CP10.481

48V, 5.4A, 260W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-240V Wide-range Input
- Width only 39mm
- +10% (5.4A) continuous current up to +60°C
- +20% (6A) continuous current up to +45°C
- Efficiency up to 95.5%
- Excellent Partial Load Efficiency
- Safe Hiccup*PLUS* Overload Mode
- Active Power Factor Correction (PFC)
- Minimal Inrush Current Surge
- Full Power Between -25°C and +60°C
- DC-OK Relay Contact
- 3 Year Warranty

GENERAL DESCRIPTION

The DIMENSION CP-Series units are high-end power supplies in a medium price range without compromising quality, reliability and performance. The CP-Series is part of the DIMENSION power supply family. The most outstanding features of CP10.481 are the high efficiency, advanced inrush current limitation, active PFC and the wide operational temperature range.

The CP-Series includes all the essential basic functions. The devices have a power reserve of 10% up to +60°C and 20% up to +45°C included, which may even be used continuously. Additionally, the CP10 can deliver three times the nominal output current for at least 12ms which helps to trip fuses on faulty output branches.

High immunity to transients and power surges as well as low electromagnetic emission, a DC-OK relay contact and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

SHORT-FORM DATA

Output voltage	DC 48V	Nominal
Adjustment range	48 – 56V	Factory setting 48.0V
Output current	6.0-5.2A	Below +45°C ambient
	5.4-4.6A	At +60°C ambient
	4.0-3.4A	At +70°C ambient
	Derate linearely between +45°C and +70°C	
Input voltage AC	AC 100-240V	±10%
Mains frequency	50-60Hz	±6%
Input current AC	2.32 / 1.20A	At 120 / 230Vac
Power factor	0.99 / 0.98	At 120 / 230Vac
Input voltage DC	DC 110-150V	±20%
Input current DC	2.51A	At 110Vdc
	Reduce output current to 5-4.3A (48-56V) below 93.5Vdc	
AC Inrush current	6 / 9A pk	At 40°C 120/230Vac
Efficiency	93.8 / 95.5%	At 120 / 230Vac
Losses	17.2 / 12.3W	At 120 / 230Vac
Hold-up time	34 / 34ms	At 120 / 230Vac
Temperature range	-25°C to +70°C	
Size (w x h x d)	39x124x117mm	Without DIN-Rail
Weight	600g / 1.3lb	

ORDER NUMBERS

Power Supply **CP10.481**

Mechanical Accessory

ZM4.WALL	Wall/panel mount bracket
ZM12.SIDE	Side mount bracket

MARKINGS

For details and a complete approval list see section 20.

c UL US LISTED IND. CONT. EQ. UL 508

c TÜV US UL 60950-1

CE

c SP US Class I Div 2

IECEx ATEX

GL Marine

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz mains frequency. AC 120V parameters are valid for 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general professional use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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. Do not replace the fuse.

If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection.

Mount the unit on a DIN-rail so that the input terminals are located on the bottom of the unit. For other mounting orientations see de-rating requirements in this document. See chapter 24.12.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 15%!

Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).

A disconnecting means shall be provided for the output of the power supplies when used in applications according to CSA C22.2 No 107.1-01.

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit 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 surfaces may cause burns.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations and for use in Group II Category 3 (Zone 2) environments. See section 20 for details.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment or S/P jumper unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15:2010.

3. AC-INPUT

AC input	Nom.	AC 100-240V	Suitable for TN-, TT- and IT mains networks
AC input range			Continuous operation
	Min.	85-264Vac	Below 90Vac, reduce output current according to Fig. 3-5.
	Min.	264-300Vac	For maximal 500ms
Allowed voltage L or N to earth	Max.	300Vac	Continuous according to IEC 62477-1
Input frequency	Nom.	50–60Hz	±6%
Turn-on voltage	Typ.	80Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	Typ.	70Vac	Steady-state value, see Fig. 3-1
	Typ.	55Vac	Dynamic value for maximal 250ms
External input protection	See recommendations in chapter 24.3.		

		AC 100V	AC 120V	AC 230V	
Input current	Typ.	2.82A	2.32A	1.20A	At 48V, 5.4A, see Fig. 3-3
Power factor*)	Typ.	0.99	0.99	0.98	At 48V, 5.4A, see Fig. 3-4
Crest factor**)	Typ.	1.5	1.5	1.65	At 48V, 5.4A
Start-up delay	Typ.	300ms	290ms	240ms	See Fig. 3-2
Rise time	Typ.	63ms	63ms	63ms	At 48V, 5.4A const. current load, 0mF load capacitance, see Fig. 3-2
	Typ.	210ms	210ms	210ms	At 48V, 5.4A const. current load, 5mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	200mV	200mV	See Fig. 3-2
External input protection	See recommendations in chapter 24.3.				

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 3-1 **Input voltage range**

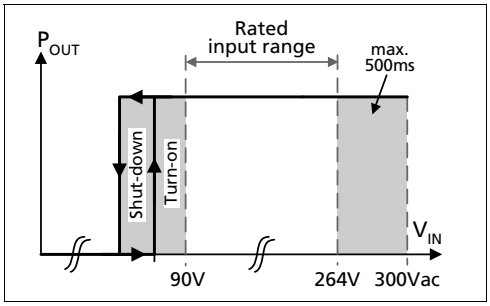


Fig. 3-2 **Turn-on behavior, definitions**

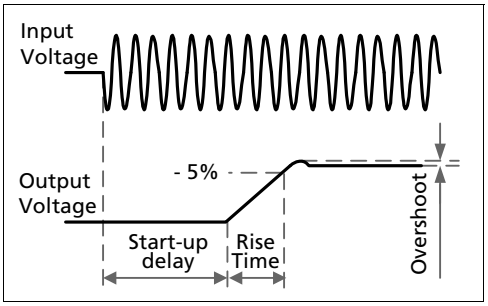


Fig. 3-3 **Input current vs. output current at 48V output voltage**

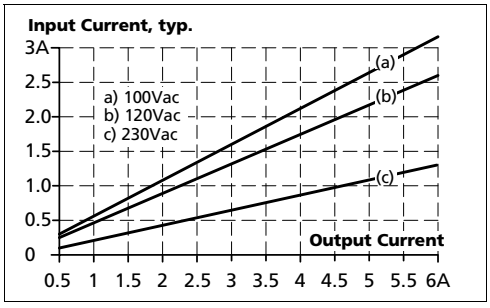


Fig. 3-4 **Power factor vs. output current at 48V output voltage**

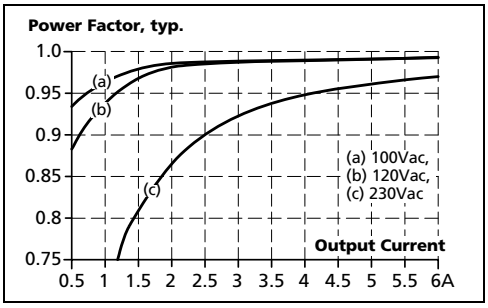
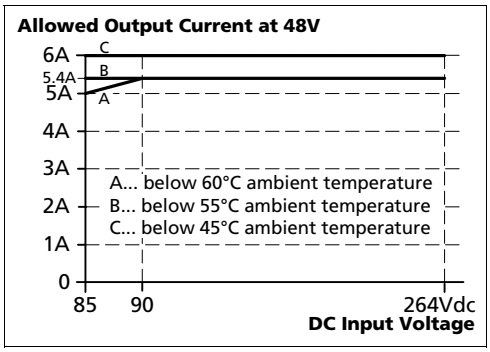


Fig. 3-5 **Derating requirements**



4. DC-INPUT

DC input	Nom.	DC 110-150V	±20%
DC input range	Min.	88-180Vdc	Continuous operation, Below 93.5Vdc, reduce output current according to Fig. 4-2.
DC input current	Typ.	2.51A	At 110Vdc
Allowed Voltage L/N to Earth	Max.	375Vdc	Continuous, according to IEC 62477-1
Turn-on voltage	Typ.	80Vdc	Steady state value
Shut-down voltage	Typ.	70Vdc	Steady state value
	Typ.	55Vdc	Dynamic value for maximal 250ms

Instructions for DC use:

a) Use a battery or a similar DC source. A supply from the intermediate DC-bus of a frequency converter is not recommended and can cause a malfunction or damage the unit.
b) Connect +pole to L and –pole to N.
c) Connect the PE terminal to an earth wire or to the machine ground.

Fig. 4-1 **Wiring for DC Input**

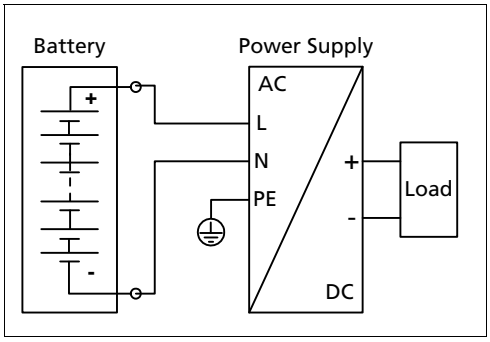
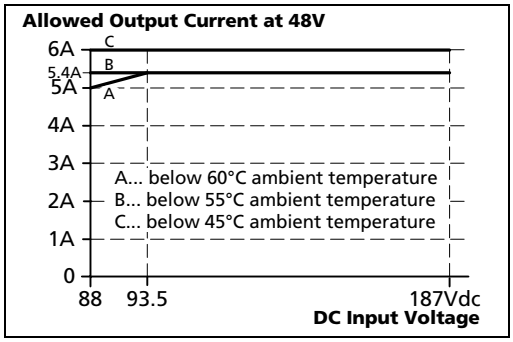


Fig. 4-2 **Derating requirements**



5. INPUT INRUSH CURRENT

An active inrush limitation circuit (NTCs, which are bypassed by a relay contact) 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.

		AC 100V	AC 120V	AC 230V	
Inrush current	Max.	$11A_{peak}$	$7A_{peak}$	$11A_{peak}$	At 40°C, cold start
	Typ.	$9A_{peak}$	$6A_{peak}$	$6A_{peak}$	At 25°C, cold start
	Typ.	$9A_{peak}$	$6A_{peak}$	$9A_{peak}$	At 40°C, cold start
Inrush energy	Max.	$0.1A^2s$	$0.1A^2s$	$0.4A^2s$	At 40°C, cold start

Fig. 5-1 **Typical turn-on behavior at nominal load, 120Vac input and 25°C ambient**

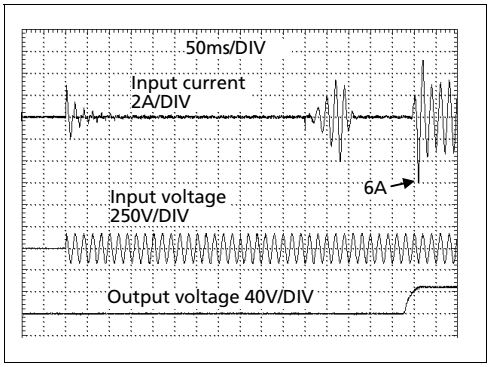
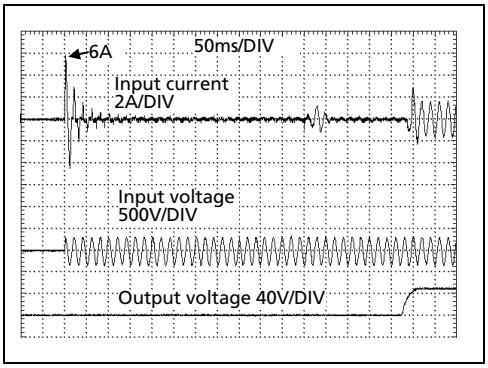


Fig. 5-2 **Typical turn-on behavior at nominal load, 230Vac input and 25°C ambient**



6. OUTPUT

Output voltage	Nom.	48V	
Adjustment range	Min.	48-56V	Guaranteed value
	Max.	58.0V	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 settings	Typ.	48.0V	±0.2%, at full load and cold unit
Line regulation	Max.	10mV	Between 85 and 300Vac
Load regulation	Max.	50mV	Between 0 and 6A, static value, see Fig. 6-1
Ripple and noise voltage	Max.	50mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	6.0A[1)]	At 48V and an ambient temperature below 45°C, see Fig. 16-1
	Nom.	5.4A	At 48V and 60°C ambient temperature, see Fig. 6-1
	Nom.	4.0A	At 48V and 70°C ambient temperature, see Fig. 16-1
	Nom.	5.2A[1)]	At 56V and an ambient temperature below 45°C, see Fig. 16-1
	Nom.	4.6A	At 56V and 60°C ambient temperature, see Fig. 6-1
	Nom.	3.4A	At 56V and 70°C ambient temperature, see Fig. 16-1
	Typ.	15A	For minimal 12ms once every five seconds, see Fig. 6-2. The output voltage stays above 40V. See chapter 24.1 for more peak current measurements. For AC 100V mains, the pulse length is shorter than 12ms.
Overload behaviour		Continuous current	Output voltage above 26Vdc, see Fig. 6-1
		Hiccup^{PLUS} mode[2)]	Output voltage below 26Vdc, see Fig. 6-1
Short-circuit current	Min.	6.3A[3)]	Load impedance <90mOhm, see Fig. 6-3
	Max.	7.7A[3)]	Load impedance <90mOhm, see Fig. 6-3
	Max.	2.2A	Average (R.M.S.) current, load impedance 50mOhm, see Fig. 6-3
	Min.	14.5A	Up to 12ms, load impedance <90mOhm, see Fig. 6-2
	Typ.	16.0A	Up to 12ms, load impedance <90mOhm, see Fig. 6-2
Output capacitance	Typ.	960µF	Included inside the power supply

1) **Power Boost**
This power/ current is continuously allowed up to an ambient temperature of 45°C.
Above 45°C, do not use this power/ current longer than a duty cycle of 10% and/ or not longer than 1 minute every 10 minutes.

2) **Hiccup^{PLUS} Mode**
At heavy overloads (when output voltage falls below 26V), the power supply delivers continuous output current for 2s. After this, the output is switched off for approx. 18s before a new start attempt is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally. See Fig. 6-3

3) Discharge current of output capacitors is not included.

Fig. 6-1 **Output voltage vs. output current, typ.**

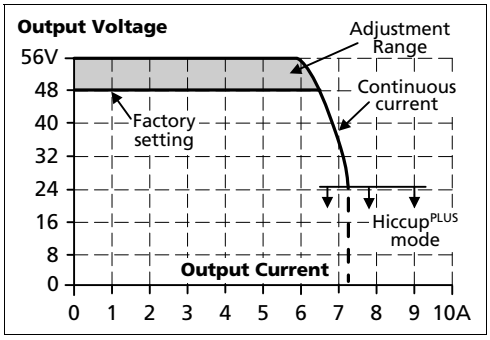


Fig. 6-2 **Dynamic output current capability, typ.**

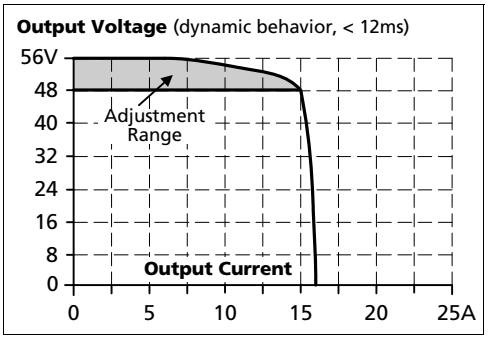
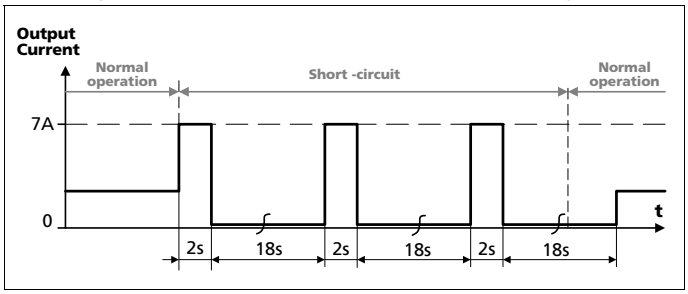


Fig. 6-3 **Short-circuit on output, Hiccup^{PLUS} mode, typ.**



7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	Typ.	67ms	67ms	67ms	At 48V, 2.7A, see Fig. 7-1
	Min.	50ms	50ms	50ms	At 48V, 2.7A, see Fig. 7-1
	Typ.	34ms	34ms	34ms	At 48V, 5.4A, see Fig. 7-1
	Min.	26ms	26ms	26ms	At 48V, 5.4A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

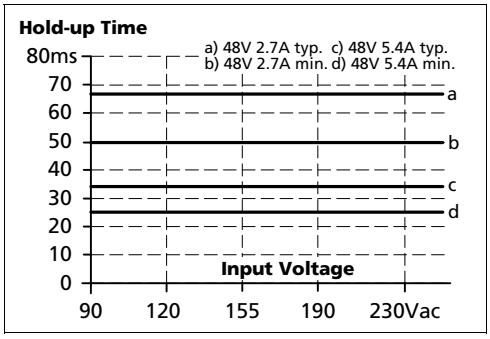
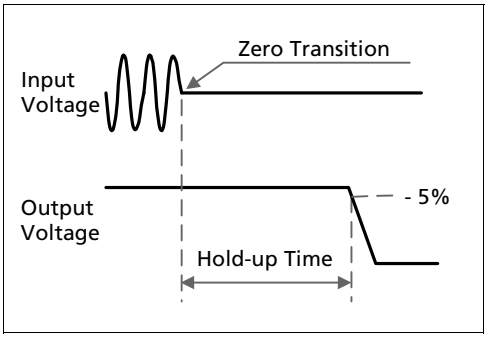


Fig. 7-2 **Shut-down behavior, definitions**

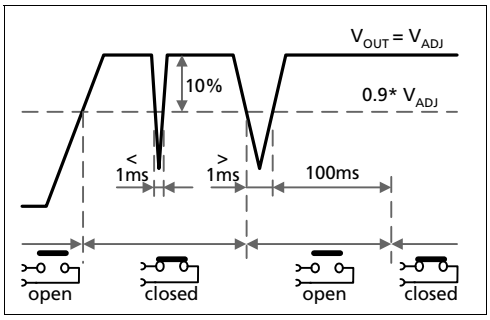


8. DC-OK RELAY CONTACT

This feature monitors the output voltage on the output terminals of a running power supply.

Contact closes	As soon as the output voltage reaches typ. 90% of the adjusted output voltage level.
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 100ms. Dips shorter than 1ms will be ignored.
Switching hysteresis	Typ. 2V
Contact ratings	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
Isolation voltage	See dielectric strength table in section 18.

Fig. 8-1 **DC-ok relay contact behavior**



9. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	Typ.	93.0%	93.8%	95.5%	At 48V, 5.4A
	Typ.	92.7%	93.6%	95.4%	At 48V, 6A (Power Boost)
Average efficiency*)	Typ.	92.8%	93.4%	94.5%	25% at 1.3A, 25% at 2.6A, 25% at 3.9A. 25% at 5.4A
Power losses	Typ.	2.5W	2.3W	2.0W	At 48V, 0A
	Typ.	10.2W	9.5W	7.4W	At 48V, 2.7A
	Typ.	19.5W	17.2W	12.3W	At 48V, 5.4A
	Typ.	22.7W	19.7W	13.9W	At 48V, 6A (Power Boost)

*) 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. 9-1 **Efficiency vs. output current at 48V, typ.**

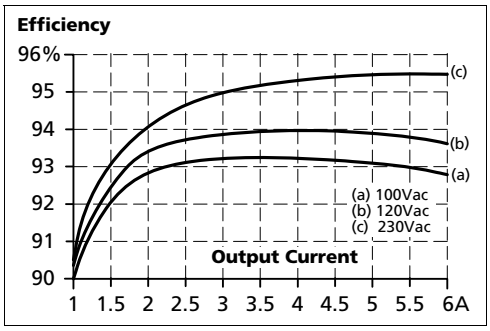


Fig. 9-2 **Losses vs. output current at 48V, typ.**

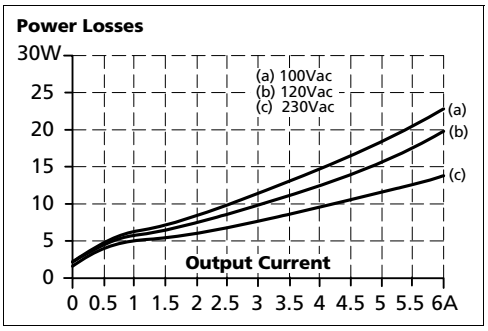


Fig. 9-3 **Efficiency vs. input voltage at 48V, 5.4A, typ.**

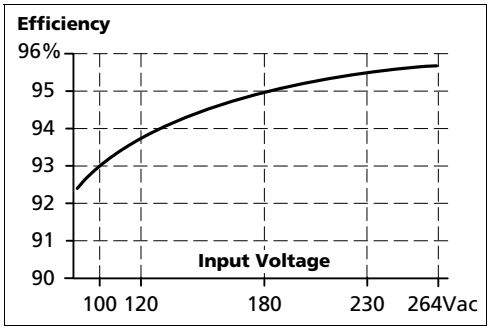
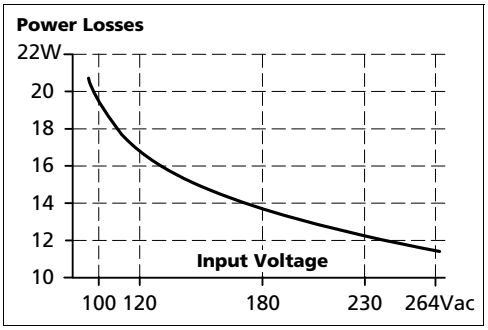


Fig. 9-4 **Losses vs. input voltage at 48V, 5.4A, typ.**



10. LIFETIME EXPECTANCY AND MTBF

The 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.

	AC 100V	AC 120V	AC 230V	
Lifetime expectancy	141 000h	158 000h	188 000h	At 48V, 2.7A and 40°C
	399 000h	446 000h	531 000h	At 48V, 2.7A and 25°C
	63 000h	77 000h	120 000h	At 48V, 5.4A and 40°C
	178 000h	219 000h	338 000h	At 48V, 5.4A and 25°C
	45 000h	57 000h	97 000h	At 48V, 6A and 40°C
	126 000h	161 000h	275 000h	At 48V, 6A and 25°C

11. LIFETIME EXPECTANCY AND MTBF

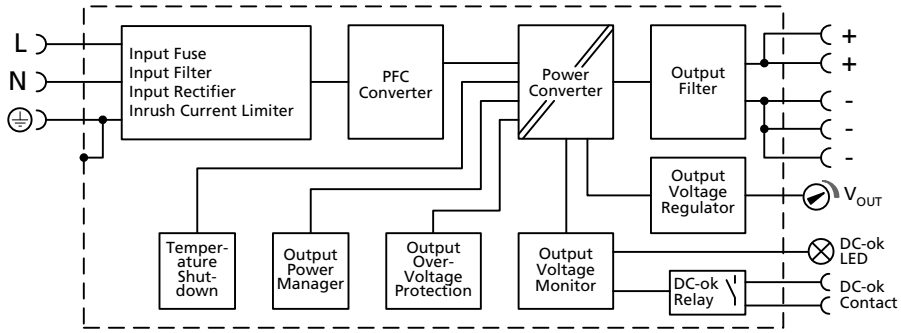
MTBF stands for **M**ean **T**ime **B**etween **F**ailure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

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.

	AC 100V	AC 120V	AC 230V	
MTBF SN 29500, IEC 61709	506 000h	523 000h	699 000h	At 48V, 5.4A and 40°C
	897 000h	923 000h	1 201 000h	At 48V, 5.4A and 25°C
MTBF MIL HDBK 217F	223 000h	224 000h	248 000h	At 48V, 5.4A and 40°C; Ground Benign GB40
	303 000h	303 000h	339 000h	At 48V, 5.4A and 25°C; Ground Benign GB25
	50 000h	51 000h	58 000h	At 48V, 5.4A and 40°C; Ground Fixed GF40
	65 000h	65 000h	74 000h	At 48V, 5.4A and 25°C; Ground Fixed GF25

12. FUNCTIONAL DIAGRAM

Fig. 12-1 **Functional diagram**



13. TERMINALS AND WIRING

The terminals are IP20 finger safe constructed and suitable for field- and factory wiring.

	Input and output	**DC-OK-Signal**
Type	Screw terminals	Push-in terminals
Solid wire	Max. 6mm²	Max. 1.5mm²
Stranded wire	Max. 4mm²	Max. 1.5mm²
American Wire Gauge	AWG 20-10	AWG 24-16
Wire diameter	Max. 2.8mm (including ferrules)	Max. 1.6mm (including ferrules)
Wire stripping length	7mm / 0.28inch	7mm / 0.28inch
Screwdriver	3.5mm slotted or cross-head No 2	Not required
Recommended tightening torque	1Nm, 9lb.in	Not applicable

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
   60°C for ambient up to 45°C and
   75°C for ambient up to 60°C minimum
   90°C for ambient up to 70°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Unused terminal compartments should be securely tightened.
e) Ferrules are allowed.

Daisy chaining:

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block as shown in Fig. 13-2.

Fig. 13-1 Daisy chaining of outputs

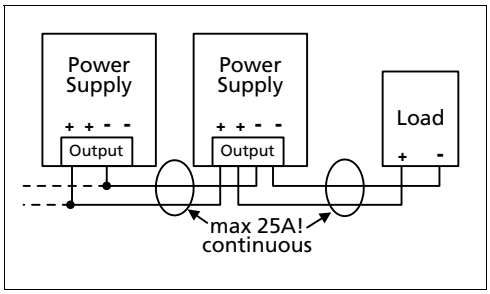
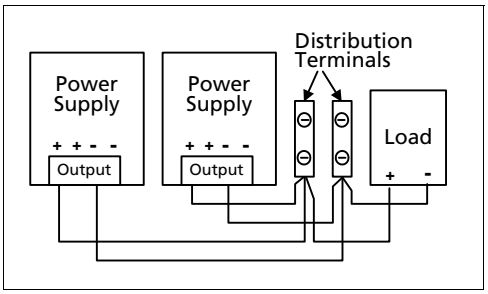


Fig. 13-2 Using distribution terminals



14. FRONT SIDE AND USER ELEMENTS

Fig. 14-1
Front side

A **Input Terminals** (screw terminals)
- **N, L** Line input
- ⏚ PE (Protective Earth) input

B **Output Terminals** (screw terminals)
(two identical + poles and three identical - poles)
- **+** Positive output
- **–** Negative (return) output

C **Output voltage potentiometer**
Open the flap to adjust the output voltage. Factory set: 48.0V

D **DC-OK LED** (green)
On, when the output voltage is >90% of the adjusted output voltage

E **DC-OK Relay Contact**
(spring-clamp terminals)
Monitors the output voltage of the running power supply. See chapter 8 for details.

15. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environments.

EMC Immunity	According to generic standards: EN 61000-6-1 and EN 61000-6-2			
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	20V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines DC-OK signal (coupling clamp)	4kV 2kV 2kV	Criterion A Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N L → PE, N → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	1kV 2kV	Criterion A Criterion A
Surge voltage on Signals	EN 61000-4-5	DC-OK signal → PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	20V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion C Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11	0% of 200Vac (=0V)	5000ms	Criterion C
Voltage sags	SEMI F47 0706	Dips on the input voltage according to SEMI F47 standard		
		80% of 120Vac (96Vac) 70% of 120Vac (84Vac) 50% of 120Vac (60Vac)	1000ms 500ms 200ms	Criterion A Criterion A Criterion A
Powerful transients	VDE 0160	Over entire load range	750V, 0.3ms	Criterion A

Criterions:

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

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

EMC Emission	According to generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55015, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B
Conducted emission output lines[2)]	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for DC power port according EN 61000-6-3 fulfilled
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Class A fulfilled between 0A and 6A load Class C fulfilled between 2.5A and 6A load
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled[1)]

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.

1) Tested with constant current loads, non pulsing

2) For information only, not mandatory for EN 61000-6-3

Switching Frequencies

PFC converter	110kHz	Fixed frequency
Main converter	84kHz to 140kHz	Output load dependent
Auxiliary converter	60kHz	Fixed frequency

16. ENVIRONMENT

Operational temperature [1]	-25°C to +70°C (-13°F to 158°F)	Reduce output power according to Fig. 16-1
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	1.9W/°C 6.5W/°C	Between +45°C and +60°C (113°F to 140°F) Between +60°C and +70°C (140°F to 158°F)
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 Do not energize while condensation is present
Vibration sinusoidal [2]	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	According to IEC 60068-2-6
Shock [2]	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	According to IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	Without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	Reduce output power or ambient temperature, see Fig. 16-2.
Altitude de-rating	15W/1000m or 5°C/1000m	Above 2000m (6500ft), see Fig. 16-2
Over-voltage category	III	According to IEC 62477-1 for altitudes up to 2000m
	II	According to IEC 62477-1 for altitudes from 2000m to 6000m
Degree of pollution	2	According to IEC 62477-1, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	
Corrosive gases	ISA-71.04-1985, Severity Level G3, IEC 60068-2-60 Test Ke Method 4	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

1) Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.
2) Tested in combination with DIN-Rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm and standard orientation.

Fig. 16-1 **Output current vs. ambient temp.**

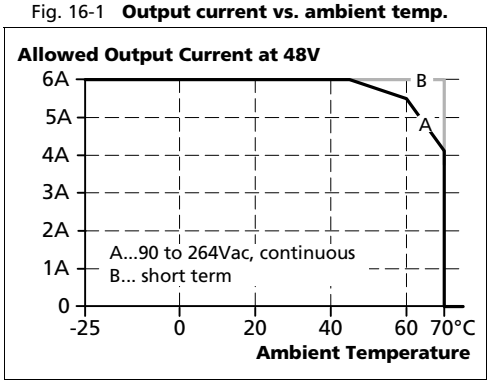
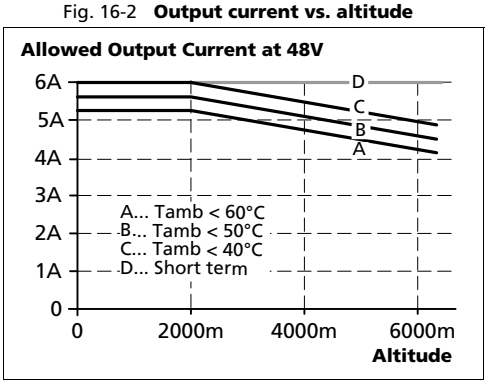


Fig. 16-2 **Output current vs. altitude**



17. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits. In case of a protection event, audible noise may occur.	
Output over-voltage protection	Typ. 58.5Vdc Max. 60Vdc	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
Penetration protection	> 4mm	E.g. screws, small parts
Over-temperature protection	Yes	Output shut-down with automatic restart. The temperature sensor is installed on critical components inside the unit and turns the unit off in safety critical situations (e.g. de-rating requirements not observed, high ambient temperature, ventilation obstructed or the mounting orientation de-rating is not followed). There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 15 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse

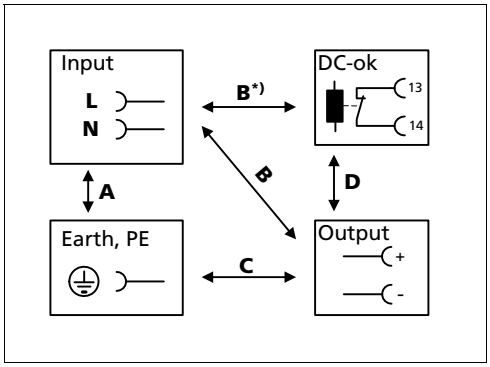
18. SAFETY FEATURES

Input / output separation	Double or reinforced galvanic isolation	
	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 62477-1, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 500MOhm	At delivered condition between input and output, measured with 500Vdc
	> 500MOhm	At delivered condition between input and PE, measured with 500Vdc
	> 500MOhm	At delivered condition between output and PE, measured with 500Vdc
	> 500MOhm	At delivered condition between output and DC-OK contacts, measured with 500Vdc
PE resistance	< 0.1Ohm	Resistance between PE terminal and the housing in the area of the DIN-rail mounting bracket.
Touch current (leakage current)	Typ. 0.14mA / 0.36mA	At 100Vac, 50Hz, TN-,TT-mains / IT-mains
	Typ. 0.20mA / 0.50mA	At 120Vac, 60Hz, TN-,TT-mains / IT-mains
	Typ. 0.33mA / 0.86mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max. 0.18mA / 0.43mA	At 110Vac, 50Hz, TN-,TT-mains / IT-mains
	Max. 0.26mA / 0.61mA	At 132Vac, 60Hz, TN-,TT-mains / IT-mains
	Max. 0.44mA / 1.05mA	At 264Vac, 50Hz, TN-,TT-mains / IT-mains

19. 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 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.

Fig. 19-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	4000Vac	1000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 10mA	> 10mA	> 20mA	> 1mA

To fulfil the PELV requirements according to EN60204-1 § 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 can not be switched off when unnoticed earth faults occur.

B*) When testing input to DC-OK ensure that the max. 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.

20. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive, - Low-voltage directive (LVD) and the - ATEX directive
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL US LISTED IND. CONT. EQ.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
UL 60950-1 2nd Edition	c RU US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
ANSI / ISA 12.12.01-2015 Class I Div 2	c SP US	Recognized for use in Hazardous Location Class I Div 2 T4 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2015) and Canada (C22.2 No. 213-M1987)
EN 60079-0, EN 60079-15 ATEX	Ex II 3G Ex nA nC IIC T4 Gc	Approval for use in hazardous locations Zone 2 Category 3G. Number of ATEX certificate: EPS 15 ATEX 1 101 X The power supply must be built-in in an IP54 enclosure.
IEC 60079-0, IEC 60079-15	IECEx	Suitable for use in Class 1 Zone 2 Groups IIa, IIb and IIc locations. Number of IECEx certificate: IECEx EPS 15.0079X
Marine	GL	GL (Germanischer Lloyd) classified Environmental category: C, EMC2 Marine and offshore applications
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

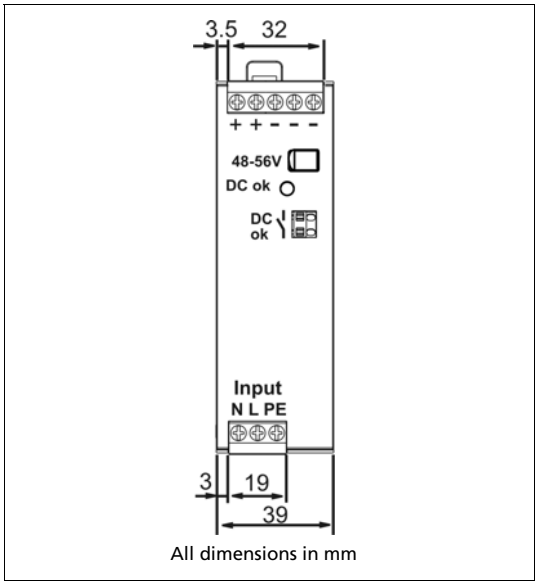
21. OTHER FULFILLED STANDARDS

RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
IEC/EN 61558-2-16 (Annex BB)	Safety Isolating Transformer	Safety Isolating Transformers corresponding to Part 2-6 of the IEC/EN 61558

22. PHYSICAL DIMENSIONS AND WEIGHT

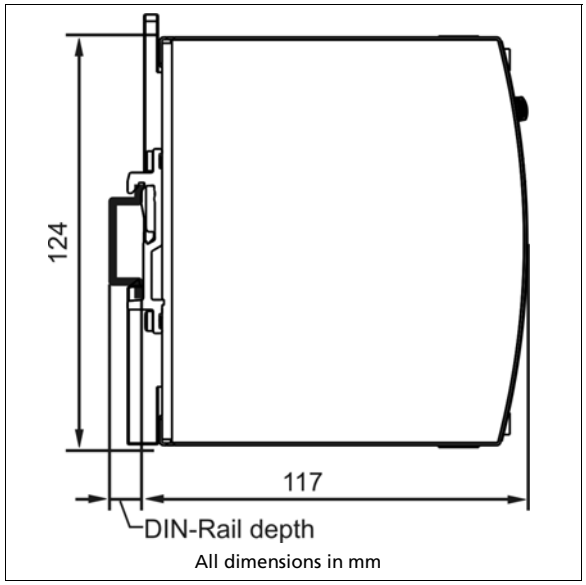
Width	39mm 1.54''
Height	124mm 4.88''
Depth	117mm 4.61'' The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	600g / 1.3lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: zinc-plated steel
Installation clearances	See chapter 2

Fig. 22-1
Front view



All dimensions in mm

Fig. 22-2
Side view



All dimensions in mm

23. ACCESSORIES

23.1. ZM4.WALL – WALL/PANEL MOUNT BRACKET

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

Fig. 23-1 **Isometric view**

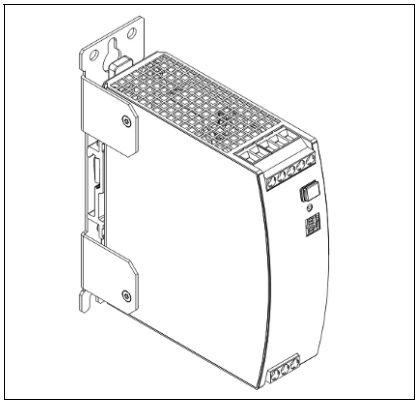


Fig. 23-2 **Isometric view**

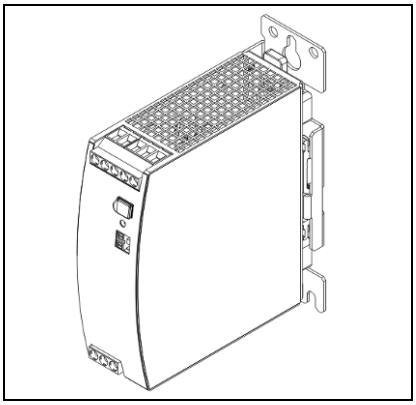


Fig. 23-3 **Isometric view**

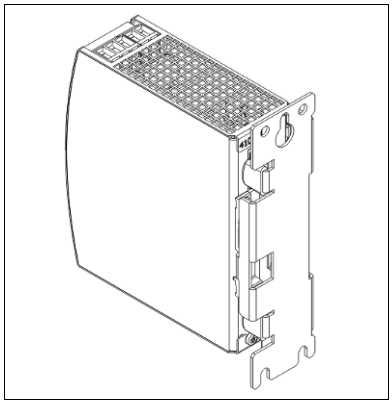


Fig. 23-4 **Wall/panel mounting, front view**

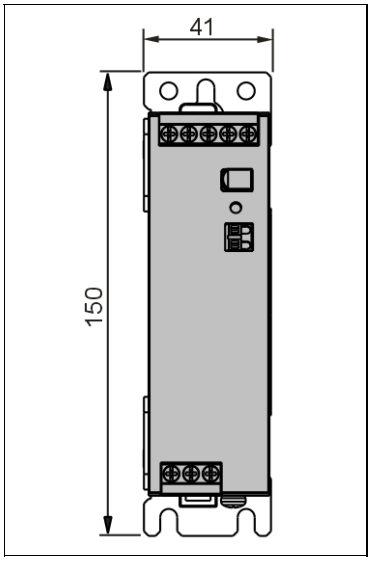


Fig. 23-5 **Hole pattern for wall mounting**

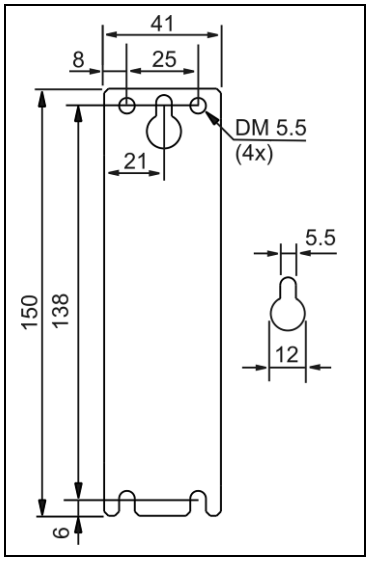
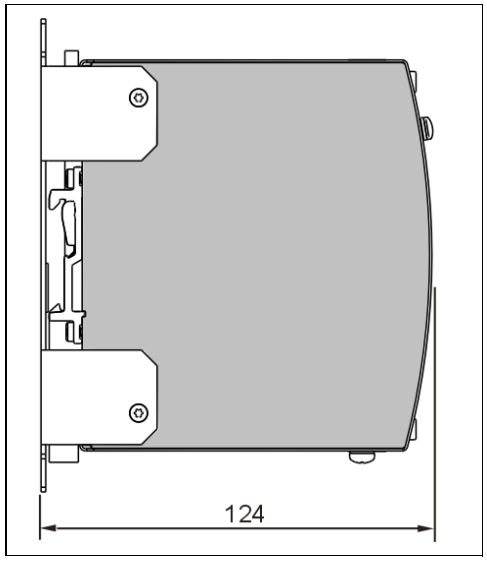


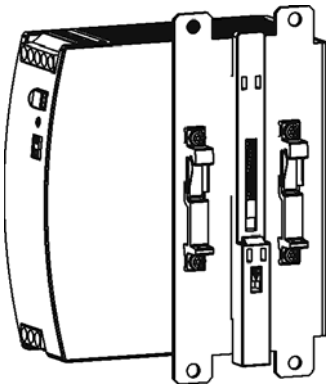
Fig. 23-6 **Wall/panel mounting, side view**



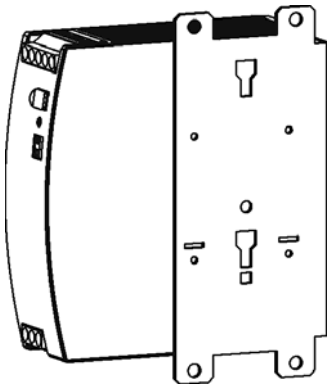
23.2. ZM12.SIDE - SIDE MOUNTING BRACKET

This bracket is used to mount DIMENSION units sideways with or without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted.

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



Side mounting with DIN-rail brackets



Side mounting without DIN-rail brackets

23.3. REDUNDANCY MODULES

YR2.DIODE – 2x 10A Inputs, 1x 20A output

The YR2.DIODE is a dual redundancy module, which has two diodes as decoupling devices included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.

The YR2.DIODE does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

The unit is very slender and only requires 32mm width on the DIN-rail.

YR40.482 – 2x 20A Inputs, 1x 40A output

The YR40.482 is equipped with two input channels, which are individually decoupled by utilizing MOSFET technology. Using MOSFETs instead of diodes reduces the heat generation and the voltage drop between input and output. The YR40.482 does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

Due to the low power losses, the unit is very slender and only requires 46mm width on the DIN-rail.

Fig. 23-7 **Typical 1+1 Redundant configuration for 5A with the YR2.DIODE redundancy module**

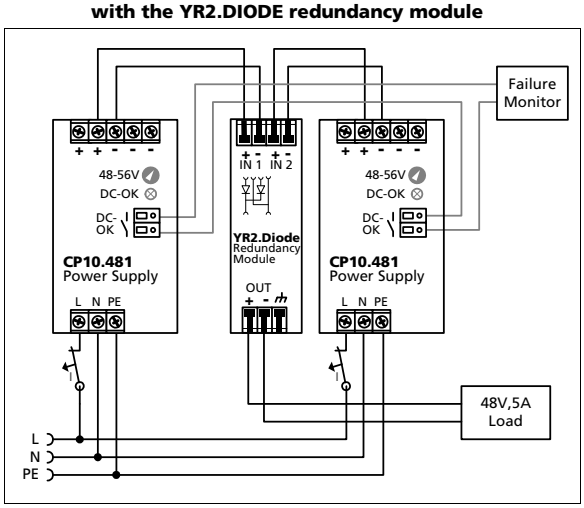
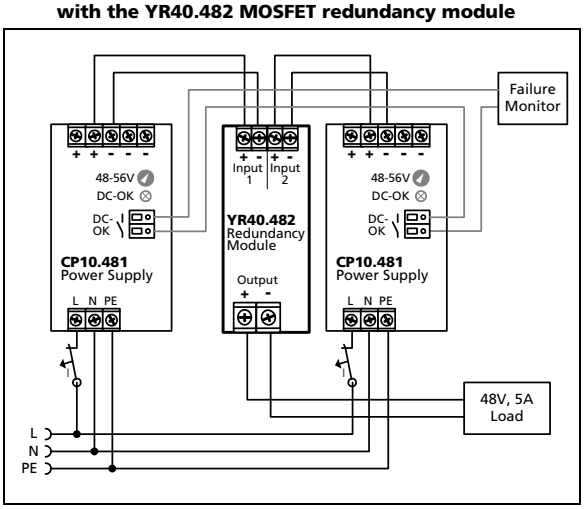


Fig. 23-8 **Typical 1+1 Redundant configuration for 5A with the YR40.482 MOSFET redundancy module**



24. APPLICATION NOTES

24.1. 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 nominal output current (including the PowerBoost). 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 for resistive loads:

Fig. 24-1 **10.8A peak current for 50ms , typ. (2x the nominal current)**

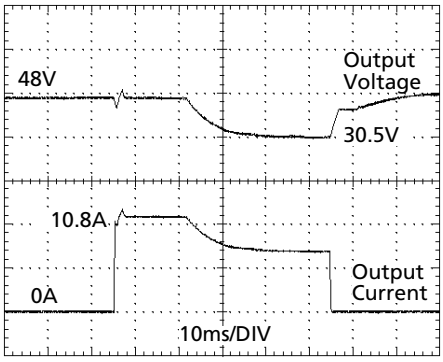


Fig. 24-2 **27A peak current for 5ms , typ. (5x the nominal current)**

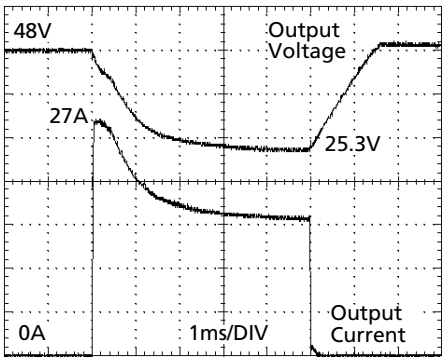
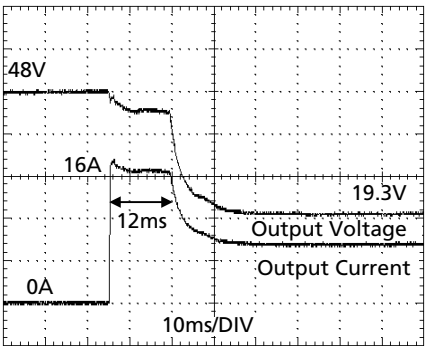


Fig. 24-3 **16A peak current for 12ms , typ. (3x the nominal current)**



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

Peak current voltage dips	Typically from 48V to 30.5V	At 10.8A for 50ms, resistive load
	Typically from 48V to 30.0V	At 27A for 2ms, resistive load
	Typically from 48V to 25.3V	At 27A for 5ms, resistive load

24.2. 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 63Vdc. The maximum allowed feed-back peak current is 21A. Higher currents can temporarily shut-down the output voltage. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 6.

24.3. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 30A (UL) and 32A (IEC). An external protection is only required if the supplying branch has an ampacity greater than this. Check also local codes and local requirements. In some countries local regulations might apply.

If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 6A B- or C-Characteristic breaker should be used.

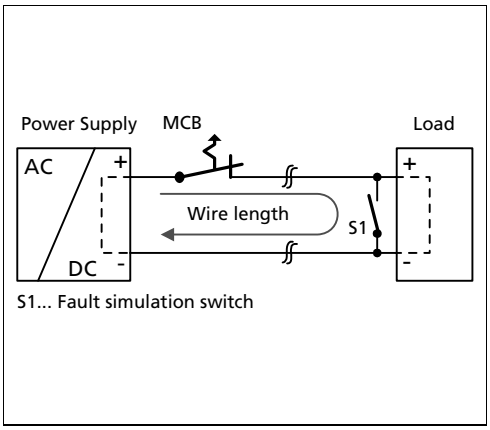
24.4. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCB's or UL 1077 circuit breakers) are commonly used for AC-supply systems and may also be used on 48V 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 48V 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. 24-4 **Test circuit**



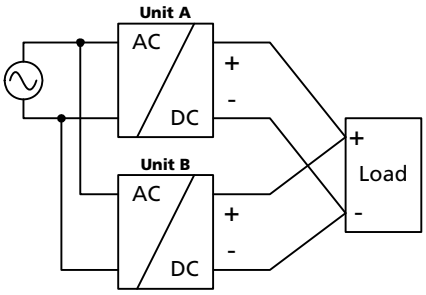
S1... Fault simulation switch

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

	0.75mm²	1.0mm²	1.5mm²	2.5mm²
C-2A	42m	49m	59m	109m
C-3A	13m	24m	28m	42m

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

24.5. PARALLEL USE TO INCREASE OUTPUT POWER



CP10.481 power supplies can be paralleled to increase the output power. The output voltage of all power supplies shall be adjusted to the same value (±100mV) with the same load conditions on all units, or the units can be left with the factory settings. There is no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 40°C.

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 10A or 12A is required on each output. Alternatively, a diode or redundancy module can also be utilized.

Energize all units at the same time to avoid the overload Hiccup^{PLUS} mode. It also might be necessary to cycle the input power (turn-off for at least five seconds), if the output was in Hiccup^{PLUS} mode due to overload or short circuits and the required output current is higher than the current of one unit.

Restrictions:
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 bottom of the unit) or in any other condition where a derating of the output current is required (e.g. altitude, …).

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

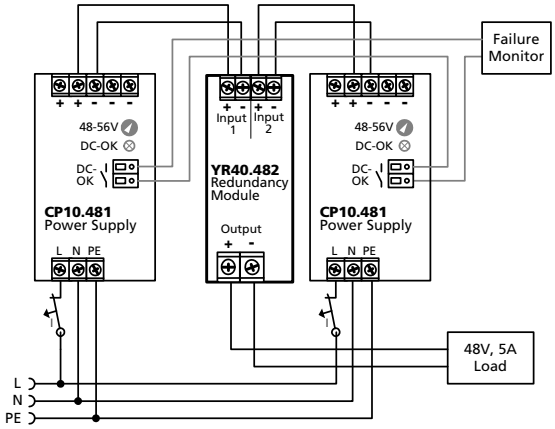
24.6. PARALLEL USE FOR REDUNDANCY

Power supplies 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 decoupled power supplies in parallel. This is called a 1+1 redundancy. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five power supplies, each rated for 5A are paralleled to build a 20A redundant system. For N+1 redundancy the same restrictions apply as for increasing the output power, see also chapter 24.5.

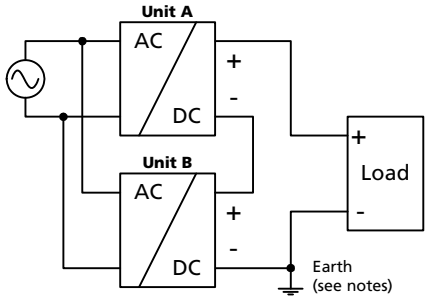
Please note: Always use a redundancy module to decouple power supplies from each other. This prevents that the defective unit becomes a load for the other power supplies and the output voltage cannot be maintained any more. Further information and wiring configurations can be found in chapter 23.3.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.
b) Monitor the individual power supply units. Therefore, use the DC-OK relay contact of the CP10 power supply.
c) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.



24.7. 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 any more 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.

Restrictions:
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 bottom of the unit).

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

24.8. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply any kind of loads, including capacitive and inductive loads. If extreme large capacitors, such as EDLCs (electric double layer capacitors or "UltraCaps") with a capacitance larger than 0.5F are connected to the output, the unit might charge the capacitor in the Hiccup^{PLUS} mode (see chapter 6).

24.9. CHARGING OF BATTERIES

The power supply can be used to charge lead-acid or maintenance free batteries (SLA or VRLA batteries). Four 12V batteries are needed in series.

Instructions for charging batteries:

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

End-of-charge voltage	55.6V	55.0V	54.3V	53.6V
Battery temperature	10°C	20°C	30°C	40°C

b) Use a 10A or 12A circuit breaker (or blocking diode) between the power supply and the battery.

c) Ensure that the output current of the power supply is below the allowed charging current of the battery.

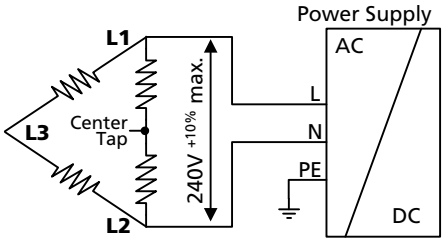
d) Use only matched batteries when putting 12V types in series.

e) Ensure that the ambient temperature of the power supply stays below 40°C.

f) The return current to the power supply (battery discharge current is typ. 1.8mA when the power supply is switched off (except in case a blocking diode is utilized).

24.10. OPERATION ON TWO PHASES

The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$.



24.11. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box, no other heat producing items are inside the box

The temperature sensor inside the box is placed in the middle of the right side of the power supply with a distance of 1cm.

	Case A	**Case B**	**Case C**	**Case D**
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100, plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100, plastic	**180**x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic	**180**x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic
Input voltage	230Vac	230Vac	230Vac	230Vac
Load	48V, 4.3A; (=**80%**)	48V, 5.4A; (=**100%**)	48V, 4.3A; (=**80%**)	48V, 5.4A; (=**100%**)
Temperature inside the box	43.7°C	48.6°C	40.9°C	45.0°C
Temperature outside the box	24.1°C	25.4°C	23.9°C	25.0°C
Temperature rise	19.6K	23.2K	17.0K	20.0K

24.12. 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. 24-5
Mounting Orientation A
(Standard orientation)

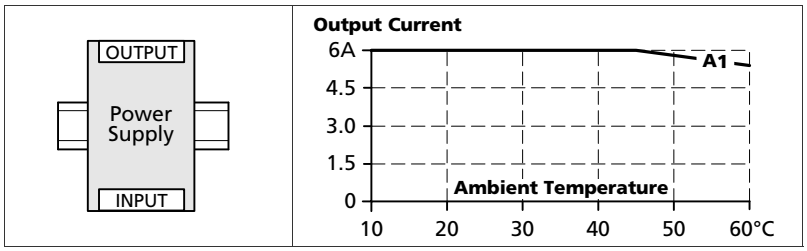


Fig. 24-6
Mounting Orientation B
(Upside down)

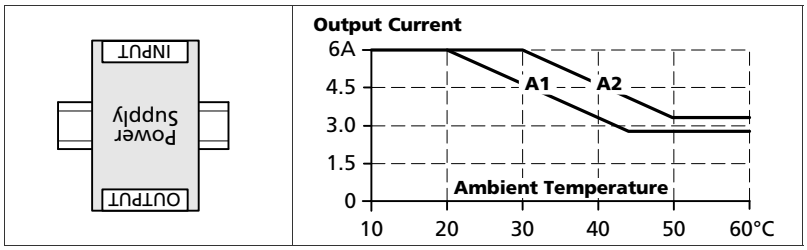


Fig. 24-7
Mounting Orientation C
(Table-top mounting)

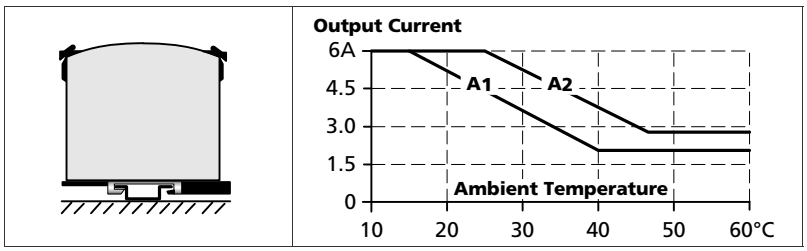


Fig. 24-8
Mounting Orientation D
(Horizontal cw)

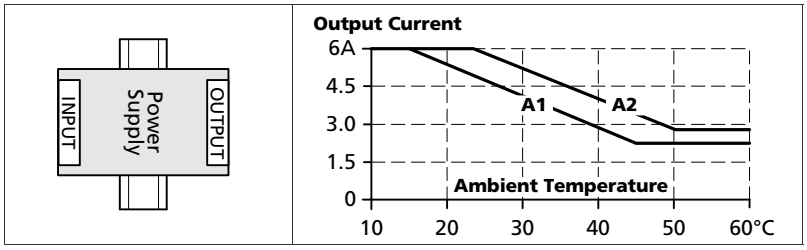
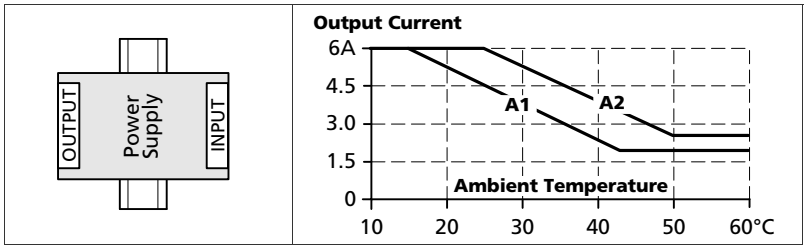


Fig. 24-9
Mounting Orientation E
(Horizontal ccw)



CP20.241, CP20.241-C1, CP20.241-S1, CP20.241-S2, CP20.241-V1, CP20.242

DIMENSION **CP-Series**

24V, 20A, 480W, SINGLE PHASE

POWER SUPPLY

- AC 100-240V Wide-range Input
- Width only 48mm
- Efficiency up to 95.6%
- Excellent Partial Load Efficiency
- 20% Output Power Reserves
- Easy Fuse Breaking – 3 times nominal current for 12ms
- Safe Hiccup^{PLUS} Overload Mode
- Active Power Factor Correction (PFC)
- Minimal Inrush Current Surge
- Full Power Between -25°C and +60°C
- DC-OK Relay Contact
- Current Sharing Feature for Parallel Use
- 3 Year Warranty

PRODUCT DESCRIPTION

The Dimension CP-Series are cost optimized power supplies without compromising quality, reliability and performance. The most outstanding features of the CP20 series are the high efficiency, electronic inrush current limitation, active PFC, wide operational temperature range and the extraordinary small size.

The CP20.241-C1 is equipped with conformal coated pc-boards preferred for applications in harsh areas.

The CP20.241-S1 is equipped with quick-connect spring-clamp terminals preferred for applications which are exposed to mechanical vibration. The CP20.241-S2 has push-in terminals optimized for easy cabinet wiring.

The CP20.241-V1 is equipped with a remote ON/OFF feature and the CP20.242 features an enhanced DC input voltage range.

The devices have a power reserve of 20% included, which may even be used continuously up to +45°C.

High immunity to transients and power surges as well as low electromagnetic emission, a DC-OK relay contact and a large international approval package makes this unit suitable for nearly every situation.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24 - 28V	Factory setting 24.1V
Output current	24.0 - 20.6A	Below +45°C ambient
	20.0 – 17.1A	At +60°C ambient
	15.0 – 13.0A	At +70°C ambient
	Derate linearly between +45°C and +70°C	
Input voltage AC	AC 100-240V	-15%/+10%
Mains frequency	50-60Hz	±6%
Input current AC	4.26 / 2.23A	At 120 / 230Vac
Power factor	0.99 / 0.98	At 120 / 230Vac
Input voltage DC	DC 110-150V$^{\pm 20\%}$	For CP20.241 (-xx)
	DC 110-300V$^{\pm 20\%}$	For CP20.242
Input current DC	4.64A / 1.66A	At 110 / 300Vdc
AC Inrush current	10.0 / 4.5Apk	At 120 / 230Vac
Efficiency	94.2 / 95.6%	At 120 / 230Vac
Losses	29.6 / 22.1W	At 120 / 230Vac
Hold-up time	32/ 32ms	At 120 / 230Vac
Temperature range	-25°C to +70°C	
Size (WxHxD)	48x124x127mm	Without DIN-rail
Weight	830g / 1.83lb	

ORDER NUMBERS

Power Supply	**CP20.241**	
	CP20.241-C1	With conformal coated pc-boards
	CP20.241-S1	With quick-connect spring-clamp terminals
	CP20.241-S2	With push-in terminals
	CP20.241-V1	With remote ON/OFF feature
	CP20.242	Enhanced DC input
Mechanical Accessory		
	ZM5.WALL	Wall/Panel mount bracket

MAIN APPROVALS

For details or a complete approval list see section 20.

c UL US LISTED IND. CONT. EQ. IECEx ATEX CE

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 230V parameters are valid at 50Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for commercial use, such as in industrial control, process control, monitoring and measurement equipment or the like.

Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

2. INSTALLATION INSTRUCTIONS

⚠ WARNING **Risk of electrical shock, fire, personal injury or death**

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not modify or repair the unit.
- Do not open the unit 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 surfaces may cause burns.

Obey the following installation instructions:

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 the 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.

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 isolation of the device is designed to withstand impulse voltages of overvoltage category III 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. Use the terminal on the input block for earth connection and not one of the screws on the housing.

The device is suitable to be supplied from TN-, TT- and IT mains networks. The voltage between the L or N terminal and the PE terminal must not exceed 300Vac continuously.

The input can also be powered from batteries or similar DC sources. The voltage between the input terminal and the PE terminal must not exceed 375Vdc continuously.

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 6000m (19685ft). See additional requirements in the product datasheet for use above 2000m (6560ft).

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.

The device is designed, tested and approved for branch circuits up to 32A (IEC) and 30A (UL) without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 10A B- or C-Characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +70°C (+158°F). 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.

Installation instructions for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations. See chapter 20 for details.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment or S/P jumper unless power has been switched off or the area is known to be non-hazardous.

Wiring must be in accordance with Class I, Division 2 wiring methods of the National Electrical Code, NFPA 70, and in accordance with other local or national codes.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-0.

3. AC-INPUT

The device is suitable to be supplied from TN-, TT- and IT mains networks with AC voltage. For suitable DC supply voltages see chapter 4.

AC input	Nom.	AC 100-240V	
AC input range	Min.	85-264Vac	Continuous operation
	Min.	264-300Vac	Occasionally for maximal 500ms
Allowed voltage L or N to earth	Max.	300Vac	Continuous, according to IEC 60664-1
Input frequency	Nom.	50–60Hz	±6%
Turn-on voltage	Typ.	82Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	Typ.	72Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	AC 120V	AC 230V	
Input current	Typ.	5.15A	4.26A	2.23A	At 24V, 20A, see Fig. 3-3
Power factor	Typ.	0.996	0.996	0.980	At 24V, 20A, see Fig. 3-4
Crest factor*)	Typ.	1.65	1.63	1.63	At 24V, 20A, The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
Start-up delay	Typ.	450ms	450ms	450ms	See Fig. 3-2
Rise time	Typ.	145ms	145ms	145ms	At 24V, 20A const. current load, 0mF load capacitance, see Fig. 3-2
	Typ.	160ms	160ms	160ms	At 24V, 20A const. current load, 20mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	200mV	200mV	In single use mode, see Fig. 3-2

Fig. 3-1 **Input voltage range**

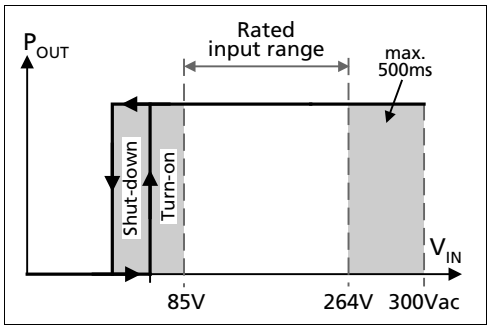


Fig. 3-2 **Turn-on behavior, definitions**

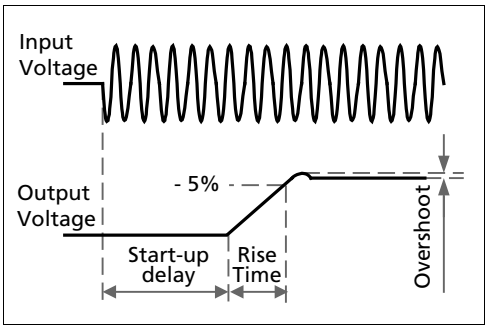


Fig. 3-3 **Input current vs. output current at 24V output voltage**

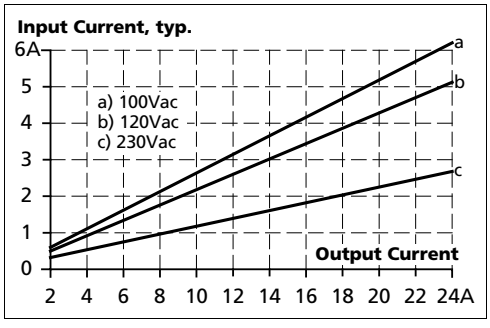
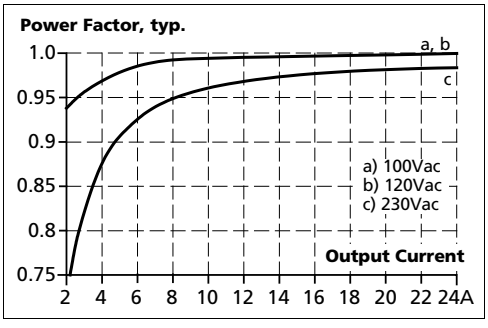


Fig. 3-4 **Power factor vs. output current at 24V output voltage**



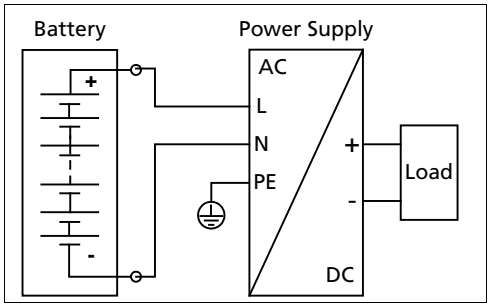
4. DC-INPUT

The device is suitable to be supplied from a DC input voltage. Use a battery or a similar DC source. A supply from the intermediate DC-bus of a frequency converter is not recommended and can cause a malfunction or damage the unit.

Connect +pole to L, –pole to N and the PE terminal to an earth wire or to the machine ground.

DC input	Nom.	DC 110-150V	±20% For CP20.241, CP20.241-C1, CP20.241-S1, CP20.241-S2, CP20.241-V1
	Nom.	DC 110-300V	±20% For CP20.242
DC input range	Min.	88-180Vdc	Continuous operation for CP20.241, CP20.241-C1, CP20.241-S1, CP20.241-S2, CP20.241-V1
		88-360Vdc	Continuous operation for CP20.242
DC input current	Typ.	4.64A	At 110Vdc, at 24V, 20A
	Typ.	1.66A	At 300Vdc, at 24V, 20A
Allowed Voltage (+) or (-) input to Earth	Max.	375Vdc	Continuous according to IEC 60664-1
Turn-on voltage	Typ.	80Vdc	Steady state value
Shut-down voltage	Typ.	70Vdc	Steady state value

Fig. 4-1 **Wiring for DC Input**

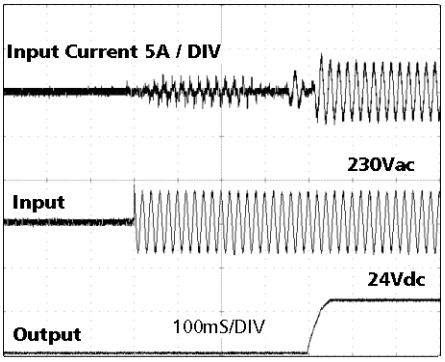


5. INPUT INRUSH CURRENT

An active inrush limitation circuit 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.

		AC 100V	AC 120V	AC 230V	
Inrush current	Max.	$15A_{peak}$	$12A_{peak}$	$5.5A_{peak}$	Temperature independent
	Typ.	$12A_{peak}$	$10A_{peak}$	$4.5A_{peak}$	Temperature independent
Inrush energy	Max.	$1A^2s$	$1A^2s$	$1A^2s$	Temperature independent

Fig. 5-1 **Typical turn-on behavior at nominal load and 25°C ambient**



6. OUTPUT

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage.

The device is designed to supply any kind of loads, including capacitive and inductive loads. If extreme large capacitors, such as EDLCs (electric double layer capacitors or "UltraCaps") with a capacitance > 1F are connected to the output, the unit might charge the capacitor in an intermittent mode.

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.	24V	
Adjustment range	Min.	24-28V	Guaranteed value
	Max.	30V	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 output voltage	Typ.	24.1V	±0.2% in "single use" mode at full load, cold unit
	Typ.	24.1V	±0.2% in "parallel use" mode at 20A, cold unit (results to 23.9V ±0.2% at 24A and 25.1V ±0.2% at no load)
Line regulation	Max.	10mV	Between 85 and 300Vac input voltage change
Load regulation	Max.	100mV	Between 0 and 24A in "single use" mode, static value
	Typ.	1000mV	Between 0 and 20A in "parallel use" mode, static value, see Fig. 6-2
Ripple and noise voltage	Max.	50mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	24A[1)]	At 24V and an ambient temperature below 45°C
	Nom.	20A	At 24V and 60°C ambient temperature
	Nom.	15A	At 24V and 70°C ambient temperature
	Nom.	20.6A[1)]	At 28V and an ambient temperature below 45°C
	Nom.	17.1A	At 28V and 60°C ambient temperature
	Nom.	13A	At 28V and 70°C ambient temperature
		Derate linearely between +45°C and +70°C	
Fuse breaking current	Typ.	60A	Up to 12ms once every five seconds, see Fig. 6-4. The fuse braking current is an enhanced transient current which helps to trip fuses on faulty output branches. The output voltage stays above 20V.
Overload behavior		Continuous current	For output voltage above 13Vdc, see Fig. 6-1
		Intermittent current[2)]	For output voltage below 13Vdc, see Fig. 6-1
Overload/ short-circuit current	Max.	29.8A	Continuous current, see Fig. 6-1
	Typ.	29A	Intermitted current peak value for typ. 2s Load impedance 10mOhm, see Fig. 6-3 Discharge current of output capacitors is not included.
	Max.	9.8A	Intermitted current average value (R.M.S.) Load impedance 10mOhm, see Fig. 6-3
Output capacitance	Typ.	8 500µF	Included inside the power supply
Back-feeding loads	Max.	35V	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.

1) This current is also available for temperatures up to +70°C with a duty cycle of 10% and/ or not longer than 1 minute every 10 minutes.

2) At heavy overloads (when output voltage falls below 13V), the power supply delivers continuous output current for 2s. After this, the output is switched off for approx. 18s before a new start attempt is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally. See Fig. 6-3.

Fig. 6-1 **Output voltage vs. output current, typ.**

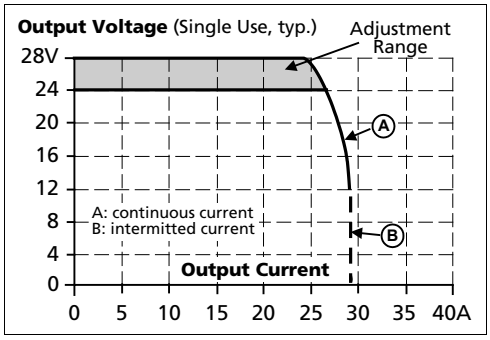


Fig. 6-2 **Output voltage in "parallel use" mode, typ.**

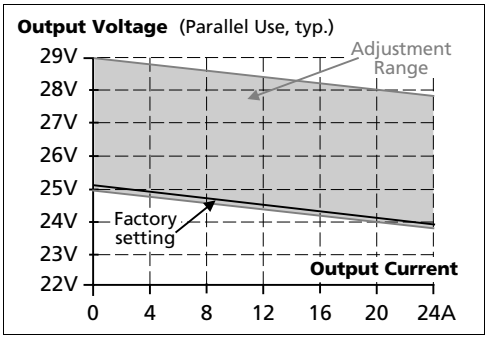


Fig. 6-3 **Short-circuit on output, Hiccup$^{PLUS®}$ mode, typ.**

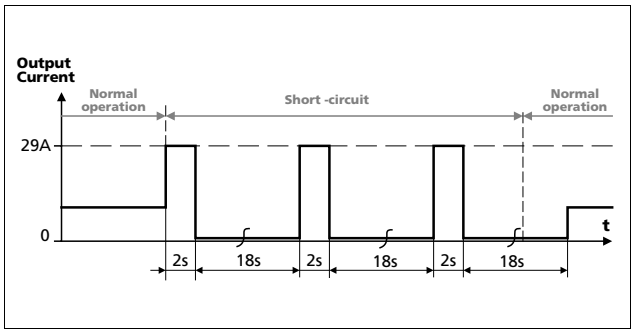
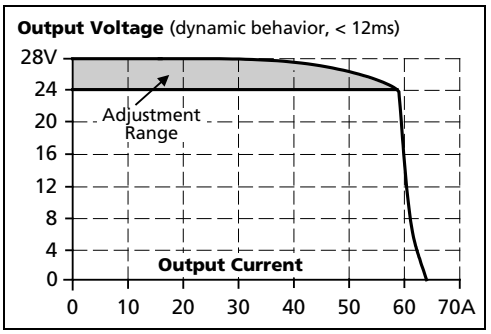


Fig. 6-4 **Dynamic overcurrent capability, typ.**



7. HOLD-UP TIME

The hold-up time is the time during which a power supply's output voltage remains within specification following the loss of input power. The hold-up time is output load dependent. At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up Time	Typ.	65ms	65ms	65ms	At 24V, 10A, see Fig. 7-1
	Min.	54ms	54ms	54ms	At 24V, 10A, see Fig. 7-1
	Typ.	32ms	32ms	32ms	At 24V, 20A, see Fig. 7-1
	Min.	24ms	24ms	24ms	At 24V, 20A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

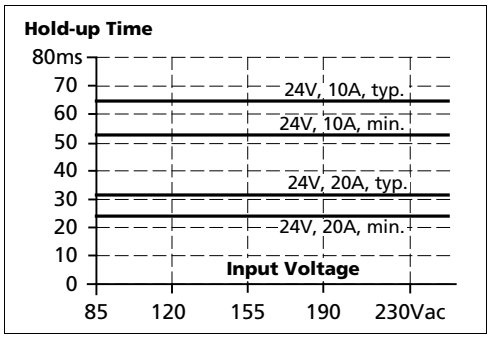
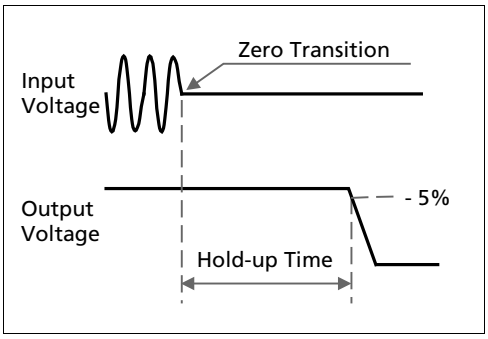


Fig. 7-2 **Shut-down behavior, definitions**

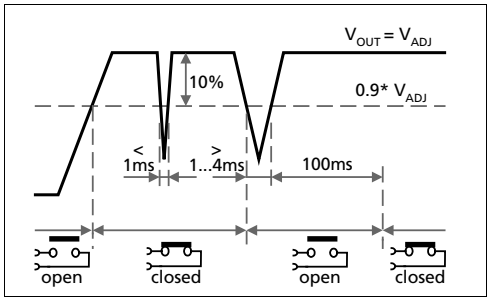


8. DC-OK RELAY CONTACT

This feature monitors the output voltage on the output terminals of a running power supply.

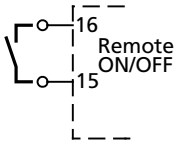
Contact closes	As soon as the output voltage reaches typ. 90% of the adjusted output voltage level.
Contact opens	As soon as the output voltage dips more than 10% below the adjusted output voltage. Short dips will be extended to a signal length of 100ms. Dips shorter than 1ms will be ignored.
Switching hysteresis	1V
Contact ratings	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
Isolation voltage	See dielectric strength table in section 18.

Fig. 8-1 **DC-ok relay contact behavior**



9. REMOTE ON / OFF FUNCTION

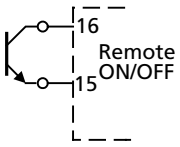
This feature is available only for the CP20.241-V1 and allows to switch-off the power supply output with a signal switch or transistor. A link between pin 15 and 16 turns the power supply on. Pin 15 is referenced to the (-) output voltage.



The open-loop voltage between pin 16 and pin 15 can be up to 18V. The maximum current, when in remote ON mode, can be up to 2.5mA.

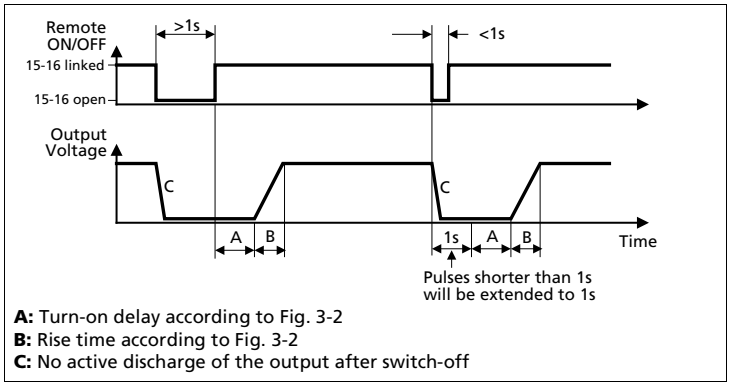
The threshold level to switch-off the output is typically 5V and the turn-on threshold is typically 9V.

When multiple power supplies are connected in parallel, pin 15 and pin 16 are also allowed to be paralleled to control all units with the same switch or transistor.



Please note: The remote ON/OFF function has no safety feature included.

Fig. 9-1 **The switch-off and the turn-on timing**



A: Turn-on delay according to Fig. 3-2
B: Rise time according to Fig. 3-2
C: No active discharge of the output after switch-off

10. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	Typ.	93.6%	94.2%	95.6%	At 24V, 20A
	Typ.	93.5%	94.1%	95.5%	At 24V, 24A (Power Boost)
Average efficiency*)	Typ.	93.2%	93.8%	95.0%	25% at 5A, 25% at 10A, 25% at 15A. 25% at 20A
Power losses	typ.	0.4W	0.5W	0.9W	CP20.241-V1 in "Remote OFF" mode
	Typ.	2.5W	2.2W	2.2W	At 24V, 0A
	Typ.	16.0W	15.0W	12.5W	At 24V, 10A
	Typ.	32.8W	29.6W	22.1W	At 24V, 20A
	Typ.	40.0W	36.1W	27.1W	At 24V, 24A (Power Boost)

*) 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. 10-1 **Efficiency vs. output current at 24V, typ**

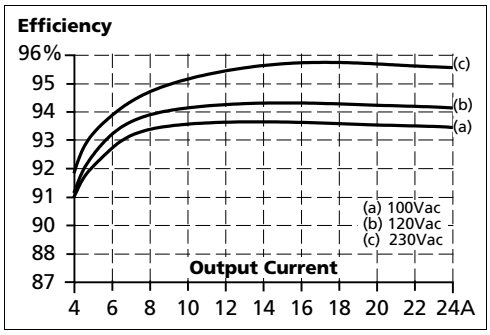


Fig. 10-2 **Losses vs. output current at 24V, typ.**

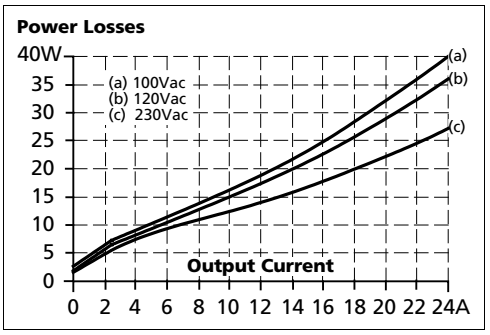


Fig. 10-3 **Efficiency vs. input voltage at 24V, 20A, typ.**

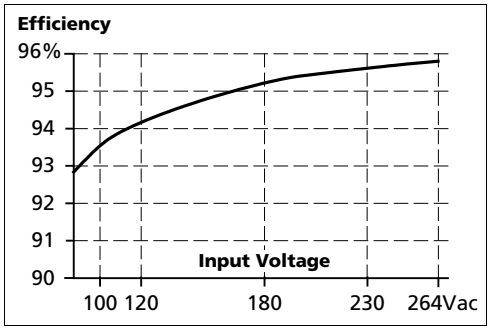
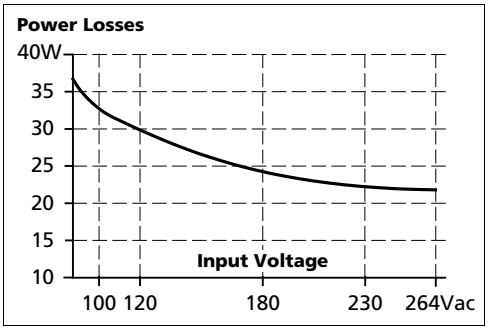


Fig. 10-4 **Losses vs. input voltage at 24V, 20A, typ.**



11. FUNCTIONAL DIAGRAM

Fig. 11-1 **Functional diagram CP20.241, CP20.241-C1, CP20,241-S1, CP20.242**

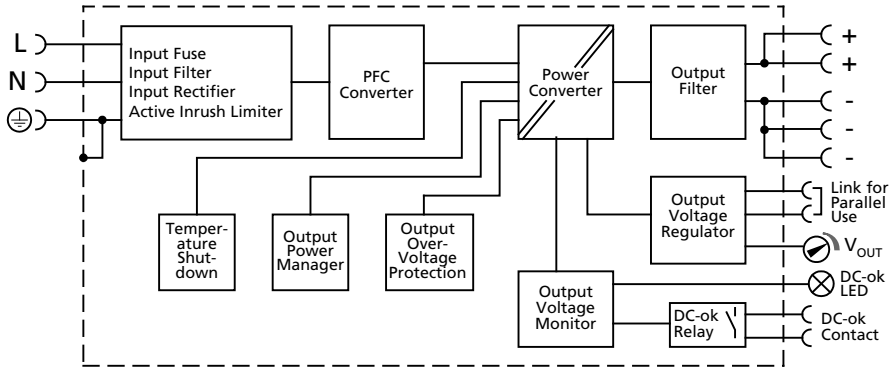


Fig. 11-2 **Functional diagram CP20.241-S2**

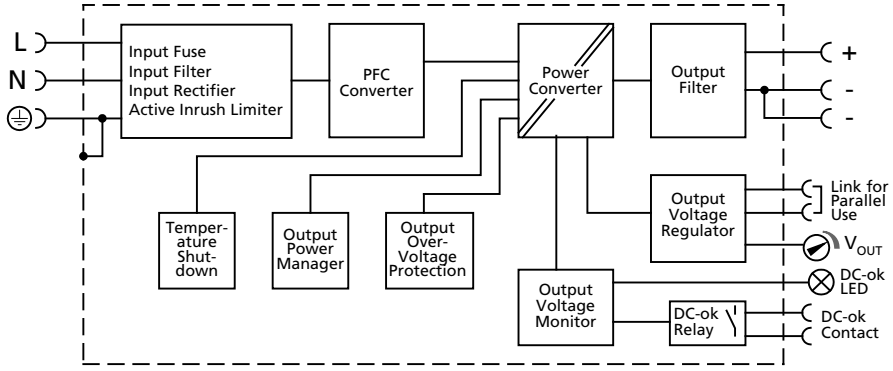
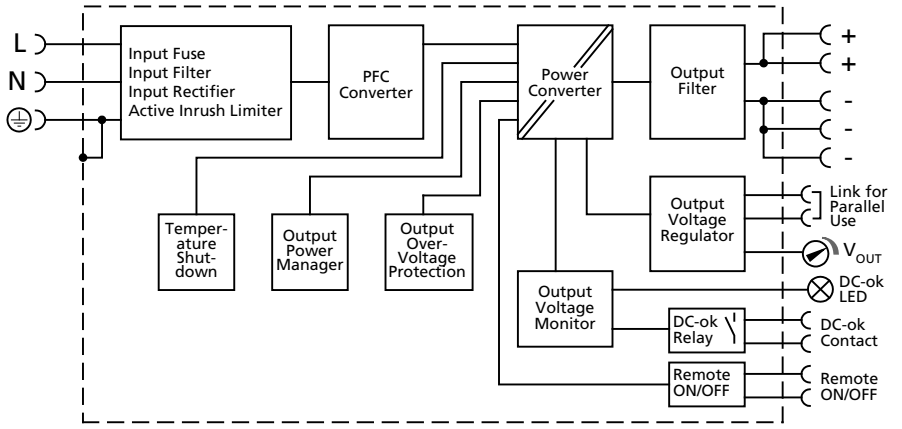


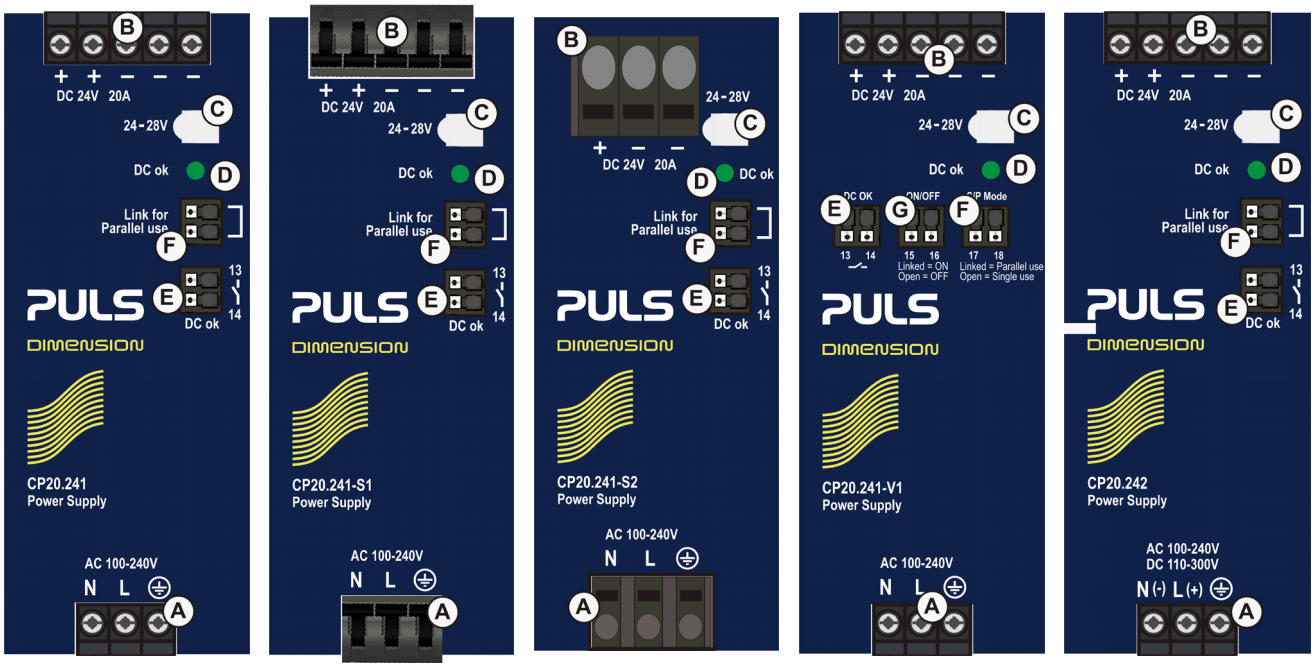
Fig. 11-3 **Functional diagram CP20.241-V1**



12. FRONT SIDE AND USER ELEMENTS

Fig. 12-1 **Front side**

CP20.241, CP20.241-C1 **CP20.241-S1** **CP20.241-S2** **CP20.241-V1** **CP10.242**



A **Input Terminals**
- **N, L** Line input
- ⏚ PE (Protective Earth) input

B **Output Terminals**
CP20.241-S2: one + pole and two identical - poles
All other units: two identical + poles and three identical - poles
- **+** Positive output
- **–** Negative (return) output

C **Output Voltage Potentiometer** Open the flap to adjust the output voltage. The factory setting is 24.1V.

D **DC-OK LED** (green) On, when the output voltage is >90% of the adjusted output voltage

E **DC-OK Relay Contact** The DC-OK relay contact is synchronized with the DC-OK LED. See chapter 8 for details.

F **"Parallel Use" "Single Use" Link**
Link the two terminal poles when power supplies are connected in parallel. 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. See also chapter 24.5.

G **Remote ON/OFF Input** Pin 15 and 16 must be connected to turn the power supply off. See chapter 9 for details.

13. CONNECTION TERMINALS

The terminals are IP20 Finger safe constructed and suitable for field- and factory wiring.

CP20.241, CP20.241-C1, CP20.241-V1, CP20.242	**Input**	**Output**	**Signal Terminals**
Type	Screw termination	Screw termination	Push-in termination
Solid wire	Max. 6mm²	Max. 6mm²	Max. 1.5mm²
Stranded wire	Max. 4mm²	Max. 4mm²	Max. 1.5mm²
American Wire Gauge	AWG 20-10	AWG 20-10	AWG 24-16
Max. wire diameter (including ferrules)	2.8mm	2.8mm	1.6mm
Recommended tightening torque	Max. 1Nm, 9lb-in	Max. 1Nm, 9lb-in	-
Wire stripping length	7mm / 0.28inch	7mm / 0.28inch	7mm / 0.28inch
Screwdriver	3.5mm slotted or cross-head No 2	3.5mm slotted or cross-head No 2	3mm slotted to open the spring

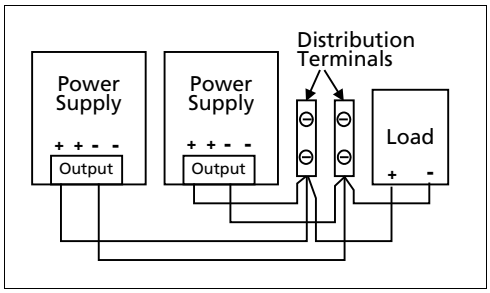
CP20.241-S1	**Input**	**Output**	**Signal Terminals**
Type	Quick-connect spring-clamp termination	Quick-connect spring-clamp termination	Push-in termination
Solid wire	Max. 6mm²	Max. 6mm²	Max. 1.5mm²
Stranded wire	Max. 4mm²	Max. 4mm²	Max. 1.5mm²
American Wire Gauge	AWG 20-10	AWG 20-10	AWG 24-16
Max. wire diameter (including ferrules)	2.8mm	2.8mm	1.6mm
Wire stripping length	10mm / 0.4inch	10mm / 0.4inch	7mm / 0.28inch
Screwdriver	-	-	3mm slotted to open the spring

CP20.241-S2	**Input**	**Output**	**Signal Terminals**
Type	Push-in termination	Push-in termination	Push-in termination
Solid wire	Max. 2.5mm²	Max. 10mm²	Max. 1.5mm²
Stranded wire	Max. 2.5mm²	Max. 6mm²	Max. 1.5mm²
Stranded wire with ferrules	Max. 1.5mm²	Max. 4mm²	Max. 1.5mm²
American Wire Gauge	AWG 24-12	AWG 24-8	AWG 24-16
Max. wire diameter (including ferrules)	2.3mm	3.3mm	1.6mm
Wire stripping length	10mm / 0.4inch	15mm / 0.6inch	7mm / 0.28inch
Screwdriver	3.0mm slotted to open the spring	3.5mm slotted to open the spring	3mm slotted to open the spring

Daisy chaining:

Daisy chaining (jumping from one power supply output to the next) is not allowed. Use a separate distribution terminal block as shown in Fig. 13-1.

Fig. 13-1 **Using distribution terminals**



14. LIFETIME EXPECTANCY

The 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.

	AC 100V	AC 120V	AC 230V	
Lifetime expectancy	48 000h	60 000h	94 000h	At 24V, 20A and 40°C
	123 000h	149 000h	173 000h	At 24V, 10A and 40°C
	23 000h	31 000h	54 000h	At 24V, 24A and 40°C
	136 000h	169 000h	265 000h	At 24V, 20A and 25°C
	348 000h	422 000h	488 000h	At 24V, 10A and 25°C
	64 000h	88 000h	152 000h	At 24V, 24A and 25°C

15. MTBF

MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

For these types of units the MTTF (**M**ean **T**ime **T**o **F**ailure) value is the same value as the MTBF value.

	AC 100V	AC 120V	AC 230V	
MTBF SN 29500, IEC 61709	422 000h	445 000h	590 000h	At 24V, 20A and 40°C
	790 000h	832 000h	1 060 000h	At 24V, 20A and 25°C
MTBF MIL HDBK 217F	186 000h	191 000h	226 000h	At 24V, 20A and 40°C; Ground Benign GB40
	256 000h	263 000h	313 000h	At 24V, 20A and 25°C; Ground Benign GB25
	40 000h	42 000h	50 000h	At 24V, 20A and 40°C; Ground Fixed GF40
	53 000h	55 000h	67 000h	At 24V, 20A and 25°C; Ground Fixed GF25

16. 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 output is allowed to be grounded or floating.

The device is investigated according to 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

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	20V/m	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	L → N L → PE, N → PE	2kV 2kV*)	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	1kV 2kV	Criterion A Criterion A
Surge voltage on DC-OK	EN 61000-4-5	Signal lines → PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	20V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11	0% of 200Vac (=0V)	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 0.3ms	Criterion A

***)** 4kV are planned for June 2019

Performance criterions:

A: Device shows normal operation behavior within the defined limits.

C: Temporary loss of function is possible. The device may shut-down and restarts by itself. No damage or hazards for the device will occur.

EMC Emission

Conducted emission input lines	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Fulfilled for Class A equipment Fulfilled for Class C equipment in the load range from 8 to 24A
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with constant current loads, non pulsing

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

PFC converter	100kHz	Fixed frequency
Main converter	80kHz to 140kHz	Output load dependent
Auxiliary converter	60kHz	Fixed frequency

17. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	The operational temperature is the ambient or surrounding temperature and is defined as the air temperature 2cm below the device.
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	6.4W/°C 12W/°C 1.33A/1000m or 5°C/1000m	Between +45°C and +60°C (113°F to 140°F) Between +60°C and +70°C (140°F to 158°F) For altitudes >2000m (6560ft), see Fig. 17-2
	The de-rating is not hardware controlled. The user has to 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	110-47kPa	See Fig. 17-2 for details
Altitude	Up to 6000m (19685ft)	See Fig. 17-2 for details
Over-voltage category	III	According to IEC 60664-1 for altitudes up to 2000m
	II	According to IEC 60664-1, for altitudes above 2000m
Degree of pollution	2	According to IEC 62477-1, not conductive
Vibration sinusoidal	2-17.8Hz: ±1.6mm 17.8-500Hz: 2g 2 hours / axis	According to IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction 18 bumps in total	According to IEC 60068-2-27
	Shock and vibration is tested in combination with DIN-Rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm and standard orientation.	
LABS compatibility	As a rule, only non-silicon precipitating materials are used. The unit conforms to the LABS criteria and is suitable for use in paint shops.	
Corrosive gases	Tested according to ISA-71.04-1985, Severity Level G3 and IEC 60068-2-60 Test Ke Method 4 for a service life of minimum 10years in these environments.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

Fig. 17-1 **Output current vs. ambient temp.**

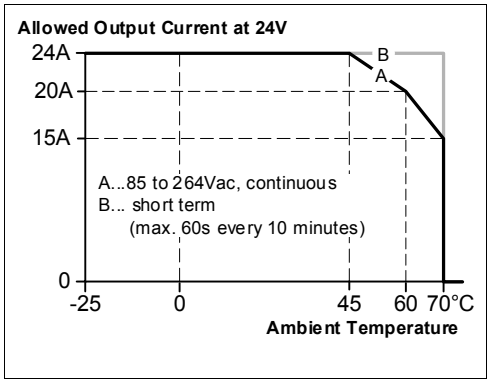
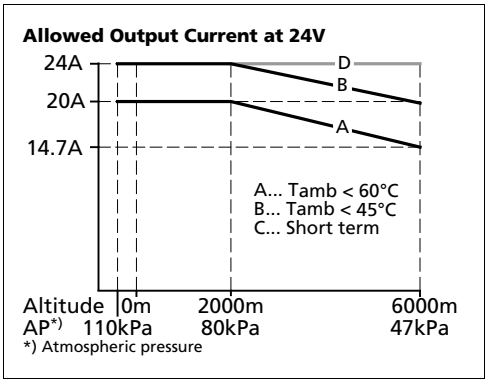


Fig. 17-2 **Output current vs. altitude**



18. SAFETY AND PROTECTION FEATURES

Isolation resistance	Min.	500MOhm	At delivered condition between input and output, measured with 500Vdc
	Min.	500MOhm	At delivered condition between input and PE, measured with 500Vdc
	Min.	500MOhm	At delivered condition between output and PE, measured with 500Vdc
	Min.	500MOhm	At delivered condition between output and DC-OK contacts, measured with 500Vdc
PE resistance	Max.	0.1Ohm	Resistance between PE terminal and the housing in the area of the DIN-rail mounting bracket.
Output over-voltage protection	Typ.	30.5Vdc	
	Max.	32Vdc	
		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 A PE (Protective Earth) connection is required
Degree of protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shuts down with automatic restart. Temperature sensors are installed on critical components inside the unit and turn the unit off in safety critical situations, which can happen e.g. when ambient temperature is too high, ventilation is obstructed or the de-rating requirements are not followed. There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.
Input transient protection		MOV (Metal Oxide Varistor)	For protection values see chapter 16 (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.12mA / 0.31mA	At 100Vac, 50Hz, TN-,TT-mains / IT-mains
	Typ.	0.18mA / 0.45mA	At 120Vac, 60Hz, TN-,TT-mains / IT-mains
	Typ.	0.30mA / 0.76mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.16mA / 0.38mA	At 110Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.23mA / 0.55mA	At 132Vac, 60Hz, TN-,TT-mains / IT-mains
	Max.	0.39mA / 0.94mA	At 264Vac, 50Hz, TN-,TT-mains / IT-mains

19. DIELECTRIC STRENGTH

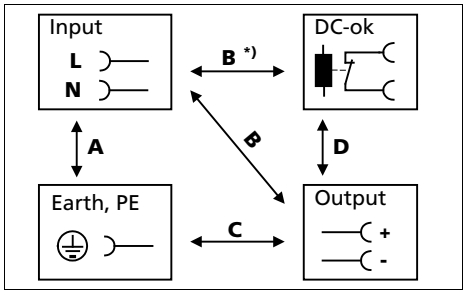
The output voltage is floating and has no ohmic connection to the ground.

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 (2s up and 2s 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.

We recommend that either the + pole or the – pole shall be connected to the protective earth system. This helps to avoid situations in which a load starts unexpectedly or can not be switched off when unnoticed earth faults occur.

Fig. 19-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	3000Vac	1000Vac	500Vac
Routine test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting for field test		> 10mA	> 10mA	> 20mA	> 1mA

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.

20. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - RoHS directive - EMC directive, - Low-voltage directive and the - ATEX directive
IEC 60950-1 2nd Edition (except for CP20.242)	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508 (except for CP20.242)	c UL US LISTED IND. CONT. EQ.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
UL 60950-1 2nd Edition (except for CP20.242)	c UL US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
EN 60079-0, EN 60079-7 ATEX (except for CP20.242)	Ex II 3G Ex ec nC II T4 Gc	Approval for use in hazardous locations Zone 2 Category 3G. Number of ATEX certificate: EPS 17 ATEX 1 089 X
IEC 60079-0, IEC 60079-7 (except for CP20.242)	IECEx	Suitable for use in Class 1 Zone 2 Groups IIa, IIb and IIc locations. Number of IECEx certificate: EPS 17.0046X
EAC TR Registration (except for CP20.241-V1 and CP20.242)	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

21. OTHER FULFILLED STANDARDS

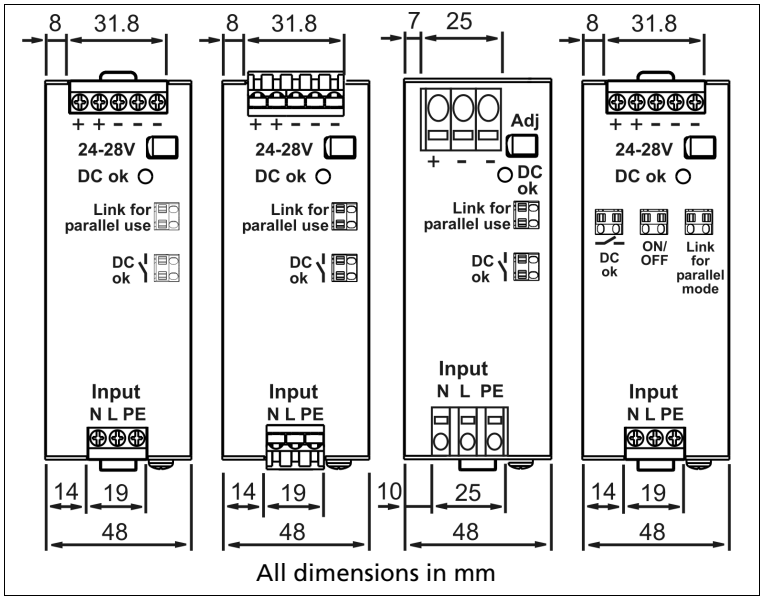
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
IEC/EN 61558-2-16 (Annex BB)	Safety Isolating Transformer	Safety Isolating Transformers corresponding to Part 2-6 of the IEC/EN 61558

22. PHYSICAL DIMENSIONS AND WEIGHT

Width	48mm 1.89''
Height	124mm 4.88''
Depth	127mm 5.0'' The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	830g / 1.83lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: zinc-plated steel
Installation clearances	See chapter 2
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 5mm

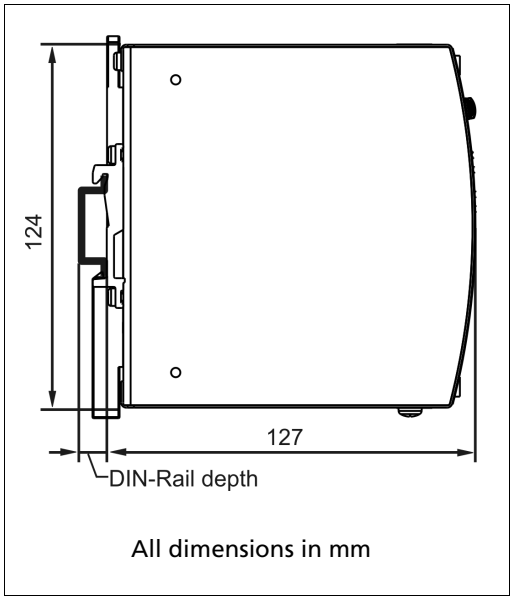
Fig. 22-1 **Front view**

CP20.241 CP20.241-S1 CP20.241-S2 CP20.241-V1
CP10.241-C1
CP10.242



All dimensions in mm

Fig. 22-2 **Side view**



All dimensions in mm

23. ACCESSORIES

23.1. ZM5.WALL – WALL/PANEL MOUNT BRACKET

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

Fig. 23-1 **Isometric view**
(Picture shows the CP20.241)

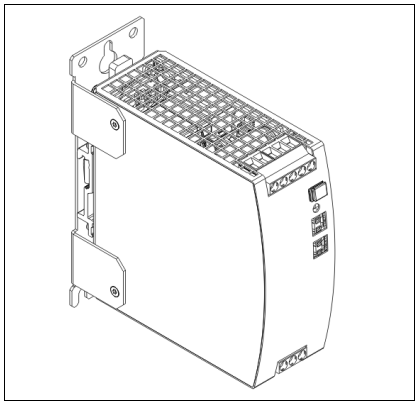


Fig. 23-2 **Isometric view-**
(Picture shows the CP20.241)

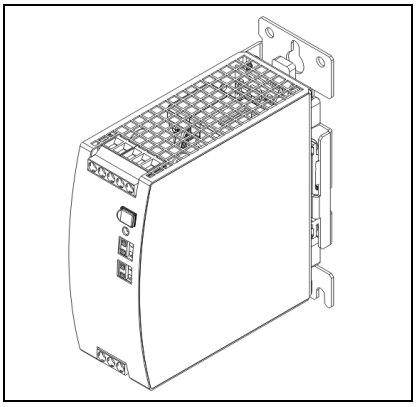


Fig. 23-3 **Isometric view**
(Picture shows the CP20.241)

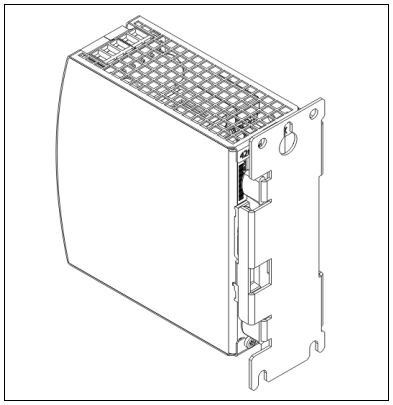
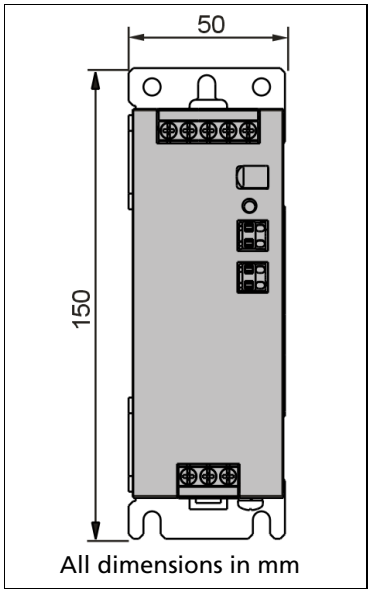
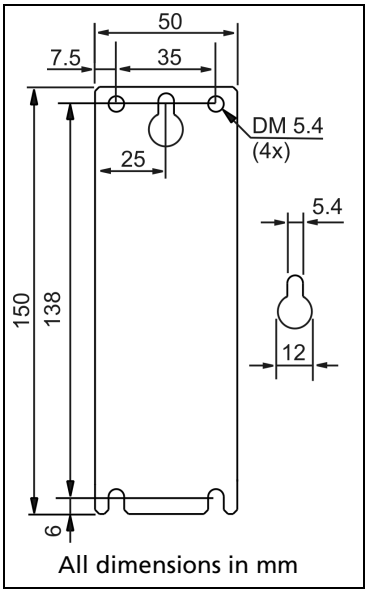


Fig. 23-4 **Wall/panel mounting, front view**
(Picture shows the CP20.241)



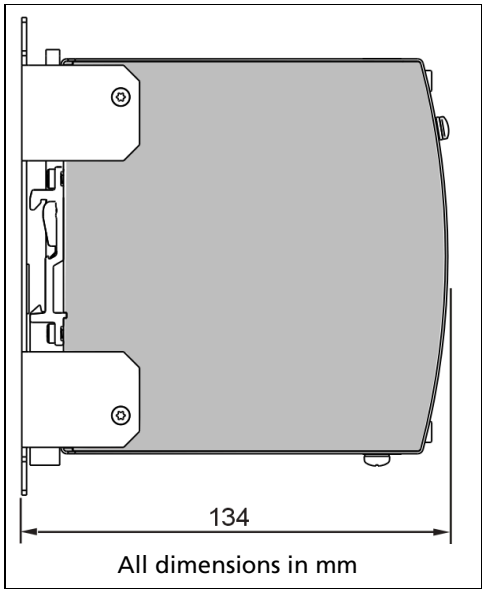
All dimensions in mm

Fig. 23-5 Hole pattern for wall mounting



All dimensions in mm

Fig. 23-6 **Wall/panel mounting, side view**
(Picture shows the CP20.241)



All dimensions in mm

23.2. UF20.241 BUFFER MODULE

The UF20.241 buffer module is a supplementary device for DC 24V power supplies. It delivers power to bridge typical mains failures or extends the hold-up time after the AC power is turned off.

When the power supply provides a sufficient voltage, the buffer module stores energy in the integrated electrolytic capacitors. When the mains voltage is lost, the stored energy is released to the DC-bus in a regulated process.

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

One buffer module can deliver 20A additional current and can be added in parallel to increase the output ampacity or the hold-up time.

23.3. YR40.241 - REDUNDANCY MODULE

The YR40.241 is a dual redundancy module, which can be used to build 1+1 or N+1 redundant systems.

The device is equipped with two 20A nominal input channels, which are individually decoupled by utilizing MOSFET technology. The output can be loaded with a nominal 40A continuous current.

Using MOSFETSs instead of diodes reduces heat generation, losses and voltage drop between input and output. Due to these advantages, the unit is very narrow and only requires 36mm width on the DIN-rail.

The device does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

A feature of this redundancy module is a special circuit, which keeps the losses and temperature low, even at overload and short circuit conditions up to 65A continuous current.

See chapter 24.6 for wiring information.

23.4. YR40.242 - REDUNDANCY MODULE

The YR40.242 is a dual redundancy module, which can be used to build 1+1 or N+1 redundant systems.

The device is equipped with two 20A nominal input channels, which are individually decoupled by utilizing MOSFET technology. The output can be loaded with a nominal 40A continuous current.

Using MOSFETSs instead of diodes reduces heat generation, losses and voltage drop between input and output. Due to these advantages, the unit is very narrow and only requires 36mm width on the DIN-rail.

The device does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output. It requires suitable power supplies on the input, where the sum of the continuous short circuit current stays below 26A. This is typically achieved when the power supplies are featured with an intermittent overload behavior (Hiccup Mode).

See chapter 24.6 for wiring information.

23.5. YR40.245 - REDUNDANCY MODULES

The YR40.245 is a 40A single channel redundancy module, which is equipped with a plug connector on the output. The plug connector allows replacing the power supply or the redundancy module while the system is running. The plug connector prevents the output wires from touching and creating a short the load circuit.

The input of the device is decoupled by utilizing MOSFET technology.

Using MOSFETSs instead of diodes reduces heat generation, losses and voltage drop between input and output. Due to these advantages, the unit is very narrow and only requires 46mm width on the DIN-rail.

The device does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output. It requires a suitable power supply on the input, where the continuous short circuit current stays below 22A. This is typically achieved when the power supply is featured with an intermittent overload behavior (Hiccup Mode).

See chapter 24.6 for wiring information.

24. APPLICATION NOTES

24.1. 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 nominal 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 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 three examples show typical voltage dips for resistive loads:

Fig. 24-1 **40A peak current for 50ms, typ. (2x the nominal current)**

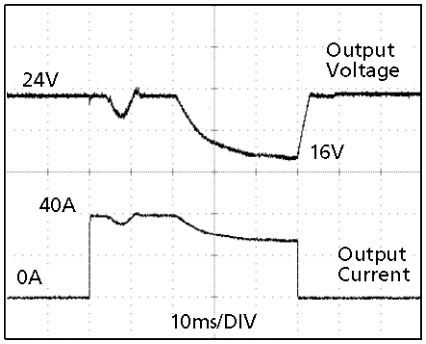


Fig. 24-2 **100A peak current for 5ms, typ. (5x the nominal current)**

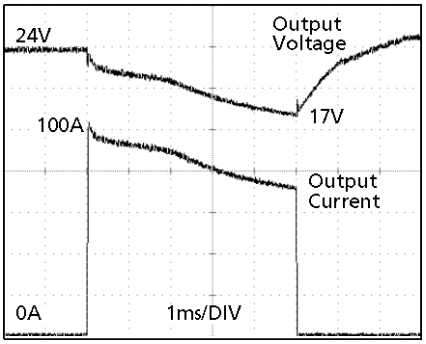
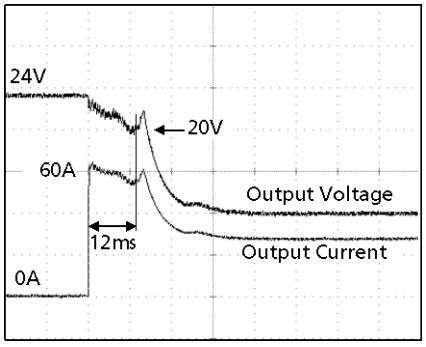


Fig. 24-3 **60A peak current for 12ms, typ. (3x the nominal current)**



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

Peak current voltage dips	Typ.	from 24V to 16V	At 40A for 50ms, resistive load
	Typ.	from 24V to 21V	At 100A for 2ms, resistive load
	Typ.	from 24V to 17V	At 100A for 5ms, resistive load

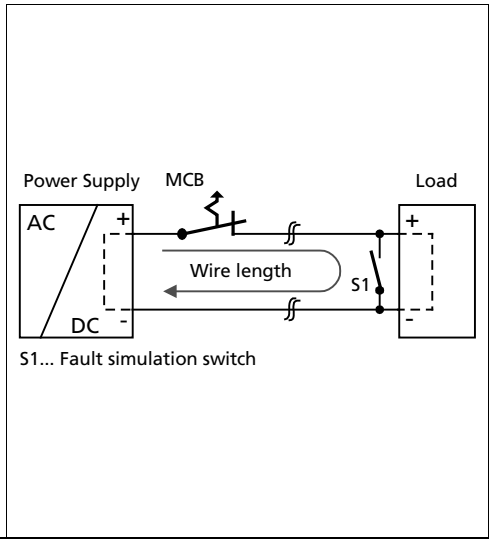
24.2. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCB's or UL 1077 circuit breakers) are commonly used for AC-supply systems and may also be used on 24V 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. 24-4 **Test circuit**



S1... Fault simulation switch

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

	0.75mm²	1.0mm²	1.5mm²	2.5mm²
C-2A	31 m	37 m	63 m	98 m
C-3A	28 m	34 m	51 m	78 m
C-4A	18 m	25 m	38 m	58 m
C-6A	9 m	11 m	18 m	26 m
C-8A	6 m	7 m	12 m	14 m
C-10A	4 m	6 m	11 m	13 m
C-13A	2 m	2 m	4 m	7 m
B-6A	23 m	28 m	46 m	66 m
B-10A	11 m	14 m	19 m	32 m
B-13A	7 m	11 m	16 m	29 m
B-16A	5 m	6 m	8 m	15 m
B-20A	1 m	1 m	2 m	4 m
B-25A				1 m

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

24.3. CHARGING OF BATTERIES

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

Instructions for charging batteries:

a) Use only matched batteries when putting 12V types in series.

b) Ensure that the ambient temperature of the power supply stays below 40°C.

c) Use a 30A or 32A circuit breaker or a blocking diode between the power supply and the battery.

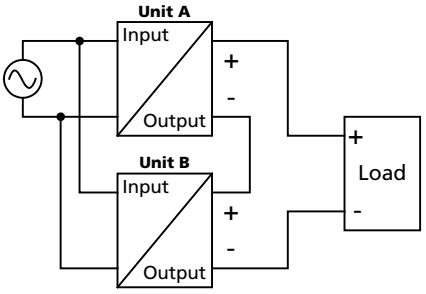
d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

e) The return current to the power supply is typically 3.5mA. This return current can discharge the battery when the power supply is switched off except in case a blocking diode is utilized.

f) Set the device into "Parallel Use" mode and adjust the output voltage, measured at no load and at the battery end of the 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

24.4. SERIES OPERATION



Devices 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 must be installed with a protection against touching.

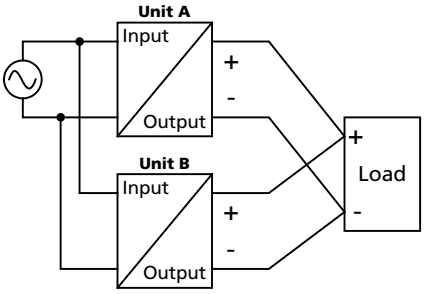
Avoid return voltage (e.g. from a decelerating motor or battery) which is applied to the output terminals.

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 leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

24.5. PARALLEL USE TO INCREASE OUTPUT POWER

Devices can be paralleled to increase the output power. The output voltage of all power supplies shall be adjusted to the same value (±100mV) 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 unit 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 6.



The ambient temperature is not allowed to exceed +60°C.

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 30A or 32A is required on each output. Alternatively, a diode or redundancy module can also be utilized.

Energize all units at the same time. It also might be necessary to cycle the input power (turn-off for at least five seconds), if the output was in overload or short circuits and the required output current is higher than the current of one unit.

Keep an installation clearance of 15mm (left / right) between two devices and avoid installing 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 (e.g. altitude).

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

24.6. PARALLEL USE FOR REDUNDANCY

Please note that there are variants with built-in redundancy are available in the CP20 series. Check CP20.241-Rx units.

1+1 Redundancy:
Devices 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 leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

Recommendations for building redundant power systems:

- Use separate input fuses for each device.
- Use separate mains systems for each device whenever it is possible.
- Monitor the individual devices. Therefore, use the DC-OK signal of the device.
- It is desirable to set the output voltages of all devices to the same value (± 100mV) or leave it at the factory setting.
- Set the devices into "Parallel Use" mode.

N+1 Redundancy:
Redundant systems for a higher power demand are usually built in a N+1 method. E.g. four power supplies, each rated for 20A are paralleled to build a 60A redundant system.

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

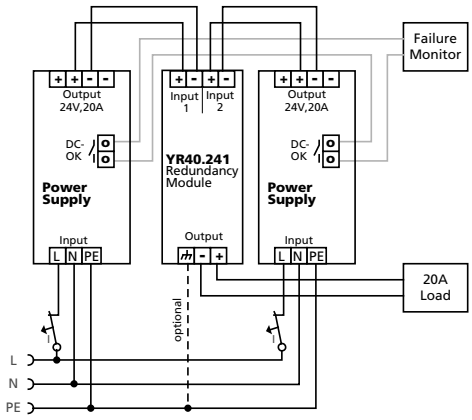
Keep an installation clearance of 15mm (left / right) between two power supplies and avoid installing the power supplies on top of each other.

Do not use power supplies in parallel in mounting orientations other than the standard mounting orientation or in any other condition, where a de-rating of the output current is required.

For N+1 redundancy the ambient temperature is not allowed to exceed +60°C.

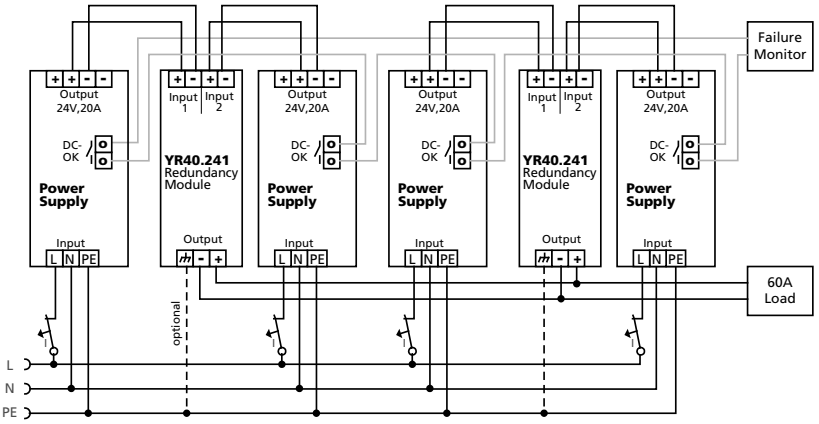
Wiring examples for 1+1 and n+1 redundancy:

Fig. 24-5 **1+1 Redundant configuration for 20A load current with a dual redundancy module**



Alternatively, the YR40.242 redundancy module can be used but has the input and output terminals reversed.

Fig. 24-6 **N+1 Redundant configuration for 60A load current with multiple power supplies and redundancy modules**



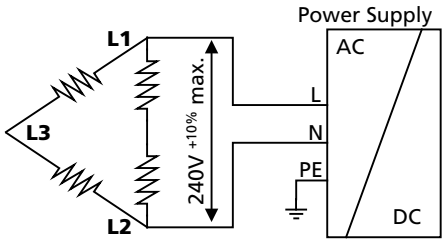
Alternatively, the YR40.242 redundancy module can be used but has the input and output terminals reversed.

24.7. OPERATION ON TWO PHASES

The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$.

Ensure that the wire, which is connected to the N-terminal, is appropriately fused.

The maximum allowed voltage between a Phase and the PE must be below 300Vac.



24.8. USE IN A TIGHTLY SEALED ENCLOSURE

When the device 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 device.

In the following test setup, the device is placed in the middle of the box, no other heat producing items are inside the box. The load is placed outside the box.

The temperature sensor inside the box is placed in the middle of the right side of the power supply with a distance of 1cm.
The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

	Case A	**Case B**
Enclosure size	180x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic	180x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic
Input voltage	230Vac	230Vac
Load	24V, 16A; (=**80%**)	24V, 20A; (=**100%**)
Temperature inside the box	51.7°C	55.8°C
Temperature outside the box	25.9°C	25.6°C
Temperature rise	25.8K	30.2K

24.9. 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 2000m (6560ft).

Fig. 24-7
Mounting Orientation A
(Standard orientation)

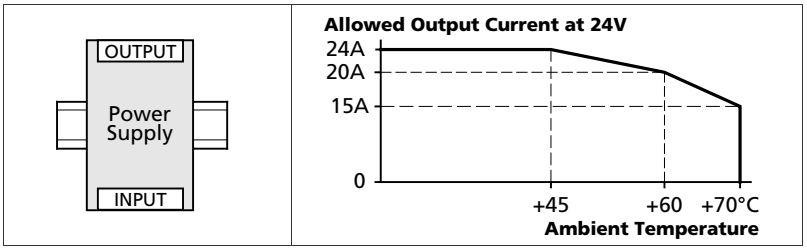


Fig. 24-8
Mounting Orientation B
(Upside down)

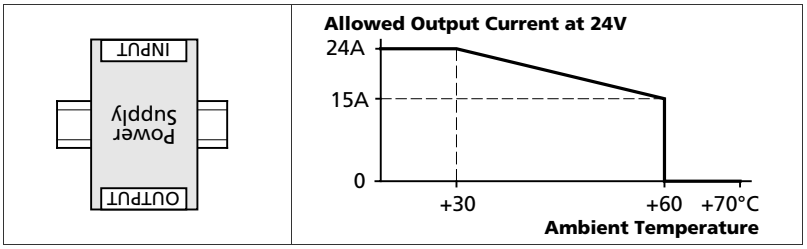


Fig. 24-9
Mounting Orientation C
(Table-top mounting)

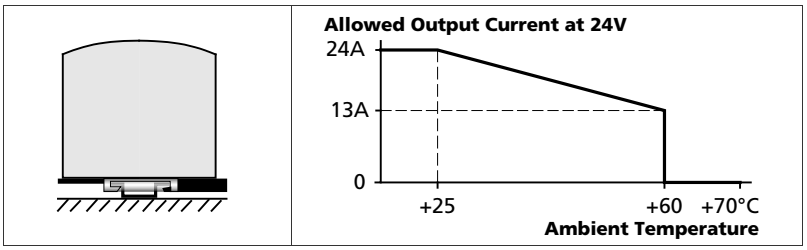


Fig. 24-10
Mounting Orientation D
(Horizontal cw)

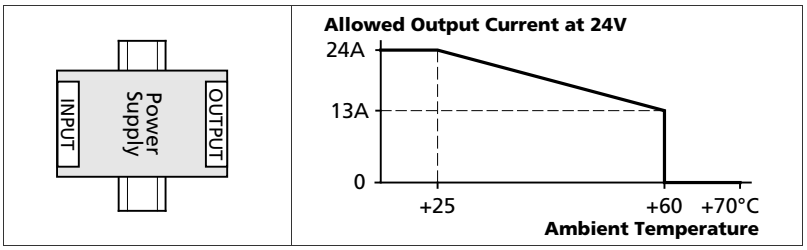
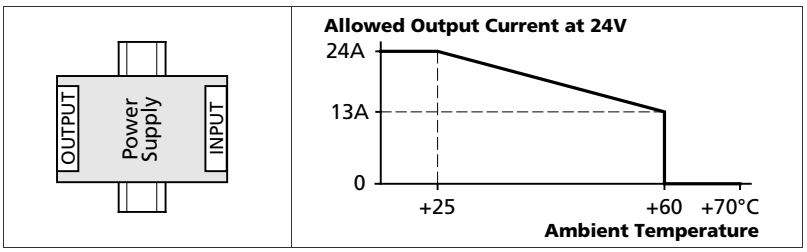


Fig. 24-11
Mounting Orientation E
(Horizontal ccw)



PULS

DIMENSION **C-Line**

CS5.241, CS5.241-C1, CS5.241-S1

24V, 5A, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-120 / 200-240V Auto-select Input
- Width only 32mm
- Optional with Conformal Coated PC-boards (CS5.241-C1)
- Optional with Spring-clamp Terminals (CS5.241-S1)
- Efficiency up to 90.2%
- Easy Fuse Breaking due to High Overload Peak Current
- 20% Output Power Reserves
- Full Power Between -25°C and +60°C
- Minimal Inrush Current Surge
- 3 Year Warranty

GENERAL DESCRIPTION

The DIMENSION C-Line units are cost optimized power supplies without compromising quality, reliability and performance. The C-Line is part of the DIMENSION power supply family, existing alongside the high featured Q-Line.

The CS5.241 includes all the essential basic functions and the devices have a power reserve of 20%. This extra current may even be used continuously at temperatures up to +45°C.

The most important features are the small size, high efficiency and the wide temperature range.

The Auto-select input makes worldwide installation and usage very simple. Defects or system failures caused by wrongly set switches cannot occur.

High immunity to transients and power surges as well as low electromagnetic emission and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	5A	at 24V, amb <60°C
	6A	at 24V, amb <45°C
	4.3A	at 28V, amb <60°C
	5.1A	at 28V, amb <45°C
Output power	120W	ambient <60°C
	144W	ambient <45°C
Output ripple	< 50mVpp	20Hz to 20MHz
AC Input voltage	AC 100-120V / 200-240V	±10% Auto-select input
Mains frequency	50-60Hz	±6%
AC Input current	2.0 / 1.23A	at 120 / 230Vac
DC Input voltage	-	not allowed
Power factor	0.56 / 0.47	at 120 / 230Vac
AC Inrush current	3 / 3A peak	at 120 / 230Vac
Efficiency	89.4 / 90.2%	at 120 / 230Vac
Losses	14.5 / 13.2W	at 120 / 230Vac
Temperature range	-25°C to +70°C	operational
Derating *)	3W/°C	+60 to +70°C
Hold-up time	80 / 78ms	at 120 / 230Vac
Dimensions	32x124x117mm	WxHxD
Weight	500g / 1.1lb	

ORDER NUMBERS

Power Supply	**CS5.241**	24-28V Standard unit
	CS5.241-C1	With conformal coated pc-boards
	CS5.241-S1	with quick-connect spring-clamp terminals
Accessory	ZM1.WALL	Wall mount bracket
	ZM13.SIDE	Side mount bracket
	YRM2.DIODE	Redundancy module

MARKINGS

c UL US LISTED IND. CONT. EQ. UL 508

c TÜV US UL 60950-1

c SP US Class I Div 2

GL Marine

CE EMC, LVD

INDEX

TERMINOLOGY, ABREVIATIONS AND DEFINITIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz mains frequency. AC 120V parameters are valid for 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general professional use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

This device is designed for use in hazardous, non-hazardous, ordinary or unclassified locations.

The power supply does not fulfil the harmonic current standard EN61000-3-2. Do not use this power supply when the following criteria apply:

a) the end-device is used within the European Union and
b) the end-device is connected to a public mains supply with a nominal voltage greater or equal 220Vac and
c) the power supply is:
- fitted in an end-device with an average input power greater than 75W or
- fitted in an end-device with a continuous input power greater than 75W or
- part of a lighting system.

Exception:
End-devices for professional applications with an input power > 1000W do not need to fulfill EN 61000-3-2.

Comments:
- The average input power must be determined in accordance with EN 61000-3-2.
- Industrial mains supplies with their own transformer are considered to be “non-public”.
- Where individual self-contained items of equipment are installed in a rack or case (e.g. devices connected in parallel), they are regarded as being individually connected to the mains supply. The rack or case need not be tested as a whole. Alternatively it is also permitted to assess the whole rack or case. This is recommended for devices used in professional applications with an input power greater than 1000W.

If PFC according to the Harmonics Standard EN 61000-3-2 is required, please use the QS5.241.

2. 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.

Mount the unit on a DIN-rail so that the input terminals are located on the bottom of the unit. For other mounting orientations see de-rating requirements in this document. See chapter 24.13.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 15%!

Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).

A disconnecting means shall be provided for the output of the power supplies when used in applications according to CSA C22.2 No 107.1-01.

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit 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 surfaces may cause burns.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

3. AC-INPUT

AC input	nom.	AC 100-120V / 200-240V ±10%	Auto-select input
Mains network systems		TN, TT or IT	
AC input range	min.	90-132Vac / 180-264Vac	continuous operation, lower input voltage range continuous operation, upper input voltage range
		85-90Vac 264-300Vac	short-tem or with reduced output current, see Fig. 3-5 max. 500ms
		no harm to the power supply with input voltages between 132 and 180Vac	
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	75Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	55Vac	steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 22.3.		

		AC 100V	AC 120V	AC 230V	
Input current	typ.	2.33A	2.0A	1.23A	at 24V, 5A, see Fig. 3-3
Power factor*)	typ.	0.58	0.56	0.47	at 24V, 5A, see Fig. 3-4
Crest factor**)	typ.	2.9	3.1	3.7	at 24V, 5A
Start-up delay	typ.	740ms	900ms	720ms	see Fig. 3-2
Rise time	typ.	8ms	8ms	8ms	at 24V, 5A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	25ms	25ms	25ms	at 24V, 5A const. current load, 5mF load capacitance,, see Fig. 3-2
Turn-on overshoot	max.	400mV	400mV	400mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 3-1 **Input voltage ranges**

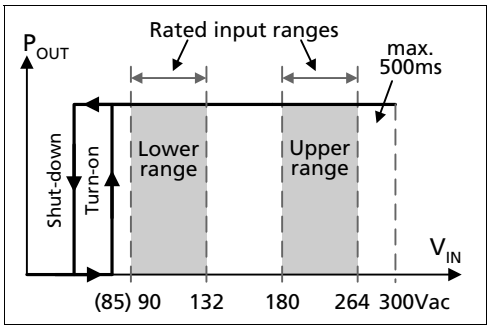


Fig. 3-2 **Turn-on behavior, definitions**

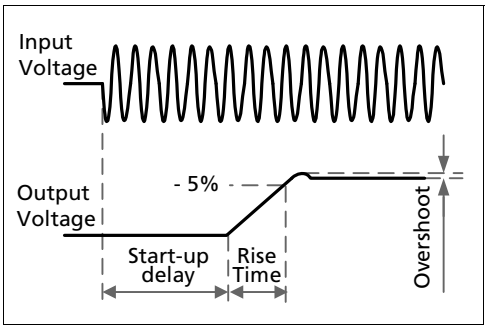


Fig. 3-3 **Input current vs. output load at 24V**

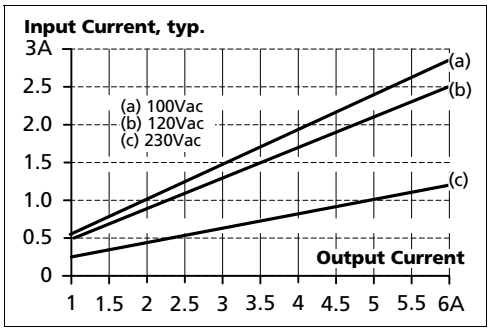


Fig. 3-4 **Power factor vs. output load**

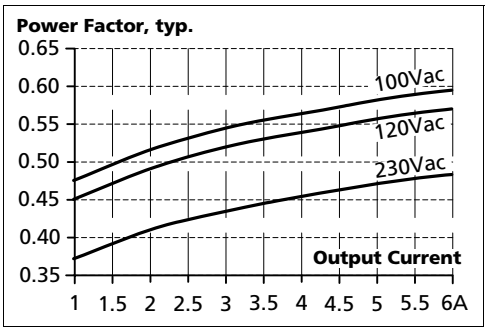
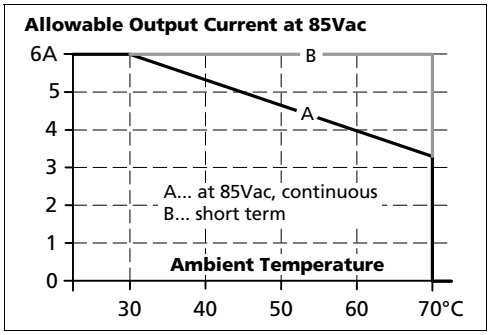


Fig. 3-5 **Input voltage derating**



4. DC-INPUT

Do not operate this power supply with DC-input voltage. Use the QS5.241 unit instead.

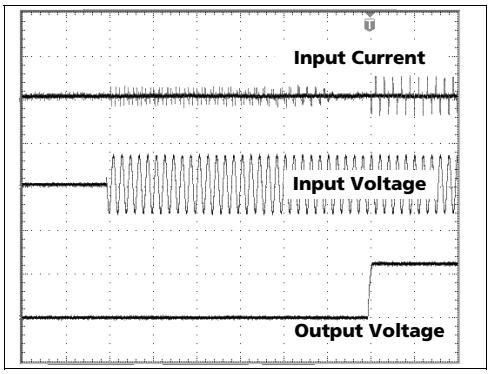
5. INPUT INRUSH CURRENT

After turn-on of the input voltage, an active inrush limitation circuit limits the input inrush current. Virtually no input inrush current is generated.

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

		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$10A_{peak}$	$10A_{peak}$	$10A_{peak}$	temperature independent
	typ.	$3A_{peak}$	$3A_{peak}$	$3A_{peak}$	temperature independent
Inrush energy	max.	$1A^2s$	$1A^2s$	$1A^2s$	temperature independent

Fig. 5-1 **Typical input inrush current behavior**



Input: 230Vac
Output: 24V, 5A
Ambient: 25°C

Upper curve: Input current (10A / DIV)
Medium curve: Input voltage (500V / DIV)
Lower curve: Output voltage (20V / DIV)
Time scale: 100ms / DIV

6. OUTPUT

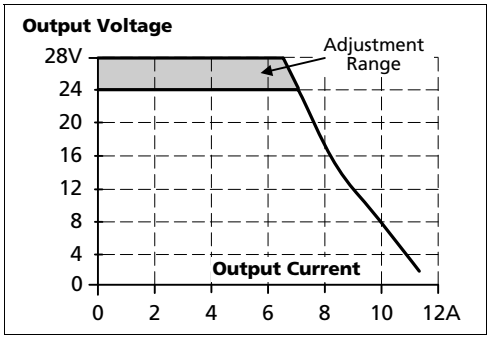
Output voltage	nom.	24V	
Adjustment range	min.	24-28V	guaranteed
	max.	30V***)	at clockwise end position of potentiometer
Factory settings	typ.	24.1V	±0.2%, at full load, cold unit,
Line regulation	max.	70mV	90-132 / 180-300Vac
Load regulation	max.	100mV	static value, 0A → 5A; see Fig. 6-1
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	5A	at 24V, ambient temperature <60°C, see Fig. 6-1
	nom.	6A*)	at 24V, ambient temperature <45°C
	nom.	3.75A	at 24V and 70°C ambient temperature
	nom.	4.3A	at 28V, ambient temperature <60°C, see Fig. 6-1
	nom.	5.1A*)	at 28V, ambient temperature <45°C, see Fig. 6-1
	nom.	3.2A	at 28V and 70°C ambient temperature
		Reduce output current linearly between +45°C and +70°C	
Output power	nom.	120W	continuously available
	nom.	144W*)	Power Boost® *)
Overload behavior		continuous current	see Fig. 6-1
Short-circuit current	min.	10A**)	load impedance <200mOhm, see Fig. 6-1
	max.	14A**)	load impedance <200mOhm, see Fig. 6-1
Output capacitance	typ.	1 800µF	included inside the power supply

*) **Power Boost**
This power/ current is continuously allowed up to an ambient temperature of 45°C.
Above 45°C, do not use this power/ current longer than a duty cycle of 10% and/ or not longer than 1 minute every 10 minutes.

**) 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 a guaranteed value which can be achieved. The typical value is about 28.5V.

Fig. 6-1 **Output voltage vs. output current, typ.**



7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	109ms	165ms	161ms	at 24V, 2.5A, see Fig. 7-1
	min.	87ms	135ms	128ms	at 24V, 2.5A, see Fig. 7-1
	typ.	50ms	80ms	78ms	at 24V, 5A, see Fig. 7-1
	min.	39ms	63ms	62ms	at 24V, 5A, see Fig. 7-1
	typ.	37ms	62ms	63ms	at 24V, 6A, see Fig. 7-1
	min.	30ms	49ms	50ms	at 24V, 6A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

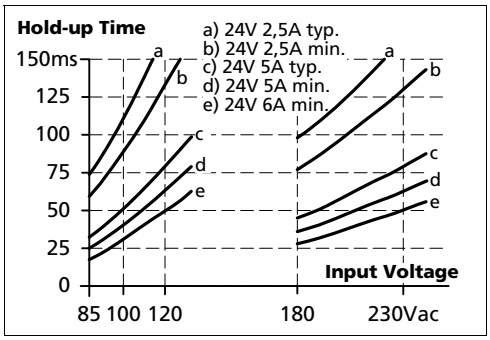
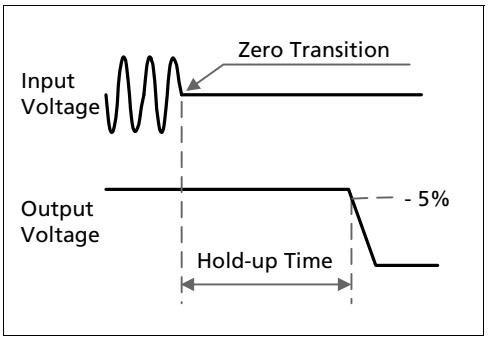


Fig. 7-2 **Shut-down behavior, definitions**



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

8. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	88.8%	89.4%	90.2%	at 24V, 5A
	typ.	88.5%	89.0%	89.9%	at 24V, 6A (Power Boost)
Average efficiency*)	typ.	86.5%	87.2%	87.8%	25% at 1.25A, 25% at 2.5A, 25% at 3.75A. 25% at 5A
Power losses	typ.	1.9W	2.0W	1.7W	at 24V, 0A
	typ.	9.1W	8.8W	8.2W	at 24V, 2.5A
	typ.	15.3W	14.5W	13.2W	at 24V, 5A
	typ.	18.7W	17.8W	16.1W	at 24V, 6A (Power Boost)

*) 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. 8-1 **Efficiency vs. output current at 24V, typ**

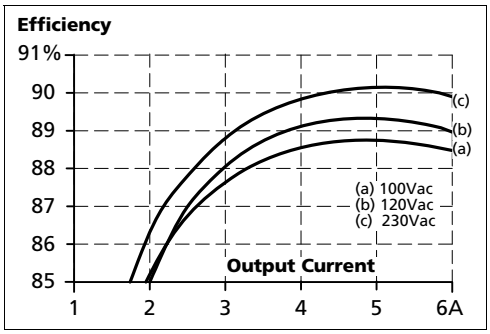


Fig. 8-2 **Losses vs. output current at 24V, typ.**

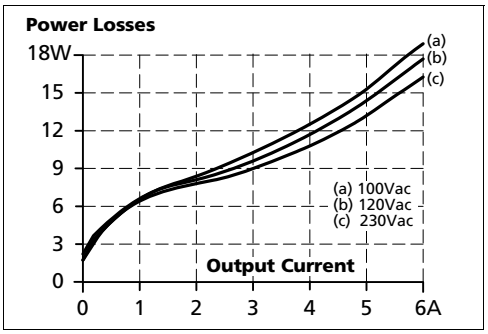


Fig. 8-3 **Efficiency vs. input voltage at 24V, 5A, typ.**

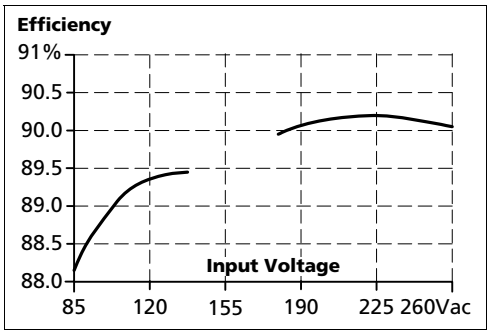
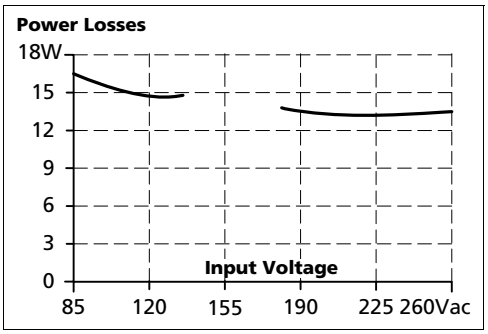


Fig. 8-4 **Losses vs. input voltage at 24V, 5A, typ.**



9. LIFETIME EXPECTANCY AND MTBF

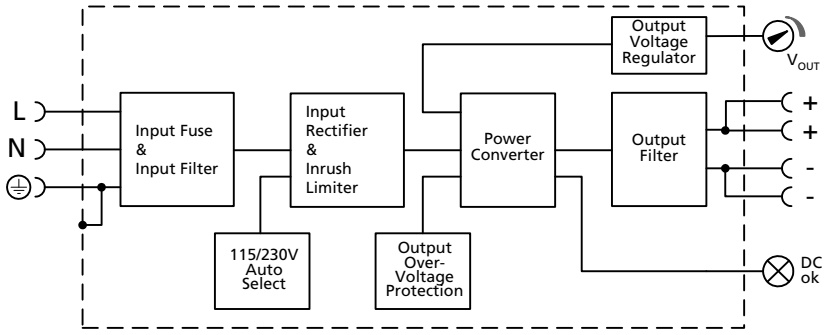
	AC 100V	AC 120V	AC 230V	
Lifetime expectancy*)	135 000h*)	128 000h	144 000h*)	at 24V, 2.5A and 40°C
	283 000h*)	363 000h*)	408 000h*)	at 24V, 2.5A and 25°C
	52 000h	58 000h	72 000h	at 24V, 5A and 40°C
	146 000h*)	163 000h*)	204 000h*)	at 24V, 5A and 25°C
	27 000h	34 000h	42 000h	at 24V, 6A and 40°C
	76 000h	96 000h	120 000h*)	at 24V, 6A and 25°C
MTBF**) SN 29500, IEC 61709	638 000h	661 000h	869 000h	at 24V, 5A and 40°C
	542 000h	562 000h	739 000h	at 24V, 6A and 40°C
	1 077 000h	1 111 000h	1 495 000h	at 24V, 5A and 25°C
MTBF**) MIL HDBK 217F	552 000h	546 000h	574 000h	at 24V, 5A and 40°C; Ground Benign GB40
	497 000h	491 000h	517 000h	at 24V, 6A and 40°C; Ground Benign GB40
	788 000h	775 000h	800 000h	at 24V, 5A and 25°C; Ground Bening GB25

*) The **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.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

10. FUNCTIONAL DIAGRAM

Fig. 10-1 **Functional diagram**



11. TERMINALS AND WIRING

The terminals are IP20 Finger safe constructed and suitable for field- and factory wiring.

	CS5.241, CS5.241-C1	**CS5.241-S1**
Type	Screw terminals	Quick-connect spring-clamp terminals
Solid wire	0.5-6mm²	0.5-6mm²
Stranded wire	0.5-4mm²	0.5-4mm²
American Wire Gauge	AWG20-10	AWG20-10
Max. wire diameter	2.8mm (including ferrules)	2.8mm (including ferrules)
Wire stripping length	7mm / 0.28inch	10mm / 0.4inch
Screwdriver	3.5mm slotted or cross-head No 2	not required
Recommended tightening torque	1Nm, 9lb.in	not applicable
Pull-out force	according to UL 486E	according to UL 486E

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
   60°C for ambient up to 45°C and
   75°C for ambient up to 60°C minimum
   90°C for ambient up to 70°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Do not use the unit without PE connection.
e) Unused terminal compartments should be securely tightened.
f) Ferrules are allowed.

12. FRONT SIDE AND USER ELEMENTS

Fig. 12-1 **Front side** CS5.241, CS5.241-C1

Fig. 12-2 **Front side** CS5.241-S1

A **Input Terminals**
CS5.241, CS5.241-C1 with screw terminals
CS5.241-S1 with spring-clamp terminals

N, L Line input
⏚ PE (Protective Earth) input

B **Output Terminals** (screw terminals, two pins per pole)
+ Positive output
– Negative (return) output

C **Output voltage potentiometer**
Open the flap to adjust the output voltage.
Factory set: 24.1V

D **DC-OK LED** (green)
On, when the voltage on the output terminals is >21V

13. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment. Restrictions apply on public mains (PFC), see chapter 1 for more information.

A detailed EMC report is available on request.

EMC Immunity	According generic standards: EN 61000-6-1 and EN 61000-6-2			
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	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N L → PE, N → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	500V 1kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion C Criterion A
Voltage interruptions	EN 61000-4-11		5000ms	Criterion C
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:
A: Power supply shows normal operation behavior within the defined limits.
B: Temporary voltage dips possible. No change in operation mode.
C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

EMC Emission	According generic standards: EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B
Conducted emission output lines**)	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	limits for DC power port according EN 61000-6-3 not fulfilled
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	not fulfilled at output currents above 2.7A
Voltage fluctuations, flicker	EN 61000-3-3	fulfilled*)

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.

*) tested with constant current loads, non pulsing
**) for information only, not mandatory for EN 61000-6-3

Switching frequency	175kHz to 225kHz	Main converter, input voltage dependent at 24V, 2.5A
	100kHz to 130kHz	Main converter, input voltage dependent at 24V, 5A

14. ENVIRONMENT

Operational temperature*)	-25°C to +70°C (-13°F to 158°F)	reduce output power according Fig. 14-1
Storage temperature	-40°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	1.6W/°C 3W/°C	45°C to 60°C (113°F to 140°F) 60°C to 70°C (140°F to 158°F)
Humidity**)	5 to 95% r.h.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g***) 2 hours / axis***)	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms***) 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature, see Fig. 14-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	7.5W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 14-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) 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
***) Tested in combination with DIN-Rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm and standard orientation.

Fig. 14-1 **Output current vs. ambient temp.**

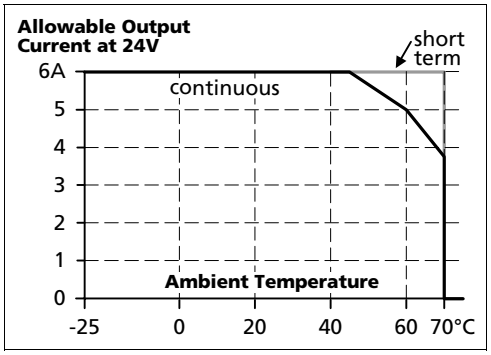
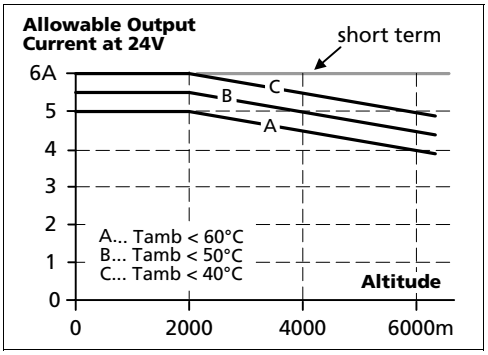


Fig. 14-2 **Output current vs. altitude**



15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits*)	
Output over-voltage protection	typ. 35Vdc max. 39Vdc	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	> 3.5mm	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

*) In case of a protection event, audible noise may occur.

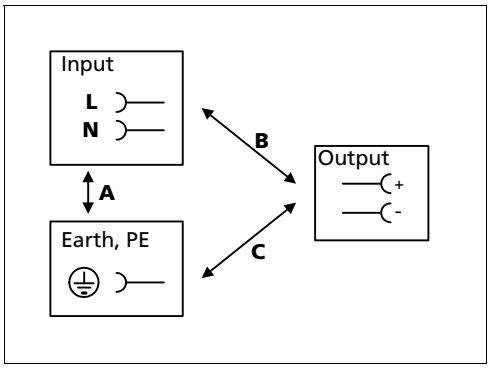
16. SAFETY FEATURES

Input / output separation*)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
	double or reinforced insulation	
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
PE resistance	< 0.1Ohm	between housing and PE terminal
Touch current (leakage current)	typ. 0.24mA / 0.58mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.35mA / 0.80mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.40mA / 0.87mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	max. 0.36mA / 0.67mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	max. 0.53mA / 0.96mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	max. 0.60mA / 1.09mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

17. 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 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.

Fig. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	3000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting		> 10mA	> 10mA	> 20mA

To fulfil the PELV requirements according to EN60204-1 § 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 can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive 2004/108/EC and the - Low-voltage directive (LVD) 2006/95/EC
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL US LISTED IND. CONT. EO.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
UL 60950-1 2nd Edition	c UL US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
ANSI / ISA 12.12.01-2007 Class I Div 2 (except CS5.241-C1)	c SP US	Recognized for use in Hazardous Location Class I Div 2 T3 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Marine	GL	GL (Germanischer Lloyd) classified Environmental category: C, EMC2 Marine and offshore applications
	ABS	ABS (American Bureau for Shipping) PDA
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

19. ROHS, REACH AND OTHER FULFILLED STANDARDS

RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

20. PHYSICAL DIMENSIONS AND WEIGHT

Width	32mm 1.26''
Height	124mm 4.88''
Depth	117mm 4.61'' The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	500g / 1.1lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: zinc-plated steel
Installation clearances	See chapter 2

Fig. 20-1 **Front view**

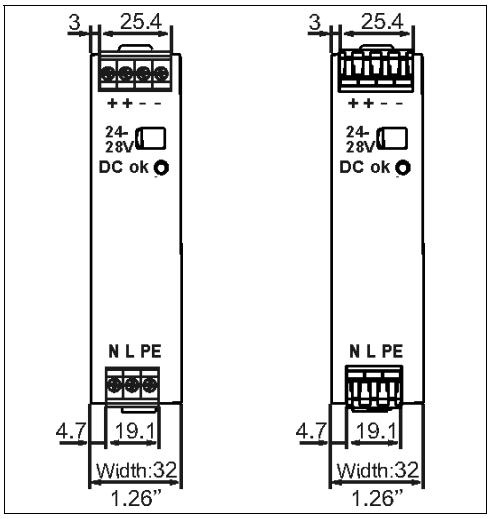
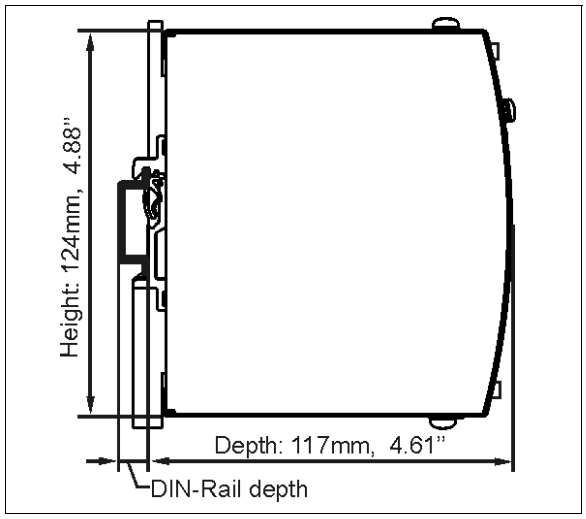


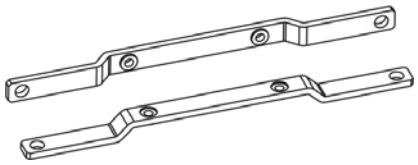
Fig. 20-2 **Side view**

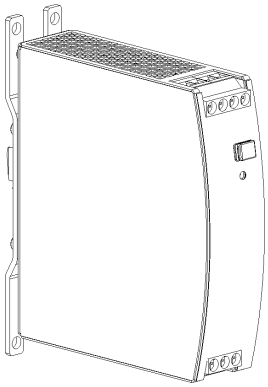


21. ACCESSORIES

21.1. ZM1.WALL - WALL MOUNTING BRACKET

This bracket is used to mount the power supply onto a flat surface without utilizing a DIN-Rail.

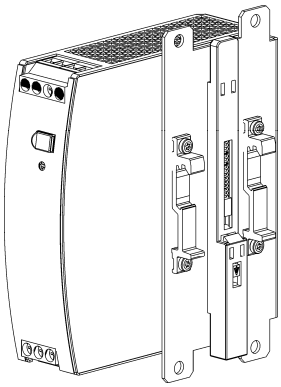




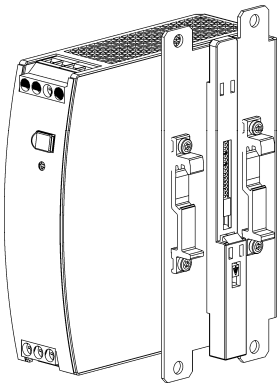
21.2. ZM13.SIDE - SIDE MOUNTING BRACKET

This bracket is used to mount Dimension units sideways with or without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit must be detached so that the steel brackets can be installed.

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



Side mounting with DIN-rail brackets



Side mounting without DIN-rail brackets

21.3. REDUNDANCY MODULES

YRM2.DIODE – (2x 10A Inputs, 1x 20A output)

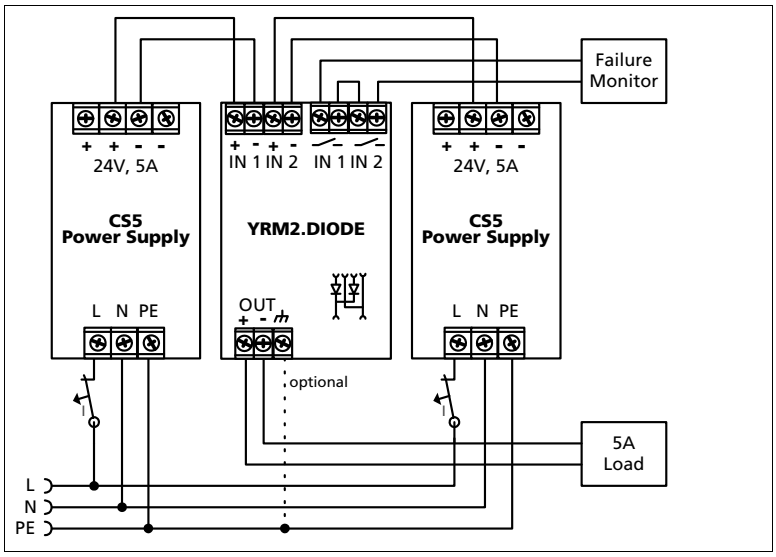
The YRM2.DIODE is a dual redundancy module, which can be used to build redundant systems. It is equipped with two input channels, which are individually decoupled by utilizing diodes.

The YRM2.DIODE does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

The YRM2.DIODE has a monitoring circuit included and is the perfect solution when the power supply has no DC-OK function. Two LEDs and two relay contacts signal when one of the two DC-input voltages is not in range due to a non-functioning or disconnected power supply.

Due to the compact design, the unit is very slender and only requires 32mm width on the DIN-rail.

Fig. 21-1 **Typical 1+1 Redundant configuration for 5A load current**



22. APPLICATION NOTES

22.1. PEAK CURRENT CAPABILITY

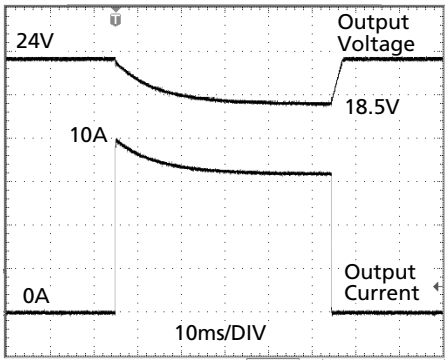
The unit can deliver peak currents (up to several milliseconds) which are higher than the specified short term currents.

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 nominal output current (including the PowerBoost). 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.

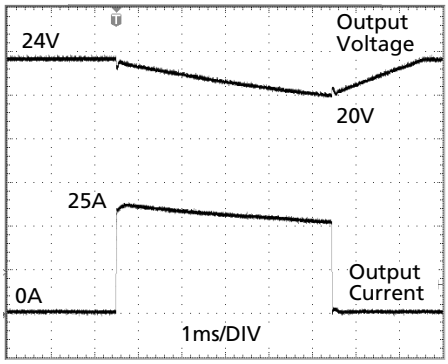
The extra current (peak current) is supplied by the power converter and the built-in large sized output capacitors of the power supply. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-1 **Peak load with 2x the nominal current for 50ms, typ.**



10A Peak load (resistive) for 50ms
Output voltage dips from 24V to 18.5V.

Fig. 22-2 **Peak load with 5x the nominal current for 5ms, typ.**



25A Peak load (resistive) for 5ms
Output voltage dips from 24V to 20V.

Peak current voltage dips	typ.	from 24V to 18.5V	at 10A for 50ms, resistive load
	typ.	from 24V to 22V	at 25A for 2ms, resistive load
	typ.	from 24V to 20V	at 25A for 5ms, resistive load

22.2. 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 6.

22.3. EXTERNAL INPUT PROTECTION

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

If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

22.4. PARALLEL USE TO INCREASE OUTPUT POWER

The power supply shall not be used in parallel to increase the output current.

22.5. PARALLEL USE FOR REDUNDANCY

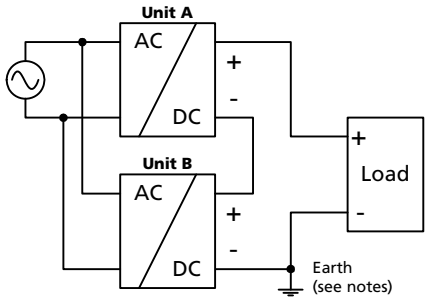
Power supplies can be paralleled for redundancy to gain higher system availability. Redundant systems require a certain amount of extra power to support the load in case one power supply unit fails. The simplest way is to put two power supplies in parallel. This is called a 1+1 redundancy. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption, see also chapter 22.4.

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 can no longer be maintained. This can be avoided by utilizing redundancy modules, which have decoupling devices (diodes or MOSFETs) included. Further information and wiring configurations can be found in chapter 21.3.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.
b) Monitor the individual power supply units.
   Therefore, use the DC-OK relay contact of the YRM2.DIODE.
c) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.6. 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 no longer SELV 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 (input terminals on bottom of the unit).

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

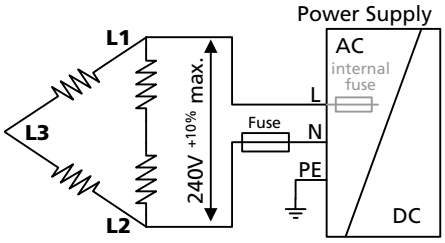
22.7. INDUCTIVE AND CAPACITIVE LOADS

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

22.8. CHARGING OF BATTERIES

The power supply shall not be used to charge batteries. Choose power supplies of the QS-Series for charging batteries.

22.9. OPERATION ON TWO PHASES



The power supply can also be used on two-phases of a three-phase-system. A phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$.

22.10. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box, no other heat producing items are inside the box

Enclosure:	Rittal Typ IP66 Box PK 9516 100, plastic, 110x180x165mm
Load:	24V, 4A; (=80%) load is placed outside the box
Input:	230Vac
Temperature inside enclosure:	44.3°C (in the middle of the right side of the power supply with a distance of 2cm)
Temperature outside enclosure:	23.3°C
Temperature rise:	21.0K

22.11. MOUNTING ORIENTATIONS

Mounting orientations other than the input 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. 22-3
Mounting Orientation A
(Standard orientation)

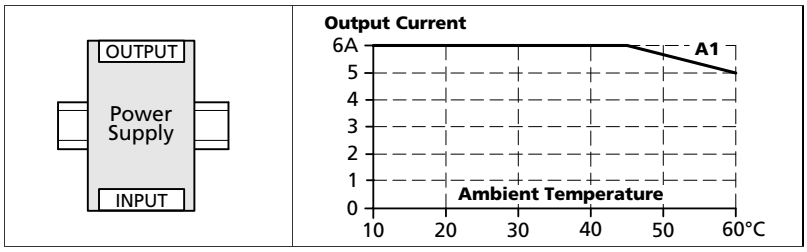


Fig. 22-4
Mounting Orientation B
(Upside down)

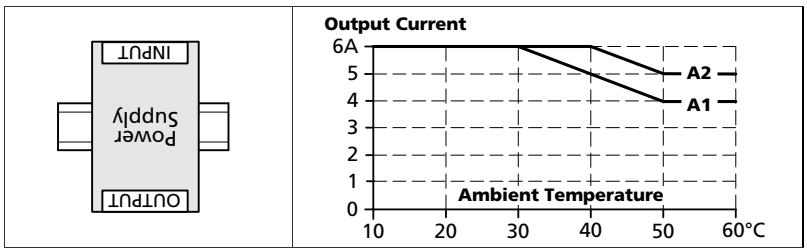


Fig. 22-5
Mounting Orientation C
(Table-top mounting)

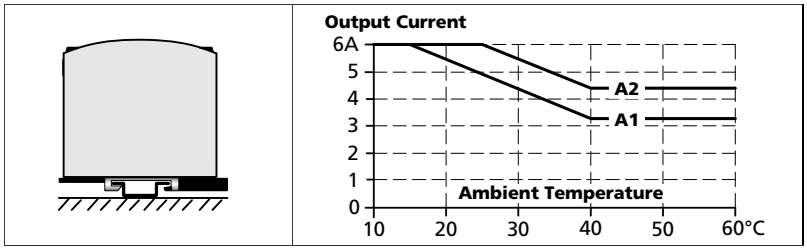


Fig. 22-6
Mounting Orientation D
(Horizontal cw)

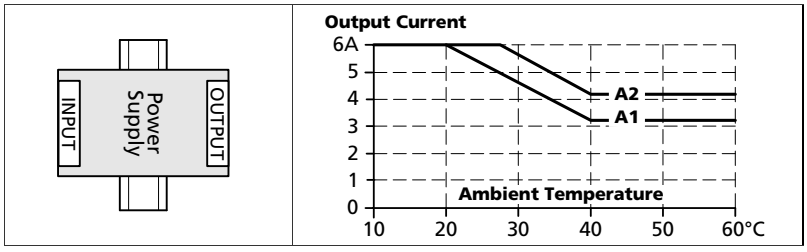
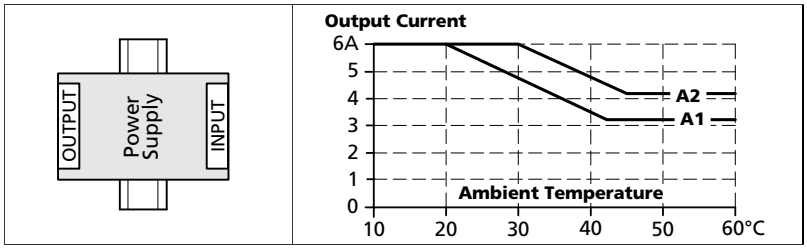


Fig. 22-7
Mounting Orientation E
(Horizontal ccw)



PULS

DIMENSION **CT-Series**

CT10.241, CT10.241-C1

3-PHASE, 24V, 10A, 240W

POWER SUPPLY

- 3AC 380-480V Wide-range Input
- 2 or 3-Phase Operation Possible
- Width only 62mm
- Efficiency up to 92.9% Due to Synchronous Rectifier
- Excellent Partial Load Efficiency
- 20% Output Power Reserves
- Easy Fuse Tripping Due to High Overload Current
- Input -Transient Blanking Circuit Included
- Minimal Inrush Current Surge
- Three Input Fuses Included
- Current Sharing Feature for Parallel Use
- Full Power Between -25°C and +60°C
- 3 Year Warranty

PRODUCT DESCRIPTION

The Dimension C-Series are cost optimized power supplies without compromising quality, reliability and performance. The C-Series is part of the DIMENSION power supply family. The most outstanding features of CT10.241 are the high efficiency, electronic inrush current limitation, active input transient filter and wide operational temperature range. The small size is achieved by a synchronous rectification and further technological design details.

The CT10.241-C1 is equipped with conformal coated pc-boards preferred for applications in harsh areas.

The C-Series includes all the essential basic functions. The devices have a power reserve of 20% included, which may even be used continuously at temperatures up to +45°C. Additionally, the CT10.241 can deliver 3 times the nominal output current for 10ms which helps to trip fuses on faulty output branches.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24 - 28V	Factory setting 24.1V
Output current	12.0 - 10.3A	Below +45°C ambient
	10.0 - 8.6A	At +60°C ambient
	7.5 – 6.5A	At +70°C ambient
	Derate linearly between +45°C and +70°C	
Input voltage AC	3AC 380-480V	-15%/+20%
Mains frequency	50-60Hz	±6%
Input current AC	0.7 / 0.6A	At 3x400 / 480Vac
Power factor	0.53 / 0.52	At 3x400 / 480Vac
AC Inrush current	4 / 4Apk	At 3x400 / 480Vac
Efficiency	92.8 / 92.9%	At 3x400 / 480Vac
Losses	18.6 / 18.3W	At 3x400 / 480Vac
Hold-up time	34 / 54ms	At 3x400 / 480Vac
Temperature range	-25°C to +70°C	
Size (WxHxD)	62x124x117mm	Without DIN-rail
Weight	750g / 1.65lb	

ORDER NUMBERS

Power Supply	**CT10.241**	
	CT10.241-C1	With conformal coated pc-boards
Mechanical Accessory		
	ZM1.WALL	Wall/panel mount bracket
	ZM13.SIDE	Side mount bracket

MAIN APPROVALS

For details or a complete approval list see section 18.

c UL US LISTED IND. CONT. EQ.

c TÜV US UL 60950-1

GL

Power Standards Lab PSL SEMI F47

CE

May 2018 / Rev. 2.0a DS-CT10.241-EN All values are typical figures specified at 3x 400Vac, 50Hz input voltage, symmetrical phase voltages, 24V, 10A output load, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

INDEX

TERMINOLOGY AND ABBREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 400V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
400Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 380V and AC 400V parameters are valid at 50Hz and AC 480V parameters are valid at 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general professional use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. INSTALLATION INSTRUCTIONS

⚠ WARNING **Risk of electrical shock, fire, personal injury or death.**

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into 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.

Obey the following installation requirements:

This device may only be installed and put into operation by qualified personnel.

This device does not contain serviceable parts. If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection. The tripping of an internal fuse is caused by an internal defect.

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.

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 allowed.

The enclosure of the device provides a degree of protection of IP20.

The isolation of the device is designed to withstand impulse voltages of overvoltage category III according to IEC 60664-1. For corner grounded delta systems, the overvoltage category level is reduced to level II.

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 suitable to be supplied from TN-, TT- and IT mains networks. The voltage between the L terminals and the PE terminal must not exceed 500Vac continuously.

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 6000m (19685ft). See additional requirements in this document for use above 2000m (6560ft).

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.

The device is designed, tested and approved for branch circuits up to 32A (IEC) and 30A (UL) without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or C-Characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +70°C (+158°F). 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.

Installation Instructions for Hazardous Location Areas

The device is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment.

Do not disconnect the device or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

3. AC-INPUT

The device is suitable to be supplied from TN-, TT- and IT mains networks with AC voltage. Grounding of one phase is allowed except for UL508 applications.

The device can also operate on only two legs of the three-phase system. See chapter 22.7 for more information.

AC input	Nom.	3AC 380-480V	
AC input range	Min.	3x 323-576Va	Continuous operation
	Min.	3x 576-700Vac	For maximal 1s (occasional)
Allowed voltage L or N to earth	Max.	500Vac	Continuous operation, according to IEC 62477-1
Input frequency	Nom.	50–60Hz	±6%
Turn-on voltage	Typ.	3x 260Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	Typ.	3x 185Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		3AC 400V	3AC 480V	
Input current	Typ.	0.7A	0.6A	At 24V, 10A, per phase, see Fig. 3-3
Power factor	Typ.	0.53	0.52	At 24V, 10A, see Fig. 3-4
Start-up delay	Typ.	90ms	90ms	See Fig. 3-2
Rise time	Typ.	40ms	40ms	At 24V, 10A const. current load, 0mF load capacitance, see Fig. 3-2
	Typ.	85ms	85ms	At 24V, 10A const. current load, 10mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	200mV	See Fig. 3-2

Fig. 3-1 **Input voltage range**

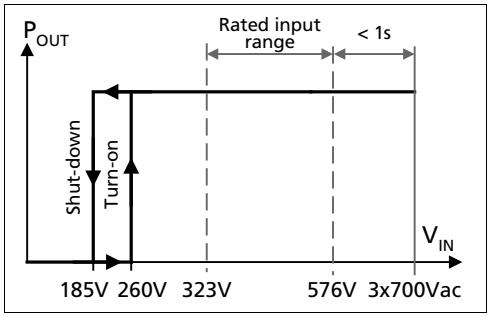


Fig. 3-2 **Turn-on behavior, definitions**

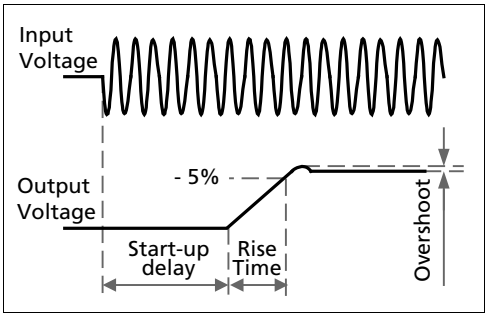


Fig. 3-3 **Input current vs. output load at 24V**

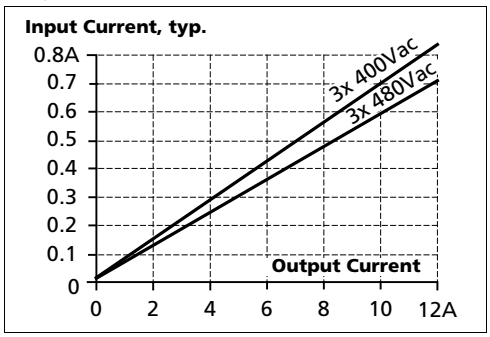
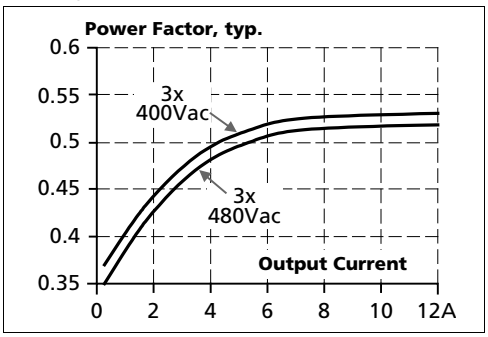


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not use the power supply with DC-input voltages.

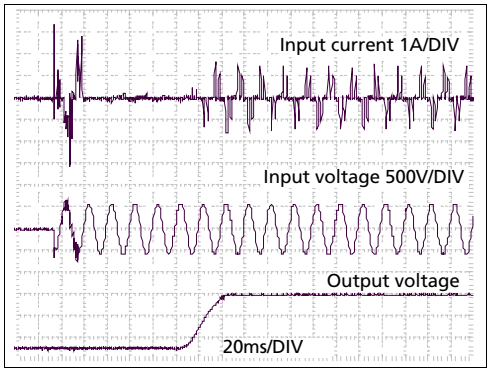
5. INPUT INRUSH CURRENT

An active inrush limitation circuit limits the input inrush current after turn-on of the input voltage and after short input voltage interruptions.

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

		3AC 400V	3AC 480V	
Inrush current	Max.	$10A_{peak}$	$10A_{peak}$	Temperature independent
	Typ.	$4A_{peak}$	$4A_{peak}$	Temperature independent
Inrush energy	Max.	$0.5A^2s$	$0.5A^2s$	Temperature independent

Fig. 5-1 **Typical input inrush current behaviour at nominal load and 25°C ambient**



6. DC OUTPUT

The output provides a SELV/PELV rated voltage, which is galvanically isolated from the input voltage.

The device 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.	24V	
Adjustment range	Min.	24-28V	Guaranteed value
	Max.	30V	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 output voltage	Typ.	24.1V	±0.2% in "single use" mode at full load, cold unit
	Typ.	24.1V	±0.2% in "parallel use" mode at 10A, cold unit (results to 23.9V ±0.7% at 12A and 25.0V ±0.2% at no load)
Line regulation	Max.	10mV	Between 3x 323 and 3x 576Vac input voltage change
Load regulation	Max.	100mV	Between 0 and 10A in "single use" mode, static value
	Typ.	1000mV	Between 0 and 10A in "parallel use" mode, static value, see Fig. 6-2
Ripple and noise voltage	Max.	50mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	12A[1)]	At 24V and an ambient temperature below 45°C
	Nom.	10A	At 24V and 60°C ambient temperature
	Nom.	7.5A	At 24V and 70°C ambient temperature
	Nom.	10.3A[1)]	At 28V and an ambient temperature below 45°C
	Nom.	8.6A	At 28V and 60°C ambient temperature
	Nom.	6.5A	At 28V and 70°C ambient temperature
		Reduce output current linearly between +45°C and +70°C	
Fuse breaking current	Typ.	23A	Up to 20ms once every five seconds, see Fig. 6-1. The fuse braking current is an enhanced transient current which helps to trip fuses on faulty output branches. The output voltage stays above 20V.
Overload behavior		Continuous current	See Fig. 6-1
Overload/ short-circuit current	Max.	23A	Continuous current, see Fig. 6-1
Output capacitance	Typ.	6 500µF	Included inside the power supply
Back-feeding loads	Max.	35V	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.

1) This current is also available for temperatures up to +70°C with a duty cycle of 10% and/ or not longer than 1 minute every 10 minutes.

Fig. 6-1 **Output voltage vs. output current, typ.**

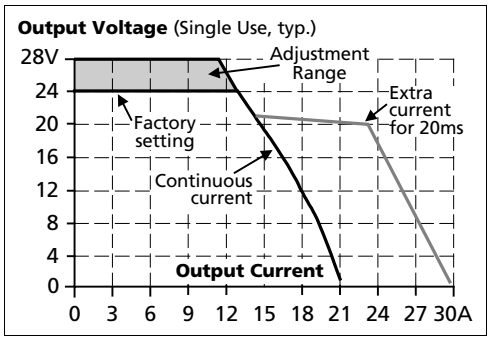
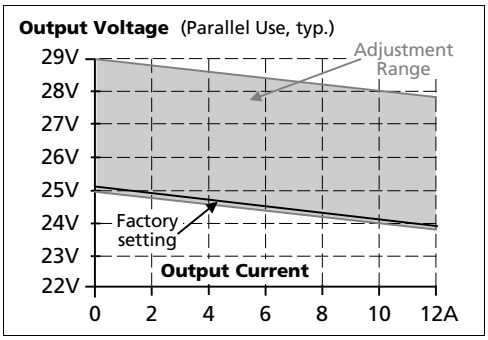


Fig. 6-2 **Output voltage in "parallel use" mode, typ.**



7. HOLD-UP TIME

		3AC 400V	3AC 480V	
Hold-up Time	Typ.	34ms	54ms	At 24V, 10A, see Fig. 7-1
	Typ.	68ms	108ms	At 24V, 5A, see Fig. 7-1
	Min	28ms	44ms	At 24V, 10A, see Fig. 7-1
	Min.	56ms	87ms	At 24V, 5A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

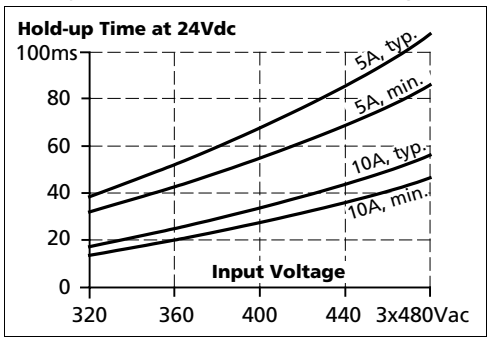
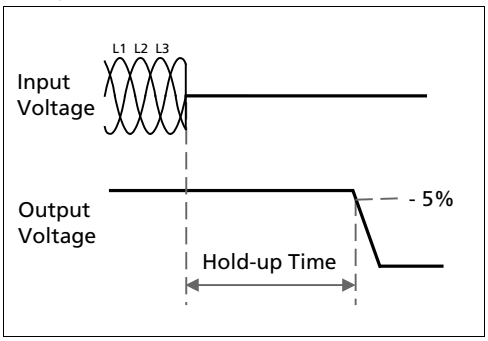


Fig. 7-2 **Shut-down behavior, definitions**



8. EFFICIENCY AND POWER LOSSES

		3AC 400V	3AC 480V	
Efficiency	Typ.	92.8%	92.9%	At 24V, 10A, 3-phase operation
	Typ.	92.4%	92.6%	At 24V, 10A, when using only two legs of a 3-phase system, see also chapter 22.7.
Average efficiency *)	Typ.	92.2%	92.0%	25% at 2.5A, 25% at 5A, 25% at 7.5A. 25% at 10A, 3-phase operation
Power losses	Typ.	2.3W	2.6W	At 0A, 3-phase operation
	Typ.	11.8W	11.8W	At 24V, 5A, 3-phase operation
	Typ.	18.6W	18.3W	At 24V, 10A, 3-phase operation
	Typ.	23.5W	22.8W	At 24V, 12A, 3-phase operation

*) 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. 8-1 **Efficiency vs. output current at 24V, typ., 3-phase operation**

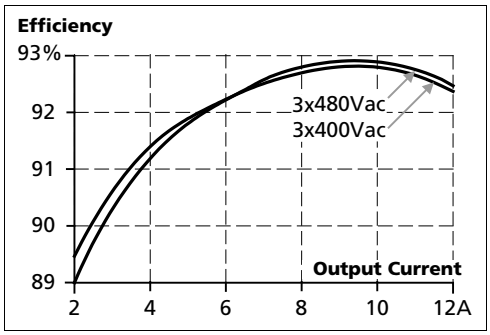


Fig. 8-2 **Losses vs. output current at 24V, typ., 3-phase operation**

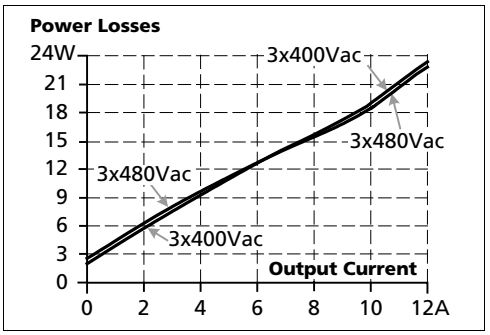


Fig. 8-3 **Efficiency vs. input voltage at 24V, 10A, typ., 3-phase operation**

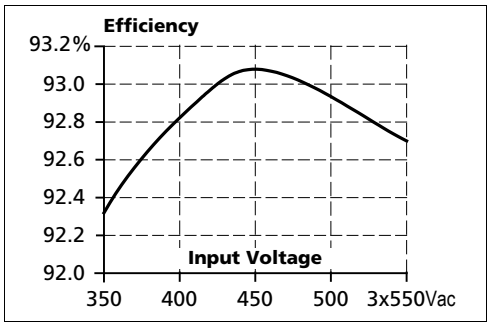
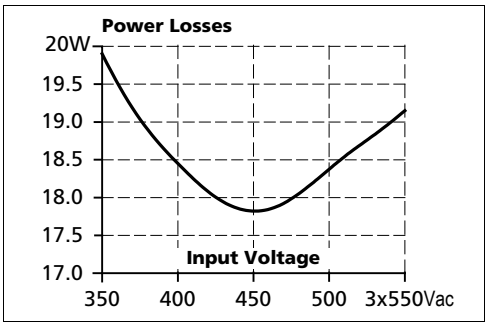
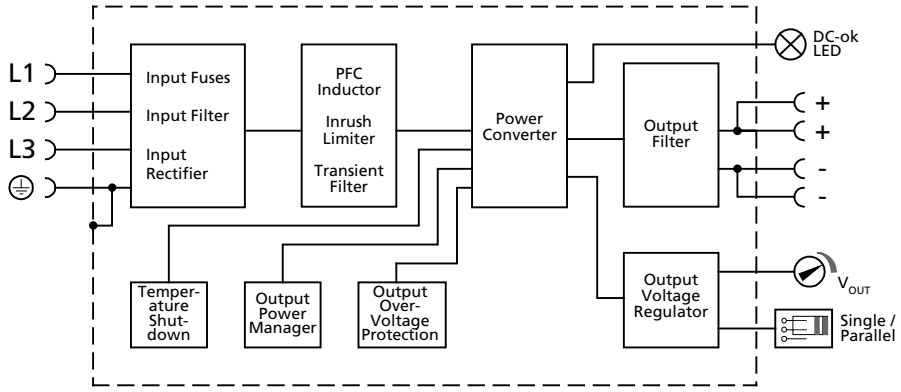


Fig. 8-4 **Losses vs. input voltage at 24V, 10A, typ., 3-phase operation**



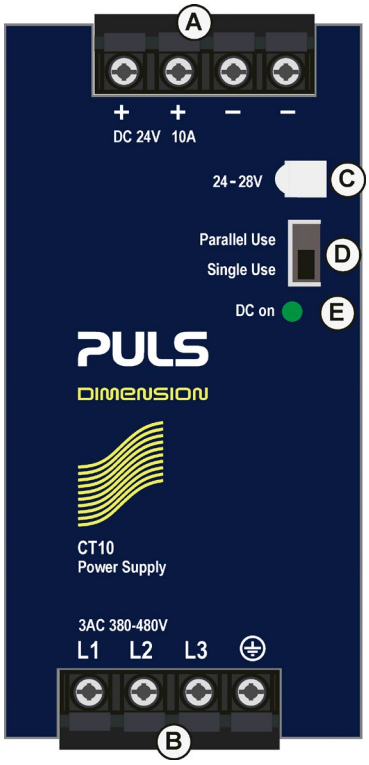
9. FUNCTIONAL DIAGRAM

Fig. 9-1 **Functional diagram**



10. FRONT SIDE AND USER ELEMENTS

Fig. 10-1 **Front side**



A **Output Terminals**

+	Positive output (two identical + poles)
–	Negative/ return output (two identical - poles)

B **Input Terminals**

L1, L2, L3	Line input
⏚	PE (Protective Earth) input

C **Output voltage potentiometer**
Open the flap to adjust the output voltage. The factory setting is 24.1V

D **Jumper for "Parallel Use" "Single Use"**
Set the jumper to "Parallel Use" when devices are connected in parallel to increase the output power. 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.
A missing jumper equals "Single Use" mode, which is also the factory setting.

E **DC-OK LED** (green)
On, when the output voltage is above 21V.

11. CONNECTION TERMINALS

The terminals are IP20 Finger safe constructed and suitable for field- and factory wiring.

	Input	**Output**
Type	Screw termination	Screw termination
Solid wire	Max. 6mm²	Max. 6mm²
Stranded wire	Max. 4mm²	Max. 4mm²
American Wire Gauge	AWG 20-10	AWG 20-10
Max. wire diameter (including ferrules)	2.8mm	2.8mm
Recommended tightening torque	1Nm, 9lb-in	1Nm, 9lb-in
Wire stripping length	7mm / 0.28inch	7mm / 0.28inch
Screwdriver	3.5mm slotted or Phillips No 1	3.5mm slotted or Phillips No 1

Daisy chaining:

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block as shown in Fig. 11-2.

Fig. 11-1 **Daisy chaining of outputs**

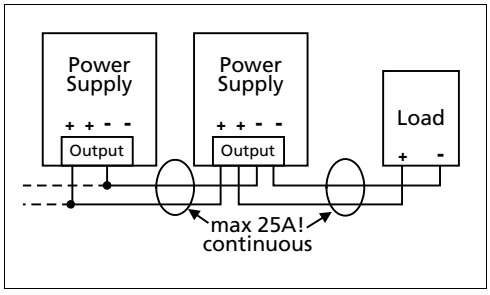
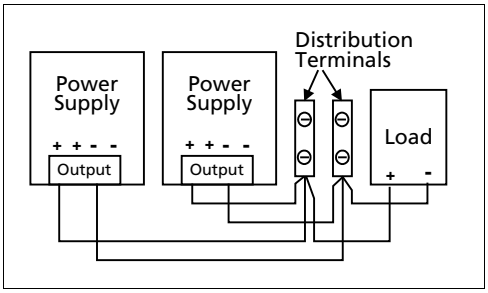


Fig. 11-2 **Using distribution terminals**



12. LIFETIME EXPECTANCY

The 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.

	3AC 400V	3AC 480V	
Lifetime expectancy	54 000h	62 000h	At 24V, 10A and 40°C, 3-phase operation
	133 000h	134 000h	At 24V, 5A and 40°C, 3-phase operation
	41 000h	47 000h	At 24V, 12A and 40°C, 3-phase operation
	151 000h	176 000h	At 24V, 10A and 25°C, 3-phase operation
	376 000h	379 000h	At 24V, 5A and 25°C, 3-phase operation
	116 000h	133 000h	At 24V, 12A and 25°C, 3-phase operation
Lifetime expectancy	48 000h	58 000h	At 24V, 10A and 40°C, 2-phase operation
	134 000h	145 000h	At 24V, 5A and 40°C, 2-phase operation
	36 000h	42 000h	At 24V, 12A and 40°C, 2-phase operation
	135 000h	164 000h	At 24V, 10A and 25°C, 2-phase operation
	379 000h	410 000h	At 24V, 5A and 25°C, 2-phase operation
	102 000h	119 000h	At 24V, 12A and 25°C, 2-phase operation

13. MTBF

MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

For these types of units the MTTF (**M**ean **T**ime **T**o **F**ailure) value is the same value as the MTBF value.

	3AC 400V	3AC 480V	
MTBF SN 29500, IEC 61709	975 000h	985 000h	At 24V, 10A and 40°C, 3-phase operation
	1 706 000h	1 723 000h	At 24V, 10A and 25°C, 3-phase operation
	925 000h	939 000h	At 24V, 10A and 40°C, 2-phase operation
	1 633 000h	1 656 000h	At 24V, 10A and 25°C, 2-phase operation
MTBF MIL HDBK 217F	444 000h	428 000h	At 24V, 10A and 40°C, 3-phase Ground Benign GB40
	584 000h	563 000h	At 24V, 10A and 25°C, 3-phase Ground Benign GB25
	100 000h	100 000h	At 24V, 10A and 40°C, 3-phase Ground Fixed GF40
	132 000h	132 000h	At 24V, 10A and 25°C, 3-phase Ground Fixed GF25
	436 000h	423 000h	At 24V, 10A and 40°C, 2-phase Ground Benign GB40
	555 000h	572 000h	At 24V, 10A and 25°C, 2-phase Ground Benign GB25
	98 000h	98 000h	At 24V, 10A and 40°C, 2-phase Ground Fixed GF40
	129 000h	129 000h	At 24V, 10A and 25°C, 2-phase Ground Fixed GF25

14. 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 output is allowed to be grounded or floating.

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

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	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L1 → L2, L2 → L3, L1 → L3 L1 / L2 / L3 → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	500V 1kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Mains voltage dips (Dips on three phases)	EN 61000-4-11	0% of 380Vac 0% of 480Vac	0Vac, 20ms 0Vac, 20ms	Criterion A Criterion A
Mains voltage dips (Dips on two phases)	EN 61000-4-11	40% of 380Vac 40% of 480Vac 70% of 380Vac 70% of 480Vac	200ms 200ms 500ms 500ms	Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11		5s	Criterion C
Powerful transients	VDE 0160	Over entire load range	1550V, 1.3ms	Criterion A

Criterions:
A: The device shows normal operation behavior within the defined limits.
C: Temporary loss of function is possible. The device may shut down and restarts by itself. No damage or hazards for the device will occur.

EMC Emission

Conducted emission input lines	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Fulfilled for Class A equipment
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with constant current loads, non pulsing

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 Frequency

Main converter	60kHz to 140kHz	Output load and input voltage dependent

15. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	The operational temperature is the ambient or surrounding temperature and is defined as the air temperature 2cm below the device.
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	3.2W/°C 6W/°C 15W/1000m or 5°C/1000m 9W/-5kPa or 3°C/-5kPa	Between +45°C and +60°C (113°F to 140°F) Between +60°C and +70°C (140°F to 158°F) For altitudes >2000m (6560ft), see Fig. 15-2 For atmospheric pressures <80kPa, see Fig. 15-2
	The de-rating is not hardware controlled. The customer has to 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	110-47kPa	See Fig. 15-2 for details
Altitude	Up to 6000m (20 000ft)	See Fig. 15-2 for details
Over-voltage category	III	According to IEC 60664-1 for altitudes up to 2000m
	II	According to IEC 60664-1 for altitudes from 2000 to 6000m and atmospheric pressures from 80 to 47kPa
Degree of pollution	2	According to IEC 62477-1, not conductive
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	According to IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	According to IEC 60068-2-27
	Shock and vibration is tested in combination with DIN-Rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm and standard orientation.	
LABS compatibility	As a rule, only non-silicon precipitating materials are used. The unit conforms to the LABS criteria and is suitable for use in paint shops.	
Corrosive gases	Tested according to ISA-71.04-1985, Severity Level G3 for a service life of minimum 10years in these environments.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

Fig. 15-1 **Output current vs. ambient temp.**

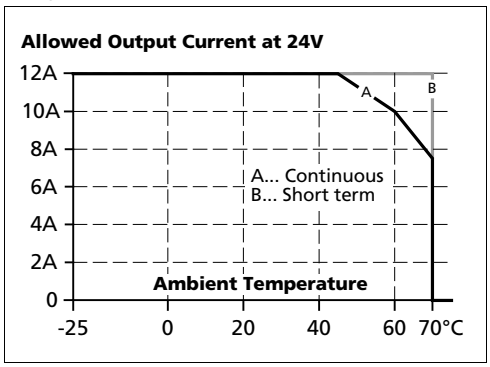
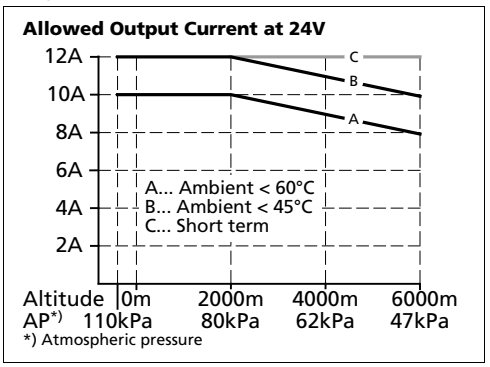


Fig. 15-2 **Output current vs. altitude at 24V**



16. SAFETY AND PROTECTION FEATURES

Isolation resistance	Min.	500MOhm	At delivered condition between input and output, measured with 500Vdc
	Min.	500MOhm	At delivered condition between input and PE, measured with 500Vdc
	Min.	500MOhm	At delivered condition between output and PE, measured with 500Vdc
	Min.	500MOhm	At delivered condition between output and DC-OK contacts, measured with 500Vdc
PE resistance	Max.	0.1Ohm	Resistance between PE terminal and the housing in the area of the DIN-rail mounting bracket.
Output over-voltage protection	Typ.	30.5Vdc	
	Max.	32Vdc	
		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 A PE (Protective Earth) connection is required
Degree of protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shuts down with automatic restart. Temperature sensors are installed on critical components inside the unit and turn the unit off in safety critical situations, which can happen e.g. when ambient temperature is too high, ventilation is obstructed or the de-rating requirements are not followed. There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.
Input transient protection		MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.17mA	At 3x 400Vac, 50Hz, TN-,TT-mains
	Typ.	0.24mA	At 3x 480Vac, 60Hz, TN-,TT-mains
	Max.	0.22mA	At 3x 440Vac, 60Hz, TN-,TT-mains
	Max.	0.31mA	At 3x 528Vac, 50Hz, TN-,TT-mains

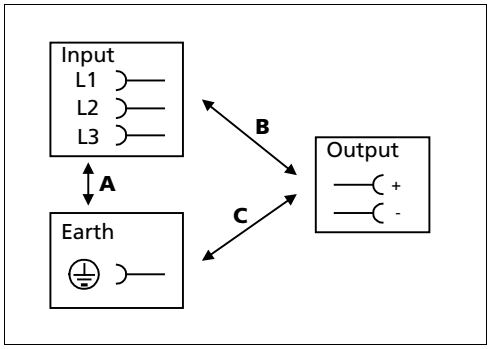
17. DIELECTRIC STRENGTH

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 (2s up and 2s 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.

Fig. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	3000Vac	500Vac
Routine test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting for field test		> 10mA	> 10mA	> 30mA

It is recommend that either the + pole, the – pole or any other part of the output circuit shall be connected to the earth/ground system. This helps to avoid situations in which a load starts unexpectedly or can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - RoHS directive - EMC directive and the - Low-voltage directive (LVD)
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL US LISTED IND. CONT. EQ.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
UL 60950-1 2nd Edition	c UL US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
Marine	GL ABS	GL (Germanischer Lloyd) classified and ABS (American Bureau for Shipping) PDA Environmental category: C, EMC2 Marine and offshore applications
SEMI F47	Power Standards Lab PSL SEMI F47	SEMI F47-0706 Ride-through compliance for the semiconductor industry. Full SEMI range compliance (Dips on two phases: 304Vac for 1000ms, 266Vac for 500ms and 190Vac for 200ms)
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

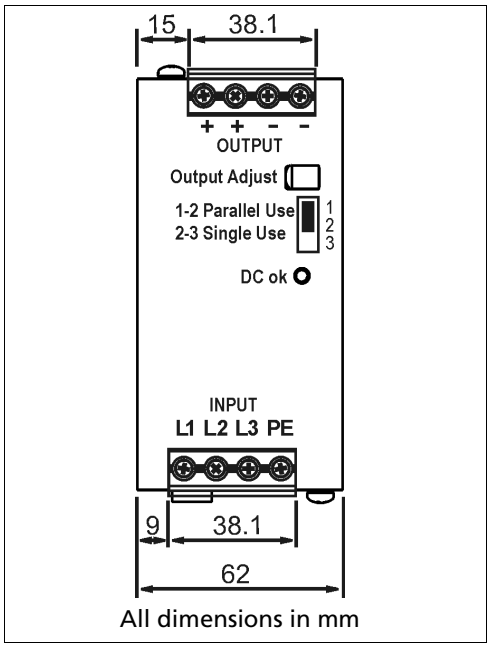
19. OTHER FULFILLED STANDARDS

RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
IEC/EN 61558-2-16 (Annex BB)	Safety Isolating Transformer	Safety Isolating Transformers corresponding to Part 2-6 of the IEC/EN 61558

20. PHYSICAL DIMENSIONS AND WEIGHT

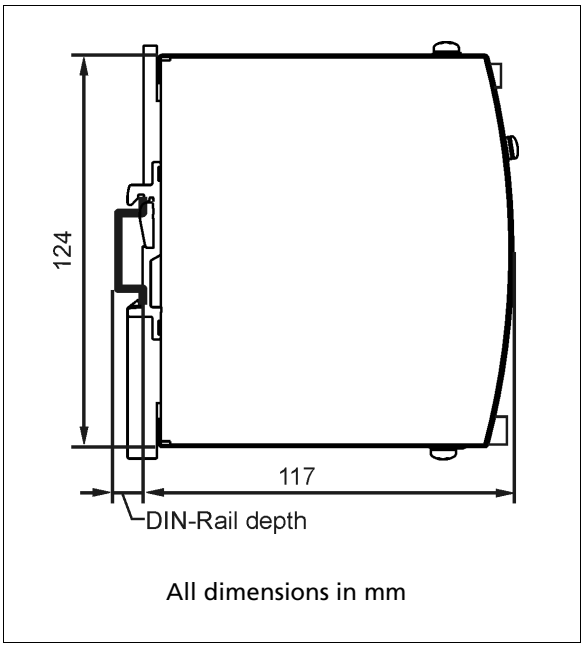
Width	62mm 2.44''
Height	124mm 4.88''
Depth	117mm 4.61'' The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	750g / 1.65lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: zinc-plated steel
Installation clearances	See chapter 2
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 3.5mm

Fig. 20-1 **Front view**



All dimensions in mm

Fig. 20-2 **Side view**



All dimensions in mm

21. ACCESSORIES

21.1. ZM1.WALL – WALL/PANEL MOUNT BRACKET

These brackets are used to mount the device on a flat surface or panel without utilizing a DIN-rail.

The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted in the holes of the aluminum brackets.

The order number ZM1.WALL contains two brackets needed for one device.

Fig. 21-1 **ZM1.Wall**

Fig. 21-2 **Hole pattern**

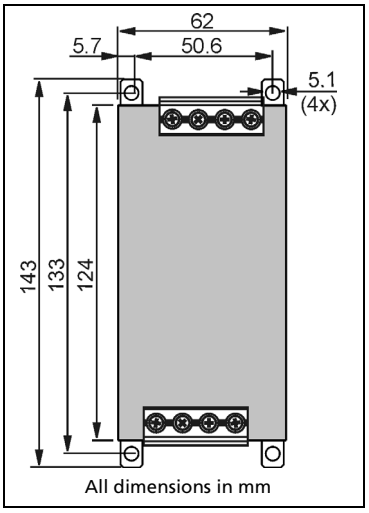


Fig. 21-3 **Side view**

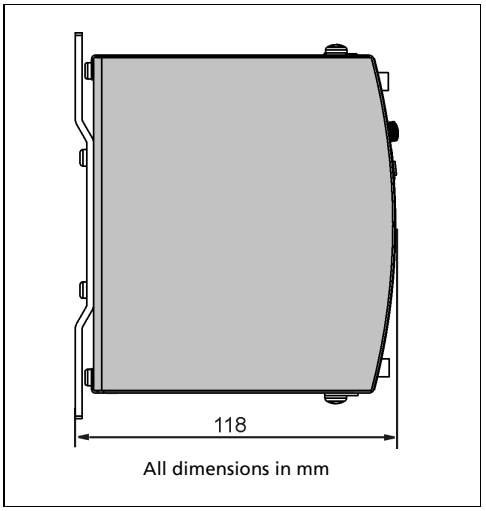


Fig. 21-4 **Isometric view**

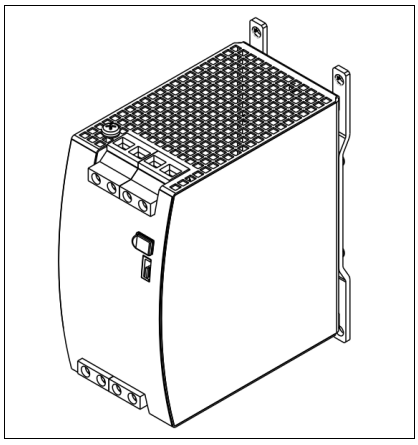


Fig. 21-5 **Isometric view**

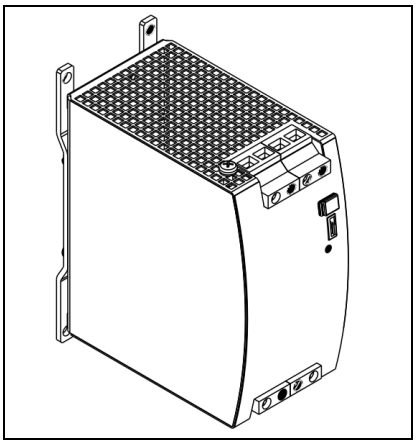
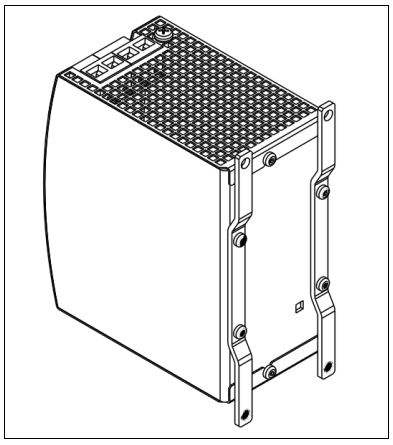


Fig. 21-6 **Isometric view**



21.2. ZM13.SIDE - SIDE MOUNT BRACKET

This ZM13.SIDE 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 ZM13.SIDE steel bracket can be mounted.

For sideway DIN-rail mounting, the removed aluminum brackets and the black plastic slider need to be mounted on the ZM13.SIDE steel bracket.

Fig. 21-7 **ZM13.SIDE**

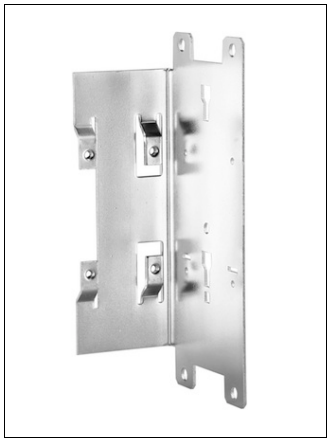


Fig. 21-8
Mounting instructions

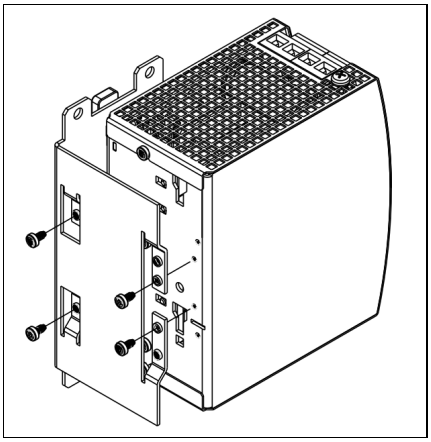


Fig. 21-9
Side mounting without DIN-rail brackets

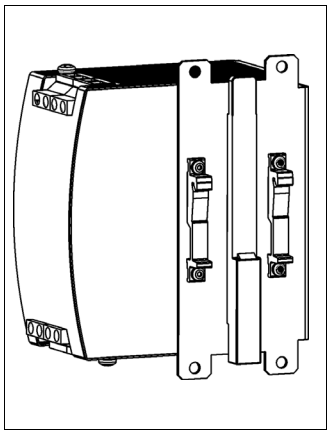


Fig. 21-10
Side mounting with DIN-rail brackets

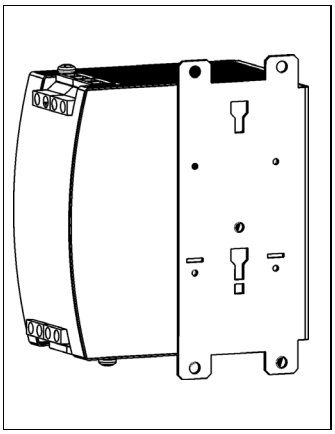
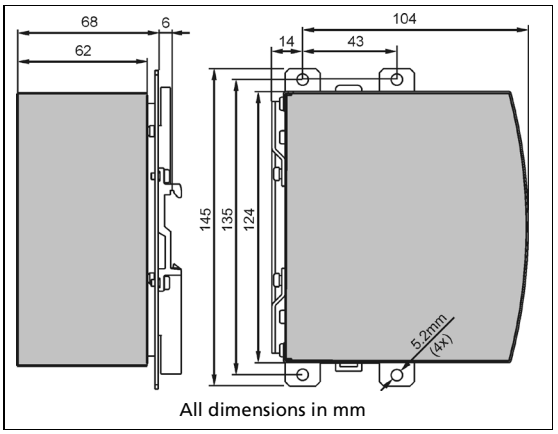


Fig. 21-11
Hole pattern



All dimensions in mm

21.3. YRM2.DIODE - REDUNDANCY MODULES

The YRM2.DIODE is a dual redundancy module, which can be used to build 1+1 or N+1 redundant systems.

The device is equipped with two input channels each 10A nominal, which are individually decoupled by utilizing diode technology. The output can be loaded with nominal 20A.

The device does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

The device has a monitoring circuit included and is the perfect choice when the power supply has no DC-OK function. Two LEDs and two relay contacts signal when one of the two input voltages is not in range due to a non-functioning or disconnected power supply.

The unit is very slender and only requires 32mm width on the DIN-rail.

See chapter 22.6 for wiring information.

22. APPLICATION NOTES

22.1. 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 nominal output current (including the PowerBoost). 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 examples show typical voltage dips for resistive loads:

Fig. 22-1 **20A peak current for 50ms, typ. (2x the nominal current)**

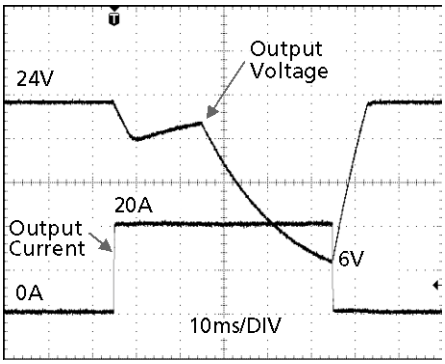
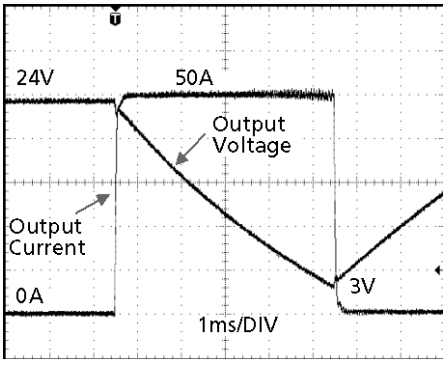


Fig. 22-2 **50A peak current for 5ms, typ. (5x the nominal current)**



Peak current voltage dips	Typ.	from 24V to 6V	At 20A for 50ms, resistive load
	Typ.	from 24V to 12V	At 50A for 2ms, resistive load
	Typ.	from 24V to 3V	At 50A for 5ms, resistive load

22.2. OUTPUT CIRCUIT BREAKERS

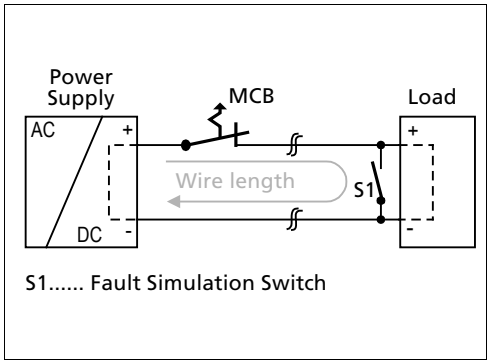
Standard miniature circuit breakers (MCB's or UL 1077 circuit breakers) are commonly used for AC-supply systems and may also be used on 24V branches.

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.

The following test results indicate the maximal wire length for a magnetic (fast) tripping. The wire length is always two times the distance to the load (+ and – wire).

Fig. 22-3 **Test circuit for maximum wire length**



S1..... Fault Simulation Switch

Test results for maximum wire length:

	0.75mm²	1.0mm²	1.5mm²	2.5mm²
C-2A	23m	28m	43m	69m
C-3A	18m	23m	34m	54m
C-4A	6m	12m	18m	28m
C-6A	3m	4m	6m	7m
C-8A	2m	3m	4m	5m
C-10A	1m	2m	3m	4m
B-6A	9m	14m	19m	33m
B-10A	4m	5m	6m	9m
B-13A	3m	4m	5m	8m

22.3. CHARGING OF BATTERIES

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

Instructions for charging batteries:

a) Ensure that the ambient temperature of the power supply stays below 45°C.

b) Set the output voltage, measured at no load and at the battery end of the 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

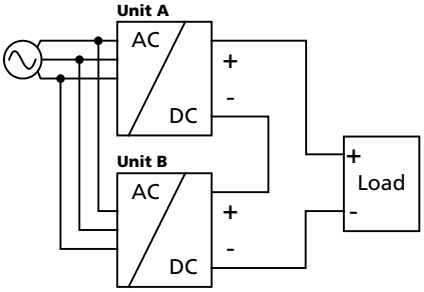
c) Use a 16A circuit breaker or a blocking diode between the power supply and the battery.

d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

e) Use only matched batteries when putting 12V types in series.

f) The return current to the power supply is typically 8mA. This return current can discharge the battery when the power supply is switched off except in case a blocking diode is utilized.

22.4. SERIES OPERATION



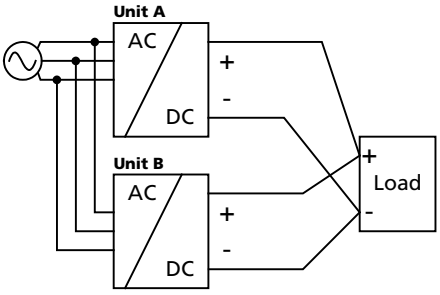
Devices of the same type can be connected in series for higher output voltages. It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc. Voltages with a potential above 60Vdc must be installed with a protection against touching.

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 leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

22.5. PARALLEL USE TO INCREASE OUTPUT POWER



Devices can be paralleled to increase the output power. The output voltage of all devices shall be adjusted to the same value (±100mV) 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 unit 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.

The ambient temperature is not allowed to exceed +60°C.

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 15A or 16A 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 devices and avoid installing 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 (e.g. altitude).

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

22.6. PARALLEL USE FOR REDUNDANCY

1+1 Redundancy:
Devices 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.

For 1+1 redundancy the ambient temperature is not allowed to exceed +70°C.

Recommendations for building redundant power systems:

- Use separate input fuses for each device.
- Use separate mains systems for each device whenever it is possible.
- Monitor the outputs of the individual devices. Use the DC-ok contact, which is included in the redundancy module.
- It is desirable to set the output voltages of all devices to the same value (± 100mV) or leave it at the factory setting.
- Set the devices into "Parallel Use" mode.

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

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

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

Keep an installation clearance of 15mm (left / right) between two devices and avoid installing 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.

For 1+1 redundancy the ambient temperature is not allowed to exceed +60°C.

Wiring examples for 1+1 and n+1 redundancy:

Fig. 22-4 **1+1 Redundant configuration for 10A load current and redundancy modules**

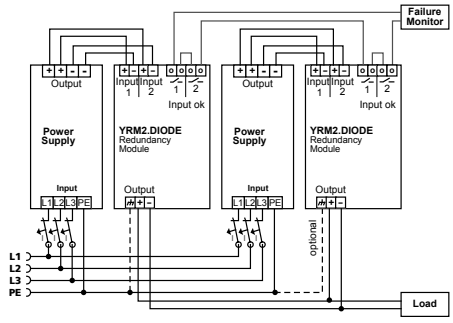
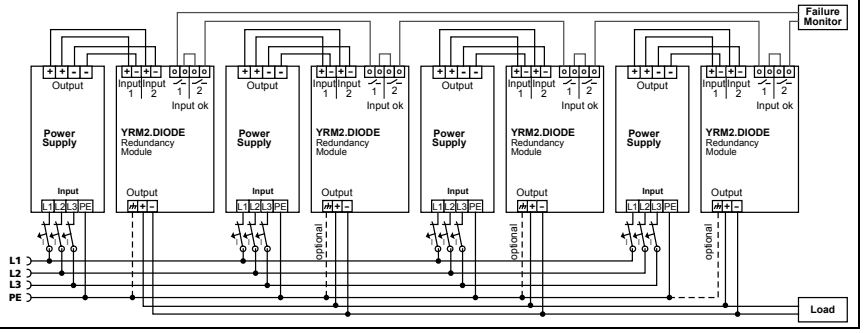
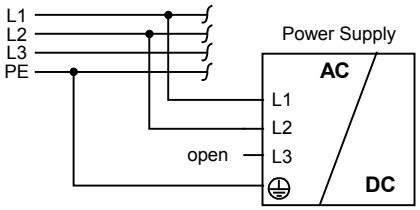


Fig. 22-5 **N+1 Redundant configuration for 30A load current with multiple power supplies and redundancy modules**



22.7. OPERATION ON TWO PHASES



No external protection device is required to protect against a phase-loss failure.

The power supply is allowed to run permanently on only two legs of a 3-phase system, when the output power is reduced according to the curves below. A long-term exceeding of these limits will result in a thermal shut-down of the device.

Pay attention that EMC performance, hold-up time and losses differ from a three phase operation. Therefore, check suitability of your individual application.

Using only two legs of a 3-phase system is not included in the agency approval. Therefore, additional investigations might be necessary during the approval process of the final system.

Fig. 22-6 **Allowed output current for use on only two legs of a 3-phase system**

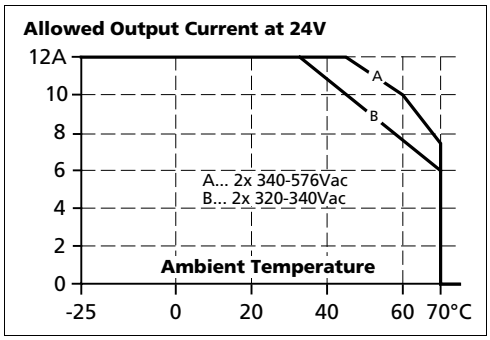


Fig. 22-7 **Hold-up time for use on only two legs of a 3-phase system**

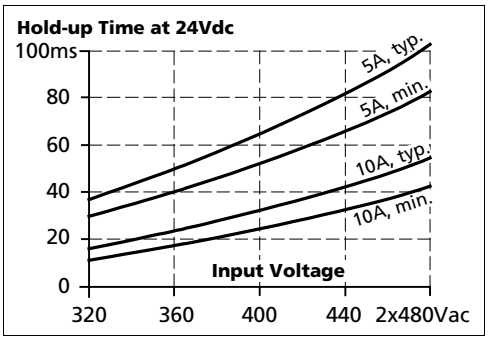


Fig. 22-8 **Efficiency vs. output current at 24V for use on only two legs of a 3-phase system**

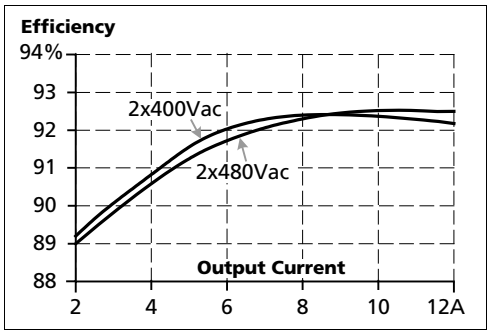
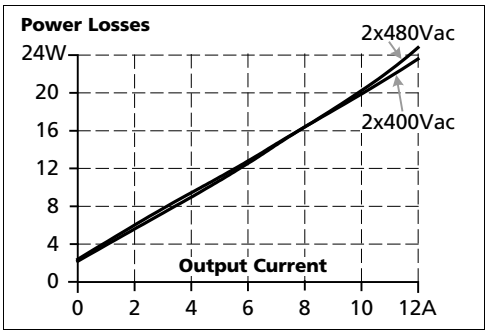


Fig. 22-9 **Losses vs. output current at 24V for use on only two legs of a 3-phase system**



22.8. USE IN A TIGHTLY SEALED ENCLOSURE

When the device 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 device.

In the following test setup, the device is placed in the middle of the box, no other heat producing items are inside the box. The load is placed outside the box.

The temperature sensor inside the box is placed in the middle of the right side of the power supply with a distance of 1cm.
The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

	Case A	**Case B**
Enclosure size	180x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic	180x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic
Input voltage	3x 400Vac	3x 400Vac
Load	24V, 8A; (=**80%**)	24V, 10A; (=**100%**)
Temperature inside the box	48.4°C	54.7°C
Temperature outside the box	24.5°C	24.9°C
Temperature rise	23.9K	29.8K

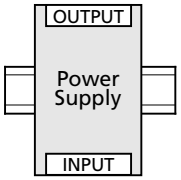
22.9. MOUNTING ORIENTATIONS

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 2000m (6560ft).

Fig. 22-10
Mounting Orientation A
(Standard orientation)



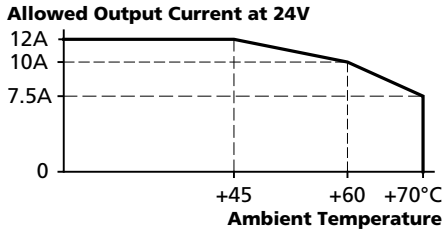
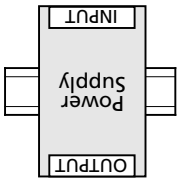


Fig. 22-11
Mounting Orientation B
(Upside down)



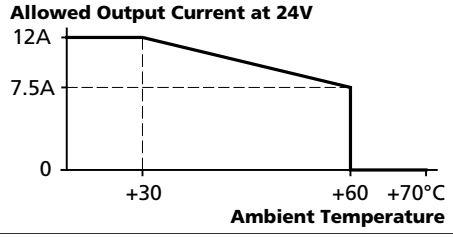
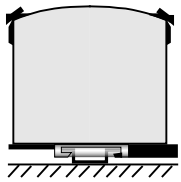


Fig. 22-12
Mounting Orientation C
(Table-top mounting)



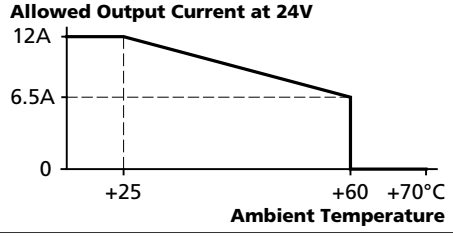
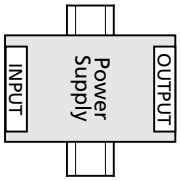


Fig. 22-13
Mounting Orientation D
(Horizontal cw)



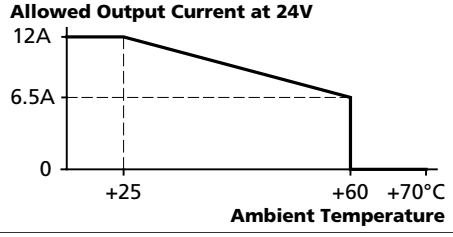
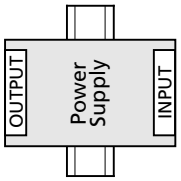
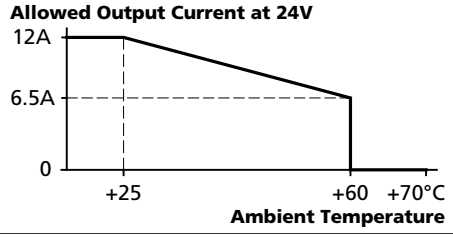


Fig. 22-14
Mounting Orientation E
(Horizontal ccw)





PULS

MiniLine-2

ML15.121

12V, 1.3A, SINGLE PHASE INPUT

POWER SUPPLY

- 100-240V Wide Range Input
- NEC Class 2 Compliant
- Adjustable Output Voltage
- Efficiency up to 83%
- Compact Design, Width only 22.5mm
- Full Output Power Between -10°C and +60°C
- Large International Approval Package
- 3 Year Warranty

GENERAL DESCRIPTION

A compact size, light weight, simple mounting onto the DIN-rail and the utilization of only quality components are what makes the MiniLine power supplies so easy to use and install within seconds.

A rugged electrical and mechanical design as well as a high immunity against electrical disturbances on the mains provides reliable output power. This offers superior protection for equipment which is connected to the public mains network or is exposed to a critical industrial environment.

The MiniLine series offers output voltages from 5 to 56Vdc and a power rating from 15W to 120W.

The supplementary MiniLine decoupling diode module MLY10.241 allows building of redundant systems or to protect against back-feed voltages.

SHORT-FORM DATA

Output voltage	DC 12V	
Adjustment range	12 - 15V	
Output current	1.3A at 12V 1.0A at 15V	
Output power	15W	
Output ripple	< 75mVpp	20Hz to 20MHz
Input voltage	AC 100-240V	-15% / +10%
Mains frequency	50-60Hz	±6%
AC Input current	0.28 / 0.17A	at 120 / 230Vac
Power factor	0.51 / 0.44	at 120 / 230Vac
AC Inrush current	typ. 16 /31A	peak value at 120/230Vac, 40°C and cold start
DC Input	88-375Vdc	
Efficiency	83.0 / 82.5%	at 120 / 230Vac
Losses	3.2 / 3.1W	at 120 / 230Vac
Temperature range	-10°C to +70°C	operational
Derating	0.4W/°C	+60 to +70°C
Hold-up time	typ. 46 / 191ms	at 120 / 230Vac
Dimensions	22.5x75x91mm	WxHxD
Weight	130g / 0.29lb	

ORDER NUMBERS

Power Supply	**ML15.121**	12-15V Standard nit
Accessory	MLY10.241	Redundancy module

MARKINGS

UL LISTED IND. CONT. EQ.
UL 508

c UL us
UL 60950-1
NEC Class 2

c SP us
Class I Div 2

c SP us
CSA 22.2 No107.1

GL
Marine

CE
EMC, LVD, RoHS

All parameters are specified at 12V, 1.3A, 230Vac input, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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.

Mount the unit on a DIN-rail so that the output terminals are located on top and input terminal on the bottom. For other mounting orientations see de-rating requirements in this document.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Keep the following installation clearances:
40mm on top, 20mm on the bottom
15mm on the left or right sides in case the adjacent device is a heat source (e.g. another power supply).

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into 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.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15:2010.

3. AC-INPUT

AC input	nom.	AC 100-240V	-15% / +10%, TN/TT/IT-mains
AC input range		85-264Vac	continuous operation
		264–300Vac	< 0.5s
Allowed voltage L or N to earth	max.	300Vac	
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	59Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	54Vac	steady-state value, see Fig. 3-1

		AC 100V	AC 120V	AC 230V	
Input current (rms)	typ.	0.34A	0.28A	0.17A	at 12V, 1.3A see Fig. 3-3
Power factor *)	typ.	0.52	0.51	0.44	at 12V, 1.3A see Fig. 3-4
Crest factor **)	typ.	3.45	3.53	3.94	at 12V, 1.3A
Start-up delay	typ.	780ms	780ms	780ms	see Fig. 5 2
Rise time	typ.	12ms	12ms	12ms	at 12V, 1.3A, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 3-1 **Input voltage range**

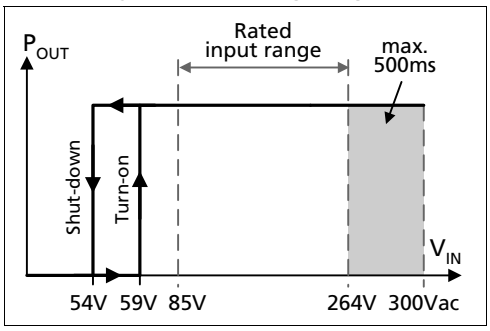


Fig. 3-2 **Turn-on behavior, definitions**

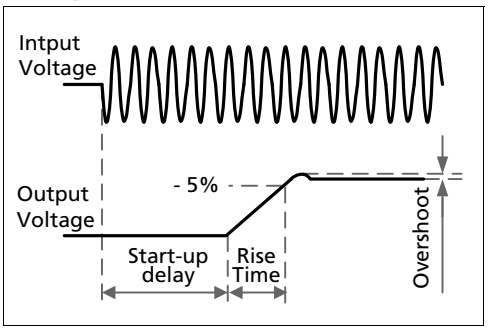


Fig. 3-3 **Input current vs. output load at 12V**

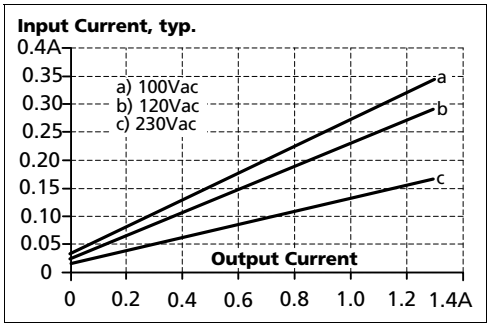
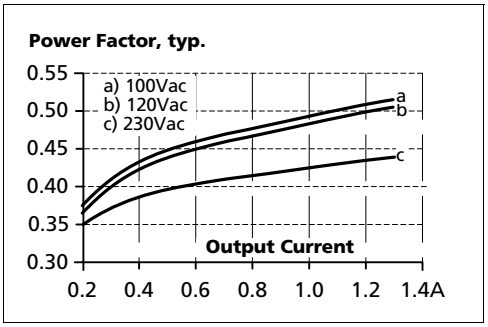


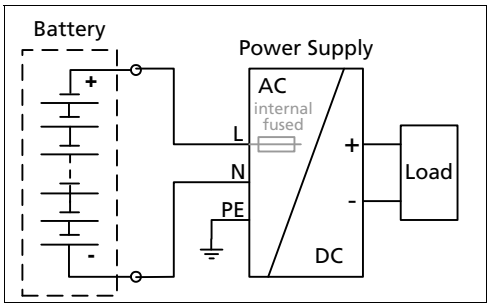
Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

DC input	nom.	DC 110-300V	-20%/+25%
DC input range	min.	88-375Vdc	continuous operation
DC input current	typ.	0.16A / 0.057A	110Vdc / 300Vdc, at 12V, 1.3A
Turn-on voltage	typ.	80Vdc	steady state value
Shut-down voltage	typ.	60Vdc	steady state value

Fig. 4-1 **Wiring for DC Input**



Instructions for DC use:

a) Use a battery or similar DC source.
   For other sources contact PULS
b) Connect +pole to L and –pole to N.
c) Connect the PE terminal to an earth wire or to the machine ground.

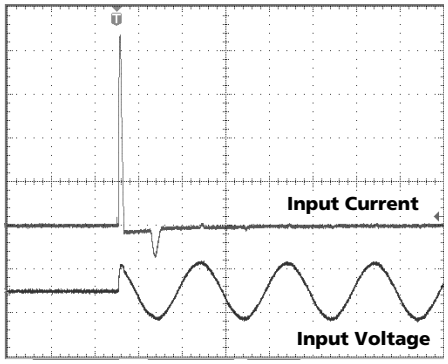
5. INPUT INRUSH CURRENT

A NTC limits the input inrush current after turn-on of the input voltage. The inrush current is input voltage and ambient temperature dependent.

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

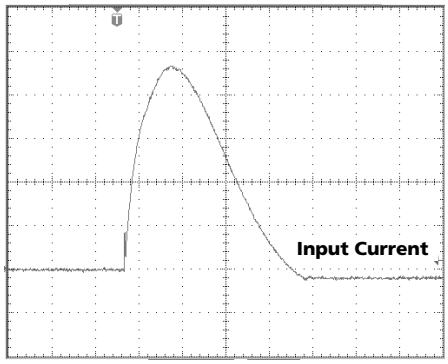
		AC 100V	**AC 120V**	**AC 230V**	
Inrush current	max.	$13A_{peak}$	$16A_{peak}$	$31A_{peak}$	40°C ambient, cold start
	typ.	$11A_{peak}$	$13A_{peak}$	$26A_{peak}$	40°C ambient, cold start
Inrush energy	max.	$0.1A^2s$	$0.1A^2s$	$0.4A^2s$	40°C ambient, cold start

Fig. 5-1 **Input inrush current, typical behavior**



Input: 230Vac
Output: 12V, 1.3A
Ambient: 25°C
Upper curve: Input current 5A/DIV
Lower curve: Input voltage 500V/DIV
Time basis: 10ms / DIV

Fig. 5-2 **Input inrush current, zoom into first peak**



Input: 230Vac
Output: 12V, 1.3A
Ambient: 25°C
Input current curve: 5A/DIV, 500µs / DIV
Ipeak 23A

6. OUTPUT

Output voltage	nom.	12V	
Adjustment range	min.	12-15V	guaranteed
	max.	16V *)	at clockwise end position of potentiometer
Factory setting		12.0V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	85-264Vac
Load regulation	max.	100mV	static value, 0A → 1.3A
Ripple and noise voltage	max.	75mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	1 650µF	
Output current	nom.	1.3A	at 12V, see Fig. 6-1
	nom.	1.0A	at 15V, see Fig. 6-1
Output power	nom.	15W	
Short-circuit current	min.	hiccup mode, see Fig. 6-2	
	max.	hiccup mode, see Fig. 6-2	

*) 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. The typical value which can be achieved by turning the potentiometer to the clock-wise end position is 15.7V.

Fig. 6-1 **Output voltage vs. output current, typ.**

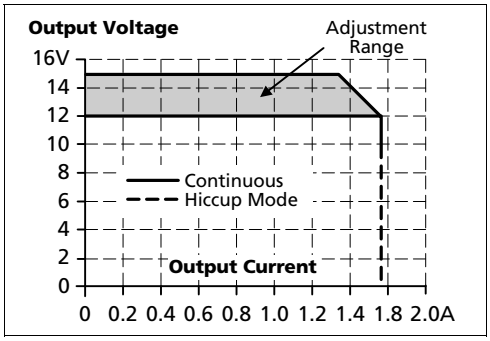
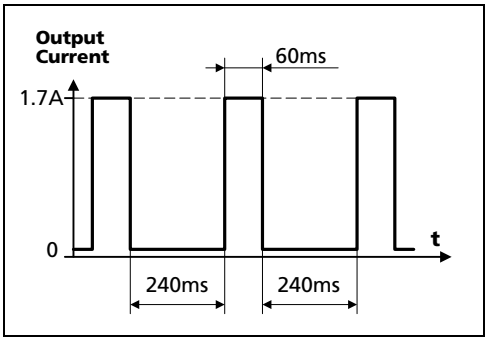


Fig. 6-2 **Hiccup mode; output current at shorted output, 230Vac, typ.**



Peak current capability (up to several milliseconds)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 22.1.

Peak current voltage dips	typ.	from 12V to 7.8V	at 2.6A for 50ms, resistive load
	typ.	from 12V to 5.2V	at 6.5A for 2ms, resistive load
	typ.	from 12V to 2.0V	at 6.5A for 5ms, resistive load

7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	62ms	96ms	365ms	at 12V, 0.65A, see Fig. 7-1
	typ.	30ms	46ms	191ms	at 12V, 1.3A, see Fig. 7-1

Note: At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is also on during this time

Fig. 7-1 **Hold-up time vs. input voltage**

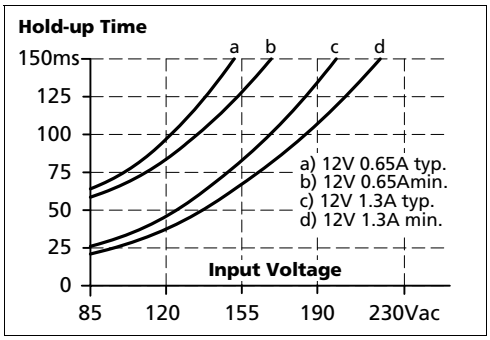
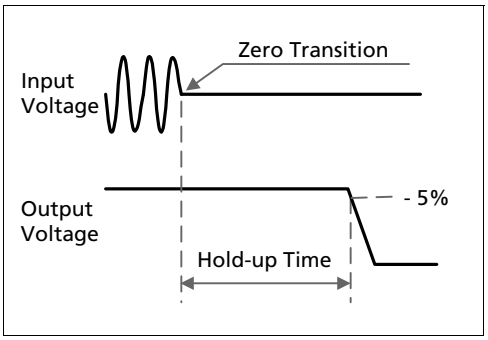


Fig. 7-2 **Shut-down behavior, definitions**



8. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	82.4%	83.0%	82.5%	at 12V, 1.3A (full load)
Power losses	typ.	0.5W	0.55W	0.75W	at 0A
	typ.	1.7W	1.6W	1.8W	at 12V, 0.65A (half load)
	typ.	3.2W	3.1W	3.2W	at 12V, 1.3A (full load)

Fig. 8-1 **Efficiency vs. output current at 12V, typ.**

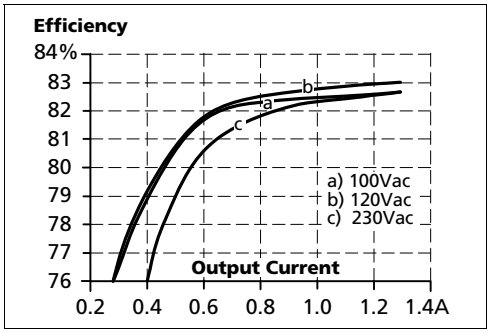


Fig. 8-2 **Losses vs. output current at 12V, typ.**

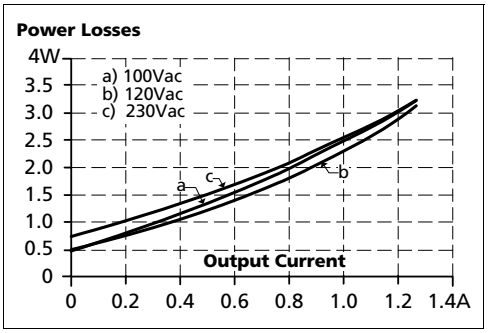


Fig. 8-3 **Efficiency vs. input voltage at 12V, 1.3A, typ.**

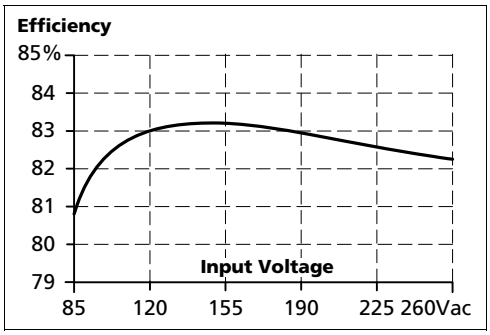
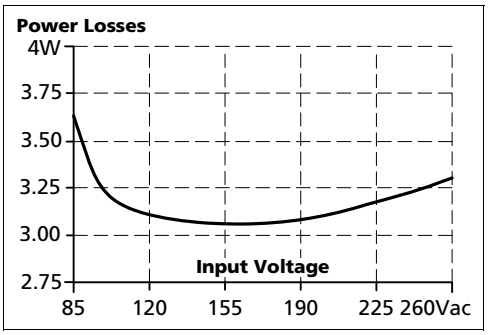
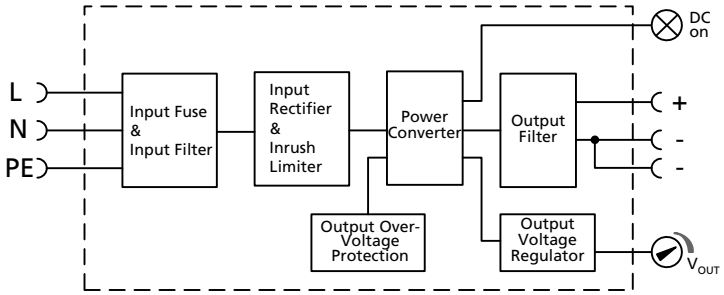


Fig. 8-4 **Losses vs. input voltage at 12V, 1.3A, typ.**



9. FUNCTIONAL DIAGRAM

Fig. 9-1 **Functional diagram**



10. FRONT SIDE AND USER ELEMENTS

Fig. 10-1 **Front side**

A **Output Terminals**
Screw terminals,
Dual terminals for the negative pole allows an easy earthing of the output voltage
+ Positive output
- Negative (return) output

B **Input Terminals**
Screw terminals
L Phase (Line) input
N Neutral conductor input
⏚ PE (Protective Earth) input

C **DC-on LED** (green)
On when the voltage on the output terminals is > 10.5V

D **Output voltage potentiometer**
Turn to set the output voltage. Factory set: 12.0V

11. TERMINALS AND WIRING

All terminals are easy to access when mounted on the panel. Input and output terminals are separated from each other (input below, output above) to help in error-free wiring.

	Input	**Output**
Type	screw terminals	screw terminals
Solid wire	0.5-6mm²	0.5-6mm²
Stranded wire	0.5-4mm²	0.5-4mm²
American Wire Gauge	20-10 AWG	20-10 AWG
Wire stripping length	7mm / 0.275inch	7mm / 0.275inch
Screwdriver	3.5mm slotted or Pozidrive No 2	3.5mm slotted or Pozidrive No 2
Recommended tightening torque	1Nm, 9lb.in	1Nm, 9lb.in

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient up to 45°C and 75°C for ambient up to 60°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).
e) Do not use the unit without PE connection.
f) Screws of unused terminal compartments should be securely tightened.
g) Ferrules are allowed.

12. LIFETIME EXPECTANCY AND MTBF

These units are extremely reliable and use only the highest quality materials. The number of critical components such as electrolytic capacitors has been reduced.

	AC 100V	**AC 120V**	**AC 230V**	
Lifetime expectancy *)	123 000h	126 000h	125 000h	at 12V, 1.3A and 40°C
	> 15 years	> 15 years	> 15 years	at 12V, 0.65A and 40°C
	> 15 years	> 15 years	> 15 years	at 12V, 1.3A and 25°C
MTBF **) SN 29500, IEC 61709	3 435 000h	3 723 000h	3 811 000h	at 12V, 1.3A and 40°C
	5 633 000h	6 106 000h	6 205 000h	at 12V, 1.3A and 25°C
MTBF **) MIL HDBK 217F	1 482 000h	1 534 000h	1 451 000h	at 12V, 1.3A and 40°C; Ground Benign GB40
	1 986 000h	2 056 000h	1 944 000h	at 12V, 1.3A and 25°C; Ground Benign GB25

*) The **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 prediction model allows only a calculation of up to 15 years from date of shipment.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

13. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available on request.

EMC Immunity	Generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 8kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N → PE, L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + → PE, - → PE	500V 2kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Input voltage swells	PULS internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:

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

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

EMC Emission	Generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Not applicable below 75W input power
Voltage fluctuations, flicker	EN 61000-3-3	fulfilled

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 frequency	Constant, typ. 65kHz

14. ENVIRONMENT

Operational temperature *)	-10°C to +70°C (14°F to 158°F)	Reduce output power according Fig. 14-1
Storage temperature	-40 to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	0.4W/°C	60-70°C (140°F to 158°F)
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 20 000ft)	Reduce output power or ambient temperature above 2000m sea level.
Altitude de-rating	1W/1000m or 5°C/1000m	above 2000m (6500ft), see Fig. 14-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	Altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 14-1 **Output power vs. ambient temp.**

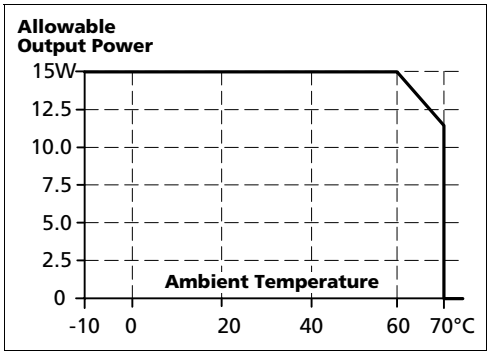
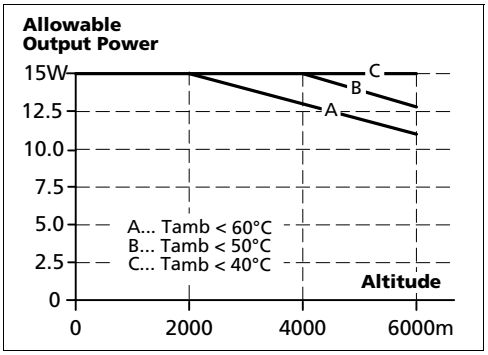


Fig. 14-2 **Output power vs. altitude**



15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits *)	
Output over-voltage protection	typ. 21.5Vdc max. 25Vdc	In case of an internal power supply fault, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and stays down until the input voltage is turned off and on again.
Output over-current protection	electronically limited	see Fig. 6-2
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 2.5mm in diameter	e.g. screws, small parts
Over-temperature protection	Not included	
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T3.15A H.B.C.	not user replaceable

*) In case of a protection event, audible noise may occur.

16. SAFETY FEATURES

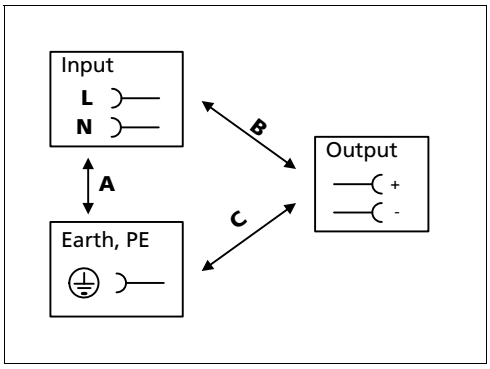
Input / output separation *)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
	II (with restrictions)	for use without PE connection contact PULS
Isolation resistance	> 5MOhm	Input to output, 500Vdc
Touch current (leakage current)	typ. 0.17mA / 0.38mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.24mA / 0.55mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.40mA / 0.86mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.21mA / 0.44mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.30mA / 0.66mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.54mA / 1.08mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

*) Double or reinforced insulation

17. 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. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	3000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting		> 6mA	> 6mA	> 1mA

To fulfill the PELV requirements according to EN60204-1 § 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 can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive 2004/108/EC, - Low-voltage directive (LVD) 2006/95/EC and - RoHS directive 2011/65/EU.
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	UL LISTED IND. CONT. EQ.	Listed for the use as Industrial Control Equipment; E-File: E198865
UL 60950-1 2nd Edition	c UL us	Recognized for the use as Information Technology Equipment, Level 3 in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006
NEC Class 2	**NEC CLASS 2**	Listed as Limited Power Source (LPS) in the UL 60950-1 UL report. According to NEC (National Electrical Code) Article 725-41 (4).
Class I Div 2 ANSI / ISA 12.12.01-2000	C US Class I Div2	Recognized for use in Hazardous Location Class I Div 2 T4 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Ind. Cont. Eq. - Canada CSA 22.2 No107.1-01	C US Ind. Cont. Eq.	CSA approval for Canada CAN/CSA C22.2 No 107-1; CAN/ CSA 60950-1-03; UL60950-1
Marine	GL ABS	GL (Germanischer Lloyd) classified Environmental category: C, EMC2 Marine and offshore applications ABS (American Bureau for Shipping) PDA
GOST P		Certificate of Conformity for Russia and other GUS countries

19. FULFILLED STANDARDS

EN 61558-2-17	Safety of Power Transformers
EN/IEC 60204-1	Safety of Electrical Equipment of Machines
EN/IEC 61131-2	Programmable Controllers
EN 50178, IEC 62103	Electronic Equipment in Power Installations

20. PHYSICAL DIMENSIONS AND WEIGHT

Weight	130g / 0.29lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the unit depth (91mm) to calculate the total required installation depth.
Installation Clearances	See chapter 2

Fig. 20-1 **Front view**

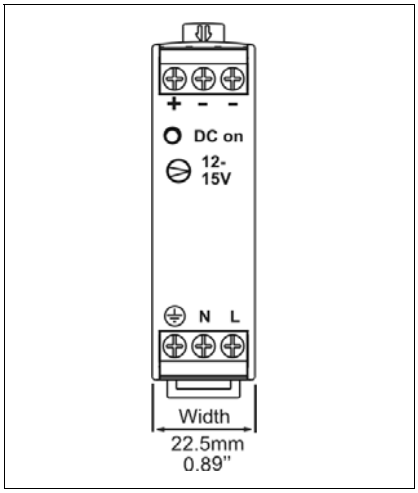
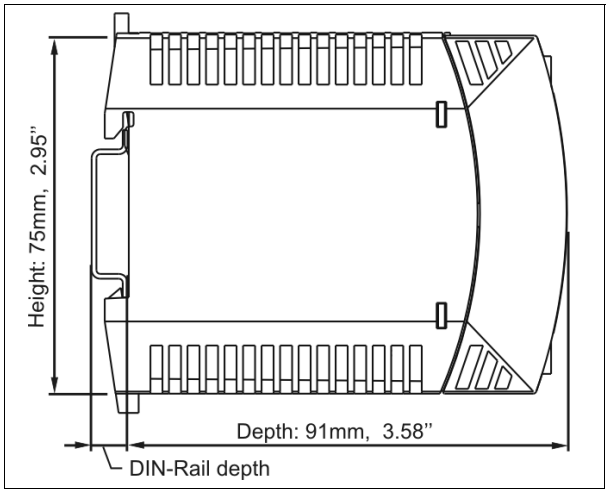


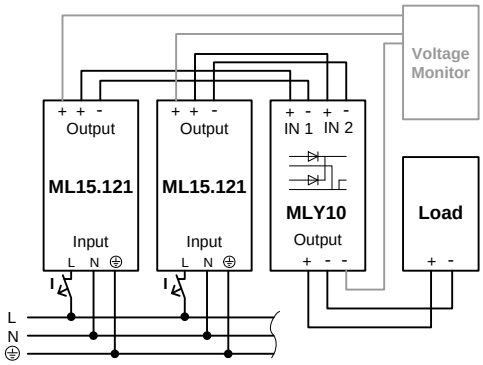
Fig. 20-2 **Side view**



21. ACCESSORY

21.1. MLY10.241 - REDUNDANCY MODULE

The MLY10.241 is a dual redundancy module, which has two diodes with a common cathode included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.



22. APPLICATION NOTES

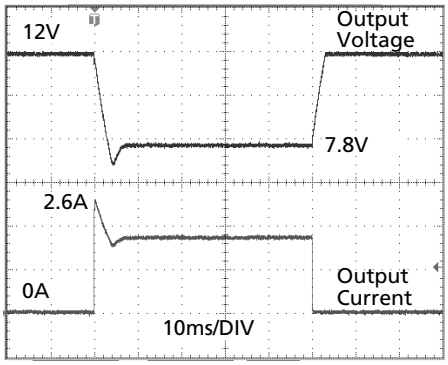
22.1. PEAK CURRENT CAPABILITY

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

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

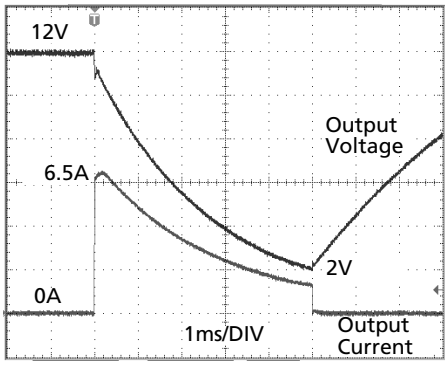
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-1 **Peak loading with 2x the nominal current for 50ms, typ.**



Peak load 2.6A (resistive load) for 50ms
Output voltage dips from 12V to 7.8V.

Fig. 22-2 **Peak loading with 5x the nominal current for 5ms, typ.**



Peak load 6.5A (resistive load) for 5ms
Output voltage dips from 12V to 2V.

22.2. 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).

The maximum allowed feed back voltage is 25Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 6.

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. However, please note that the output voltage can dip to zero for approximately 200ms if the back-feed voltage is removed.

22.3. CHARGING OF BATTERIES

The power supply can be used to charge 12V lead-acid or maintenance free batteries.

Instructions for charging batteries (float charging):

a) Ensure that the ambient temperature of the power supply is below 45°C

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

End-of-charge voltage	13.9V	13.75V	13.6V	13.4V
Battery temperature	10°C	20°C	30°C	40°C

c) Use a 2A or 3A circuit breaker (or blocking diode) between the power supply and the battery.

d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

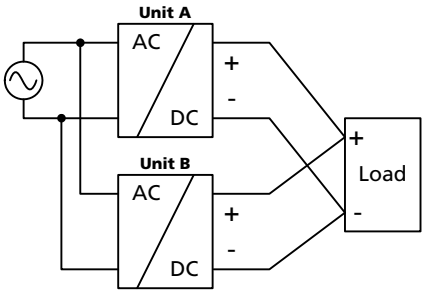
e) The return current to the power supply (battery discharge current) is typ. 12mA when the power supply is switched off (except in case a blocking diode is utilized).

22.4. EXTERNAL INPUT PROTECTION

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

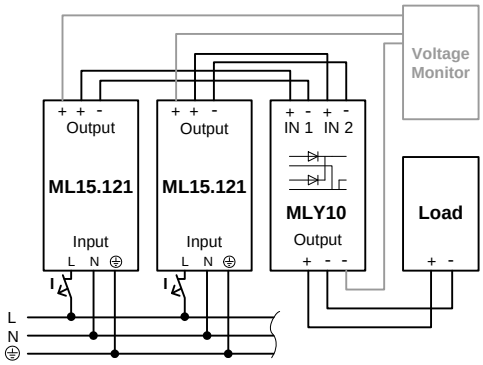
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 6A B- or 3A C-Characteristic breaker should be used.

22.5. PARALLEL USE TO INCREASE OUTPUT POWER



ML15.121 power supplies can be paralleled to increase the output power. This power supply has no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 45°C. The ML15.121 can not be paralleled with power supplies from the MiniLine series. The output voltages of all power supplies shall be adjusted to the same value (±100mV). A fuse or diode on the output of each unit is only required if more than three units are connected in parallel. If a fuse (or circuit breaker) is used, choose one with approximately 150% of the rated output current of one power supply. 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 (input terminals on the bottom and output terminals on top of the unit). Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

22.6. PARALLEL USE FOR REDUNDANCY



Power supplies 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. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five power supplies, each rated for 1.3A are paralleled to build a 5.2A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module MLY10.241.

Recommendations for building redundant power systems:

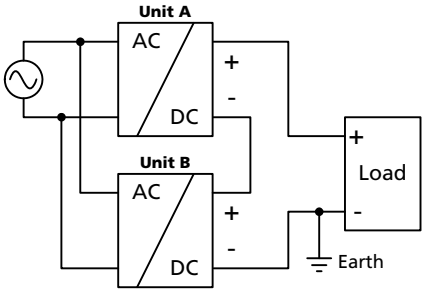
a) Use separate input fuses for each power supply.

b) Monitor the individual power supply units.

c) 1+1 Redundancy is allowed up to an ambient temperature of 60°C
N+1 Redundancy is allowed up to an ambient temperature of 45°C

d) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.7. SERIES OPERATION



Power supplies of the exact 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 any more 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 (input terminals on the bottom and output terminals on top of the unit). Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

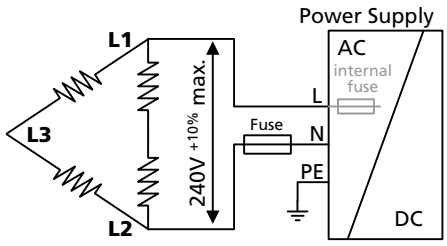
22.8. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply unlimited inductive loads.

The max. capacitive load depend on the steady state output current. At 1.3A output current, the output capacity should not be larger than 1 000µF and at 0.65A output current not larger than 2 500µF. In case of larger capacitors, the unit can show start-up attempts or start-up problems.

22.9. OPERATION ON TWO PHASES

The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$. Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire. Appropriate fuses or circuit breakers are specified in section 22.4 "External Input Protection".



22.10. USE WITHOUT PE ON THE INPUT

From a safety standpoint, the unit is internally designed according to the requirements for Protection Class 1 and 2. Please contact PULS if you do not plan to use the PE terminal. A different marking of the front foil is then required.

Grounding of the input is beneficial for a high EMI immunity: Symmetrical spikes or fast transients on the input side can be conducted directly to earth by the built-in filter capacitors. The magnitude of such spikes or fast transients on the output side caused by the input is much smaller compared to not connecting this terminal to ground.

Fig. 22-3 **Earthed input**

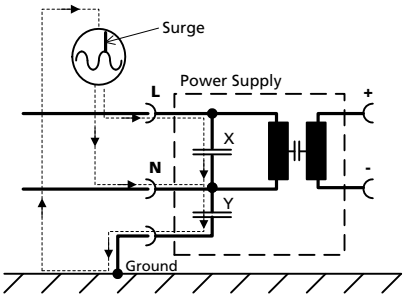
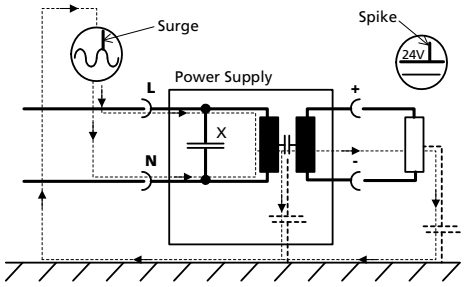


Fig. 22-4 **Not earthed input**



22.11. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box, no other heat producing items are inside the box

Enclosure:	Rittal Type IP66 Box PK 9510 100, plastic, 130x130x75mm
Input:	230Vac

Case A:

Load:	12V, 1.3A; load is placed outside the box
Temperature inside the box:	38.9°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	28.0°C
Temperature rise:	10.9K

Case B:

Load:	12V, 1.05A; (=80%) load is placed outside the box
Temperature inside the box:	33.9°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	27.4°C
Temperature rise:	8.5K

22.12. MOUNTING ORIENTATIONS

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

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

Fig. 22-5
Mounting Orientation A
(Standard orientation)

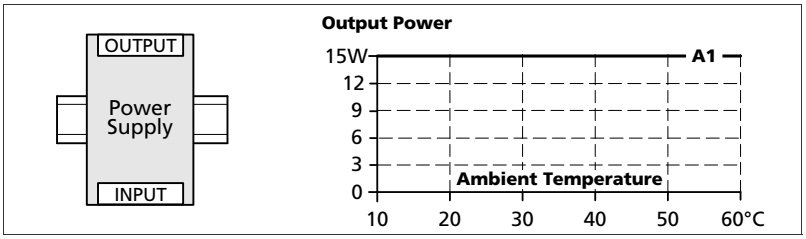


Fig. 22-6
Mounting Orientation B
(Upside down)

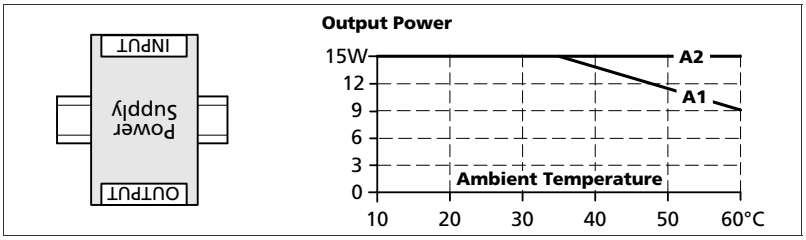


Fig. 22-7
Mounting Orientation C
(Table-top mounting)

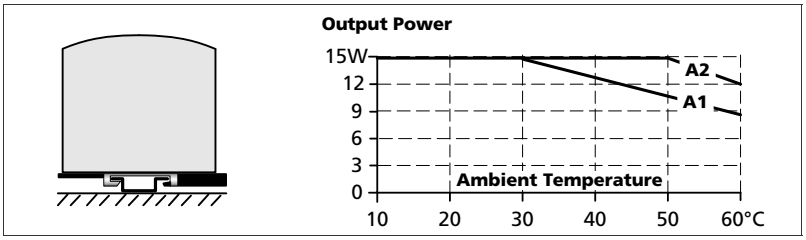


Fig. 22-8
Mounting Orientation D
(Horizontal cw)

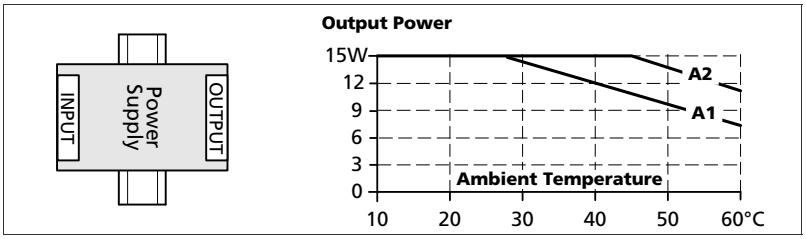
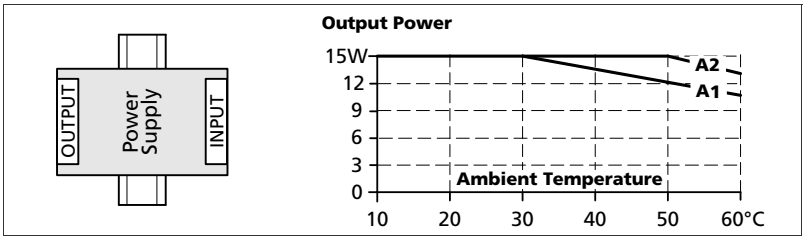


Fig. 22-9
Mounting Orientation E
(Horizontal ccw)



PULS

MiniLine-2

ML15.241

24V, 0.63A, SINGLE PHASE INPUT

POWER SUPPLY

- 100-240V Wide Range Input
- NEC Class 2 Compliant
- Adjustable Output Voltage
- Efficiency up to 86.1%
- Compact Design, Width only 22.5mm
- Full Output Power Between -10°C and +60°C
- Large International Approval Package
- 3 Year Warranty

GENERAL DESCRIPTION

A compact size, light weight, simple mounting onto the DIN-rail and the utilization of only quality components are what makes the MiniLine power supplies so easy to use and install within seconds.

A rugged electrical and mechanical design as well as a high immunity against electrical disturbances on the mains provides reliable output power. This offers superior protection for equipment which is connected to the public mains network or is exposed to a critical industrial environment.

The MiniLine series offers output voltages from 5 to 56Vdc and a power rating from 15W to 120W.

The supplementary MiniLine decoupling diode module MLY10.241 allows building of redundant systems or to protect against back-feed voltages.

SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	0.63A at 24V 0.54A at 28V	
Output power	15W	
Output ripple	< 50mVpp	20Hz to 20MHz
Input voltage	AC 100-240V	-15% / +10%
Mains frequency	50-60Hz	±6%
AC Input current	0.28 / 0.17A	at 120 / 230Vac
Power factor	0.51 / 0.44	at 120 / 230Vac
AC Inrush current	typ. 16 /31A	peak value at 120/230Vac, 40°C and cold start
DC Input	88-375Vdc	
Efficiency	86.1 / 85.1%	at 120 / 230Vac
Losses	2.5 / 2.7W	at 120 / 230Vac
Temperature range	-10°C to +70°C	operational
Derating	0.4W/°C	+60 to +70°C
Hold-up time	typ. 47 / 196ms	at 120 / 230Vac
Dimensions	22.5x75x91mm	WxHxD
Weight	130g / 0.29lb	

ORDER NUMBERS

Power Supply	**ML15.241**	24-28V Standard unit
Accessory	MLY10.241	Redundancy module

MARKINGS

UL LISTED IND. CONT. EQ.
UL 508

c UL us
UL 60950-1
NEC Class 2

c SP us
Class I Div 2

c SP us
CSA 22.2 No107.1

GL
Marine

CE
EMC, LVD, RoHS

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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.

Mount the unit on a DIN-rail so that the output terminals are located on top and input terminal on the bottom. For other mounting orientations see de-rating requirements in this document.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Keep the following installation clearances:
40mm on top, 20mm on the bottom
15mm on the left or right sides in case the adjacent device is a heat source (e.g. another power supply).

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into 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.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15:2010.

3. AC-INPUT

AC input	nom.	AC 100-240V	-15% / +10%, TN/TT/IT-mains
AC input range		85-264Vac	continuous operation
		264–300Vac	< 0.5s
Allowed voltage L or N to earth	max.	300Vac	
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	59Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	54Vac	steady-state value, see Fig. 3-1

		AC 100V	AC 120V	AC 230V	
Input current (rms)	typ.	0.34A	0.28A	0.17A	at 24V, 0.63A see Fig. 3-3
Power factor *)	typ.	0.52	0.51	0.44	at 24V, 0.63A see Fig. 3-4
Crest factor **)	typ.	3.45	3.53	3.94	at 24V, 0.63A
Start-up delay	typ.	700ms	700ms	700ms	see Fig. 5 2
Rise time	typ.	20ms	20ms	24ms	at 24V, 0.63A, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 3-1 **Input voltage range**

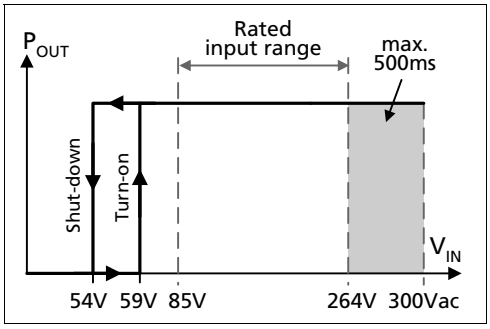


Fig. 3-2 **Turn-on behavior, definitions**

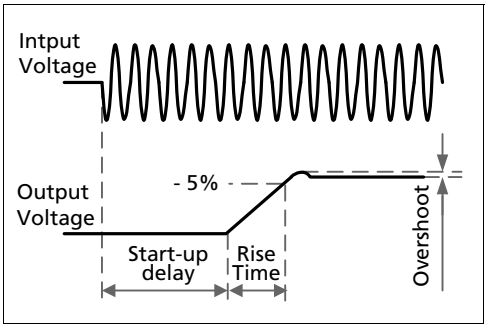


Fig. 3-3 **Input current vs. output load at 24V**

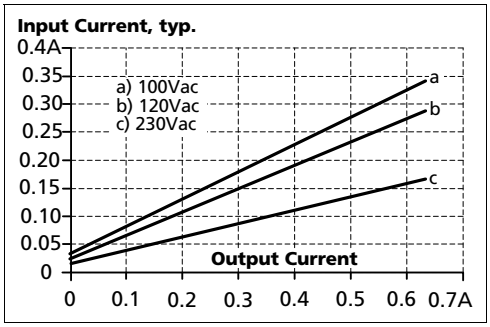
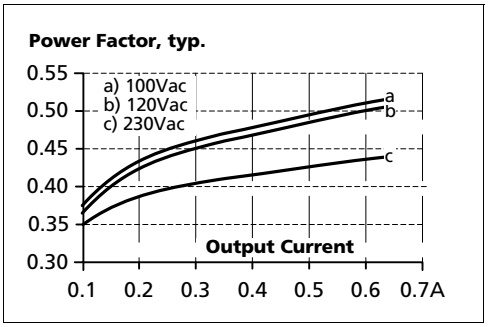


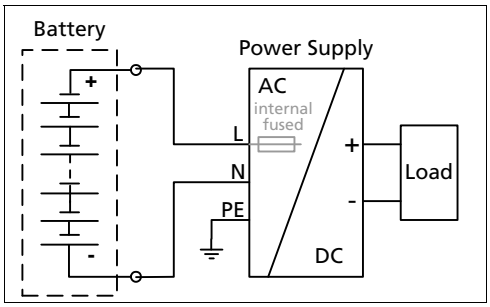
Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

DC input	nom.	DC 110-300V	-20%/+25%
DC input range	min.	88-375Vdc	continuous operation
DC input current	typ.	0.16A / 0.057A	110Vdc / 300Vdc, at 24V, 0.63A
Turn-on voltage	typ.	80Vdc	steady state value
Shut-down voltage	typ.	60Vdc	steady state value

Fig. 4-1 **Wiring for DC Input**



Instructions for DC use:

a) Use a battery or similar DC source.
   For other sources contact PULS
b) Connect +pole to L and –pole to N.
c) Connect the PE terminal to an earth wire or to the machine ground.

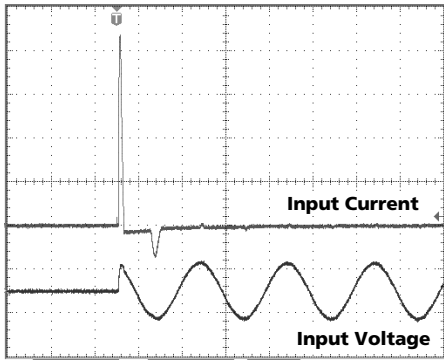
5. INPUT INRUSH CURRENT

A NTC limits the input inrush current after turn-on of the input voltage. The inrush current is input voltage and ambient temperature dependent.

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

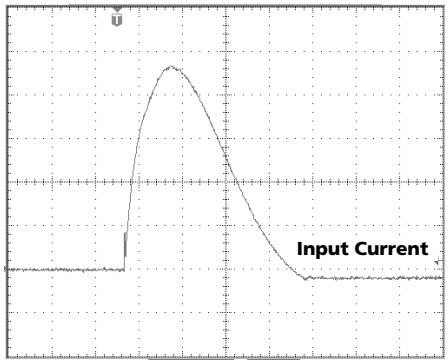
		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$13A_{peak}$	$16A_{peak}$	$31A_{peak}$	40°C ambient, cold start
	typ.	$11A_{peak}$	$13A_{peak}$	$26A_{peak}$	40°C ambient, cold start
Inrush energy	max.	$0.1A^2s$	$0.1A^2s$	$0.4A^2s$	40°C ambient, cold start

Fig. 5-1 **Input inrush current, typical behavior**



Input: 230Vac
Output: 24V, 0.63A
Ambient: 25°C
Upper curve: Input current 5A/DIV
Lower curve: Input voltage 500V/DIV
Time basis: 10ms / DIV

Fig. 5-2 **Input inrush current, zoom into first peak**



Input: 230Vac
Output: 24V, 0.63A
Ambient: 25°C
Input current curve: 5A/DIV, 500µs / DIV
Ipeak 23A

6. OUTPUT

Output voltage	nom.	24V	
Adjustment range	min.	24-28V	guaranteed
	max.	30V *)	at clockwise end position of potentiometer
Factory setting		24.5V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	85-264Vac
Load regulation	max.	100mV	static value, 0A → 0.63A
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	900µF	
Output current	nom.	0.63A	at 24V, see Fig. 6-1
	nom.	0.54A	at 28V, see Fig. 6-1
Output power	nom.	15W	
Short-circuit current	min.	hiccup mode, see Fig. 6-2	
	max.	hiccup mode, see Fig. 6-2	

*) 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. The typical value which can be achieved by turning the potentiometer to the clock-wise end position is 28.6V.

Fig. 6-1 **Output voltage vs. output current, typ.**

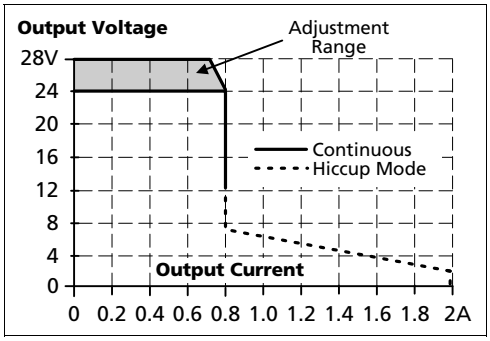
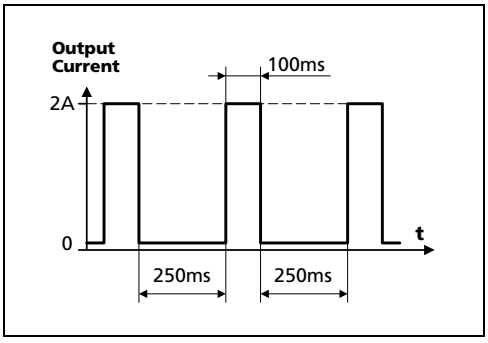


Fig. 6-2 **Hiccup mode; output current at shorted output, 230Vac, typ.**



Peak current capability (up to several milliseconds)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 22.1.

Peak current voltage dips	typ.	from 24V to 15.5V	at 1.3A for 50ms, resistive load
	typ.	from 24V to 17.5V	at 3.15A for 2ms, resistive load
	typ.	from 24V to 11.5V	at 3.15A for 5ms, resistive load

7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	64ms	98ms	375ms	at 24V, 0.32A, see Fig. 7-1
	typ.	31ms	47ms	196ms	at 24V, 0.63A, see Fig. 7-1

Note: At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is also on during this time

Fig. 7-1 **Hold-up time vs. input voltage**

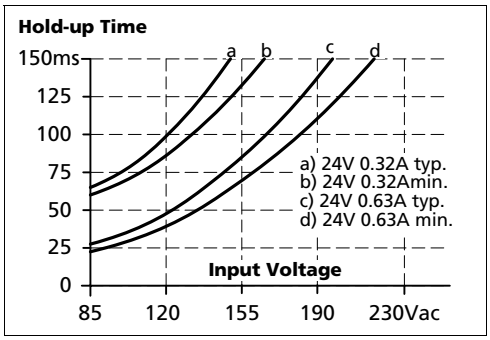
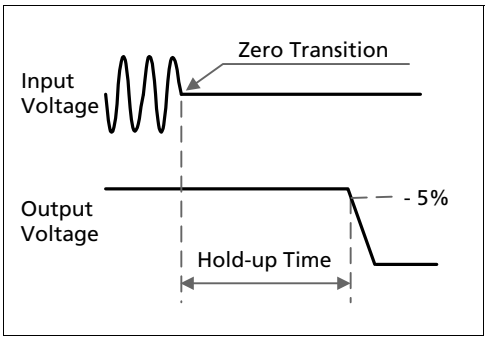


Fig. 7-2 **Shut-down behavior, definitions**



8. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	85.0%	86.1%	85.1%	at 24V, 0.63A (full load)
Power losses	typ.	0.5W	0.55W	0.75W	at 0A
	typ.	1.5W	1.4W	1. 8W	at 24V, 0.315A (half load)
	typ.	2.7W	2.5W	2.7W	at 24V, 0.63A (full load)

Fig. 8-1 **Efficiency vs. output current at 24V, typ.**

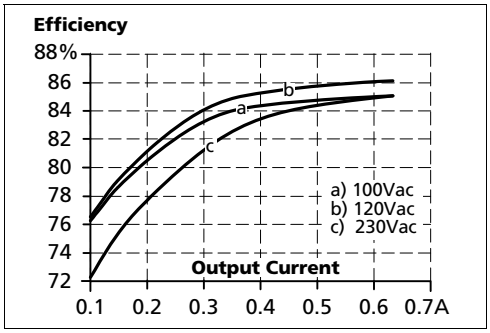


Fig. 8-2 **Losses vs. output current at 24V, typ.**

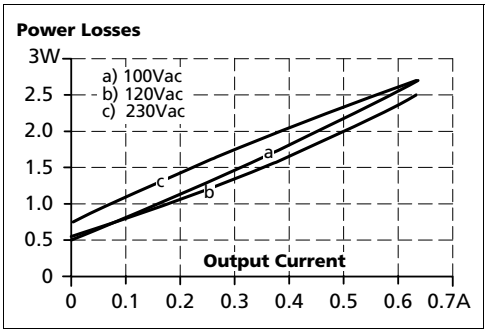


Fig. 8-3 **Efficiency vs. input voltage at 24V, 0.63A, typ.**

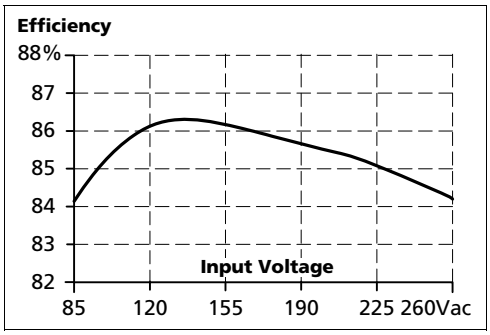
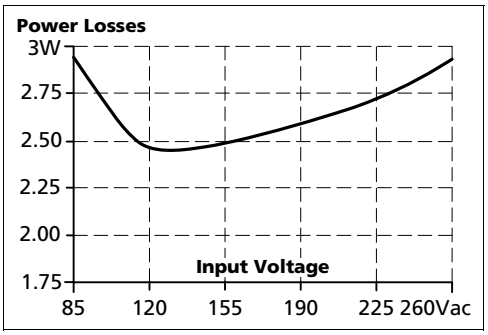
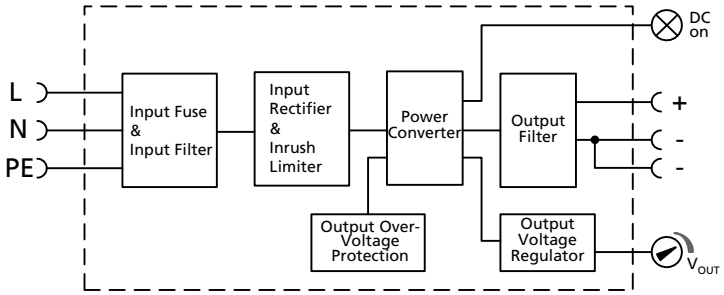


Fig. 8-4 **Losses vs. input voltage at 24V, 0.63A, typ.**



9. FUNCTIONAL DIAGRAM

Fig. 9-1 **Functional diagram**



10. FRONT SIDE AND USER ELEMENTS

Fig. 10-1 **Front side**

A **Output Terminals**
Screw terminals,
Dual terminals for the negative pole allows an easy earthing of the output voltage
+ Positive output
- Negative (return) output

B **Input Terminals**
Screw terminals
L Phase (Line) input
N Neutral conductor input
⏚ PE (Protective Earth) input

C **DC-on LED** (green)
On when the voltage on the output terminals is > 19V

D **Output voltage potentiometer**
Turn to set the output voltage. Factory set: 24.5V

11. TERMINALS AND WIRING

All terminals are easy to access when mounted on the panel. Input and output terminals are separated from each other (input below, output above) to help in error-free wiring.

	Input	Output
Type	screw terminals	screw terminals
Solid wire	0.5-6mm²	0.5-6mm²
Stranded wire	0.5-4mm²	0.5-4mm²
American Wire Gauge	20-10 AWG	20-10 AWG
Wire stripping length	7mm / 0.275inch	7mm / 0.275inch
Screwdriver	3.5mm slotted or Pozidrive No 2	3.5mm slotted or Pozidrive No 2
Recommended tightening torque	1Nm, 9lb.in	1Nm, 9lb.in

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient up to 45°C and 75°C for ambient up to 60°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).
e) Do not use the unit without PE connection.
f) Screws of unused terminal compartments should be securely tightened.
g) Ferrules are allowed.

12. LIFETIME EXPECTANCY AND MTBF

These units are extremely reliable and use only the highest quality materials. The number of critical components such as electrolytic capacitors has been reduced.

	AC 100V	AC 120V	AC 230V	
Lifetime expectancy *)	197 000h	200 000h	196 000h	at 24V, 0.63A and 40°C
	> 15 years	> 15 years	> 15 years	at 24V, 0.315A and 40°C
	> 15 years	> 15 years	> 15 years	at 24V, 0.63A and 25°C
MTBF **) SN 29500, IEC 61709	4 016 000h	4 360 000h	4 369 000h	at 24V, 0.63A and 40°C
	6 586 000h	7 150 000h	7 165 000h	at 24V, 0.63A and 25°C
MTBF **) MIL HDBK 217F	1 112 000h	1 169 000h	1 095 000h	at 24V, 0.63A and 40°C; Ground Benign GB40
	1 490 000h	1 566 000h	1 467 000h	at 24V, 0.63A and 25°C; Ground Benign GB25

*) The **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 prediction model allows only a calculation of up to 15 years from date of shipment.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

13. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available on request.

EMC Immunity	Generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 8kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N → PE, L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + → PE, - → PE	500V 2kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Input voltage swells	PULS internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:

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

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

EMC Emission	Generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	Not applicable below 75W input power
Voltage fluctuations, flicker	EN 61000-3-3	fulfilled

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 frequency	Constant, typ. 65kHz

14. ENVIRONMENT

Operational temperature *)	-10°C to +70°C (14°F to 158°F)	Reduce output power according Fig. 14-1
Storage temperature	-40 to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	0.4W/°C	60-70°C (140°F to 158°F)
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 20 000ft)	Reduce output power or ambient temperature above 2000m sea level.
Altitude de-rating	1W/1000m or 5°C/1000m	above 2000m (6500ft), see Fig. 14-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	Altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 14-1 **Output power vs. ambient temp.**

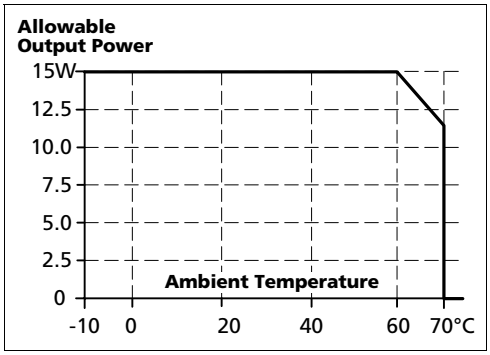
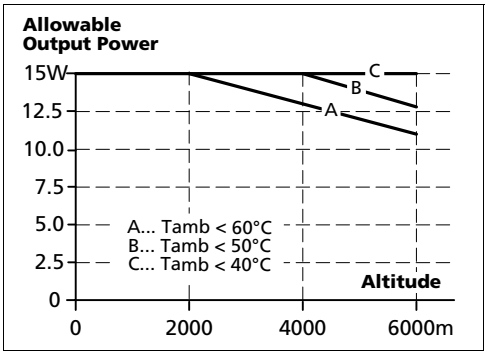


Fig. 14-2 **Output power vs. altitude**



15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits *)	
Output over-voltage protection	typ. 34Vdc max. 37Vdc	In case of an internal power supply fault, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and stays down until the input voltage is turned off and on again.
Output over-current protection	electronically limited	see Fig. 6-2
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 2.5mm in diameter	e.g. screws, small parts
Over-temperature protection	Not included	
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T3.15A H.B.C.	not user replaceable

*) In case of a protection event, audible noise may occur.

16. SAFETY FEATURES

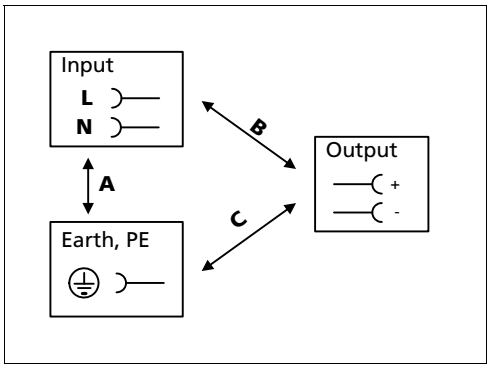
Input / output separation *)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
	II (with restrictions)	for use without PE connection contact PULS
Isolation resistance	> 5MOhm	Input to output, 500Vdc
Touch current (leakage current)	typ. 0.17mA / 0.38mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.24mA / 0.55mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.40mA / 0.86mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.21mA / 0.44mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.30mA / 0.66mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.54mA / 1.08mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

*) Double or reinforced insulation

17. 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. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	3000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting		> 6mA	> 6mA	> 1mA

To fulfill the PELV requirements according to EN60204-1 § 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 can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive 2004/108/EC, - Low-voltage directive (LVD) 2006/95/EC and - RoHS directive 2011/65/EU.
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	UL LISTED IND. CONT. EQ.	Listed for the use as Industrial Control Equipment; E-File: E198865
UL 60950-1 2nd Edition	c UL us	Recognized for the use as Information Technology Equipment, Level 3 in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006
NEC Class 2	**NEC CLASS 2**	Listed as Limited Power Source (LPS) in the UL 60950-1 UL report. According to NEC (National Electrical Code) Article 725-41 (4).
Class I Div 2 ANSI / ISA 12.12.01-2000	C US Class I Div2	Recognized for use in Hazardous Location Class I Div 2 T4 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Ind. Cont. Eq. - Canada CSA 22.2 No107.1-01	C US Ind. Cont. Eq.	CSA approval for Canada CAN/CSA C22.2 No 107-1; CAN/ CSA 60950-1-03; UL60950-1
Marine	GL ABS	GL (Germanischer Lloyd) classified Environmental category: C, EMC2 Marine and offshore applications ABS (American Bureau for Shipping) PDA
GOST P		Certificate of Conformity for Russia and other GUS countries

19. FULFILLED STANDARDS

EN 61558-2-17	Safety of Power Transformers
EN/IEC 60204-1	Safety of Electrical Equipment of Machines
EN/IEC 61131-2	Programmable Controllers
EN 50178, IEC 62103	Electronic Equipment in Power Installations

20. PHYSICAL DIMENSIONS AND WEIGHT

Weight	130g / 0.29lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the unit depth (91mm) to calculate the total required installation depth.
Installation Clearances	See chapter 2

Fig. 20-1 **Front view**

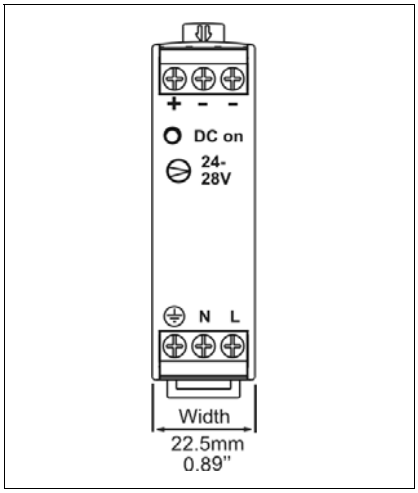
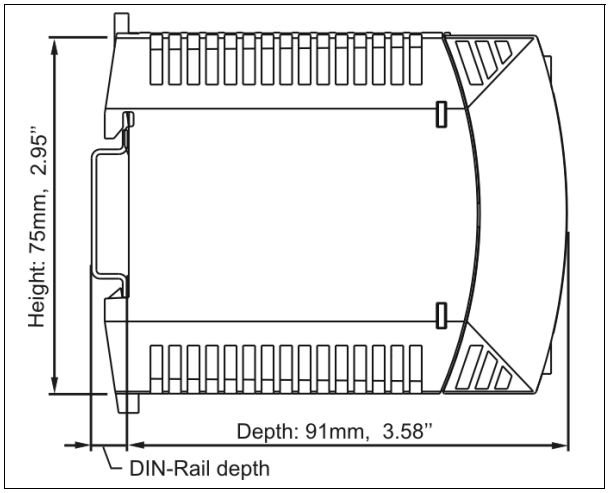


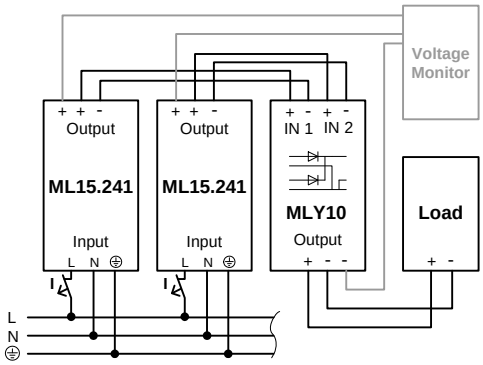
Fig. 20-2 **Side view**



21. ACCESSORY

21.1. MLY10.241 - REDUNDANCY MODULE

The MLY10.241 is a dual redundancy module, which has two diodes with a common cathode included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.



22. APPLICATION NOTES

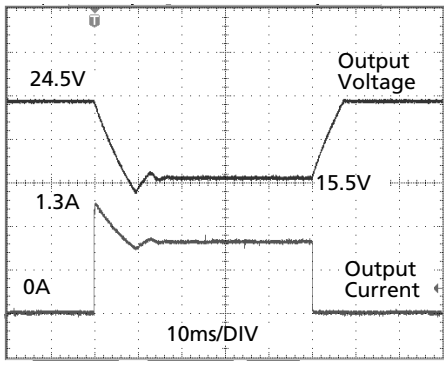
22.1. PEAK CURRENT CAPABILITY

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

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

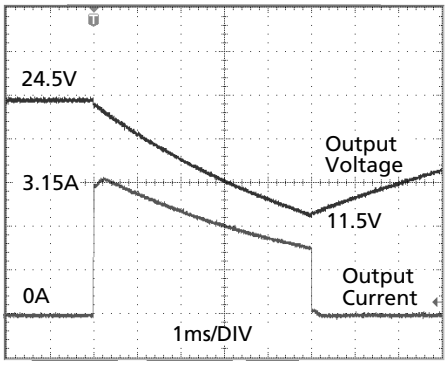
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-1 **Peak loading with 2x the nominal current for 50ms, typ.**



Peak load 1.3A (resistive load) for 50ms
Output voltage dips from 24V to 15.5V.

Fig. 22-2 **Peak loading with 5x the nominal current for 5ms, typ.**



Peak load 3.15A (resistive load) for 5ms
Output voltage dips from 24V to 11.5V.

22.2. 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).

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 6.

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. However, please note that the output voltage can dip to zero for approximately 365ms if the back-feed voltage is removed.

22.3. CHARGING OF BATTERIES

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

Instructions for charging batteries (float charging):

a) Ensure that the ambient temperature of the power supply is below 45°C

b) Set output voltage (measured at no load and at the battery end of the 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

c) Use a 1A or 2A circuit breaker (or blocking diode) between the power supply and the battery.

d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

e) Use only matched batteries when putting 12V types in series.

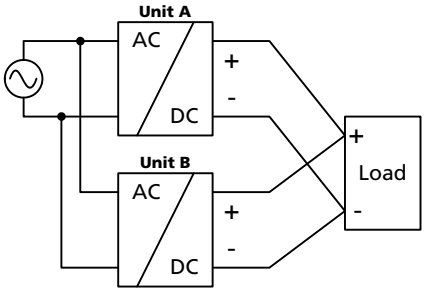
f) The return current to the power supply (battery discharge current) is typ. 15mA when the power supply is switched off (except in case a blocking diode is utilized).

22.4. EXTERNAL INPUT PROTECTION

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

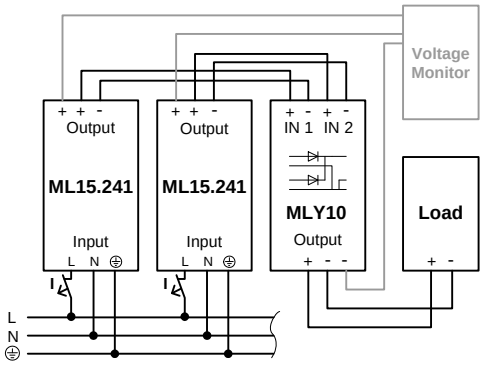
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 6A B- or 3A C-Characteristic breaker should be used.

22.5. PARALLEL USE TO INCREASE OUTPUT POWER



ML15.241 power supplies can be paralleled to increase the output power. This power supply has no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 45°C. The ML15.241 can also be paralleled with power supplies from MiniLine series with 24V output voltage. The output voltages of all power supplies shall be adjusted to the same value (±100mV). A fuse or diode on the output of each unit is only required if more than three units are connected in parallel. If a fuse (or circuit breaker) is used, choose one with approximately 150% of the rated output current of one power supply. 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 (input terminals on the bottom and output terminals on top of the unit). Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

22.6. PARALLEL USE FOR REDUNDANCY



Power supplies 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. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five power supplies, each rated for 0.63A are paralleled to build a 2.52A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module MLY10.241.

Recommendations for building redundant power systems:

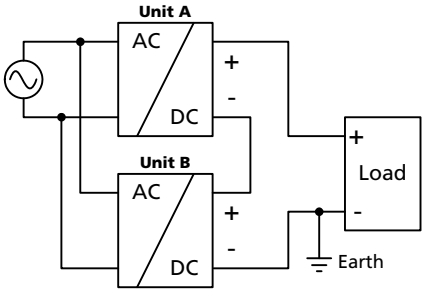
a) Use separate input fuses for each power supply.

b) Monitor the individual power supply units.

c) 1+1 Redundancy is allowed up to an ambient temperature of 60°C
N+1 Redundancy is allowed up to an ambient temperature of 45°C

d) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.7. SERIES OPERATION



Power supplies of the exact 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 any more 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 (input terminals on the bottom and output terminals on top of the unit). Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

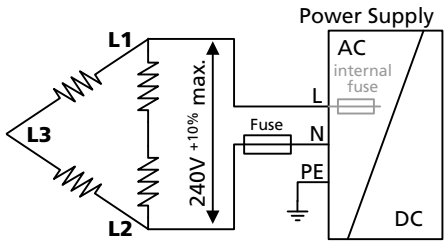
22.8. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply unlimited inductive loads.

The max. capacitive load depend on the steady state output current. At 0.6A output current, the output capacity should not be larger than 660µF and at 0.3A output current not larger than 2 500µF. In case of larger capacitors, the unit can show start-up attempts or start-up problems.

22.9. OPERATION ON TWO PHASES

The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$. Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire. Appropriate fuses or circuit breakers are specified in section 22.4 “External Input Protection”.



22.10. USE WITHOUT PE ON THE INPUT

From a safety standpoint, the unit is internally designed according to the requirements for Protection Class 1 and 2. Please contact PULS if you do not plan to use the PE terminal. A different marking of the front foil is then required.

Grounding of the input is beneficial for a high EMI immunity: Symmetrical spikes or fast transients on the input side can be conducted directly to earth by the built-in filter capacitors. The magnitude of such spikes or fast transients on the output side caused by the input is much smaller compared to not connecting this terminal to ground.

Fig. 22-3 **Earthed input**

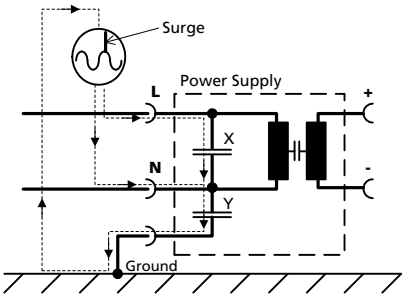
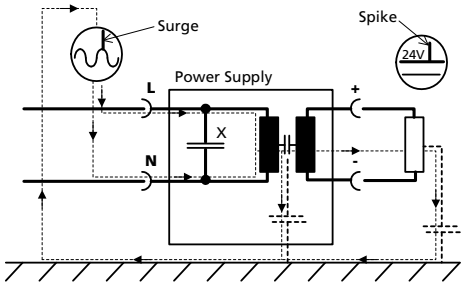


Fig. 22-4 **Not earthed input**



22.11. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box, no other heat producing items are inside the box

Enclosure:	Rittal Type IP66 Box PK 9510 100, plastic, 130x130x75mm
Input:	230Vac

Case A:

Load:	24V, 0.63A; load is placed outside the box
Temperature inside the box:	37.9°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	27.9°C
Temperature rise:	10.0K

Case B:

Load:	24V, 0.5A; (=80%) load is placed outside the box
Temperature inside the box:	35.0°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	27.4°C
Temperature rise:	7.6K

22.12. MOUNTING ORIENTATIONS

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

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

Fig. 22-5
Mounting Orientation A
(Standard orientation)

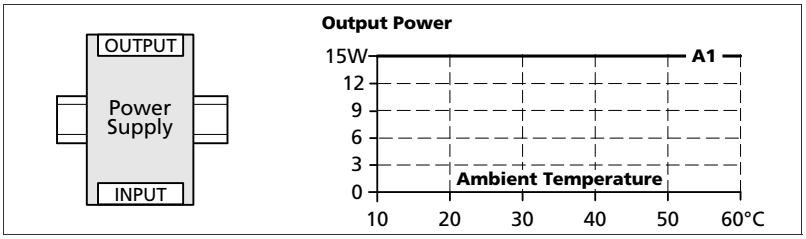


Fig. 22-6
Mounting Orientation B
(Upside down)

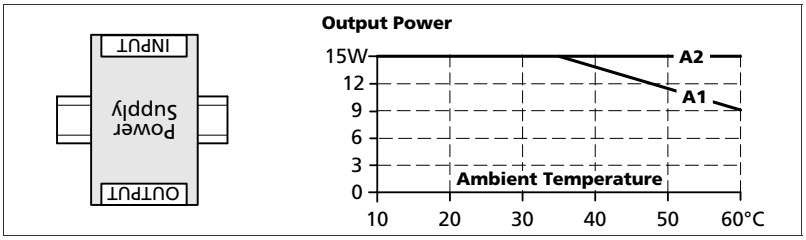


Fig. 22-7
Mounting Orientation C
(Table-top mounting)

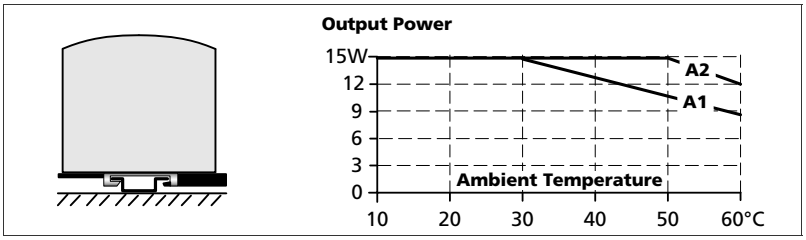


Fig. 22-8
Mounting Orientation D
(Horizontal cw)

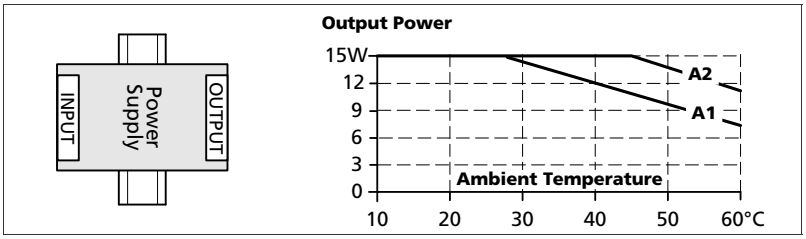
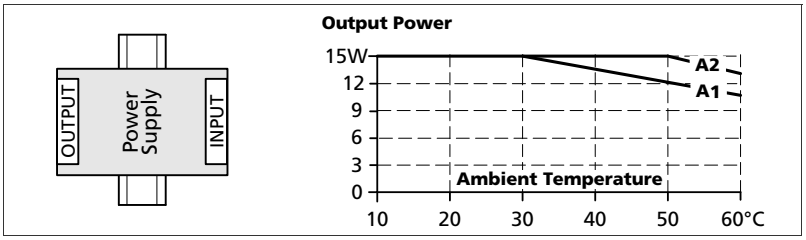


Fig. 22-9
Mounting Orientation E
(Horizontal ccw)



PULS

MiniLine-2

ML30.241

24V, 1.3A, SINGLE PHASE INPUT

POWER SUPPLY

- 100-240V Wide Range Input
- NEC Class 2 Compliant
- Adjustable Output Voltage
- Efficiency up to 89.4%
- Compact Design, Width only 22.5mm
- Full Power between -10°C and +60°C
- Large International Approval Package
- 3 Year Warranty

GENERAL DESCRIPTION

A compact size, light weight, simple mounting onto the DIN-rail and the utilization of only quality components are what makes the MiniLine power supplies so easy to use and install within seconds.

The rugged electrical and mechanical design as well as a high immunity against electrical disturbances on the mains provides reliable output power. This offers superior protection for equipment which is connected to the public mains network or is exposed to a harsh industrial environment.

The MiniLine series offers output voltages from 5 to 56Vdc and a power rating from 15W to 120W.

The supplementary MiniLine redundancy module MLY10.241 allows building of redundant systems or to protect against back-feeding voltages.

SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	1.3A at 24V 1.1A at 28V	
Output power	30W	
Output ripple	< 50mVpp	20Hz to 20MHz
Input voltage	AC 100-240V	-15% / +10%
Mains frequency	50-60Hz	±6%
AC Input current	0.54 / 0.3A	at 120 / 230Vac
Power factor	0.52 / 0.49	at 120 / 230Vac
AC Inrush current	typ. 18 / 35A	peak value at 120 / 230Vac 40°C and cold start
DC Input	88-375Vdc	below 110Vdc derating required
Efficiency	88.5 / 89.4%	at 120 / 230Vac
Losses	4.1 / 3.7W	at 120 / 230Vac
Temperature range	-10°C to +70°C	operational
Derating	0.8W/°C	+60 to +70°C
Hold-up time	typ. 31 / 141ms	at 120 / 230Vac
Dimensions	22.5x75x91mm	WxHxD
Weight	140g / 0.31lb	

ORDER NUMBERS

Power Supply	**ML30.241**	24-28V Standard unit
Accessory	MLY10.241	Redundancy module

MARKINGS

cULus LISTED
Ind. Cont. Eq. UL 508

cULus
UL 60950-1

GL
Marine

SP cULus
Class I Div 2

NEC Class 2

CE
EMC, LVD, RoHS

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.B.D.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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.

Mount the unit on a DIN-rail so that the output terminals are located on top and input terminal on the bottom. For other mounting orientations see de-rating requirements in this document.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Keep the following installation clearances:
40mm on top, 20mm on the bottom
Left / right: 0mm (or 15mm in case the adjacent device is a heat source; in example another power supply….).

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into 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.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15:2010.

3. AC-INPUT

AC input	nom.	AC 100-240V	-15% / +10%, TN/TT/IT-mains
AC input range		85-264Vac	continuous operation
		264–300Vac	< 0.5s
Allowed voltage L or N to earth	max.	264Vac or 375Vdc	
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	46Vac	see Fig. 3-1
Shut-down voltage	typ.	44Vac	see Fig. 3-1

		AC 100V	AC 120V	AC 230V	
Input current (rms)	typ.	0.63A	0.54A	0.3A	at 24V, 1.3A see Fig. 3-3
Power factor *)	typ.	0.55	0.52	0.49	at 24V, 1.3A see Fig. 3-4
Crest factor **)	typ.	3.1	3.3	3.9	at 24V, 1.3A
Start-up delay	typ.	90ms***)	90ms***)	90ms***)	see Fig. 3-2
Rise time	typ.	40ms	40ms	40ms	at 24V, 1.3A, 0mF, see Fig. 3-2
	typ.	90ms	90ms	100ms	at 24V, 1.3A, 1.3mF
Turn-on overshoot	max.	250mV	250mV	250mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
***) At low temperatures, start-up attempts may occur which extends the start-up delay

Fig. 3-1 **Input voltage range**

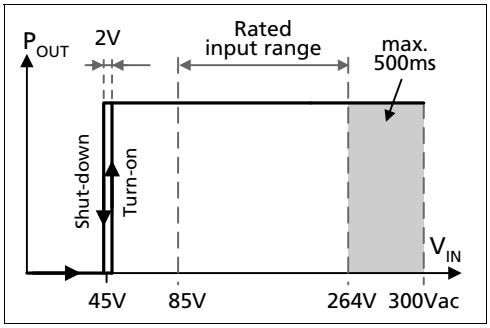


Fig. 3-2 **Turn-on behavior, definitions**

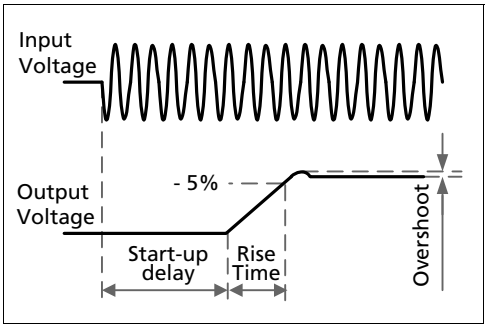


Fig. 3-3 **Input current vs. output load at 24V**

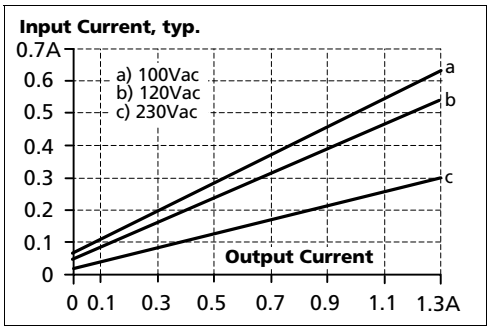
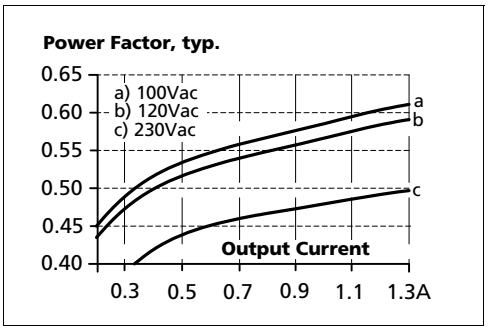


Fig. 3-4 **Power factor vs. output load at 24V**



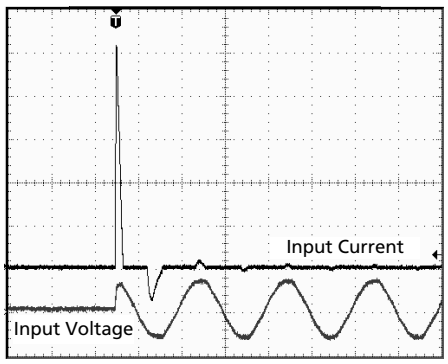
4. INPUT INRUSH CURRENT

A NTC limits the input inrush current after turn-on of the input voltage. The inrush current is input voltage and ambient temperature dependent.

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

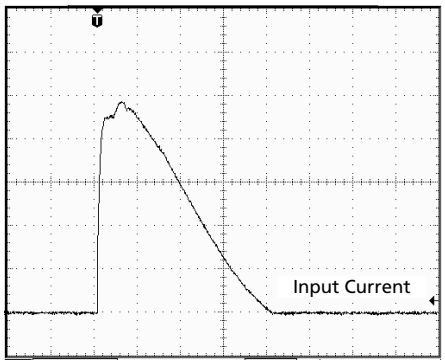
		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$19A_{peak}$	$22A_{peak}$	$44A_{peak}$	40°C ambient, cold start
	typ.	$15A_{peak}$	$18A_{peak}$	$35A_{peak}$	40°C ambient, cold start
Inrush energy	typ.	$0.15A^2s$	$0.2A^2s$	$1.0A^2s$	40°C ambient, cold start

Fig. 4-1 **Input inrush current, typical behavior**



Input: 230Vac
Output: 24V, 1.3A
Ambient: 25°C
Upper curve: Input current 5A/DIV
Lower curve: Input voltage 500V/DIV
Time basis: 10ms / DIV

Fig. 4-2 **Input inrush current, zoom into first peak**



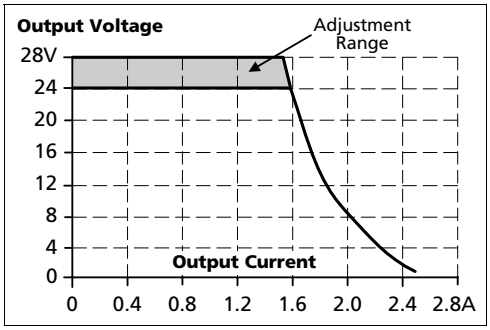
Input: 230Vac
Output: 24V, 1.3A
Ambient: 25°C
Input current 5A/DIV
Time basis: 400µs / DIV

5. OUTPUT

Output voltage	nom.	24V	
Adjustment range	min.	24-28V	guaranteed
	max.	30V *)	at clockwise end position of potentiometer
Factory setting		24.5V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	85-264Vac
Load regulation	max.	100mV	static value, 0A → 1.3A
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	900µF	
Output current	nom.	1.3A	at 24V, see Fig. 5-1
	nom.	1.1A	at 28V, see Fig. 5-1
Output power	nom.	30W	
Short-circuit current	min.	1.9A	load impedance 800mOhm, see Fig. 5-1
	max.	2.9A	load impedance 800mOhm, see Fig. 5-1

*) 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. The typical value which can be achieved by turning the potentiometer to the clock-wise end position is 28.6V.

Fig. 5-1 **Output voltage vs. output current, typ.**



Peak current capability (up to several milliseconds)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 22.1.

Peak current voltage dips	typ.	from 24V to 16V	at 2.6A for 50ms, resistive load
	typ.	from 24V to 15V	at 6.5A for 2ms, resistive load
	typ.	from 24V to 10V	at 6.5A for 5ms, resistive load

6. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	41ms	66ms	285ms	at 24V, 0.65A, see Fig. 6-1
	typ.	18ms	31ms	141ms	at 24V, 1.3A, see Fig. 6-1

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

Fig. 6-1 **Hold-up time vs. input voltage**

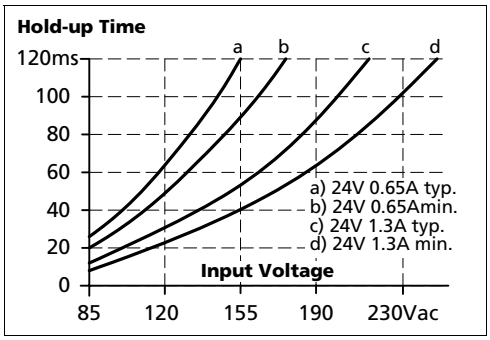
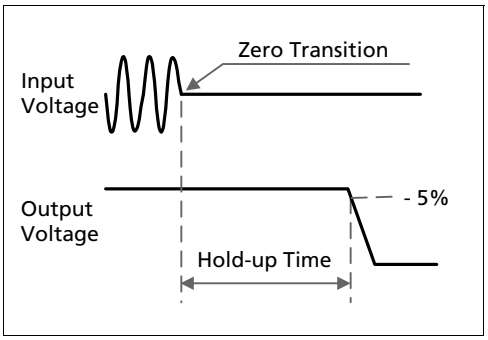


Fig. 6-2 **Shut-down behavior, definitions**



7. DC-INPUT

The power supply can also be supplied from a DC source. Use a battery or similar DC source. For other sources contact PULS. Connect the + pole to L and the – pole to N. Connect the PE terminal to an earth wire or to the machine ground.

DC input	nom.	DC 110-300V	-20%/+25%
DC input range	min.	88-375Vdc	continuous operation, reduce output power according Fig. 7-2 at voltages below 110Vdc
Allowed Voltage L/N to Earth	max.	375Vdc	IEC 62103
DC input current	typ.	0.31A / 0.12A	110Vdc / 300Vdc, at 24V, 1.3A
Turn-on voltage	typ.	60Vdc	steady state value
Shut-down voltage	typ.	35Vdc	steady state value

Fig. 7-1 **Wiring for DC Input**

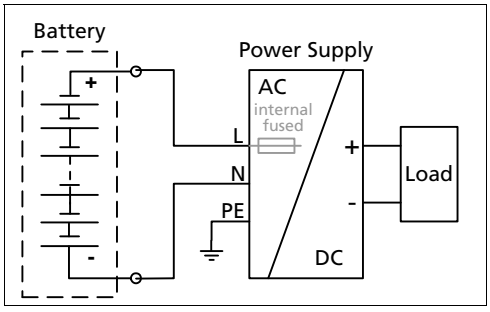
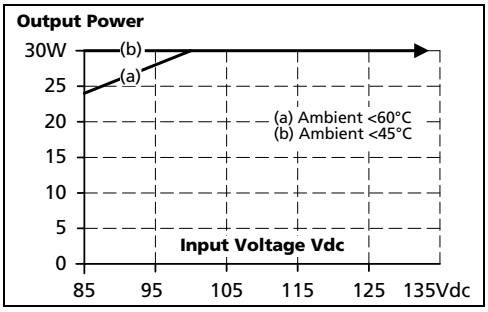


Fig. 7-2 **Allowable output current below 110Vdc input voltage**



8. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	86.4%	88.0%	89.4%	at 24V, 1.3A (full load)
Power losses	typ.	0.3W	0.3W	0.4W	at 0A
	typ.	2.2W	2.1W	2.3W	at 24V, 0.65A (half load)
	typ.	4.9W	4.3W	3.7W	at 24V, 1.3A (full load)

Fig. 8-1 **Efficiency vs. output current at 24V, typ.**

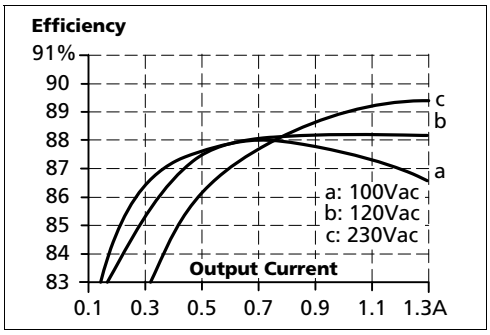


Fig. 8-2 **Losses vs. output current at 24V, typ.**

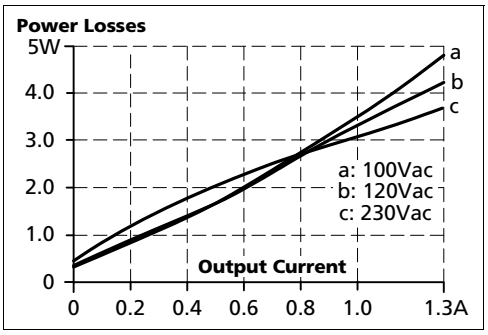


Fig. 8-3 **Efficiency vs. input voltage at 24V, 1.3A, typ.**

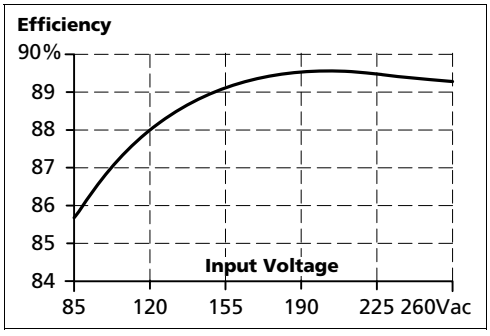
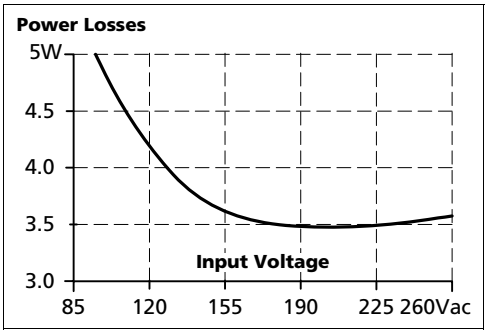
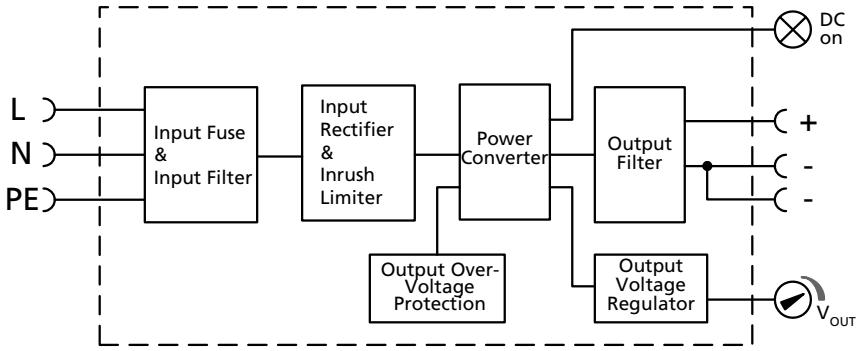


Fig. 8-4 **Losses vs. input voltage at 24V, 1.3A, typ.**



9. FUNCTIONAL DIAGRAM

Fig. 9-1 **Functional diagram**



10. FRONT SIDE AND USER ELEMENTS

Fig. 10-1 **Front side**

A **Output Terminals**
Screw terminals,
Dual terminals for the negative pole. Both poles are equal
+ Positive output
- Negative (return) output

B **Input Terminals**
Screw terminals
L Phase (Line) input
N Neutral conductor input
⏚ PE (Protective Earth) input

C **DC-on LED** (green)
On, when the voltage on the output terminals is > 17V

D **Output voltage potentiometer**
(single turn potentiometer)
Turn to set the output voltage. Factory set: 24.5V

11. TERMINALS AND WIRING

All terminals are easy to access when the power supply is mounted on the panel. Input and output terminals are separated from each other (input below, output above) to help in error-free wiring.

	Input	**Output**
Type	screw terminals	screw terminals
Solid wire	0.5-6mm²	0.5-6mm²
Stranded wire	0.5-4mm²	0.5-4mm²
American Wire Gauge	20-10 AWG	20-10 AWG
Wire stripping length	7mm / 0.275inch	7mm / 0.275inch
Screwdriver	3.5mm slotted or Pozidrive No 2	3.5mm slotted or Pozidrive No 2
Recommended tightening torque	1Nm, 9lb.in	1Nm, 9lb.in

Instructions:

a) Use appropriate copper cables that are designed for an operating temperature of:
60°C for ambient up to 45°C and 75°C for ambient up to 60°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).
e) Do not use the unit without PE connection.
f) Screws of unused terminal compartments should be securely tightened.
g) Ferrules are allowed.

12. LIFETIME EXPECTANCY AND MTBF

These units are extremely reliable and use only the highest quality materials. The number of critical components such as electrolytic capacitors has been reduced.

	AC 100V	**AC 120V**	**AC 230V**	
Lifetime expectancy *)	151 000h *)	171 000h *)	174 000h *)	at 24V, 1.3A and 40°C
	259 000h *)	259 000h *)	254 000h *)	at 24V, 0.65A and 40°C
	386 000h *)	426 000h *)	484 000h *)	at 24V, 1.3A and 25°C
MTBF **) SN 29500, IEC 61709	2 123 000h	2 312 000h	2 405 000h	at 24V, 1.3A and 40°C
	3 688 000h	3 971 000h	4 124 000h	at 24V, 1.3A and 25°C
MTBF **) MIL HDBK 217F	1 219 000h	1 270 000h	1 187 000h	at 24V, 1.3A , 40°C; Ground Benign GB40
	1 611 000h	1 686 000h	1 588 000h	at 24V, 1.3A , 25°C; Ground Benign GB25
	295 000h	314 000h	309 000h	at 24V, 1.3A , 40°C; Ground Fixed GF40
	380 000h	405 000h	400 000h	at 24V, 1.3A , 25°C; Ground Fixed GF25

*) The **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.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

13. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available on request.

EMC Immunity	Generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 8kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N → PE, L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + → PE, - → PE	1kV 2kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Input voltage swells	PULS internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:

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

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

EMC Emission	Generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
Radiated emission	EN 55011, EN 55022, CISPR 11, CISPR 22	Class B
Harmonic input current	EN 61000-3-2	Not applicable below 75W input power
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled *)

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.

*) tested with constant current loads, non pulsing

Switching frequency		
Converter frequency	variable, typ. 100kHz, min. 45kHz, max. 180kHz	Input voltage and output load dependent

14. ENVIRONMENT

Operational temperature *)	-10°C to +70°C (-14°F to 158°F)	reduce output power according Fig. 14-1
Storage temperature	-40°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	0.8W/°C	60-70°C (140°F to 158°F)
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature see Fig. 14-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	4W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 14-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 14-1 **Output power vs. ambient temp.**

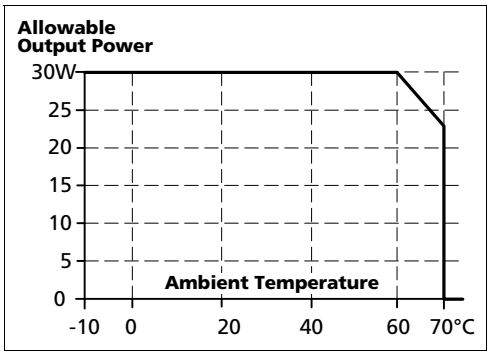
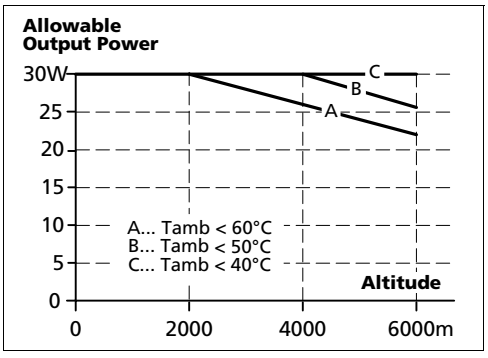


Fig. 14-2 **Output power vs. altitude**



15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits *)	
Output over-voltage protection	typ. 36Vdc max. 38Vdc	In case of an internal power supply fault, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and stays down until the input voltage is turned off and on again.
Output over-current protection	electronically limited	see Fig. 5-1
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 2.5mm in diameter	e.g. screws, small parts
Over-temperature protection	not included	
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T3.15A H.B.C.	not user replaceable

*) In case of a protection event, audible noise may occur.

16. SAFETY FEATURES

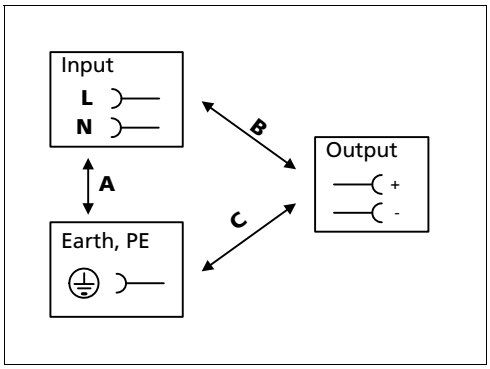
Input / output separation *)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
	II (with restrictions)	for use without PE connection contact PULS
Isolation resistance	> 5MOhm	Input to output, 500Vdc
Touch current (leakage current)	typ. 0.17mA / 0.38mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.24mA / 0.55mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.40mA / 0.86mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.21mA / 0.44mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.30mA / 0.66mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.54mA / 1.08mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

*) Double or reinforced insulation

17. 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. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	3000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting		> 6mA	> 6mA	> 1mA

To fulfill 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 can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive 2004/108/EC, - Low-voltage directive (LVD) 2006/95/EC and - RoHS directive 2011/65/EU.
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL US LISTED IND. CONT. EQ.	Listed for the use as Industrial Control Equipment; E-File: E198865
UL 60950-1 2nd Edition	c UL us	Recognized for the use as Information Technology Equipment, Level 3 in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006
NEC Class 2	**NEC CLASS 2**	Listed as Limited Power Source (LPS) in the UL 60950-1 UL report. According to NEC (National Electrical Code) Article 725-41 (4).
Class I Div 2 ANSI / ISA 12.12.01-2000	c SA us Class I Div2	Recognized for use in Hazardous Location Class I Div 2 T4 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Marine	GL ABS	GL (Germanischer Lloyd) classified Environmental category: C, EMC1 Marine and offshore applications ABS (American Bureau for Shipping) PDA
GOST P		Certificate of Conformity for Russia and other GUS countries

19. FULFILLED STANDARDS

EN 61558-2-17	Safety of Power Transformers
EN/IEC 60204-1	Safety of Electrical Equipment of Machines
EN 50178, IEC 62103	Electronic Equipment in Power Installations
EN/IEC 61131-2	Programmable Controllers except for chapter 6.4.2.1 (Gradual shut-down/start-up test)

20. PHYSICAL DIMENSIONS AND WEIGHT

Weight	140g / 0.31lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the unit depth (91mm) to calculate the total required installation depth.
Installation Clearances	See chapter 2

Fig. 20-1 **Front view**

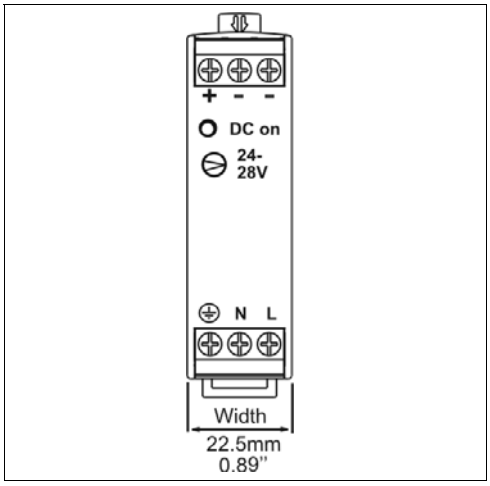
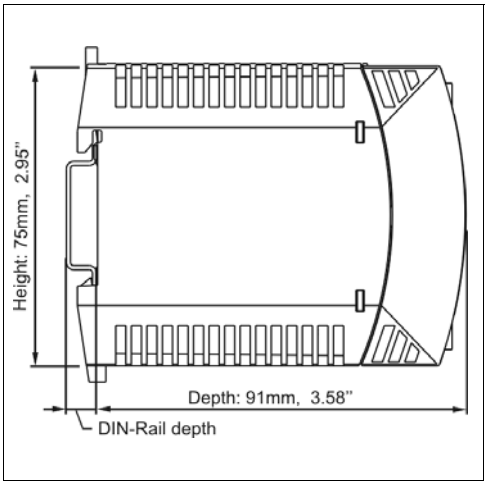


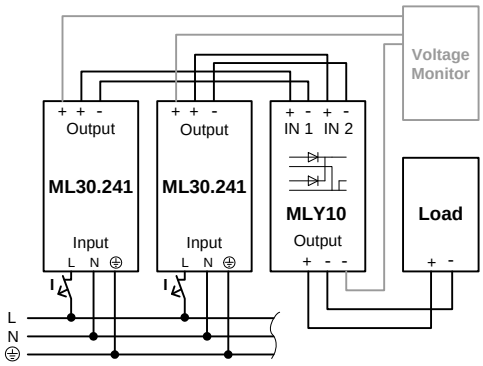
Fig. 20-2 **Side view**



21. ACCESSORY

21.1. MLY10.241 - REDUNDANCY MODULE

The MLY10.241 is a dual redundancy module, which has two diodes with a common cathode included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.



22. APPLICATION NOTES

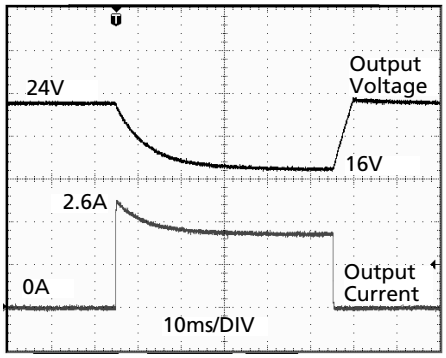
22.1. PEAK CURRENT CAPABILITY

Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady-state current and usually exceeds the nominal output current. The same situation applies when starting a motor or switching-on a capacitive load.

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

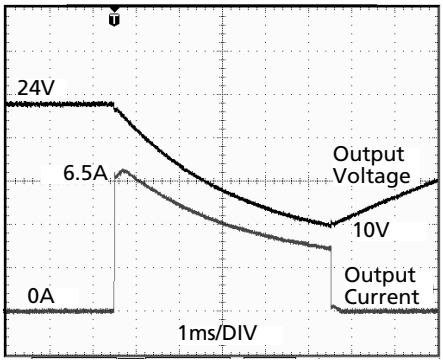
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-1 **Peak loading with 2x the nominal current for 50ms, typ.**



Peak load 2.6A (resistive load) for 50ms
Output voltage dips from 24V to 16V.

Fig. 22-2 **Peak loading with 5x the nominal current for 5ms, typ.**



Peak load 6.5A (resistive load) for 5ms
Output voltage dips from 24V to 10V.

22.2. 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 5.

22.3. CHARGING OF BATTERIES

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

Instructions for charging batteries (float charging):

a) Ensure that the ambient temperature of the power supply is below 45°C

b) Set output voltage (measured at no load and at the battery end of the 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

c) Use a 2A circuit breaker (or blocking diode) between the power supply and the battery.

d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

e) Use only matched batteries when putting 12V types in series.

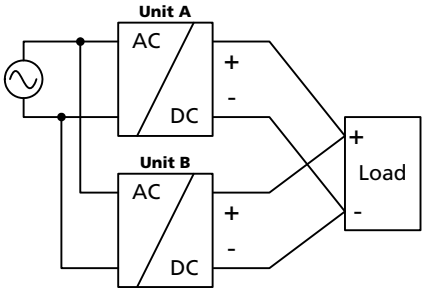
f) The return current to the power supply (battery discharge current) is typical 9mA when the power supply is switched off (except in case a blocking diode is utilized).

22.4. EXTERNAL INPUT PROTECTION

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

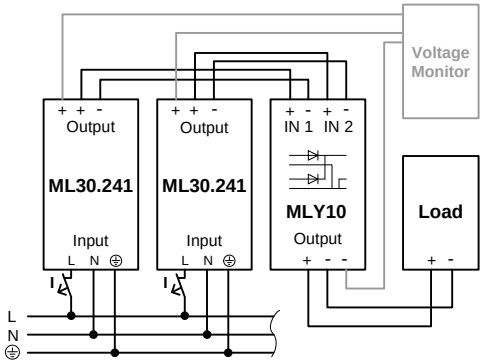
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 6A B- or 3A C-Characteristic breaker should be used.

22.5. PARALLEL USE TO INCREASE OUTPUT POWER



ML30.241 power supplies can be paralleled to increase the output power. This power supply has no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 45°C. The ML30.241 can also be paralleled with other power supplies from MiniLine series with 24V output voltage. The output voltages of all power supplies shall be adjusted to the same value (±100mV). A fuse or diode on the output of each unit is only required if more than three units are connected in parallel. If a fuse (or circuit breaker) is used, choose one with approximately 150% of the rated output current of one power supply. 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 (input terminals on the bottom and output terminals on top of the unit). Be aware that leakage current, EMI, inrush current and harmonics will increase when using multiple power supplies in parallel.

22.6. PARALLEL USE FOR REDUNDANCY



Power supplies 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. Redundant systems for a higher power demand are usually built in an N+1 method. E.g. five power supplies, each rated for 1.3A are paralleled to build a 5A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module MLY10.241.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.

b) Use separate mains systems for each power supply whenever it is possible.

c) Monitor the individual power supply units.

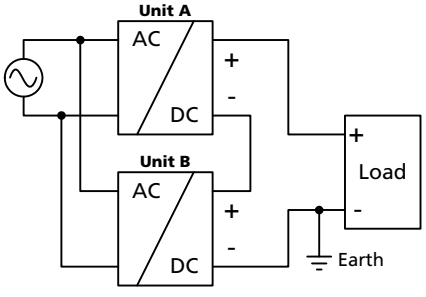
d) 1+1 Redundancy is allowed up to an ambient temperature of 60°C.
N+1 Redundancy is allowed up to an ambient temperature of 45°C.

e) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.7. INDUCTIVE AND CAPACITIVE LOADS

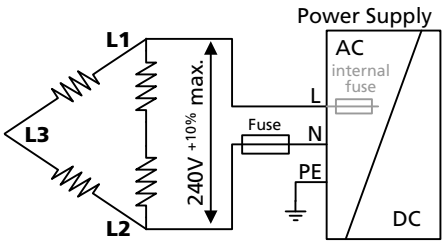
The unit is designed to supply any type of load, including unlimited capacitive and inductive loads.

22.8. SERIES OPERATION



Power supplies of the exact 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 any more 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 (input terminals on the bottom and output terminals on top of the unit). Be ware that leakage current, EMI, inrush current and harmonics will increase when using multiple power supplies series.

22.9. OPERATION ON TWO PHASES



The power supply can also be used on two-phases of a three-phase-system. A phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$. Use a fuse or a circuit breaker to protect the N input. The N input is not internally protected and is in this case connected to a hot wire. Appropriate fuses or circuit breakers are specified in section 22.4.

22.10. USE WITHOUT PE ON THE INPUT

From a safety standpoint, the unit is internally designed according to the requirements for Protection Class 1 and 2. Please contact PULS if you do not plan to use the PE terminal. A different marking of the front foil is then required.

Grounding of the input is beneficial for a high EMI immunity: Symmetrical spikes or fast transients on the input side can be conducted directly to earth by the built-in filter capacitors. The magnitude of such spikes or fast transients on the output side caused by the input is much smaller compared to not connecting this terminal to ground.

Fig. 22-3 **Earthed input**

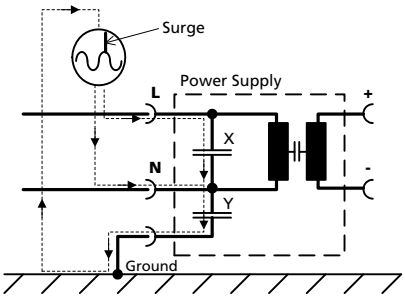
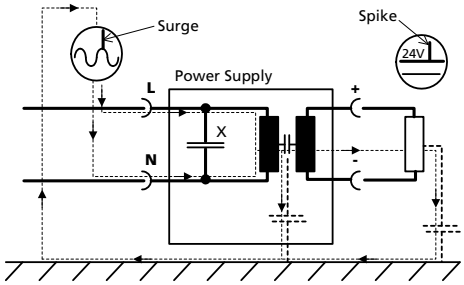


Fig. 22-4 **Not earthed input**



22.11. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box; no other heat producing items are inside the box.

Enclosure:	Rittal Type IP66 Box PK 9510 100, plastic, 130x130x75mm
Input:	230Vac

Case A:

Load:	24V, 1.3A; load is placed outside the box
Temperature inside the box:	35.2°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	23.9°C
Temperature rise:	11.3K

Case B:

Load:	24V, 1.04A; (=80%) load is placed outside the box
Temperature inside the box:	32.0°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	23.1°C
Temperature rise:	8.9K

22.12. 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 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. 22-5
Mounting Orientation A
(Standard orientation)

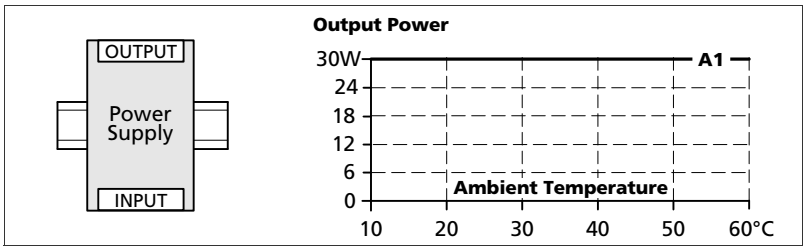


Fig. 22-6
Mounting Orientation B
(Upside down)

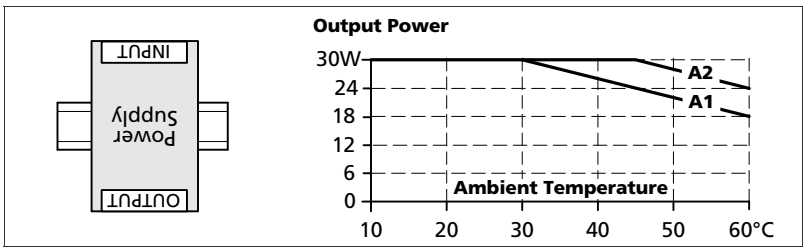


Fig. 22-7
Mounting Orientation C
(Table-top mounting)

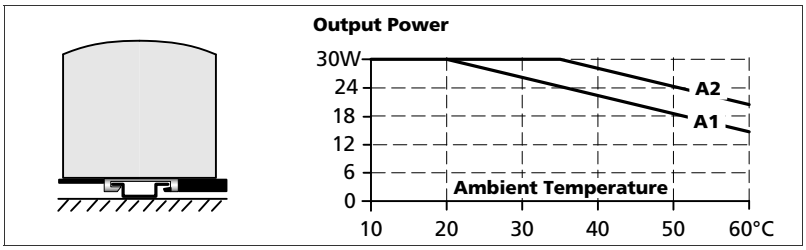


Fig. 22-8
Mounting Orientation D
(Horizontal cw)

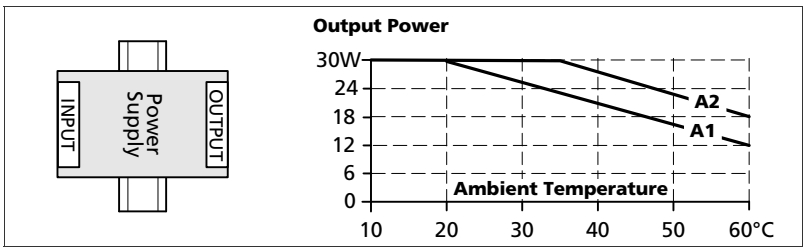
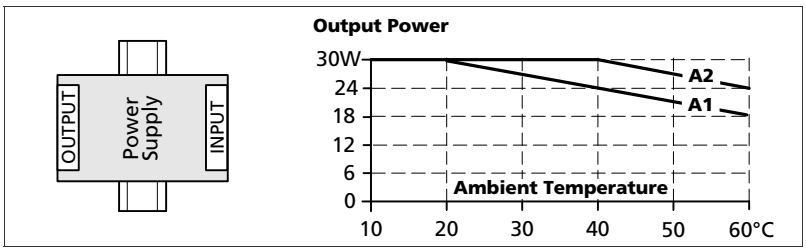


Fig. 22-9
Mounting Orientation E
(Horizontal ccw)



PULS

MiniLine-2

ML60.121

12V, 4.5A, SINGLE PHASE INPUT

POWER SUPPLY

- 100-240V Wide Range Input
- NEC Class 2 Compliant
- Adjustable Output Voltage
- Efficiency up to 87.2%
- Low No-load Losses and Excellent Partial-load Efficiency
- Compact Design, Width only 45mm
- Full Power between -10°C and +60°C
- Large International Approval Package
- 3 Year Warranty

GENERAL DESCRIPTION

A compact size, light weight, simple mounting onto the DIN-rail and the utilization of only quality components are what makes the MiniLine power supplies so easy to use and install within seconds.

A rugged electrical and mechanical design as well as a high immunity against electrical disturbances on the mains provides reliable output power. This offers superior protection for equipment which is connected to the public mains network or is exposed to a critical industrial environment.

The MiniLine series offers output voltages from 5 to 56Vdc and a power rating from 15W to 120W.

The supplementary MiniLine decoupling diode module MLY10.241 allows building of redundant systems or to protect against back-feeding voltages.

SHORT-FORM DATA

Output voltage Adjustment range	DC 12V 12 - 15V	
Output current	4.5A at 12V 3.6A at 15V	
Output power	54W	
Output ripple	< 50mVpp	20Hz to 20MHz
Input voltage	AC 100-240V	-15% / +10% AC 100V mains requires derating
Mains frequency	50-60Hz	±6%
AC Input current	0.91 / 0.54A	at 120 / 230Vac
Power factor	0.58 / 0.5	at 120 / 230Vac
AC Inrush current	typ. 16 / 32A	peak value at 120 / 230Vac 40°C and cold start
DC Input	88-375Vdc	below 130Vdc derating required
Efficiency	85.3 / 87.2%	at 120 / 230Vac
Losses	9.3 / 7.9W	at 120 / 230Vac
Temperature range	-10°C to +70°C	operational
Derating	1.4W/°C	+60 to +70°C
Hold-up time	typ. 25 / 113ms	at 120 / 230Vac
Dimensions	45x75x91mm	WxHxD
Weight	250g / 0.55lb	

ORDER NUMBERS

Power Supply	**ML60.121**	12-15V Standard unit
Accessory	MLY10.241	Redundancy Module
	ZM3.WALL	Wall mount bracket

MARKINGS

c UL us LISTED
Ind. Cont. Eq. UL 508

c TÜV us
UL 60950-1

GL
Marine

CSA C US
Class I Div 2

NEC Class 2

CE
EMC, LVD

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.B.D.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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.

Mount the unit on a DIN-rail so that the output terminals are located on top and input terminal on the bottom. For other mounting orientations see de-rating requirements in this document.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Keep the following installation clearances:
40mm on top, 20mm on the bottom
Left / right: 0mm (or 15mm in case the adjacent device is a heat source; in example another power supply….).

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into 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.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15:2010.

3. AC-INPUT

AC input	nom.	AC 100-240V	-15% / +10%, TN/TT/IT-mains
AC input range		85-264Vac	continuous operation, see Fig. 3-3 for de-rating requirements for AC 100V mains.
		264–300Vac	< 0.5s
Allowed voltage L or N to earth	max.	264Vac or 375Vdc	
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	65Vac	
Shut-down voltage	typ.	see Fig. 3-1	

		AC 100V	**AC 120V**	**AC 230V**	
Input current (rms)	typ.	1.06A	0.91A	0.54A	at 12V, 4.5A see Fig. 3-3
Power factor *)	typ.	0.61	0.58	0.50	at 12V, 4.5A see Fig. 3-4
Crest factor **)	typ.	3.2	3.3	3.7	at 12V, 4.5A
Start-up delay	typ.	120ms ***)	100ms ***)	90ms	see Fig. 3-2
Rise time	typ.	40ms	40ms	50ms	at 12V, 4.5A, 0mF, see Fig. 3-2
		100ms	90ms	110ms	at 12V, 4.5A, 4.5mF
Turn-on overshoot	max.	200mV	200mV	200mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
***) At low temperatures, start-up attempts may occur which extends the start-up delay time.

Fig. 3-1 **Input voltage range**

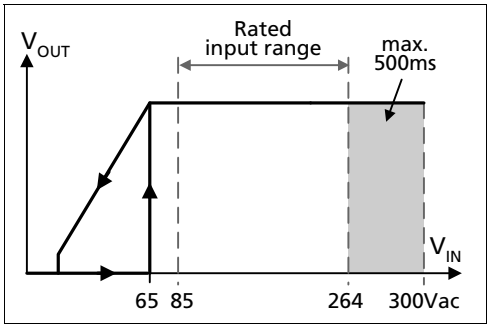


Fig. 3-2 **Turn-on behavior, definitions**

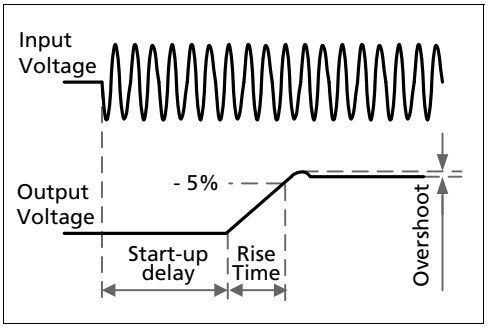


Fig. 3-3 **Input current vs. output load at 12V**

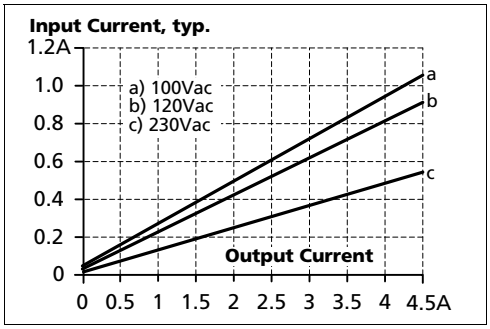


Fig. 3-4 **Power factor vs. output load at 12V**

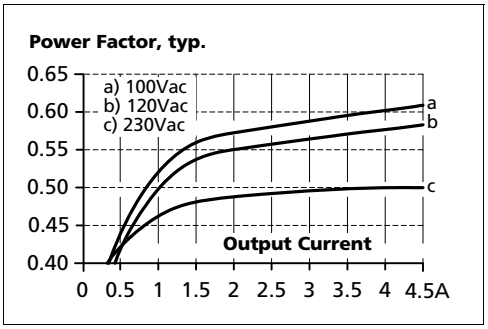
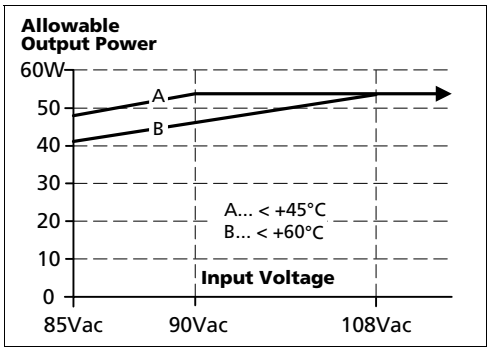


Fig. 3-5 **De-rating requirements for low input voltages**



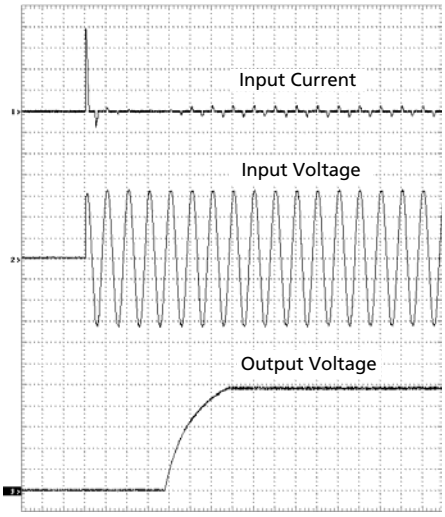
4. INPUT INRUSH CURRENT

A NTC limits the input inrush current after turn-on of the input voltage. The inrush current is input voltage and ambient temperature dependent.

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

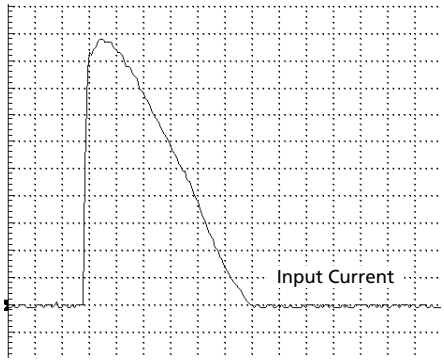
		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$17A_{peak}$	$21A_{peak}$	$40A_{peak}$	40°C ambient, cold start
	typ.	$14A_{peak}$	$16A_{peak}$	$32A_{peak}$	40°C ambient, cold start
Inrush energy	typ.	$0.15A^2s$	$0.2A^2s$	$1.0A^2s$	40°C ambient, cold start

Fig. 4-1 **Input inrush current, typical behavior**



Input: 230Vac
Output: 12V, 4.5A
Ambient: 25°C
Upper curve: Input current 5A/DIV
Middle curve: Input voltage 100V/DIV
Lower curve: Output voltage 2.5V/DIV
Time basis: 20ms / DIV

Fig. 4-2 **Input inrush current, zoom into first peak**



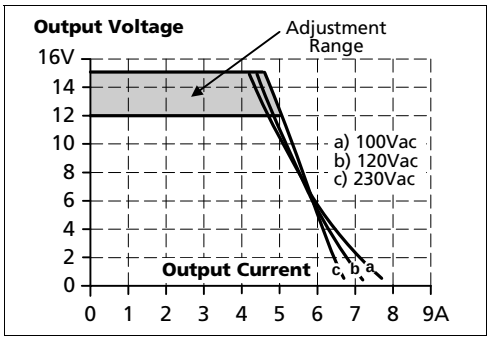
Input: 230Vac
Output: 12V, 4.5A
Ambient: 25°C
Input current 2A/DIV
Time basis: 0.5ms / DIV

5. OUTPUT

Output voltage	nom.	12V	
Adjustment range	min.	12-15V	guaranteed
	max.	16.2V *)	at clockwise end position of potentiometer
Factory setting		12.0V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	85-264Vac
Load regulation	max.	100mV	static value, 0A → 4.5A
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	3 000µF	
Output current	nom.	4.5A	at 12V, see Fig. 5-1
	nom.	3.6A	at 15V, see Fig. 5-1
Output power	nom.	54W	
Short-circuit current	min.	6.0A	load impedance 250mOhm, see Fig. 5-1
	max.	8.0A	load impedance 250mOhm, see Fig. 5-1

*) 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 15.8V.

Fig. 5-1 **Output voltage vs. output current, typ.**



Peak current capability (up to several milliseconds)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 22.1.

Peak current voltage dips	typ.	from 12V to 7V	at 9A for 50ms, resistive load
	typ.	from 12V to 5V	at 22.5A for 2ms, resistive load
	typ.	from 12V to 3.2V	at 22.5A for 5ms, resistive load

6. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	37ms	56ms	229ms	at 12V, 2.25A, see Fig. 6-1
	typ.	16ms	25ms	113ms	at 12V, 4.5A, see Fig. 6-1

Note: At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is also on during this time

Fig. 6-1 **Hold-up time vs. input voltage**

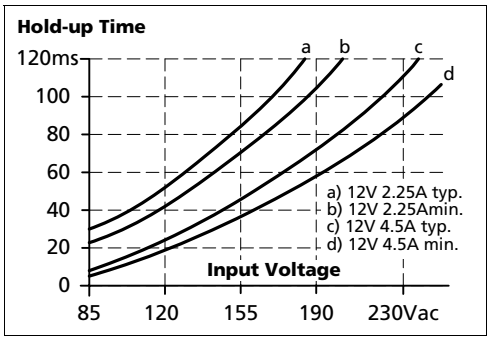
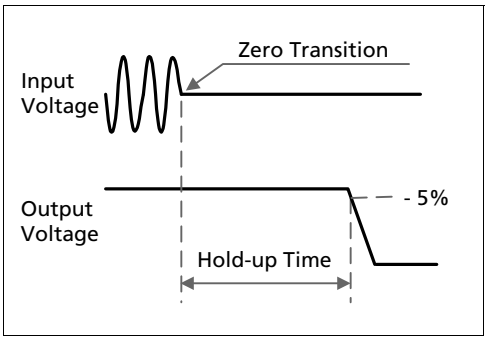


Fig. 6-2 **Shut-down behavior, definitions**



7. DC-INPUT

The power supply can also be supplied from a DC source. Use a battery or similar DC source. For other sources contact PULS. Connect the + pole to L and the – pole to N. Connect the PE terminal to an earth wire or to the machine ground.

DC input	nom.	DC 110-300V	-20%/+25%
DC input range	min.	88-375Vdc	continuous operation, reduce output power according Fig. 7-2 at voltages below 130Vdc
Allowed Voltage L/N to Earth	max.	375Vdc	IEC 62103
DC input current	typ.	0.57A / 0.2A	110Vdc / 300Vdc, at 12V, 4.5A
Turn-on voltage	typ.	80Vdc	steady state value
Shut-down voltage	typ.	30-70Vdc	depending on output load

Fig. 7-1 **Wiring for DC Input**

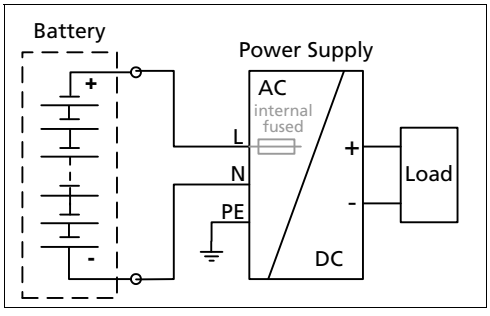
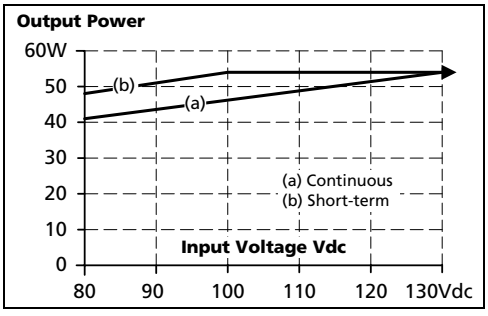


Fig. 7-2 **Allowable output current below 110Vdc input voltage**



8. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	83.5%	85.3%	87.2%	at 12V, 4.5A (full load)
Power losses	typ.	0.45W	0.5W	0.85W	at 0A
	typ.	4.2W	3.9W	4.2W	at 12V, 2.25A (half load)
	typ.	10.6W	9.3W	7.9W	at 12V, 4.5A (full load)

Fig. 8-1 **Efficiency vs. output current at 12V, typ.**

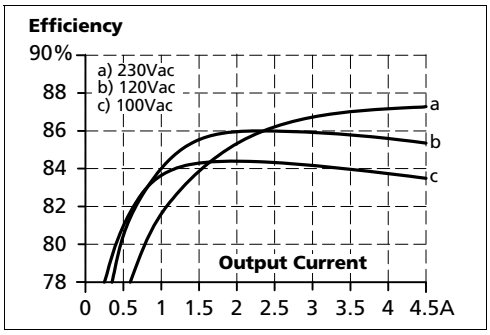


Fig. 8-2 **Losses vs. output current at 12V, typ.**

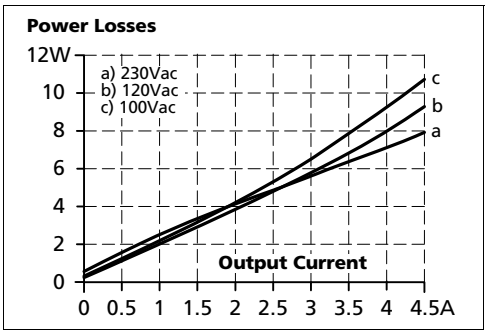


Fig. 8-3 **Efficiency vs. input voltage at 12V, 4.5A, typ.**

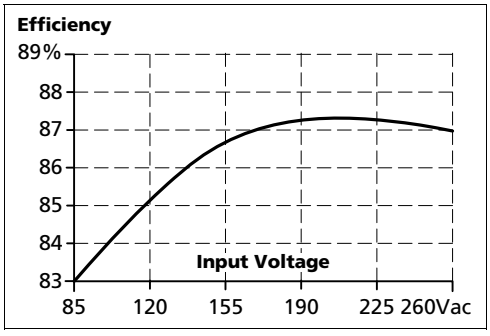
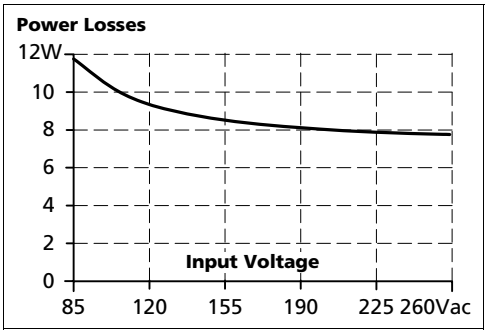
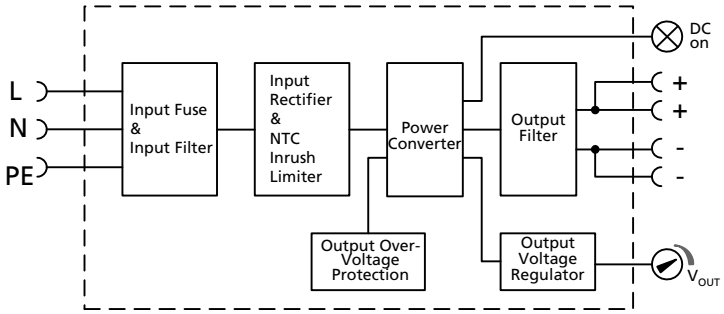


Fig. 8-4 **Losses vs. input voltage at 12V, 4.5A, typ.**



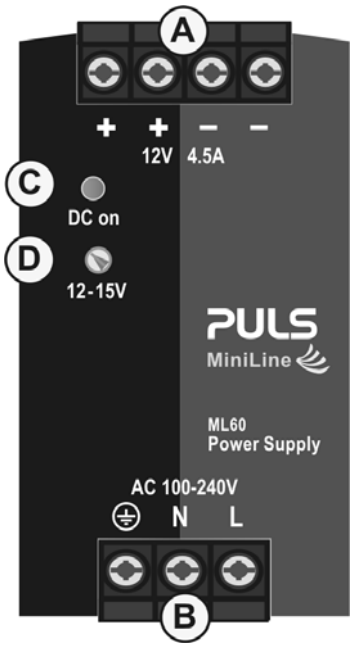
9. FUNCTIONAL DIAGRAM

Fig. 9-1 **Functional diagram**



10. FRONT SIDE AND USER ELEMENTS

Fig. 10-1 **Front side**



A **Output Terminals**
Screw terminals,
Dual terminals for the negative and positive pole. Both poles are equal
+ Positive output
- Negative (return) output

B **Input Terminals**
Screw terminals
L Phase (Line) input
N Neutral conductor input
⏚ PE (Protective Earth) input

C **DC-on LED** (green)
On, when the voltage on the output terminals is > 9V

D **Output voltage potentiometer**
(single turn potentiometer)
Turn to set the output voltage. Factory set: 12.0V

11. TERMINALS AND WIRING

All terminals are easy to access when mounted on the panel. Input and output terminals are separated from each other (input below, output above) to help in error-free wiring.

	Input	Output
Type	screw terminals	screw terminals
Solid wire	max. 6mm²	max. 6mm²
Stranded wire	max. 4mm²	max. 4mm²
American Wire Gauge	max. AWG10	max. AWG10
Wire stripping length	7mm / 0.275inch	7mm / 0.275inch
Screwdriver	3.5mm slotted or Pozidrive No 2	3.5mm slotted or Pozidrive No 2
Recommended tightening torque	1Nm, 9lb.in	1Nm, 9lb.in

Instructions:

a) Use appropriate copper cables that are designed for an operating temperature of:
60°C for ambient up to 45°C and 75°C for ambient up to 60°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).
e) Do not use the unit without PE connection.
f) Screws of unused terminal compartments should be securely tightened.
g) Ferrules are allowed.

12. LIFETIME EXPECTANCY AND MTBF

These units are extremely reliable and use only the highest quality materials. The number of critical components such as electrolytic capacitors has been reduced.

	AC 100V	AC 120V	AC 230V	
Lifetime expectancy *)	34 000h	41 000h	56 000h	at 12V, 4.5A and 40°C
	180 000h *)	181 000h *)	128 000h *)	at 12V, 2.25A and 40°C
	95 000h *)	115 000h *)	158 000h *)	at 12V, 4.5A and 25°C
MTBF **) SN 29500, IEC 61709	1 327 000h	1 458 000h	1 690 000h	at 12V, 4.5A and 40°C
	2 437 000h	2 639 000h	3 007 000h	at 12V, 4.5A and 25°C
MTBF **) MIL HDBK 217F	1 085 000h	1 126 000h	1 067 000h	at 12V, 4.5A and 40°C; Ground Benign GB40
	1 464 000h	1 520 000h	1 445 000h	at 12V, 4.5A and 25°C; Ground Benign GB25

*) The **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.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

13. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available on request.

EMC Immunity	Generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 8kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	20V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N → PE, L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + → PE, - → PE	1kV 2kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	20V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A *) Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Input voltage swells	PULS internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:

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

B: The power supply operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the power supply itself.

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

***)** Up to 3A output current criterion A, above 3A output current criterion B

EMC Emission	Generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
Radiated emission	EN 55011, EN 55022, CISPR 11, CISPR 22	Class B
Harmonic input current	EN 61000-3-2	Not applicable below 75W input power Class A limits acc. to EN 61000-3-2 fulfilled.
Voltage fluctuations, flicker *)	EN 61000-3-3	Fulfilled

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.

*) tested with constant current loads, non pulsing

Switching frequency		
Converter frequency	variable, typ. 100kHz, min. 45kHz, max. 160kHz	Input voltage and output load dependent

14. ENVIRONMENT

Operational temperature *)	-10°C to +70°C (14°F to 158°F)	reduce output power according Fig. 14-1
Storage temperature	-40°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	1.4W/°C	60-70°C (140°F to 158°F)
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	15g 6ms, 10g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature see Fig. 14-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	4W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 14-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 14-1 **Output power vs. ambient temp.**

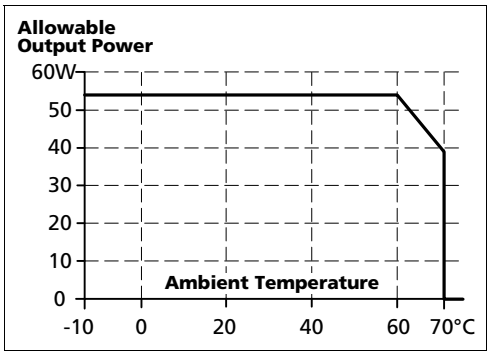
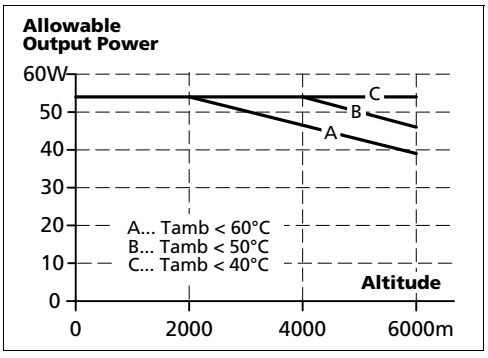


Fig. 14-2 **Output power vs. altitude**



15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits *)	
Output over-voltage protection	typ. 18Vdc max. 19Vdc	In case of an internal power supply fault, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and stays down until the input voltage is turned off and on again.
Output over-current protection	electronically limited	see Fig. 5-1
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 2.5mm in diameter	e.g. screws, small parts
Over-temperature protection	not included	
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T3.15A H.B.C.	not user replaceable

*) In case of a protection event, audible noise may occur.

16. SAFETY FEATURES

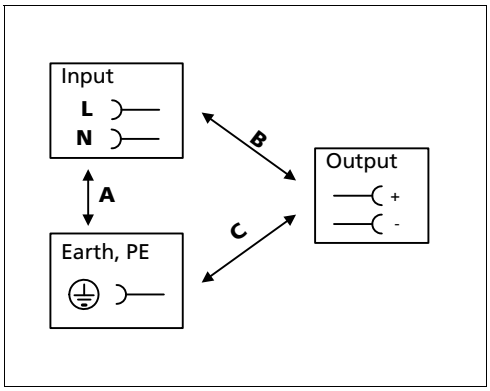
Input / output separation *)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
	II (with restrictions)	for use without PE connection contact PULS
Isolation resistance	> 5MOhm	Input to output, 500Vdc
Touch current (leakage current)	typ. 0.13mA / 0.29mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.19mA / 0.40mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.30mA / 0.63mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.17mA / 0.38mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.25mA / 0.53mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.41mA / 0.85mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

*) Double or reinforced insulation

17. 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. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	4000Vac	2000Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting		> 4mA	> 4mA	> 1mA at 500V > 4mA at 2000V

To fulfill 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 can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive and the - Low-voltage directive (LVD). See Declaration of Conformity (DoC) for further information.
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL US LISTED IND. CONT. EQ.	Listed for the use as Industrial Control Equipment; E-File: E198865
UL 60950-1 2nd Edition	c UL us	Recognized for the use as Information Technology Equipment, Level 3 in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006
NEC Class 2	**NEC CLASS 2**	Listed as Limited Power Source (LPS) in the UL 60950-1 UL report. According to NEC (National Electrical Code) Article 725-41 (4).
Class I Div 2 ANSI / ISA 12.12.01-2000	c SA us Class I Div2	Recognized for use in Hazardous Location Class I Div 2 T3 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Marine	GL ABS	GL (Germanischer Lloyd) classified Environmental category: C, EMC2 Marine and offshore applications ABS (American Bureau for Shipping) PDA
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

19. ROHS, REACH AND OTHER FULFILLED STANDARDS

RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

20. PHYSICAL DIMENSIONS AND WEIGHT

Weight	250g / 0.55lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the unit depth (91mm) to calculate the total required installation depth.
Installation Clearances	See chapter 2

Fig. 20-1 **Front view**

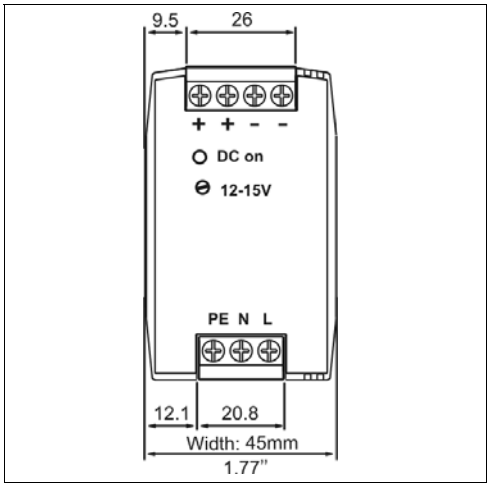
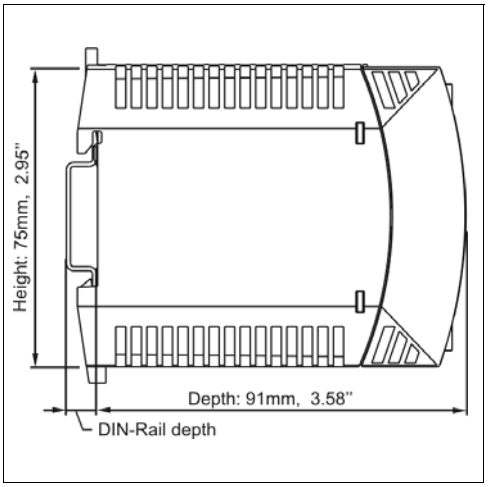


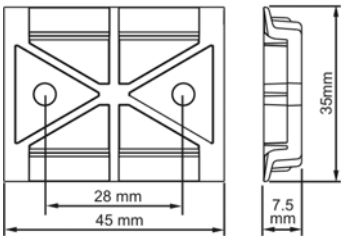
Fig. 20-2 **Side view**



21. ACCESSORY

21.1. ZM3.WALL – WALL MOUNT BRACKET

DIN-Rail bracket for wall or panel mount:



The picture of the power supply is for representation only

Hole diameter: 4.2mm

21.2. MLY10.241 - REDUNDANCY MODULE

The MLY10.241 is a dual redundancy module, which has two diodes with a common cathode included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.

22. APPLICATION NOTES

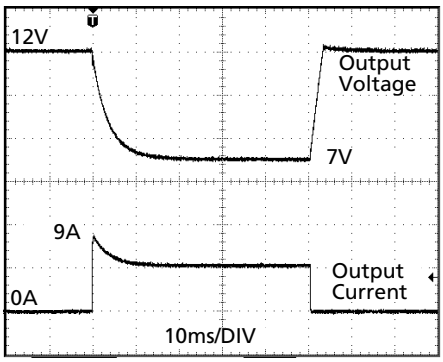
22.1. PEAK CURRENT CAPABILITY

Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady-state current and usually exceeds the nominal output current. The same situation applies when starting a motor or switching-on a capacitive load.

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

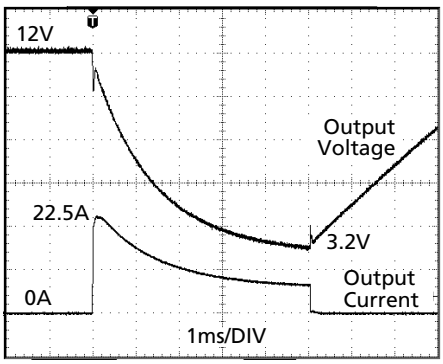
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-1 **Peak loading with 2x the nominal current for 50ms, typ.**



Peak load 9A (resistive load) for 50ms
Output voltage dips from 12V to 7V.

Fig. 22-2 **Peak loading with 5x the nominal current for 5ms, typ.**



Peak load 22.5A (resistive load) for 5ms
Output voltage dips from 12V to 3.2V.

22.2. 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 25Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 5.

22.3. CHARGING OF BATTERIES

The power supply can be used to charge 12V lead-acid or maintenance free batteries.

Instructions for charging batteries (float charging):

a) Ensure that the ambient temperature of the power supply is below 45°C

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

End-of-charge voltage	13.9V	13.75V	13.6V	13.4V
Battery temperature	10°C	20°C	30°C	40°C

c) Use a 6A circuit breaker (or blocking diode) between the power supply and the battery.

d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

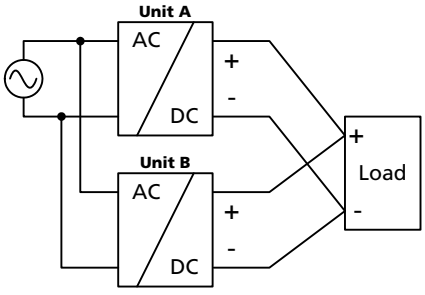
e) The return current to the power supply (battery discharge current) is typical 6mA when the power supply is switched off (except in case a blocking diode is utilized).

22.4. EXTERNAL INPUT PROTECTION

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

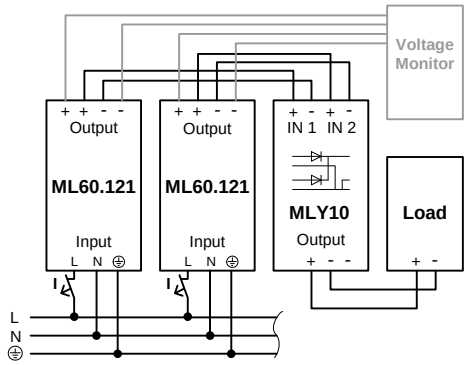
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

22.5. PARALLEL USE TO INCREASE OUTPUT POWER



ML60.121 power supplies can be paralleled to increase the output power. This power supply has no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 45°C. The ML60.121 can also be paralleled with other power supplies from MiniLine series with 12V output voltage. The output voltages of all power supplies shall be adjusted to the same value (±100mV). A fuse or diode on the output of each unit is only required if more than three units are connected in parallel. If a fuse (or circuit breaker) is used, choose one with approximately 150% of the rated output current of one power supply. 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 (input terminals on the bottom and output terminals on top of the unit). Be aware that leakage current, EMI, inrush current and harmonics will increase when using multiple power supplies in parallel.

22.6. PARALLEL USE FOR REDUNDANCY



Power supplies 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. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five power supplies, each rated for 4.5A are paralleled to build a 18A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module MLY10.241.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.

b) Use separate mains systems for each power supply whenever it is possible.

c) Monitor the individual power supply units.

d) 1+1 Redundancy is allowed up to an ambient temperature of 60°C.
N+1 Redundancy is allowed up to an ambient temperature of 45°C.

e) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.7. DAISY CHAINING OF OUTPUTS

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block.

Fig. 22-3 Daisy chaining of outputs

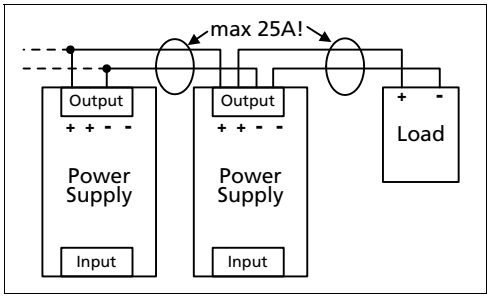
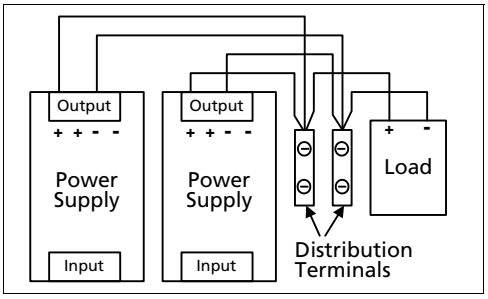


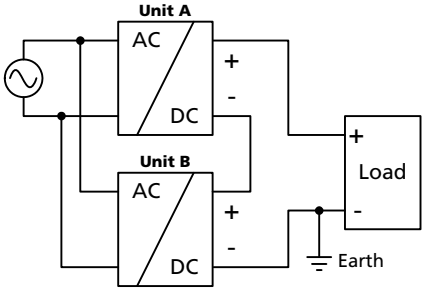
Fig. 22-4 Using distribution terminals



22.8. INDUCTIVE AND CAPACITIVE LOADS

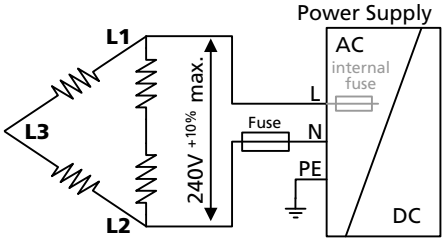
The unit is designed to supply any type of load, including unlimited capacitive and inductive loads.

22.9. SERIES OPERATION



Power supplies of the exact 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 any more 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 (input terminals on the bottom and output terminals on top of the unit). Be ware that leakage current, EMI, inrush current and harmonics will increase when using multiple power supplies series.

22.10. OPERATION ON TWO PHASES



The power supply can also be used on two-phases of a three-phase-system. A phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$. Use a fuse or a circuit breaker to protect the N input. The N input is not internally protected and is in this case connected to a hot wire. Appropriate fuses or circuit breakers are specified in section 22.4 “External Input Protection”.

22.11. USE WITHOUT PE ON THE INPUT

From a safety standpoint, the unit is internally designed according to the requirements for Protection Class 1 and 2. Please contact PULS if you do not plan to use the PE terminal. A different marking of the front foil is then required.

Grounding of the input is beneficial for a high EMI immunity: Symmetrical spikes or fast transients on the input side can be conducted directly to earth by the built-in filter capacitors. The magnitude of such spikes or fast transients on the output side caused by the input is much smaller compared to not connecting this terminal to ground.

Fig. 22-5 **Earthed input**

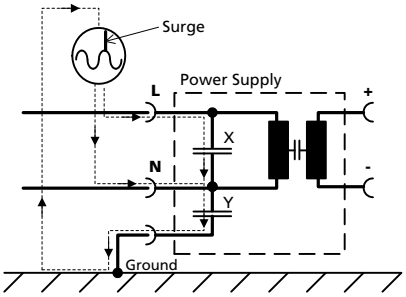
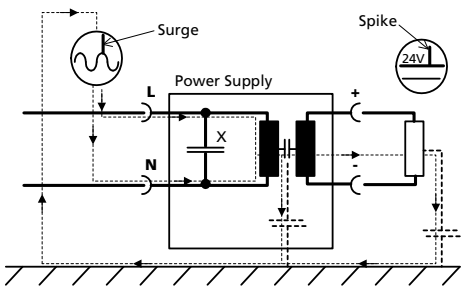


Fig. 22-6 **Not earthed input**



22.12. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box; no other heat producing items are inside the box.

Enclosure:	Rittal Type IP66 Box PK 9510 100, plastic, 130x130x75mm
Input:	230Vac

Case A:

Load:	12V, 4.5A; load is placed outside the box
Temperature inside the box:	42.8°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	21.7°C
Temperature rise:	21.1K

Case B:

Load:	12V, 3.6A; (=80%) load is placed outside the box
Temperature inside the box:	41.1°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	21.9°C
Temperature rise:	19.2K

22.13. 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 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. 22-7
Mounting Orientation A
(Standard orientation)

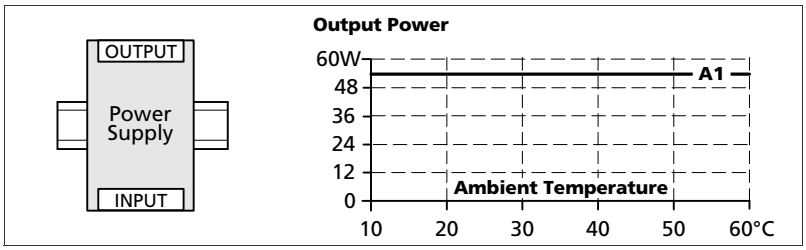


Fig. 22-8
Mounting Orientation B
(Upside down)

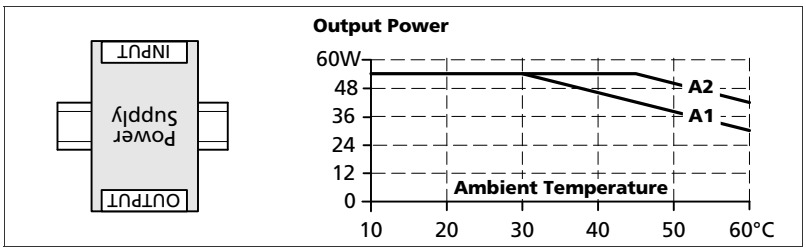


Fig. 22-9
Mounting Orientation C
(Table-top mounting)

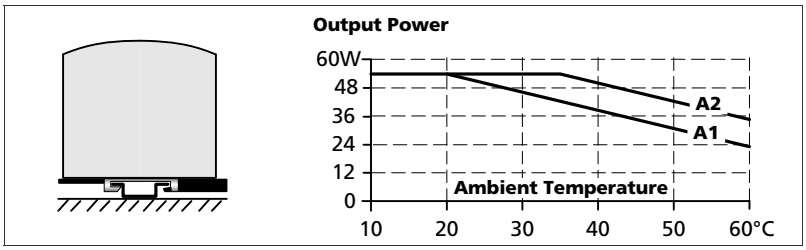


Fig. 22-10
Mounting Orientation D
(Horizontal cw)

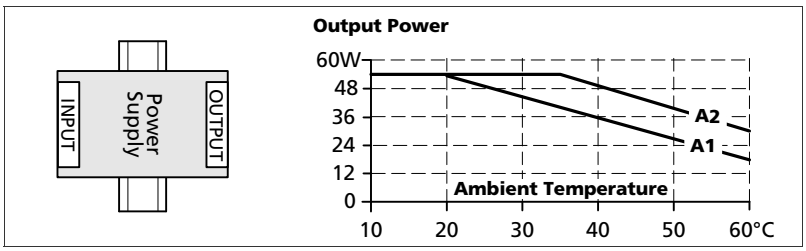
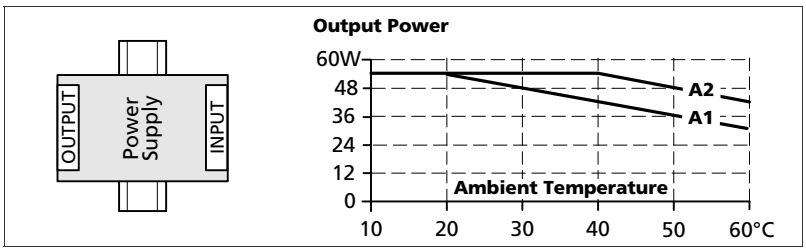


Fig. 22-11
Mounting Orientation E
(Horizontal ccw)



PULS

MiniLine-2

ML60.241

24V, 2.5A, SINGLE PHASE INPUT

POWER SUPPLY

- 100-240V Wide Range Input
- NEC Class 2 Compliant
- Adjustable Output Voltage
- Efficiency up to 89.7%
- Low No-load Losses and Excellent Partial-load Efficiency
- Compact Design, Width only 45mm
- Full Power between -10°C and +60°C
- Large International Approval Package
- 3 Year Warranty

GENERAL DESCRIPTION

A compact size, light weight, simple mounting onto the DIN-rail and the utilization of only quality components are what makes the MiniLine power supplies so easy to use and install within seconds.

A rugged electrical and mechanical design as well as a high immunity against electrical disturbances on the mains provides reliable output power. This offers superior protection for equipment which is connected to the public mains network or is exposed to a critical industrial environment.

The MiniLine series offers output voltages from 5 to 56Vdc and a power rating from 15W to 120W.

The supplementary MiniLine decoupling diode module MLY10.241 allows building of redundant systems or to protect against back-feeding voltages.

SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	2.5A at 24V 2.1A at 28V	
Output power	60W	
Output ripple	< 50mVpp	20Hz to 20MHz
Input voltage	AC 100-240V	-15% / +10%
Mains frequency	50-60Hz	±6%
AC Input current	0.98 / 0.58A	at 120 / 230Vac
Power factor	0.58 / 0.5	at 120 / 230Vac
AC Inrush current	typ. 16 / 32A	peak value at 120 / 230Vac 40°C and cold start
DC Input	88-375Vdc	below 110Vdc derating required
Efficiency	87.8 / 89.7%	at 120 / 230Vac
Losses	8.3 / 6.7W	at 120 / 230Vac
Temperature range	-10°C to +70°C	operational
Derating	1.5W/°C	+60 to +70°C
Hold-up time	typ. 24 / 107ms	at 120 / 230Vac
Dimensions	45x75x91mm	WxHxD
Weight	250g / 0.55lb	

ORDER NUMBERS

Power Supply	**ML60.241**	24-28V Standard unit
Accessory	MLY10.241	Redundancy Module
	UF20.241	Buffer Module
	ZM3.WALL	Wall mount bracket

MARKINGS

c UL us LISTED
Ind. Cont. Eq. UL 508

c TÜV us
UL 60950-1

GL
Marine

SA c us
Class I Div 2

NEC Class 2

CE
EMC, LVD

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.B.D.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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.

Mount the unit on a DIN-rail so that the output terminals are located on top and input terminal on the bottom. For other mounting orientations see de-rating requirements in this document.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Keep the following installation clearances:
40mm on top, 20mm on the bottom
Left / right: 0mm (or 15mm in case the adjacent device is a heat source; in example another power supply….).

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering into 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.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15:2010.

3. AC-INPUT

AC input	nom.	AC 100-240V	-15% / +10%, TN/TT/IT-mains
AC input range		85-264Vac	continuous operation, reduce output power linearly to 50W between 90Vac and 85Vac at ambient temperatures above +45°C, see Fig. 3-5
		264–300Vac	< 0.5s
Allowed voltage L or N to earth	max.	264Vac or 375Vdc	
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	65Vac	
Shut-down voltage	typ.	see Fig. 3-1	

		AC 100V	AC 120V	AC 230V	
Input current (rms)	typ.	1.14A	0.98A	0.58A	at 24V, 2.5A see Fig. 3-3
Power factor *)	typ.	0.61	0.58	0.50	at 24V, 2.5A see Fig. 3-4
Crest factor **)	typ.	3.2	3.3	3.7	at 24V, 2.5A
Start-up delay	typ.	170ms ***)	110ms ***)	90ms	see Fig. 3-2
Rise time	typ.	50ms	50ms	60ms	at 24V, 2.5A, 0mF, see Fig. 3-2
		120ms	110ms	140ms	at 24V, 2.5A, 2.5mF
Turn-on overshoot	max.	200mV	200mV	200mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
***) At low temperatures, start-up attempts may occur which extends the start-up delay

Fig. 3-1 **Input voltage range**

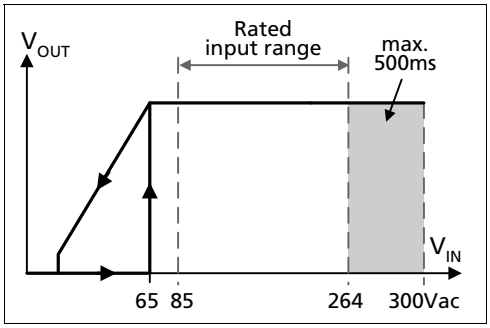


Fig. 3-2 **Turn-on behavior, definitions**

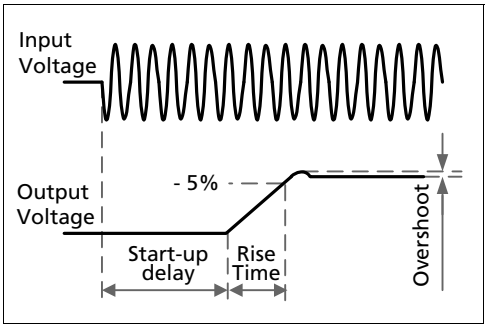


Fig. 3-3 **Input current vs. output load at 24V**

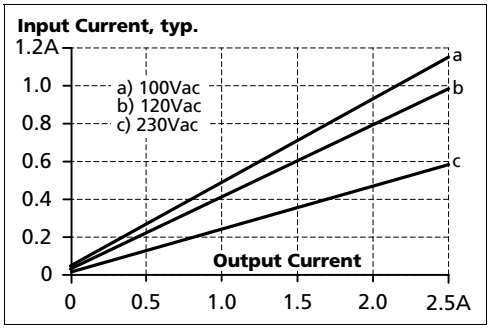


Fig. 3-4 **Power factor vs. output load at 24V**

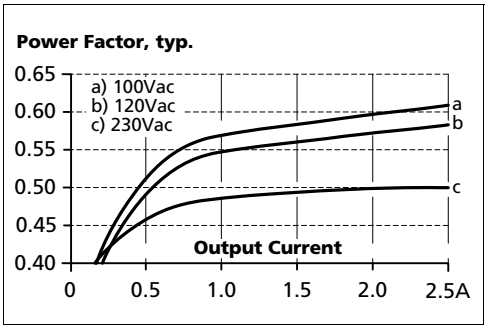
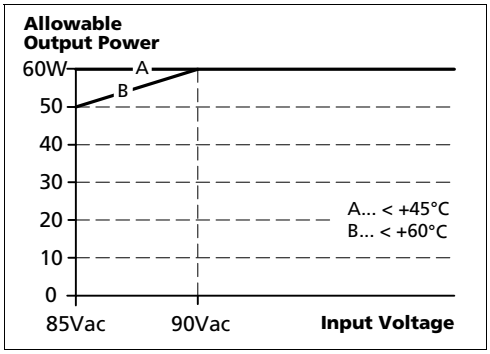


Fig. 3-5 **De-rating requirements for low input voltages**



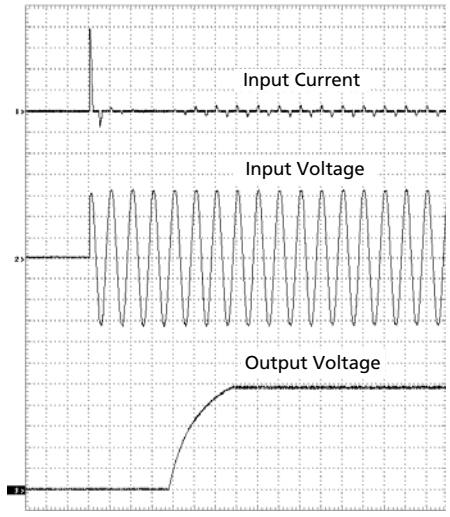
4. INPUT INRUSH CURRENT

A NTC limits the input inrush current after turn-on of the input voltage. The inrush current is input voltage and ambient temperature dependent.

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

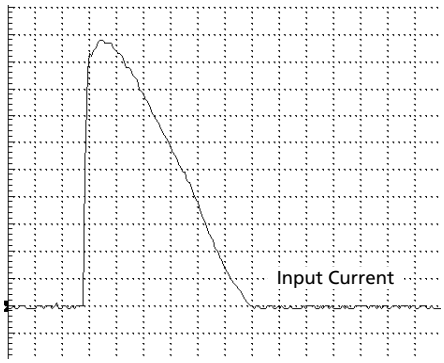
		AC 100V	AC 120V	AC 230V	
Inrush current	max.	$17A_{peak}$	$21A_{peak}$	$40A_{peak}$	40°C ambient, cold start
	typ.	$14A_{peak}$	$16A_{peak}$	$32A_{peak}$	40°C ambient, cold start
Inrush energy	typ.	$0.15A^2s$	$0.2A^2s$	$1.0A^2s$	40°C ambient, cold start

Fig. 4-1 **Input inrush current, typical behavior**



Input: 230Vac
Output: 24V, 2.5A
Ambient: 25°C
Upper curve: Input current 5A/DIV
Middle curve: Input voltage 100V/DIV
Lower curve: Output voltage 5V/DIV
Time basis: 20ms / DIV

Fig. 4-2 **Input inrush current, zoom into first peak**



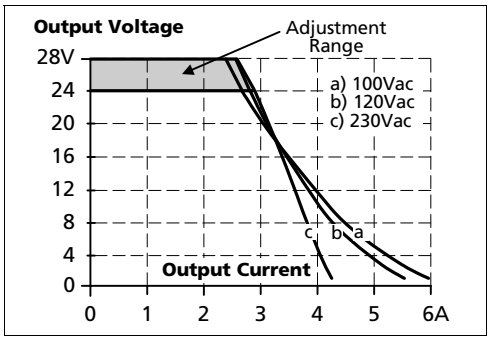
Input: 230Vac
Output: 24V, 2.5A
Ambient: 25°C
Input current 2A/DIV
Time basis: 0.5ms / DIV

5. OUTPUT

Output voltage	nom.	24V	
Adjustment range	min.	24-28V	guaranteed
	max.	30V *)	at clockwise end position of potentiometer
Factory setting		24.5V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	85-264Vac
Load regulation	max.	100mV	static value, 0A → 2.5A
Ripple and noise voltage	max.	50mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	1 600µF	
Output current	nom.	2.5A	at 24V, see Fig. 5-1
	nom.	2.1A	at 28V, see Fig. 5-1
Output power	nom.	60W	
Short-circuit current	min.	3.6A	load impedance 400mOhm, see Fig. 5-1
	max.	6.2A	load impedance 400mOhm, see Fig. 5-1

*) 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 28.6V.

Fig. 5-1 **Output voltage vs. output current, typ.**



Peak current capability (up to several milliseconds)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 22.1.

Peak current voltage dips	typ.	from 24V to 16V	at 5A for 50ms, resistive load
	typ.	from 24V to 15V	at 12.5A for 2ms, resistive load
	typ.	from 24V to 10.5V	at 12.5A for 5ms, resistive load

6. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	36ms	54ms	218ms	at 24V, 1.25A, see Fig. 6-1
	typ.	15ms	24ms	107ms	at 24V, 2.5A, see Fig. 6-1

Note: At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is also on during this time

Fig. 6-1 **Hold-up time vs. input voltage**

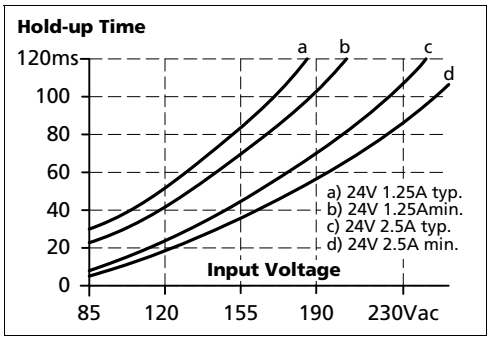
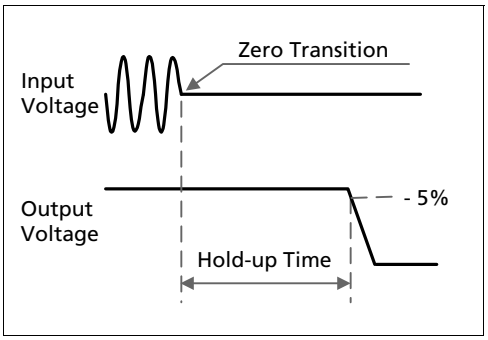


Fig. 6-2 **Shut-down behavior, definitions**



7. DC-INPUT

The power supply can also be supplied from a DC source. Use a battery or similar DC source. For other sources contact PULS. Connect the + pole to L and the – pole to N. Connect the PE terminal to an earth wire or to the machine ground.

DC input	nom.	DC 110-300V	-20%/+25%
DC input range	min.	88-375Vdc	continuous operation, reduce output power according Fig. 7-2 at voltages below 110Vdc
Allowed Voltage L/N to Earth	max.	375Vdc	IEC 62103
DC input current	typ.	0.62A / 0.22A	110Vdc / 300Vdc, at 24V, 2.5A
Turn-on voltage	typ.	80Vdc	steady state value
Shut-down voltage	typ.	30-70Vdc	depending on output load

Fig. 7-1 **Wiring for DC Input**

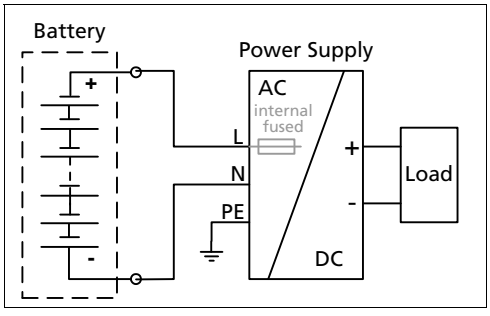
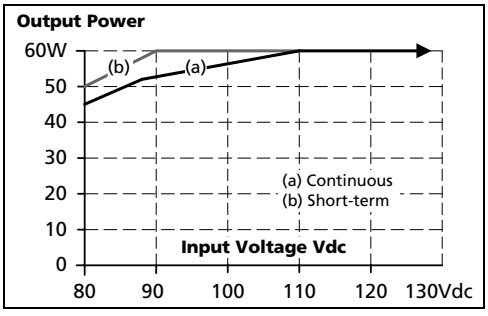


Fig. 7-2 **Allowable output current below 110Vdc input voltage**



8. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	86.5%	87.8%	89.7%	at 24V, 2.5A (full load)
Power losses	typ.	0.45W	0.5W	0.85W	at 0A
	typ.	4.0W	3.8W	4.0W	at 24V, 1.25A (half load)
	typ.	9.4W	8.3W	6.9W	at 24V, 2.5A (full load)

Fig. 8-1 **Efficiency vs. output current at 24V, typ.**

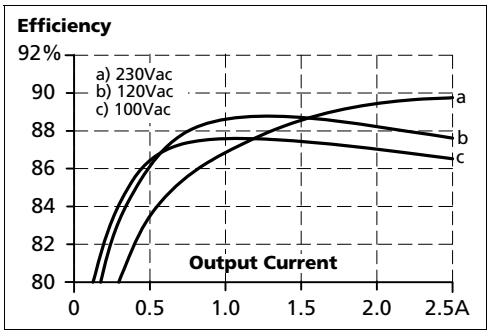


Fig. 8-2 **Losses vs. output current at 24V, typ.**

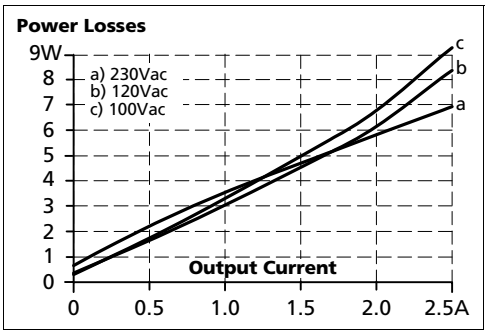


Fig. 8-3 **Efficiency vs. input voltage at 24V, 2.5A, typ.**

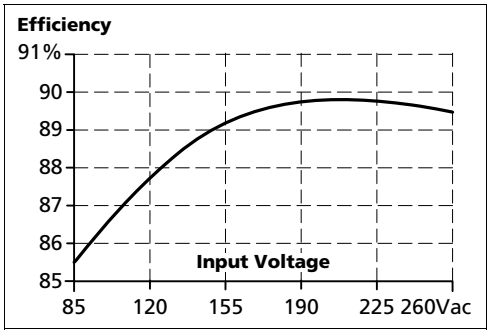
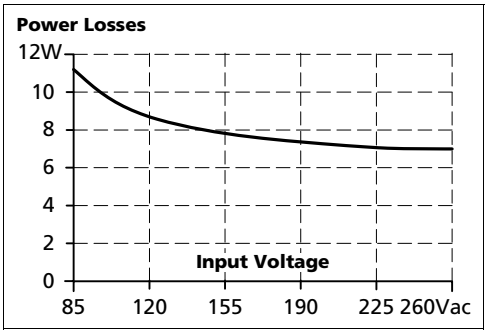
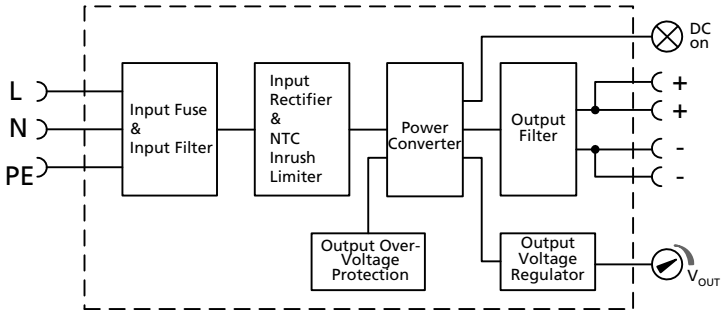


Fig. 8-4 **Losses vs. input voltage at 24V, 2.5A, typ.**



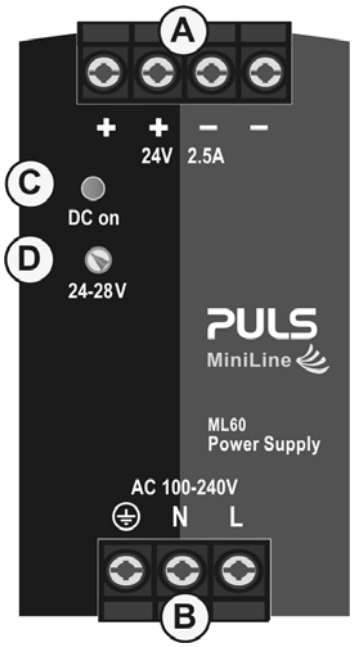
9. FUNCTIONAL DIAGRAM

Fig. 9-1 **Functional diagram**



10. FRONT SIDE AND USER ELEMENTS

Fig. 10-1 **Front side**



A **Output Terminals**
Screw terminals,
Dual terminals for the negative and positive pole. Both poles are equal
+ Positive output
- Negative (return) output

B **Input Terminals**
Screw terminals
L Phase (Line) input
N Neutral conductor input
⏚ PE (Protective Earth) input

C **DC-on LED** (green)
On, when the voltage on the output terminals is > 17V

D **Output voltage potentiometer**
(single turn potentiometer)
Turn to set the output voltage. Factory set: 24.5V

11. TERMINALS AND WIRING

All terminals are easy to access when mounted on the panel. Input and output terminals are separated from each other (input below, output above) to help in error-free wiring.

	Input	Output
Type	screw terminals	screw terminals
Solid wire	max. 6mm²	max. 6mm²
Stranded wire	max. 4mm²	max. 4mm²
American Wire Gauge	max. AWG10	max. AWG10
Wire stripping length	7mm / 0.275inch	7mm / 0.275inch
Screwdriver	3.5mm slotted or Pozidrive No 2	3.5mm slotted or Pozidrive No 2
Recommended tightening torque	1Nm, 9lb.in	1Nm, 9lb.in

Instructions:

a) Use appropriate copper cables that are designed for an operating temperature of:
60°C for ambient up to 45°C and 75°C for ambient up to 60°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Up to two stranded wires with the same cross section are permitted in one connection point (except PE wire).
e) Do not use the unit without PE connection.
f) Screws of unused terminal compartments should be securely tightened.
g) Ferrules are allowed.

12. LIFETIME EXPECTANCY AND MTBF

These units are extremely reliable and use only the highest quality materials. The number of critical components such as electrolytic capacitors has been reduced.

	AC 100V	AC 120V	AC 230V	
Lifetime expectancy *)	71 000h	93 000h	128 000h	at 24V, 2.5A and 40°C
	200 000h *)	264 000h *)	363 000h *)	at 24V, 1.25A and 40°C
	162 000h *)	233 000h *)	327 000h *)	at 24V, 2.5A and 25°C
MTBF **) SN 29500, IEC 61709	1 391 000h	1 667 000h	1 916 000h	at 24V, 2.5A and 40°C
	2 541 000h	2 964 000h	3 345 000h	at 24V, 2.5A and 25°C
MTBF **) MIL HDBK 217F	1 038 000h	1 112 000h	1 060 000h	at 24V, 2.5A , 40°C; Ground Benign GB40
	1 414 000h	1 517 000h	1 450 000h	at 24V, 2.5A , 25°C; Ground Benign GB25
	269 000h	295 000h	291 000h	at 24V, 2.5A , 40°C; Ground Fixed GF40
	355 000h	389 000h	384 000h	at 24V, 2.5A , 25°C; Ground Fixed GF25

*) The **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.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

13. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available on request.

EMC Immunity	Generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 8kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	20V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines	4kV 2kV	Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N N → PE, L → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + → PE, - → PE	1kV 2kV	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	20V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A *) Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11		0Vac, 5000ms	Criterion C
Input voltage swells	PULS internal standard		300Vac, 500ms	Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:

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

B: The power supply operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the power supply itself.

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

***)** Up to 2A output current criterion A, above 2A output current criterion B

EMC Emission	Generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B, input lines
Radiated emission	EN 55011, EN 55022, CISPR 11, CISPR 22	Class B
Harmonic input current	EN 61000-3-2	Not applicable below 75W input power Class A limits acc. to EN 61000-3-2 fulfilled.
Voltage fluctuations, flicker *)	EN 61000-3-3	Fulfilled

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.

*) tested with constant current loads, non pulsing

Switching frequency		
Converter frequency	variable, typ. 100kHz, min. 45kHz, max. 160kHz	Input voltage and output load dependent

14. ENVIRONMENT

Operational temperature *)	-10°C to +70°C (14°F to 158°F)	reduce output power according Fig. 14-1
Storage temperature	-40°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	1.5W/°C	60-70°C (140°F to 158°F)
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	15g 6ms, 10g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature see Fig. 14-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	4W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 14-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 14-1 **Output power vs. ambient temp.**

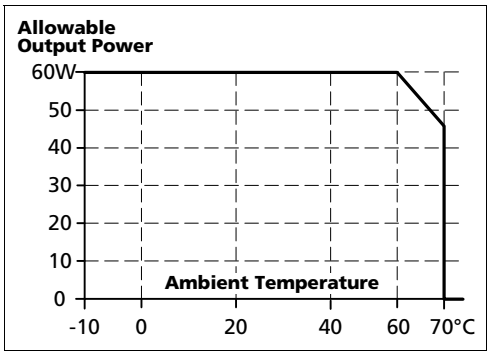
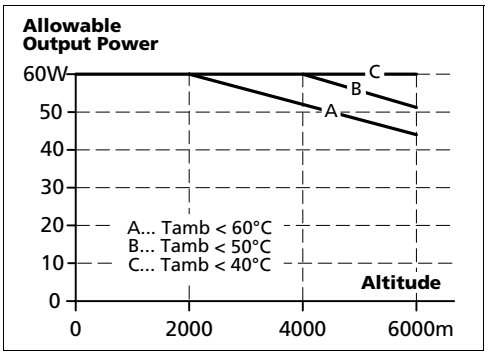


Fig. 14-2 **Output power vs. altitude**



15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits *)	
Output over-voltage protection	typ. 31Vdc max. 32.5Vdc	In case of an internal power supply fault, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and stays down until the input voltage is turned off and on again.
Output over-current protection	electronically limited	see Fig. 5-1
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 2.5mm in diameter	e.g. screws, small parts
Over-temperature protection	not included	
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T3.15A H.B.C.	not user replaceable

*) In case of a protection event, audible noise may occur.

16. SAFETY FEATURES

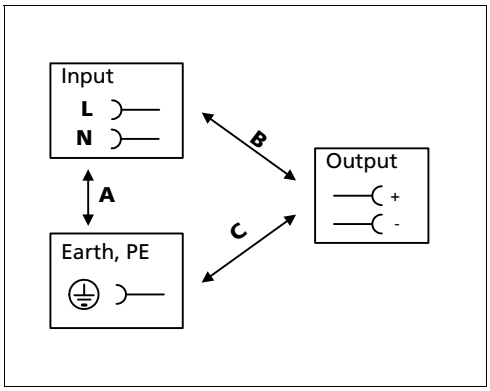
Input / output separation *)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
	II (with restrictions)	for use without PE connection contact PULS
Isolation resistance	> 5MOhm	Input to output, 500Vdc
Touch current (leakage current)	typ. 0.13mA / 0.29mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.19mA / 0.40mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.30mA / 0.63mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.17mA / 0.38mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.25mA / 0.53mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.41mA / 0.85mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

*) Double or reinforced insulation

17. 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. 17-1 **Dielectric strength**



		A	B	C
Type test	60s	2500Vac	4000Vac	2000Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Cut-off current setting		> 4mA	> 4mA	> 1mA at 500V > 4mA at 2000V

To fulfill 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 can not be switched off when unnoticed earth faults occur.

18. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive and the - Low-voltage directive (LVD). See Declaration of Conformity (DoC) for further information.
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL us LISTED IND. CONT. EQ.	Listed for the use as Industrial Control Equipment; E-File: E198865
UL 60950-1 2nd Edition	c UL us	Recognized for the use as Information Technology Equipment, Level 3 in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006
NEC Class 2	**NEC CLASS 2**	Listed as Limited Power Source (LPS) in the UL 60950-1 UL report. According to NEC (National Electrical Code) Article 725-41 (4).
Class I Div 2 ANSI / ISA 12.12.01-2000	c SA us Class I Div2	Recognized for use in Hazardous Location Class I Div 2 T4 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Marine	GL ABS	GL (Germanischer Lloyd) classified Environmental category: C, EMC1 Marine and offshore applications ABS (American Bureau for Shipping) PDA
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

19. ROHS, REACH AND OTHER FULFILLED STANDARDS

RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

20. PHYSICAL DIMENSIONS AND WEIGHT

Weight	250g / 0.55lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the unit depth (91mm) to calculate the total required installation depth.
Installation Clearances	See chapter 2

Fig. 20-1 **Front view**

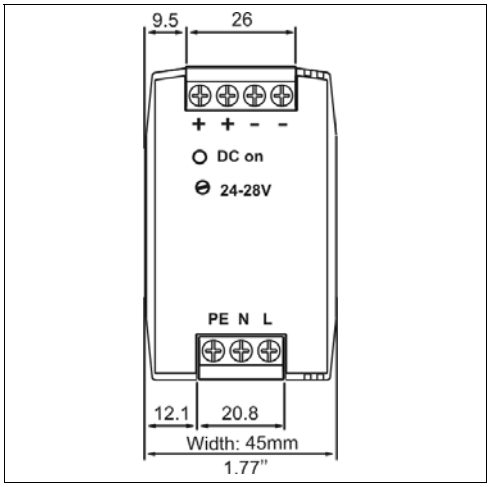
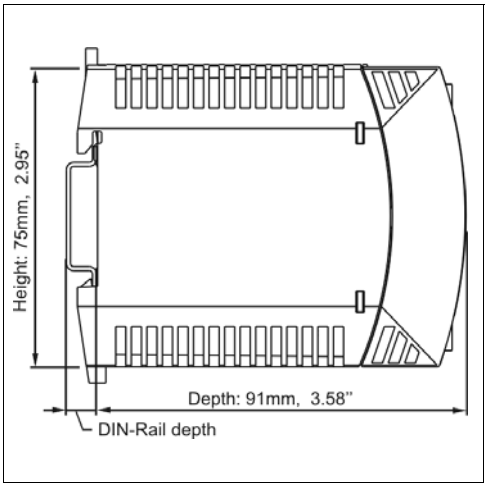


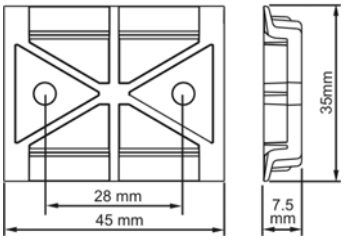
Fig. 20-2 **Side view**



21. ACCESSORY

21.1. ZM3.WALL – WALL MOUNT BRACKET

DIN-Rail bracket for wall or panel mount:

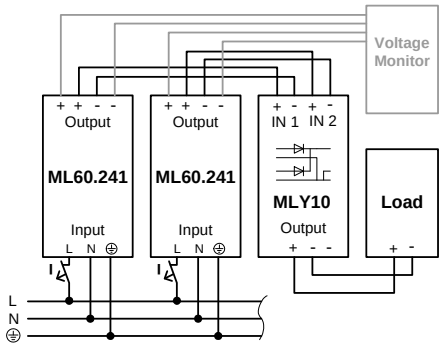


The picture of the power supply is for representation only

Hole diameter: 4.2mm

21.2. MLY10.241 - REDUNDANCY MODULE

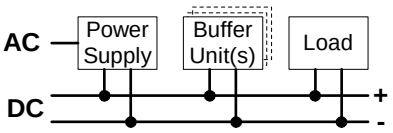
The MLY10.241 is a dual redundancy module, which has two diodes with a common cathode included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.



21.3. UF20.241 - BUFFER MODULE

This buffer unit is a supplementary device for DC 24V power supplies. It delivers power to bridge typical mains failures or extends the hold-up time after turn-off of the AC power. In times when the power supply provides sufficient voltages, the buffer module stores energy in integrated electrolytic capacitors. In case of mains voltage fault, this energy is released again in a regulated process. One buffer module can deliver 20A which can also be used to support peak current demands.

The buffer unit does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer units can be added in parallel to increase the output ampacity or the hold-up time.



22. APPLICATION NOTES

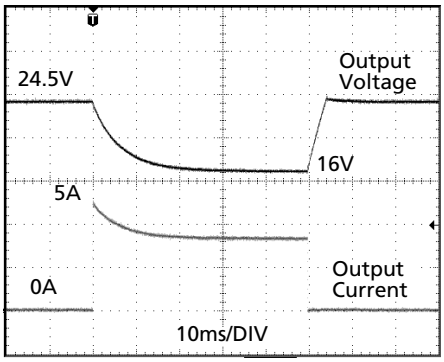
22.1. PEAK CURRENT CAPABILITY

Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady-state current and usually exceeds the nominal output current. The same situation applies when starting a motor or switching-on a capacitive load.

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

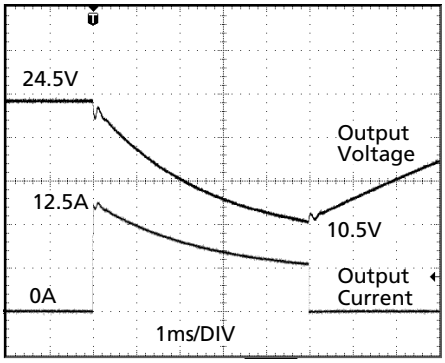
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-1 **Peak loading with 2x the nominal current for 50ms, typ.**



Peak load 5A (resistive load) for 50ms
Output voltage dips from 24V to 16V.

Fig. 22-2 **Peak loading with 5x the nominal current for 5ms, typ.**



Peak load 12.5A (resistive load) for 5ms
Output voltage dips from 24V to 10.5V.

22.2. 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 5.

22.3. CHARGING OF BATTERIES

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

Instructions for charging batteries (float charging):

a) Ensure that the ambient temperature of the power supply is below 45°C

b) Set output voltage (measured at no load and at the battery end of the 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

c) Use a 4A circuit breaker (or blocking diode) between the power supply and the battery.

d) Ensure that the output current of the power supply is below the allowed charging current of the battery.

e) Use only matched batteries when putting 12V types in series.

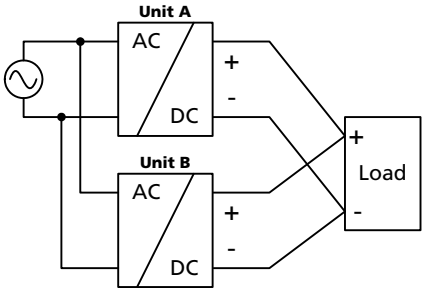
f) The return current to the power supply (battery discharge current) is typical 7.3mA when the power supply is switched off (except in case a blocking diode is utilized).

22.4. EXTERNAL INPUT PROTECTION

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

If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

22.5. PARALLEL USE TO INCREASE OUTPUT POWER



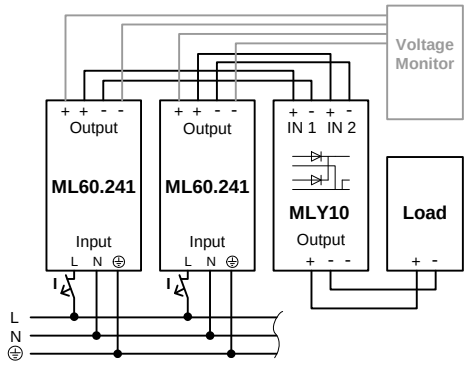
ML60.241 power supplies can be paralleled to increase the output power. This power supply has no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 45°C. The ML60.241 can also be paralleled with other power supplies from MiniLine series with 24V output voltage. The output voltages of all power supplies shall be adjusted to the same value (±100mV).

A fuse or diode on the output of each unit is only required if more than three units are connected in parallel. If a fuse (or circuit breaker) is used, choose one with approximately 150% of the rated output current of one power supply.

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 (input terminals on the bottom and output terminals on top of the unit).

Be aware that leakage current, EMI, inrush current and harmonics will increase when using multiple power supplies in parallel.

22.6. PARALLEL USE FOR REDUNDANCY



Power supplies 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. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five power supplies, each rated for 2.5A are paralleled to build a 10A redundant system.

Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module MLY10.241.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.

b) Use separate mains systems for each power supply whenever it is possible.

c) Monitor the individual power supply units.

d) 1+1 Redundancy is allowed up to an ambient temperature of 60°C.
N+1 Redundancy is allowed up to an ambient temperature of 45°C.

e) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.7. DAISY CHAINING OF OUTPUTS

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block.

Fig. 22-3 Daisy chaining of outputs

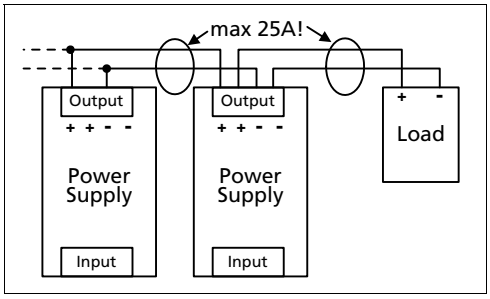
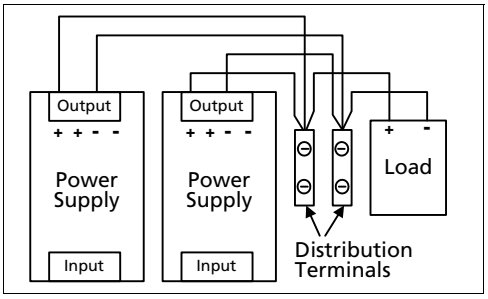


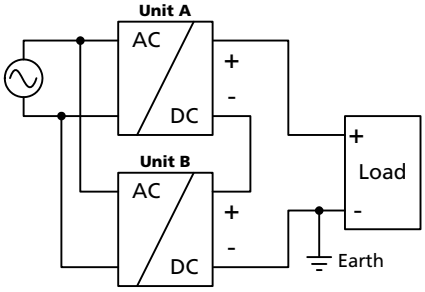
Fig. 22-4 Using distribution terminals



22.8. INDUCTIVE AND CAPACITIVE LOADS

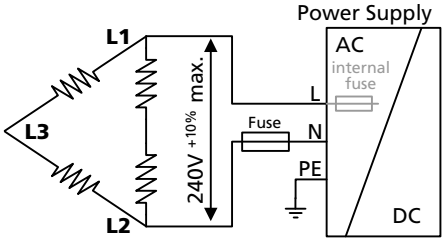
The unit is designed to supply any type of load, including unlimited capacitive and inductive loads.

22.9. SERIES OPERATION



Power supplies of the exact 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 any more 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 (input terminals on the bottom and output terminals on top of the unit). Be ware that leakage current, EMI, inrush current and harmonics will increase when using multiple power supplies series.

22.10. OPERATION ON TWO PHASES



The power supply can also be used on two-phases of a three-phase-system. A phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$. Use a fuse or a circuit breaker to protect the N input. The N input is not internally protected and is in this case connected to a hot wire. Appropriate fuses or circuit breakers are specified in section 22.4 “External Input Protection”.

22.11. USE WITHOUT PE ON THE INPUT

From a safety standpoint, the unit is internally designed according to the requirements for Protection Class 1 and 2. Please contact PULS if you do not plan to use the PE terminal. A different marking of the front foil is then required.

Grounding of the input is beneficial for a high EMI immunity: Symmetrical spikes or fast transients on the input side can be conducted directly to earth by the built-in filter capacitors. The magnitude of such spikes or fast transients on the output side caused by the input is much smaller compared to not connecting this terminal to ground.

Fig. 22-5 **Earthed input**

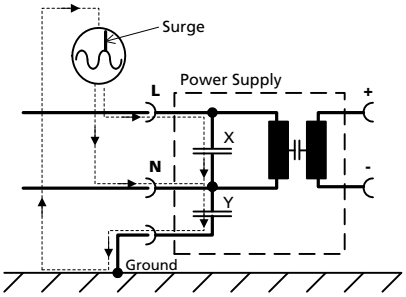
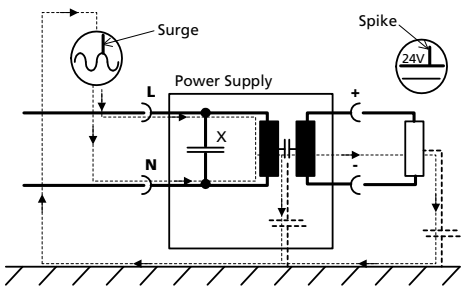


Fig. 22-6 **Not earthed input**



22.12. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box; no other heat producing items are inside the box.

Enclosure:	Rittal Type IP66 Box PK 9510 100, plastic, 130x130x75mm
Input:	230Vac

Case A:

Load:	24V, 2.5A; load is placed outside the box
Temperature inside the box:	40.1°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	21.9°C
Temperature rise:	18.2K

Case B:

Load:	24V, 2.0A; (=80%) load is placed outside the box
Temperature inside the box:	38.4°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	22.0°C
Temperature rise:	16.4K

22.13. 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 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. 22-7
Mounting Orientation A
(Standard orientation)

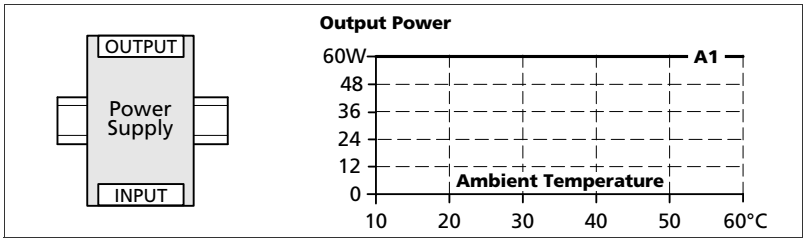


Fig. 22-8
Mounting Orientation B
(Upside down)

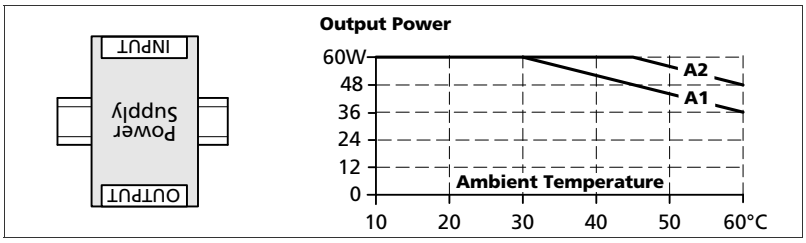


Fig. 22-9
Mounting Orientation C
(Table-top mounting)

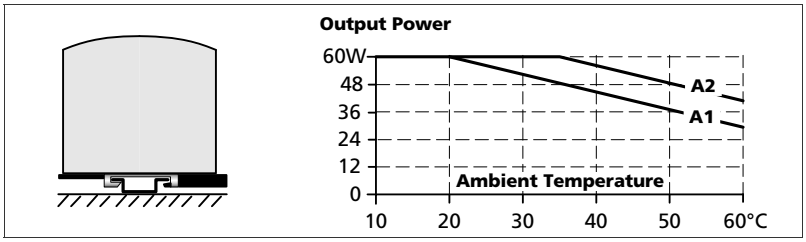


Fig. 22-10
Mounting Orientation D
(Horizontal cw)

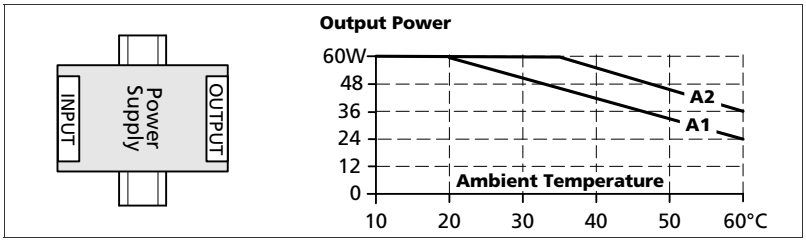
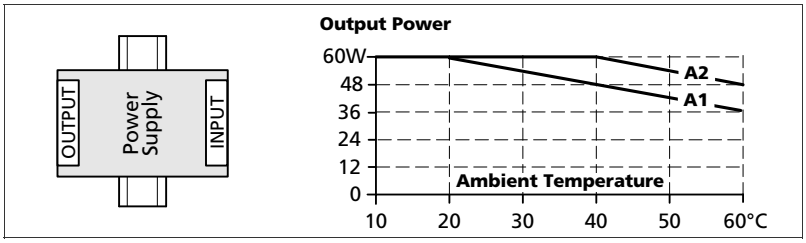


Fig. 22-11
Mounting Orientation E
(Horizontal ccw)



PULS does it again:
practical, versatile and reliable like the SilverLine – yet small like no other.

PULS

Data Sheet

MiniLine
with DC 48-56V / 100W

- Mounted and connected in record time, no tools required
- World-wide approvals (UL, EN, CSA, CB Scheme) for industry and office/ home
- Tiny: WxHxD = 73 x 75 x 103mm
- Adjustable output voltage up to DC 56V
- 115/230V Auto Select Input
- PULS Overload Design™ (high output overload capability)
- Selectable single/parallel operation (jumper)

PULS GmbH, Arabellastrasse 15, 81925 Munich
Tel. +49.(0)89.9278-244, Fax: +49.(0)89.9278-199
sales@puls-power.com, http://www.puls-power.com

Mini is more.

Technical Data ML100.105

Spring Clamps

Input

Input voltage	AC 100-120/220-240V (Auto Select), 47...63 Hz (AC 85...132V / AC 184...264V, DC 220...375V, N=⊕ and L=⊖)
Input current	<2.1A (@ AC 100V_{in}, 100W P_{out}) <1A (@ AC 220V_{in}, 100W P_{out})
External fusing	not required, unit provides internal fuse (T3A15H, not accessible)
Transient immunity	Transient resistance acc. to VDE 0160 / W2 (750V/ 1.3 ms), over entire load range
Hold-up time (see diagram below)	>40 ms @ AC 230V, 48V / 2.1A >20 ms @ AC 196V, 48V / 2.1A >20 ms @ AC 100V, 48V / 2.1A

Efficiency, Reliability

Efficiency	typ. 91% (AC 230V, 48V / 2.1A) (see also diagram below)
Losses	typ. 10W (AC 230V, 48V / 2.1A)
MTBF (Reliability)	appr. 500.000 h acc. to Siemensnorm SN 29500 48V / 2.1A, AC 230V, T_{amb} = +40 °C)

Prior to shipment, *every* unit undergoes the following tests in order to isolate any defective units which might suffer an early failure:
- Run-in / burn-in (Full load, T_{amb} = +60°C, on/off cycle)
- Functional test (100 %)

Construction, Mechanics, Installation

Robust plastic housing (US Patent No. D442, 923S), fine ventilation grid on three housing sides to keep out small parts (e.g. screws), IP20

Dimensions and weight	
• W x H x D	73 mm x 75 mm x 103 mm (+ DIN rail) Depth incl. terminals: 98 mm (+ DIN rail)
• Weight	360 g
Mounting orientation	, or (cf. 'Output')
Ventilation/Cooling	Normal convection, no fan required
• Free space f. cooling	recom'd.: 25mm on sides with ventilation grid

Easy snap-on mounting onto the DIN-rail (TS35/7,5 or TS35/15).
Unit sits safely and firmly on the rail; no tools required even to remove

Connection	by Spring Clamp terminals; uniformly firm hold, vibration-resistant and maintenance-free: 2 terminals per output
Connector size range	
• flexible cable	0.3-2.5mm² (28-12 AWG)
• solid cable	0.3-4mm² (28-12 AWG) Ferrules admissible
• Wire strip length	6mm (0.24in) recommended

Design details – for your advantage:
- All terminals are easy to reach as mounted on the front panel.
- Input and output are strictly apart from each other (input below, output above) and so cannot be mixed up.
- **Mounting *and* connection do not require any screwdriver**
- Easy, quick, durable and reliable installation

Output

Output voltage	DC 48-56V (adj. by front panel potentiometer)
• preset	48V ± 0.5% @ 2.1A
Voltage regulation	stat. <1% V_{out} (Jumper in pos. 'Single Use') stat. <3% V_{out} (Jumper in pos. 'Parallel Use'), dyn. ±1.5% V_{out} over all
Ripple/Noise	<50mV_{PP} (20 MHz bandw., 50 Ω measurem.)
Overvoltage prot. (OVP)	<60V
Rated continuous loading	up to 2.1A @ 48V / 1.8A @ 56V (convection cooling), depending on built-in orientation, V_{in} and T_{amb} For details see derating diagram below
Overload behaviour	**PULS Overload Design™:** No switch-off at overload/short-circuit, instead: up to 1.9 · I_{rated}. So you need no oversizing to start awkward loads.
Protection	Unit is protected against (also permanent) short-circuit, overload and open-circuit.
Derating	depending on built-in orientation; see diagram below
Parallel operation	yes (selectable by front panel jumper)
Power back immunity	63V
Operating indicator	Green LED

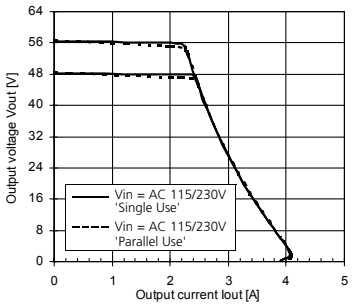
Environmental Data, EMC, Safety

Ambient temperature range (measured 25 mm below unit)	
• storage/transport	-25°C ... +85°C
• operation	-10°C ... +70°C (for derating see diagram below)
Humidity	max. 95% (without condensation)
Electromagnetic emissions (EME)	EN 61000-6-3 (includes EN 61000-6-4) Class B (EN 55011, EN 55022) EN 61000-3-2 (PFC)
Electromagnetic immunity (EMI)	EN 61000-6-2 (includes EN 61000-6-1)
Safe low voltage: Prot. class/degree:	SELV (EN 60950, VDE0100/T.410), PELV (EN 50178) Class 1 (EN 60950) / IP20 (EN 60529)

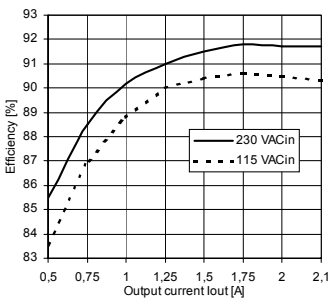
This unit fulfills all major **safety approvals** for EU (EN 60 950, EN 60204-1, EN 50178), USA (UL 60950, E137006, UL508 LISTED, E198865), Canada (CAN/CSA-C22.2 No 60950 [CUR], CAN/CSA-C22.2 No. 14 [CUL]), CB Scheme (IEC 60950).

Diagrams

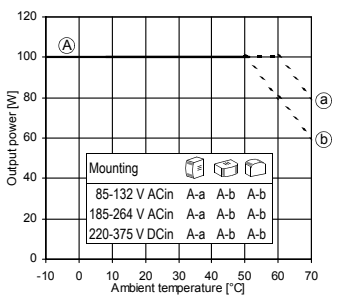
Output characteristic V_{out}/I_{out} (min.)



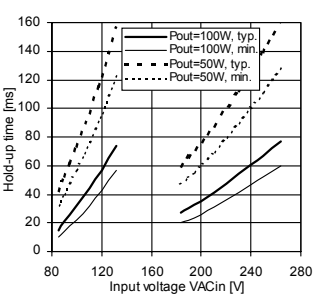
Efficiency (@ V_{out} = 48V, typ.)



Derating of output power



Hold-up time with ACin (at V_{out} = 48V, typ. + min.)



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PULS

PIANO-Series

PIC120.241D

24V, 5A, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-120V / 200-240V Auto-Select Input
- Cost Optimized without Compromising Quality or Reliability.
- Width only 39mm
- Efficiency up to 92.3%
- Full Power Between -10°C and +55°C
- DC-OK Relay Contact Included
- 3 Year Warranty

GENERAL DESCRIPTION

These PIANO series units are extraordinarily compact, industrial grade power supplies that focus on the essential features needed in today's industrial applications. The excellent cost/performance ratio presents many new and exciting opportunities without compromising quality or reliability.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits the units to be used in surrounding temperatures up to 70°C.

The unit is equipped with a auto-select input voltage stage, which makes the unit suitable for global use.

The addition of a DC-OK signal makes the unit suitable for many industry applications such as: process, automation and many other critical applications where preventive function monitoring can help to avoid long downtimes.

SHORT-FORM DATA

Output voltage	DC 24V	
	24 - 28Vdc	Adjustment range
Output	for AC 110-120 / 220-240V mains:	
	5.0 - 4.3A	at 24-28V, <55°C
	3.1 - 2.7A	at 24-28V, <70°C
	for AC 100 / 200V mains:	
	5.0 - 4.3A	at 24-28V, <50°C
	2.5 - 2.1A	at 24-28V, <70°C
Output ripple	< 100mVpp	20Hz to 20MHz
AC Input voltage	AC 100-120V / 200-240V	±10% Auto-Select
Mains frequency	50-60Hz	±6%
AC Input current	1.72A / 1.05A	at 120/ 230Vac
Power factor	0.64 / 0.54	at 120/ 230Vac
AC Inrush current	22A / 33A peak	at 120/ 230Vac, 40°C
Efficiency	91.2% / 92.3%	at 120/ 230Vac
Losses	11.6W / 10.0W	at 120/ 230Vac
Temp. range	-10°C to +70°C	operational
Derating	3W/°C	+55 to +70°C *)
Hold-up time	51ms / 50ms	at 120/ 230Vac
Dimensions	39x124x124mm	WxHxD
Weight	370g / 0.81lb	

*) +50 to +70°C for AC 100V / 200V mains

ORDER NUMBERS

Power Supply	**PIC120.241D**	24-28V Unit
Accessory	YR2.DIODE	Redundancy module
	UF20.241	Buffer Module

MARKINGS

c UL US LISTED
IND. CONT. EQ.
UL 508

c TÜV US
UL 60950-1

CE
EMC, LVD

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz mains frequency. AC 120V parameters are valid for 60Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general professional use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

2. 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.

Mount the unit on a DIN-rail so that the input terminals are located on the bottom of the unit.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 15%!

Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).

A disconnecting means shall be provided for the output of the power supplies when used in applications according to CSA C22.2 No 107.1-01.

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit 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 surfaces may cause burns.

3. AC-INPUT

AC input	nom.	AC 100-120V / 200-240V	Auto-select, suitable for TN-, TT- and IT mains networks
AC input range	min.	90-132Vac / 180- 264Vac	continuous operation
	min.	264-300Vac	< 500ms
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
External input protection	See recommendations in chapter 23.3.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	2.0A	1.72A	1.05A	at 24V, 5A, see Fig. 3-3
Power factor*)	typ.	0.66	0.64	0.54	at 24V, 5A, see Fig. 3-4
Crest factor**)	typ.	2.7	2.8	3.4	at 24V, 5A
Turn-on voltage	typ.	78Vac	78Vac	157Vac	at 24V 0A, steady-state value, see Fig. 3-1
Shut-down voltage	typ.	68Vac	68Vac	68Vac	at 24V 5A, steady-state value, see Fig. 3-1
Start-up delay	typ.	400ms	400ms	100ms	see Fig. 3-2
Rise time	typ.	30ms	30ms	30ms	at 24V, 5A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	90ms	90ms	90ms	at 24V, 5A const. current load, 5mF load capacitance,, see Fig. 3-2
Turn-on overshoot	max.	200mV	200mV	200mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 3-1 **Input voltage range, typ.**

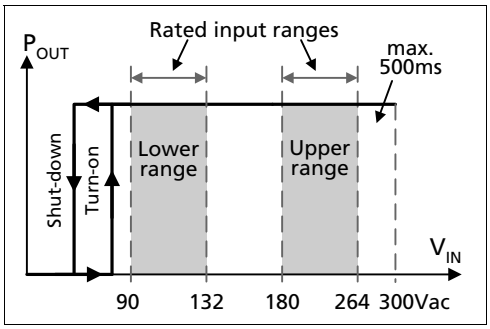


Fig. 3-2 **Turn-on behavior, definitions**

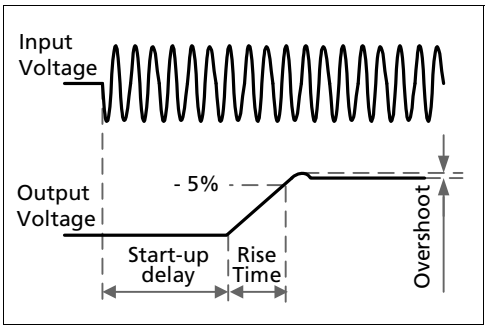


Fig. 3-3 **Input current vs. output load at 24V**

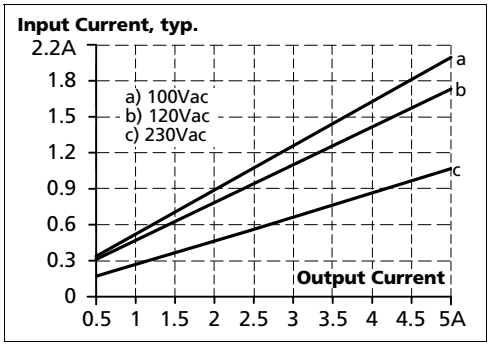
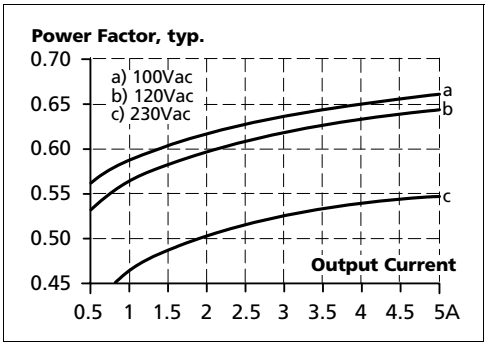


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not operate this power supply with DC-input voltage.

5. INPUT INRUSH CURRENT

A NTC inrush limiter limits the input inrush current after turn-on of the input voltage.

		AC 100V	AC 120V	AC 230V	
Inrush current*)	max.	$23A_{peak}$	$27A_{peak}$	$40A_{peak}$	40°C ambient, cold start
	typ.	$18A_{peak}$	$22A_{peak}$	$33A_{peak}$	40°C ambient, cold start
	typ.	$13A_{peak}$	$16A_{peak}$	$30A_{peak}$	25°C ambient, cold start
Inrush energy*)	max.	$0.4A^2s$	$0.5A^2s$	$1.5A^2s$	40°C ambient, cold start

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

Fig. 5-1 **Input inrush current, typical behavior**
230Vac input, 24V 5A output, 40°C ambient

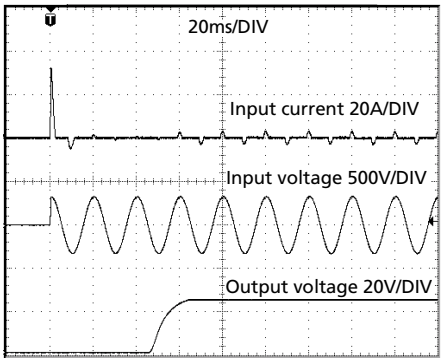
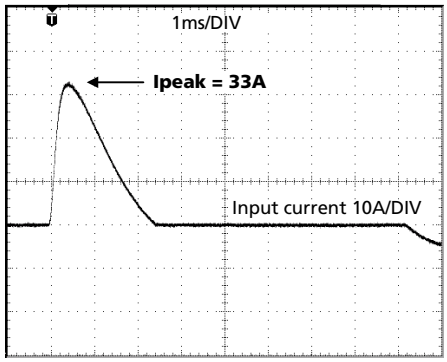


Fig. 5-2 **Input inrush current, zoom into first peak**
230Vac input, 24V 5A output, 40°C ambient



6. OUTPUT

Output voltage	nom.	DC 24V	
Adjustment range	min.	24-28V	guaranteed
	max.	30V**)	at clockwise end position of potentiometer
Factory settings	typ.	24.1V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	90-132 / 180-264Vac
Load regulation	max.	150mV	static value, 0A → 5A → 0A
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	for AC 110-120 / 220-240V mains voltages (includes AC 208V mains):		
	nom.	5A	at 24V, below +55°C ambient temperature
	nom.	4.3A	at 28V, below +55°C ambient temperature
	nom.	3.1A	at 24V, at +70°C ambient temperature
	nom.	2.7A	at 28V, at +70°C ambient temperature
			Derate linearly between +55°C and +70°C
	for AC 100 / 200V mains voltages:		
	nom.	5A	at 24V, below +50°C ambient temperature
	nom.	4.3A	at 28V, below +50°C ambient temperature
	nom.	2.5A	at 24V, at +70°C ambient temperature
	nom.	2.1A	at 28V, at +70°C ambient temperature
			Derate linearly between +50°C and +70°C
Overload behaviour		continuous current	output voltage > 10Vdc, see Fig. 6-1
		Intermittent	output voltage < 10Vdc, see Fig. 6-1
Short-circuit current	typ.	3.5A*)	average (R.M.S.) current, load impedance 50mOhm
Output capacitance	typ.	2 050µF	included inside the power supply

*) 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. 6-1 **Output voltage vs. output current, RMS current, typ.**

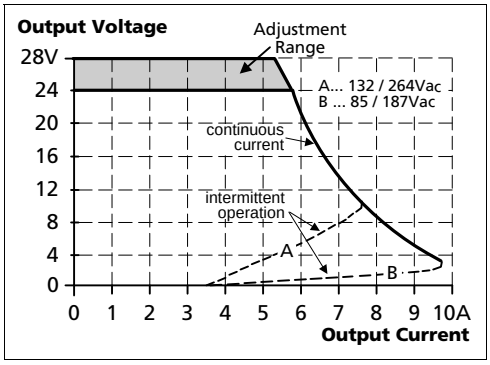
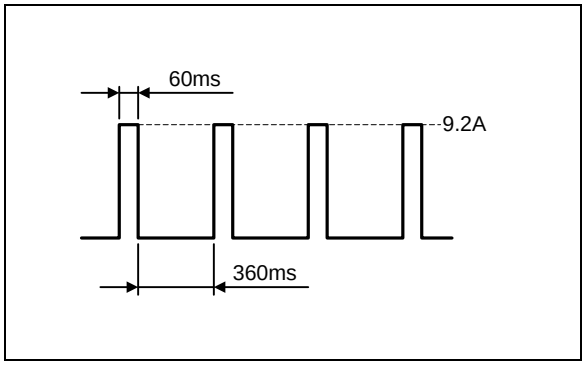


Fig. 6-2 **Intermittent operation at shorted output, typ.**



7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	64ms	108ms	105ms	at 24V, 2.5A, see Fig. 7-1
	min.	54ms	91ms	88ms	at 24V, 2.5A, see Fig. 7-1
	typ.	26ms	51ms	50ms	at 24V, 5A, see Fig. 7-1
	min.	22ms	43ms	42ms	at 24V, 5A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

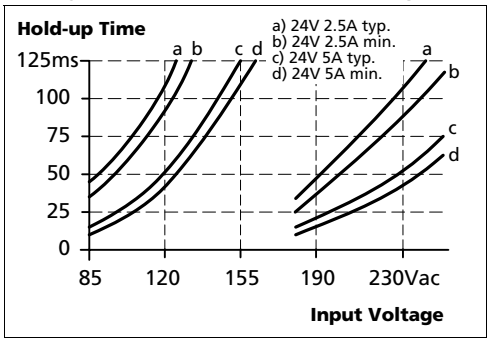
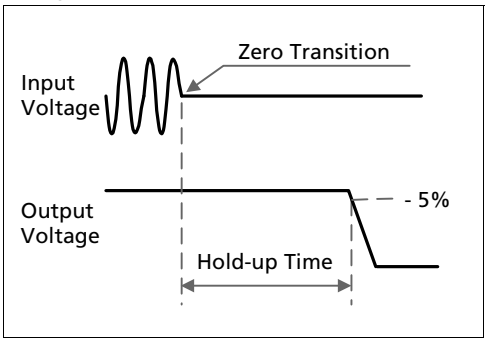


Fig. 7-2 **Shut-down behavior, definitions**

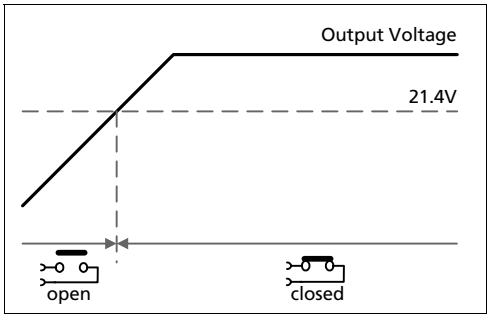


8. DC-OK RELAY CONTACT

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 (e.g. redundant application).

Contact closes	As soon as the output voltage reaches 21.4V.		
Contact opens	As soon as the output voltage dips below 21.4V.		
Contact ratings	max.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min.	1mA at 5Vdc	minimum required load
Isolation voltage	See dielectric strength table in section 18.		

Fig. 8-1 **DC-ok relay contact behavior**



9. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	90.7%	91.2%	92.3%	at 24V, 5A
Average efficiency*)	typ.	89.2%	89.4%	90.6%	25% at 1.25A, 25% at 2.5A, 25% at 3.75A. 25% at 5A
Power losses	typ.	1.4W	1.5W	0.7W	at 24V, 0A
	typ.	7.0W	7.4W	6.0W	at 24V, 2.5A
	typ.	12.3W	11.6W	10.0W	at 24V, 5A

*) 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. 9-1 **Efficiency vs. output current at 24V, typ.**

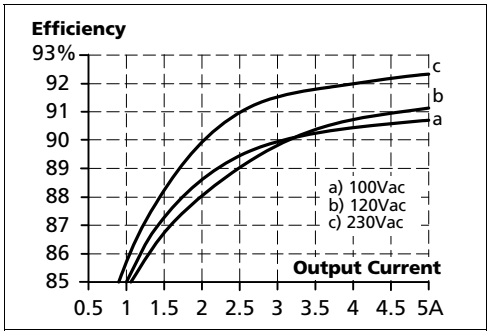


Fig. 9-2 **Losses vs. output current at 24V, typ.**

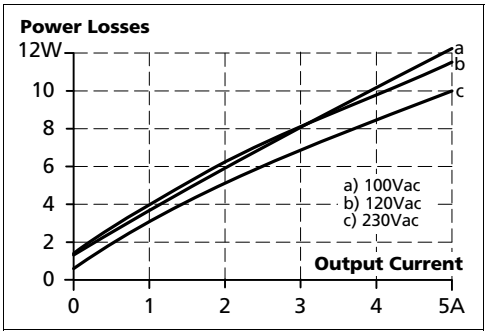


Fig. 9-3 **Efficiency vs. input voltage at 24V, 5A, typ.**

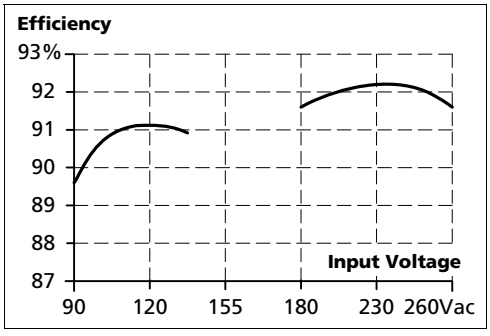
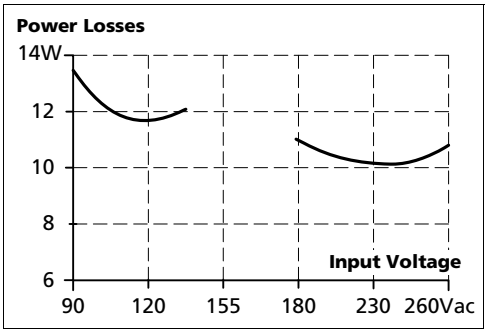


Fig. 9-4 **Losses vs. input voltage at 24V, 5A, typ.**



10. LIFETIME EXPECTANCY AND MTBF

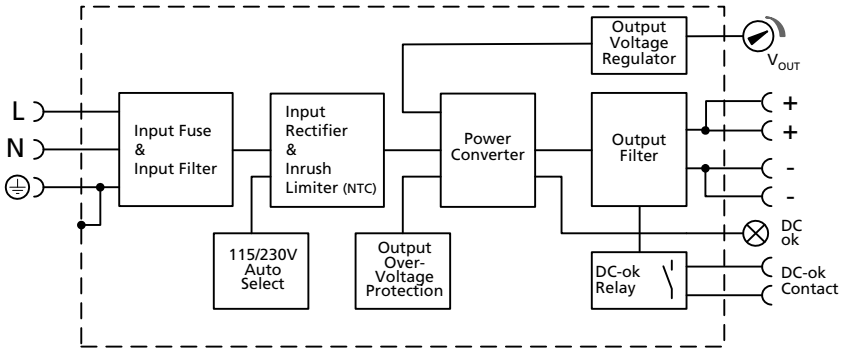
	AC 100V	AC 120V	AC 230V	
Lifetime expectancy*)	181 000h*)	194 000h*)	219 000h*)	at 24V, 2.5A and 40°C
	511 000h*)	548 000h*)	621 000h*)	at 24V, 2.5A and 25°C
	66 000h	68 000h	83 000h	at 24V, 5A and 40°C
	188 000h*)	193 000h*)	234 000h*)	at 24V, 5A and 25°C
MTBF**) SN 29500, IEC 61709	1 065 000h	1 147 000h	1 379 000h	at 24V, 5A and 40°C
	2 038 000h	2 166 000h	2 519 000h	at 24V, 5A and 25°C
MTBF**) MIL HDBK 217F	681 000h	651 000h	645 000h	at 24V, 5A and 40°C; Ground Benign GB40
	872 000h	842 000h	839 000h	at 24V, 5A and 25°C; Ground Benign GB25
	165 000h	164 000h	168 000h	at 24V, 5A and 40°C; Ground Fixed GF40
	206 000h	205 000h	211 000h	at 24V, 5A and 25°C; Ground Fixed GF25

*) The **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.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

11. FUNCTIONAL DIAGRAM

Fig. 11-1 **Functional diagram**



12. TERMINALS AND WIRING

The terminals are IP20 finger safe constructed and suitable for field- and factory wiring.

	Input and output	**DC-OK-Signal**
Type	screw terminals	push-in terminals
Solid wire	max. 6mm²	max. 1.5mm²
Stranded wire	max. 4mm²	max. 1.5mm²
American Wire Gauge	AWG20-10	AWG28-16
Max. wire diameter	2.8mm (including ferrules)	1.6mm (including ferrules)
Wire stripping length	7mm / 0.28inch	7mm / 0.28inch
Screwdriver	3.5mm slotted or cross-head No 2	not required
Recommended tightening torque	1Nm, 9lb.in	not applicable

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
75°C for ambient up to 55°C minimum and
90°C for ambient up to 70°C minimum.
b) Follow national installation codes and installation regulations!
c) Ensure that all strands of a stranded wire enter the terminal connection!
d) Do not use the unit without PE connection.
e) Unused terminal compartments should be securely tightened.
f) Ferrules are allowed.

13. FRONT SIDE AND USER ELEMENTS

Fig. 13-1 **Front side**

A **Input Terminals** (screw terminals)
- **N, L** Line input
- ⏚ PE (Protective Earth) input

B **Output Terminals** (screw terminals, two pins per pole)
- **+** Positive output
- **–** Negative (return) output

C **Output voltage potentiometer**
Guaranteed adjustment range: 24-28V
Factory set: 24.1V

D **DC-OK LED** (green)
On, when the output voltage is >18V

E **DC-OK Relay Contact** (push-in terminals)
Description see chapter 8.

14. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment. A detailed EMC report is available on request.

EMC Immunity	According generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	contact discharge air discharge	8kV 8kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	20V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines output lines DC-OK signal (coupling clamp)	4kV 2kV 2kV	Criterion A Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N L → PE, N → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	500V 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	20V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A *) Criterion A Criterion C Criterion A
Voltage interruptions	EN 61000-4-11	0% of 220Vac (=0V)	5000ms	Criterion C
Voltage sags	SEMI F47 0706	dips on the input voltage according to SEMI F47 standard		
		80% of 208Vac (166Vac) 70% of 208Vac (146Vac) 50% of 208Vac (104Vac) 80% of 120Vac (96Vac) 70% of 120Vac (84Vac) 50% of 120Vac (60Vac)	1000ms 500ms 200ms 1000ms 500ms 200ms	Criterion A Criterion A Criterion C Criterion A Criterion A Criterion C
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion A

Criterions:

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

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

*) below 4.5A, Criterion C for currents > 5A

EMC Emission	According generic standards: EN 61000-6-3, EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B
Conducted emission output lines**)	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	limits for DC power port according EN 61000-6-3 not fulfilled
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	fulfilled for class A equipment
Voltage fluctuations, flicker	EN 61000-3-3	fulfilled*)

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.

*) tested with constant current loads, non pulsing

**) for information only, not mandatory for EN 61000-6-3

Switching frequency		
Main converter	40kHz to 120kHz	for load current range between 1A - 5A

15. ENVIRONMENT

Operational temperature*)	-10°C to +70°C (14°F to 158°F)	reduce output power according Fig. 15-1
Storage temperature	-40°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	3W/°C (55°C to 70°C; 131°F to 158°F) 3W/°C (50°C to 70°C; 122°F to 158°F)	for AC 110-120 / 220-240V mains systems****) for AC 100 / 200V mains systems****)
Humidity**)	5 to 95% r.h.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g***) 2 hours / axis***)	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms***) 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature, see Fig. 15-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	7.5W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 15-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) 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
***) Tested on a DIN-Rail with a thickness of 1.3mm.
****) For AC 208V mains use AC 200-220V values.

Fig. 15-1 **Output current vs. ambient temp.**

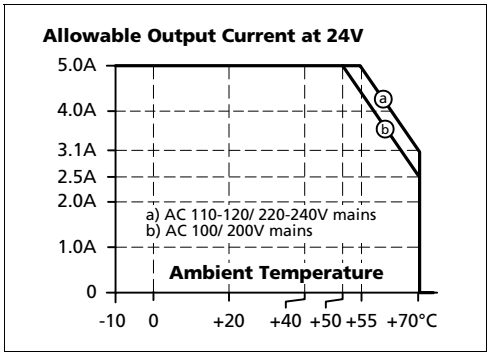
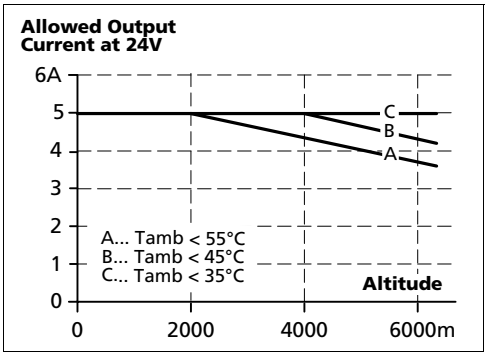


Fig. 15-2 **Output current vs. altitude**



16. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits*)	
Output over-voltage protection	typ. 31Vdc max. 34Vdc	In case of an internal power supply defect, a redundant circuit limits the maximum output voltage. In such a case, the output shuts down and stays down until the input voltage is turned off and on again for at least one minute or until the green LED went off.
Degree of protection	IP 20	EN/IEC 60529 Caution: For use in a controlled environment according to CSA 22.2 No 107.1-01.
Over-temperature protection	no	
Input transient protection	MOV (Metal Oxide Varistor)	
Internal input fuse	included	not user replaceable

*) In case of a protection event or in a low-load condition, audible noise may occur.

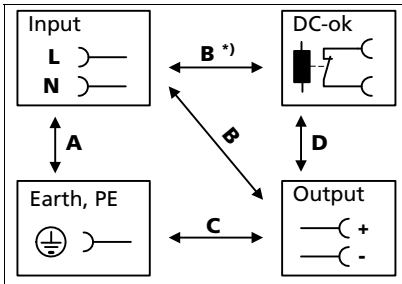
17. SAFETY FEATURES

Input / output separation	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
	double or reinforced insulation	
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 100MOhm	input to output, 500Vdc
Touch current (leakage current)	typ. 0.21mA / 0.46mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.30mA / 0.65mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.33mA / 0.72mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.27mA / 0.56mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.38mA / 0.78mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.43mA / 0.90mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

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 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.

Fig. 18-1 **Dielectric strength**



B*) When testing input to DC-OK ensure that the max. 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	1000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 10mA	> 10mA	> 15mA	> 1mA

To fulfil the PELV requirements according to EN60204-1 § 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 can not be switched off when unnoticed earth faults occur.

19. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive 2004/108/EC and the - Low-voltage directive (LVD) 2006/95/EC
IEC 60950-1 2nd Edition, planned	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 60950-1 2nd Edition, planned	c US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
UL 508, planned	c UL US LISTED IND. CONT. EQ.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
EAC TR Registration	EAC	Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

20. ROHS, REACH AND OTHER FULFILLED STANDARDS

RoHS Directive	RoHS ✓	Directive 2011/65/EU of the European Parliament and the Council of June 8th, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.
REACH Directive	REACH ✓	Directive 1907/2006/EU of the European Parliament and the Council of June 1st, 2007 regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	39mm 1.54''
Height	124mm 4.88''
Depth	124mm 4.88'' The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	370g / 0.81lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Plastic Material of Housing	Flame retardant Polycarbonate (PC) - UL94-V0 Vicat softening temperature specified with 149°C according to ASTM D1525
Installation Clearances	See chapter 2

Fig. 21-1 **Front view**

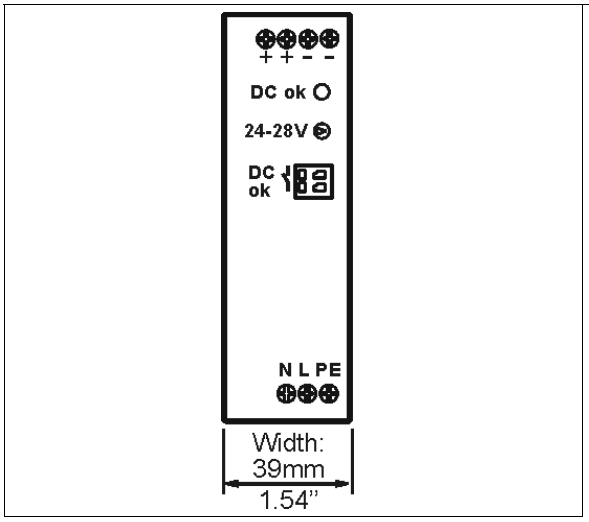
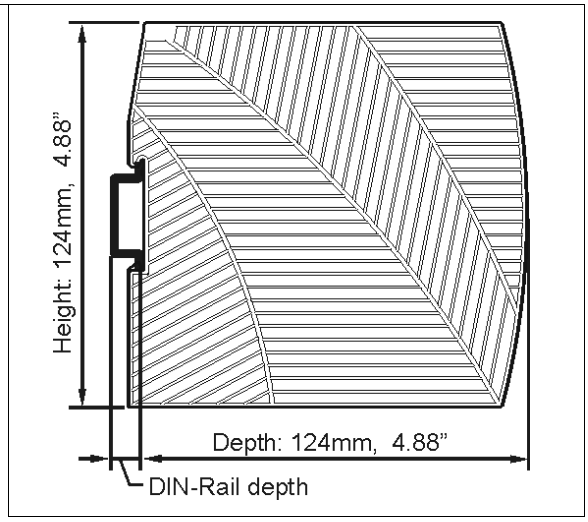


Fig. 21-2 **Side view**

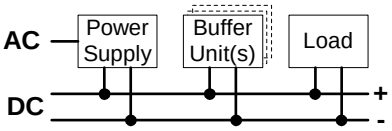


22. ACCESSORY

22.1. UF20.241 BUFFER MODULE

This buffer unit is a supplementary device for DC 24V power supplies. It delivers power to bridge typical mains failures or extends the hold-up time after turn-off of the AC power. In times when the power supply provides sufficient voltages, the buffer module stores energy in integrated electrolytic capacitors. In case of mains voltage fault, this energy is released again in a regulated process. One buffer module can deliver 20A which can also be used to support peak current demands.

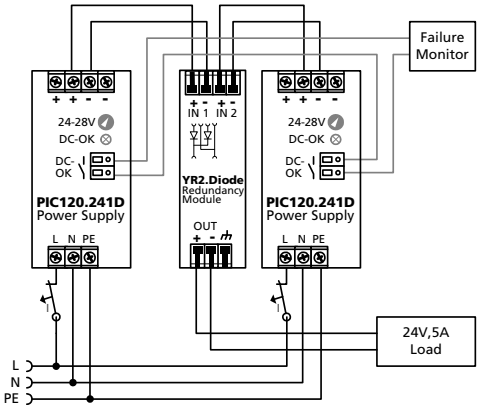
The buffer unit does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer units can be added in parallel to increase the output ampacity or the hold-up time.



22.2. YR2.DIODE REDUNDANCY MODULE

The YR2.DIODE is a dual redundancy module, which has two diodes with a common cathode included. It can be used for various purposes. The most popular application is to configure highly reliable and true redundant power supply systems. Another interesting application is the separation of sensitive loads from non-sensitive loads. This avoids the distortion of the power quality for the sensitive loads which can cause controller failures.

See chapter 23.5 for instructions how to build a redundant system.



23. APPLICATION NOTES

23.1. PEAK CURRENT CAPABILITY

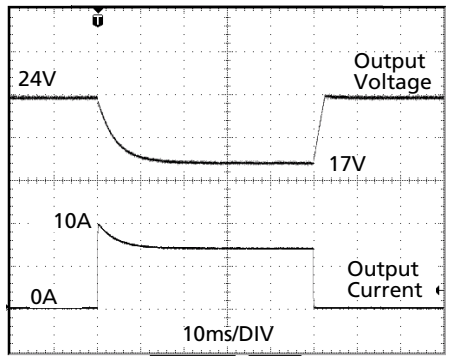
The unit can deliver peak currents (up to several milliseconds) which are higher than the specified short term currents.

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 nominal 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 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.

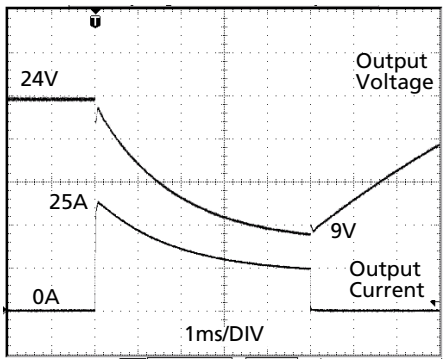
The extra current (peak current) is supplied by the power converter and the built-in large sized output capacitors of the power supply. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 23-1 **Peak load with 2x the nominal current for 50ms, typ.**



10A Peak load (resistive) for 50ms
Output voltage dips from 24V to 17V.

Fig. 23-2 **Peak load with 5x the nominal current for 5ms, typ.**



25A Peak load (resistive) for 5ms
Output voltage dips from 24V to 9V.

Peak current voltage dips	typ.	from 24V to 17V	at 10A for 50ms, resistive load
	typ.	from 24V to 13V	at 25A for 2ms, resistive load
	typ.	from 24V to 9V	at 25A for 5ms, resistive load

23.2. 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 6.

23.3. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 30A (UL) and 32A (IEC). An external protection is only required if the supplying branch has an ampacity greater than this. Check also local codes and local requirements. In some countries local regulations might apply.

If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

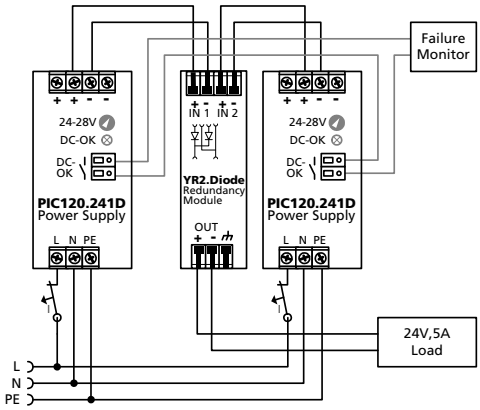
23.4. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.5. PARALLEL USE FOR REDUNDANCY

Power supplies 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 defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module YR2.DIODE.



Recommendations for building redundant power systems:

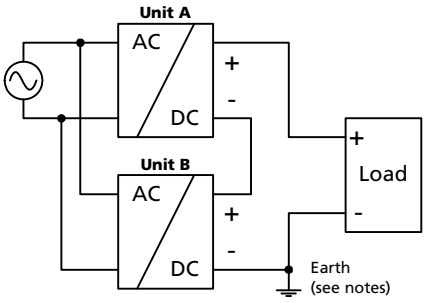
a) Use the DC-OK signal contact to monitor the individual power supply units.

b) Use separate input fuses for each power supply.

c) Use separate mains systems for each power supply whenever it is possible.

d) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

23.6. 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 any more 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.

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

23.7. INDUCTIVE AND CAPACITIVE LOADS

No limitations for inductive loads

No limitations for capacitive loads in combination with an additional resistive type of load.

Limitations apply for capacitive loads in combination with constant current type of loads:

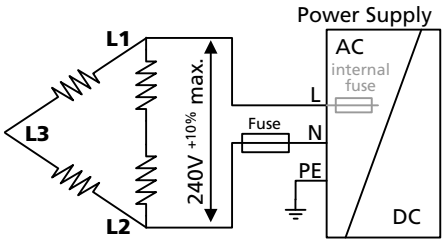
- max. 20mF with an additional 2.5A constant current load and
- max. 10mFwith an additional 5A constant current load.

23.8. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.9. OPERATION ON TWO PHASES

The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+10\%}$.



23.10. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box; no other heat producing items are inside the box.

Enclosure:	Rittal Type IP66 Box PK 9516 100, plastic, 110x180x165mm
Input:	230Vac

Case A:

Load:	24V, 5A; load is placed outside the box
Temperature inside the box:	41.5°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	24.4°C
Temperature rise:	17.1K

Case B:

Load:	24V, 4A; (=80%) load is placed outside the box
Temperature inside the box:	38.9°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	24.2°C
Temperature rise:	14.5K

PULS

DIMENSION **Q-Series**

QS20.481

48V, 10A, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-240V Wide-range Input
- Width only 82mm
- Efficiency up to 94.3%
- 150% (720W) Peak Load Capability
- Safe Hiccup^{PLUS} Overload Mode
- Easy Fuse Tripping due to High Overload Current
- Active Power Factor Correction (PFC)
- Negligible low Inrush Current Surge
- Short-term Operation down to 60Vac and up to 300Vac
- Full Power Between -25°C and +60°C
- DC-OK Relay Contact
- Quick-connect Spring-clamp Terminals
- 3 Year Warranty

GENERAL DESCRIPTION

The most outstanding features of this Dimension Q-Series DIN-rail power supply are the high efficiency and the small size, which are achieved by a synchronous rectification and further novel design details.

With short-term peak power capability of 150% and built-in large sized output capacitors, these features help start motors, charge capacitors and absorb reverse energy and often allow a unit of a lower wattage class to be used.

High immunity to transients and power surges as well as low electromagnetic emission makes usage in nearly every environment possible.

The integrated output power manager, a wide range input voltage design and virtually no input inrush current make installation and usage simple. Diagnostics are easy due to the dry DC-ok contact, a green DC-ok LED and red overload LED.

Unique quick-connect spring-clamp terminals allow a safe and fast installation and a large international approval package for a variety of applications makes this unit suitable for nearly every situation.

SHORT-FORM DATA

Output voltage Adjustment range	DC 48V 48 - 55V	
Output current	10 – 8.7A 15 – 13.1A	continuous for typ. 4s
Output power	480W 720W	continuous for typ. 4s
Output ripple	< 100mVpp	20Hz to 20MHz
Input voltage Mains frequency AC Input current Power factor AC Inrush current	AC 100-240V 50-60Hz 4.56 / 2.48A 0.95 / 0.90 typ. 9 / 7A peak	±15% ±6% at 120 / 230Vac at 120 / 230Vac at 120 / 230Vac
Efficiency Losses	92.8 / 94.3% 37.2 / 29.0W	at 120 / 230Vac at 120 / 230Vac
Temperature range Derating	-25°C to +70°C 12W/°C	operational +60 to +70°C
Hold-up time	typ. 32 / 51ms	at 120 / 230Vac
Dimensions	82x124x127mm	WxHxD

ORDER NUMBERS

Power Supply	**QS20.481**	48-55V Standard unit
Accessory	ZM2.WALL	Wall mount bracket
	ZM15.SIDE	Side mount bracket
	YR40.482	Redundancy module

MARKINGS

c UL US LISTED IND. CONT. EQ.
UL 508

c UL US
UL 60950-1

GL
Marine

c SP US
Class I Div 2

CE
EMC, LVD, RoHS

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
AC 230V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
230Vac	A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.
50Hz vs. 60Hz	As long as not otherwise stated, AC 230V parameters are valid at 50Hz mains frequency.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	A key word indicating flexibility of choice with a strongly preferred implementation.

1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general use such as in industrial control, office, communication, and instrumentation equipment.

Do not use this power supply in equipment, where malfunction may cause severe personal injury or threaten human life.

This device is designed for use in hazardous, non-hazardous, ordinary or unclassified locations.

2. 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.

Mount the unit on a DIN-rail so that the output terminals are located on the top and the input terminals are located on the bottom of the unit. For other mounting orientations see de-rating requirements in this document. See chapter 22.13.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 30%!

Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).

A disconnecting means shall be provided for the output of the power supplies when used in applications according to CSA C22.2 No 107.1-01.

⚠ WARNING Risk of electrical shock, fire, personal injury or death.

- Do not use the power supply without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit 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 surfaces may cause burns.

Notes for use in hazardous location areas:

The power supply is suitable for use in Class I Division 2 Groups A, B, C, D locations.

WARNING EXPLOSION HAZARDS!

Substitution of components may impair suitability for this environment. Do not disconnect the unit or operate the voltage adjustment unless power has been switched off or the area is known to be non-hazardous.

A suitable enclosure must be provided for the end product which has a minimum protection of IP54 and fulfils the requirements of the EN 60079-15.

3. AC-INPUT

AC input	nom.	AC 100-240V	suitable for TN-, TT- and IT mains networks
AC input range	min.	85-276Vac	continuous operation
	min.	60-85Vac	full power for 200ms, no damage between 0 and 85Vac
	min.	276-300Vac	< 500ms
Allowed voltage L or N to earth	max.	276Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	77Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	73Vac	steady-state value, see Fig. 3-1
	typ.	53Vac	dynamic value

		AC 100V	AC 120V	AC 230V	
Input current	typ.	5.47A	4.56A	2.48A	at 48V, 10A, see Fig. 3-3
Power factor *)	typ.	0.96	0.95	0.90	at 48V, 10A, see Fig. 3-4
Crest factor **)	typ.	1.6	1.7	2.05	at 48V, 10A
Start-up delay	typ.	640ms	610ms	660ms	see Fig. 3-2
Rise time	typ.	80ms	80ms	80ms	0mF, 48V, 10A, see Fig. 3-2
	typ.	100ms	100ms	100ms	10mF, 48V, 10A, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	see Fig. 3-2

*) The power factor is the ratio of the true (or real) power to the apparent power in an AC circuit.
**) The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.

Fig. 3-1 **Input voltage range**

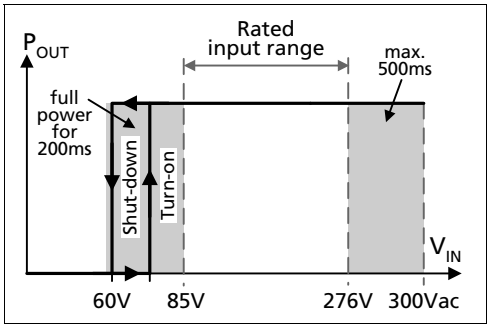


Fig. 3-2 **Turn-on behavior, definitions**

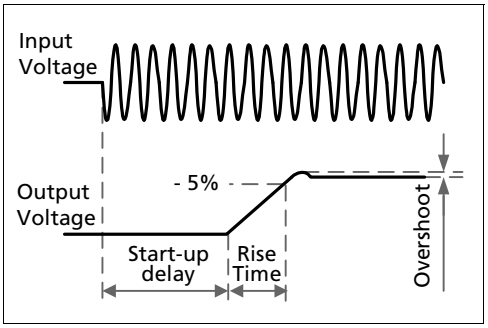


Fig. 3-3 **Input current vs. output load at 48V**

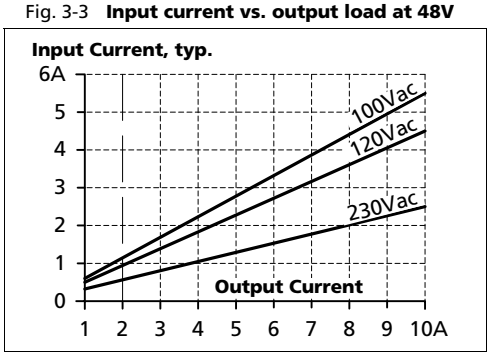
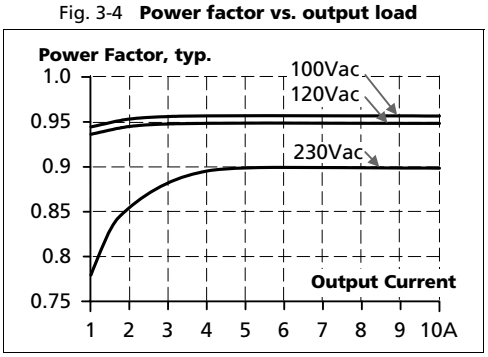


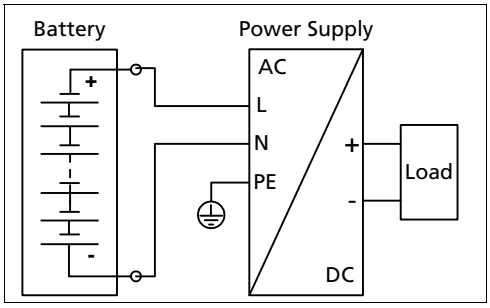
Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

DC input	nom.	DC 110-150V	-20%/+25%
DC input range	min.	88-187Vdc	
DC input current	typ.	4.6A	110Vdc, at 48V, 10A
Allowed Voltage L/N to Earth	max.	375Vdc	IEC 62103
Turn-on voltage	typ.	74Vdc	steady state value
Shut-down voltage	typ.	69Vdc	steady state value

Fig. 4-1 **Wiring for DC Input**



Instructions for DC use:

a) Use a battery or similar DC source.
   For other sources contact PULS
b) Connect +pole to L and –pole to N.
c) Connect the PE terminal to an earth wire or to the machine ground.

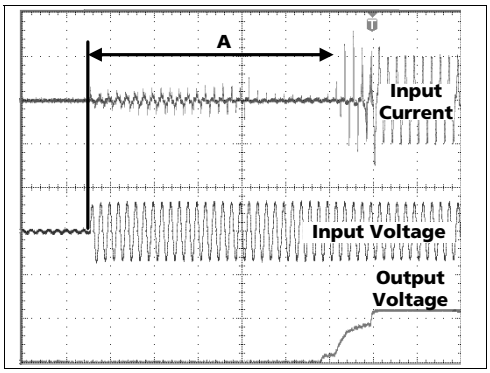
5. INPUT INRUSH CURRENT

An active inrush limitation circuit limits the input inrush current after turn-on of the input voltage and after short input voltage interruptions.

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

		AC 100V	**AC 120V**	**AC 230V**	
Inrush current	max.	$13A_{peak}$	$13A_{peak}$	$13A_{peak}$	over entire temperature range; mains interruptions > 750ms
	typ.	$11A_{peak}$	$9A_{peak}$	$7A_{peak}$	over entire temperature range; mains interruptions > 750ms
Inrush energy	max.	$5A^2s$	$5A^2s$	$5A^2s$	over entire temperature range; mains interruptions > 750ms
Inrush delay (A)	typ.	400ms	400ms	650ms	see (A) in Fig. 5-1

Fig. 5-1 **Input inrush current, typical behavior**



A….	Inrush delay
Input:	230Vac
Output:	48V, 10A
Ambient:	25°C
Upper curve:	Input current 5A / DIV
Middle curve:	Input voltage 500V / DIV
Lower curve:	Output voltage 40V / DIV
Time basis:	100ms / DIV

6. OUTPUT

Output voltage	nom.	48V	
Adjustment range	min.	48-55V	guaranteed
	max.	59V ****)	at clockwise end position of potentiometer
Factory setting	typ.	48.0V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	60-300Vac
Load regulation	max.	100mV	static value, 0A → 10A
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	10A	continuously available at 48V, see Fig. 6-1
	nom.	8.7A	continuously available at 55V, see Fig. 6-1
	nom.	15A *)	short term available BonusPower® *), at 48V, for typical 4s, see Fig. 6-1
	nom.	13.1A *)	short term available BonusPower® *), at 55V, for typical 4s, see Fig. 6-1
Output power	nom.	480W	continuously available
	nom.	720W *)	short term available BonusPower® *)
BonusPower® time	typ.	4s	duration until the output voltage dips, see Fig. 6-2
	min.	3.5s	
	max.	4.5s	
BonusPower® recovery time	typ.	7s	overload free time to reset power manager Fig. 6-4
Overload behaviour		cont. current	output voltage > 40Vdc, see Fig. 6-1
		Hiccup^{PLUS} mode**)	output voltage < 40Vdc, see Fig. 6-1
Short-circuit current	min.	15A ***)	load impedance 100mOhm, see Fig. 6-3
	max.	20A ***)	load impedance 100mOhm, see Fig. 6-3
	max.	7A ***)	average (R.M.S.) current, load impedance <10mOhm, see Fig. 6-3
Output capacitance	typ.	3 100µF	included inside the power supply

*) **BonusPower®, 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 BonusPower® is repeatedly available. Detailed information can be found in chapter 22.1. If the power supply is loaded longer with the BonusPower® than shown in the Bonus-time diagram (see Fig. 6-2), the max. output power is automatically reduced to 480W. If the power requirement is continuously above 480W and the voltage falls below approx. 40V (due to the current regulating mode at overload), the unit shuts-off and makes periodical restart attempts. This behaviour is called hiccup mode, which is described below. If the voltage is above 40V, the unit continuously delivers current.

) **Hiccup^{PLUS} Mode
At heavy overloads (when output voltage falls below 40V), the power supply delivers continuous output current for 2s. After this, the output is switched off for approx. 17s before a new start attempt is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally. See also Fig. 6-3.
During the off-period a small rest voltage and rest current is present on the output.

***) 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 56.5V.

Peak current capability (up to several milliseconds)

The power supply can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and causes a voltage dip on the output. Detailed curves can be found in chapter 22.2.

Peak current voltage dips	typ.	from 48V to 39V	at 20A for 50ms, resistive load
	typ.	from 48V to 34V	at 50A for 2ms, resistive load
	typ.	from 48V to 32V	at 50A for 5ms, resistive load

Fig. 6-1 **Output voltage vs. output current, typ.**

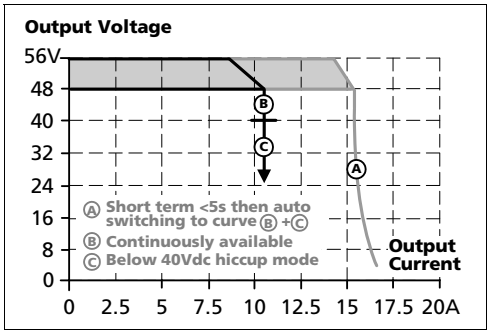


Fig. 6-2 **Bonus time vs. output power**

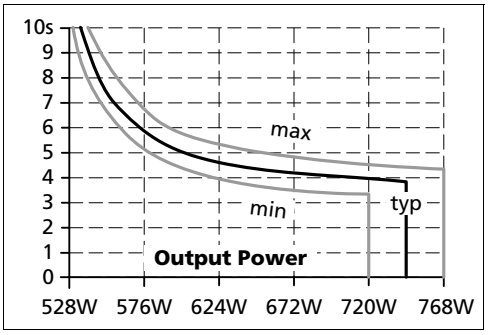


Fig. 6-3 **Short-circuit on output, hiccup mode (typ.)**

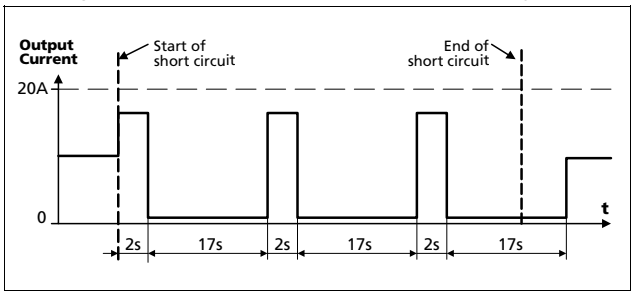
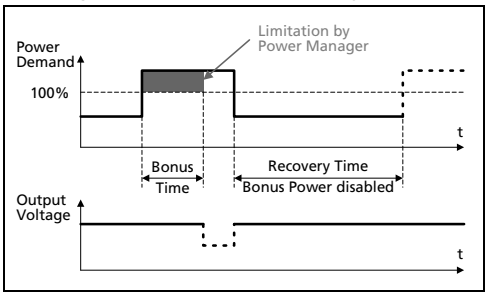


Fig. 6-4 **BonusPower® recovery time**



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

Fig. 6-5 **BonusPower® after input turn-on**

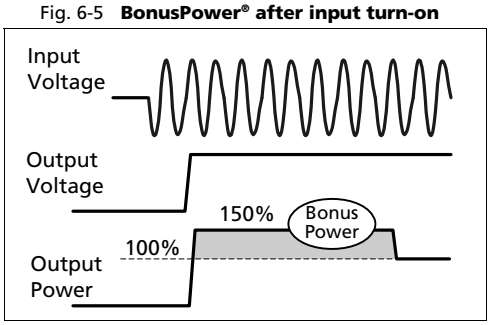
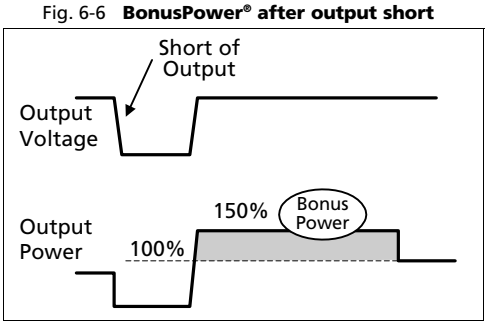


Fig. 6-6 **BonusPower® after output short**



7. HOLD-UP TIME

		AC 100V	AC 120V	AC 230V	
Hold-up Time	typ.	64ms	64ms	99ms	at 48V, 5A, see Fig. 7-1
	typ.	32ms	32ms	51ms	at 48V, 10A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

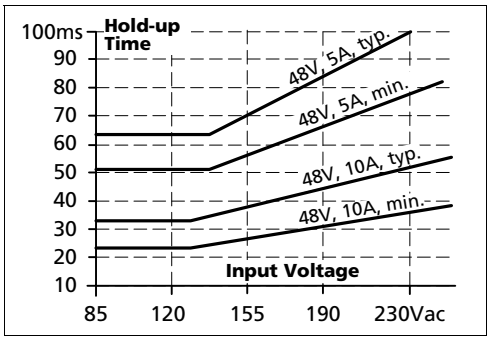
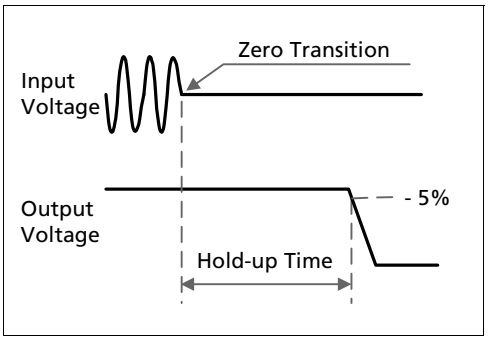


Fig. 7-2 **Shut-down behavior, definitions**

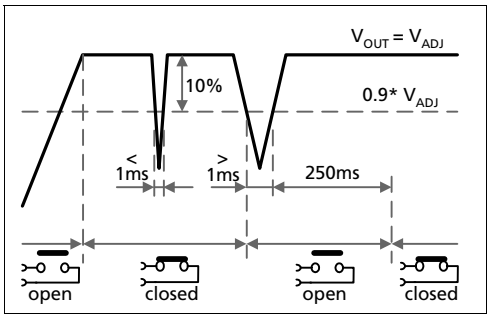


8. DC-OK RELAY CONTACT

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 the adjusted output voltage level.		
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	max	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min	1mA at 5Vdc	min. permissible load
Isolation voltage	See dielectric strength table in section 18.		

Fig. 8-1 **DC-ok relay contact behavior**



Note: The DC-ok feature requires that the output voltage reaches the nominal (=adjusted) level after turn-on in order to function according to specification. If this level cannot be achieved, the overload lamp will be on and the DC-ok contact will be open. The overload signal will only shut off as soon as the adjusted voltage is reached. This is an important condition to consider particularly, if the load is a battery, the power supply is used in parallel or the power supply is used for N+1 redundant systems.

9. EFFICIENCY AND POWER LOSSES

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	92.0%	92.8%	94.3%	at 48V, 10A
Average efficiency *)	typ.	91.7%	92.4%	93.4%	25% at 2.5A, 25% at 5A, 25% at 7.5A. 25% at 10A
Power losses	typ.	9.0W	9.2W	10.0W	at 48V, 0A
	typ.	41.7W	37.2W	29.0W	at 48V, 10A

*) 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. 9-1 **Efficiency vs. output current at 48V, typ**

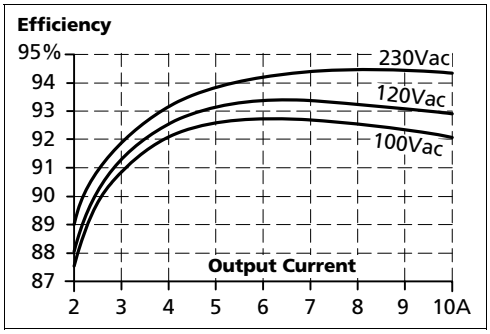


Fig. 9-2 **Losses vs. output current at 48V, typ.**

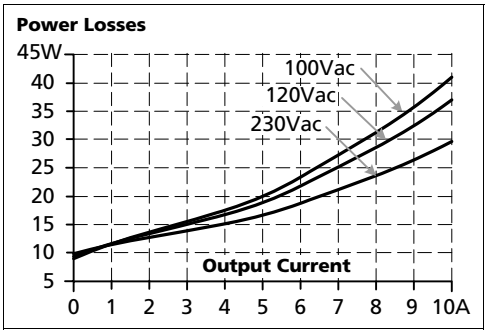


Fig. 9-3 **Efficiency vs. input voltage at 48V, 10A, typ.**

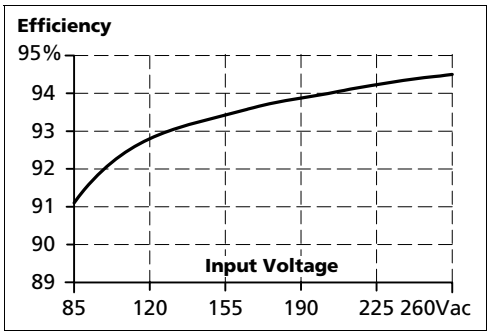
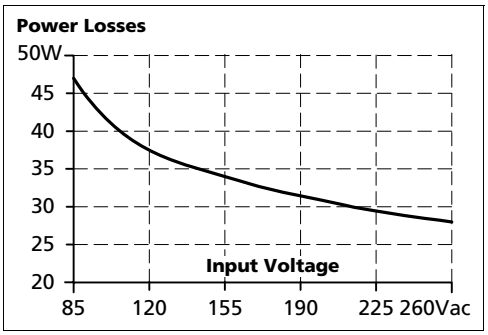


Fig. 9-4 **Losses vs. input voltage at 48V, 10A, typ.**



10. LIFETIME EXPECTANCY AND MTBF

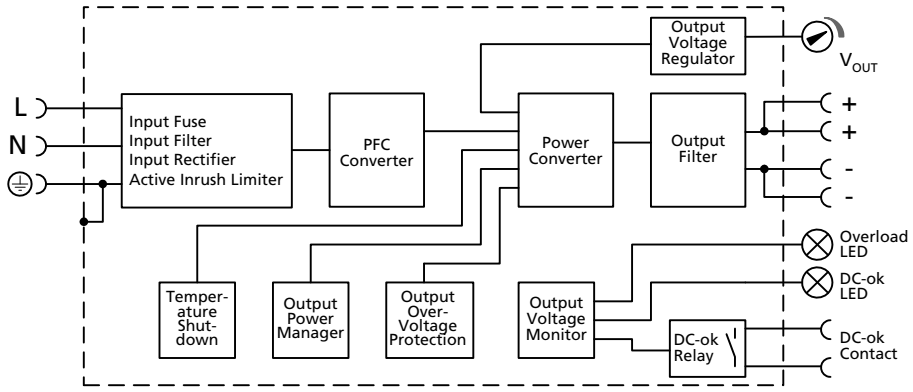
	AC 100V	AC 120V	AC 230V	
Lifetime expectancy *)	49 000h	63 000h	92 000h	at 48V, 10A and 40°C
	119 000h	178 000h	147 000h	at 48V, 5A and 40°C
	138 000h *)	165 000h *)	259 000h *)	at 48V, 10A and 25°C
MTBF **) SN 29500, IEC 61709	407 000h	441 000h	469 000h	at 48V, 10A and 40°C
	749 000h	799 000h	840 000h	at 48V, 10A and 25°C
MTBF **) MIL HDBK 217F	204 000h	215 000h	229 000h	at 48V, 10A and 40°C; Ground Benign GB40
	273 000h	288 000h	308 000h	at 48V, 10A and 25°C; Ground Benign GB25

*) The **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.

) **MTBF stands for **M**ean **T**ime **B**etween **F**ailure, 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 can not be determined if the failed unit has been running for 50 000h or only for 100h.

11. FUNCTIONAL DIAGRAM

Fig. 11-1 **Functional diagram**



12. TERMINALS AND WIRING

Bi-stable, quick-connect spring clamp terminals. Shipped in open position.
- IP20 Finger safe construction.
- Suitable for field- and factory installation.

	Input	Output	DC-OK-Signal
Type	spring-clamp terminals	spring-clamp terminals	spring-clamp terminals
Solid wire	0.5-6mm²	0.5-6mm²	0.3-4mm²
Stranded wire	0.5-4mm²	0.5-4mm²	0.3-2.5mm²
American Wire Gauge	20-10 AWG	20-10 AWG	26-12 AWG
Wire stripping length	10mm / 0.4inch	10mm / 0.4inch	6mm / 0.25inch
Max. wire diameter (including ferrules)	2.8mm	2.8mm	2.25mm

Instructions:

a) Use appropriate copper cables that are designed for minimum operating temperatures of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C minimum
90°C for ambient up to 70°C minimum.

b) Follow national installation codes and installation regulations!

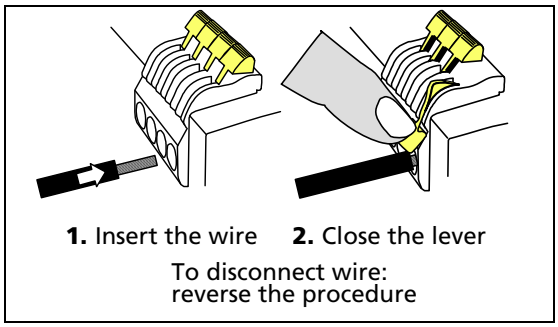
c) Ensure that all strands of a stranded wire enter the terminal connection!

d) Do not use the unit without PE connection.

e) Unused terminal compartments should be securely tightened.

f) Ferrules are allowed.

Fig. 12-1 **Connecting a wire**



1. Insert the wire **2.** Close the lever

To disconnect wire:
reverse the procedure

Daisy Chaining of Outputs:

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block as shown in Fig. 12-3.

Fig. 12-2 Daisy chaining of outputs

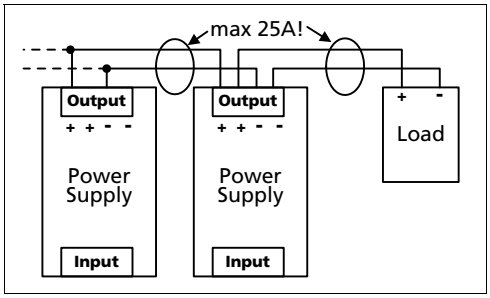
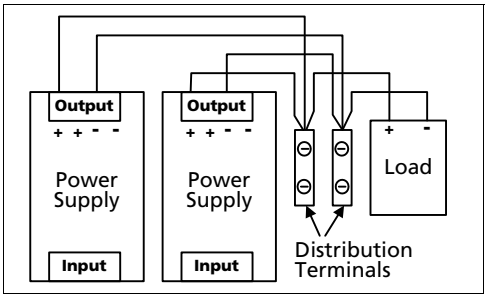
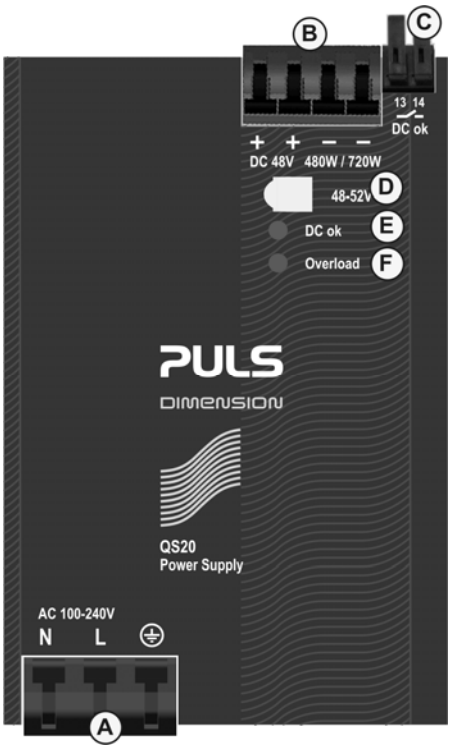


Fig. 12-3 Using distribution terminals



13. FRONT SIDE AND USER ELEMENTS

Fig. 13-1 **Front side**



A **Input Terminals** (Quick-connect spring-clamp terminals)
- **N, L** Line input
- ⏚ PE (Protective Earth) input

B **Output Terminals** (Quick-connect spring-clamp terminals, two pins per pole)
- **+** Positive output
- **–** Negative (return) output

C **DC-OK Relay Contact** (Quick-connect spring-clamp terminals)
The DC-OK relay contact is synchronized with the DC-OK LED.
See chapter 8 for details.

D **Output voltage potentiometer**
Open the flap to adjust the output voltage. Factory set: 48.0V

E **DC-OK LED** (green)
On, when the output voltage is >90% of the adjusted output voltage

F **Overload LED** (red)
On, when the voltage on the output terminals is <90% of the adjusted output voltage, or in case of a short circuit in the output. Input voltage is required.

Indicators, LEDs

	Overload LED	DC-OK LED	DC-OK Contact
Normal mode	OFF	ON	Closed
During BonusPower®	OFF	ON	Closed
Overload (V_{OUT} < 90%)	*)	OFF	Open
Output short circuit	*)	OFF	Open
Temperature Shut-down	*)	OFF	Open
No input power	OFF	OFF	Open

*) Up to 4s of overloading, the power supply delivers continuous output current. After this, the output power is reduced to nearly zero for approx. 17s before a new start attempt is automatically performed. If the overload has been cleared, the device will operate normally. If the overload still exists, the output current will be delivered for 2 to 4s (depending on the overload) again followed by a 17s rest time. This cycle is repeated as long as the overload exists.
The red overload LED is permanently on when the overload current is continuously flowing. During the 17s rest period, the red LED is flashing with a frequency of approx. 1.3Hz.

14. EMC

The power supply is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions. A detailed EMC report is available on request.

EMC Immunity	According generic standards: EN 61000-6-1 and EN 61000-6-2			
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	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines output lines DC-OK signal (coupling clamp)	4kV 2kV 1kV	Criterion A Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	L → N L → PE, N → PE	2kV 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
Mains voltage dips	EN 61000-4-11	0% of 100Vac 40% of 100Vac 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion A Criterion A Criterion A Criterion A
Voltage interruptions	EN 61000-4-11	0% of 200Vac (=0V)	5000ms	Criterion C
Voltage sags	SEMI F47 0706	dips on the input voltage according to SEMI F47 standard		
		80% of 120Vac (96Vac) 70% of 120Vac (84Vac) 50% of 120Vac (60Vac)	1000ms 500ms 200ms	Criterion A Criterion A Criterion A
Powerful transients	VDE 0160	over entire load range	750V, 1.3ms	Criterion C

Criterions:

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

C: Temporary loss of function is possible. Power supply may shut-down and restarts by itself. No damage or hazards for the power supply will occur.

EMC Emission	According generic standards: EN 61000-6-3 and EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	Class B
Conducted emission output lines **)	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	limits for DC power port acc. EN 61000-6-3 are not fulfilled ***)
Radiated emission	EN 55011, EN 55022	Class B
Harmonic input current	EN 61000-3-2	fulfilled for class A equipment
Voltage fluctuations, flicker	EN 61000-3-3	fulfilled *)

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.

*) tested with constant current loads, non pulsing

**) for information only, not mandatory for EN 61000-6-3

***) Quasi-peak values fulfilled, average values +5dB

Switching Frequencies	The power supply has four converters with four different switching frequencies included. One is nearly constant. The others are input voltage and load dependent.	
Switching frequency 1	100kHz	Resonant converter, nearly constant
Switching frequency 2	110kHz to 500kHz	Boost converter, input voltage and load dependent
Switching frequency 3	73kHz to 114kHz	PFC converter, input voltage and load dependent
Switching frequency 4	35kHz to 45kHz	Aux. converter, input voltage and load dependent

15. ENVIRONMENT

Operational temperature *)	-25°C to +70°C (-13°F to 158°F)	reduce output power according Fig. 15-1
Storage temperature	-40 to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	12W/°C	60-70°C (140°F to 158°F)
Humidity **)	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	15g 6ms, 10g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27, DIN-rail mounting
	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27, with wall mounting bracket ZM2.WALL
Altitude	0 to 2000m (0 to 6 560ft)	without any restrictions
	2000 to 6000m (6 560 to 20 000ft)	reduce output power or ambient temperature, see Fig. 15-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	30W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 15-2
Over-voltage category	III	IEC 62103, EN 50178, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.
**) Do not energize while condensation is present

Fig. 15-1 **Output current vs. ambient temp.**

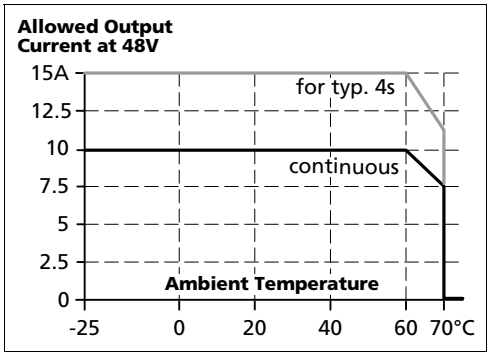
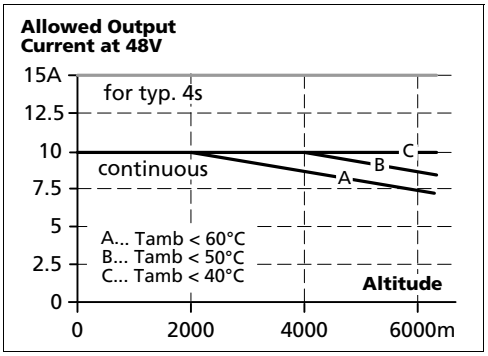


Fig. 15-2 **Output current vs. altitude**



16. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits *)	
Output over-voltage protection	typ. 58Vdc max. 60Vdc	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
Penetration protection	> 3.5mm / > 5mm	top side / bottom side; 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

*) In case of a protection event, audible noise may occur.

17. SAFETY FEATURES

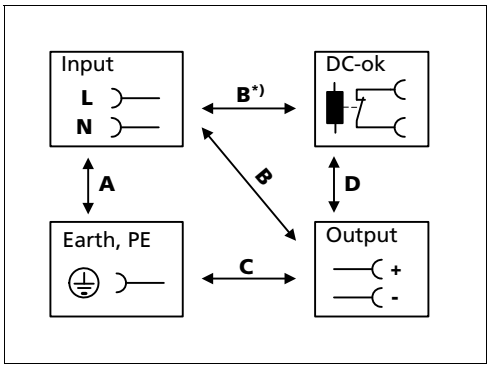
Input / output separation *)	SELV	IEC/EN 60950-1
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
	double or reinforced insulation	
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
PE resistance	< 0.1Ohm	
Touch current (leakage current)	typ. 0.23mA / 0.63mA	100Vac, 50Hz, TN-,TT-mains / IT-mains
	typ. 0.34mA / 0.93mA	120Vac, 60Hz, TN-,TT-mains / IT-mains
	typ. 0.58mA / 1.56mA	230Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.31mA / 0.77mA	110Vac, 50Hz, TN-,TT-mains / IT-mains
	< 0.45mA / 1.13mA	132Vac, 60Hz, TN-,TT-mains / IT-mains
	< 0.80mA / 2.00mA	264Vac, 50Hz, TN-,TT-mains / IT-mains

*) double or reinforced insulation

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 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.

Fig. 18-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 15mA	> 15mA	> 40mA	> 1mA

To fulfil the PELV requirements according to EN60204-1 § 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 can not be switched off when unnoticed earth faults occur.

B*) When testing input to DC-OK ensure that the max. 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.

19. APPROVALS

EC Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive 2004/108/EC, - Low-voltage directive (LVD) 2006/95/EC and - RoHS directive 2011/65/EU
IEC 60950-1 2nd Edition	IECEE CB SCHEME	CB Scheme, Information Technology Equipment
UL 508	c UL US LISTED IND. CONT. EQ.	Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
UL 60950-1 2nd Edition	c UL US	Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
ANSI / ISA 12.12.01-2007 (Class I Div 2)	C SP US	Recognized for use in Hazardous Location Class I Div 2 T3 Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2007) and Canada (C22.2 No. 213-M1987)
Marine	GL ABS	GL (Germanischer Lloyd) classified and ABS (American Bureau for Shipping) PDA Environmental category: C, EMC2 Marine and offshore applications
GOST P		Certificate of Conformity for Russia and other GUS countries

20. PHYSICAL DIMENSIONS AND WEIGHT

Weight	1200g / 2.65lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the unit depth (127mm) to calculate the total required installation depth.
Installation Clearances	See chapter 2

Fig. 20-1 **Front view**

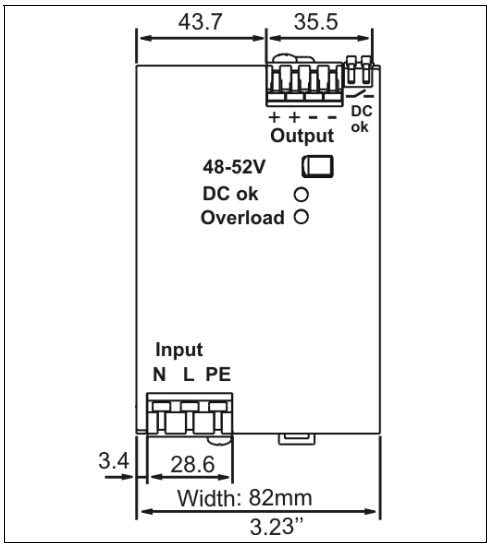
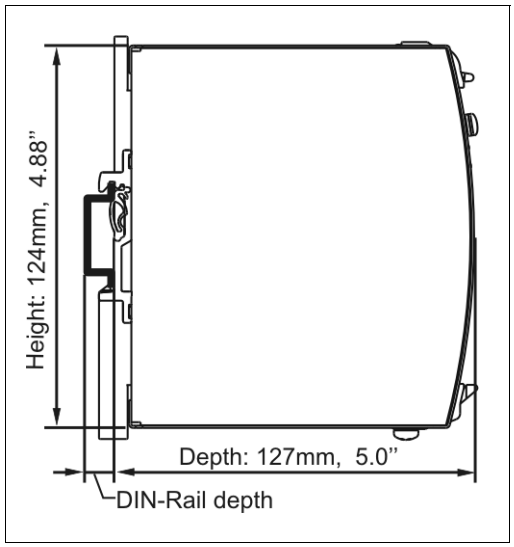


Fig. 20-2 **Side view**

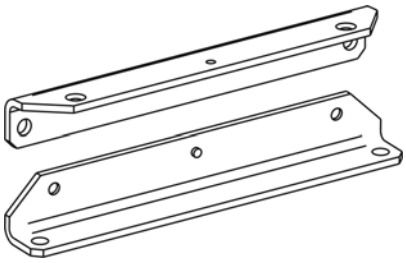


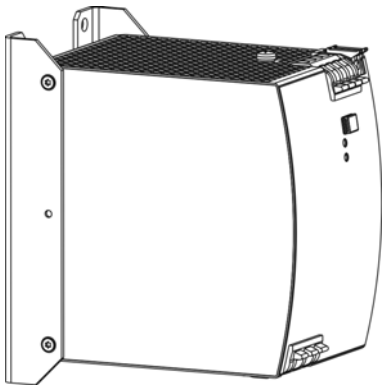
21. ACCESSORIES

21.1. ZM2.WALL WALL MOUNTING BRACKET

This bracket is used to mount the power supply onto a flat surface without utilizing a DIN-Rail.

C

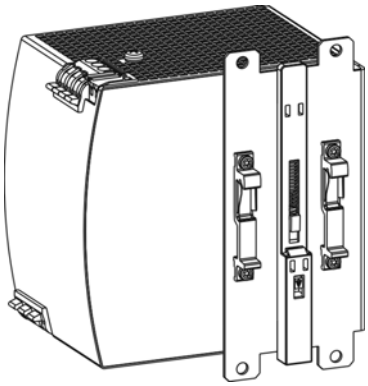




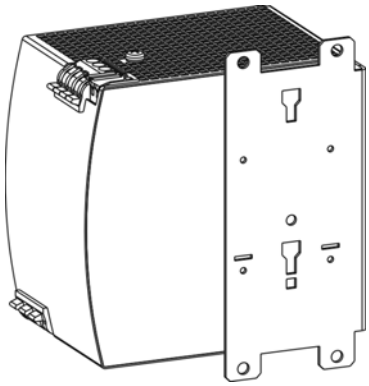
21.2. ZM15.SIDE SIDE MOUNTING BRACKET

This bracket is used to mount Dimension units sideways with or without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted.

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



Side mounting with DIN-rail brackets



Side mounting without DIN-rail brackets

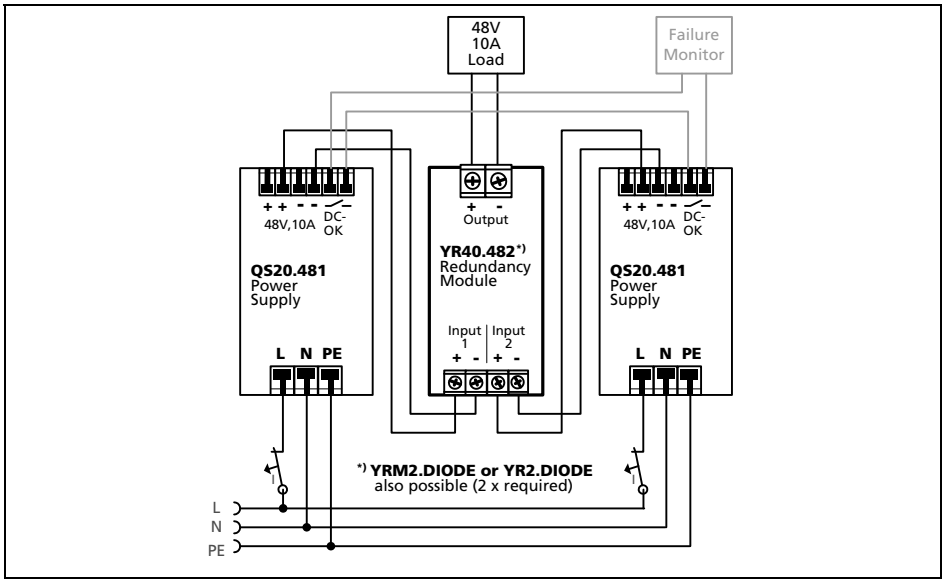
21.3. YR40.482 REDUNDANCY MODULES

YR40.482 – (2x 20A Inputs, 1x 40A output)

The YR40.482 is equipped with two input channels, which are individually decoupled by utilizing mosfet technology. Using mosfets instead of diodes reduces the heat generation and the voltage drop between input and output. The YR40.482 does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

Due to the low power losses, the unit is very slender and only requires 46mm width on the DIN-rail.

Fig. 21-1 **Typical 1+1 Redundant configuration for 48V, 10A with a dual redundancy module**



22. APPLICATION NOTES

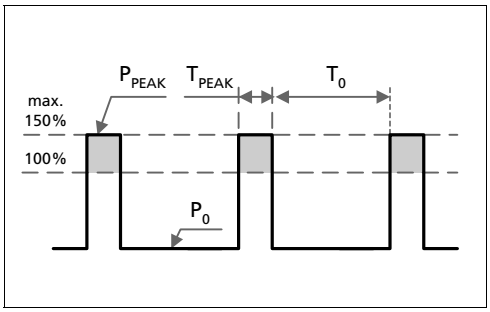
22.1. REPETITIVE PULSE LOADING

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 6) has elapsed.

To avoid this, the following rules must be met:

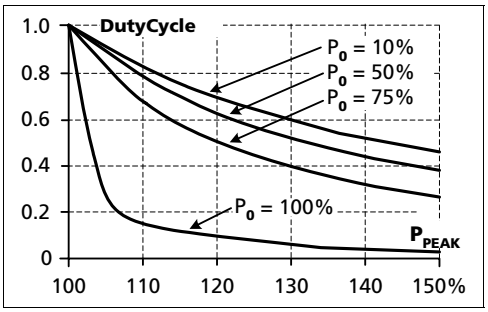
a) The power demand of the pulse must be below 150% of the nominal output power.
b) The duration of the pulse power must be shorter than the allowed BonusPower® time. (see output section)
c) The average (R.M.S.) output current must be below the specified continuous output current.
If the R.M.S. current is higher, the unit will respond with a thermal shut-down after a period of time. Use the maximum duty cycle curve (Fig. 22-2) to check if the average output current is below the nominal current.

Fig. 22-1 **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. 22-2 **Max. duty cycle curve**



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

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

Example: A load is powered continuously with 240W (= 50% of the rated output load). From time to time a peak power of 720W (= 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:
- Result: The required pause length = 1.7s
- Max. repetition rate = pulse +pause length = **2.7s**

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

More examples for pulse load compatibility:

P_{PEAK}	P_0	T_{PEAK}	T_0
720W	480W	1s	>25s
720W	0W	1s	>1.3s
600W	240W	1s	> 0.75s

P_{PEAK}	P_0	T_{PEAK}	T_0
720W	240W	0.1s	>0.16s
720W	240W	1s	>1.6s
720W	240W	3s	>4.9s

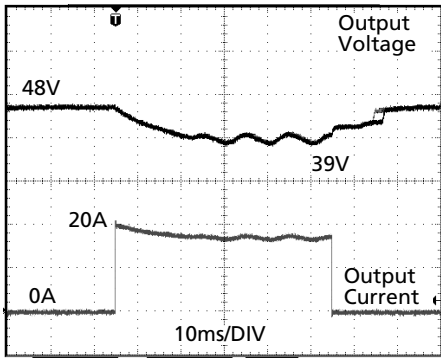
22.2. PEAK CURRENT CAPABILITY

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

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

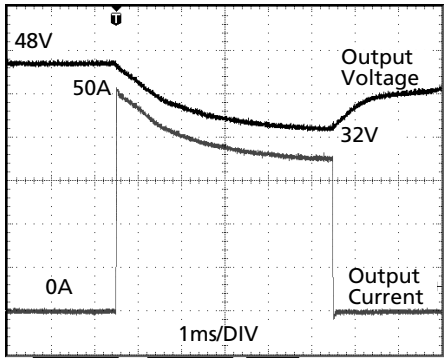
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 22-3 **Peak load with 2x the nominal current for 50ms, typ.**



Peak load 20A (resistive) for 50ms
Output voltage dips from 48V to 39V.

Fig. 22-4 **Peak load with 5x the nominal current for 5ms, typ.**



Peak load 50A (resistive) for 5ms
Output voltage dips from 48V to 32V.

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

22.3. BACK-FEEDING LOADS

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

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

The maximum allowed feed-back-voltage is 58Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 6.

22.4. EXTERNAL INPUT PROTECTION

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

If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or C-Characteristic breaker should be used

22.5. CHARGING OF BATTERIES

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

Instructions for charging batteries:

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

End-of-charge voltage	55.6V	55.0V	54.3V	53.6V
Battery temperature	10°C	20°C	30°C	40°C

b) Use a 13A, 15A or 16A circuit breaker (or blocking diode) between the power supply and the battery.

c) Ensure that the output current of the power supply is below the allowed charging current of the battery.

d) Use only matched batteries when putting 12V types in series.

e) The return current to the power supply (battery discharge current) is typ. 10mA when the power supply is switched off (except in case a blocking diode is utilized).

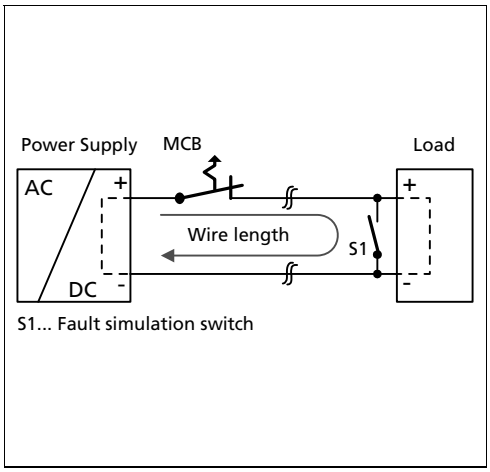
22.6. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCB's or UL1077 circuit breakers) are commonly used for AC-supply systems and may also be used on 48V 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. 22-5 **Test circuit**

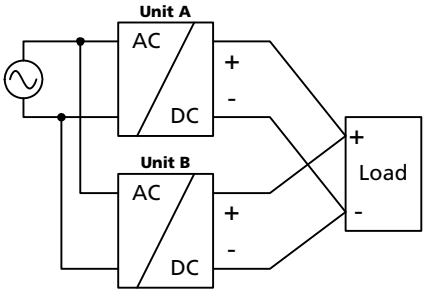


Maximal wire length*) for a fast (magnetic) tripping:

	0.75mm²	**1.0mm²**	**1.5mm²**	**2.5mm²**
C-2A	67m	86m	129m	185m
C-3A	48m	63m	92m	157m
C-4A	32m	44m	63m	93m
C-6A	12m	18m	23m	38m
C-8A	5m	6m	9m	14m
C-10A	4m	5m	7m	11m
C-13A	2m	2m	3m	5m
B-6A	30m	39m	52m	87m
B-10A	11m	16m	22m	29m
B-13A	9m	12m	17m	24m
B-16A	-	2m	2m	4m

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

22.7. PARALLEL USE TO INCREASE OUTPUT POWER



Power supplies from the same series (Q-Series) can be paralleled to increase the output power. The output voltage shall be adjusted to the same value (±100mV) with the same load conditions on all units, or the units can be left with the factory settings.

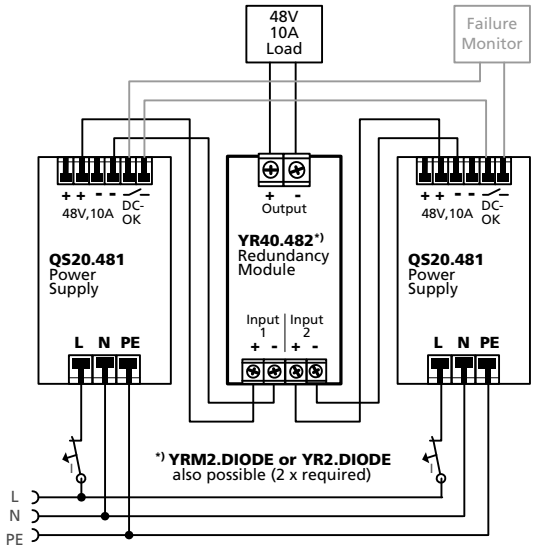
If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 15A or 16A is required on each output. Alternatively, a diode or redundancy module can also be utilized.

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 (input terminals on bottom and output terminals on the top 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.

22.8. PARALLEL USE FOR REDUNDANCY

Power supplies 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. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five power supplies, each rated for 10A are paralleled to build a 40A redundant system. For N+1 redundancy the same restrictions apply as for increasing the output power, see also section 22.7.

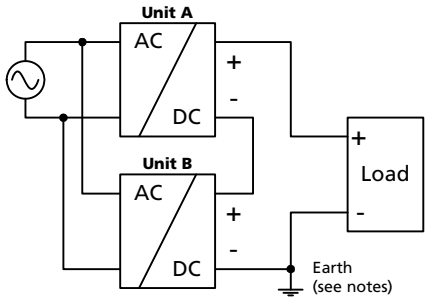


Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defective unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can be avoided by utilizing decoupling diodes, which are included in the redundancy module YR40.482.

Recommendations for building redundant power systems:

a) Use separate input fuses for each power supply.
b) Monitor the individual power supply units. Therefore, use the DC-OK relay contact of the QS20 power supply.
c) It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

22.9. 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 any more 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 (input terminals on bottom and output terminals on the top of the unit).

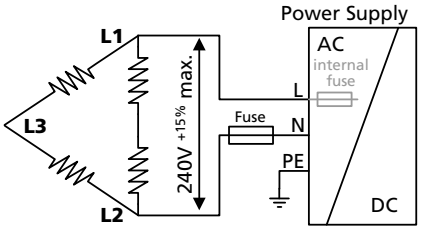
Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple power supplies.

22.10. INDUCTIVE AND CAPACITIVE LOADS

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

22.11. OPERATION ON TWO PHASES

The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 240V$^{+15\%}$. Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire. Appropriate fuses or circuit breakers are specified in section 22.4 “External Input Protection”.



22.12. USE IN A TIGHTLY SEALED ENCLOSURE

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

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

The power supply is placed in the middle of the box, no other heat producing items are inside the box

Enclosure:	Rittal Typ IP66 Box PK 9522 100, plastic, 254x180x165mm
Load:	48V, 8A; (=80%) load is placed outside the box
Input:	230Vac
Temperature inside enclosure:	48.2°C (in the middle of the right side of the power supply with a distance of 2cm)
Temperature outside enclosure:	24.2°C
Temperature rise:	24.0K

22.13. 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 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. 22-6
Mounting Orientation A
(Standard orientation)

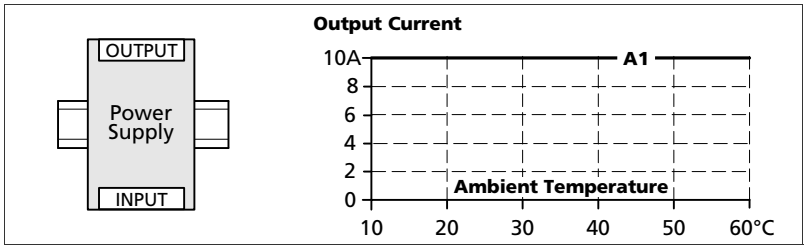


Fig. 22-7
Mounting Orientation B
(Upside down)

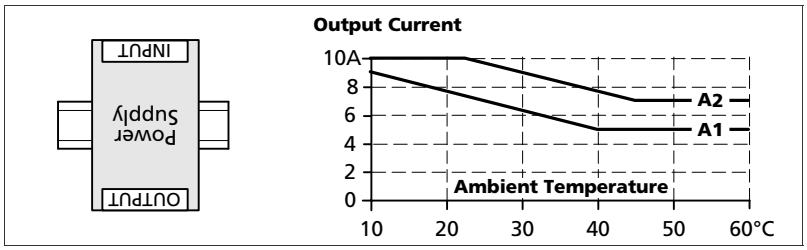


Fig. 22-8
Mounting Orientation C
(Table-top mounting)

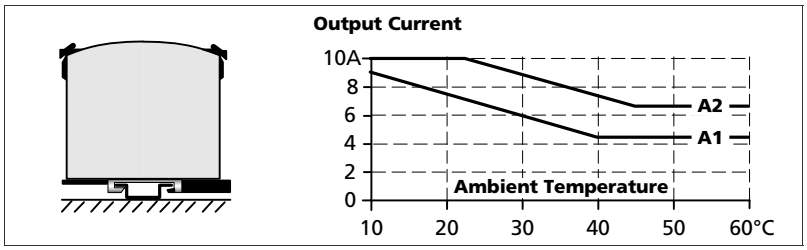


Fig. 22-9
Mounting Orientation D
(Horizontal cw)

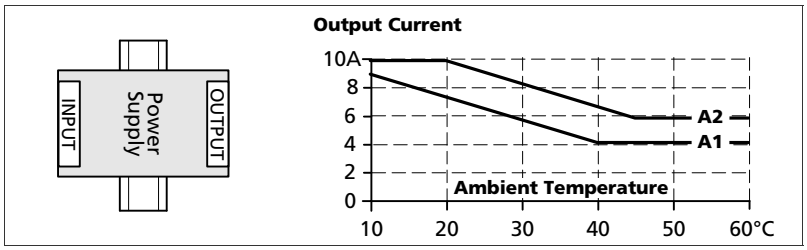


Fig. 22-10
Mounting Orientation E
(Horizontal ccw)