 3.5mm.

■As unexpected stress may be applied to the pins from vibration or shock, fix the power module by using the mounting holes with screws to reduce stress.

■Fix the power module to the PCB with the screws before soldering the input and output pins to prevent the PCB pattern being damaged.

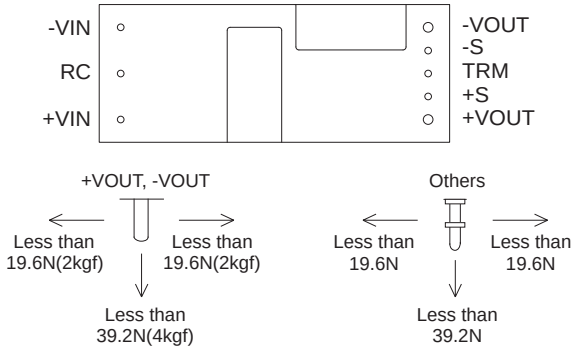


Fig. 6.2 Stress onto Pins (CQHS250)

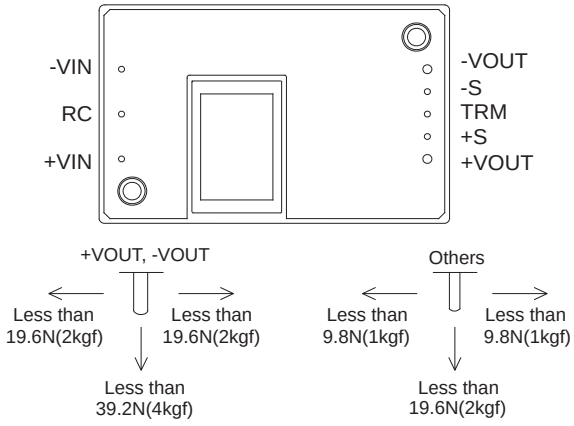


Fig. 6.3 Stress onto Pins (CQHS300/CQHS350)

6.3 Cleaning

■Clean the soldered side of the power module with a brush.
Prevent liquid from getting into the power module. Do not clean by soaking the power module into liquid.

■Do not allow solvent to come in contact with product labels in cases as this may cause deletion of the letters printed on the product labels.

■After cleaning, dry the power modules well.

6.4 Soldering temperature

■Flow soldering : 260℃ for up to 15 seconds.

■Soldering iron (26W) : 450℃ for up to 5 seconds.

6.5 Derating

■It is necessary to note the thermal fatigue life by power cycle.
Please reduce the temperature fl uctuation range as much as possible when the up and down of the temperature are frequently generated.
Contact us for more information on cooling methods.

● CQHS250

■Use with the convection cooling or the forced air cooling.
Make sure the temperatures at temperature measurement locations shown from Fig.6.4 below are on or under the derating curve in Fig.6.4.
Ambient temperature must be kept at 85℃ or under.

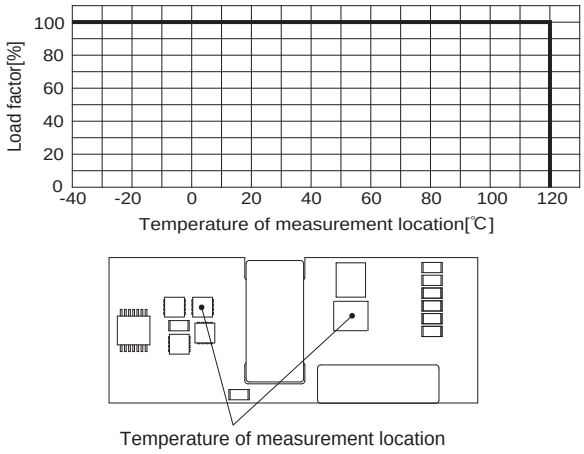
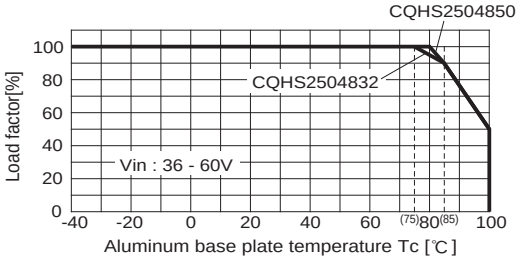


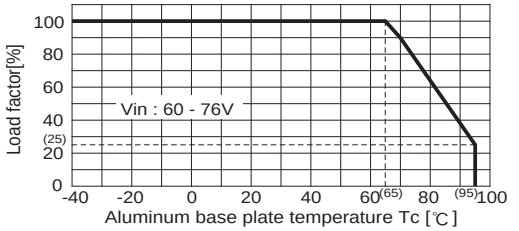
Fig. 6.4 Derating curve (CQHS250)

■For option “B” which is used with the convection cooling, forced air cooling or conduction cooling, use the temperature measurement location as shown in Fig.6.5.

①Vin=DC36-60V



②Vin=DC60-76V



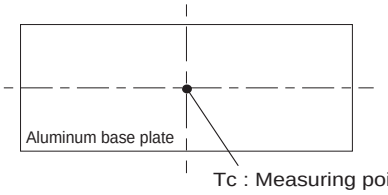


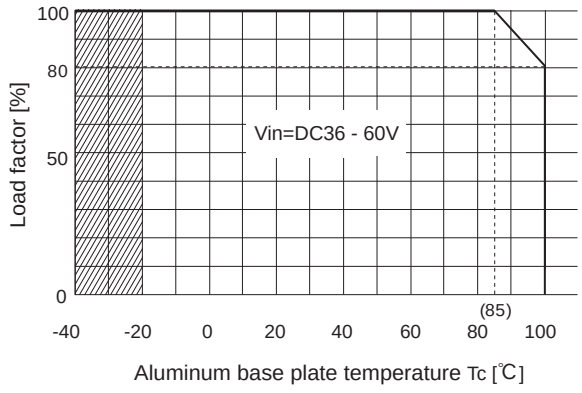
Fig. 6.5 Derating curve (CQHS250 option "B")

● CQHS300/CQHS350

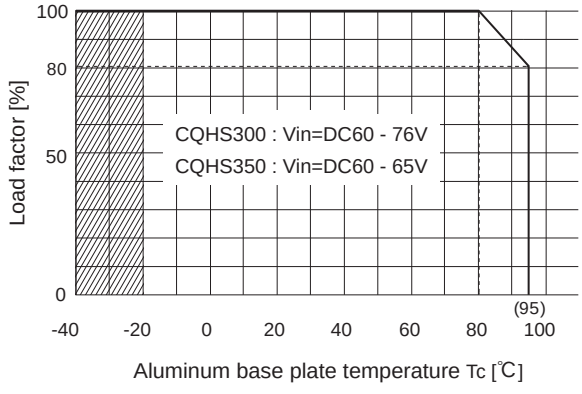
■Use the power modules with conduction cooling (e.g. heat dissipation from the aluminum base plate to the attached heat sink).
Fig. 6.6 shows the derating curves with respect to the aluminum base plate temperature. Note that operation within the hatched areas will cause a significant level of ripple and ripple noise. Contact us for more information on cooling methods.

■Please measure the temperature on the aluminum base plate edge side when you cannot measure the temperature of the center part of the aluminum base plate.
In this case, please take 5deg temperature margin from the derating characteristic of Fig. 6.6.

①Vin=DC36-60V



②CQHS300 : Vin=DC60 - 76V　CQHS350 : Vin=DC60 - 65V



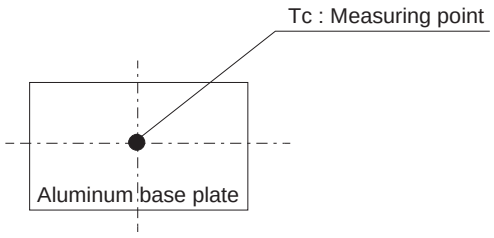


Fig. 6.6 Derating curve (CQHS300/CQHS350)

6.6 Heat sink (CQHS300/CQHS350 Optional parts)

■CQHS300/CQHS350 works with conduction cooling and needs heat dissipation using heat sinks. Optional heat sinks are available for CQHS Series. Refer to Table 6.2 for details on the thermal resistance of heat sinks.

Table 6.2 Types of Heat Sinks Available

No.	Model	Size[mm]			Thermal resistance[℃/W]		Style
		H	W	D	Convection (0.1m/s)	Forced Air	
1	F-QB-F1	12.7	58.4	37.6	14.0	Refer Fig.6.8	Horizontal
2	F-QB-F2	12.7	58.7	37.3			Vertical
3	F-QB-F3	25.4	58.4	37.6	7.5		Horizontal
4	F-QB-F4	25.4	58.7	37.3			Vertical
5	F-QB-F5	38.1	58.4	37.6	5.0		Horizontal
6	F-QB-F6	38.1	58.7	37.3			Vertical

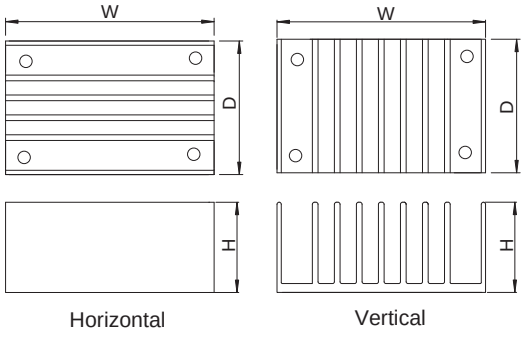


Fig.6.7 Heat Sink Types

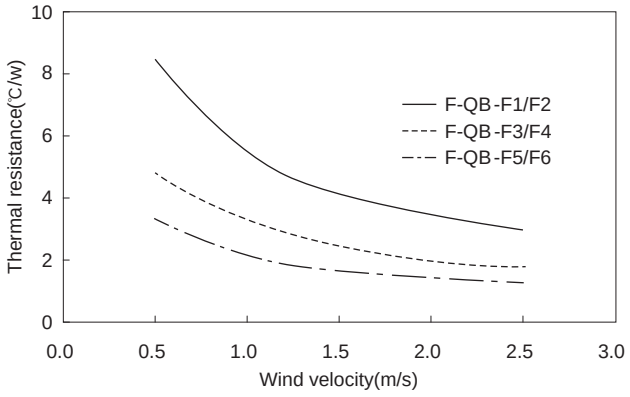


Fig.6.8 Thermal Resistance of Heat Sink(Forced Air)

CQHS

7 Safety Considerations

■To apply for safety standard approvals with the power module, the following conditions must be met. Consult us for more details.

- ●The power modules must be used as a component power supply in end-use equipment.
- ●Neither basic isolation nor double/reinforced isolation is provided across input, output and the base plate of the power module. If the power module is to be used with input voltage of more than 60VDC and needs basic or double/reinforced isolation, the required isolation must be provided in the construction of the final product.
- ●Use external fuses that comply with safety standards at the input.