

Documentation | EN

PS9731-2410-0000

DC/DC Converter 48 V / 24 V, 10 A, 240 W

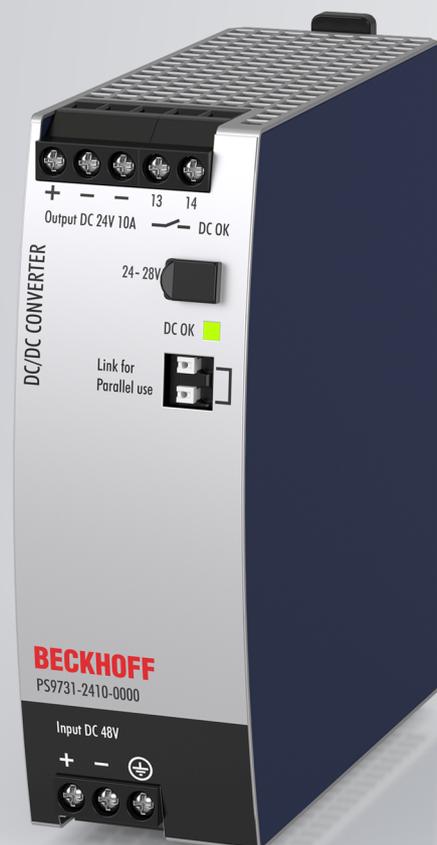


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1 Overview

PS9731-2410-0000 | DC/DC converter 48 V / 24 V, 10 A, 240 W



- 48 V DC input
- Isolated 24 Vdc output
- Efficiency 94 %
- DC-OK relay contact
- Width only 42 mm
- 20 % output reserves
- Full output between -25 °C and +60 °C
- Soft-start Function
- Minimum inrush current surge
- Current-sharing function for parallel use
- Reverse Input Polarity Protection

The PS9731-2410-0000 is a DIN rail mountable DC/DC converter with an input voltage of 36 to 60 V DC which provides a floating, stabilized and galvanically separated SELV/PELV output voltage of 24 V DC with 10 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

The most outstanding features of PS9731-2410-0000 are the high efficiency, the small size, the extra Power reserves, and the wide operating temperature range.

The device has a power reserve of 20% included, which may even be used continuously at temperatures up to +45 °C.

Overview of technical data ^{*)}

Overview of technical data	PS9731-2410-0000
Output voltage	DC 24 V (nominal)
Adjustment range	24 - 28 V (factory setting 24.1 V)
Output current	12.0-10.3 A (ambient temperature below +45 °C) 10.0-8.6 A (ambient temperature at +60 °C) 7.5-6.5 A (ambient temperature at +70 °C) Load reduction between +45 °C and +70 °C
Input voltage	48 V DC (+/- 25 %)
Input current	5.4 A
Inrush current	9 A _{peak} at 40 °C, cold start
Efficiency	94 %
Losses	15.4 W
Hold-up time	7 ms
Temperature range	-25 °C...+70 °C
Size (W x H x D)	42 x 124 x 117 mm (without DIN rail)
Weight	520 g
Approvals/markings	CE, cULus

^{*)} All values are typical at 48 Vdc input voltage, 10 A output current, 25 °C ambient temperature, and after a run-in time of 5 minutes, unless otherwise specified.

2 Foreword

2.1 Notes on the documentation

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.

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.

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2.2 Safety instructions

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.

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.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER

Hazard with high risk of death or serious injury.

⚠ WARNING

Hazard with medium risk of death or serious injury.

⚠ CAUTION

There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE

The environment, equipment, or data may be damaged.

Information on handling the product



This information includes, for example:
recommendations for action, assistance or further information on the product.

2.3 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.

2.4 Safety instructions and installation requirements for PS9731-2410-0000

Safety instructions and installation requirements for PS9731-2410-0000 power supply

⚠ 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 the components during and immediately after operation. Hot surfaces may cause burns.

i Further notes on installation requirements

- This device may only be installed and put into operation by qualified personnel.
- 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. Other mounting orientations require a reduction in output current.
- Ensure that the wiring is correct by following all local and national regulations.
 - ⇒ 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 input can also be supplied by batteries or similar DC sources.
 - ⇒ The voltage between the input terminals and ground must not exceed 60 Vdc continuously.
 - ⇒ The input must be powered from a PELV or SELV source or an "Isolated Secondary Circuit" in order to maintain a SELV or PELV output.
- 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 as "Protection Class I" equipment according to IEC 61140. Do not use without a proper PE (Protective Earth) connection.
- The device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid!
- Observe the following minimum installation distances:
 - ⇒ 40 mm at the top, 20 mm at the bottom and 5 mm on the left and right sides.
 - ⇒ Increase the 5 mm to 15 mm in case the adjacent device is a heat source.
 - ⇒ When the device is permanently loaded with less than 50 %, the 5 mm can be reduced to zero.
- The device is designed, tested and approved for branch circuits up to 50 A without additional protective device.
If an external protection is used, a circuit breaker with a minimum value of 16 A with B or C characteristic should be used to avoid false tripping of the circuit breaker.
- The maximum surrounding air temperature is +70 °C. The operating temperature is the same as the ambient or surrounding air temperature and is defined 2 cm below the device.

i Further notes on operation

- This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect.
- The device is designed for areas with a pollution degree 2 in controlled environments. No condensation or frost is allowed.
- The device housing has an IP20 protection rating. The housing does not provide protection against spilled liquids. The isolation of the devices is designed to withstand impulse voltages up to 1.5 kV according to IEC 60664-1.
- The device is designed to operate in areas between 5 % and 95 % relative humidity.
- The device is designed for altitudes up to 5000 m. Above 2000 m a reduction in output current is required.

2.5 Terminology and abbreviations

PE and the earthing symbol 	PE is the abbreviation for "protective earth" and has the same meaning as the earthing symbol 
Earth, ground	This document uses the term "earth" which is the same as the U.S. term "ground".
t.b.d.	Still to be defined, value or description will follow in due course.
DC 48 V	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).
48 Vdc	A value followed by the unit Vac or Vdc is an instantaneous value that does not contain any additional tolerances.
may	A keyword indicating a choice without implied preference.
shall	A keyword indicating a mandatory requirement.
should	A keyword indicating a choice with a clearly preferred method of implementation.

3 Technical data, mounting, wiring

3.1 DC input

The input can be powered from batteries or similar DC sources and must be a PELV or SELV source or an "Isolated Secondary Circuit" in order to maintain a SELV or PELV output.

DC input			
DC input	Nom.	DC 48 V	+/- 25 %
DC input range		36-60 Vdc	
Allowed voltage between input and ground	Max.	60 Vdc or 42.2 Vac	according to IEC 62477-1
Allowed input ripple voltage	Max.	10 Vpp	In the frequency range from 47 to 500 Hz, the momentary input voltage must always be within the specified limits.
Turn-on voltage	Typ.	35 Vdc	Steady-state value, see Fig. "Input voltage range"
Shut-down voltage	Typ.	32 Vdc	Steady-state value, see Fig. "Input voltage range"
Input current	Typ.	5.4 A	For 48 Vdc input and 24 V, 10 A output load, see fig. "Input current vs. Output load"
		7.5 A	For 36 Vdc input and 24 V, 10 A output load, see fig. "Input current vs. Output load"
Inrush delay	Typ.	200 ms	See Fig. "Input voltage range"
Rise time	Typ.	150 ms	At 24 V, 10 A constant current load, 0 mF load capacitance, see Fig. "Turn-on behavior, definitions"
		250 ms	At 24 V, 10 A constant current load, 5 mF load capacitance, see Fig. "Turn-on behavior, definitions"
Turn-on overshoot	Max.	500 mV	See Fig. "Turn-on behavior, definitions"
Input capacitance	Typ.	1,650 μ F	Installed inside the device, external capacitors on the input are allowed without any limitations.
Ext. input protection	See recommendations in chapter "Further notes on installation requirements [► 10]"		

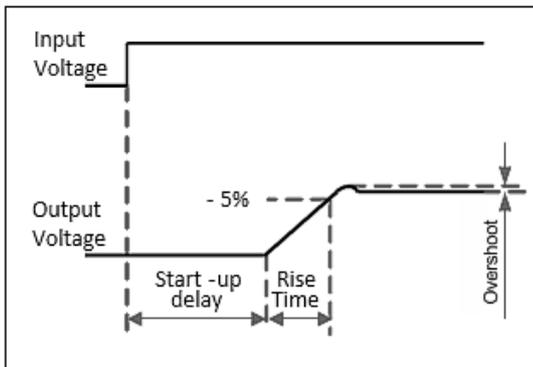


Fig. 1: Input voltage range, Turn-on behavior, definitions

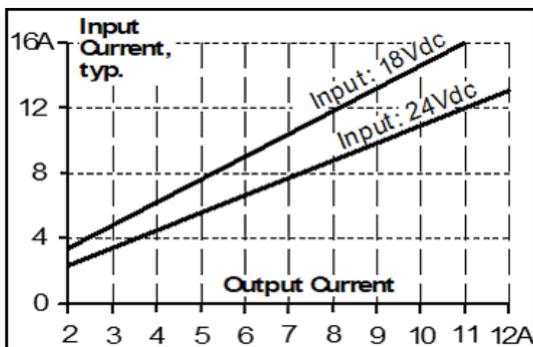


Fig. 2: Input current vs. output load

Requirements for the Supplying Source

In certain circumstances, the input filter of the DC/DC converter can show a resonant effect which is caused by the supplying network. Especially when additional external input filters are utilized, a superimposed AC voltage can be generated on the input terminals of the DC/DC converter which might cause a malfunction of the unit. Therefore, additional input filters are not recommended. To avoid the resonant effects, the minimal resistance of the supplying network which depends on the inductance of the input network, shall be above the boundary curve in Fig. "External input filter requirements to avoid filter instabilities".

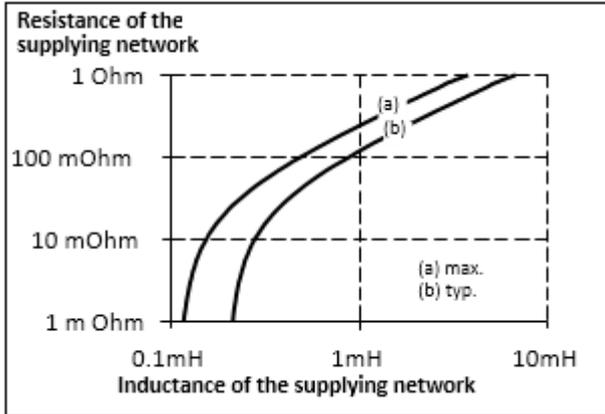


Fig. 3: External input filter requirements to avoid filter instabilities

3.2 Input inrush current

An active inrush limitation circuit (inrush limiting NTC resistor which is bypassed by a MOSFET) limits the input inrush current after turn-on of the input voltage.

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

Input inrush current	max.	9 A _{peak}	At 40°C, cold start
	typ.	8 A _{peak}	At 40°C, cold start
	typ.	7 A _{peak}	At 25°C, cold start
Inrush energy	max.	1 A ² s	At 40°C, cold start

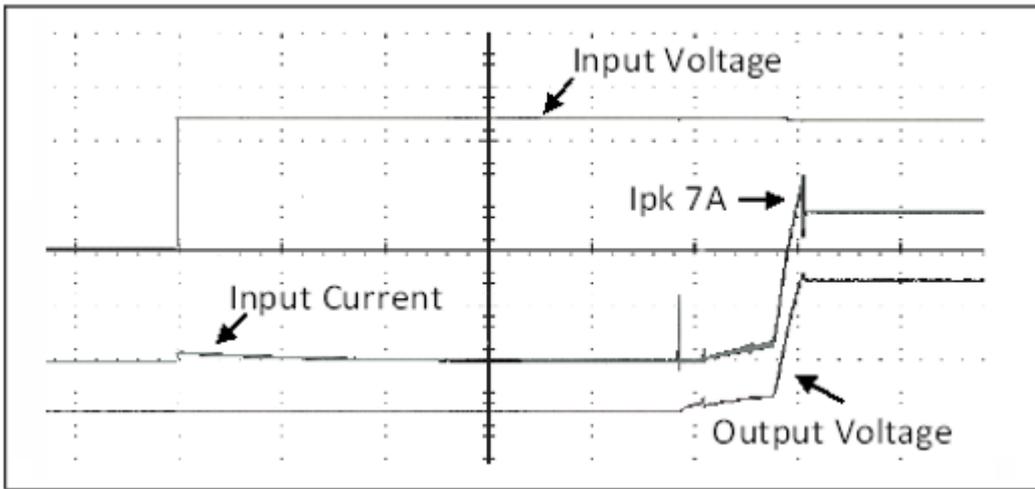


Fig. 4: Typical input inrush current behavior at nominal load and 25°C ambient

- Input: 48 Vdc
- Output: 24 V, 10 A, constant current load
- Ambient: 25°C
- Input current: 2 A / DIV
- Input voltage: 20 V / DIV
- Output voltage: 10 V / DIV
- Time basis: 200 ms / DIV

3.3 Soft-Start feature

After the DC/DC converter is turned on, the internal output current rises slowly to its nominal value. This method charges the output capacitors (internal and external capacitors) slowly and avoids high input currents during turn-on.

High input currents can generate a high voltage drop on the input wiring (especially with long and thin cables), which reduces the terminal voltage on the DC/DC converter.

If the terminal voltage is below the shut-down voltage, the DC/DC converter switches off and makes a new start attempt. This effect is avoided with the integrated soft-start function.

Notice Please note, that this function increases the rise time of the output voltage by a small amount.

3.4 Output

The output provides a SELV/PELV rated voltage, which is galvanically isolated from the input voltage and is designed to supply any kind of loads, including unlimited capacitive and inductive loads.

The output is electronically protected against overload, no-load and short-circuits. In case of a protection event, audible noise may occur.

Output voltage	Nom.	24 V	
Adjustment range		24-28 V	
	Max.	30 V	This is the maximum output voltage which can occur at the clockwise end position of the potentiometer due to tolerances. It is not a guaranteed value which can be achieved.
Factory setting		24.1 V	±0.2%, at full load, cold unit
Line regulation	Max.	25 mV	Between 36 and 60 Vdc input voltage variation
Load regulation	max.	100 mV	In "single use" mode: static value, 0 A to 10 A, see Fig. "Current limitation vs. input voltage"
	typ.	1000 mV	In "parallel use" mode: static value, 0 A to 10 A, see Fig. "Current limitation vs. input voltage"
Ripple and noise voltage	Max.	100 mVpp	Bandwidth 20 Hz to 20 MHz, 50 Ohm
Output current	Nom.	12 A	At 24 V and an ambient temperature below 45°C
	Nom.	10 A	At 24 V and 60°C ambient temperature
	Nom.	7.5 A	At 24 V and 70°C ambient temperature
	Nom.	10.3 A ¹⁾	At 28 V and an ambient temperature below 45°C
	Nom.	8.6 A	At 28 V and 60°C ambient temperature
	Nom.	6.5 A	At 28 V and 70°C ambient temperature
Overload behavior		Continuous current	
Overload/ short-circuit current	Min.	16 A	Continuous current, Load impedance typ. 100 mOhm
Output capacity	Typ.	4,500µF	Included in the power supply
Back-feeding loads	Max.	35 V	The unit 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 absorbing energy can be calculated according to the built-in large sized output capacitor.

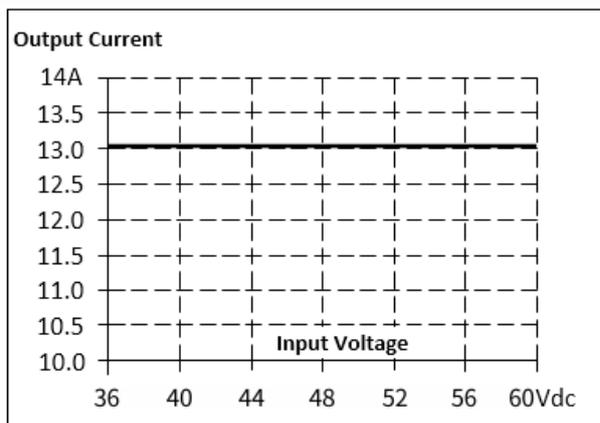
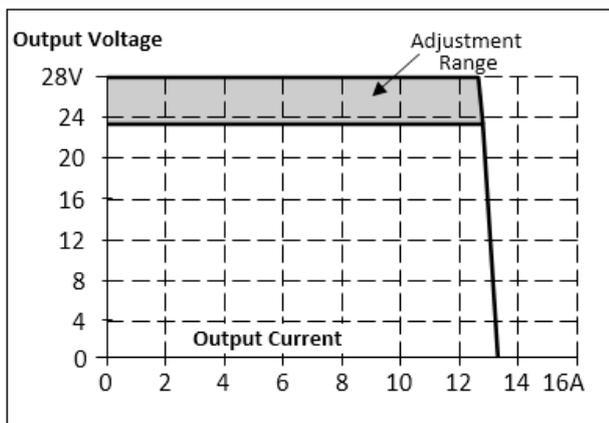


Fig. 5: Output voltage vs. output current at 48Vdc input voltage, typ., Current limitation vs. input voltage, (23V constant voltage load), typ.

3.5 Hold-up time

The input side of the DC/DC converter is equipped with a bulk capacitor which keeps the output voltage alive for a certain period of time when the input voltage dips or is removed. The bulk capacitor can be discharged by loading the DC/DC converter on the output side or through a load which is parallel to the input. There is no protection in the DC/DC converter which prevents current from flowing back to the input terminals. If prevention is needed, an external diode should be used.

At no load, the hold-up time can be up to several seconds. The green DC-OK LED is also on during this time.

Hold-up time	typ.	14 ms	At 48 Vdc input voltage, 24 V, 5 A output, see Fig. Hold-up time vs. input voltage
	min.	11 ms	At 48 Vdc input voltage, 24 V, 5 A output, see Fig. Hold-up time vs. input voltage
	typ.	7 ms	At 48 Vdc input voltage, 24 V, 10 A output, see Fig. Hold-up time vs. input voltage
	min.	5 ms	At 48 Vdc input voltage, 24 V, 10 A output, see Fig. Hold-up time vs. input voltage

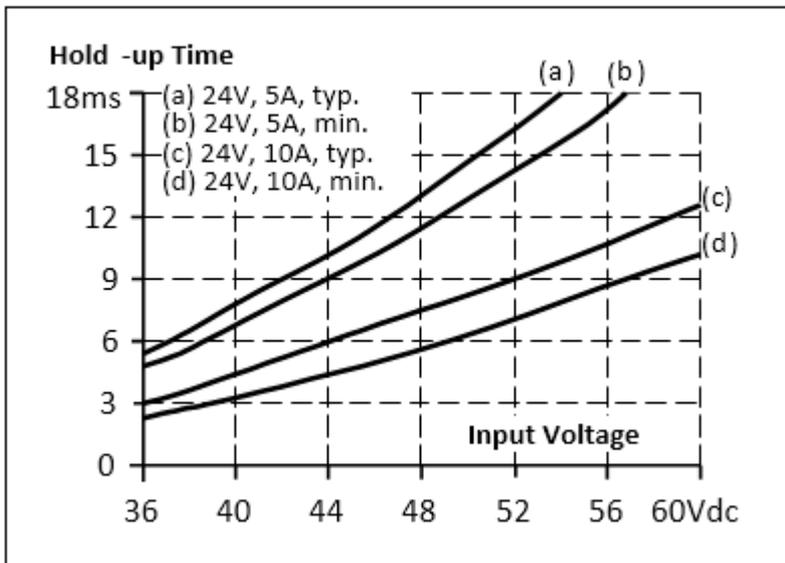


Fig. 6: Hold-up time vs. input voltage

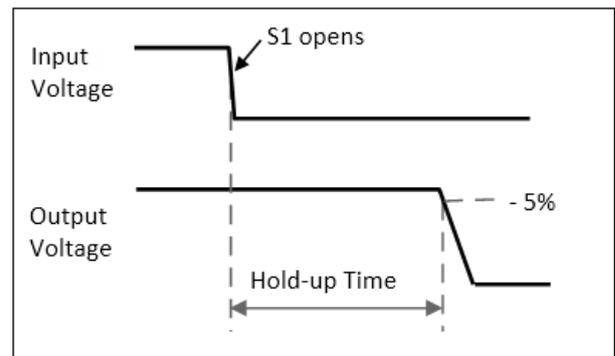
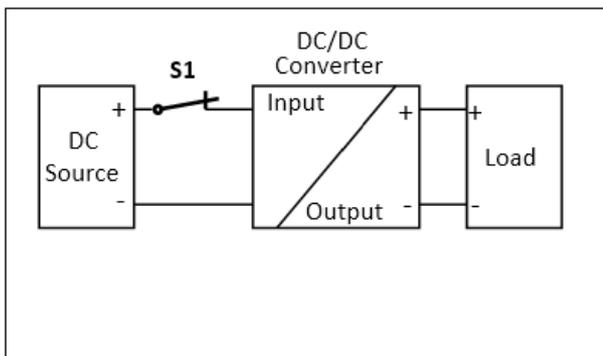


Fig. 7: Shut-down test setup; Shut-down behavior, definitions

3.6 DC-OK relay contact

This feature monitors the output voltage on the output terminals.

Threshold voltage	typ. 21 V (fixed)
Contact closes	As soon as the output voltage reaches 21 V.
Contact opens	As soon as the output voltage falls below 21 V.
Contact ratings	Maximal 60 Vdc 0.3 A, 30 Vdc 1 A, 30 Vac 0.5 A, resistive load Minimal permissible load 1 mA at 5 Vdc
Isolation voltage	See the dielectric strength table in the chapter "Dielectric strength [p. 27]"

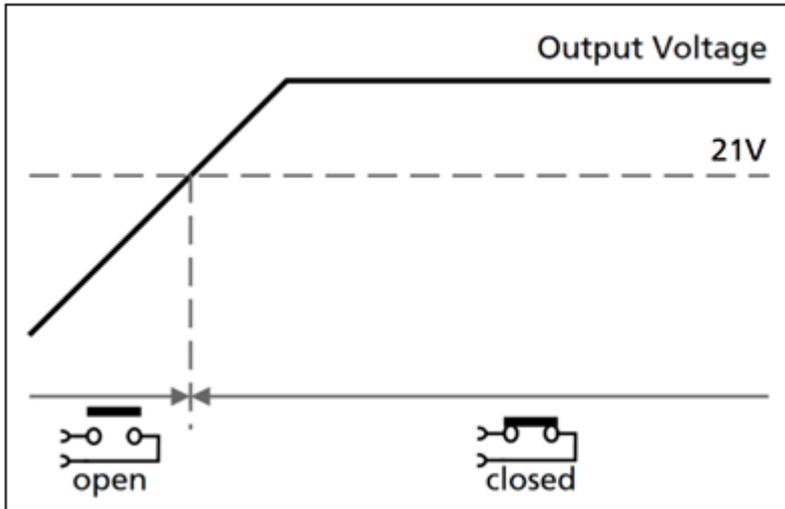


Fig. 8: Behavior of the DC-OK relay contact

3.7 Efficiency and losses

		Input 48Vdc	
Efficiency	typ.	94.0%	At 24 V, 10 A
	typ..	93.5%	At 24 V, 12 A (Extra Power)
Average efficiency ¹⁾	typ..	93.8%	At 25% at 2.5 A, 25% at 5 A, 25% at 7.5 A. 25% at 10 A
Losses	typ.	1.4 W	At no output load
	typ.	7.5 W	At 24 V, 5 A
	typ..	15.4 W	At 24 V, 10 A
	typ.	20 W	At 24 V, 12 A

¹⁾ 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.

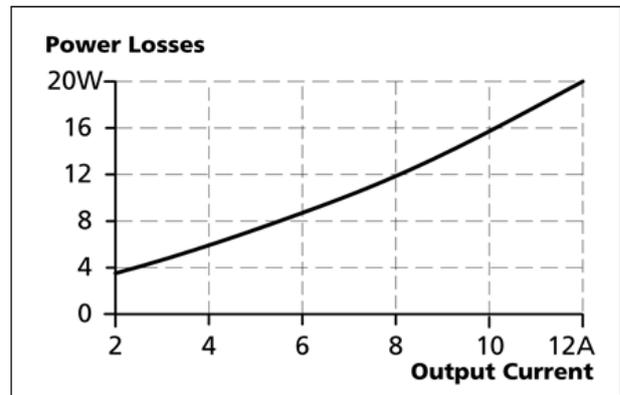
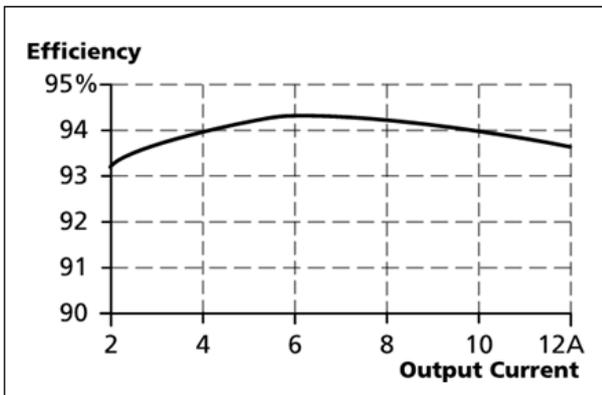


Fig. 9: Efficiency vs. output current at 24 V, typ; Losses vs. output current at 24 V, typ.

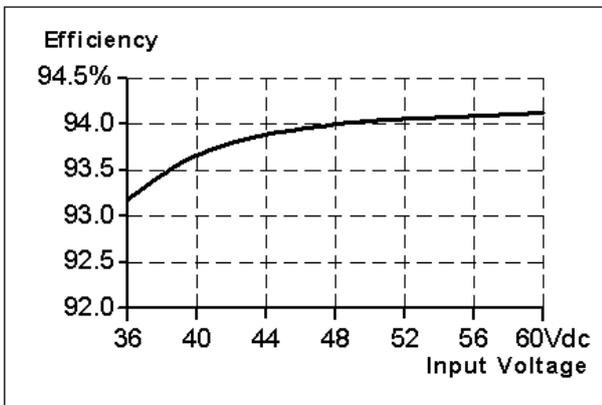


Fig. 10: Efficiency vs. input voltage at 24 V, 10 A, typ.; Losses vs. input voltage at 24 V, 10 A, typ.

3.8 Lifetime expectancy

The lifetime expectancy shown in the table indicates the minimum number of operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. The lifetime expectancy is stated in operating hours and is calculated according to the specifications of the capacitor manufacturer. The manufacturer of the electrolytic capacitors only guarantees a maximum life of up to 15 years (131,400 h).

Any number exceeding this value represents a calculated theoretical lifetime which can be used to compare devices.

	Input 48Vdc	
Lifetime expectancy	275,000 h	At 24 V, 5 A and 40°C
	117,000 h	At 24 V, 10 A and 40°C
	70,000 h	At 24 V, 12 A and 40°C
	788,000 h	At 24 V, 5 A and 25°C
	327,000 h	At 24 V, 10 A and 25°C
	197,000 h	At 24 V, 12 A and 25°C

3.9 MTBF

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. 1,000,000 h 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 50,000 h or only for 100 h.

For these types of units, the MTTF (**Mean Time To Failure**) value is the same value as the MTBF value.

	Input 48Vdc	
MTBF SN 29500, IEC 61709	765,000 h	At 24 V, 10 A and 40°C
	1,363,000 h	At 24 V, 10 A and 25°C
MTBF MIL HDBK 217F	358,000 h	At 10 A and 40°C; Ground Benign GB40
	403,000 h	At 10 A and 25°C; Ground Benign GB25
	66,000 h	At 10 A and 40°C; Ground Fixed GF40
	90,000 h	At 10 A and 25°C; Ground Fixed GF25

3.10 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
Connection cross-section	e*: max. 6 mm ² f*: max. 4 mm ² a*: max 4 mm ² (d<2.8 mm)	e*: max. 6 mm ² f*: max. 4 mm ² a*: max 4 mm ² (d<2.8 mm)	e*: max. 1.5 mm ² f*: max. 1.5 mm ² a*: max 1.5 mm ² (d<1.6 mm)
Connection cross section (AWG)	e*: AWG 20-10 f*: AWG 20-10 a* AWG 20-10 (d<2.8 mm)	e*: AWG 20-10 f*: AWG 20-10 a* AWG 20-10 (d<2.8 mm)	e*: AWG 24-16 f*: AWG 24-16 a* AWG 24-16 (d<1.6 mm)
Strip length	7 mm / 0.28 inch	7 mm / 0.28 inch	7 mm / 0.28 inch
Screwdriver	3.5 mm slotted screwdriver or Phillips No 1		

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 permitted as long as the average output current through a connector pin does not exceed 25 A. If the current is higher, use a separate distribution terminal block.

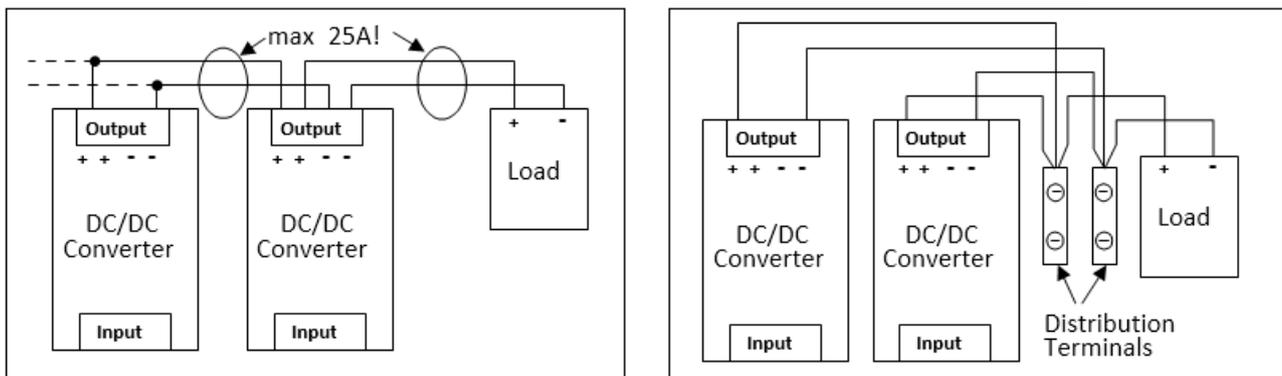


Fig. 11: Daisy chaining of outputs; Using distribution terminals

3.11 Functional wiring diagram

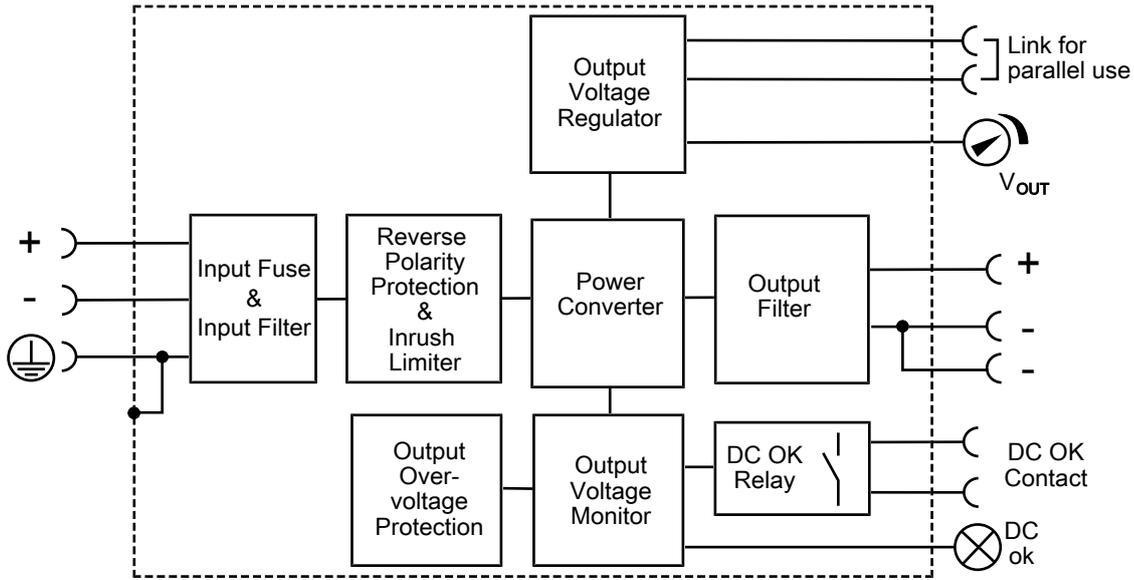


Fig. 12: Functional wiring diagram

3.12 Front side and operating elements



Fig. 13: Front PS9731-2410-0000

Input terminals (screw terminals)

Designation (A)	Description
+	positive input
-	negative input
	PE -> Protective Earth (Ground) connection

Output terminals (screw terminals)

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

Output voltage potentiometer

Designation (C)	Description
Potentiometer	Adjust the output voltage, Factory setting: 24.1 V

DC-OK LED

Designation (D)	Description
LED green	DC-OK LED (green) On: voltage on the output terminals is > 21 V

DC-OK relay contact (screw terminals)

Designation (E)	Description
13 / 14	The DC-OK relay contact is synchronized with the DC-OK LED. See chapter DC-OK relay contact [18] for more details

Link for parallel use (F), “Parallel Use” “Single Use” link

Designation (F)	Description
Push-in terminals	Connect the two terminals when power supplies are connected in parallel. In order to achieve a sharing of the load current between the individual devices, 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. (See chapter Parallel Use to Increase Output Power [33] for details).

3.13 EMC

The EMC behavior of the device is designed for applications in industrial environment as well as in residential, commercial, and light industry environments.

The device is investigated according to the generic standards EN 61000-6-1, EN 61000-6-2, EN 61000-6-3 and EN 61000-6-4.

Without additional measures to reduce the conducted emissions on the output (e.g. by using a filter), the device is not suited to supply a local DC power network in residential, commercial and light-industrial environments. No restrictions apply for local DC power networks in industrial environments.

EMC immunity (Power lines and housing)				
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8 kV 15 kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80 MHz-2.7 GHz 2.7 GHz-6 GHz	20 V/m 10 V/m	Criterion A Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4 kV 2 kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	+ → - +/- → chassis ground	1 kV 2 kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → chassis ground	500 V 1 kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80 MHz	20 V	Criterion A

EMC immunity (DC-OK signal lines)				
Electromagnetic RF field	EN 61000-4-3	80 MHz-2.7 GHz 2.7 GHz-6 GHz	20 V/m 10 V/m	Criterion A Criterion A
Fast transients (Burst)	EN 61000-4-4	DC-OK lines with coupling clamp	2 kV	Criterion A
Surge	EN 61000-4-5	DC-OK lines → chassis ground	1 kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80 MHz	20 V	Criterion A

Criteria:

A: The device shows normal operation behavior within the defined limits.

EMC emission		
Conducted emission on input lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for DC power networks according to EN 61000-6-3 fulfilled
Conducted emission on output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for DC power networks according to IEC 61000-6-4 fulfilled
Radiated emission	EN 55011, EN 55032	Class B
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.		

Switching frequencies		
Main converter	15kHz to 500kHz	Output load and input voltage dependent

3.14 Environment

Environment		
Operating temperature	-25 °C...+70 °C	The operating temperature is the ambient or surrounding temperature and is defined as the air temperature 2 cm below the device.
Storage temperature	-40 °C...+85 °C	For storage and transport
Power derating	3.2 W/°C 6 W/°C 15 W/1000 m or 5 K/1000 m 9 W/-5 kPa or 3 K/-5 kPa	Between +45 °C and +60 °C Between +60 °C and +70 °C For altitudes > 2000 m see Fig. below For atmospheric pressures < 80 kPa, see Fig. below
	The derating is not hardware-controlled. The customer must take care by himself to stay below the de-rated current limits in order not to overload the unit.	
Humidity	5 to 95 % r.h.	According to IEC 60068-2-30
Atmospheric pressure	110-47 kPa	See Fig. below for details
Altitude	Up to 5000 m	See Fig. below for details
Pollution degree	2	According to IEC 62477-1, not conductive
Vibration sinusoidal	2-17.8 Hz: ±1.6 mm; 17.8-500 Hz: 2g 2 hours / axis	According to IEC 60068-2-6
Shock	30g 6 ms, 20g 11 ms 3 bumps / direction, 18 bumps in total	According to IEC 60068-2-27
	Shock and vibration are tested in combination with DIN rails according to EN 60715 with a height of 15 mm and a thickness of 1.3 mm and standard orientation.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

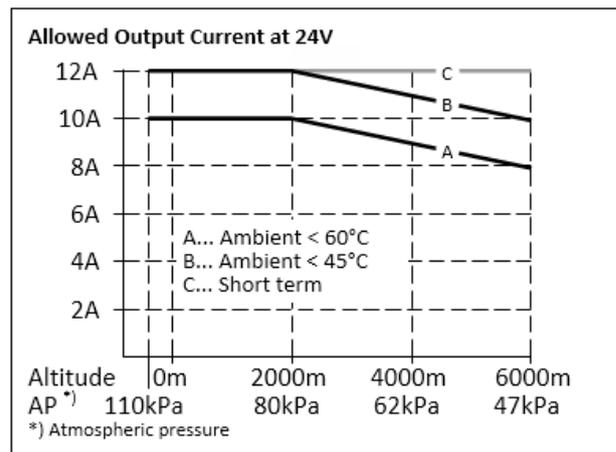
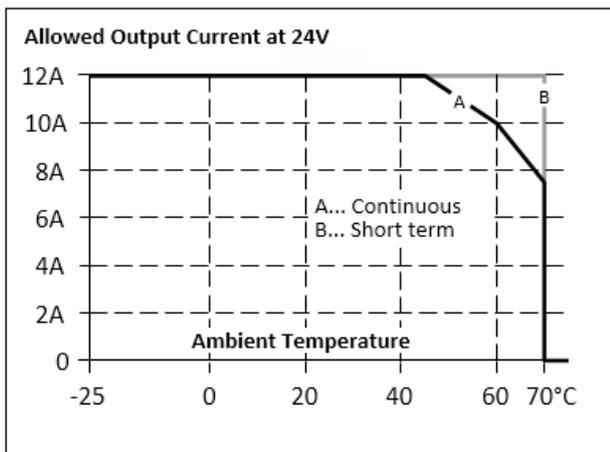


Fig. 14: Output current vs. ambient temp.; Output current vs. altitude

3.15 Safety and protection features

Insulation resistance	Min. 500 MOhm	In the delivery state between input and output, measured with 500 Vdc
	Min. 500 MOhm	In the delivery state between input and Chassis Ground, measured with 500 Vdc
	Min. 500 MOhm	In the delivery state between output and Chassis Ground, measured with 500Vdc
	Min. 500 MOhm	In the delivery state between output and DC-OK contacts, measured with 500 Vdc
PE resistance	Max. 0.1 Ohm	Resistance between PE terminal and the housing in the area of the DIN rail mounting bracket.
Output overvoltage protection	Typ. 31 Vdc Max. 32.5 Vdc	In case of an internal defect, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Class of protection	I	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter "EMC [► 24]"
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	The leakage current, which is produced by the DC/DC converter itself, depends on the input voltage ripple and need to be investigated in the final application. For a smooth DC input voltage, the produced leakage current is less than 100 µA.	

3.16 Dielectric strength

The output voltage is floating and has no ohmic connection to the ground.

The output is insulated to the input by a double or reinforced insulation.

Type and routine 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 (2 s up and 2 s down).

- Connect all input-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.
- When checking the input to DC-OK (see the following figure. B^{*)}), make sure that the maximum voltage between DC-OK and the output is not exceeded (see column D in the table below). We recommend connecting DC-OK pins and the output pins together when performing the test.
- We recommend connecting either the positive pole or the negative pole to the protective earthing system. This helps to avoid situations in which a load starts unexpectedly or cannot be switched off when unnoticed earth faults occur.

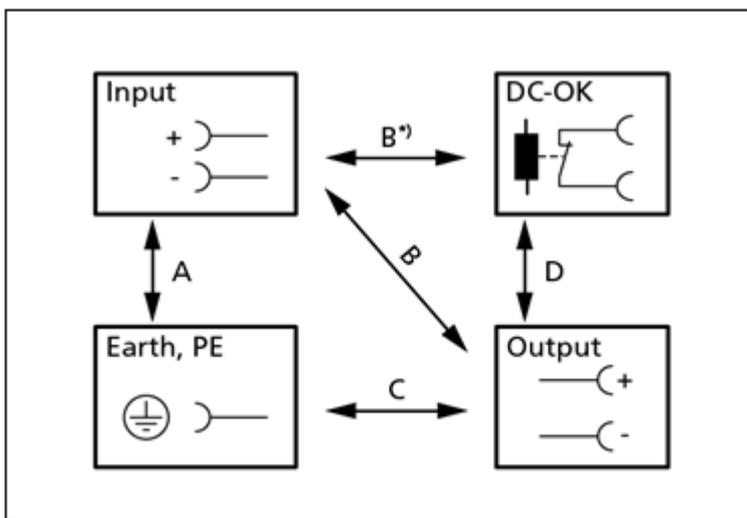


Fig. 15: Dielectric strength

		A	B	C	D
Type test	60 s	1500 Vac	1500 Vac	500 Vac	500 Vac
Routine test	5 s	1500 Vac	1500 Vac	500 Vac	500 Vac
Field test	5 s	1000 Vac	1000 Vac	500 Vac	500 Vac
Cut-off current setting		> 20 mA	> 10 mA	> 80 mA	> 1 mA

3.17 Declaration of conformity and approvals

	EU declaration of conformity
	UL Certificate: Applicable for US and Canada

3.18 Dimensions and weight

Dimensions and weight	
Overall width	42 mm
Height	124 mm
Depth	117 mm 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	520 g
Housing material	Body: Aluminum alloy Cover: zinc-plated steel
Installation clearances	See chapter on Safety instructions and installation requirements [► 9]
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 3.5 mm

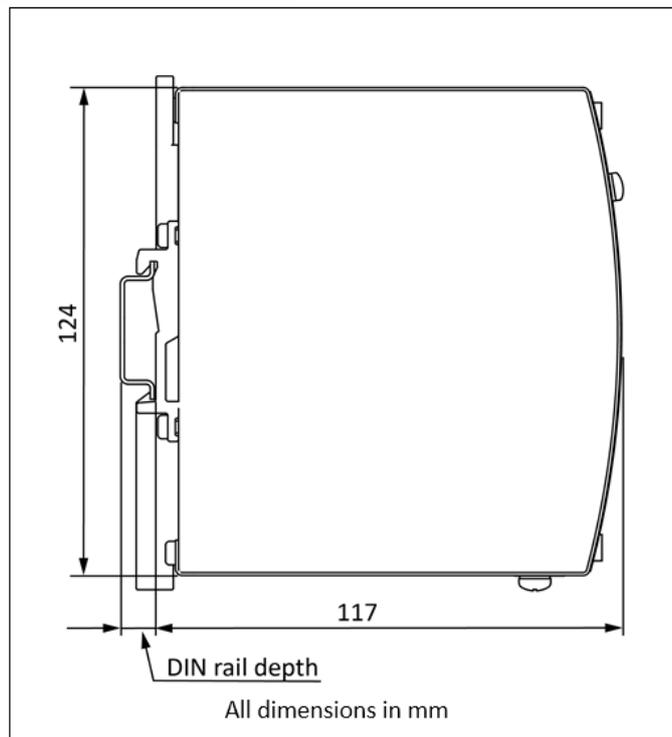
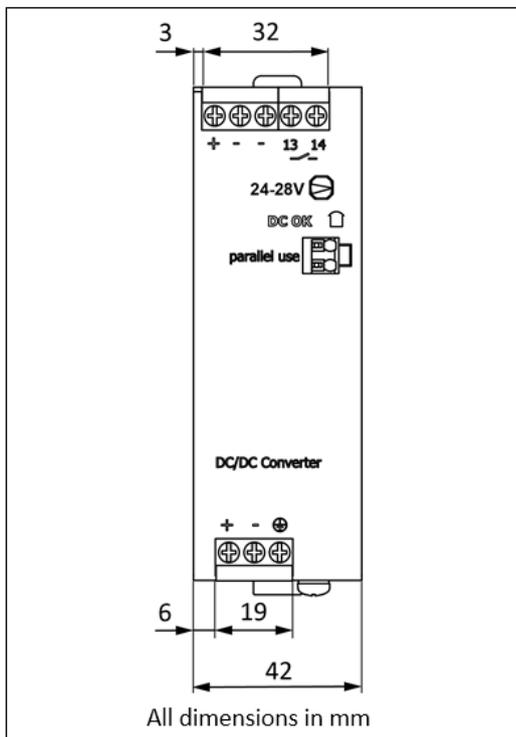


Fig. 16: Front/side view PS9731-2410-0000, all specifications in mm

4 Application notes

4.1 Peak current capability

The unit 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 rated output current. 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 circuits are often individually fused 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 are discharged during such an event, which leads to a voltage sag at the output. The following two examples show typical voltage sags:

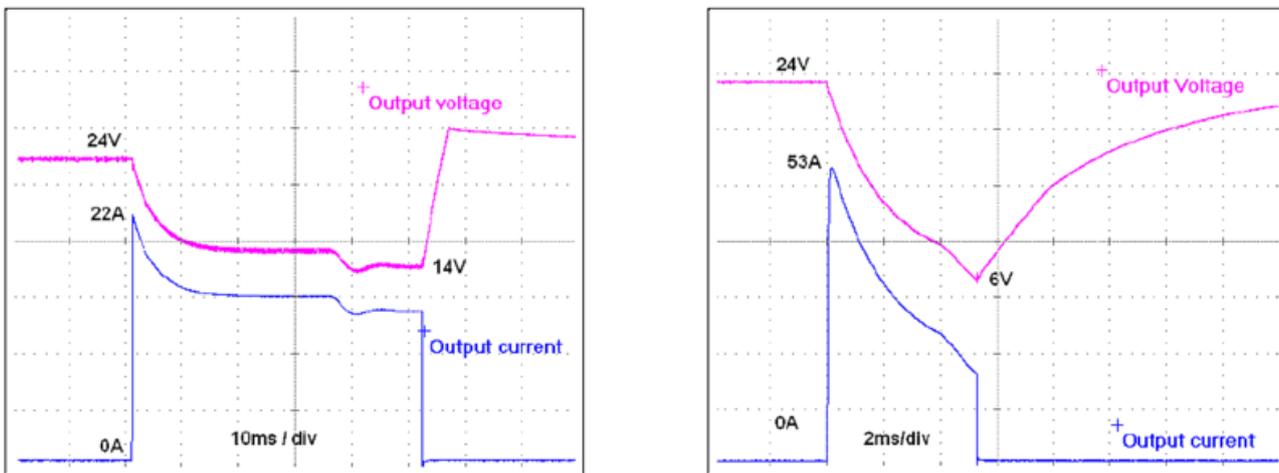


Fig. 17: 20 A resistive peak load (2x the nominal current) for 50 ms, typ.; 50 A resistive peak load (5x the nominal current) for 5 ms, typ.

Peak current voltage sags	
Typically from 24 V to 16 V	at 20 A for 50 ms, resistive load
Typically from 24 V to 12 V	at 50 A for 2 ms, resistive load
Typically from 24 V to 6 V	at 50 A for 5 ms, resistive load

4.2 Output circuit breakers

Standard miniature circuit breakers (MCBs) are commonly used for AC supply systems but can also be used in DC branches if specified.

Such MCBs 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 sags and undervoltage situations in adjacent DC branches fed by the same source, fast (magnetic) tripping of the MCB is desirable. For example, a fast trip within 10 ms avoids a shutdown and restart of the PLC. For this purpose, power supplies with high current reserves and large output capacitors are advantageous. Furthermore, the impedance of the faulty branch must be sufficiently small in order for the current to actually flow.

The following table provides typical test results showing which MCBs magnetically trip as a function of wire size and length. The lengths given correspond to the total length, which is the sum of the outgoing (+) and return (-) wire. The tests were performed without additional load.

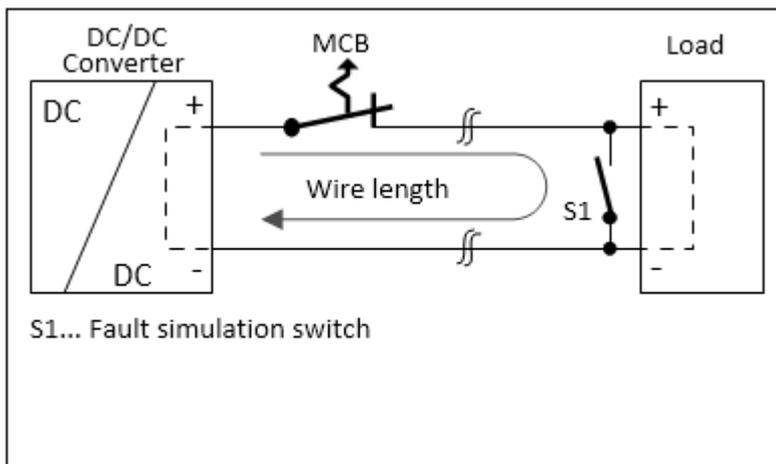


Fig. 18: Test circuit for maximum wire length

Test results for maximum wire length:

	0.75 mm ²	1.0 mm ²	1.5 mm ²	2.5 mm ²
C-2A	23 m	32 m	43 m	62 m
C-3A	14 m	18 m	26 m	39 m
C-4A	8 m	9 m	14 m	18 m
C-6A	2 m	2 m	4 m	6 m
C-8A	0 m	1 m	1 m	1 m

	0.75 mm ²	1.0 mm ²	1.5 mm ²	2.5 mm ²
B-6A	11 m	13 m	21 m	29 m
B-10A	2 m	2 m	4 m	4 m
B-13A	1 m	1 m	1 m	2 m

4.3 Charging batteries

The device can be used to charge lead-acid or maintenance free batteries. Two 12 V SLA or VLRA batteries are needed in series connection.

Instructions for charging batteries:

- Ensure that the ambient temperature of the device is below 45°C.
- 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	27.8 V	27.5 V	27.15 V	26.8 V
Battery temperature	10°C	20°C	30°C	40°C

- Use a 16 A circuit breaker or blocking diode between the device and the battery.
- Ensure that the output current of the device is below the allowed charging current of the battery.
- Use only matched batteries when putting 12 V types in series.
- The return current to the device (battery discharge current) is typ. 10 mA when the device is switched off except in case a blocking diode is utilized.
- Do not use the devices for battery charging in mounting orientations other than the standard mounting orientation or in any other condition where a reduction of the output current is required (e.g., altitude).

4.4 Series operation

Devices of the same Type PS9731-2410-0000 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 must be installed with a protection against touching.

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.

Pay attention that EMI and inrush current will increase when using multiple devices.

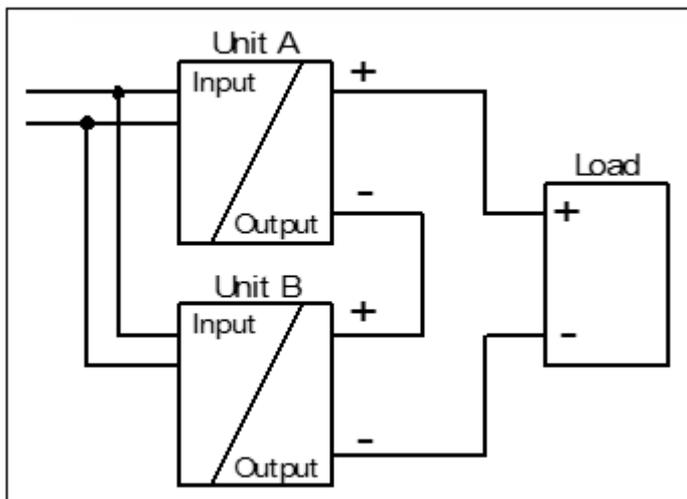


Fig. 19: Series operation

4.5 Parallel use to increase output power

Devices of the same type PS9731-2410-0000 can be connected in parallel to increase the output power.

- The output voltage of all power supplies shall be adjusted to the same value (± 100 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, set the device to “Parallel Use” mode, 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 [► 16]”.
- If more than three devices are connected in parallel, a diode, a fuse or circuit breaker with a rating of 15 A or 16 A is required on each output. Alternatively, a diode or redundancy module can also be utilized.
- The ambient temperature is not allowed to exceed +60 °C.

Restrictions

- Maintain an installation distance of 15 mm (left/right) between two devices.
- Avoid installing devices on top of each other.
- Do not use devices connected in parallel in installation positions other than the standard installation position or under other conditions that require a reduction in the output current (e.g., installation altitude).
- Pay attention that leakage current, EMI, inrush current will increase when using multiple devices.

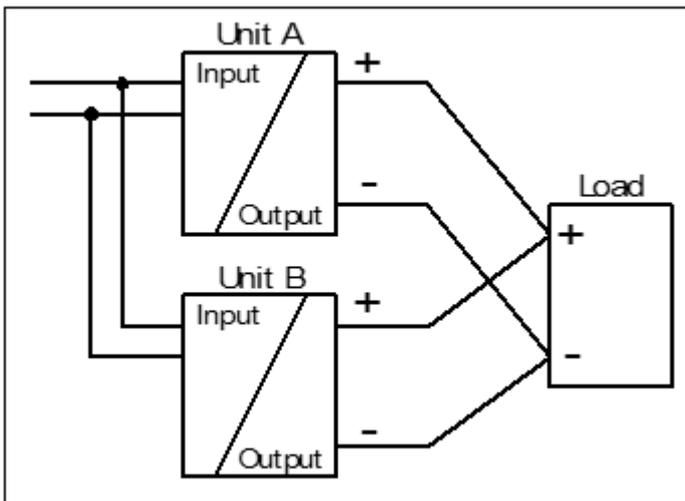


Fig. 20: Parallel connection

4.6 Parallel use for redundancy

1+1 Redundancy

Devices of the same Type PS9731-2410-0000 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 device fails. The simplest way is to put two devices in parallel. This is called a 1+1 redundancy. In case one device fails, the other one is automatically able to support the load current without any interruption. It is essential to use a redundancy module to decouple devices from each other. This prevents that the defective unit becomes a load for the other device and the output voltage cannot be maintained any more.

1+1 redundancy allows ambient temperatures up to +70°C.

Pay attention that EMI and inrush current will increase when using multiple devices.

Recommendations for building redundant power systems:

- Use separate input fuses for each device.
- Use separate supply systems for each device whenever it is possible.
- It is desirable to set the output voltages of all devices to the same value ($\pm 100\text{mV}$) or leave it at the factory setting.

N+1 Redundancy

i Notes on parallel use for N + +1 redundancy

- Pay attention that EMI and inrush current will increase when using multiple devices.
- For N+1 redundant systems the ambient temperature is not allowed to exceed +45 °C.

Redundant systems for a higher power demand are usually built in a N+1 method. E.g. four devices, each rated for 10 A, are paralleled to build a 30 A redundant system.

- Maintain an installation distance of 15 mm (left/right) between two devices.
- Do not install the devices on top of each other.
- Do not use devices in parallel in mounting orientations other than the standard mounting orientation or in any other condition, where a reduction of the output current is required.

Wiring example

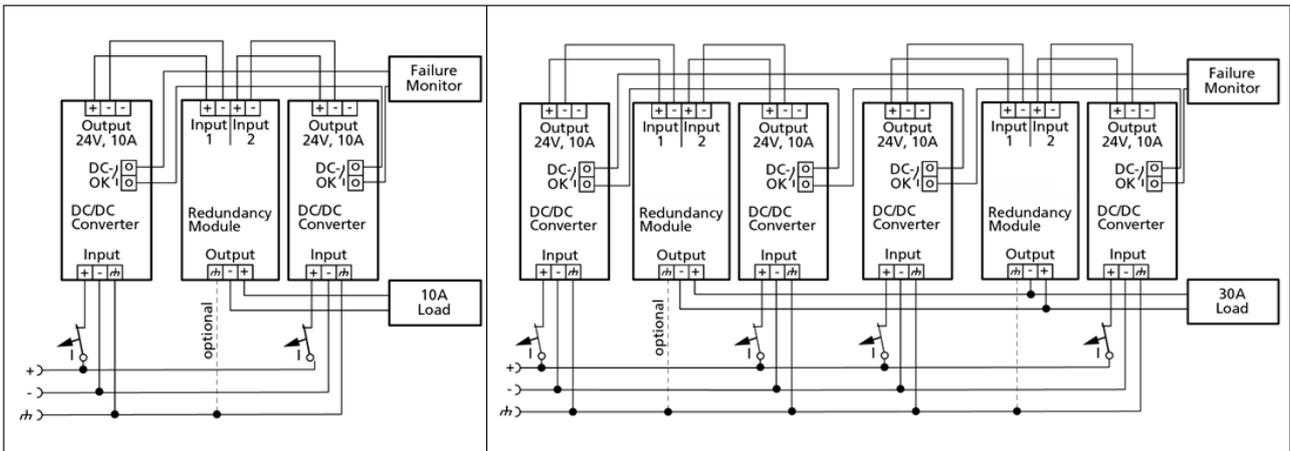


Fig. 21: 1+1 Redundant configuration for 10 A load current; N+1 Redundant configuration for 30 A load current with multiple DC/DC converters and redundancy module

4.7 Use in a tightly sealed enclosure

When the DC/DC Converter is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. In such situations, the inside temperature defines the ambient temperature for the DC/DC Converter.

The following measurement results can be used as a reference to estimate the temperature rise inside the housing. The DC/DC converter is placed in the center of the housing, and there are no other heat-generating parts in the housing.

The temperature sensor in the housing is located in the middle of the right side of the DC/DC converter at a distance of 1 cm.

	Case A	Case B
Housing size	110x180x165 mm Rittal Type IP66 Box PK 9516 100, plastic	110x180x165 mm Rittal Type IP66 Box PK 9516 100, plastic
Input voltage	48 Vdc	48 Vdc
Load	24 V, 8 A; (=80 %)	24 V, 10 A; (=100 %)
Temperature inside the box	45.4 °C	52.4 °C
Temperature outside the box	21.0 °C	21.0 °C
Temperature rise	24.4 K	31.4 K

4.8 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 maximum allowed ambient temperature.

The listed lifetime and MTBF values from this datasheet apply only for the standard mounting orientation.

The following curves give an indication for allowed output currents for altitudes up to 2000 m.

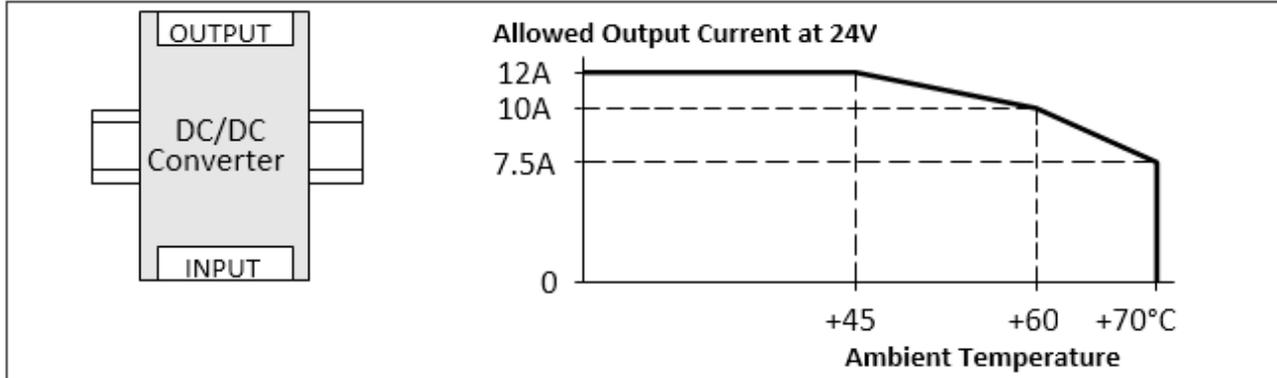


Fig. 22: Mounting position A (standard mounting position)

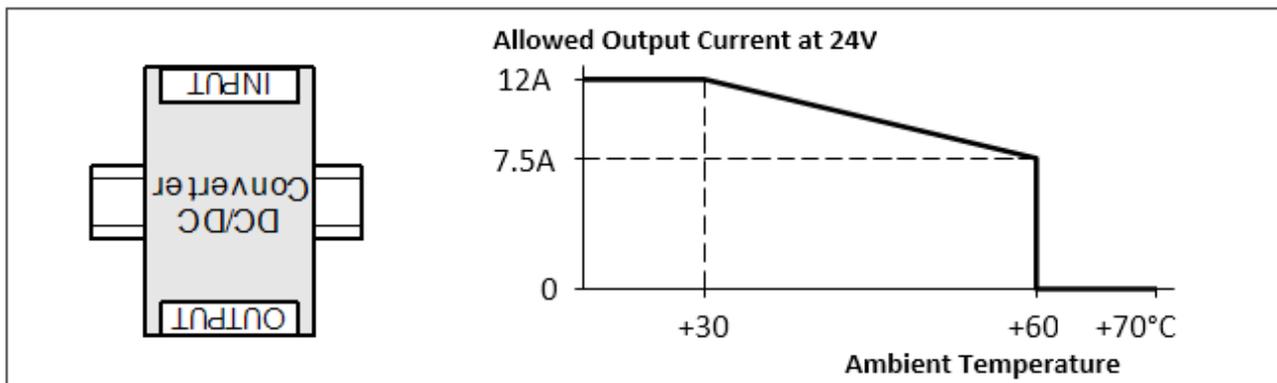


Fig. 23: Mounting position B (upside down)

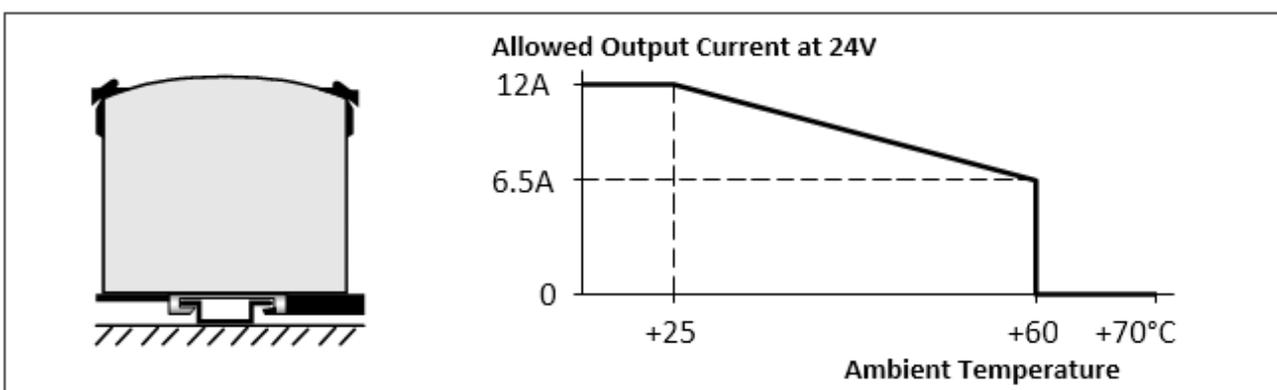


Fig. 24: Mounting position C (table-top mounting)

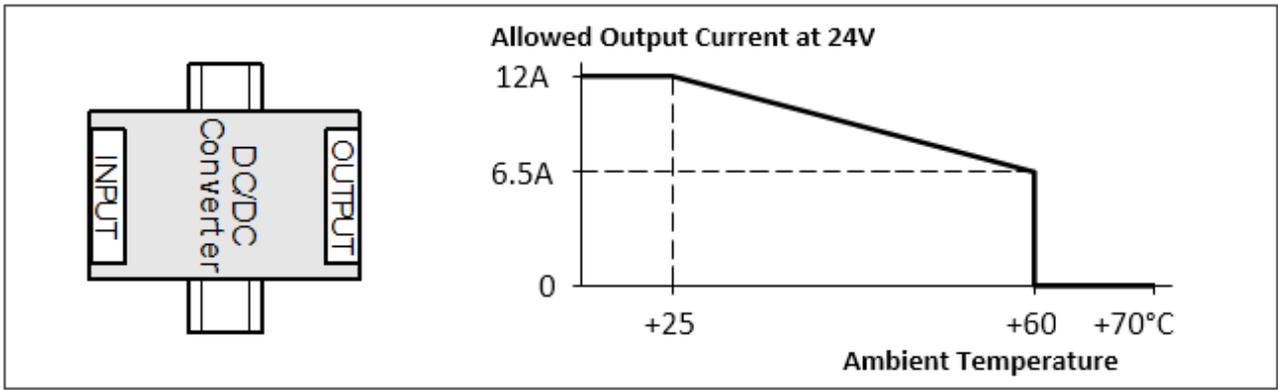


Fig. 25: Mounting position D (horizontal clockwise)

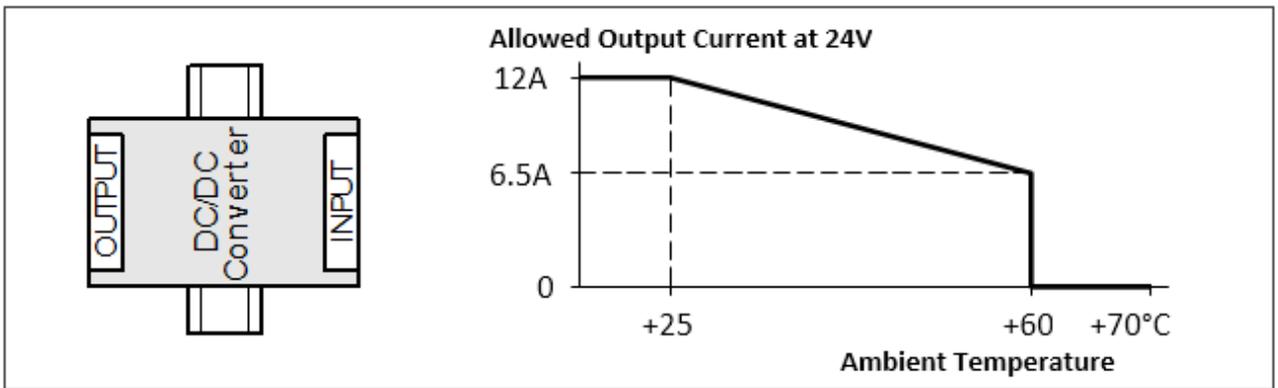


Fig. 26: Mounting position E (horizontal counterclockwise)

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

DC/DC converter	Accessories	
	Redundancy module	Buffer module
PS9731-2410-0000	PS9401-2440-0000	PS9011-2420-0001

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](#) [[▶ 34](#)]!"

PS9011-2420-0001 – Buffer Module



The PS9011-2420-0001 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 20 A of additional power and can be added in parallel to increase the output current or hold-up time.

The PS9011-2420-0001 buffer module can optionally be used to achieve longer hold-up times.

6.1.2 Accessories for mounting

ZS5301-0003 – Bracket for wall mounting

This bracket is used to mount the devices on a wall/panel without utilizing the DIN rail. The bracket can be mounted without detaching the DIN rail brackets from the power supply.

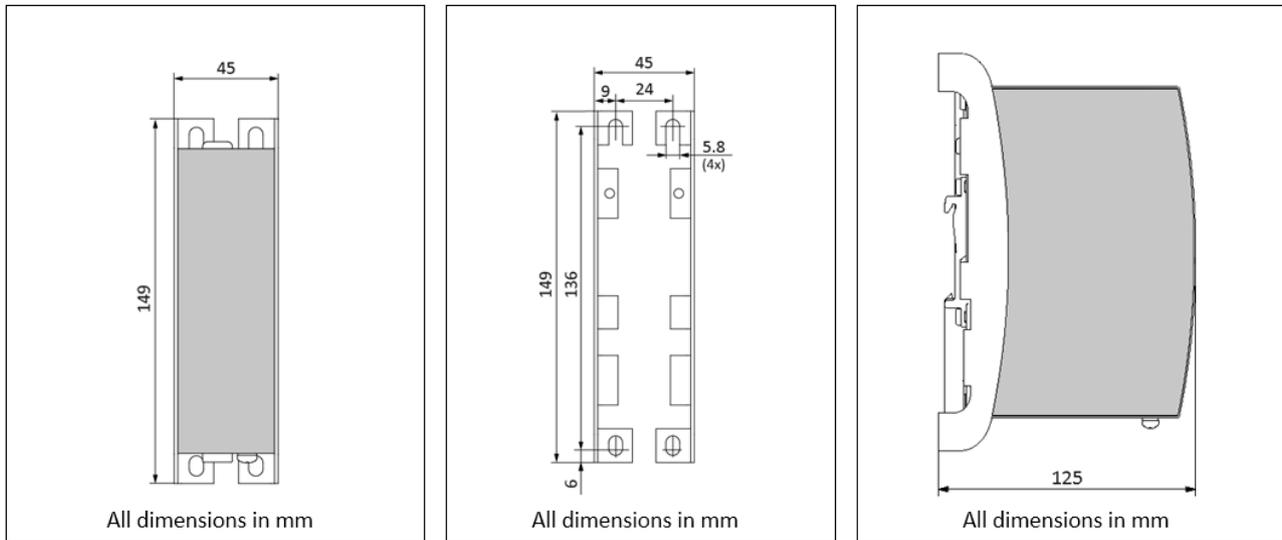


Fig. 27: ZS5301-0003, Hole pattern; Side view

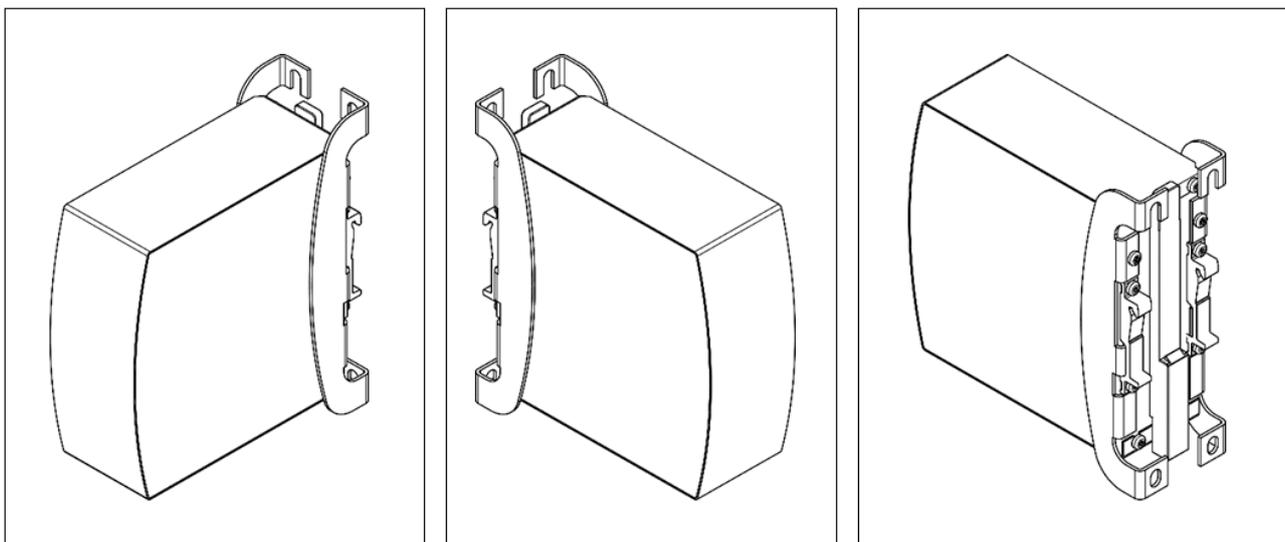


Fig. 28: Isometric view

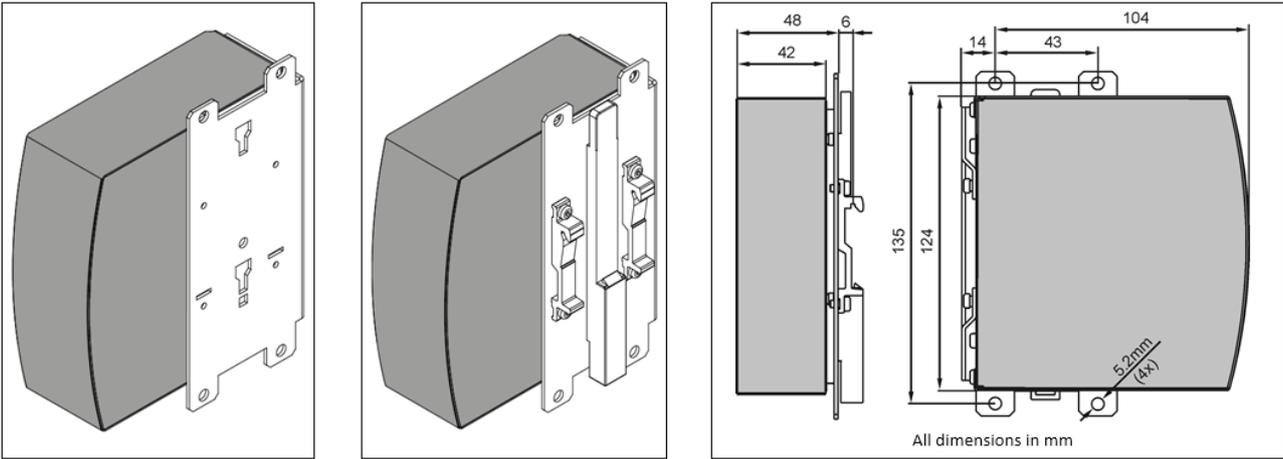
ZS5301-0005 – Bracket for side mounting

This ZS5301-0005 bracket is used to mount the device sideways with or without utilizing a DIN-rail to save installation depth.

The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the ZS5301-0005 steel bracket can be mounted.

For sideways DIN-rail mounting, the removed aluminum brackets and the black plastic slider need to be mounted on the ZS5301-0005 steel bracket.

PSU for illustration purpose only.



Side mounting without/with DIN-rail brackets; Hole pattern

6.2 Documentation issue status

Version	Comment
1.1.0	<ul style="list-style-type: none">• Update Foreword• Update chapter "Declaration of conformity and approvals"• Structural update
1.0	<ul style="list-style-type: none">• First release
0.1 - 0.4	<ul style="list-style-type: none">• Preliminary documentation for PS9731-2410-0000

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