

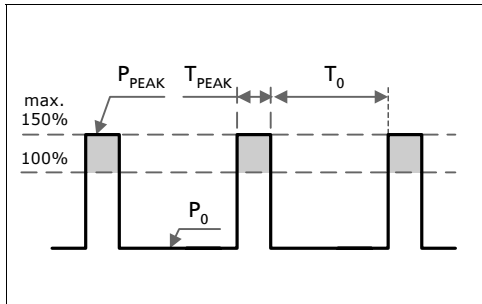
27. APPLICATION NOTES

27.1. REPETITIVE PULSE LOADING

Typically, a load current is not constant. It varies over time. For pulse load compatibility, following rules must be met:

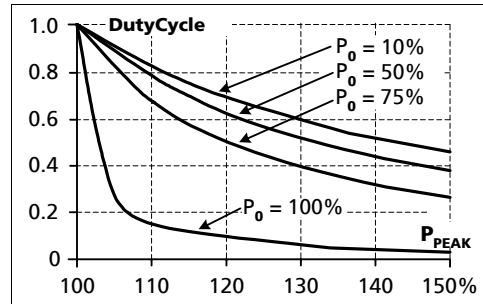
- a) The pulse power demand must be below 150% of the nominal power.
- b) The duration of the pulse power must be shorter than the allowed Bonus Time. (see output section)
- c) The average (R.M.S.) output current must be below the specified continuous output current. If the R.M.S. current is higher, the unit will respond with a thermal shut-down after a while. Use the max. duty cycle curve (Fig. 27-2) to check if the average output current is below the nominal current.
- d) For altitudes higher than 2000m reduce the pulse loading (30W/1000m) or the ambient temperature (5°C/1000m)

Fig. 27-1 Repetitive pulse loads, definitions



- P₀** Base load (W)
- P_{PEAK}** Pulse load (above 100%)
- T₀** Duration between pulses (s)
- T_{PEAK}** Pulse duration (s)

Fig. 27-2 Max. Duty Cycle Curve



$$\text{DutyCycle} = \frac{T_{\text{peak}}}{T_{\text{peak}} + T_0}$$

$$T_0 = \frac{T_{\text{peak}} - (\text{DutyCycle} \times T_{\text{peak}})}{\text{DutyCycle}}$$

Utilizing the Max. Duty Cycle Curve:

Example to determine the repetition rate of pulses without dipping of the output voltage:

Parameters of application:

Pulse length is T_{PEAK} = 1s

Steady state load P₀=120W
(= 50% of I_{RATED})

Peak load P_{PEAK} = 360W
(= 150% of I_{RATED})

Determining the repetition rate:

- 1) make a vertical line at P_{PEAK} = 150%
- 2) make a horizontal line where the vertical line crosses the P₀ = 50% curve
- 3) Read the Max. Duty Cycle from the Duty Cycle-axis (= 0.37)
- 4) Calculate the min. pause (base load) length T₀ :

$$T_0 = \frac{T_{\text{peak}} - (\text{DutyCycle} \times T_{\text{peak}})}{\text{DutyCycle}} = \frac{1\text{s} - (0.37 \times 1\text{s})}{0.37} = \underline{1.7\text{s}}$$

- 5) Pulse length = 1s, min. pause length = 1.7s
- 6) Max. repetition rate = pulse length + pause length = **2.7s**

More examples for pulse load compatibility:

P _{PEAK}	P ₀	T _{PEAK}	T ₀
720W	480W	1s	>25s
720W	0W	1s	>1.3s
600W	240W	1s	> 0.75s

P _{PEAK}	P ₀	T _{PEAK}	T ₀
720W	240W	0.1s	>0.16s
720W	240W	1s	>1.6s
720W	240W	3s	>4.9s

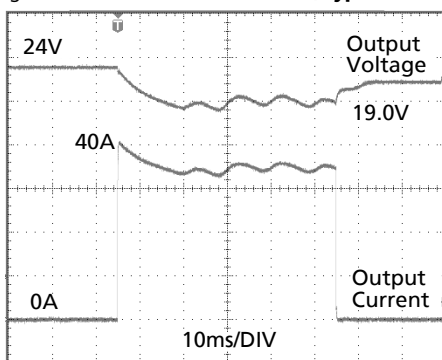
27.2. PEAK CURRENT CAPABILITY

Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady state current and usually exceeds the nominal output current (including the Bonus Power®). The same situation applies, when starting a capacitive load.

Branch circuits are often protected with circuit breakers or fuses. In case of a short or an overload in the branch circuit, the fuse needs a certain amount of over-current to trip or to blow. The peak current capability ensures the safe operation of subsequent circuit breakers.

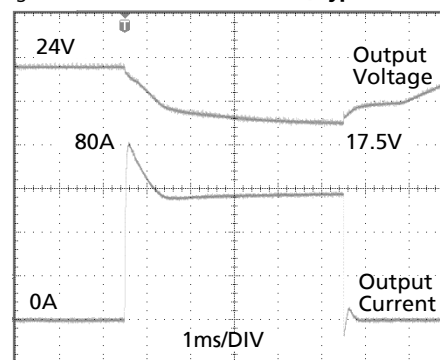
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 27-3 Peak load 40A for 50ms, typ.



Peak load 40A (resistive) for 50ms
Output voltage dips from 24V to 19.0V.

Fig. 27-4 Peak load 80A for 5ms, typ.



Peak load 80A (nearly resistive) for 5ms
Output voltage dips from 24V to 17.5V.

Please note: The DC-OK relay triggers when the voltage dips more than 10% for longer than 1ms.

27.3. BACK-FEEDING LOADS

Loads such as decelerating motors and inductors can feed voltage back to the power supply. This feature is also called return voltage immunity or resistance against Back- E.M.F. (Electro Magnetic Force).

This power supply is resistant and does not show malfunctioning when a load feeds back voltage to the power supply. It does not matter, whether the power supply is on or off.

The maximum allowed feed back voltage is 34Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 8. If the feed back voltage gets higher than 34Vdc, the power supply responds with a shut-down and a subsequent start-up attempt.

27.4. CHARGING OF BATTERIES

The power supply can be used for float-charging of lead-acid or maintenance free 24V VRLA batteries.

Instructions for charging batteries:

- a) Set the output voltage, at disconnected load, very precisely to the end-of-charge voltage according to the expected battery temperature.

End-of-charge voltage	27.8V	27.5V	27.15V	26.8V
Battery temperature	10°C	20°C	30°C	40°C

- b) Use a 25A circuit breaker (or blocking diode) between the power supply and the battery.
- c) Ensure that the output current of the power supply is below the allowed charging current of the battery.
- d) Use only matched batteries when putting 12V types in series.
- e) The return current to the power supply is typ. 9mA at 25Vdc when the power supply is switched off.

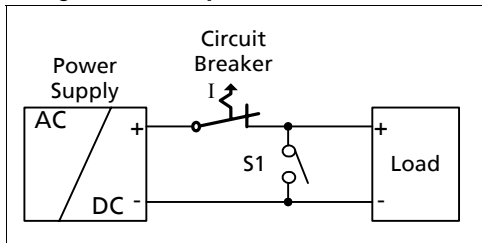
27.5. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCBs) can be used for branch protection. Ensure that the MCB is rated for DC voltage, too. The following tests show which circuit breakers the power supply typically trips.

Circuit breakers have huge tolerances in their tripping behavior. Therefore, these typical tests can only be used as a recommendation or for comparing two different power supplies. Furthermore, the loop impedance has a major influence on whether a breaker trips or not. Two tests were performed, representing typical situations:

Test 1: Short circuit with S1 on the power supply end of the cable (loop impedance approx. 20mOhm)

Fig. 27-5 **Branch protectors, test circuit 1**



Parameters:

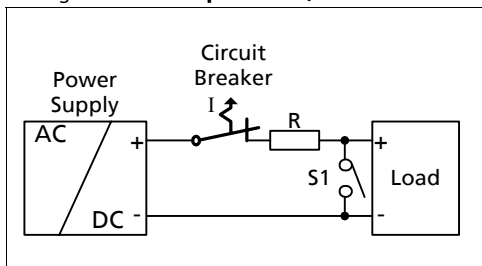
Input voltage: 230Vac, load current: 0A
Tripping time shorter than 5s.

The following circuit breaker tripped during the test:

- A- or Z- Characteristic:** equal or smaller 25A *)
- B- Characteristic:** equal or smaller 20A *)
- C- Characteristic:** equal or smaller 13A *)

Test 2: Short circuit with S1 on the load end (additional impedance included; represents longer load wire length).

Fig. 27-6 **Branch protectors, test circuit 2**



Parameters:

Input voltage: 230Vac, load current: 0A
Tripping time shorter than 5s.

The following circuit breaker tripped during the test:

- A- or Z- Characteristic:** ≤ 20A and R < 82mOhm *)
- B- Characteristic:** ≤ 13A and R < 120mOhm *)
- C- Characteristic:** ≤ 8A and R < 150mOhm *)

What does this resistance mean in wire length?

	0.5mm ²	0.7mm ²	1.0mm ²	1.5mm ²	2.5mm ²	4.0mm ²
82mOhm	2.3m	3.2m	4.6m	6.9m	11.4m	18.3m
120mOhm	3.3m	4.7m	6.7m	10.0m	16.7m	26.7m
150mOhm	4.2m	5.9m	8.4m	12.5m	20.9m	33.4m

*) A list of the circuit breakers under test is available on request.

Example:

Which wire gauge must be used to trip a C-Characteristic circuit breaker with a rating of 8A? The load wire length is 19m.

Answer: A 8A C-Characteristic circuit breaker requires a loop impedance of less than 150mOhm (test results). The wire length table shows that up to 20.9m wire with a cross section of 2.5mm² are below 150mOhm. A wire not smaller than 2.5mm² shall be used.

27.6. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 20A. External protection is only required, if the supplying branch has an ampacity greater than this. In some countries local regulations might apply. Check also local codes and local requirements.

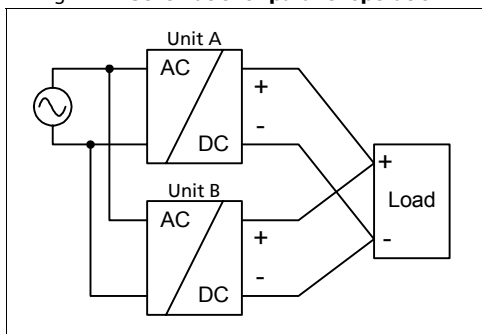
If an external fuse is necessary or utilized, a minimum value is required to avoid undesired tripping of the fuse.

		B-Characteristic	C-Characteristic
Ampacity	max.	20A	20A
	min.	10A	10A

27.7. PARALLEL USE TO INCREASE OUTPUT POWER

Power supplies can be paralleled to increase the output power.

Fig. 27-7 Schematic for parallel operation



Instructions for parallel use:

- Use only power supplies from the same series (Q-Series).
- Adjust the output voltages of all power supplies to approximately the same value ($\pm 500\text{mV}$). Otherwise, the DC-ok signal might not work properly.
- A fuse (or diode) on the output is only required if more than three units are connected in parallel.
- Do not continuously load the terminals with more than 25A. Follow wiring instructions according to chapter 27.9
- Keep an installation clearance of 15mm (left/right) between two power supplies and avoid installing the power supplies on top of each other.

27.8. PARALLEL USE FOR REDUNDANCY

Power supplies can be paralleled for redundancy to gain a higher system availability. Redundant systems require a certain amount of extra power to support the load in case one power supply unit fails. The simplest way is to put two Q-Series power supplies in parallel. This is called a 1+1 redundancy. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. Five power supplies, each rated for 10A are paralleled to build a 40A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a - virtually nearly impossible - case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the decoupling module YR2.DIODE. (One Diode module per power supply)

Recommendations for building redundant power systems:

- Use separate input fuses for each power supply.
- Monitor the individual power supply units. A DC-ok LED and a DC-ok contact is already included in the units. This feature reports a faulty unit.
- When possible, connect each power supply to different phases or circuits.
- It is desirable to set the output voltages of all power supplies to the same value to avoid a false DC-ok signal.

27.9. DAISY-CHAINING OF OUTPUTS

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the max. current through one terminal pin does not continuously exceed 20A. If the current is higher, use a separate distribution terminal.

Fig. 27-8 **Daisy chaining of outputs**

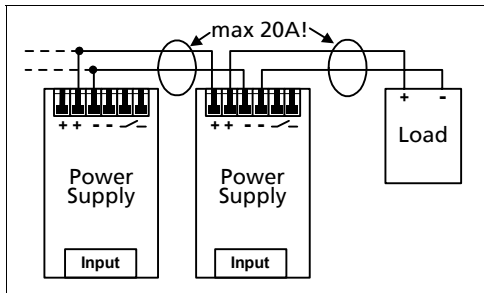
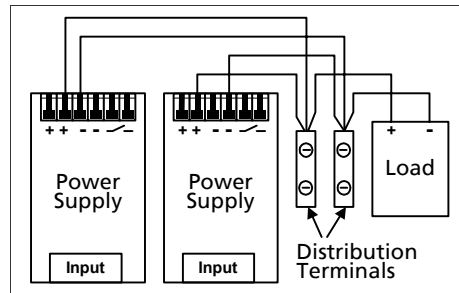


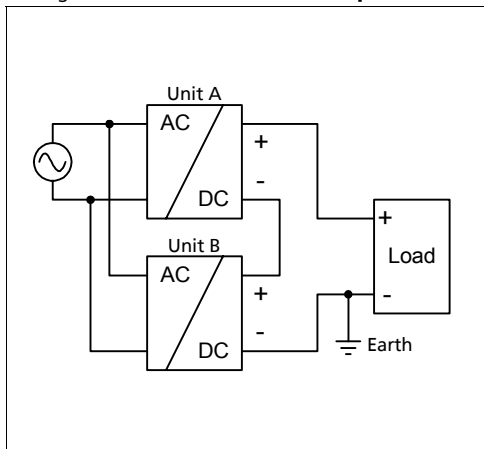
Fig. 27-9 **Using distribution terminals**



27.10. SERIES OPERATION

The power supply can be put in series to increase the output voltage.

Fig. 27-10 **Schematic for series operation**



Instructions for use in series:

- It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc.
- Voltages with a potential above 60Vdc are not SELV any more and can be dangerous. Such voltages must be installed with a protection against touching.
- For serial operation use power supplies of the same type.
- Earthing of the output is required when the sum of the output voltage is above 60Vdc.
- Keep an installation clearance of 15mm (left/right) between two power supplies and avoid installing the power supplies on top of each other.

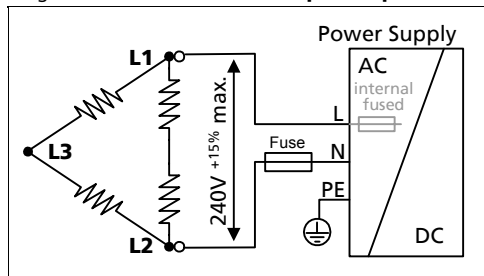
Note: Avoid return voltage (e.g. from a decelerating motor or battery) which is applied to the output terminals.

27.11. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply any kind of load, including unlimited capacitive and inductive loads.

27.12. OPERATION ON TWO PHASES

Fig. 27-11 Schematic for two phase operation



Instructions for two phase operation:

- A phase to phase connection is allowed as long as the supplying voltage is below $240V^{+15\%}$.
- Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire.

Appropriate fuses or circuit breakers are specified in section 27.6 "External Input Protection".

27.13. USE IN A TIGHTLY SEALED ENCLOSURE

When the power supply is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. The inside temperature defines the ambient temperature for the power supply.

Results from such an installation:

Power supply is placed in the middle of the box, no other heat producer inside the box

Enclosure:	Rittal Type IP66 Box PK 9522 100, plastic, 254x180x165mm
Load:	24V, 16A; (=80%) load is placed outside the box
Input:	230Vac
Temperature inside enclosure:	49.2°C (in the middle of the right side of the power supply with a distance of 2cm)
Temperature outside enclosure:	24.4°C
Temperature rise:	24.8K

27.14. MOUNTING ORIENTATIONS

Mounting orientations other than input terminals on the bottom and output on the top require a reduction in continuous output power or a limitation in the max. allowed ambient temperature. The amount of reduction influences the lifetime expectancy of the power supply. Therefore, two different derating curves for continuous operation can be found below:

Curve A1 Recommended output current.

Curve A2 Max allowed output current (results approx. in half the lifetime expectancy of A1).

Fig. 27-12
Mounting Orientation A
Standard Orientation

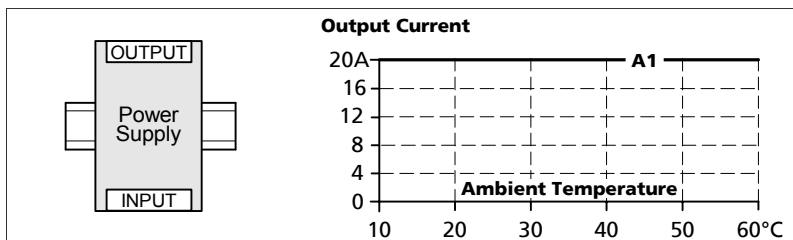


Fig. 27-13
Mounting Orientation B
(Upside down)

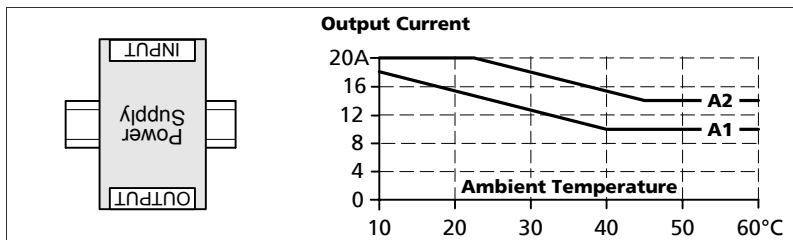


Fig. 27-14
Mounting Orientation C
(Table-top mounting)

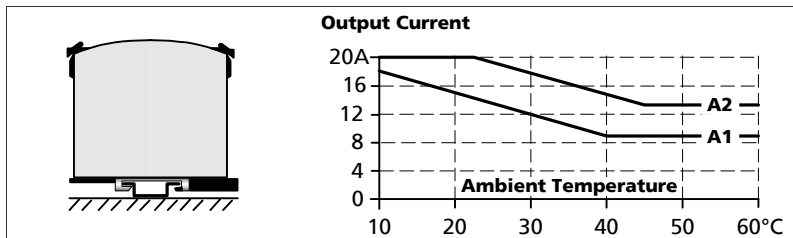


Fig. 27-15
Mounting Orientation D
(Horizontal cw)

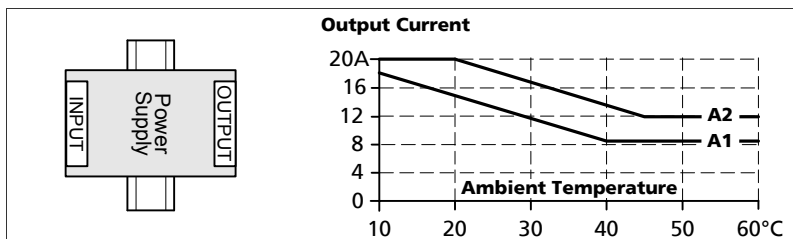


Fig. 27-16
Mounting Orientation E
(Horizontal ccw)

