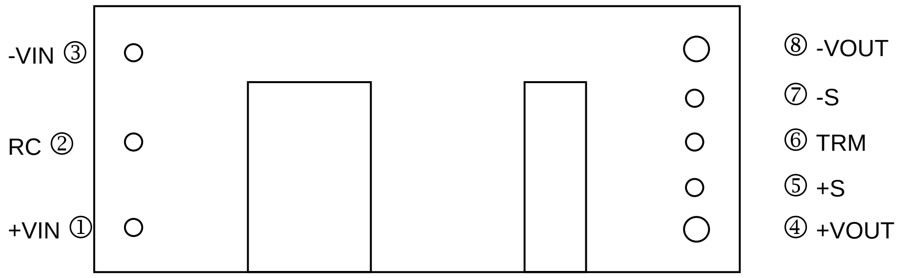
8. CES and CQS series

8.1 Pin configuration

● CES series

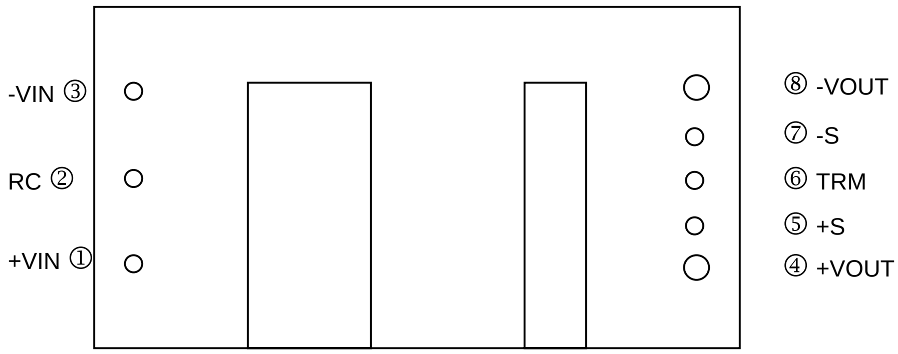
Fig.8.1.1
Pin configuration
for CES series



bottom view

● CQS series

Fig.8.1.2
Pin configuration
for CQS series



bottom view

Table 8.1.1
Pin configuration and
function

Pin №	Pin Name	Function	Reference
①	+VIN	+DC input	8.3 Connection method for standard use
②	RC	Remote ON/OFF	8.6 Remote ON/OFF
③	-VIN	-DC input	8.3 Connection method for standard use
④	+VOUT	+DC output	8.3 Connection method for standard use
⑤	+S	+Remote sensing	8.7 Remote sensing
⑥	TRM	Adjustment of output voltage	-
⑦	-S	-Remote sensing	8.7 Remote sensing
⑧	-VOUT	-DC output	8.3 Connection method for standard use

8.2 Do's and Don'ts for module

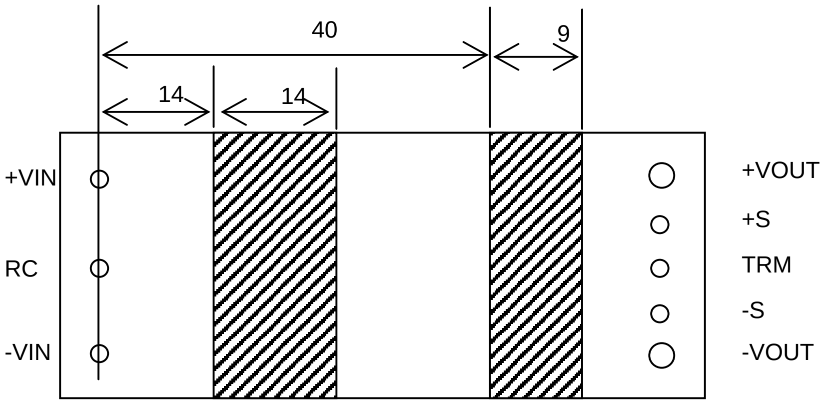
8.2.1 Isolation

- For receiving inspection, such as Hi-Pot test, gradually increase (decrease) the voltage for start (shut down). Avoid using Hi-Pot tester with the timer because it may generate voltage a few times higher than the applied voltage, at ON/OFF of a timer.

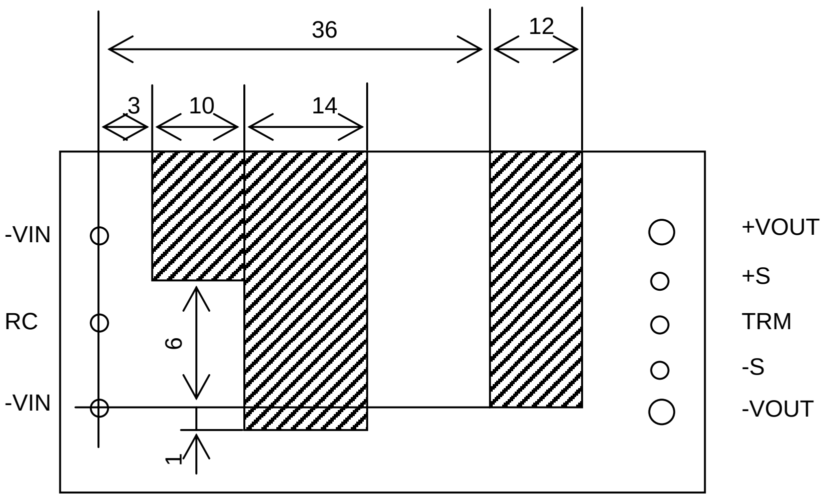
8.2.2 Mounting method

- The unit can be mounted in any direction. When two or more power supplies are used side by side, position them with proper intervals to allow enough air ventilation. The temperature around each power supply should not exceed the temperature range shown in derating curve.
- Avoid placing the DC input line pattern layout underneath the unit, it will increase the line conducted noise. Make sure to leave an ample distance between the line pattern layout and the unit. Also avoid placing the DC output line pattern underneath the unit because it may increase the output noise. Lay out the pattern away from the unit.
- Avoid placing the signal line pattern layout underneath the unit, this power supply might become unstable.
  Lay out the pattern away from the unit.
- Avoid placing pattern layout in hatched area in Fig.8.2.1 to insulate between pattern and power supply.

Fig.8.2.1
Prohibition area of
Pattern layout (top view)



(a) CES

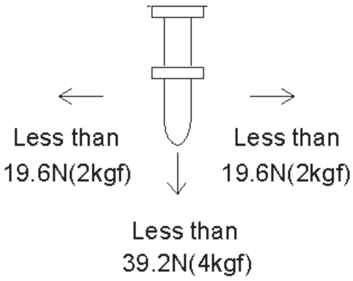


(b) CQS

8.2.3 Stress onto the pins

- When too much stress is applied to the pins of the power supply, the internal connection may be weakened.
  As shown in Fig.8.2.2 avoid applying stress of more than 19.6N (2kgf) on the pins horizontally and more than 39.2N (4kgf) vertically.
- The pins are soldered on PWB internally, therefore, do not pull or bend them with abnormal forces.
- Fix the unit on PWB (using silicone rubber or fixing fittings) to reduce the stress onto the pins.

Fig.8.2.2
Stress onto the pins



8.2.4 Cleaning

- When cleaning is necessary, follow the under mentioned condition.

Method	:	Varnishing, ultrasonic wave and vapor
Cleaning agents	:	IPA (Solvent type)
Total time	:	2 minutes or less

- Do not apply pressure to the lead and name plate with a brush or scratch it during the cleaning.
- After cleaning, dry them enough.

8.2.5 Soldering

- Flow soldering : 260°C less than 15 seconds.
- Soldering iron : 450°C less than 5 seconds (less than 26W).

8.2.6 Safety standard

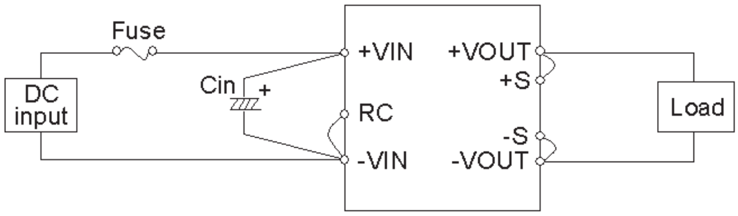
- This unit must be used as a component of the end-use equipment.
- The equipment contain basic insulation between input and output.
  If double or reinforced insulation is required, it has to be provided by the end-use equipment according the final build in condition.
- Safety approved fuse must be externally installed on input side.

8.3 Connection method for use

8.3.1 Connection for standard use

- In order to use power supply, it is necessary to wire as shown in Fig.8.3.1.
- Short the following pins to turn on the power supply.
  -VIN ↔RC, +VOUT ↔+S, -VOUT ↔-S
  Reference : 8.6 "Remote ON/OFF"
  8.7 "Remote sensing"

Fig.8.3.1
Connection method for standard use



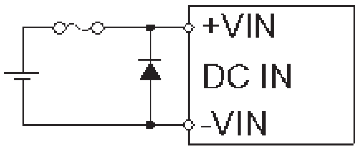
Cin : External capacitor on the input side

8.3.2 Input power source

- The CES series and the CQS series handle only the DC input.
  Avoid applying AC input directly, because it will damage the power supply.
- Make sure that the voltage fluctuation, including the ripple voltage, will not exceed the input voltage range.
- Use a front end unit with enough power, considering the start-up current Ip of this unit.

- Reverse input voltage protection
  Avoid the reverse polarity input voltage. It will damage the power supply.
  It is possible to protect the unit from the reverse input voltage by installing an external diode as shown in Fig.8.3.2.

Fig.8.3.2
Reverse input voltage protection



8.3.3 External fuse

- Fuse is not built-in on input side. In order to protect the unit, install the normal-blow type fuse on input side.
- When the input voltage from a front end unit is supplied to multiple units, install a normal-blow type fuse in each unit.

Table 8.3.1
Recommended fuse
(normal-blow type)

MODEL	CES48	CQS48
Rated current	6.3A	10A

8.3.4 External capacitor on the input side Cin

- Install an external capacitor Cin, with more than 33μF, between +VIN and -VIN input pins for low line-noise and for stable operation of the power supply.
  - Ta = -20 to +85°C : Electrolytic or Ceramic capacitor
  - Ta = -40 to +85°C : Ceramic capacitor

- Cin is within 50mm from pins. Make sure that ripple current of Cin should be less than rate.

8.3.5 Wiring output pin

- When the CES series or the CQS series supplies the pulse current for the pulse load, please install capacitor Co between +VOUT and -VOUT pins.
  Recommended capacitance of Co is shown in Table 8.3.2.
- If output current is decreased rapidly, output voltage rises transiently and the overvoltage protection circuit may operate.
  In this case, please install capacitor Co.
- Select the high frequency type capacitor. Output ripple and start up waveform may be influenced by ESR, ESL of the capacitor and the wiring impedance.
- Make sure that ripple current of Co should be less than rating.

Table 8.3.2 Recommended capacitance Co

No.	Output voltage	CES	CQS
1	1.8 - 3.3V	0 - 20,000μF	1 - 40,000μF
2	5V	0 - 10,000μF	1 - 20,000μF
3	12V	0 - 1,000μF	1 - 2,200μF

8.4 Derating

8.4.1 CES derating

- Use with the convection cooling or the forced air cooling.
  The temperature measurement location as shown in Fig.8.4.2 must keep below 120°C.
  And then ambient temperature must keep below 85°C.

Fig.8.4.1 Derating curve for CES

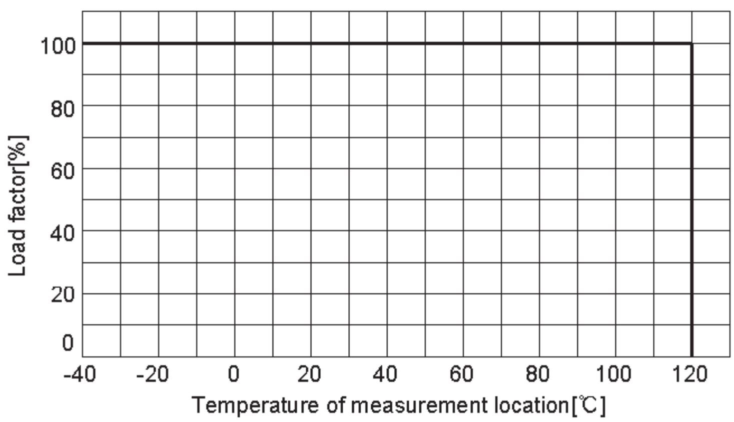
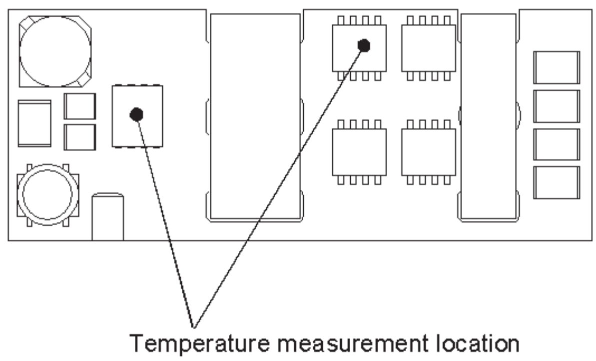


Fig.8.4.2 Temperature measurement location for CES



- Fig.8.4.4 ~ 8.4.10 show the derating curve in the condition that is measured as shown in Fig.8.4.3.
  Verify final design by actual temperature measurement.
  The temperature measurement location as shown in Fig.8.4.2 must keep below 120°C.

Fig.8.4.3
Measuring method

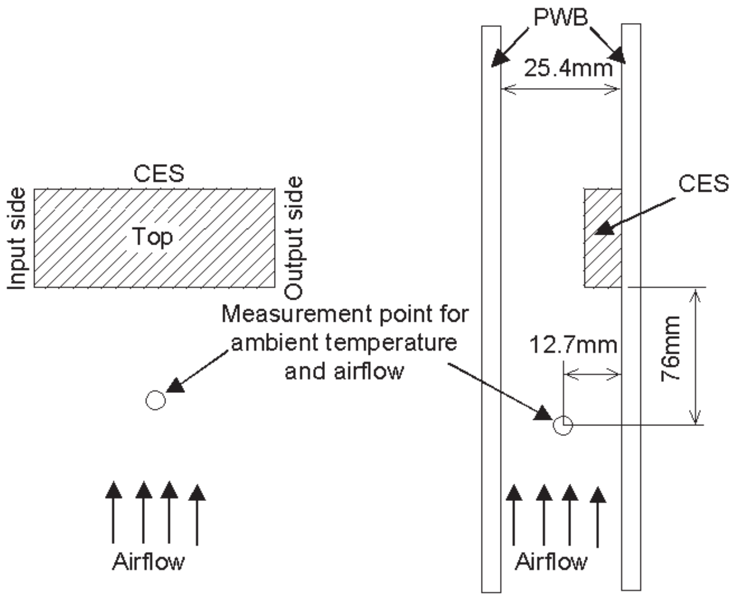


Fig.8.4.4
Derating curve
for CES48018-30
at 48Vin

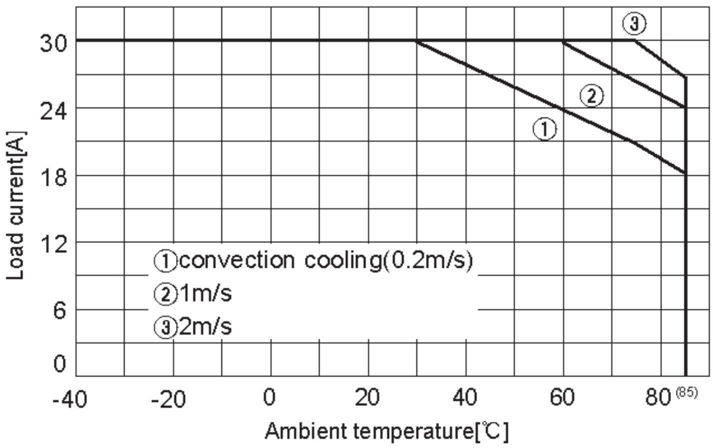


Fig.8.4.5
Derating curve
for CES48025-25
at 48Vin

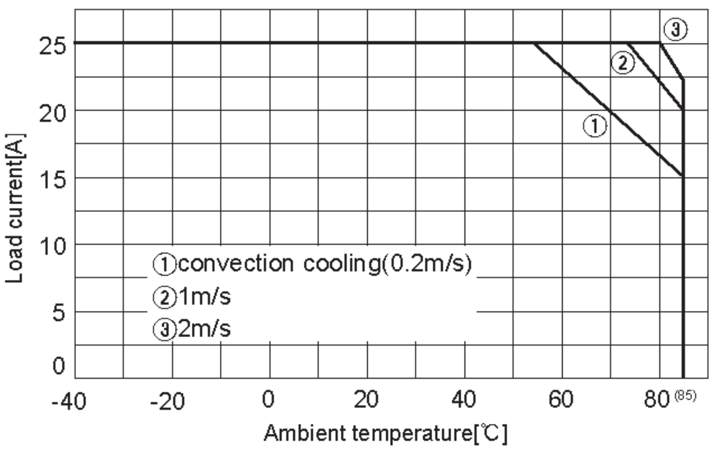


Fig.8.4.6
Derating curve
for CES48033-25
at 48Vin

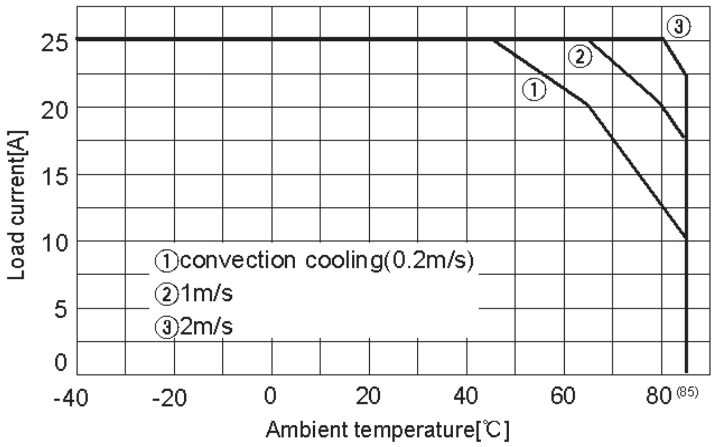


Fig.8.4.7
Derating curve
for CES48050-16
at 48Vin

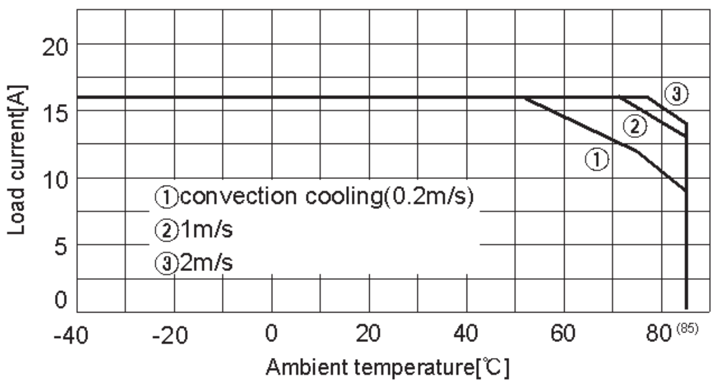


Fig.8.4.8
Derating curve
for CES48120-6
at 48Vin

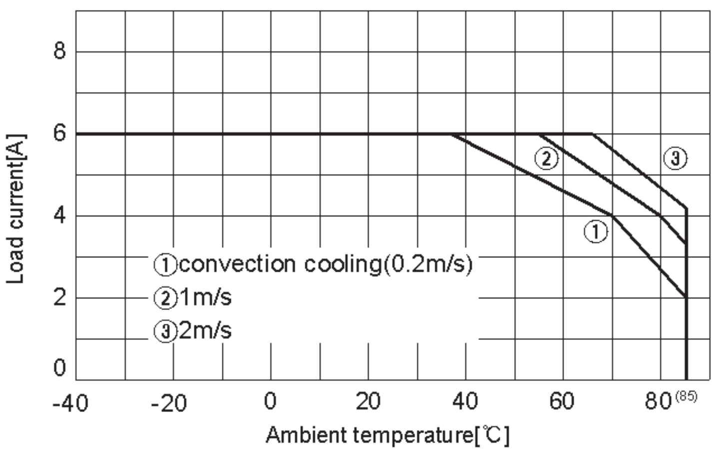


Fig.8.4.9
Derating curve
for CES48033-30
at 48Vin

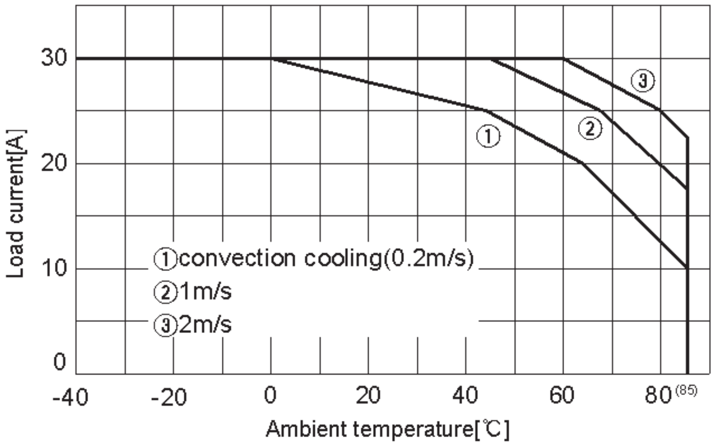
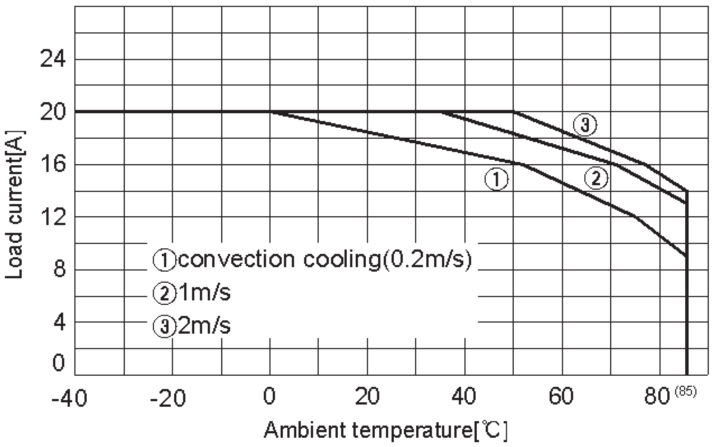


Fig.8.4.10
Derating curve
for CES48050-20
at 48Vin



8.4.2 CQS derating

- Use with the convection cooling or the forced air cooling.
  The temperature measurement location as shown in Fig.8.4.12 must keep below 120°C.
  And then ambient temperature must keep below 85°C.

Fig.8.4.11
Derating curve
for CQS

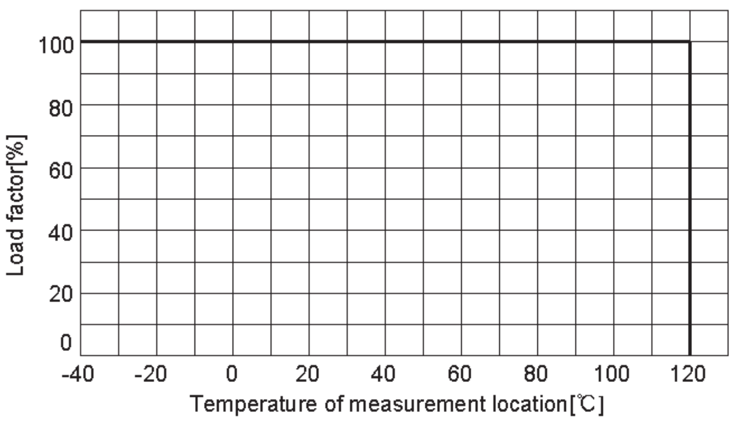
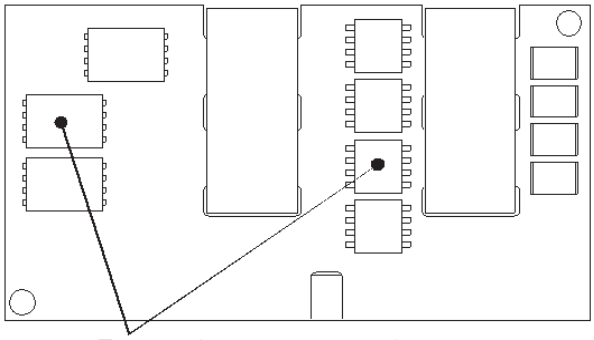


Fig.8.4.12
Temperature measurement location for CQS



- Fig.8.4.14 ~ 8.4.16 show the derating curve in the condition that is measured as shown in Fig.8.4.13.
  Verify final design by actual temperature measurement.
  The temperature measurement location as shown in Fig.8.4.12 must keep below 120°C.

Fig.8.4.13
Measuring method

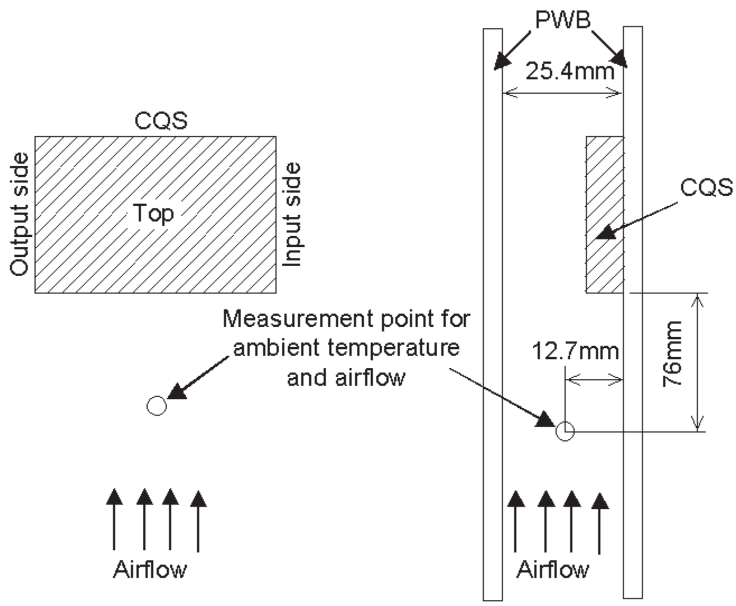


Fig.8.4.14
Derating curve
for CQS48018-50
at 48Vin

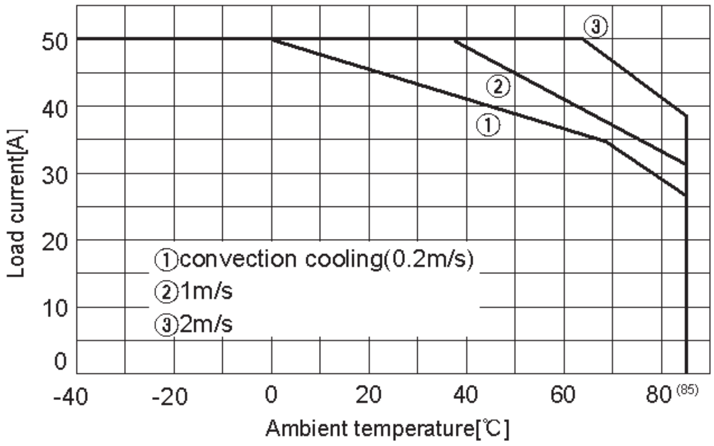


Fig.8.4.15
Derating curve
for CQS48025-45
at 48Vin

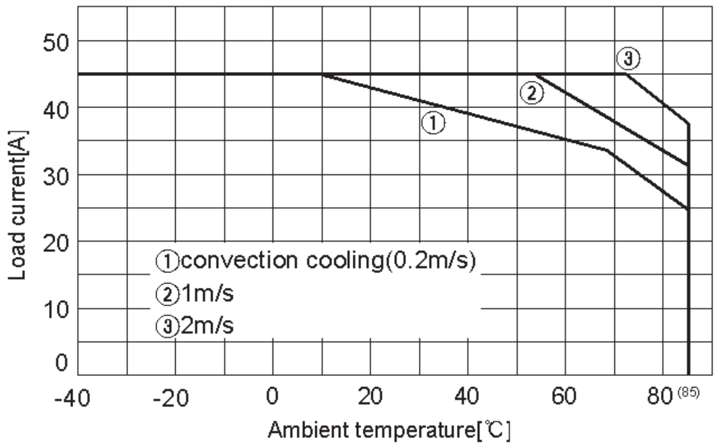
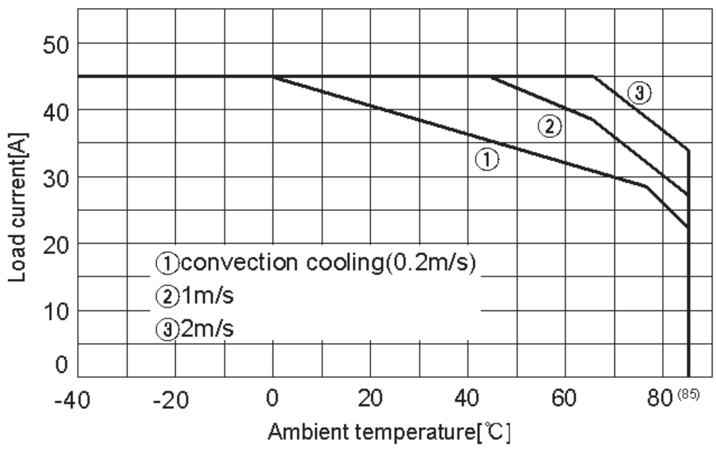


Fig.8.4.16
Derating curve
for CQS48033-45
at 48Vin



8.5 Adjustable voltage range

- Output voltage is adjustable by the external potentiometer.
- When the output voltage adjustment is used, note that the over voltage protection circuit operates with the output voltage sets too high.
- If the output voltage drops under the output voltage adjustment range, note that the Low voltage protection operates.

8.5.1 Output voltage adjusting method by external potentiometer

- By connecting the external potentiometer (VR1) and resistors (R1, R2) more than 1/10W, 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.

Fig.8.5.1
Output voltage
control circuit

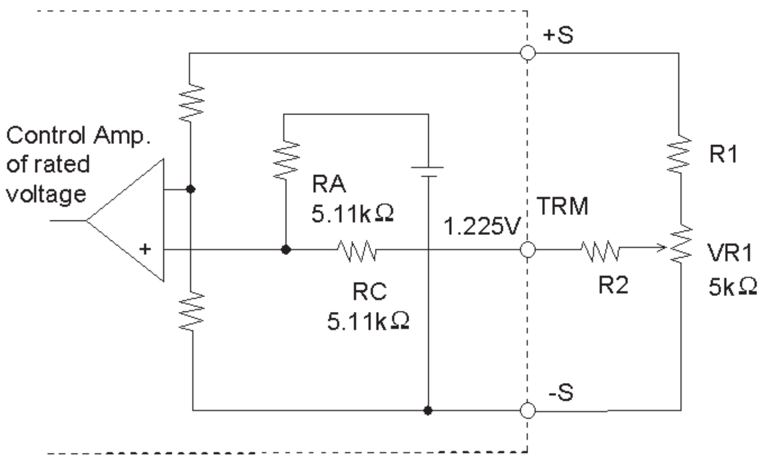


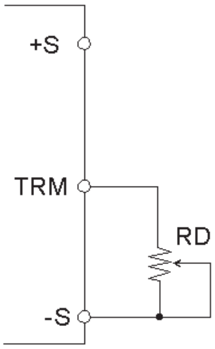
Table 8.5.1
Recommended value
of external resistor

No.	Vout	Output adjustable range					
		Vout ±5%			Vout ±6%		
		R1	R2	VR1	R1	R2	VR1
1	1.8V	0	39kΩ	5kΩ	0	18kΩ	5kΩ
2	2.5V	330Ω	68kΩ		560Ω	33kΩ	
3	3.3V	2.2kΩ	68kΩ		2.2kΩ	33kΩ	
4	5V	4.7kΩ	68kΩ		5.6kΩ	33kΩ	
5	12V	18Ω	68kΩ		18kΩ	33kΩ	

8.5.2 Output voltage decreasing by external resistor

- By connecting the external resistors (RD) more than 1/10W, output voltage becomes adjustable to decrease as shown in Fig8.5.2.
  The external resistor (RD) is calculated the following equation.

Fig.8.5.2
Connection for
output voltage degreasing



$$RD = \frac{5.11}{\Delta} - 10.22 \quad [k\Omega]$$

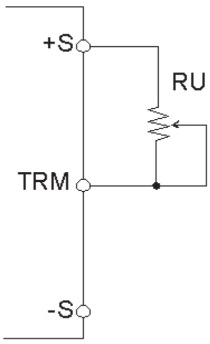
$$\Delta = \frac{V_{OR}-V_{OD}}{V_{OR}}$$

V_{OR} : Rated output voltage [V]
V_{OD} : Desired output voltage [V]

8.5.3 Output voltage increasing by external resistor

- By connecting the external resistors (RU) more than 1/10W, output voltage becomes adjustable to decrease as shown in Fig8.5.3.
  The external resistor (RU) is calculated the following equation.

Fig.8.5.3
Connection for
output voltage increasing



$$RU = \frac{5.11 \times V_{OR} \times (1+\Delta)}{1.225 \times \Delta} - \frac{5.11}{\Delta} - 10.22 \quad [k\Omega]$$

$$\Delta = \frac{V_{OU}-V_{OD}}{V_{OR}}$$

V_{OR} : Rated output voltage [V]
V_{OU} : Desired output voltage [V]

8.6 Protect circuit

8.6.1 Overvoltage protection

- The overvoltage protection circuit is built-in. The DC input should be shut down if overvoltage protection is in operation.
  In this case, to recover from overvoltage protection turn the DC input power off for at least 1 second (*), and turn on or toggling Remote ON/OFF signal.
  *The recovery time varies depending on input voltage and input capacity.
  ● Remarks :
  Please note that device inside the power supply might fail when voltage more than rated output voltage more than rated output voltage is applied to output pin of the power supply. This could happen when the customer tests the overvoltage protection of the unit.

8.6.2 Overcurrent protection

- Overcurrent protection is built-in and activated 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).
  In this case, to recover from overvoltage protection turn the DC input power off for at least 1 second (*), and turn on or toggling Remote ON/OFF signal.
  *The recovery time varies depending on input voltage and input capacity.

8.6.3 Thermal protection

- When the power supply temperature is kept 120°C, the thermal protection will be activated and simultaneously shut off the output.
  When this function is activated, remove all possible causes of overheat condition and cool down the unit to the normal level temperature.
  And in this case, to recover from overvoltage protection turn the DC input power off for at least 1 second (*), and turn on or toggling Remote ON/OFF signal.
  *The recovery time varies depending on input voltage and input capacity.
- Option "-N" means auto recovery from thermal protection.

8.7 Remote ON/OFF

- Remote ON/OFF circuit is built-in on input side.
  The ground pin of input side remote ON/OFF circuit is "-VIN" pin.

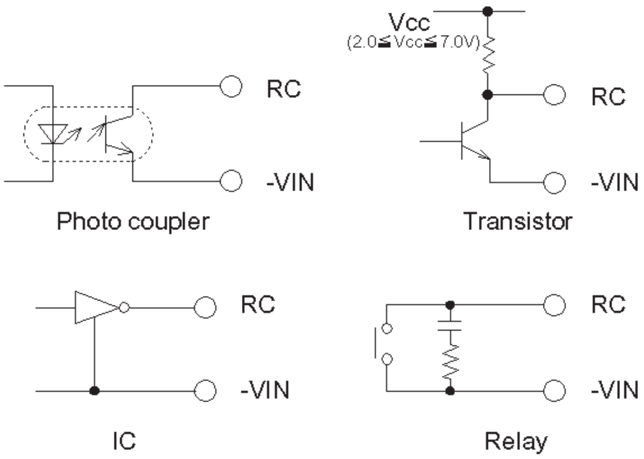
Table 8.7.1
Specification of
Remote ON/OFF

	ON/OFF logic	Between RC and -VIN	Output voltage
Standard	Negative	"L" level (0 - 0.8V) or short	ON
		"H" level (2.0 - 7.0V) or open	OFF
Optional -R	Positive	"L" level (0 - 0.8V) or short	OFF
		"H" level (2.0 - 7.0V) or open	ON

- When RC is "Low" level, sink current is 0.1mA typ. When Vcc is applied, use 2 ~ 7V.

- When remote ON/OFF function is not used, please short between RC and -VIN
  (-R : Open between RC and -VIN).

Fig.8.7.1
RC connection
example

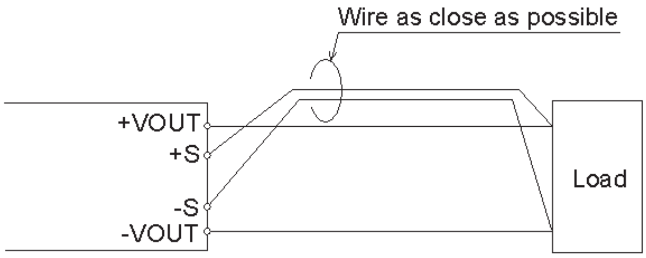


8.8 Remote sensing

- This function compensate line voltage drop.

8.8.1 When the remote sensing function is in use

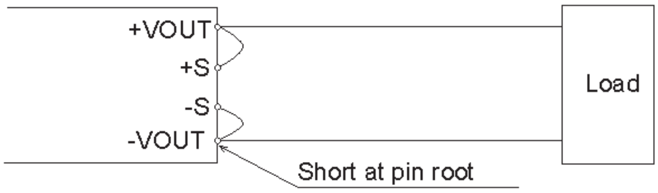
Fig.8.8.1
Connection when
the remote sensing
is in use



- Twisted-pair wire or shield wire should be used for sensing wire.
- Thick wire should be used for wiring between the power supply and a load. Line drop should be less than 0.3V. Voltage between +VOUT and -VOUT should remain within the output voltage adjustment range.
- If the sensing patterns short, heavy current flows and the pattern may be damaged.
  The pattern disconnection can be prevented by installing the protection parts near a load.
- Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 40cm.

8.8.2 When the remote sensing function is not in use

Fig.8.8.2
Connection when the remote sensing is not in use

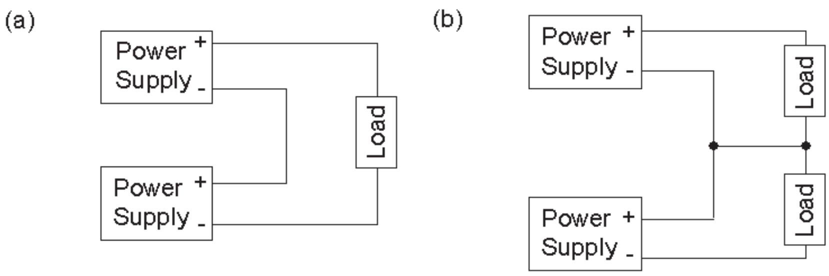


- When the remote sensing function is not in use, it is necessary to confirm that pins are shorted between +S and +VOUT and between -S and -VOUT.
- Wire between +S and +VOUT and between -S and -VOUT as short as possible.
  Loop wiring should be avoided.
  This power supply might become unstable by the noise coming from poor wiring.

8.9 Series operation

- Series operation is available by connecting the outputs of two or more power supplies, as shown Fig.8.9.1. Output current in series connection should be lower than the lowest rated current in each power supply.

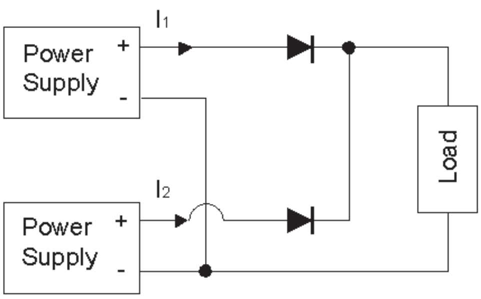
Fig. 8.9.1
Examples of serial operation



8.10 Parallel operation / Redundant operation

- Parallel redundancy operation is available by connecting the units as shown Fig.8.10.1.

Fig.8.10.1
Parallel redundancy operation



- Values of I1 and I2 become unbalance by a slight difference of the output voltage.
  Make sure that the output voltage of units is of equal value and the output current from each power supply does not exceed the rated current.

I_1 and I_2 must be less than a rated current value

Use an external potentiometer to adjust the output voltage from each power supply.

8.11 EMC consideration

8.11.1 Line conducted noise

(1) Overview of the conducted noise

- The switch mode power supply generates the conducted noise to the input lines.
  The conducted noise can be categorized into the common mode noise and the differential mode noise.
  CISPR and FCC standards have been used as a world wide benchmark especially for line conducted interference levels.
  If an EMI specification such as CISPR standard must be met, additional filtering may be needed.
- The common mode noise exists between the input terminals and FG.
  The most effective way to reduce common mode noise are to bypass from the input lines to FG with Y capacitor (C_Y) and the common mode choke (L1).
  Fig.8.11.1 shows the overview of the path of the common mode noise.
- The differential mode noise exists between the input terminals.
  The most effective means to reduce differential mode noise are to bypass the input lines with X capacitors (Cx3, Cx4) and the normal mode choke (L2).
  Fig.8.11.2 shows the overview of the path of the differential mode noise.

Fig.8.11.1
Common mode
noise path

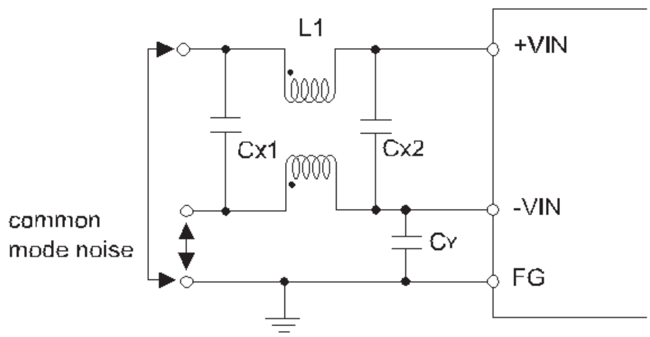
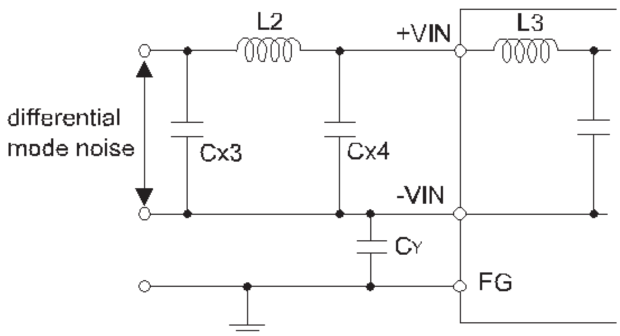


Fig.8.11.2
Differential mode
noise path



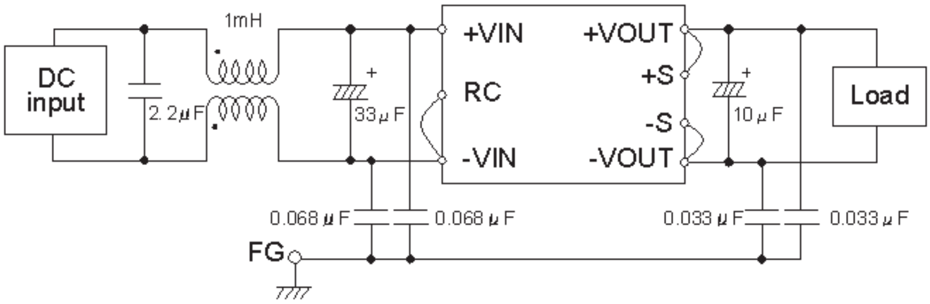
- The CES and CQS provide the normal mode choke (L3) to reduce the differential mode noise. Install the capacitor (Cx4) to reduce the differential mode noise.
  The most effective way to reduce the differential mode noise are to install since X capacitor (Cx3) and the normal mode choke (L2).
- The leakage inductance of the common mode choke (L1) works as the normal mode choke. The normal mode choke (L2) is not necessary.

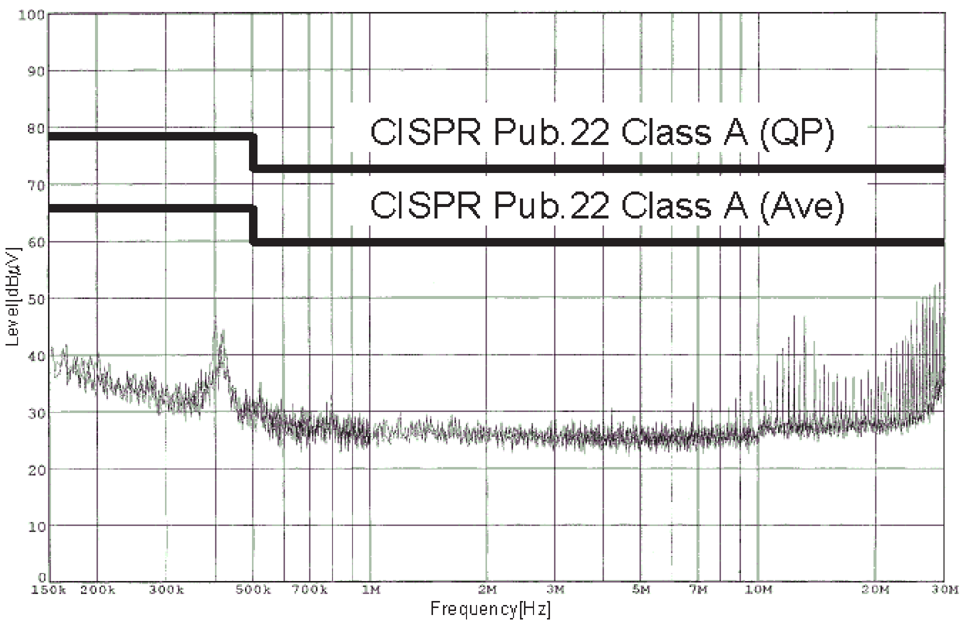
(2) Recommended of noise-filter

- Fig.8.11.3 shows the recommended circuit of noise-filter which meets CISPR Pub. 22 Class A and the noise level.

CES48033-25 : DC48V INPUT, 3.3V25A OUTPUT

Fig.8.11.3
Recommended circuit
for CES and CQS
and noise level
(CISPR Pub.22 Class A)





8.11.2 Radiated noise

- High-frequency noise is radiated directly from the module, the input lines and the output lines to the atmosphere.
  The noise-filter (EMC component) is required to reduce the radiated noise.
- The effective ways to reduce the radiated noise are to cover units with the metal plate or film.

8.11.3 Output noise

- Install an external capacitor Co between +VOUT and -VOUT for stable operation and low output noise.
- Select the high frequency type capacitor (film or ceramic capacitor) for low output high-frequency noise.
- Ripple and ripple noise are measured, as shown in Fig.8.11.4.

Fig.8.11.4
Measuring method of the output noise

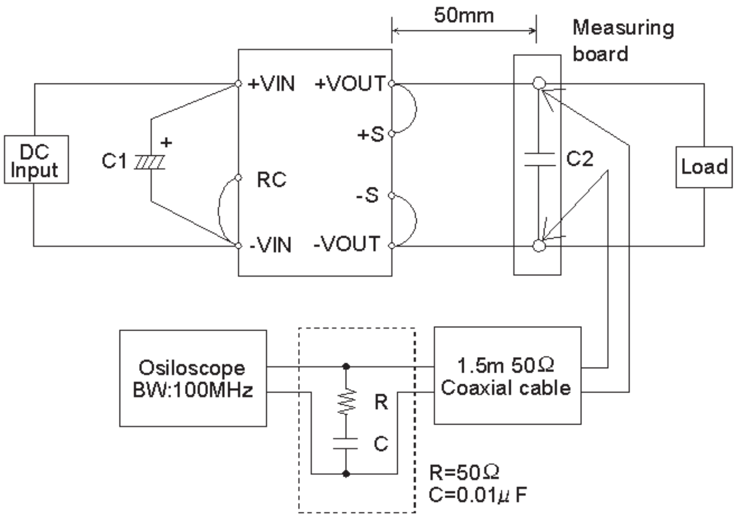


Table 8.11.1
Recommended capacitance Co

No.	Capacitor	CES / CQS	CES48033-30	CES48050-20
1	C1	33μF	47μF	
2	C2	22μF		