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1 Connection for Standard Use

■ The power module needs input and output connection as shown in Fig.1.1 or Fig.1.2.

[Reference: 2 "Wiring Input/Output Pin"]

■ Short the following pins to turn on the power supply.

-VIN↔RC, +VOUT↔S, -VOUT↔-S

[Reference: 3.4 "Remote ON/OFF"
3.5 "Remote sensing"]

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

● CQHS250

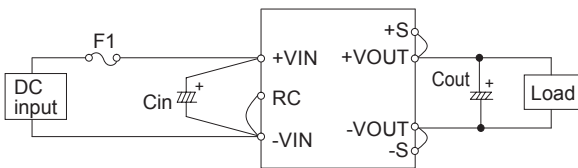


Fig.1.1 Connection for Standard Use (CQHS250)

● CQHS300/CQHS350

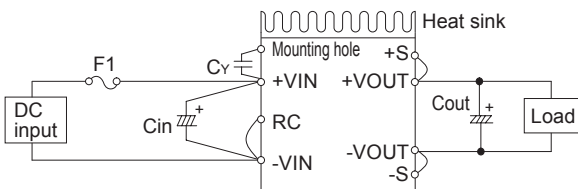


Fig.1.2 Connection for Standard Use (CQHS300/CQHS350)

Table 1.1 External components

No.	Symbol	Component	Reference
1	F1	Input fuse	2.1(1) "External fuse"
2	C_Y	Primary decoupling capacitor	2.1(2) "Noise Filter/Decoupling Capacitor"
3	C_{in}	External capacitor on the input side	2.1(3) "External capacitor on the Input"
4	C_{out}	External capacitor on the output side	2.2 "Wiring output pin"
5	—	Heat sink	"Option Parts"

2 Wiring Input/Output Pin

2.1 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 2.1 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 C_Y must be used to reduce the line noise on the input line and stabilize the power module operation (Fig. 1.2). Note that resonance and inductance from the input line filter may cause the power module to become unstable.

■ Install a decoupling capacitor C_Y 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 C_{in} must be installed between +VIN and -VIN to reduce line noise and stabilize the power module operation (Fig. 1.1 and Fig.1.2).

[Capacitance CQHS250/300/350 : at least $68\mu F \times 2$
CQHS250
Ta=-20 to +85°C Electrolytic or Ceramic capacitor
Ta=-40 to +85°C Ceramic capacitor
CQHS300/CQHS350
Tc=-20 to +100°C Electrolytic or Ceramic capacitor
Tc=-40 to +100°C 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 I_p (Fig. 2.2) for starting up the power module.

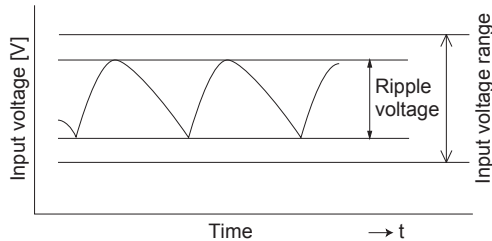


Fig.2.1 Input Voltage Ripple

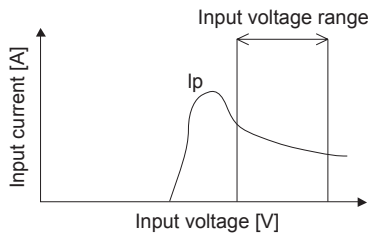


Fig.2.2 Input Current Characteristics

(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.

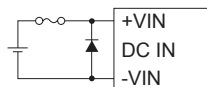


Fig.2.3 Reverse Input Voltage Protection

2.2 Wiring output pin

- Install an external capacitor C_{out} between +VOUT and -VOUT to increase stability of output (Fig. 1.1 and Fig.1.2). Recommended capacitance of C_{out} is shown in Table 2.2 and Table 2.3.
- Choose a high frequency type electrolytic capacitor for C_{out} . 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 C_{out} , pay attention to the ripple current rating of the capacitor.
- Install capacitor C_{out} 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 C_{out} is high, it may destabilize the operation of power supply, so please refer to Table 2.2 and Table 2.3 for the value of the external capacitor C_{out} .

Table 2.2 Capacitance Values for External Output Capacitor C_{out} [μ F] (CQHS250)

Output voltage(V)	Recommended capacitance			Maximum capacitance
	Ambient temperature			
	$T_a=-40\sim-20^\circ\text{C}$	$T_a=-20\sim 0^\circ\text{C}$	$T_a=0\sim+85^\circ\text{C}$	
32	470	470	220	2200
50	330	100	100	1000

Table 2.3 Capacitance Values for External Output Capacitor C_{out} [μ F] (CQHS300/CQHS350)

Output voltage(V)	Recommended capacitance			Maximum capacitance
	Base plate temperature			
	$T_c=-40\sim-20^\circ\text{C}$	$T_c=-20\sim 0^\circ\text{C}$	$T_c=0\sim+100^\circ\text{C}$	
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. 2.4 and Fig.2.5.

● CQHS250

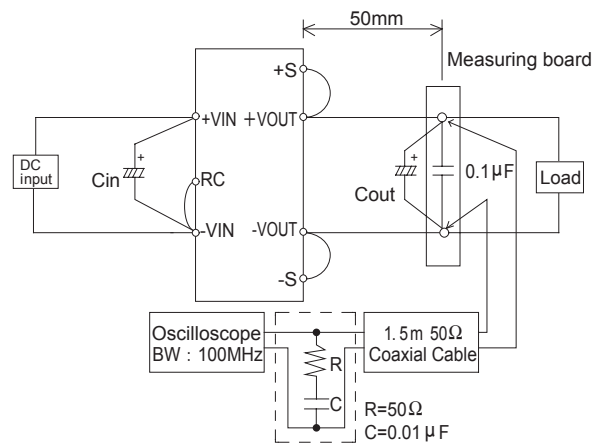


Fig.2.4 Method of Measuring Output Ripple and Ripple Noise (CQHS250)

● CQHS300/CQHS350

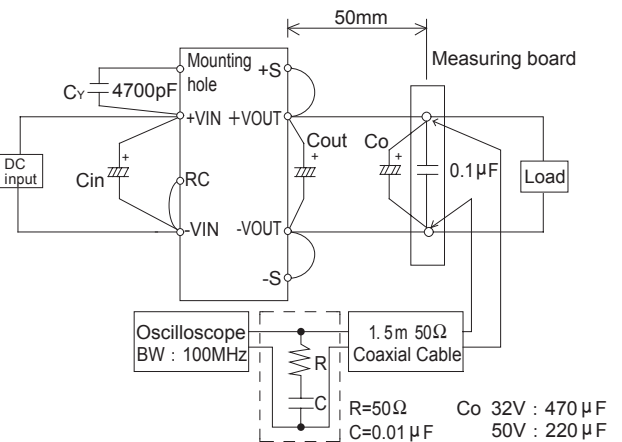


Fig.2.5 Method of Measuring Output Ripple and Ripple Noise (CQHS300/CQHS350)

3 Function

3.1 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.

3.2 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.

3.3 Thermal protection

- Over Temperature Protection (OTP) is built in. If the temperature of PCB exceed 120°C (CQHS250) or the base plate temperature exceed 100°C (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.

3.4 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 3.1 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:
 $4 \leq VCC \leq 7V$.
 When remote ON/OFF is not used, short RC and -VIN.

Table 3.2 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:
 $3.5 \leq VCC \leq 7V$.
 When remote ON/OFF is not used, short RC and -VIN.

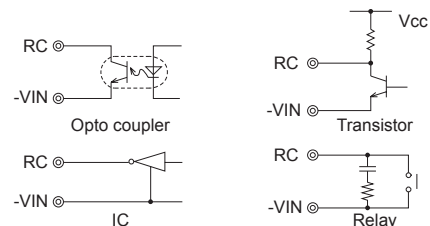


Fig. 3.1 RC Connection Example

3.5 Remote sensing

(1) When Remote Sensing is Not Used

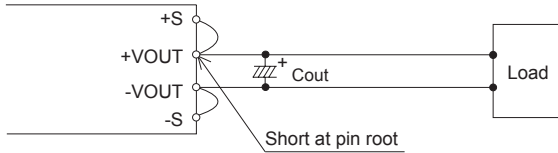


Fig. 3.2 When Remote Sensing is Not Used

- 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

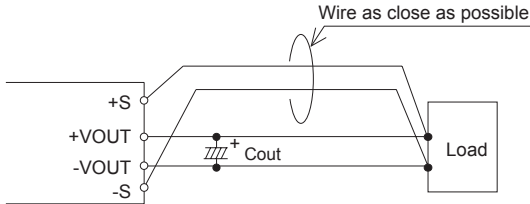


Fig. 3.3 When Remote Sensing is Used

- 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.

3.6 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.3.4, recommended external parts are shown in Table 3.2.
 - 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 $\pm 100\text{ppm}/^\circ\text{C}$
 Potentiometer.....Cermet type, coefficient of less than $\pm 300\text{ppm}/^\circ\text{C}$
- When the output voltage adjustment is not used, open the TRM pin respectively.

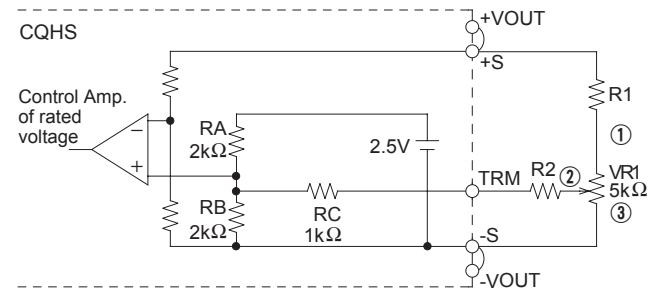


Fig. 3.4 Output voltage control circuit

Table 3.2 Recommended Values of External Resistors

No.	VOUT	Adjustable range			
		VOUT $\pm 5\%$		VOUT $\pm 10\%$	
		R1	R2	R1	R2
1	32V	51k Ω	11k Ω	51k Ω	6.2k Ω
2	50V	82k Ω		82k Ω	

(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.

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

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

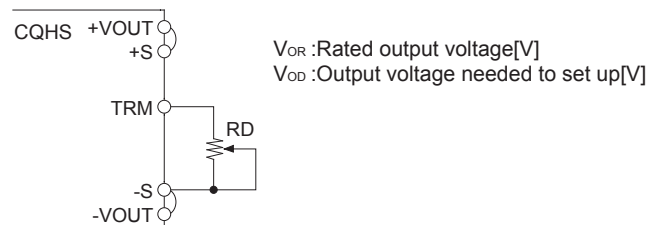


Fig. 3.5 Connection for output voltage decreasing

(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.

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

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

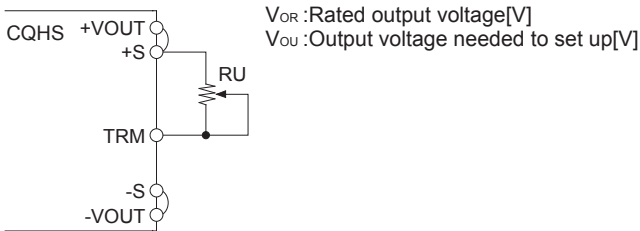


Fig. 3.6 Connection for output voltage increasing

(4) Input voltage derating

■When the input voltage is 36 - 40VDC, the output voltage adjustment range becomes as shown in Fig. 3.7.

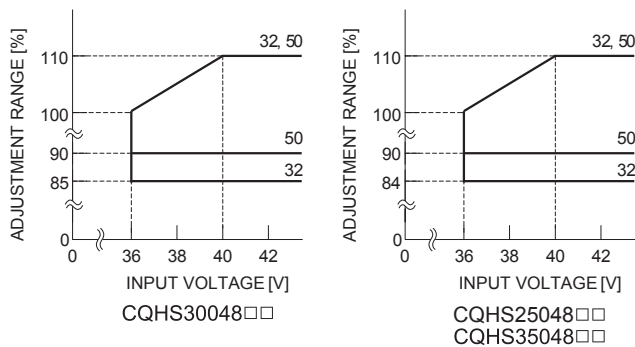


Fig. 3.7 Output voltage adjustment range

(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. 3.8.

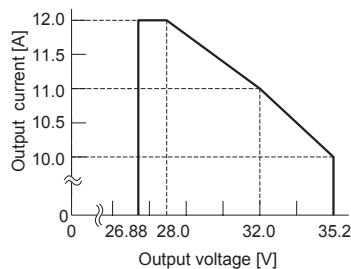


Fig. 3.8 Output Current derating curve (CQHS3504832)

3.7 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.

4 Series and Parallel Operation

4.1 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.

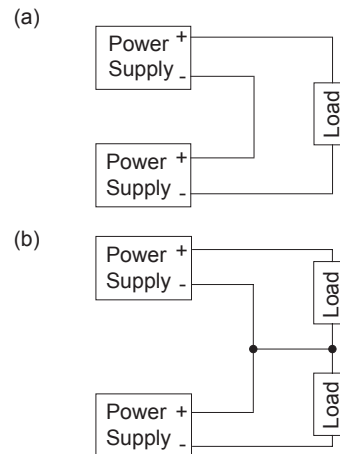


Fig. 4.1 Examples of series operation

4.2 Redundancy operation

■Parallel operation is not possible.

■Redundancy operation is available by wiring as shown below.

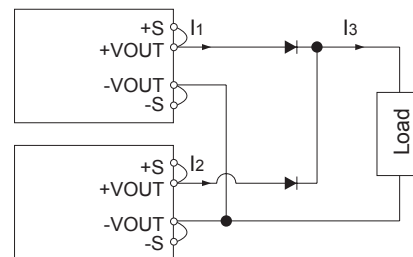


Fig. 4.2 Example of Redundancy Operation

■Even a slight difference in output voltage can affect the balance between the values of I₁ and I₂.

Please make sure that the value of I₃ does not exceed the rated current of a power supply.

$$I_3 \leq \text{the rated current value}$$

5 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 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.