# Basic characteristics data

<table>
<thead>
<tr>
<th>Model</th>
<th>Circuit method</th>
<th>Switching frequency [KHz]</th>
<th>Input current</th>
<th>Rated input fuse</th>
<th>Inrush current protection circuit</th>
<th>PCB/Pattern Material</th>
<th>Single sided</th>
<th>Double sided</th>
<th>Series operation</th>
<th>Redundancy operation</th>
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</thead>
<tbody>
<tr>
<td>CES</td>
<td>Forward converter</td>
<td>420</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>glass fabric base, epoxy resin</td>
<td>Multilayer</td>
<td>Yes</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CES (type-P)</td>
<td>Forward converter</td>
<td>400</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>glass fabric base, epoxy resin</td>
<td>Multilayer</td>
<td>Yes</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>CQS</td>
<td>Forward converter</td>
<td>420</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>glass fabric base, epoxy resin</td>
<td>Multilayer</td>
<td>Yes</td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

*1 Refer to Specification.
*2 Refer to Instruction Manual.
# Pin Connection

## 1. Function

<table>
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<td>Overcurrent protection and Low voltage protection</td>
<td>CE/CQ-12</td>
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<tr>
<td>Overvoltage protection</td>
<td>CE/CQ-12</td>
</tr>
<tr>
<td>Thermal protection</td>
<td>CE/CQ-12</td>
</tr>
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<td>Remote ON/OFF</td>
<td>CE/CQ-12</td>
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<td>Remote sensing</td>
<td>CE/CQ-12</td>
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<tr>
<td>Adjustable voltage range</td>
<td>CE/CQ-13</td>
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<td>Isolation</td>
<td>CE/CQ-14</td>
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## 2. Series and Parallel Operation

<table>
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<th>Operation</th>
<th>Page</th>
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</thead>
<tbody>
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<td>Series operation</td>
<td>CE/CQ-14</td>
</tr>
<tr>
<td>Redundancy operation</td>
<td>CE/CQ-14</td>
</tr>
</tbody>
</table>

## 3. Implementation · Mounting Method

<table>
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<th>Page</th>
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<td>Mounting method</td>
<td>CE/CQ-15</td>
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<tr>
<td>Automatic Mounting (CES series: option S)</td>
<td>CE/CQ-15</td>
</tr>
<tr>
<td>Soldering</td>
<td>CE/CQ-15</td>
</tr>
<tr>
<td>Stress onto the pins</td>
<td>CE/CQ-16</td>
</tr>
<tr>
<td>Cleaning</td>
<td>CE/CQ-16</td>
</tr>
<tr>
<td>Storage method (CES series: option S)</td>
<td>CE/CQ-16</td>
</tr>
<tr>
<td>Stress to the product</td>
<td>CE/CQ-16</td>
</tr>
</tbody>
</table>

## 4. Safety Considerations

## 5. Derating

<table>
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<th>Derating</th>
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</tr>
</thead>
<tbody>
<tr>
<td>CES Derating</td>
<td>CE/CQ-16</td>
</tr>
<tr>
<td>CQS Derating</td>
<td>CE/CQ-20</td>
</tr>
</tbody>
</table>

## 6. SMD type(optionS) package information

<table>
<thead>
<tr>
<th>Information</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruction Manual</td>
<td>CE/CQ-22</td>
</tr>
</tbody>
</table>
1 Pin Connection

- **CES Series**
  - Pin Connection:
    - -VIN
    - RC
    - +VIN
    - ① -VOUT
    - ② -S
    - ③ TRM
    - ④ +S
    - ⑤ +VOUT

- **CQS Series**
  - Pin Connection:
    - -VIN
    - RC
    - +VIN
    - ① -VOUT
    - ② -S
    - ③ TRM
    - ④ +S
    - ⑤ +VOUT

Table 1.1 Pin Connection and function

<table>
<thead>
<tr>
<th>No.</th>
<th>Pin Connection</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>+VIN</td>
<td>+DC input</td>
</tr>
<tr>
<td>②</td>
<td>RC</td>
<td>Remote ON/OFF</td>
</tr>
<tr>
<td>③</td>
<td>-VIN</td>
<td>-DC input</td>
</tr>
<tr>
<td>④</td>
<td>+VOUT</td>
<td>+DC output</td>
</tr>
<tr>
<td>⑤</td>
<td>+S</td>
<td>+Remote sensing</td>
</tr>
<tr>
<td>⑥</td>
<td>TRM</td>
<td>Adjustment of output voltage</td>
</tr>
<tr>
<td>⑦</td>
<td>-S</td>
<td>-Remote sensing</td>
</tr>
<tr>
<td>⑧</td>
<td>-VOUT</td>
<td>-DC output</td>
</tr>
</tbody>
</table>

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

2 Connection for Standard Use

- In order to use the power supply, it is necessary to wire as shown in Fig.2.1.
  - Reference: 3 "Wiring Input/Output Pin"
  - 8 "Derating"

- Short the following pins to turn on the power supply.
  - -VIN, +VOUT-S, -VOUT+S
  - Reference: 4.4 "Remote ON/OFF"
  - 4.5 "Remote sensing"

- The CES series and the CQS series handle only the DC input. Avoid applying AC input directly. It will damage the power supply.

Table 2.1 Recommended External capacitor on the input side

<table>
<thead>
<tr>
<th>Model</th>
<th>CES48033-30, CES48050-20, CES48060-17, CES48033-30P, CES48050-20P, CES48120-7P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cin</td>
<td>33µF or more 47µF or more</td>
</tr>
</tbody>
</table>

3 Wiring Input/Output Pin

3.1 Wiring input pin

1) 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 the normal-blow type fuse in each unit.

Table 3.1 Recommended fuse (Normal-blow type)

<table>
<thead>
<tr>
<th>Model</th>
<th>CES24</th>
<th>CQS24</th>
<th>CES48</th>
<th>CQS48</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated current</td>
<td>10A</td>
<td>15A</td>
<td>6.3A</td>
<td>10A</td>
</tr>
</tbody>
</table>
(2) External capacitor on the input side
- Install an external capacitor Cin, between +VIN and -VIN input pins for low line-noise and for stable operation of the power supply.
- Capacitance: Refer to Table 2.1
  - Ta = -20 to +85°C: Electrolytic or Ceramic capacitor
  - Ta = -40 to +85°C: Ceramic capacitor
- Cin is within 50mm for pins. Make sure that ripple current of Cin should be less than rate.

(3) Recommended of noise-filter
- Install an external input filter as shown in Fig.3.1 in order to reduce conducted noise. Cin is shown in Table 2.1.
  - The result for this solution is shown in Fig.3.2.

(4) 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.3.3.

3.2 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 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 rate.

<table>
<thead>
<tr>
<th>No.</th>
<th>Output voltage</th>
<th>CES</th>
<th>CQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5 - 3.3V</td>
<td>0 - 20,000μF</td>
<td>0 - 40,000μF</td>
</tr>
<tr>
<td>2</td>
<td>5V, 6V</td>
<td>0 - 10,000μF</td>
<td>0 - 20,000μF</td>
</tr>
<tr>
<td>3</td>
<td>12V, 15V</td>
<td>0 - 1,000μF</td>
<td>0 - 2,200μF</td>
</tr>
</tbody>
</table>

- Ripple and Ripple Noise are measured, as shown in the Fig.3.4. Cin is shown in Table 2.1.
4 Function

4.1 Overcurrent protection and Low voltage protection

- Overcurrent protection is built-in and comes into effect 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, recovery from low voltage protection is accomplished by cycling the DC input power off for at least 1 second, or toggling Remote ON/OFF signal.
- The recovery time varies depending on input voltage and input capacity.

4.2 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, recovery from overvoltage protection is accomplished by cycling the DC input power off for at least 1 second, or toggling Remote ON/OFF signal.
- The recovery time varies depending on input voltage and input capacity.

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

- When the power supply temperature is kept above 120°C, the thermal protection will be activated and simultaneously shut down the output.
- In this case, the unit should be cool down, and then recovery from thermal protection is accomplished by cycling the DC input power off for at least 1 second, or toggling Remote ON/OFF signal.

* -N
- Option "-N" means auto restart from thermal protection.

4.4 Remote ON/OFF

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

Table 4.1.1 Specification of Remote ON/OFF

<table>
<thead>
<tr>
<th>ON/OFF logic</th>
<th>Between RC and -VIN</th>
<th>Output voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Negative</td>
<td>L level(0 - 0.8V) or short</td>
<td>ON</td>
</tr>
<tr>
<td>H level(2.0 - 7.0V) or open</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Optional -R Positive</td>
<td>L level(0 - 0.8V) or short</td>
<td>OFF</td>
</tr>
<tr>
<td>H level(2.0 - 7.0V) or open</td>
<td>ON</td>
<td></td>
</tr>
</tbody>
</table>

When RC is "Low" level, fan out current is 0.1mA typ. When Vcc is applied, use 2.0≤Vcc≤7.0V.

Table 4.1.2 Specification of Remote ON/OFF (type-P)

<table>
<thead>
<tr>
<th>ON/OFF logic</th>
<th>Between RC and -VIN</th>
<th>Output voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Negative</td>
<td>L level(0 - 0.8V) or short</td>
<td>ON</td>
</tr>
<tr>
<td>H level(4.0 - 7.0V) or open</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Optional -R Positive</td>
<td>L level(0 - 0.8V) or short</td>
<td>OFF</td>
</tr>
<tr>
<td>H level(4.0 - 7.0V) or open</td>
<td>ON</td>
<td></td>
</tr>
</tbody>
</table>

When RC is "Low" level, fan out current is 0.1mA typ. When Vcc is applied, use 4.0≤Vcc≤7.0V.

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

Fig.4.1 RC connection example

4.5 Remote sensing

(1) When the remote sensing function is not in use

Fig.4.2 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 & +VOUT and between -S & -VOUT.

Wire between +S & +VOUT and between -S & -VOUT as short as possible.

Loop wiring should be avoided.

This power supply might become unstable by the noise coming from poor wiring.

(2) When the remote sensing function 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 are short, heavy-current is drawn and the pattern may be damaged.

The pattern disconnection can be prevented by installing the protection parts as close as a load.

Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 40cm.

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/°C

Potentiometer: Cermet type, coefficient of less than ±300ppm/°C

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

Table 4.2 Recommended value of external potentiometer & resistor

<table>
<thead>
<tr>
<th>No.</th>
<th>VOUT</th>
<th>R1</th>
<th>R2</th>
<th>VR1</th>
<th>R1</th>
<th>R2</th>
<th>VR1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5V</td>
<td>0</td>
<td>10kΩ</td>
<td>0</td>
<td>0</td>
<td>10kΩ</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>1.8V</td>
<td>0</td>
<td>39kΩ</td>
<td>0</td>
<td>0</td>
<td>39kΩ</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>2.5V</td>
<td>330Ω</td>
<td>68kΩ</td>
<td>560Ω</td>
<td>33kΩ</td>
<td>68kΩ</td>
<td>33kΩ</td>
</tr>
<tr>
<td>4</td>
<td>3.3V</td>
<td>2.2kΩ</td>
<td>68kΩ</td>
<td>2.2kΩ</td>
<td>2.2kΩ</td>
<td>33kΩ</td>
<td>33kΩ</td>
</tr>
<tr>
<td>5</td>
<td>5V</td>
<td>4.7kΩ</td>
<td>68kΩ</td>
<td>5.6kΩ</td>
<td>33kΩ</td>
<td>68kΩ</td>
<td>33kΩ</td>
</tr>
<tr>
<td>6</td>
<td>6V</td>
<td>5.6kΩ</td>
<td>68kΩ</td>
<td>6.8kΩ</td>
<td>33kΩ</td>
<td>68kΩ</td>
<td>33kΩ</td>
</tr>
<tr>
<td>7</td>
<td>12V</td>
<td>18kΩ</td>
<td>68kΩ</td>
<td>18kΩ</td>
<td>33kΩ</td>
<td>68kΩ</td>
<td>33kΩ</td>
</tr>
<tr>
<td>8</td>
<td>15V</td>
<td>22kΩ</td>
<td>68kΩ</td>
<td>22kΩ</td>
<td>33kΩ</td>
<td>68kΩ</td>
<td>33kΩ</td>
</tr>
</tbody>
</table>

(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.

\[
RD = \frac{5.11}{\Delta} - 10.22 \ [kΩ]
\]

\[
\Delta = \frac{V_{OR} - V_{OD}}{V_{OR}}
\]

Where:

\[V_{OR}\] : Rated output voltage [V]

\[V_{OD}\] : Output voltage needed to set up [V]
Output voltage increasing

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

\[
RU = \frac{5.11 \times V_{O\text{R}} \times (1+\Delta)}{1.225 \times \Delta} - \frac{5.11}{\Delta} - 10.22 \text{ [kΩ]}
\]

\[
\Delta = \frac{V_{O\text{U}} - V_{O\text{R}}}{V_{O\text{R}}}
\]

- VOR: Rated output voltage [V]
- VOU: Output voltage needed to set up [V]

---

Input voltage derating

- CES24□□ and CQS24□□ require DC20V or more input to trim the output voltage up more than rated.
- CES48050-20P require DC40V or more input to trim the output voltage up more than 5.5V.

---

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.

---

Redundancy operation

Parallel operation is not possible. Redundancy operation is available by wiring as shown below.

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 I2 does not exceed the rated current of a power supply.

I2 ≤ the rated current value
6 Implementation · Mounting Method

6.1 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 the 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.6.1 to insulate between pattern and power supply.

6.2 Automatic Mounting (CES series: option S)

To mount CES series automatically, use the transformer area near the center of the PCB as the adsorption point. Please see the External View for details of the adsorption point.

If the bottom dead point of a suction nozzle is too low when mounting excessive force is applied to the transformer, which could cause damage. Please mount carefully.

6.3 Soldering

(1) Flow Soldering: 
- Temperature: 260°C
- Time: 15 seconds or less

(2) Soldering Iron: 
- Maximum Temperature: 450°C
- Time: 5 seconds or less

(3) Reflow Soldering (option "-S")

Fig.6.2 shows conditions for the reflow soldering for option "-S" of CES series. Please make sure that the temperatures of pin terminals +VIN and -VOUT shown in Fig.6.2 do not exceed the temperatures shown in Fig.6.3.

If time or temperature of the reflow soldering goes beyond the conditions, reliability of internal components may be compromised. Please use the unit under the recommended reflow conditions.

![Fig.6.2 Temperature Measuring Points when Setting Reflow Soldering Conditions](image)

![Fig.6.3 Recommend Reflow Soldering Conditions](image)
6.7 Stress to the product

- CES/CQS series transformer core and choke coil core are attached by glue. There is a possibility that the core will be removed and power supply will be damaged when it took stress by the fall or some kind of stress.

To apply for safety standard approval using this power supply, the following conditions must be met.

1. This unit must be used as a component of the end-use equipment.
2. 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.
3. Safety approved fuse must be externally installed on input side.

7 Safety Considerations

- It is necessary to note thermal fatigue life by power cycle. Please reduce the temperature fluctuation range as much as possible when the up and down of temperature are frequently generated.

8 Derating

- It is necessary to note thermal fatigue life by power cycle. Please reduce the temperature fluctuation range as much as possible when the up and down of temperature are frequently generated.

8.1 CES Derating

- Use with the convection cooling or the forced air cooling. Use the temperature measurement location as shown in Fig.8.2.1 to Fig.8.2.3 below the regulated temperature. Refer to Fig.8.1 for derating curve. Ambient temperature must keep below 85°C.
Option “B” and “BT” (Type-P) used with convection cooling or forced air cooling or conduction cooling.

Use the temperature measurement location as shown in Fig. 8.2.3.

Verify final design by actual temperature measurement. Use the temperature measurement location as shown in Fig. 8.2.1 to Fig. 8.2.3 at 120°C or less.

Shown the thermal curve with measuring as shown in Fig. 8.3.

Fig. 8.2.1 Temperature measurement location

Fig. 8.2.2 Temperature measurement location (CES Type P)

Fig. 8.2.3 Measurement point (CES Type P option “B”, “BT”)

Input side

Output side

Measurement point for ambient temperature and airflow

Airflow

Fig. 8.3 Measuring method

Load current[A] vs. ambient temperature [°C]

Ambient temperature [°C]

Load current [A]

-40 -20 0 20 40 60 80

-40 -20 0 20 40 60 80

Fig. 8.4 Load current vs. ambient temperature (CES24033-25 Vin=24V)

Fig. 8.5 Load current vs. ambient temperature (CES24050-16 Vin=24V)
For other thermal curves, please consult with us.
8.2 CQS Derating

- Use with the convection cooling or the forced air cooling.
- Use the temperature measurement location as shown in Fig. 8.21 at 120°C or less.
- Ambient temperature must keep below 85°C.

Verify final design by actual temperature measurement.

Temperature measurement location as shown in Fig. 8.22 to Fig. 8.25 at 120°C or less.

Shown the thermal curve with measuring as shown in Fig. 8.26.

Measure the temperature at 120°C or less.

Ambient temperature must keep below 85°C.

Fig. 8.21 Derating curve

Fig. 8.22 CQS□□-□, Temperature measurement location

Fig. 8.23 CQS48015-50, CQS48018-50, CQS48025-45, CQS48033-45, Temperature measurement location

Fig. 8.24 CQS48050-28, Temperature measurement location

Fig. 8.25 CQS48120-14, CQS48150-8 Temperature measurement location

Fig. 8.26 Measuring method
These are packed in a tray (Fig. 1.1).
Please order “CES□□-□-S” for tray type packaging.

Capacity of the tray is 8 max.
In case of fractions, the units are stored in numerical order.