

Documentation | EN

# PS9771-2440-0000

DC/DC Converter 475-750 V / 24 V, 40 A, 960 W





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# 1 Overview

## PS9771-2440-0000 | DC/DC converter 475-750V / 24V, 40A, 960W



- Width only 110mm, weight only 1.5kg
- 95,2% Full load and excellent partial load efficiencies
- 50% Extra Power, 1440W for up to 4s
- 100A Peak current for 10ms for easy fuse tripping
- Active filtering of input transients
- Negligible low input inrush current surge
- Full power between -25°C and +60°C
- Current sharing feature for parallel use
- Remote control of output voltage
- DC-OK relay contact
- Shut-down input

The PS9771-2440-0000 is a DIN-rail mountable DC/DC converter with an input voltage of 475 to 750 V DC which provides a floating, stabilized and galvanically separated SELV/PELV output voltage of 24 V DC with 40 A.

It contains various functions and can be used for the following purposes:

- convert voltages to another voltage level
- refresh, amplify and stabilize voltages
- provide a galvanically isolated SELV/PELV voltage

Large power reserves of 150% support the starting of heavy loads such as DC-motors or capacitive loads. In many cases this allows the use of a unit from a lower wattage class which saves space and money.

The integrated output power manager, the near zero input inrush current make installation and usage simple.

Diagnostics are easy due to the DC-OK relay, a green DC-OK LED and the red overload LED.

### Overview of technical data <sup>\*)</sup>

Overview of technical data	PS9771-2440-0000
Output voltage	DC 24V (nominal)
Adjustment range	24 - 28V (factory setting 24.1V)
Output current	40 – 34.3A, continuous 60 – 51.5A, short term (4s)
Output power	960W, continuous, 1440W, short term (4s)
Output ripple	< 100mVpp (20Hz to 20MHz)
Input voltage	DC 475-750V (-32.6%/+7%)
DC Input current	1.6A
DC Inrush current	5A peak
Efficiency	95.2%
Losses	48.4W
Temperature range	-25°C to +70°C (operational)
Derating	24W/°C (+60 to +70°C)
Hold-up time	typ. 25ms
Dimensions (w x h x d)	110x124x127mm
Weight	1500g
Approvals/markings	CE

\*) All parameters are specified at 24V, 40A, 650Vdc, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

## 2 Foreword

### 2.1 Notes on the documentation

#### Copyright

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#### Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

#### Trademarks

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#### Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

#### Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.

The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

## 2.2 Safety instructions

### Description of instructions

In this documentation the following instructions are used.  
These instructions must be read carefully and followed without fail!

#### **DANGER**

##### **Serious risk of injury!**

Failure to follow this safety instruction directly endangers the life and health of persons.

#### **WARNING**

##### **Risk of injury!**

Failure to follow this safety instruction endangers the life and health of persons.

#### **CAUTION**

##### **Personal injuries!**

Failure to follow this safety instruction can lead to injuries to persons.

#### **NOTICE**

##### **Damage to environment/equipment or data loss**

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.



#### **Tip or pointer**

This symbol indicates information that contributes to better understanding.

### Intended use

This device is designed for installation in a housing and is intended for general professional use, for example in industrial control systems or office, communication and measuring equipment.

Do not use this power supply in installations where a malfunction could cause serious injury or danger to human life.

### Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

### Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

### Safety regulations

Please note the following safety instructions and explanations!  
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

**Safety instructions and installation requirements for PS9771-2440-0000 power supply unit**** DANGER****Danger of electric shock, fire, injuries, injuries resulting in death!**



- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not modify or repair the device.
- Do not open the device, as high voltages are present inside.
- Use caution to prevent any foreign objects from entering the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
- Do not touch during power-on, and immediately after power-off. Hot surface may cause burns.



## **i** Further notes on installation requirements

- This device may only be installed and put into operation by qualified personnel.
- This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect.
- If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection
- Install device in an enclosure providing protection against electrical, mechanical and fire hazards.
- Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.
- Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +60°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.
- The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.
- The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.
- The isolation of the devices is designed to withstand impulse voltages up to 4kV according to IEC 60664-1.
- The device is designed as “Class of Protection I” equipment according to IEC 61140. Do not use without a proper PE (Protective Earth) connection.
- The device is designed to be supplied from a DC (input) voltage derived from a 3-phase TN, TT, IT or Corner grounded delta mains supply systems by means of a B6 bridge rectifier.
- The input can also be supplied by batteries or similar DC sources. Since the continuous voltage between the input voltage and the PE/earth potential must not exceed 480V r.m.s., the input voltage must be grounded at about half the supply voltage as shown in option 2 in “Wiring Scheme”.
- Do not ground the positive or negative input voltage pole. Follow the wiring scheme shown in this document.
- The continuous voltage between the supply voltage and PE/ground must not exceed 480V r.m.s.. Check for correct input polarity. The device will not operate when the voltage is reversed.
- A disconnecting means shall be provided for the input of the device.
- The device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid!
- The device is designed for altitudes up to 2000m.
- Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 5mm left and right side. Increase the 5mm to 15mm in case the adjacent device is a heat source. When the device is permanently loaded with less than 50%, the 5mm can be reduced to zero.
- For external branch protection consider diagram “Wiring Scheme”. There are two options:
- Option 1: For using the device powered by a B6 rectification the unit is tested and approved for branch circuits up to 25A. Do not use fuses smaller than 4A to avoid a nuisance tripping of the circuit breaker.
- Option 2: For all other DC sources, the device is tested and approved with max. 10A fuses in the plus and minus path. It is possible to use two devices on 10A fuses or one single device on 6A fuses. Do not use fuses smaller than 6A to avoid a nuisance tripping of the fuse. Use following fuse types with Option 2: Littelfuse type 0SPF010 or equivalent UL listed fuse, SIBA type URZ 5020434.
- The maximum surrounding air temperature is +70°C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.
- The device is designed to operate in areas between 5% and 95% relative humidity.

## 2.3 Terminology and abbreviations

<b>PE and the earthing symbol</b> 	PE is the abbreviation for "protective earth" and has the same meaning as the earthing symbol 
<b>Earth, ground</b>	This document uses the term "earth" which is the same as the U.S. term "ground".
<b>t.b.d.</b>	Still to be defined, value or description will follow in due course.
<b>DC 650 V</b>	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances included. Example: DC 12 V refers to a 12 V battery, regardless of whether it is fully charged (13.7 Vdc) or discharged (10 Vdc).
<b>400 Vdc</b>	A figure with the unit (Vdc) at the end is a momentary figure without any additional.
<b>may</b>	A key word indicates flexibility of choice with no implied preference.
<b>shall</b>	A key word indicates a mandatory requirement.
<b>should</b>	A key word indicates flexibility of choice with a strongly preferred implementation.

### 3 Technical data, mounting, wiring

#### 3.1 DC input

DC-Eingang			
DC input	nom.	475-750 Vdc	for rated output power
DC input range		320-475 Vdc	with derating on output power (see Fig. "Input voltage range" and chapter „Output“)
		320-802Vdc	full tolerance range
Turn-on voltage	typ.	435 Vdc	steady-state value, load independent, see Fig. "Input voltage range"
Shut-down voltage	typ.	310 Vdc	steady-state value, load independent, see Fig. "Input voltage range"

DC 650 V			
Input current	typ.	1,6 A	at 24V, 40A
Start-up delay	typ.	600 ms	see Fig. "Input voltage range"
Rise time	typ.	35 ms	at 24V, 40A, resistive load, 0mF, see Fig. "Turn-on behavior, definitions"
		40 ms	at 24V, 40A, resistive load, 40mF, see Fig. "Turn-on behavior, definitions"
Turn-on overshoot	max.	500 mV	see Fig. "Turn-on behavior, definitions"

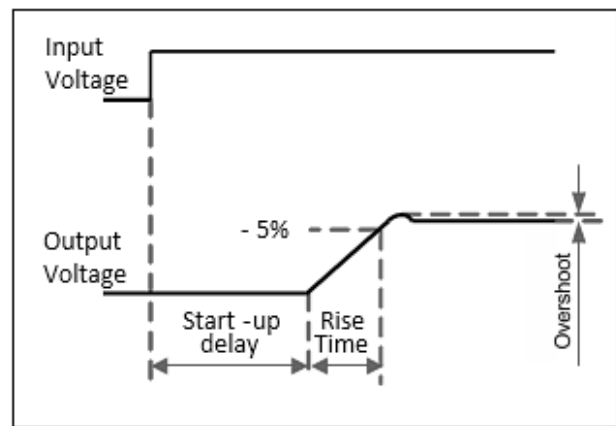
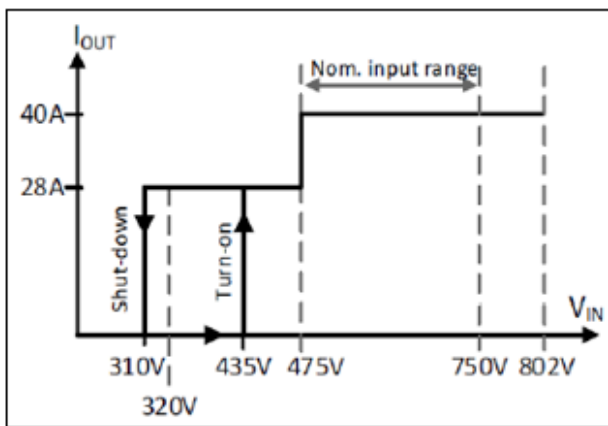


Fig. 1: Input voltage range, Turn-on behavior, definitions

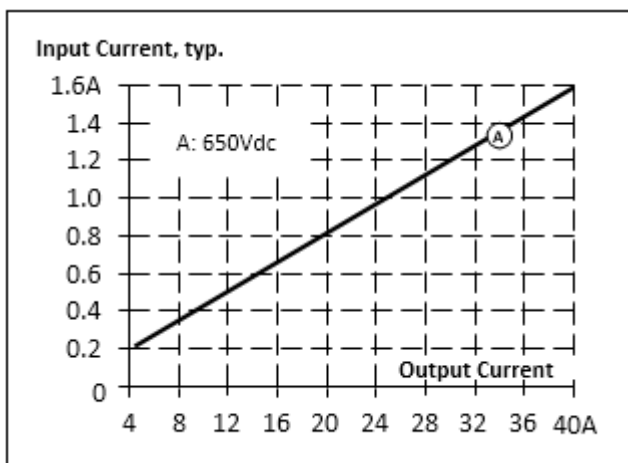


Fig. 2: Input current vs. output load

## 3.2 Input inrush current

The power supply is equipped with an active inrush current limitation circuit, which limits the input inrush current after turn-on to a negligible low value. The input current is usually smaller than the steady state input current.

Input inrush current <sup>*)</sup>	max.	$5A_{\text{peak}}$	over entire temperature range
	typ.	$4.5A_{\text{peak}}$	over entire temperature range
Inrush energy	max.	$1.5A^2s$	over entire temperature range
Inrush delay	typ.	500ms	

\*) The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

### 3.3 Output

Output voltage	nom.	24V	
Adjustment range		24-28V	guaranteed
	max.	30V <sup>***)</sup>	at the clockwise end position of the potentiometer
Factory setting	typ.	24.1V	±0.2%, at full load, cold unit, in "single use" mode
	typ.	24.1V	±0.2%, at full load, cold unit, in "parallel use" mode
	typ.	25.1V	at no load, cold unit, in "parallel use" mode
Line regulation	max.	10mV	475-750Vdc
Load regulation	max.	50mV	In "single use" mode: static value, 0A → 40A, see Fig. "Output voltage vs. output current in 'single use' mode, typ."
	typ.	1000mV	In "parallel use" mode: static value, 0A → 40A, see Fig. "Output voltage vs. output current in 'parallel use' mode, typ."
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	40A	continuously available at 24V, see Fig. "Output voltage vs. output current in 'single use' mode, typ." and Fig. "Output voltage vs. output current in 'parallel use' mode, typ."
	nom.	34.3A	continuously available at 28V, see Fig. "Output voltage vs. output current in 'single use' mode, typ." and Fig. "Output voltage vs. output current in 'parallel use' mode, typ."
	nom.	60A	short term (4s) available Extra Power*), at 24V, see Fig. "Output voltage vs. output current in 'single use' mode, typ."; Fig. "Output voltage vs. output current in 'parallel use' mode, typ." and Fig. "Dynamic overcurrent capability, typ."
	nom.	51.5A	short term (4s) available BonusPower*), at 28V, see Fig. "Output voltage vs. output current in 'single use' mode, typ."; Fig. "Output voltage vs. output current in 'parallel use' mode, typ." and Fig. "Dynamic overcurrent capability, typ."
	nom.	28A	continuously available at 24V, 320-474Vdc
	nom.	24A	continuously available at 28V, 320-474Vdc
	typ.	100A	up to 10ms, output voltage stays above 20V, see Fig. "Dynamic overcurrent capability, typ.", this peak current is available once every second.  See chapter "Peak current capability [▶ 331]" for more peak current measurements.
Output power	nom.	960W	continuously available at 24-28V
	nom.	1440W <sup>)</sup>	short term available Extra Power <sup>)</sup> at 24-28V
Extra Power time	typ.	4s	duration until the output voltage dips, see Fig. "Bonus time vs. output power"
Recovery time	typ.	7s	overload free time to reset power manager, see Fig. "Extra Power recovery time"
Overload behaviour		continuous current	see Fig. "Output voltage vs. output current in "single use" mode, typ."
Short-circuit current <sup>*)</sup>	min.	40A	continuous, load impedance 25mOhm, see Fig. "Output voltage vs. output current in 'single use' mode, typ."
	max.	44A	continuous, load impedance 25mOhm, see Fig. "Output voltage vs. output current in 'single use' mode, typ."
	min.	60A	short-term (4s), load impedance 25mOhm, see Fig. "Output voltage vs. output current in 'single use' mode, typ."
	max.	68A	short-term (4s), load impedance 25mOhm, see Fig. "Output voltage vs. output current in 'single use' mode, typ."
	typ.	46A	continuous, load impedance <10mOhm
	max.	51A	continuous, load impedance <10mOhm
Output capacitance	typ.	10.200µF	included in the power supply

\*) Extra Power, short term power capability (up to typ. 4s)

The power supply is designed to support loads with a higher short-term power requirement without damage or shutdown. The short-term duration is hardware controlled by an output power manager. This Extra Power is repeatedly available. Detailed information can be found in chapter "Repetitive pulse loading [▶ 31]". If the power supply is loaded longer with the Extra Power than shown in the bonus-time diagram (see Fig. "Bonus time vs. output power"), the max. output power is automatically reduced to 960W.

\*\*) Discharge current of output capacitors is not included.

\*\*\*) This is the maximum output voltage which can occur at the clockwise end position of the potentiometer due to tolerances. It is not guaranteed value which can be achieved. The typical value is about 28.5V.

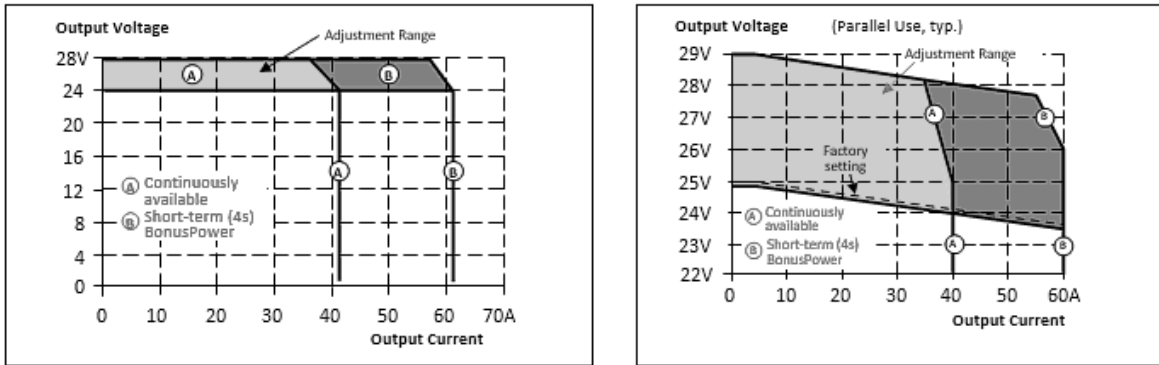


Fig. 3: Output voltage vs. output current in “single use” mode, typ.;  
Output voltage vs. output current in “parallel use” mode, typ.

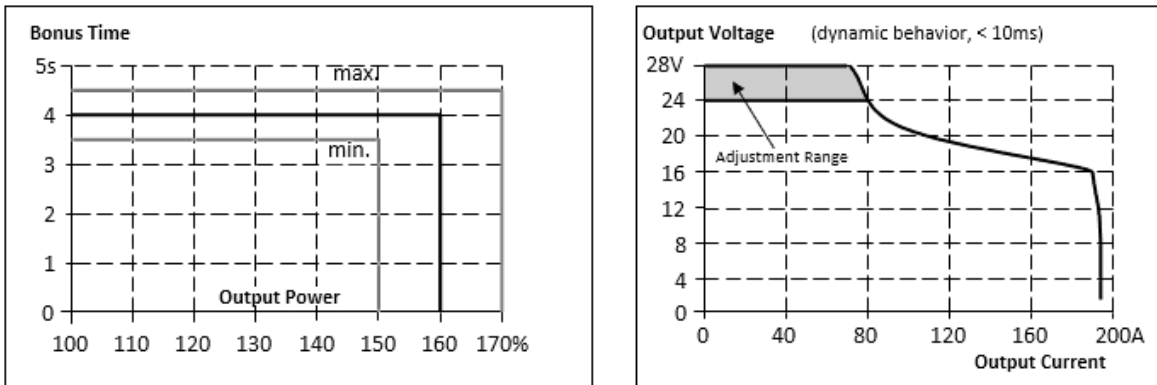


Fig. 4: Bonus time vs. output power;  
Dynamic overcurrent capability, typ.

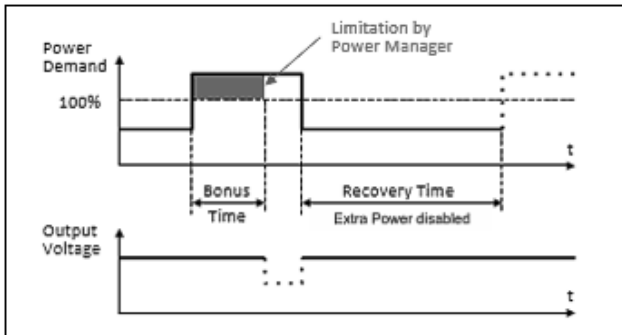


Fig. 5: Extra Power recovery time

The Extra Power is available as soon as power comes on and after the end of an output short circuit or output overload.

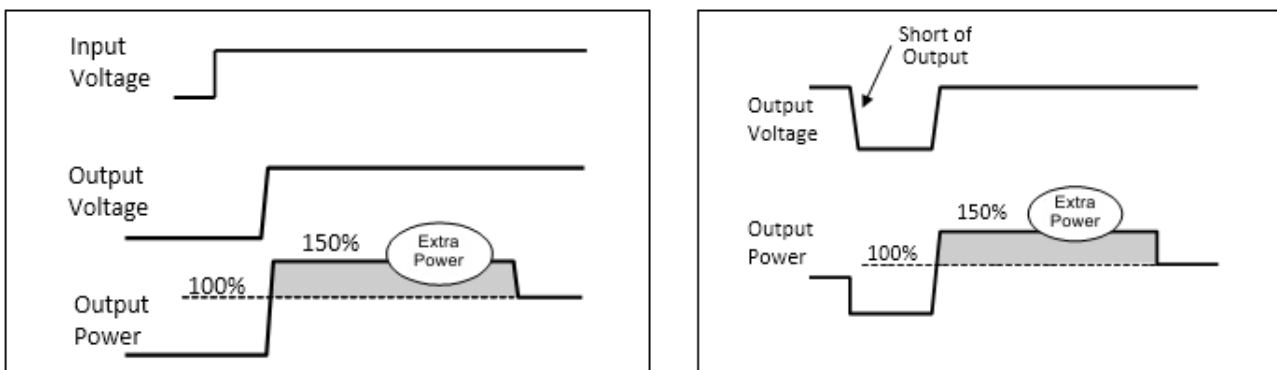


Fig. 6: BonusPower after input turn-on; BonusPower after output short

### 3.4 Hold-up time

		DC 650V	
Hold-up time	typ.	50ms	at 24V, 20A, see Fig. "Hold-up time vs. input voltage"
	min.	40ms	at 24V, 20A, see Fig. "Hold-up time vs. input voltage"
	typ.	25ms	at 24V, 40A, see Fig. "Hold-up time vs. input voltage"
	min.	20ms	at 24V, 40A, see Fig. "Hold-up time vs. input voltage"

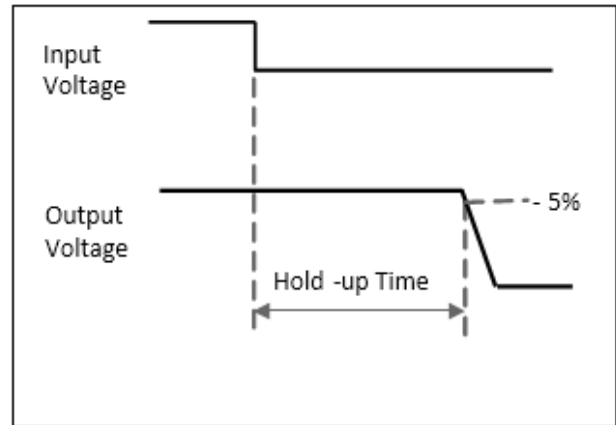
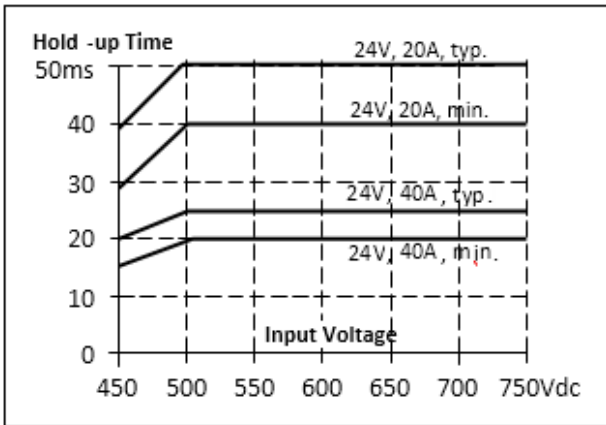


Fig. 7: Hold-up time vs. input voltage; Shut-down behavior, definitions

### 3.5 DC-OK relay contact

This feature monitors the output voltage, which is produced by the power supply itself. It is independent of a back-fed voltage from a unit connected in parallel to the power supply output.

Contact closes	As soon as the output voltage reaches 90% of the adjusted output voltage.
Contact opens	As soon as the output voltage dips more than 10% below the adjusted output voltage. Short dips will be extended to a signal length of 250ms. Dips shorter than 1ms will be ignored.
Contact re-closes	As soon as the output voltage exceeds 90% of the adjusted voltage.
Contact ratings	maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load minimal permissible load 1mA at 5Vdc
Isolation voltage	see the dielectric strength table in the chapter "Dielectric strength [► 28]"

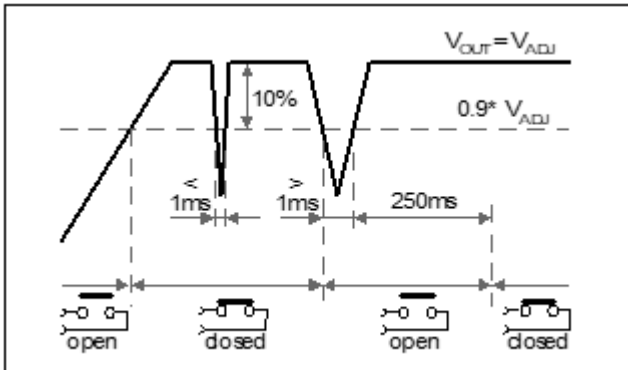


Fig. 8: Behavior of the DC-OK relay contact



### 3.6 Shut-down input

This feature allows a switch-off of the output of the power supply with a signal switch or an external voltage. The shut-down occurs immediately while the turn-on is delayed up to 350ms. In a shut-down condition, the output voltage is <math><2V</math> and the output power is <math><0.5W</math>.

The voltage between different minus pole output terminals must be below 1V when units are connected in parallel. In a series operation of multiple power supplies only wiring option "A" with individual signal switches is allowed.

Please note:

- Option C requires a current sink capability of the voltage source. Do not use a blocking diode.
- The shut-down function has no safety feature included.
- Please be aware, that shutting-down the device very often could result in reduction of product lifetime. We recommend staying below 50 shut-down cycles per day.

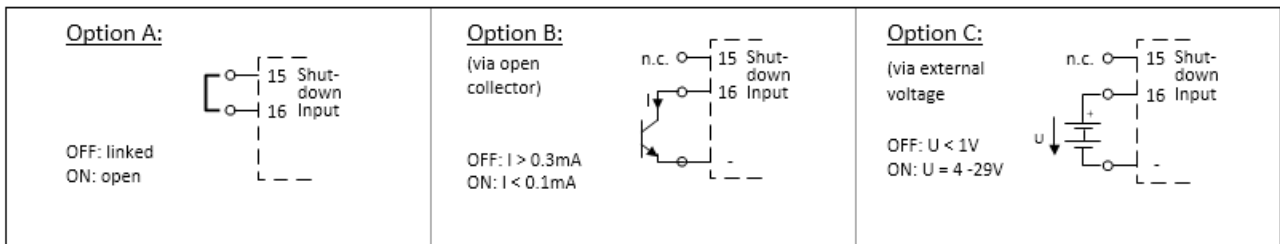


Fig. 9: Activation of the shut-down input

### 3.7 Remote control of output voltage

The shut-down input can also be used to remotely adjust the output voltage between typically 14Vdc and 28Vdc.

Please be aware, that a continuously change of the output voltage of more than 4V reduces the lifetime. We recommend not adjusting the output voltage more than 50 times per day when the adjustment is larger than 4V.

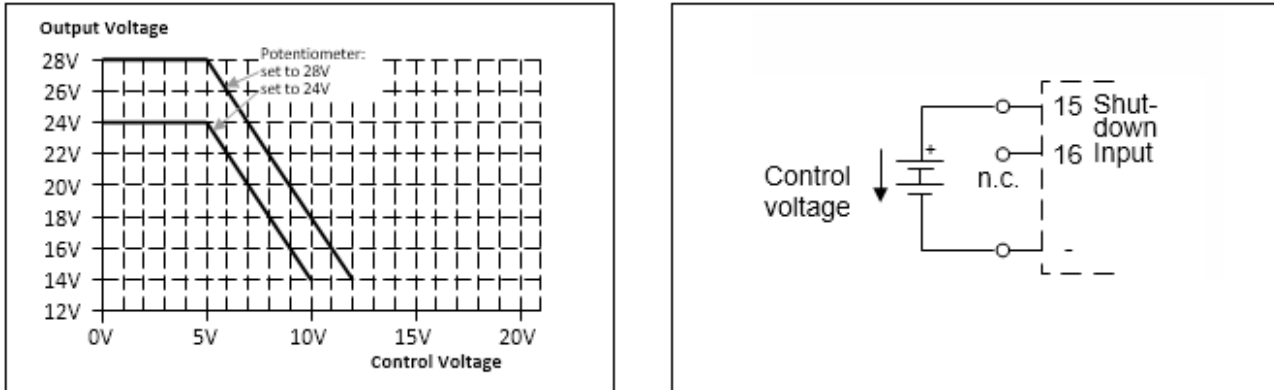


Fig. 10: Remote control of the output voltage; Applying the control voltage

**Instructions:**

1. Set the unit into “Single Use” mode.
2. Set the output voltage adjustment (24-28V) to the maximum desired voltage.
3. Apply a control voltage between typ. 5V DC and typ. 12V DC to pin 15 and main ground (negative output voltage). The control voltage must be permanently supplied.

### 3.8 Efficiency and losses

		DC 650V	
Efficiency	typ.	95.2%	at 24V, 40A
Average efficiency <sup>1)</sup>	typ..	94.6%	25% at 10A, 25% at 20A, 25% at 30A. 25% at 40A
Losses	typ.	1.5W	with activated shut-down
	typ.	9.8W	at 24V, 0A (no load)
	typ..	25.0W	at 24V, 20A (half load)
	typ.	48.4W	at 24V, 40A (full load)

<sup>1)</sup> The average efficiency is an assumption for a typical application where the power supply is loaded with 25% of the nominal load for 25% of the time, 50% of the nominal load for another 25% of the time, 75% of the nominal load for another 25% of the time and with 100% of the nominal load for the rest of the time.

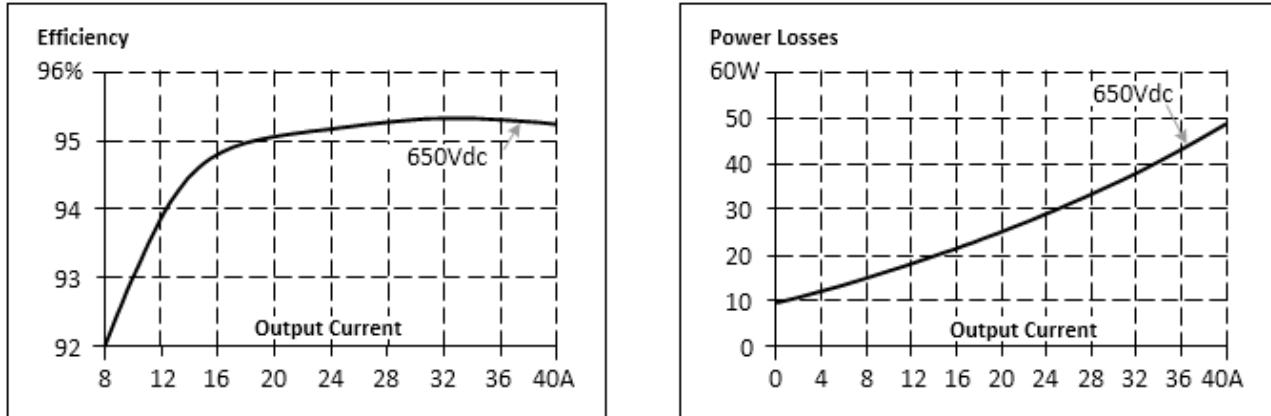


Fig. 11: Efficiency vs. output current at 24V, typ.; Losses vs. output current at 24V, typ.

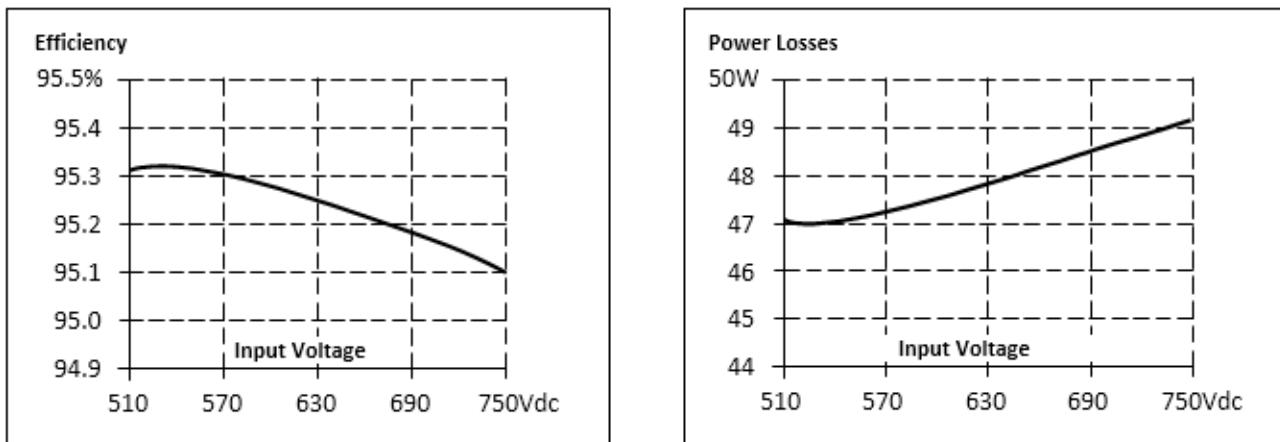


Fig. 12: Efficiency vs. input voltage at 24V, 40A, typ.; Losses vs. input voltage at 24V, 40A, typ.

### 3.9 Lifetime expectancy

	DC 650V	
Calculated lifetime expectancy <sup>*)</sup>	174,621h	at 24V, 40A and 25°C
	60,035h	at 24V, 40A and 40°C

\*) The **calculated lifetime expectancy** shown in the table indicates the minimum operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. Lifetime expectancy is specified in operational hours and is calculated according to the capacitor's manufacturer specification. The manufacturer of the electrolytic capacitors only guarantees a maximum life of up to 15 years (131 400h). Any number exceeding this value is a calculated theoretical lifetime which can be used to compare devices.

### 3.10 MTBF

	DC 650V	
MTBF <sup>**) SN 29500, IEC 61709</sup>	373,000h	at 24V, 40A and 40°C
	674,000h	at 24V, 40A and 25°C
MTBF <sup>**) MIL HDBK 217F</sup>	145,000h	at 24V, 40A and 40°C; Ground Benign GB40
	194,000h	at 24V, 40A and 25°C; Ground Benign GB25
	31,000h	at 24V, 40A and 40°C; Ground Fixed GF40
	40,000h	at 24V, 40A and 25°C; Ground Fixed GF25

\*\*) **MTBF** stands for **Mean Time Between Failure**, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g., 1 000 000h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it cannot be determined if the failed unit has been running for 50 000h or only for 100h.

### 3.11 Functional wiring diagram

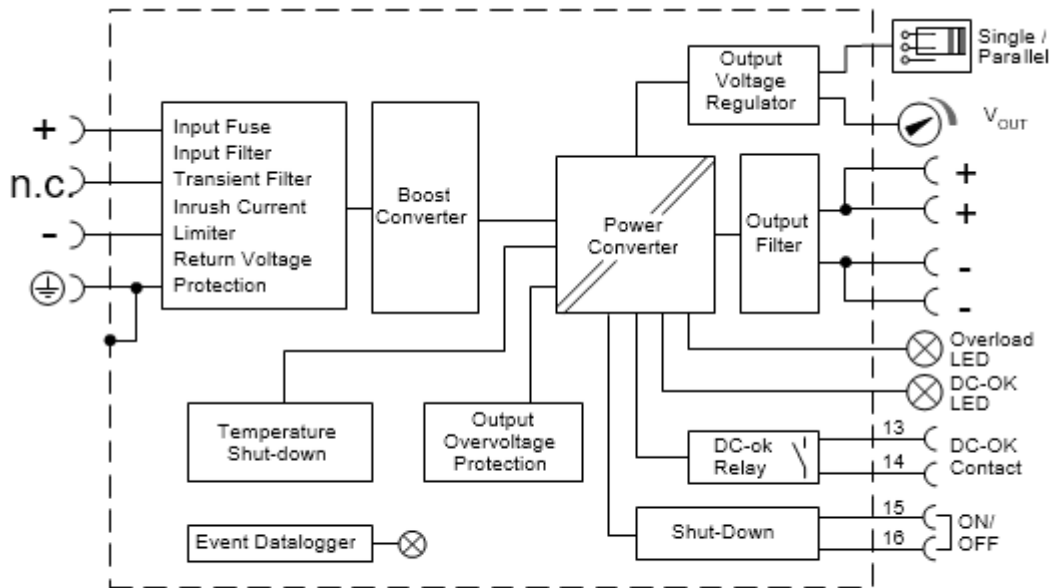


Fig. 13: Functional wiring diagram

### 3.12 Terminals and wiring

The terminals are designed to be finger-safe according to IP20 and are suitable for field and factory wiring.

Technical data	Input	Output	DC-OK signal, Shut down
Connection cross-section	e*: max. 6mm <sup>2</sup> f*: max. 4mm <sup>2</sup> a*: max. 4mm <sup>2</sup> (d<2.8mm)	e*: max. 16mm <sup>2</sup> f*: max. 10mm <sup>2</sup> a*: max 10mm <sup>2</sup> (d<5.2mm)	e*: max. 1.5mm <sup>2</sup> f*: max. 1.5mm <sup>2</sup> a*: max. 1.5mm <sup>2</sup> (d<1.5mm)
Connection cross section (AWG)	e*: AWG 20-10 f*: AWG 20-10 a* AWG 20-10 (d<2.8mm)	e*: AWG 22-8 f*: AWG 22-8 a* AWG 22-8 (d<5.2mm)	e*: AWG 26-14 f*: AWG 26-14 a*: AWG 26-14 (d<1.5mm)
Strip length	7mm	12mm	7mm
Screwdriver	3.5/5mm slotted or Phillips No 2		3mm slotted (to open the spring)

e\* = solid single wire

f\* = stranded wire

a\* = with ferrule

#### Wiring instructions:

- Use suitable copper cables that are designed for at least the following operating temperatures: +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C, and +90°C for ambient temperatures up to +70°C.
- Observe the national installation rules and regulations!
- Make sure that all single wires of a strand are connected to the terminal!
- Unused terminals should be tightened firmly.
- Ferrules are permitted.

#### Daisy chaining of outputs

Daisy chaining (jumping from one DC/DC-converter output to the next) is allowed as long as the average output current through one terminal pin does not exceed 54A. If the current is higher, use a separate distribution terminal block as shown below.

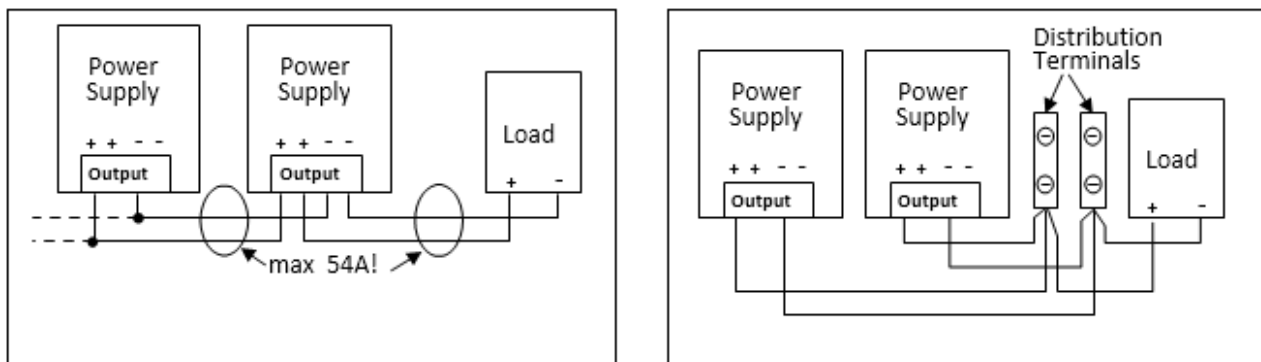


Fig. 14: Daisy chaining of outputs; Using distribution terminals

### 3.13 Front side and operating elements

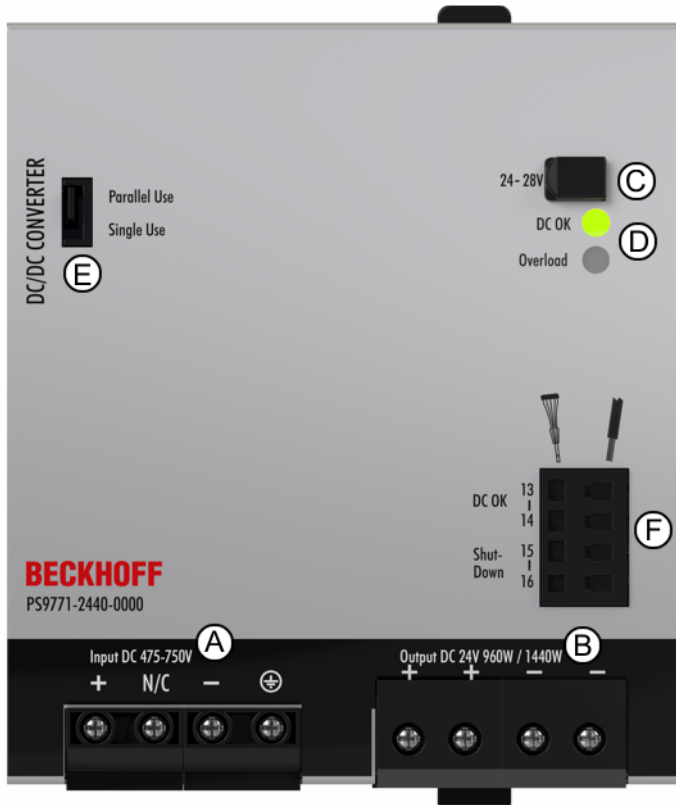



Fig. 15: Front PS9771-2440-0000

#### Input terminals (screw terminals)

Designation (A)	Description
+	Line input +
-	Line input -
N/C	Not connected
	Earth input

#### Output terminals (screw terminals)

Designation (B)	Description
+	2 identical positive poles, positive output
-	2 identical negative poles, negative output

#### Output voltage potentiometer

Designation (C)	Description
Potentiometer cover	Multi turn potentiometer; open the flap to adjust the output voltage. Factory set: 24.1V at full output current, "Single Use" mode

**DC-OK / Overload LED**

Designation (D)	Description
DC-OK LED (green)	<ul style="list-style-type: none"> <li>• On: the voltage on the output terminals is &gt;90% of the adjusted output voltage.</li> </ul>
Overload LED (red)	<ul style="list-style-type: none"> <li>• On: the voltage on the output terminals is &lt;90% of the adjusted output voltage, or in case of a short circuit in the output.</li> <li>• Flashing: the shut-down has been activated or the unit has switched off due to over-temperature. Input voltage is required</li> </ul>

**“Parallel Use” / “Single Use” selector**

Designation (E)	Description
Jumper	<p>Set jumper to “Parallel Use” when power supplies are connected in parallel to increase the output power.</p> <p>In order to achieve a sharing of the load current between the individual power supplies, the “parallel use” regulates the output voltage in such a manner that the voltage at no load is approx. 4% higher than at nominal load.</p> <p>See also chapter “Parallel use for redundancy [▶ 38]”. A missing jumper is equal to a “Single Use” mode.</p>

**DC-OK relay / Shut down contact**

Designation (F)	Description
Push-in terminals 13 / 14	<p>The DC-OK relay contact is synchronized with the DC-OK LED.</p> <p>See chapter “DC-OK relay contact” [▶ 16] for details.</p>
Push-in terminals 15/ 16	<p>Allows the power supply to be shut down. Can be activated with a switch contact or an external voltage.</p> <p>See chapter “Shut-down input [▶ 17]” for details.</p>

**LEDs**

Indicators/LEDs	Overload LED	DC-OK LED	DC-OK contact
Normal mode	OFF	ON	Closed
During Extra Power	OFF	ON	Closed
Overload (Vout < 90%)	ON	OFF	Open
Output short circuit	ON	OFF	Open
Temperature Shut-down	flashing	OFF	Open
Active Shut-down input	flashing	OFF	Open
No input power	OFF	OFF	Open



### 3.14 EMC

The device is suitable for applications in industrial environment.

<b>EMC immunity (According generic standards: EN 61000-6-2, EN IEC 61000-6-2)</b>				
Electrostatic discharge	EN 61000-4-2	contact discharge air discharge	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz 2.7GHz-6GHz	20V/m 10V/m	Criterion A Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines output lines signal lines (coupling clamp)	4kV 2kV 2kV	Criterion A Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	+ → - +/- → PE	1kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	1kV 1kV	Criterion A Criterion A
Surge voltage on DC-OK	EN 61000-4-5	DC-OK signal → PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A

**Criteria:**

A: Power supply shows normal operation behavior within the defined limits.

<b>EMC emission (According generic standards: EN 61000-6-4, EN IEC 61000-6-4)</b>		
Conducted emission on input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR 32	Requirements for DC power ports according EN IEC 61000-6-4 Annex A and EN 61000-6-3 fulfilled
Conducted emission on output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Requirements for DC power ports according EN IEC 61000-6-4 Annex A fulfilled
Radiated emission	EN 55011, EN 55032	Class A
This device complies with FCC Part 15 rules.		
Operation is subjected to following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.		

<b>Switching frequencies</b>		
Switching frequency 1	105kHz	Resonant converter, nearly constant
Switching frequency 2	1kHz to 135kHz	Boost converter, load dependent
Switching frequency 3	40kHz to 210kHz	Input converter, input voltage and load dependent
The power supply has three converters with three different switching frequencies included. One is nearly constant. The others are variable.		

### 3.15 Environment

Environment		
Operating temperature <sup>*)</sup>	-25°C to +70°C	reduce output power according to Fig. below
Storage temperature	-40°C to +85°C	for storage and transportation
Output derating	24W/°C	60-70°C
Humidity <sup>**)</sup>	5 to 95% r.h.	according to IEC 60068-2-30
Altitude	0 to 2000m	without any restrictions
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 1g <sup>***)</sup> 2 hours / axis	according to IEC 60068-2-6
Shock	15g 6ms, 10g 11ms <sup>***)</sup> 3 bumps / direction, 18 bumps in total	according to IEC 60068-2-27
Degree of pollution	2	IEC 62103, EN 50178, not conductive

\*) Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.

\*\*) Do not energize while condensation is present.

\*\*\*) Higher levels allowed when using the wall mounting bracket

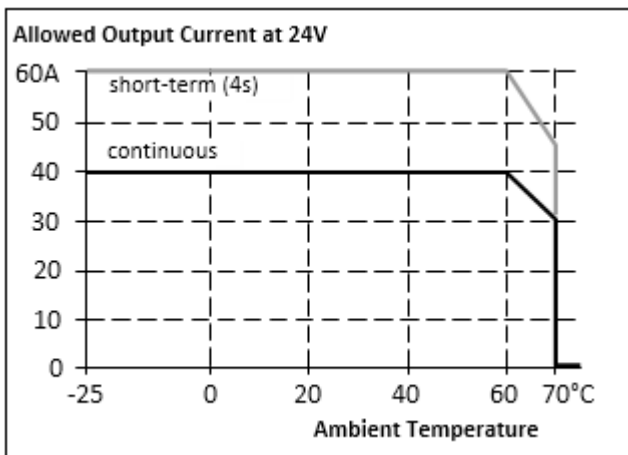


Fig. 16: Output current vs. ambient temp

### 3.16 Protection features

Output protection	Electronically protected against overload, no-load and short-circuits <sup>*)</sup>	
Output overvoltage protection	typ. 30Vdc max. 32Vdc	in case of an internal power supply defect, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Degree of protection	IP 20	EN/IEC 60529 Caution: For use in a controlled environment according to CSA 22.2 No 107.1-01.
Penetration protection	> 5mm	e.g., screws, small parts
Over-temperature protection	yes	Output shut-down with automatic restart
Input transient protection	MOV (Metal Oxide Varistor)	
Internal input fuse	Included	not user replaceable

<sup>\*)</sup> In case of a protection event, audible noise may occur.

### 3.17 Safety features

Input / output separation <sup>*)</sup>	SELV	IEC/EN 61010-2-201
	PELV	IEC/EN 61010-2-201
	double or reinforced insulation	
Class of protection	I	PE (Protective Earth) connection required
PE resistance	> 100MΩ	input to output, 500Vdc
	< 0.1Ω	

<sup>\*)</sup> double or reinforced insulation

### 3.18 Dielectric strength

The output voltage is floating and has no ohmic connection to the ground. Type and factory tests are conducted by the manufacturer.

Field tests may be conducted in the field using the appropriate test equipment which applies the voltage with a slow ramp (2s up and 2s down). Connect all phase terminals together as well as all output poles before conducting the test. When testing, set the cut-off current settings to the value in the table below.

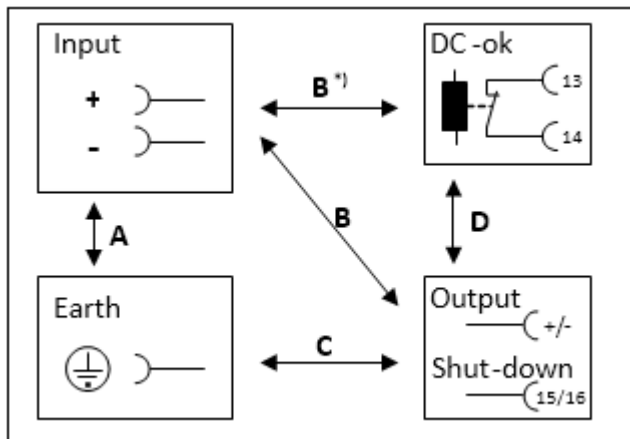


Fig. 17: Dielectric strength

B\*) When testing input to DC-OK ensure that the maximal voltage between DC-OK and the output is not exceeded (column D). We recommend connecting DC-OK pins and the output pins together when performing the test.

		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Routine test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 10mA	>10mA	>40mA	>1mA

To fulfil the PELV requirements according to EN 60204-1 § 6.4.1, we recommend that either the + pole, the – pole or any other part of the output circuit shall be connected to the protective earth system. This helps to avoid situations in which a load starts unexpectedly or cannot be switched off when unnoticed earth faults occur.

### 3.19 Declaration of conformity and approvals

	EU declaration of conformity
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### 3.20 Dimensions and weight

Dimensions and weight	
Width	110mm
Height	124mm
Depth	127mm The DIN rail height must be added to the unit depth to calculate the total required installation depth.
DIN rail	Use 35 mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Weight	1500g
Housing material	Body: Aluminum alloy Cover: Zinc-plated steel
Installation clearances	see chapter on <a href="#">Safety instructions and installation requirements</a> [► 8]

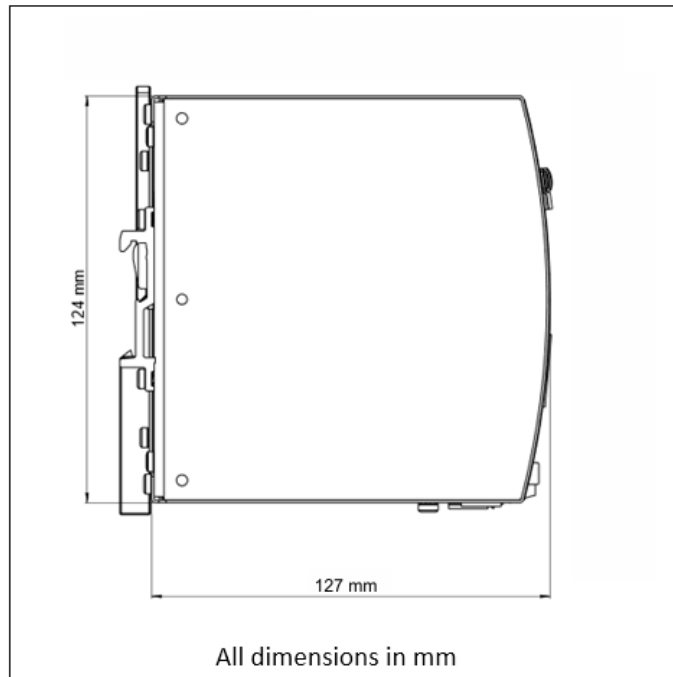
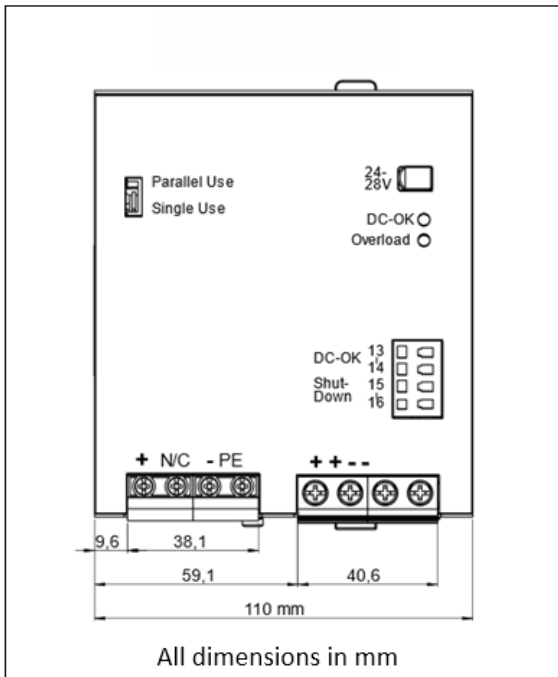


Fig. 18: Front/side view PS9771-2440-0000, all specifications in mm

## 4 Application notes

### 4.1 Repetitive pulse loading

Typically, a load current is not constant and varies over time. This power supply is designed to support loads with a higher short-term power demand (=BonusPower). The short-term duration is hardware controlled by an output power manager and is available on a repeated basis. If the BonusPower load lasts longer than the hardware controller allows it, the output voltage will dip and the next BonusPower is available after the BonusPower recovery time (see chapter “Output [▶ 131]”) has elapsed.

To avoid this, the following rules must be met:

- The power demand of the pulse must be below 150% of the nominal output power.
- The duration of the pulse power must be shorter than the allowed BonusPower time. (see output section)
- 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 period of time. Use the maximum duty cycle curve (Fig. “Max. duty cycle curve”) to check if the average output current is below the nominal current.
- The duty cycle must be below 0.5.:

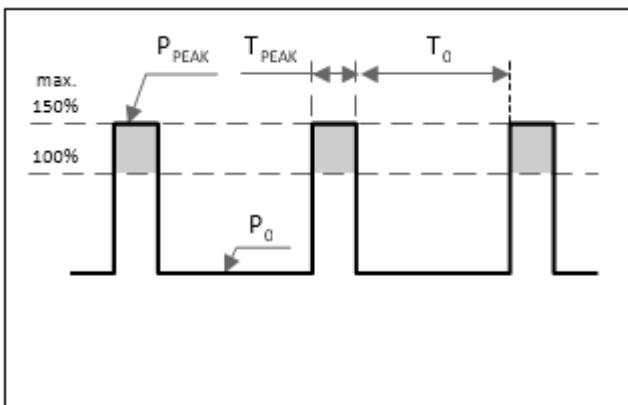


Fig. 19: Repetitive pulse loads, definitions

$P_0$  Base load (W)

$P_{PEAK}$  Pulse load (above 100%)

$T_0$  Duration between pulses (s)

$T_{PEAK}$  Pulse duration (s)

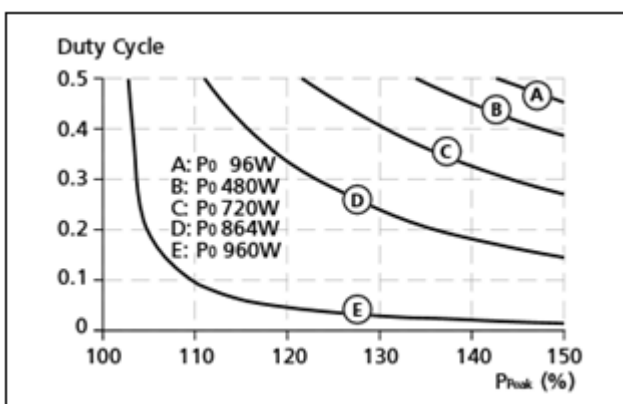


Fig. 20: Max. duty cycle curve

$$\text{DutyCycle} = T_{PEAK} / (T_{PEAK} + T_0)$$

$$T_0 = (T_{PEAK} - (\text{DutyCycle} \times T_{PEAK})) / \text{DutyCycle}$$

**Example:**

A load is powered continuously with 480W (= 50% of the rated output load). From time to time a peak power of 1440W (= 150% of the rated output load) is needed for 1 second.

The question is: How often can this pulse be supplied without overloading the power supply?

- Make a vertical line at  $P_{PEAK} = 150\%$  and a horizontal line where the vertical line crosses the  $P_0 = 50\%$  curve. Read the max. duty cycle from the duty cycle-axis (= 0.37)
- Calculate the required pause (base load) length  $T_0$ :

$$T_0 = (T_{PEAK} - (\text{DutyCycle} \times T_{PEAK})) / \text{DutyCycle}$$

$$T_0 = (1s - (0.37 \times 1s)) / 0.37 = 1.7s$$

- Result: The required pause length = 1.7s
- **Max. repetition rate = pulse +pause length = 2.7s**

**More examples for pulse load compatibility**

$P_{PEAK}$	$P_0$	$T_{PEAK}$	$T_0$
1440W	960W	1s	>25s
1440W	0W	1s	>1.3s
1200W	480W	1s	> 0.75s

$P_{PEAK}$	$P_0$	$T_{PEAK}$	$T_0$
1440W	480W	0.1s	>0.16s
1440W	480W	1s	>1.6s
1440W	480W	3s	>4.9s



## 4.2 Peak current capability

The power supply can deliver peak currents (up to several milliseconds) which are higher than the specified short-term currents.

This helps to start current demanding loads. 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 Extra Power). The same situation applies when starting a capacitive load.

The peak current capability also ensures the safe operation of subsequent circuit breakers of load circuits. The load branches are often individually protected with circuit breakers or fuses. In case of a short or an overload in one branch circuit, the fuse or circuit breaker need a certain amount of over-current to open in a timely manner. This avoids voltage loss in adjacent circuits.

The extra current (peak current) is supplied by the power converter and the built-in large sized output capacitors of the power supply. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following two examples show typical voltage dips:

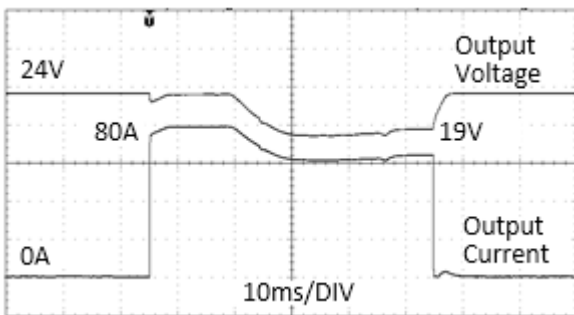


Fig. 21: 80A Peak load (resistive) for 50ms, Output voltage dips from 24V to 19V

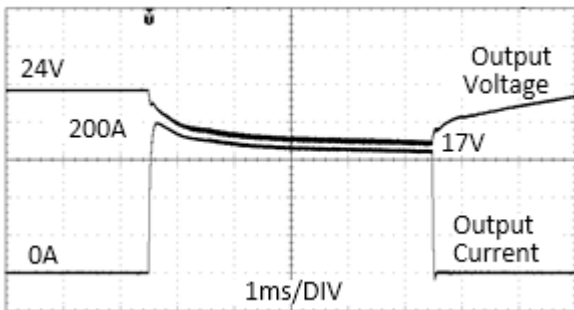


Fig. 22: 200A Peak load (resistive) for 5ms, Output voltage dips from 24V to 17V

Peak current voltage dips	
Typ. from 24V to 19V	at 80A for 50ms, resistive load
Typ. from 24V to 18V	at 200A for 2ms, resistive load
Typ. from 24V to 17V	at 200A for 5ms, resistive load

## 4.3 External input protection

Option 1: For using the device powered by a B6 rectification the unit is tested and approved for branch circuits up to 25A. Do not use fuses smaller than 4A to avoid a nuisance tripping of the circuit breaker.

Option 2: For all other DC sources the device is tested and approved with max. 10A fuses in the plus and minus path. It is possible to use two devices on 10A fuses or one single device on 6A fuses. Do not use fuses smaller than 6A to avoid a nuisance tripping of the fuse. Use following fuse types with option 2: Littelfuse type 0SPF010 or equivalent UL listed fuse, SIBA type URZ 5020434.

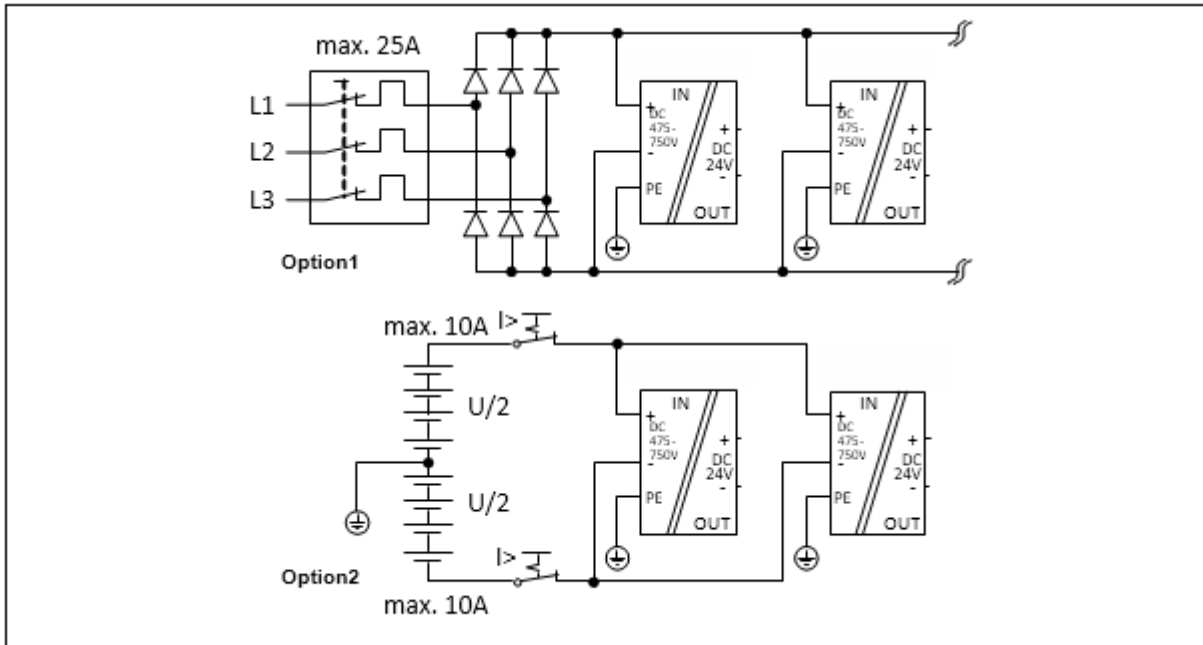


Fig. 23: Wiring scheme

## 4.4 Charging batteries

The power supply can be used to charge lead-acid or maintenance free batteries. (Two 12V batteries in series)

### Instructions for charging batteries:

- Set the output voltage (measured at no load and at the end of the battery cable) very precisely to the end-of-charge voltage.

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

- Use a 50A or 63A circuit breaker (or blocking diode) between the power supply and the battery.
- Ensure that the output current of the power supply is below the allowed charging current of the battery.
- Use only matched batteries when putting 12V types in series.
- The return current to the power supply (battery discharge current) is typ. 18mA when the power supply is switched off (except in case a blocking diode is utilized).

## 4.5 Output circuit breakers

Standard miniature circuit breakers (MCB's or UL1077 circuit breakers) are commonly used for AC-supply systems and may also be used on DC branches.

MCB's are designed to protect wires and circuits. If the ampere value and the characteristics of the MCB are adapted to the wire size that is used, the wiring is considered as thermally safe regardless of whether the MCB opens or not.

To avoid voltage dips and under-voltage situations in adjacent 24V branches which are supplied by the same source, a fast (magnetic) tripping of the MCB is desired. A quick shutdown within 10ms is necessary corresponding roughly to the ride-through time of PLC's. This requires power supplies with high current reserves and large output capacitors. Furthermore, the impedance of the faulty branch must be sufficiently small in order for the current to actually flow. The best current reserve in the power supply does not help if Ohm's law does not permit current flow. The following table has typical test results showing which B- and C-Characteristic MCBs magnetically trip depending on the wire cross section and wire length.

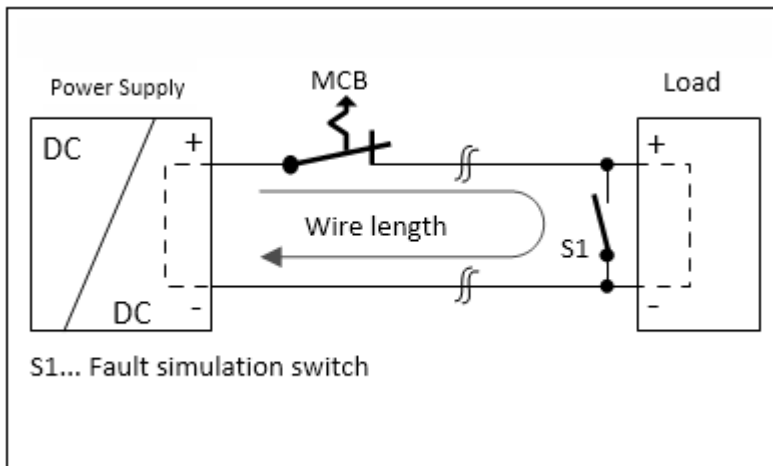


Fig. 24: Test circuit

Maximal wire length\*) for a fast (magnetic) tripping:

	0.75mm <sup>2</sup>	1.0mm <sup>2</sup>	1.5mm <sup>2</sup>	2.5mm <sup>2</sup>
<b>C-2A</b>	31 m	42 m	62 m	92 m
<b>C-3A</b>	28 m	36 m	51 m	77 m
<b>C-4A</b>	18 m	23 m	36 m	55 m
<b>C-6A</b>	11 m	14 m	21 m	33 m
<b>C-8A</b>	8 m	12 m	18 m	27 m
<b>C-10A</b>	7 m	10 m	15 m	22 m
<b>C-13A</b>	4 m	6 m	8 m	13 m
<b>C-16A</b>	2 m	3 m	4 m	7 m
<b>C-20A</b>	1 m	2 m	3 m	5 m

	0.75mm <sup>2</sup>	1.0mm <sup>2</sup>	1.5mm <sup>2</sup>	2.5mm <sup>2</sup>
<b>B-6A</b>	23 m	29 m	40 m	64 m
<b>B-10A</b>	13 m	16 m	24 m	38 m
<b>B-13A</b>	11 m	13 m	20 m	32 m
<b>B-16A</b>	8 m	12 m	18 m	26 m
<b>B-20A</b>	4 m	6 m	9 m	15 m
<b>B-25A</b>	3 m	4 m	7 m	9 m
<b>B-32A</b>	3 m	4 m	5 m	7 m

\*) Don't forget to consider twice the distance to the load (or cable length) when calculating the total wire length (+ and - wire).

## 4.6 Parallel use to increase output power

Devices of the same type can be paralleled to increase the output power. The output voltage shall be adjusted to the same value ( $\pm 100\text{mV}$ ) in "Single use" mode with the same load conditions on all units, or the units can be left with the factory settings. After the adjustments, the jumper on the front of the unit shall be moved from "Single use" to "Parallel use", in order to achieve load sharing. The "Parallel use" mode regulates the output voltage in such a manner that the voltage at no load is approx. 4% higher than at nominal load. See also chapter "Output [► 13]". If no jumper is plugged in, the unit is in "Single use" mode. Factory setting is also "Single use" mode.

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 50A or 63A is required on each output. Alternatively, a diode or redundancy module can also be utilized.

Keep an installation clearance of 15mm (left / right) between two power supplies and avoid installing the power supplies on top of each other. Do not use power supplies in parallel in mounting orientations other than the standard mounting orientation (terminals on the bottom of the unit) or in any other condition where a derating of the output current is required (e.g. altitude, above 60°C, ...).

Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

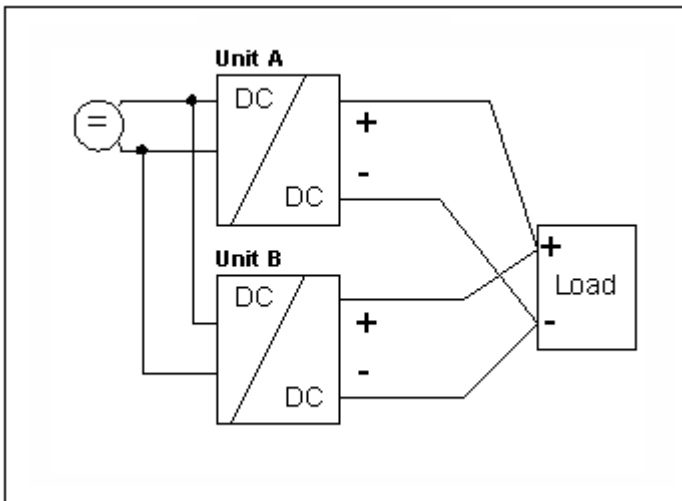


Fig. 25: Parallel connection

## 4.7 Parallel use for redundancy

Devices of the same type can be paralleled for redundancy to gain 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 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.

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 case, the defective unit becomes a load for the other power supplies and the output voltage cannot be maintained any more. This can be avoided by utilizing redundancy modules, which have decoupling devices (diodes or MOSFETs) included.

Recommendations for building redundant power systems:

- Use separate input fuses for each power supply. A separate source for each supply when possible, increases the reliability of the redundant system.
- Set the power supply into “Parallel Use” mode.
- Monitor the individual power supply units. Therefore, use the DC-OK relay contact of the power supply.
- It is desirable to set the output voltages of all units to the same value ( $\pm 100\text{mV}$ ) or leave it at the factory setting.

### Wiring example

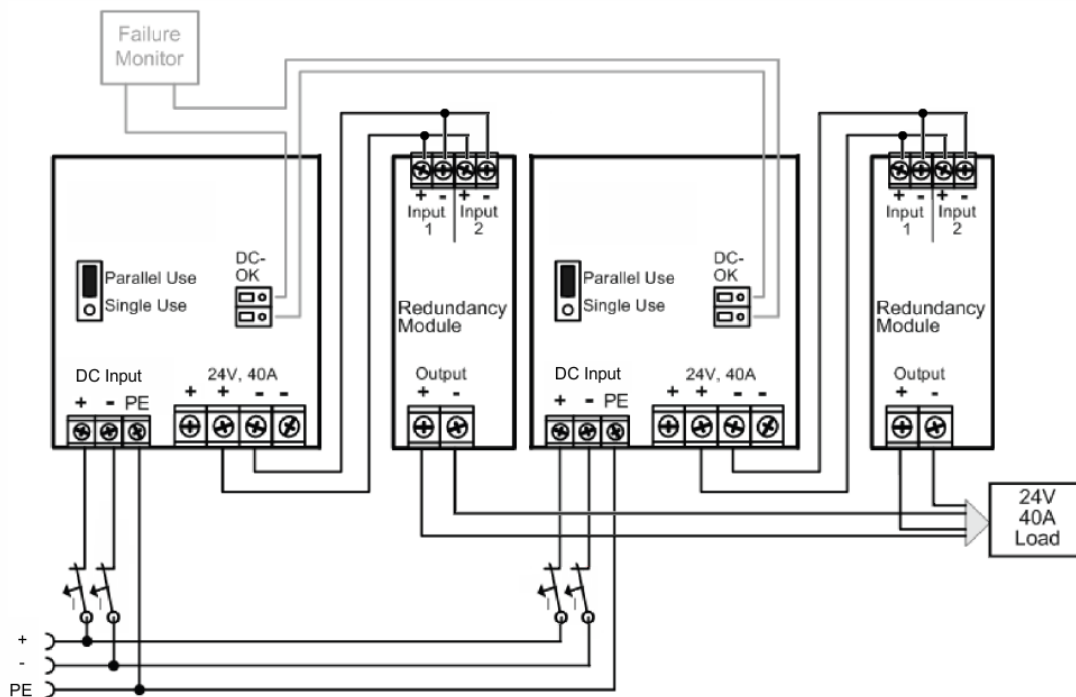


Fig. 26: Wiring example

## 4.8 Series operation

Power supplies of the same type can be connected in series for higher output voltages. 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 anymore and can be dangerous. Such voltages must be installed with a protection against touching.

Earthing of the output is required when the sum of the output voltage is above 60Vdc.

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

Keep an installation clearance of 15mm (left / right) between two power supplies and avoid installing the power supplies on top of each other. Do not use power supplies in series in mounting orientations other than the standard mounting orientation (terminals on the bottom of the unit).

Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

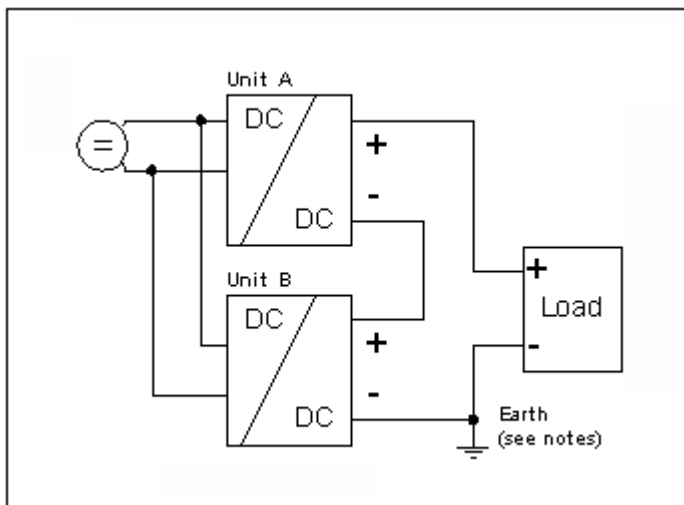


Fig. 27: Series operation

## 4.9 Inductive and capacitive loads

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

## 4.10 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 35Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter "[Output](#) | 131".

## 4.11 Mounting orientations

Mounting orientations other than all terminals on the bottom require a reduction in continuous output power or a limitation in the maximum 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 in approximately half the lifetime expectancy of A1).

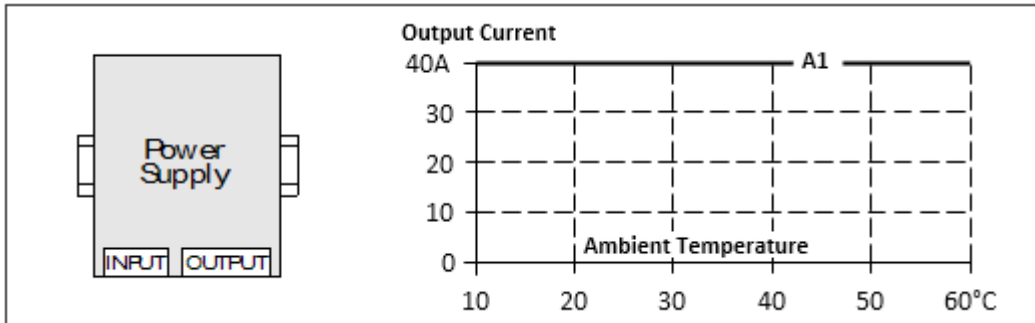


Fig. 28: Mounting position A (standard mounting position)

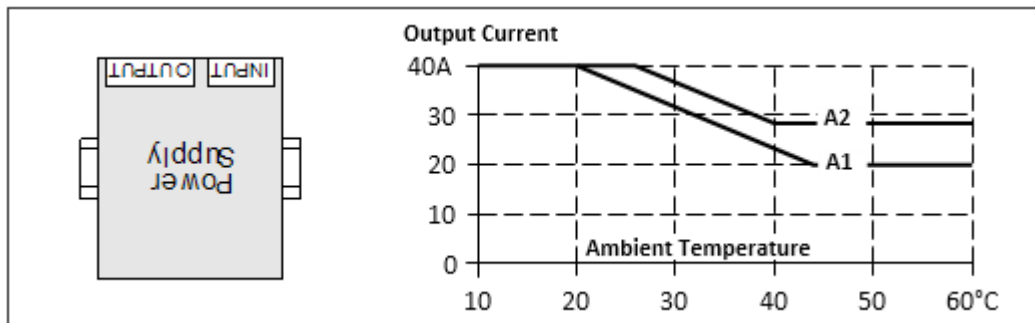


Fig. 29: Mounting position B (upside down)

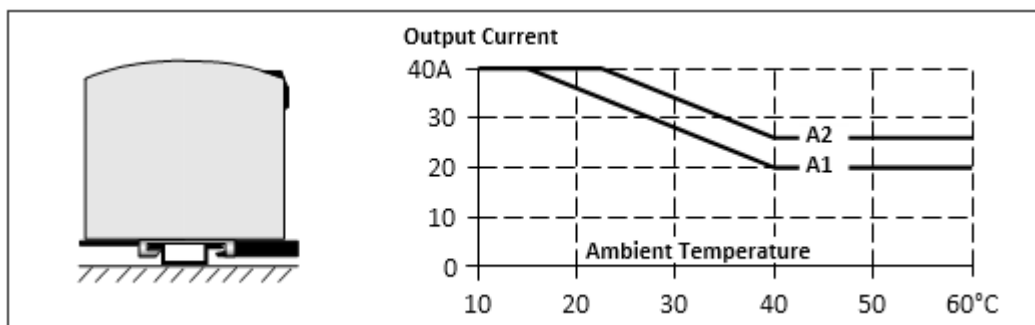


Fig. 30: Mounting position C (table-top mounting)

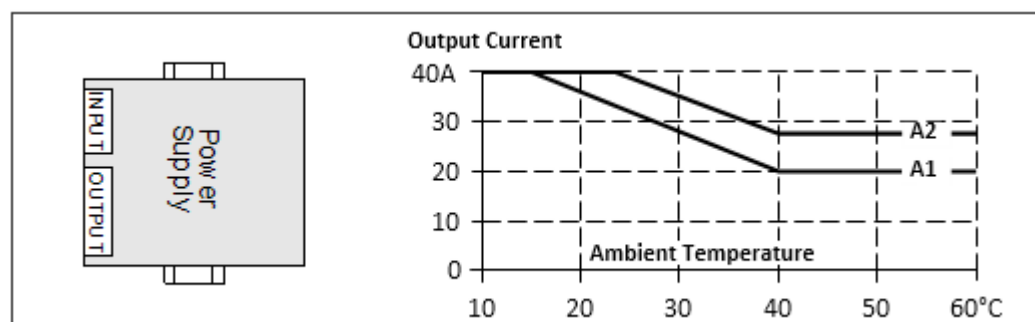


Fig. 31: Mounting position D (horizontal clockwise)



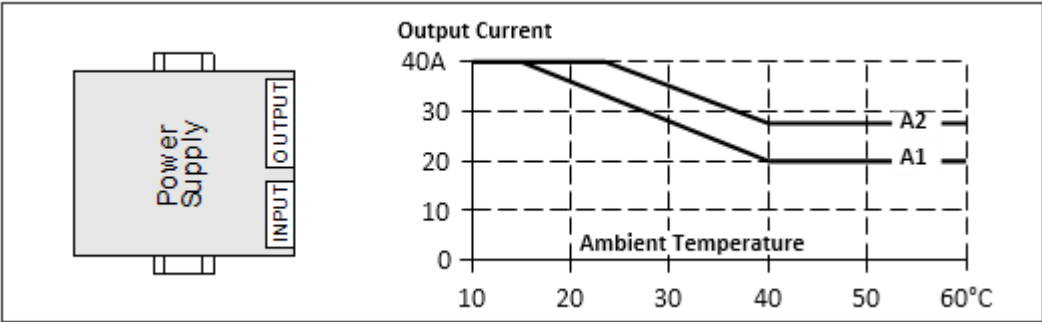


Fig. 32: Mounting position E (horizontal counterclockwise)

## 5 Disposal



Products marked with a crossed-out wheeled bin shall not be discarded with the normal waste stream. The device is considered as waste electrical and electronic equipment. The national regulations for the disposal of waste electrical and electronic equipment must be observed.

## 6 Appendix

### 6.1 Accessories

#### 6.1.1 Redundancy and Buffer Modules

Power supply	Accessories	
	Redundancy module	Buffer module
PS9771-2440-0000	PS9401-2440-0000	PS9011-2440-0000

##### PS9401-2440-0000 - Redundancy Module



The PS9401-2440-0000 is a redundancy module that can be used for the construction of 1+1 and N+1 redundancy systems.

It has two input channels, to which power supplies with output currents of up to 20 A can be connected, and one output that can carry nominal currents of up to 40 A.

The redundancy module uses MOSFET technology instead of diodes for decoupling the two input channels. This reduces the heat development and the voltage drop between input and output. Due to the low power loss, the device is very narrow and requires a width of just 36 mm on the DIN rail. Large connection terminals enable secure and fast installation. The redundancy module requires no additional auxiliary voltage.

Due to the international approvals package, the device is suitable for virtually every application.

Observe the connection instructions in the chapter "[Parallel use for redundancy \[► 38\]](#)"!

##### PS9011-2440-0000 – Buffer Module



The PS9011-2440-0000 buffer module is an additional device for 24 V DC power supply units. It supplies power to bridge typical mains power failures or extends the hold-up time after switching off the AC voltage.

If the power supply unit supplies sufficient voltage, the buffer module stores energy in the integrated electrolytic capacitors. In the event of a failure of the mains voltage, the stored energy is supplied to the DC bus in a controlled process.

The buffer module can be connected at any point in parallel with the load circuit and does not require any control wiring.

A buffer module can provide 40 A of additional power and can be added in parallel to increase the output current or hold-up time.

## 6.1.2 Accessories for mounting

DC/DC Converter	Accessories	
	Wall mounting	Side mounting
PS9771-2440-0000	ZS5301-0002	-

### ZS5301-0002 – Bracket for wall mounting

This bracket is used to mount the devices on a wall or control panel without using a DIN rail.

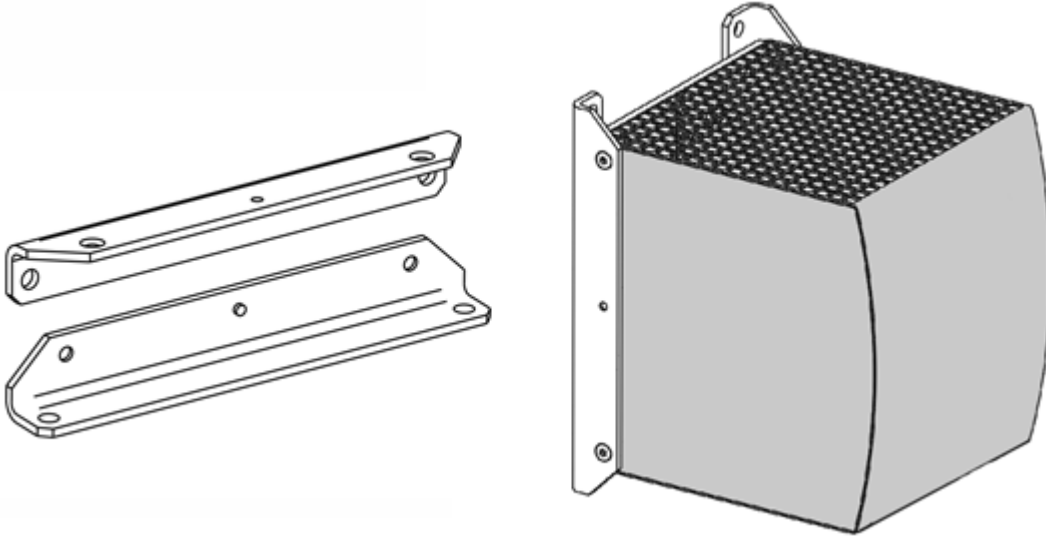


Fig. 33: ZS5301-0002 for wall mounting

## 6.2 Documentation issue status

Version	Comment
1.0	- 1 <sup>st</sup> public issue
0.1 – 0.5	- Preliminary documentation for PS9771-2440-0000

## 6.3 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

### Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

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