PULS

PIC120.241C, PIC120.242C

PIANO-Series

24V, 5A, 120W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 200-240V Regional Input
- Cost Optimized without Compromising Quality or Reliability.
- Width only 39mm
- Efficiency up to 90.5%
- Low No-load Power Losses
- Full Power Between -10°C and +55°C
- DC-OK Relay Contact Included
- 3 Year Warranty

PRODUCT 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.

Since typical industrial applications do not require multiple mains inputs, the reduction to a regional input voltage range (AC 200-240V) simplifies the circuitry and has significant advantages for reliability, efficiency and cost.

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	nominal
Adjustment range	24 - 28V	factory setting 24.1V
Output current	5 - 4.3A	below +60°C ambient
	3.1 - 2.7A	at +70°C ambient
	Derate between +60°C and +70°C	
AC Input voltage	AC 200-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	1.06A	
Power factor	0.54	
AC Inrush current	28A peak	at 40°C, cold start
Efficiency	90.5%	
Losses	12.6W	
Temperature range	-10°C to +70°C	
Hold-up time	33ms	
Dimensions	39x124x124mm	Without DIN rail
Weight	350g	

ORDER NUMBERS

Power Supply	PIC120.241C	with DC-OK relay contact
	PIC120.242C	without DC-OK relay contact
Accessory	YR2.DIODE	Redundancy Module
	UF20.241	Buffer Module

MAIN APPROVALS

For details and the complete approval list, see chapter 19

c UL us LISTED	DNV DNV.COM/AF	ABS
UL 61010-2-201	Marine	Marine

INDEX

TERMINOLOGY AND ABREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for Protective Earth 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, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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 industrial, residential, commercial and light-industrial environments.

Do not use this device on AC 200V mains with more than 4.5A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°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 ingress protection of IP20. The enclosure does not provide protection against spilled liquids.

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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac.

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 5000m. Above 2000m the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A C-characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +70°C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.

The device is designed to operate in areas between 5% and 95% relative humidity.

3. AC-INPUT

AC input	nom.	AC 200-240V	suitable for TN-, TT- and IT mains networks
AC input range		180-264Vac	
		264-300Vac	< 500ms
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	162Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	100Vac	at 24V 0A, steady-state value, see Fig. 3-1
	typ.	130Vac	at 24V 5A, steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 23.2.		

		AC 230V	
Input current	typ.	1.06A	at 24V, 5A, see Fig. 3-3
Power factor*)	typ.	0.54	at 24V, 5A, see Fig. 3-4
Crest factor**)	typ.	4	at 24V, 5A
Start-up delay	typ.	75ms	see Fig. 3-2
Rise time	typ.	30ms	at 24V, 5A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	90ms	at 24V, 5A const. current load, 5mF load capacitance,, see Fig. 3-2
Turn-on overshoot	max.	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.

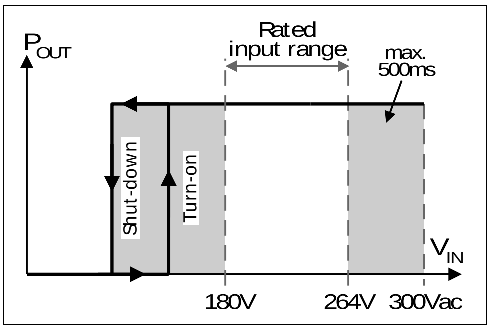


Fig. 3-2 Turn-on behavior, definitions

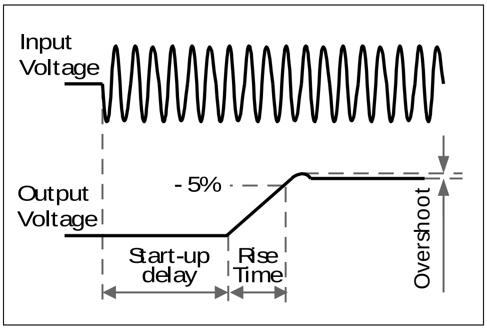


Fig. 3-3 Input current vs. output load at 24V

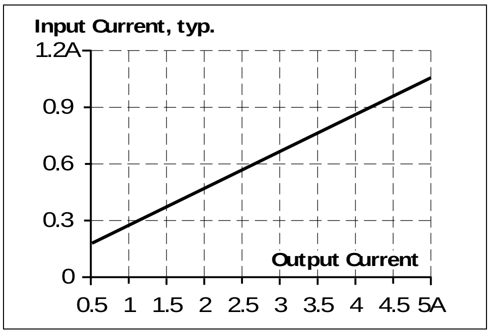
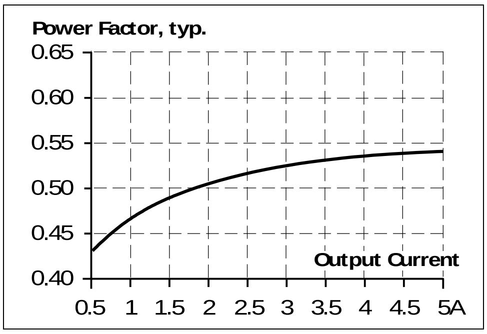


Fig. 3-4 Power factor vs. output load



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 230V	
Inrush current*)	max.	37A_{peak}	40°C ambient, cold start
	typ.	28A_{peak}	40°C ambient, cold start
	typ.	23A_{peak}	25°C ambient, cold start
Inrush energy*)	max.	1.0A^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, 25°C ambient

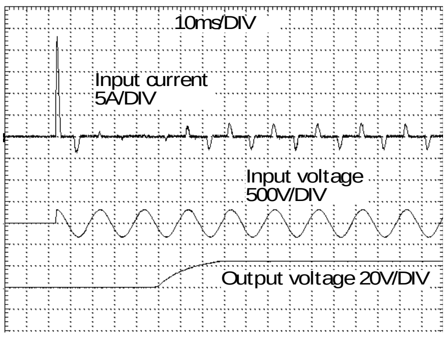
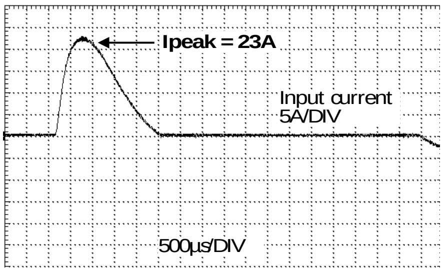


Fig. 5-2 Input inrush current, zoom into first peak
230Vac input, 24V 5A output, 25°C ambient



6. OUTPUT

Output voltage	nom.	24V	
Adjustment range		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	180-264Vac
Load regulation	max.	150mV	static value, 0A → 5A; see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	5A	at 24V, ambient temperature <55°C, see Fig. 6-1
	nom.	3.1A	at 24V, ambient temperature <70°C, see Fig. 6-1
	nom.	4.3A	at 28V, ambient temperature <55°C, see Fig. 6-1
	nom.	2.7A	at 28V, ambient temperature <70°C, see Fig. 6-1
Output power	nom.	120W	ambient temperature <55°C
	nom.	75W	ambient temperature <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.

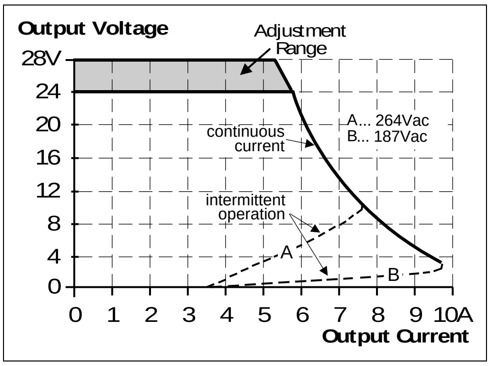
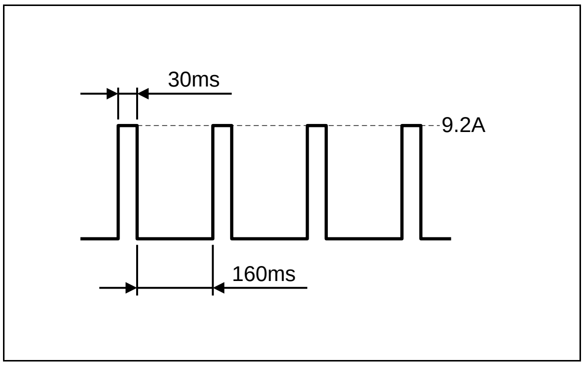


Fig. 6-2 Intermittent operation at shorted output, typ.



7. HOLD-UP TIME

		AC 230V	
Hold-up Time	typ.	69ms	at 24V, 2.5A, see Fig. 7-1
	min.	61ms	at 24V, 2.5A, see Fig. 7-1
	typ.	33ms	at 24V, 5A, see Fig. 7-1
	min.	29ms	at 24V, 5A, see Fig. 7-1

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

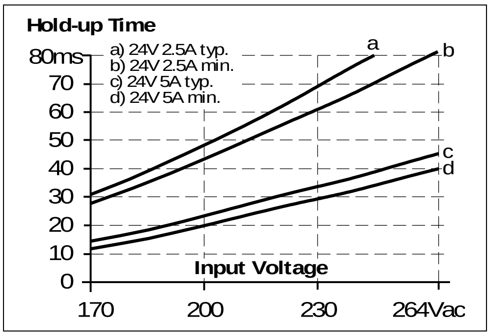
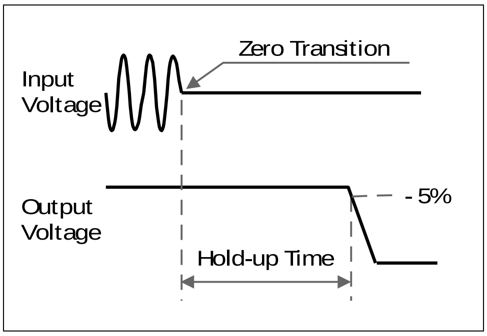


Fig. 7-2 Shut-down behavior, definitions

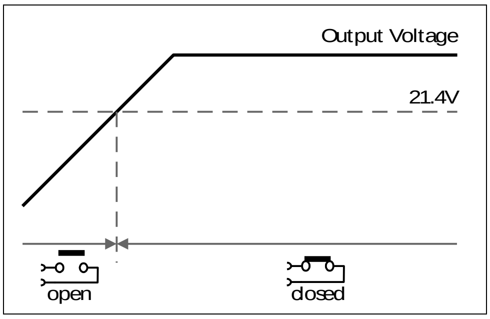


8. DC-OK RELAY CONTACT

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).

Threshold voltage	typ.	21.4V (fixed)	
Contact closes	As soon as the output voltage reaches 21.4V.		
Contact opens	As soon as the output voltage falls below 21.4V.		
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 chapter 18.		

Fig. 8-1 DC-OK relay contact behavior
(only for PIC120.241C)



9. EFFICIENCY AND POWER LOSSES

		AC 230V	
Efficiency	typ.	90.5%	at 24V, 5A
Average efficiency*)	typ.	89.5%	25% at 1.25A, 25% at 2.5A, 25% at 3.75A. 25% at 5A
Power losses	typ.	0.6W	PIC120.241C: at 24V, 0A
	typ.	0.5W	PIC120.242C: at 24V, 0A
	typ.	7.0W	at 24V, 2.5A
	typ.	12.6W	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.

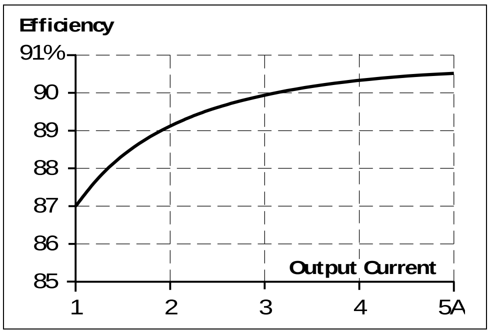
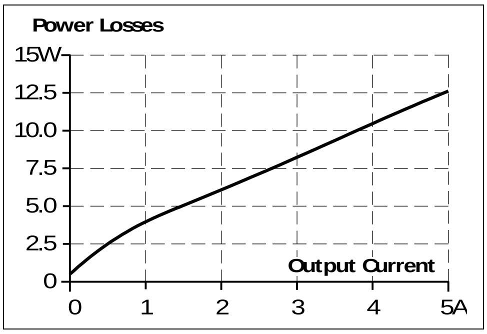


Fig. 9-2 Losses vs. output current at 24V, typ.



10. LIFETIME EXPECTANCY AND MTBF

	AC 230V	
Lifetime expectancy*)	110 000h	at 24V, 2.5A and 40°C
	312 000h*)	at 24V, 2.5A and 25°C
	47 000h	at 24V, 5A and 40°C
	133 000h*)	at 24V, 5A and 25°C
MTBF**) SN 29500, IEC 61709	1 720 000h	at 24V, 5A and 40°C
	3 223 000h	at 24V, 5A and 25°C
MTBF**) MIL HDBK 217F	1 322 000h	at 24V, 5A and 40°C; Ground Benign GB40
	1 785 000h	at 24V, 5A and 25°C; Ground Benign GB25
	385 000h	at 24V, 5A and 40°C; Ground Fixed GF40
	502 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 Mean Time Between Failure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.
The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it 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 PIC120.241C

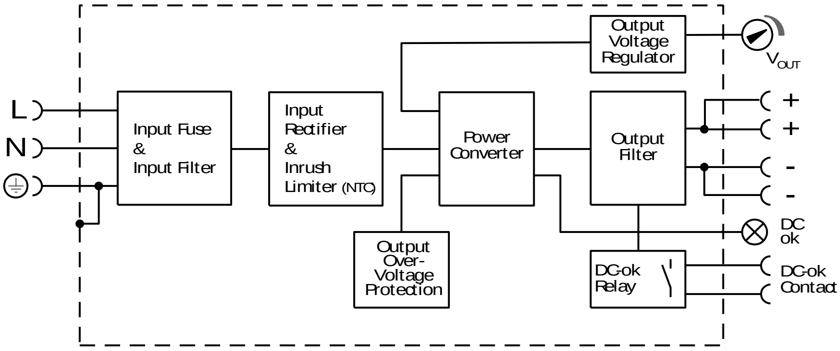
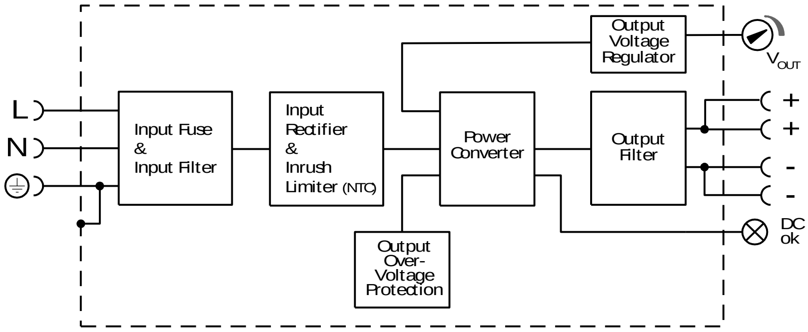


Fig. 11-2 Functional diagram PIC120.242C



12. TERMINALS AND WIRING

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

	Input and output	DC-OK-Signal only available in PIC120.241C
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	7mm
Screwdriver	4mm slotted or cross-head No 1	not required
Recommended tightening torque	1Nm	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 PIC120.241C

Fig. 13-2 Front side PIC120.242C

<u>A</u> Input Terminals (screw terminals)
- N, L Line input
- ⏚ PE (Protective Earth) input

<u>B</u> Output Terminals (screw terminals, two pins per pole)
- \+ Positive output
- – Negative (return) output

<u>C</u> Output voltage potentiometer
Guaranteed adjustment range: 24-28V
Factory set: 24.1V

<u>D</u> DC-OK LED (green)
On, when the output voltage is >18V

<u>E</u> DC-OK Relay Contact (push-in terminals)
Description see chapter 8.
This feature is not available in the PIC120.242C.

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 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 200Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A <4.5A Criterion B >4.5A Criterion C 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 200Vac (160Vac) 70% of 200Vac (140Vac) 50% of 200Vac (100Vac)	 1000ms 500ms 200ms	 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.
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 61000-6-3, EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR 32	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 55032	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	reduce output power according Fig. 15-1
Storage temperature	-40°C to +85°C	for storage and transportation
Output derating	3W/°C	55°C to 70°C
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	without any restrictions
	2000 to 6000m	reduce output power or ambient temperature, see Fig. 15-2 IEC 62103, EN 50178, overvoltage category II
Altitude derating	7.5W/1000m or 5°C/1000m	> 2000m, 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

*) 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.

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

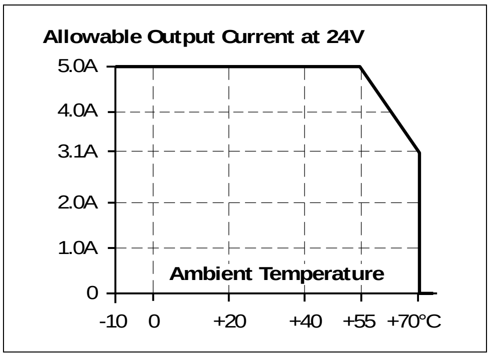
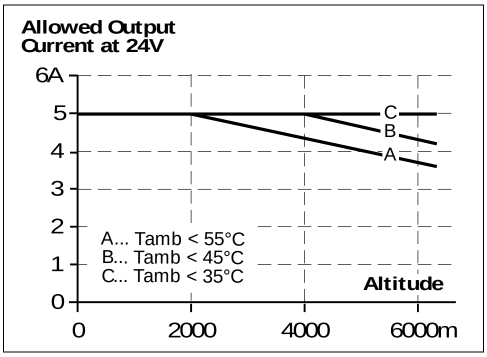


Fig. 15-2 Output current vs. altitude



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 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 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.

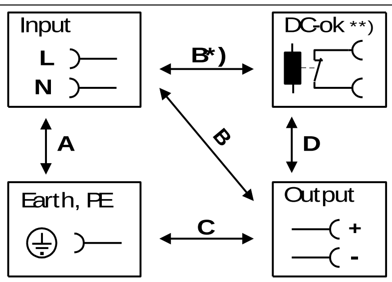
17. SAFETY FEATURES

Input / output separation	SELV PELV double or reinforced insulation	IEC/EN 60950-1 IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
Touch current (leakage current)	typ. 0.30mA / 0.75mA max. 0.39mA / 0.94mA	230Vac, 50Hz, TN-,TT-mains / IT-mains 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



**) DC-OK contact not included in PIC120.242C

		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		> 15mA	> 15mA	> 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.

19. APPROVED, FULFILLED OR TESTED STANDARDS

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
UL 61010	c UL US LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
Marine (DNV)	DNV DNV.COM/AF	DNV Certificate DNV Type approved product Certificate: TAA00002JT Temperature: Class B Humidity: Class B Vibration: Class C EMC: Class A Enclosure: Class A
Marine (ABS)	ABS	ABS Design Assessment Certificate ABS (American Bureau of Shipment) assessed product Certificate: 17-HG1599236-PD
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of 10 years
IEC 61558-2-16	Safety	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

20. REGULATORY PRODUCT COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Regulation (EU)	REACH ✓	Manufacturer's Declaration EU regulation regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) fulfilled. EU Regulation (EC) 1907/2006.
WEEE Regulation		Manufacturer's Declaration EU Regulation on Waste Electrical and Electronic Equipment Registered as business to business (B2B) products. EU Regulation 2012/19/EU
KC		KC Korean Certification Korean - Registration of Broadcasting and Communication Equipment Registered under Clause3, Article 58-2 of Radio Waves Act. Registration No. R-R-PUG-PIC120_241C.
UKCA	UK CA	UKCA Declaration of Conformity Trade conformity assessment for England, Scotland and Wales The UKCA mark indicates conformity with the UK Statutory Instruments 2016 No.1101, 2016 No.1091, 2012 No.3032

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	39mm
Height	124mm
Depth	124mm The DIN rail depth must be added to the unit depth to calculate the total required installation depth.
Weight	350g
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 PIC120.241

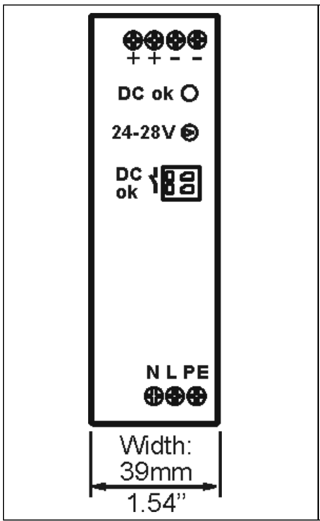


Fig. 21-2 Front view PIC120.242C

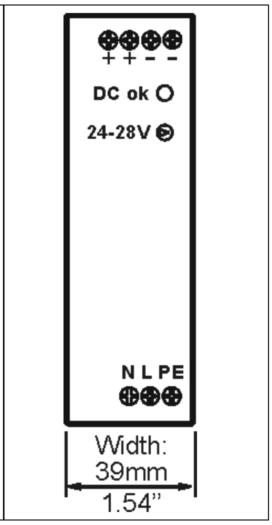
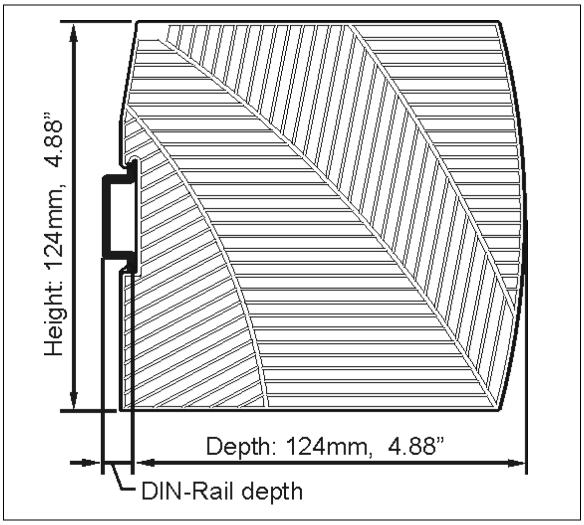


Fig. 21-3 Side view

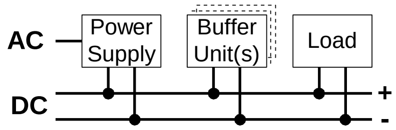


22. ACCESSORY

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.

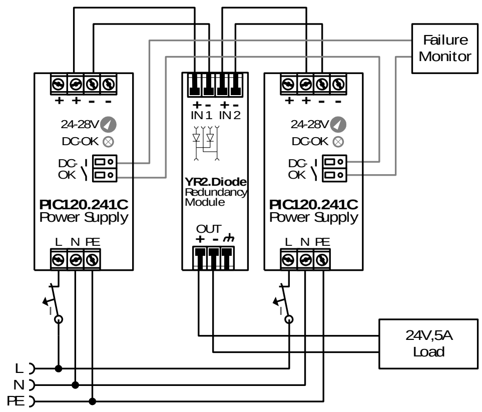
The buffer unit does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer units can be added in parallel to increase the output ampacity or the hold-up time.



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 23.4 for instructions how to build a redundant system.



23. APPLICATION NOTES

23.1. 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.

23.2. 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.

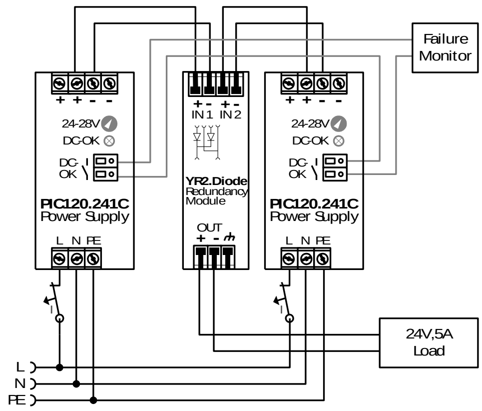
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. 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:

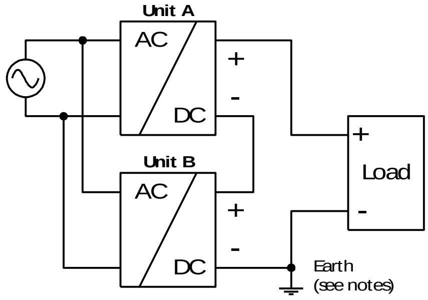
a) The preferred power supply is the PIC120.241C since it has a DC-OK signal contact included, which the PIC120.242C does not have. Use this DC-OK signal contact to monitor the individual power supply units.

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.

23.5. 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.

23.6. 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:

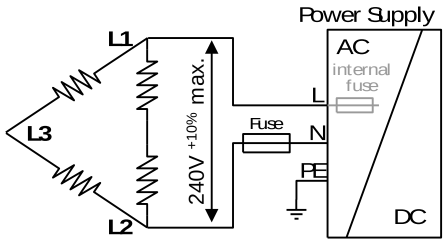
- max. 10mF with an additional 2.5A constant current load and
- max. 5mFwith an additional 5A constant current load.

23.7. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.8. 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$^{+10\%}$.



23.9. 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: 49.2°C	(in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	26.5°C
Temperature rise:	22.7K
Case B:	
Load:	24V, 4A; (=80%) load is placed outside the box
Temperature inside the box: 46.0°C	(in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	26.8°C
Temperature rise:	19.2K

PIC120.241D

24V, 5A, 120W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-120V / 200-240V Auto-select Input
- Width only 39mm
- Efficiency up to 92.3%
- Full Power Between -10°C and +55°C
- DC-OK Relay Contact
- 3 Year Warranty

PRODUCT 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 an auto-select input voltage stage for 100-120V and 200-240V mains systems, many safety approvals and a wide operational temperature range, which makes the unit applicable for global use.

The addition of a DC-OK signal makes the unit suitable for many industry applications such as process control, factory automation or many other critical applications, where preventive function monitoring can help to avoid long downtimes.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24 – 28V	Factory setting 24.1V
Output current	For AC 110-120V,AC 208-240V mains:	
	5.0 – 4.3A	Below +55°C amb.
	3.1 – 2.7A	At +70°C amb.
	For AC 100, 120V mains:	
	5.0 – 4.3A	Below +50°C amb.
	2.5 – 2.1A	At +70°C amb.
	Derate linearly between +50°C and +70°C	
Input voltage AC	AC 100-120V / 200-240V	±10%, Auto-select
Mains frequency	50-60Hz	±6%
AC Input current	1.72 / 1.05A	At 120 / 230Vac
Power factor	0.64 / 0.54	At 120 / 230Vac
AC Inrush current	22 / 33A pk	At 120 / 230Vac, 40°C, cold start
Efficiency	91.2 / 92.3%	At 120 / 230Vac
Losses	11.6 / 10.0W	At 120 / 230Vac
Hold-up time	51 / 50ms	At 120 / 230Vac
Temperature range	-10 to +70°C	
Size (WxHxD)	39x124x124mm	
Weight	370g	

ORDER NUMBERS

Power Supply	**PIC120.241D**	
Accessory	PIRD20.241	Redundancy Module
	UF20.241	Buffer Module

MAIN APPROVALS

For details and the complete approval list, see chapter 19.

c UL US LISTED

UL 61010-2-201

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 indicate flexibility of choice with no implied preference.
shall	A key word indicate a mandatory requirement.
should	A key word indicate 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, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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 industrial, residential, commercial and light-industrial environments.

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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The isolation of the 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac.

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 5000m. Above 2000m the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or C-characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +70°C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.

The device is designed to operate in areas between 5% and 95% relative humidity.

3. AC-INPUT

The device is suitable to be supplied from TN, TT or IT mains networks with AC voltage.

AC input	Nom.	AC 100-120V / 200-240V	Auto-select
AC input range		90-132Vac / 180- 264Vac	
		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%
External input protection	See recommendations in chapter 2.		

		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, The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
Turn-on voltage	Typ.	78Vac	78Vac	157Vac	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

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

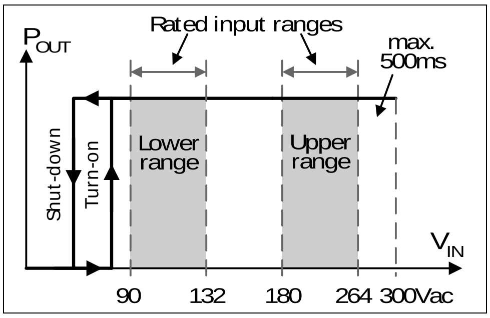


Fig. 3-2 **Turn-on behaviour, definitions**

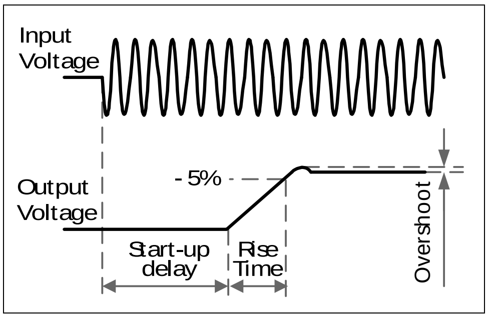


Fig. 3-3 **Input current vs. output load at 24V**

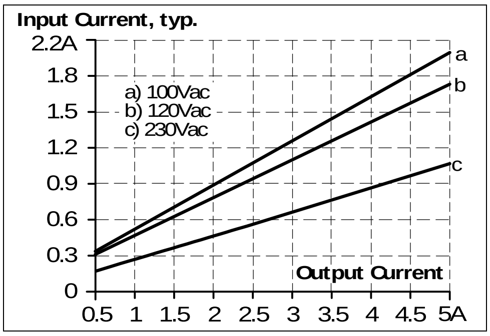
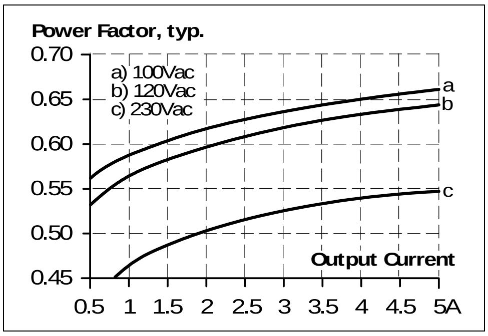


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not operate this power supply with DC-input voltage.

5. INPUT INRUSH CURRENT

An NTC inrush limiter 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.	$23A_{peak}$	$27A_{peak}$	$40A_{peak}$	At 40°C, cold start
	Typ.	$13A_{peak}$	$16A_{peak}$	$30A_{peak}$	At 25°C, cold start
	Typ.	$18A_{peak}$	$22A_{peak}$	$33A_{peak}$	At 40°C, cold start
Inrush energy	Max.	$0.4A^2s$	$0.5A^2s$	$1.5A^2s$	At 40°C, cold start

Fig. 5-1 **Input inrush current, typical behavior**
230Vac input, 24V 5A output, 40°C ambient

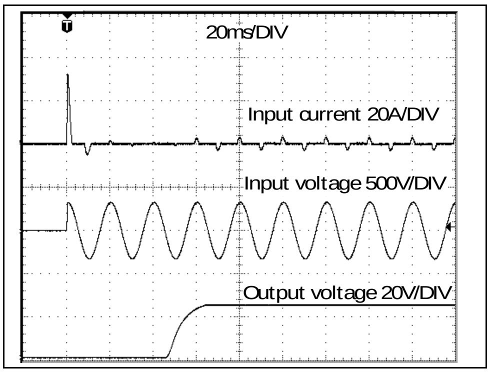
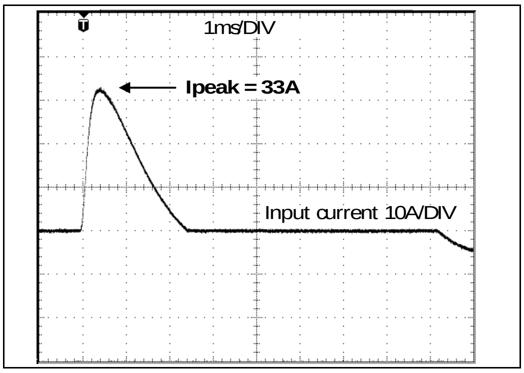


Fig. 5-2 **Input inrush current, zoom into first peak**
230Vac input, 24V 5A output, 40°C ambient



6. OUTPUT

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

The output is designed to supply any kind of loads, including capacitive and inductive loads. The output can supply any kind of loads, including unlimited inductive and capacitive loads. If capacitors with a capacitance >10mF and 2.5A or >5mF with 5A additional current load are connected, the unit might charge the capacitor in an intermittent mode. No limitation for capacitive loads in combination with an additional resistive type of load.

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.	DC 24V	
Adjustment range		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 settings	Typ.	24.1V	±0.2%, at full load and cold unit
Line regulation	Max.	10mV	Between 85 and 300Vac
Load regulation	Max.	150mV	Between 0A and 5A, static value, see Fig. 6-1
Ripple and noise voltage	Max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	5.0A	At 24V and an ambient temperature below 55°C
	Nom.	3.1A	At 24V and 70°C ambient temperature
	Nom.	4.3A	At 28V and an ambient temperature below 55°C
	Nom.	2.7A	At 28V and 70°C ambient temperature
		Derate linearly between +55°C and +70°	
Overload behaviour		Continuous current	For output voltage above 2…10Vdc (depending on the input voltage), see Fig. 6-1
		Intermittent current 1)	For output voltage below 2…10Vdc (depending on the input voltage), see Fig. 6-1
Overload/ short-circuit current	Max.	9.8A	Continuous current, see Fig. 6-1
	Typ.	9.2A	Intermittent current peak value for typ. 60ms Load impedance 50mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	Max.	3.5A	Intermittent current average value (R.M.S.) Load impedance 50mOhm, see Fig. 6-2
Output capacitance	Typ.	2 050µF	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) At heavy overloads (when output voltage falls below 2…10V, depending on the input voltage), the power supply delivers output current for 60ms. After this, the output is switched off for 360ms 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.

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

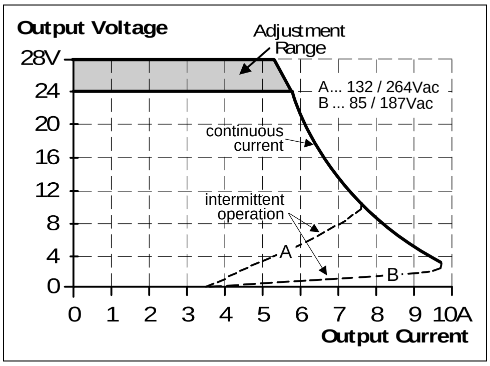
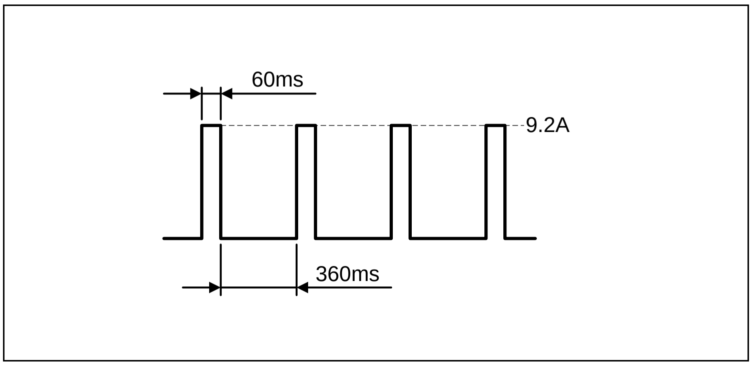


Fig. 6-2 **Intermittent operation at shorted output, typ.**



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 LED is also on during this 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**

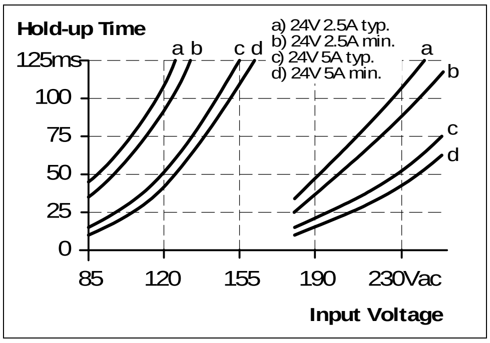
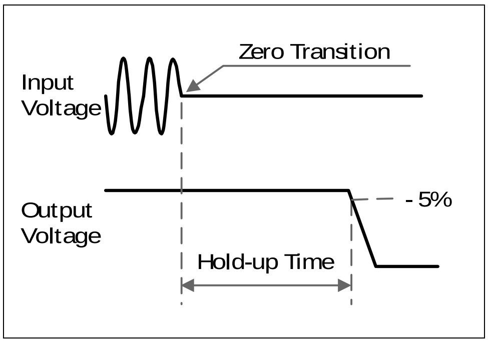


Fig. 7-2 **Shut-down behaviour, definitions**

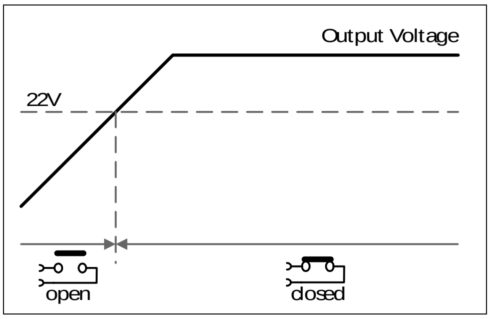


8. DC-OK RELAY CONTACT

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

Contact closes	As soon as the output voltage reaches 22V.
Contact opens	As soon as the output voltage falls below 22V.
Switching hysteresis	Typically, 0.7V
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 chapter 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.**

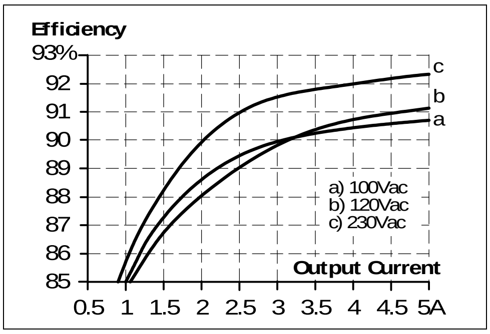


Fig. 9-2 **Losses vs. output current at 24V, typ.**

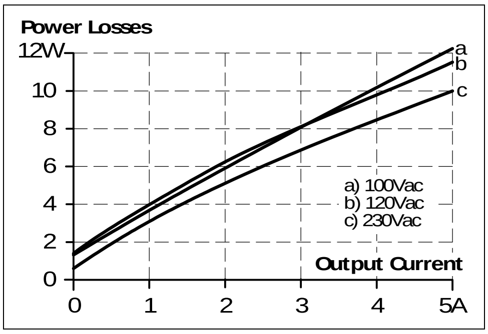


Fig. 9-3 **Efficiency vs. input voltage at 24V, 5A, typ.**

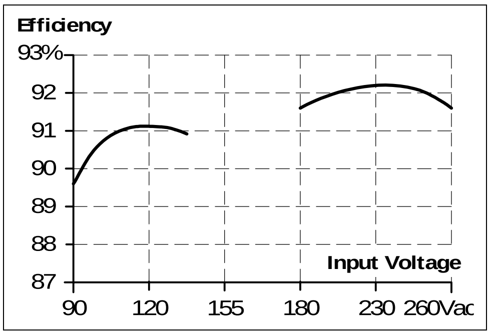
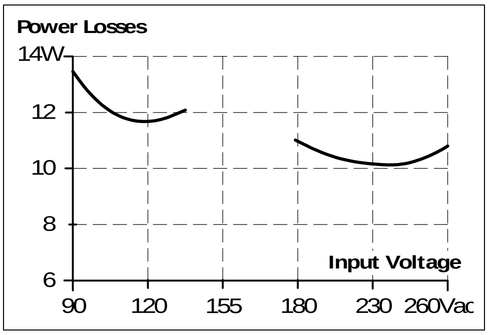
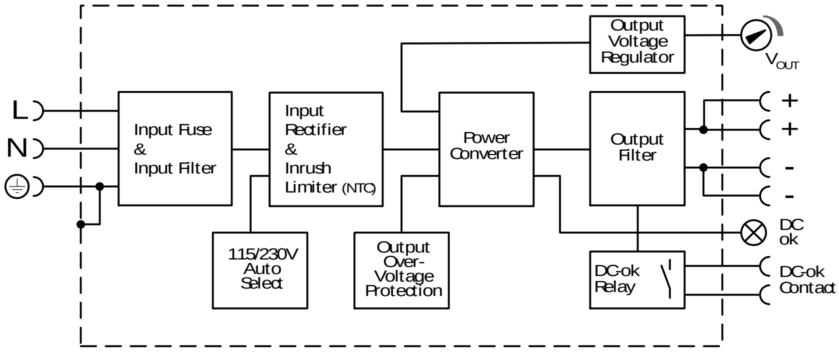


Fig. 9-4 **Losses vs. input voltage at 24V, 5A, typ.**



10. FUNCTIONAL DIAGRAM

Fig. 10-1 **Functional diagram**



11. FRONT SIDE AND USER ELEMENTS

Fig. 11-1 **Front side**

A **Input Terminals**

N, L Line input

⏚ PE (Protective Earth) input

B **Output Terminals**

Two identical + poles and two identical - poles

+ Positive output

– Negative (return) output

C **DC-OK LED** (green)

On, when the output voltage is above 18V.

D **Output Voltage Adjustment Potentiometer**

E **DC-OK Relay Contact**

The DC-OK relay contact is not synchronized with the DC-OK LED.

See chapter 8 for details.

12. CONNECTION TERMINALS

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

	Input	Output	DC-OK-Signal
Type	Screw Terminal	Screw Terminal	Push-in Terminal
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	Max. 1Nm	-
Wire stripping length	7mm	7mm	7mm
Screwdriver	4mm slotted or crosshead No 1	4mm slotted or crosshead No 1	3mm slotted to open the spring

13. 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	66 000h	68 000h	83 000h	At 24V, 5A and 40°C
	181 000h	194 000h	219 000h	At 24V, 2.5A and 40°C
	188 000h	193 000h	234 000h	At 24V, 5A and 25°C
	511 000h	548 000h	621 000h	At 24V, 2.5A and 25°C

14. 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	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

15. EMC

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

The device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3.

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.

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 industrial, residential, commercial and light-industrial environments.

EMC Immunity

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 70% of 100Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 40Vac, 200ms 70Vac, 500ms 70Vac, 500ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C below 4.5A Criterion A above 4.5A Criterion C Criterion A Criterion C Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance 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 55032, FCC Part 15, CISPR 11, CISPR 32	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 not fulfilled
Radiated emission	EN 55011, EN 55032	Class B
Harmonic input current	EN 61000-3-2	Fulfilled, Class A limits
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with constant current loads, non pulsing

Switching frequencies:

Main converter	40kHz to 120kHz	Output voltage and load dependent, min. load 1A

16. ENVIRONMENT

Operational temperature	-10°C to +70°C	Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.
Storage temperature	-40°C to +85°C	For storage and transportation
Output derating	3W/°C 7.5W/1000m or 5°C/1000m	Between +55°C and +70°C For altitudes >2000m, see Fig. 16-2
	The derating is not hardware controlled. The user has to take this into consideration 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	110-54kPa	See Fig. 16-2 for details
Altitude	Up to 5000m	See Fig. 16-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes up to 5000m
Impulse withstand voltages	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes up to 2000m
Degree of pollution	2	According to IEC 60664-1, 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 per 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.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

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

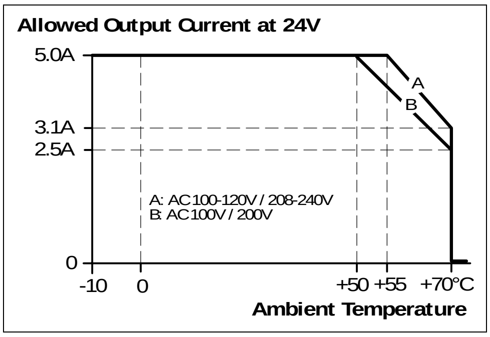
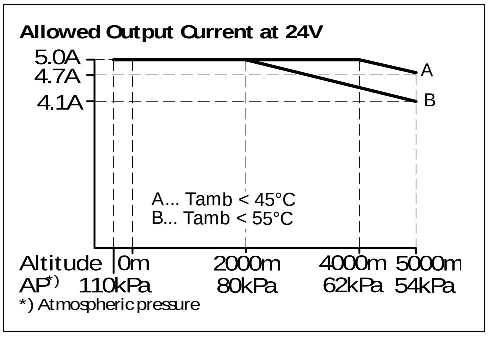


Fig. 16-2 **Output current vs. altitude**



17. 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
Output over-voltage protection	Typ.	31.0Vdc	
	Max.	34.0Vdc	
		In case of an internal defect, a redundant circuit limits the maximum output voltage. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection		I	According to IEC 61140 A PE (Protective Earth) connection is required
Ingress protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Not included	
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
Touch current (leakage current)	Typ.	0.21mA / 0.46mA	At 100Vac, 50Hz, TN-,TT-mains / IT-mains
	Typ.	0.30mA / 0.65mA	At 120Vac, 60Hz, TN-,TT-mains / IT-mains
	Typ.	0.33mA / 0.72mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.27mA / 0.56mA	At 110Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.38mA / 0.78mA	At 132Vac, 60Hz, TN-,TT-mains / IT-mains
	Max.	0.43mA / 0.90mA	At 264Vac, 50Hz, TN-,TT-mains / IT-mains

18. Dielectric Strength

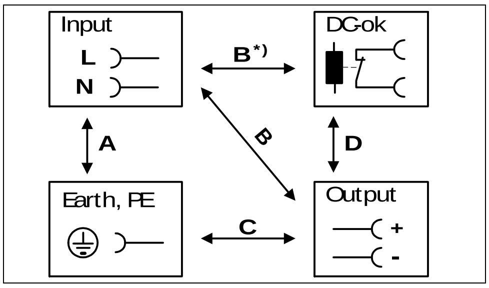
The output voltage is floating and has no ohmic connection to the ground.

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. 18-1 **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
Field test cut-off current settings		> 10mA	> 10mA	> 15mA	> 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.

19. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
IEC 61558-2-16	Safety	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

20. REGULATORY PRODUCT COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Regulation (EU)	REACH ✓	Manufacturer's Declaration EU regulation regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) fulfilled. EU Regulation (EC) 1907/2006.
WEEE Regulation		Manufacturer's Declaration EU Regulation on Waste Electrical and Electronic Equipment Registered as business to business (B2B) products. EU Regulation 2012/19/EU
KC		KC Korean Certification Korean - Registration of Broadcasting and Communication Equipment Registered under Clause3, Article 58-2 of Radio Waves Act. Registration No. R-R-PUG-PIC120.241D
UKCA	UK CA	UKCA Declaration of Conformity Trade conformity assessment for England, Scotland and Wales The UKCA mark indicates conformity with the UK Statutory Instruments 2016 No.1101, 2016 No.1091, 2012 No.3032

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	39mm
Height	124mm
Depth	124mm The DIN rail depth must be added to the unit depth to calculate the total required installation depth.
Weight	370g
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
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4mm

Fig. 21-1 **Front view**

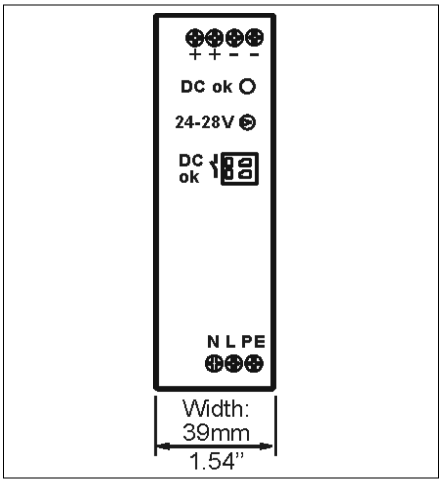
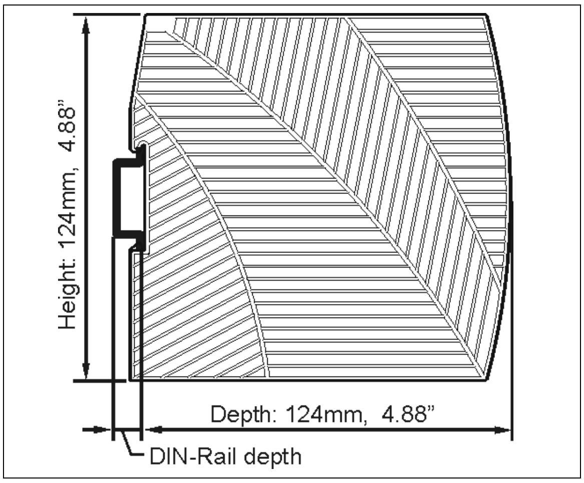


Fig. 21-2 **Side view**



22. ACCESSORY

22.1. PIRD20.241 REDUNDANCY MODULE

The PIRD20.241 is a dual redundancy module, which can be used to build 1+1 or N+1 redundant system.

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

The device 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 narrow and only requires 39mm width on the DIN rail.

See chapter 23.4 for wiring information.

22.2. 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.

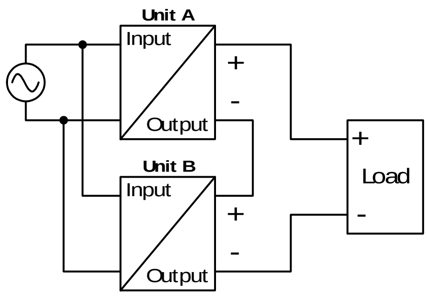
For longer hold-up times the UF40.241 might also be an option.

23. APPLICATION NOTES

23.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.2. 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.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. PARALLEL USE FOR 1+1 REDUNDANCY

The device can be used to built 1+1 redundant systems.

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.

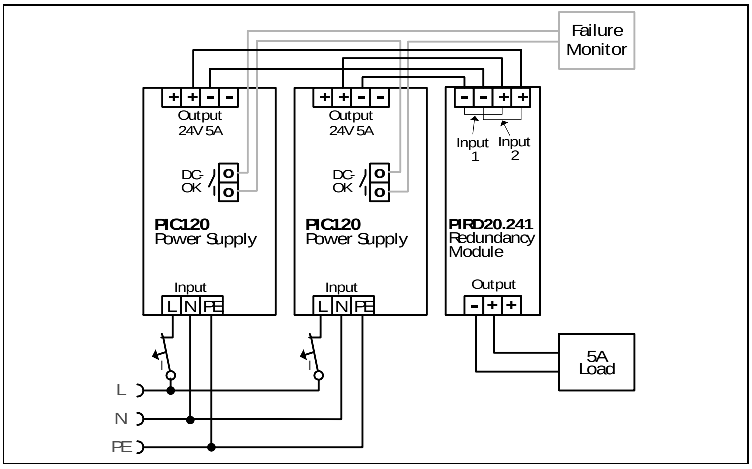
Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

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.

Wiring examples:

Fig. 23-1 **1+1 Redundant wiring with a PIRD20.241 redundancy module**

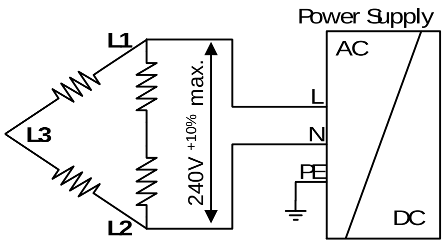


23.5. OPERATION ON TWO PHASES

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.



23.6. 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.

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

	Case A	**Case B**
Enclosure size	110x180x165mm Rittal Typ IP66 Box PK 9516 100, plastic	110x180x165mm Rittal Typ IP66 Box PK 9516 100, plastic
Input voltage	230Vac	230Vac
Load	24V, 4A; (=80%)	24V, 5A; (=100%)
Temperature inside the box	35.5°C	38.1°C
Temperature outside the box	21.0°C	21.0°C
Temperature rise	14.5K	17.1K

PIC120.241C, PIC120.242C

24V, 5A, 120W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 200-240V Regional Input
- Cost Optimized without Compromising Quality or Reliability.
- Width only 39mm
- Efficiency up to 90.5%
- Low No-load Power Losses
- Full Power Between -10°C and +55°C
- DC-OK Relay Contact Included
- 3 Year Warranty

PRODUCT 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.

Since typical industrial applications do not require multiple mains inputs, the reduction to a regional input voltage range (AC 200-240V) simplifies the circuitry and has significant advantages for reliability, efficiency and cost.

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	nominal
Adjustment range	24 - 28V	factory setting 24.1V
Output current	5 - 4.3A	below +60°C ambient
	3.1 - 2.7A	at +70°C ambient
	Derate between +60°C and +70°C	
AC Input voltage	AC 200-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	1.06A	
Power factor	0.54	
AC Inrush current	28A peak	at 40°C, cold start
Efficiency	90.5%	
Losses	12.6W	
Temperature range	-10°C to +70°C	
Hold-up time	33ms	
Dimensions	39x124x124mm	Without DIN rail
Weight	350g	

ORDER NUMBERS

Power Supply	PIC120.241C	with DC-OK relay contact
	PIC120.242C	without DC-OK relay contact
Accessory	YR2.DIODE	Redundancy Module
	UF20.241	Buffer Module

MAIN APPROVALS

For details and the complete approval list, see chapter 19

c UL US LISTED	DNV DNV.COM/AF	ABS
UL 61010-2-201	Marine	Marine

All parameters are specified at 24V, 5A, 230Vac, 50Hz, 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 Protective Earth 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, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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 industrial, residential, commercial and light-industrial environments.

Do not use this device on AC 200V mains with more than 4.5A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°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 ingress protection of IP20. The enclosure does not provide protection against spilled liquids.

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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac.

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 5000m. Above 2000m the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A C-characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +70°C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.

The device is designed to operate in areas between 5% and 95% relative humidity.

3. AC-INPUT

AC input	nom.	AC 200-240V	suitable for TN-, TT- and IT mains networks
AC input range		180-264Vac	
		264-300Vac	< 500ms
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	162Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	100Vac	at 24V 0A, steady-state value, see Fig. 3-1
	typ.	130Vac	at 24V 5A, steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 23.2.		

		AC 230V	
Input current	typ.	1.06A	at 24V, 5A, see Fig. 3-3
Power factor*)	typ.	0.54	at 24V, 5A, see Fig. 3-4
Crest factor**)	typ.	4	at 24V, 5A
Start-up delay	typ.	75ms	see Fig. 3-2
Rise time	typ.	30ms	at 24V, 5A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	90ms	at 24V, 5A const. current load, 5mF load capacitance,, see Fig. 3-2
Turn-on overshoot	max.	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.

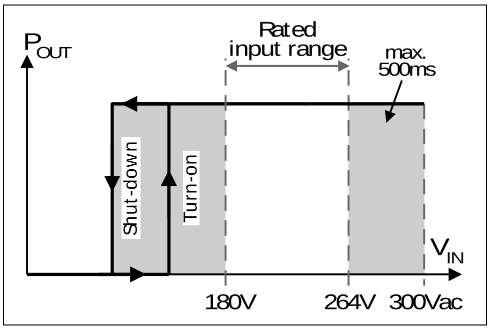


Fig. 3-2 Turn-on behavior, definitions

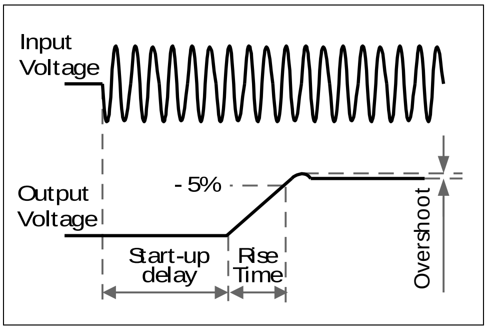


Fig. 3-3 Input current vs. output load at 24V

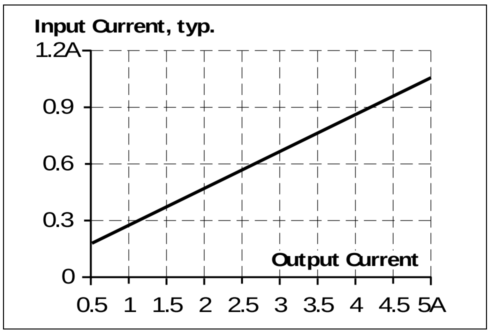
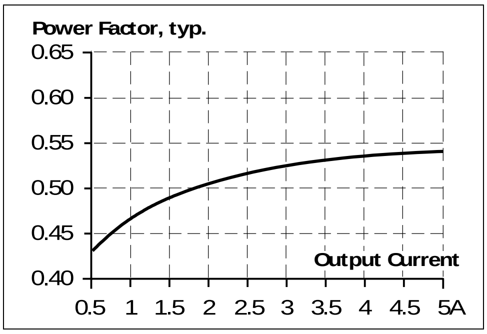


Fig. 3-4 Power factor vs. output load



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 230V	
Inrush current*)	max.	$37A_{peak}$	40°C ambient, cold start
	typ.	$28A_{peak}$	40°C ambient, cold start
	typ.	$23A_{peak}$	25°C ambient, cold start
Inrush energy*)	max.	$1.0A^2s$	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, 25°C ambient

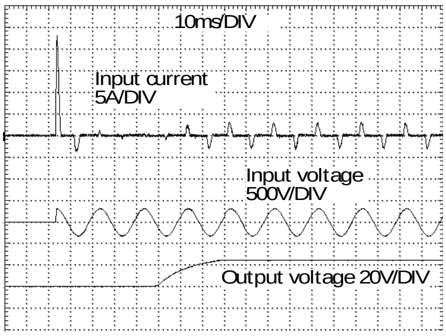
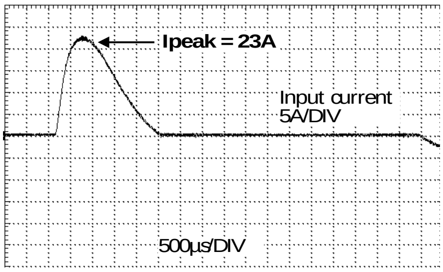


Fig. 5-2 Input inrush current, zoom into first peak
230Vac input, 24V 5A output, 25°C ambient



6. OUTPUT

Output voltage	nom.	24V	
Adjustment range		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	180-264Vac
Load regulation	max.	150mV	static value, 0A → 5A; see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	5A	at 24V, ambient temperature <55°C, see Fig. 6-1
	nom.	3.1A	at 24V, ambient temperature <70°C, see Fig. 6-1
	nom.	4.3A	at 28V, ambient temperature <55°C, see Fig. 6-1
	nom.	2.7A	at 28V, ambient temperature <70°C, see Fig. 6-1
Output power	nom.	120W	ambient temperature <55°C
	nom.	75W	ambient temperature <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.

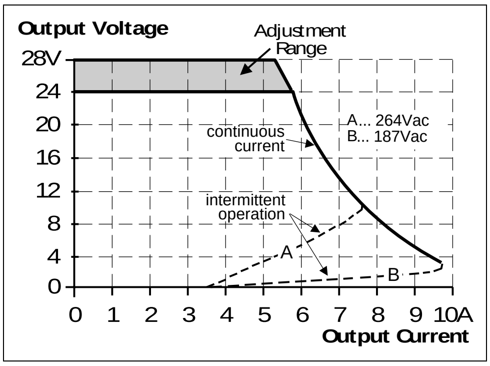
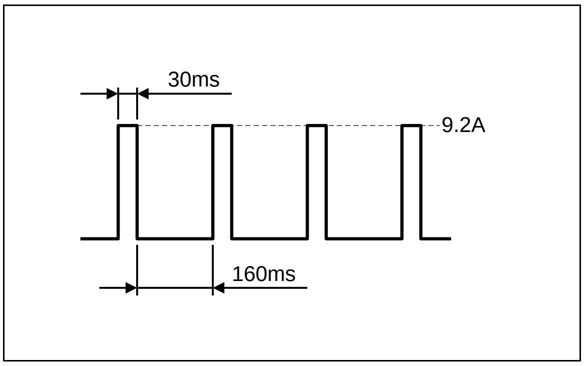


Fig. 6-2 Intermittent operation at shorted output, typ.



7. HOLD-UP TIME

		AC 230V	
Hold-up Time	typ.	69ms	at 24V, 2.5A, see Fig. 7-1
	min.	61ms	at 24V, 2.5A, see Fig. 7-1
	typ.	33ms	at 24V, 5A, see Fig. 7-1
	min.	29ms	at 24V, 5A, see Fig. 7-1

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

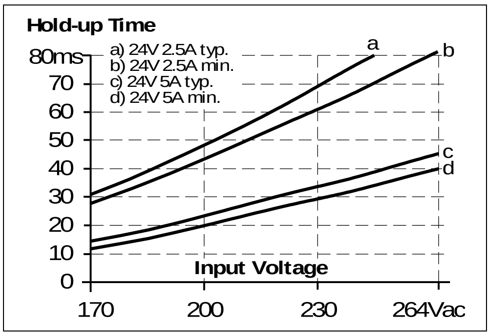
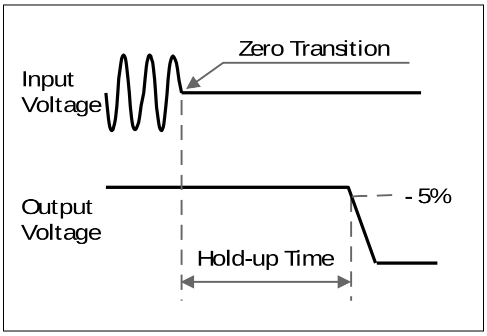


Fig. 7-2 Shut-down behavior, definitions

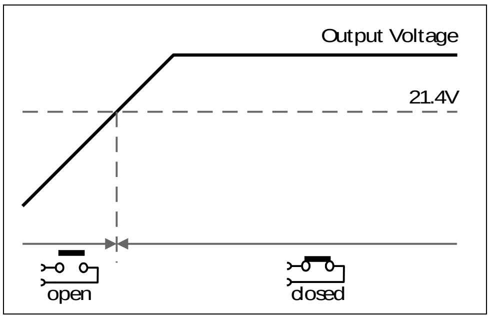


8. DC-OK RELAY CONTACT

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).

Threshold voltage	typ.	21.4V (fixed)	
Contact closes	As soon as the output voltage reaches 21.4V.		
Contact opens	As soon as the output voltage falls below 21.4V.		
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 chapter 18.		

Fig. 8-1 DC-OK relay contact behavior
(only for PIC120.241C)



9. EFFICIENCY AND POWER LOSSES

		AC 230V	
Efficiency	typ.	90.5%	at 24V, 5A
Average efficiency*)	typ.	89.5%	25% at 1.25A, 25% at 2.5A, 25% at 3.75A. 25% at 5A
Power losses	typ.	0.6W	PIC120.241C: at 24V, 0A
	typ.	0.5W	PIC120.242C: at 24V, 0A
	typ.	7.0W	at 24V, 2.5A
	typ.	12.6W	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.

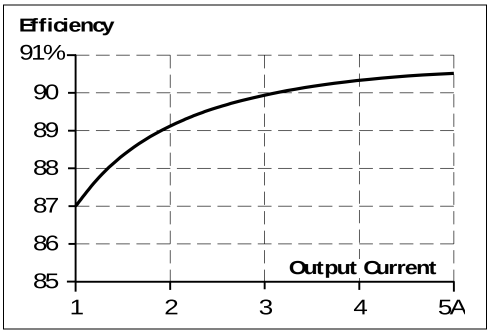
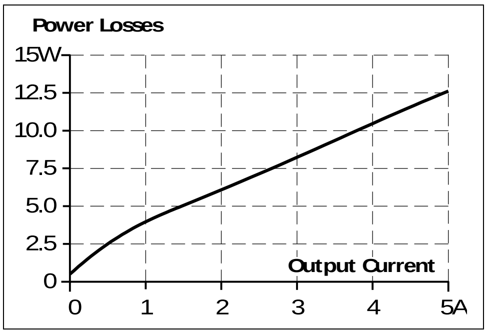


Fig. 9-2 Losses vs. output current at 24V, typ.



10. LIFETIME EXPECTANCY AND MTBF

	AC 230V	
Lifetime expectancy*)	110 000h	at 24V, 2.5A and 40°C
	312 000h*)	at 24V, 2.5A and 25°C
	47 000h	at 24V, 5A and 40°C
	133 000h*)	at 24V, 5A and 25°C
MTBF**) SN 29500, IEC 61709	1 720 000h	at 24V, 5A and 40°C
	3 223 000h	at 24V, 5A and 25°C
MTBF**) MIL HDBK 217F	1 322 000h	at 24V, 5A and 40°C; Ground Benign GB40
	1 785 000h	at 24V, 5A and 25°C; Ground Benign GB25
	385 000h	at 24V, 5A and 40°C; Ground Fixed GF40
	502 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 Mean Time Between Failure, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.
The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it 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 PIC120.241C

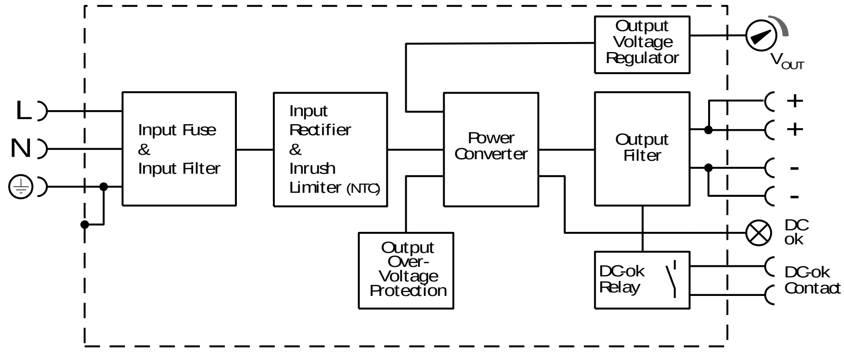
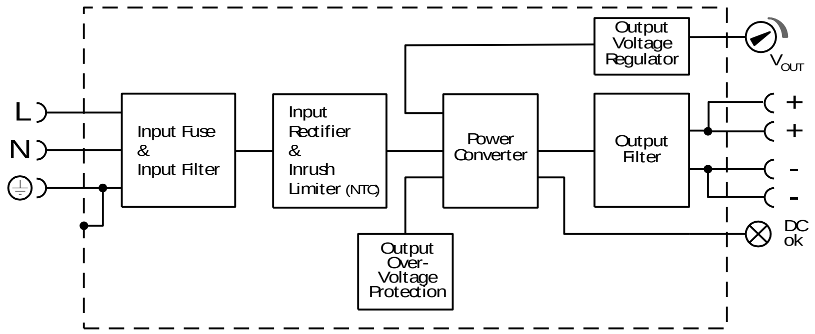


Fig. 11-2 Functional diagram PIC120.242C



12. TERMINALS AND WIRING

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

	Input and output	DC-OK-Signal only available in PIC120.241C
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	7mm
Screwdriver	4mm slotted or cross-head No 1	not required
Recommended tightening torque	1Nm	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 PIC120.241C

Fig. 13-2 Front side PIC120.242C

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.
This feature is not available in the PIC120.242C.

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 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 200Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A <4.5A Criterion B >4.5A Criterion C 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 200Vac (160Vac) 70% of 200Vac (140Vac) 50% of 200Vac (100Vac)	 1000ms 500ms 200ms	 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.
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 61000-6-3, EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR 32	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 55032	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	reduce output power according Fig. 15-1
Storage temperature	-40°C to +85°C	for storage and transportation
Output derating	3W/°C	55°C to 70°C
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	without any restrictions
	2000 to 6000m	reduce output power or ambient temperature, see Fig. 15-2 IEC 62103, EN 50178, overvoltage category II
Altitude derating	7.5W/1000m or 5°C/1000m	> 2000m, 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

*) 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.

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

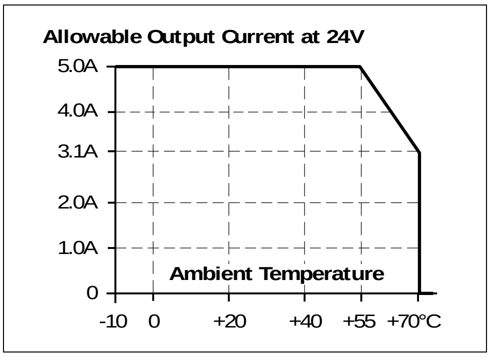
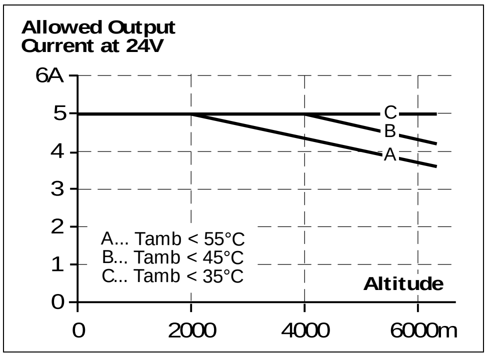


Fig. 15-2 Output current vs. altitude



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 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 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.

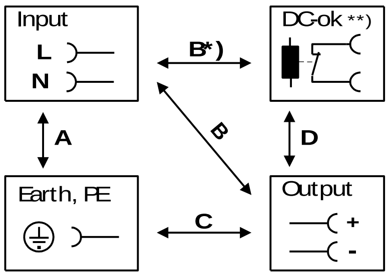
17. SAFETY FEATURES

Input / output separation	SELV PELV double or reinforced insulation	IEC/EN 60950-1 IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
Touch current (leakage current)	typ. 0.30mA / 0.75mA max. 0.39mA / 0.94mA	230Vac, 50Hz, TN-,TT-mains / IT-mains 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



**) DC-OK contact not included in PIC120.242C

		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		> 15mA	> 15mA	> 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.

19. APPROVED, FULFILLED OR TESTED STANDARDS

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
Marine (DNV)	DNV DNV.COM/AF	DNV Certificate DNV Type approved product Certificate: TAA00002JT Temperature: Class B Humidity: Class B Vibration: Class C EMC: Class A Enclosure: Class A
Marine (ABS)	ABS	ABS Design Assessment Certificate ABS (American Bureau of Shipment) assessed product Certificate: 17-HG1599236-PD
ISA-71.04-1985	Corrosion G3-ISA-71.04 ✓	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of 10 years
IEC 61558-2-16	Safety ✓	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

20. REGULATORY PRODUCT COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Regulation (EU)	REACH	Manufacturer's Declaration EU regulation regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) fulfilled. EU Regulation (EC) 1907/2006.
WEEE Regulation		Manufacturer's Declaration EU Regulation on Waste Electrical and Electronic Equipment Registered as business to business (B2B) products. EU Regulation 2012/19/EU
KC		KC Korean Certification Korean - Registration of Broadcasting and Communication Equipment Registered under Clause3, Article 58-2 of Radio Waves Act. Registration No. R-R-PUG-PIC120_241C.
UKCA	UK CA	UKCA Declaration of Conformity Trade conformity assessment for England, Scotland and Wales The UKCA mark indicates conformity with the UK Statutory Instruments 2016 No.1101, 2016 No.1091, 2012 No.3032

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	39mm
Height	124mm
Depth	124mm The DIN rail depth must be added to the unit depth to calculate the total required installation depth.
Weight	350g
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 PIC120.241

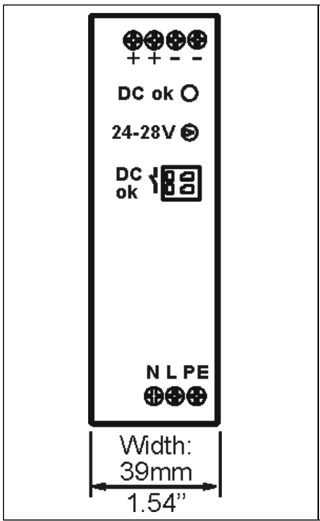


Fig. 21-2 Front view PIC120.242C

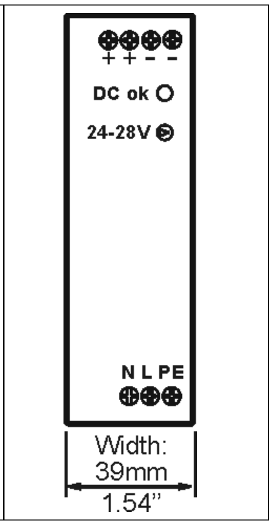
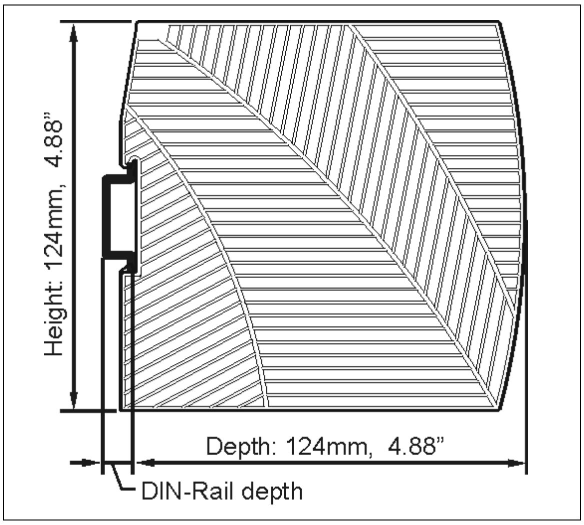


Fig. 21-3 Side view

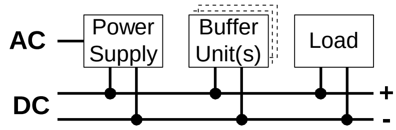


22. ACCESSORY

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.

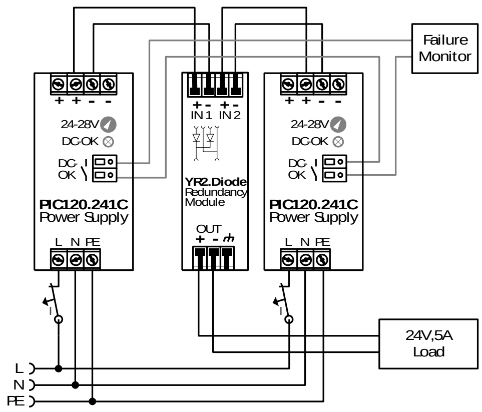
The buffer unit does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer units can be added in parallel to increase the output ampacity or the hold-up time.



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 23.4 for instructions how to build a redundant system.



23. APPLICATION NOTES

23.1. 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.

23.2. 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.

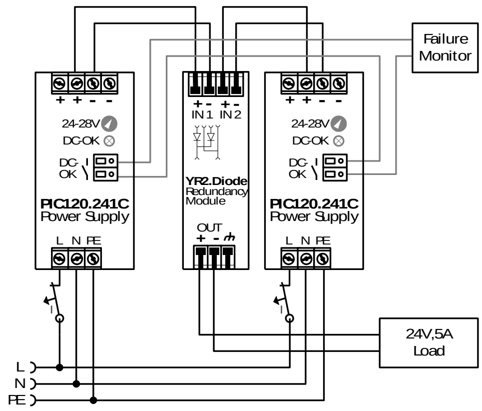
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. 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:

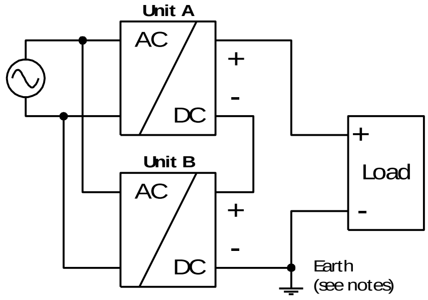
a) The preferred power supply is the PIC120.241C since it has a DC-OK signal contact included, which the PIC120.242C does not have. Use this DC-OK signal contact to monitor the individual power supply units.

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.

23.5. 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.

23.6. 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:

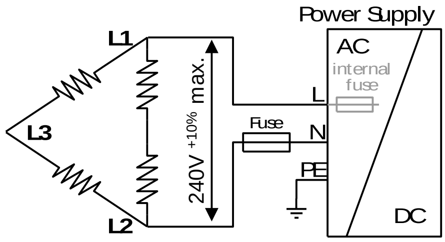
- max. 10mF with an additional 2.5A constant current load and
- max. 5mFwith an additional 5A constant current load.

23.7. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.8. 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$^{+10\%}$.



23.9. 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: 49.2°C	(in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	26.5°C
Temperature rise:	22.7K

Case B:

Load:	24V, 4A; (=80%) load is placed outside the box
Temperature inside the box: 46.0°C	(in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	26.8°C
Temperature rise:	19.2K

PIC240.241C

24V, 10A, 240W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 200-240V Regional Input
- Cost Optimized without Compromising Quality or Reliability.
- Width only 49mm
- Efficiency up to 91.4%
- 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.

Since typical industrial applications do not require multiple mains inputs, the reduction to a regional input voltage range (AC 200-240V) simplifies the circuitry and has significant advantages for reliability, efficiency and cost.

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	
Adjustment range	24 - 28V	
Output current	10A	at 24V, amb <55°C
	6.25A	at 24V, amb <70°C
	8.6A	at 28V, amb <55°C
	5.4A	at 28V, amb <70°C
Output power	240W	ambient <55°C
	150W	ambient <70°C
Output ripple	< 100mVpp	20Hz to 20MHz
AC Input voltage	AC 200-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	2.2A	at 230Vac
Power factor	0.52	at 230Vac
AC Inrush current	typ. 48A peak	at 230Vac, 40°C
Efficiency	91.4%	at 230Vac
Losses	22.6W	at 230Vac
Temperature range	-10°C to +70°C	operational
Derating	6W/°C	+55 to +70°C
Hold-up time	33ms	at 230Vac
Dimensions	49x124x124mm	WxHxD
Weight	550g / 1.2lb	

ORDER NUMBERS

Power Supply	**PIC240.241C**	
Accessory	YR2.DIODE	Redundancy module
	UF20.241	Buffer Module

MARKINGS

IECEE CB SCHEME — IEC 61010-2-201

c UL us LISTED — UL 61010-2-201

IECEE CB SCHEME — IEC 62368-1

DNV·GL dnvgl.com/af — Marine

ABS — Marine

CE

Mar. 2021 / Rev. 2.0 DS-PIC240.241C-EN
All parameters are specified at 24V, 10A, 230Vac, 50Hz, 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 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, measurement, Audio/Video, information or communication equipment or the like.

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

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Without additional measures to reduce the harmonic input current (PFC), the power supply is not suited to be connected to the public mains system in residential, commercial and light-industrial environments. No additional measures are necessary for use in industrial environments. Exceptions for various countries outside the European Union exist and can be determined locally.

Do not use this device on AC 200V mains with more than 8A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

2. INSTALLATION INSTRUCTIONS

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The isolation of the 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac.

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 5000m (16400ft). Above 2000m (6560ft) the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 16A B- or 10A 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.

3. AC-INPUT

AC input	nom.	AC 200-240V	suitable for TN-, TT- and IT mains networks
AC input range		180-264Vac	continuous operation
		264-300Vac	< 500ms
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	173Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	107Vac	at 24V 0A, steady-state value, see Fig. 3-1
	typ.	140Vac	at 24V 10A, steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 23.3.		

Input current	typ.	2.2A	at 24V, 10A, 230Vac, see Fig. 3-3
Power factor*)	typ.	0.52	at 24V, 10A, 230Vac, see Fig. 3-4
Crest factor**)	typ.	3.7	at 24V, 10A, 230Vac
Start-up delay	typ.	130ms	see Fig. 3-2
Rise time	typ.	35ms	at 24V, 10A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	100ms	at 24V, 10A const. current load, 10mF load capacitance,, see Fig. 3-2
Turn-on overshoot	max.	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.**

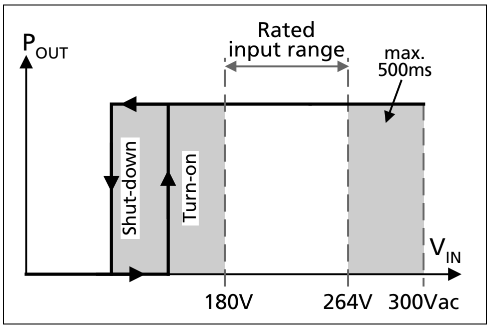


Fig. 3-2 **Turn-on behavior, definitions**

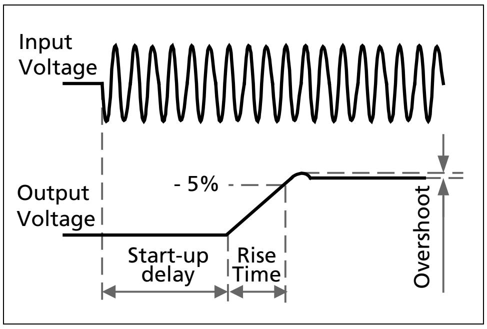


Fig. 3-3 **Input current vs. output load at 24V**

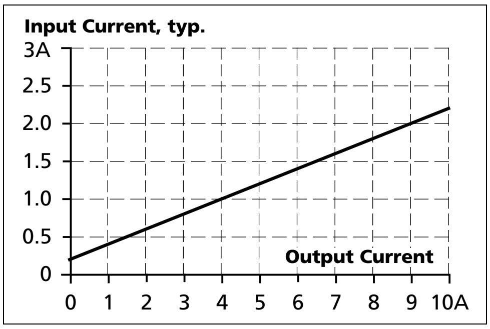
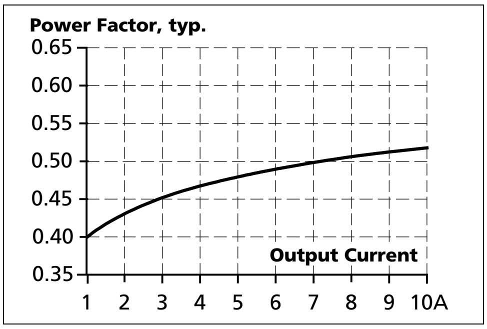


Fig. 3-4 **Power factor vs. output load**



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.

Inrush current*)	max.	$59A_{peak}$	40°C ambient, 230Vac, cold start
	typ.	$48A_{peak}$	40°C ambient, 230Vac, cold start
	typ.	$35A_{peak}$	25°C ambient, 230Vac, cold start
Inrush energy*)	max.	$2.5A^2s$	40°C ambient, 230Vac, 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 10A output, 25°C ambient**

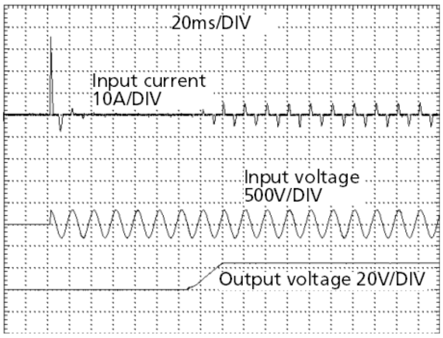
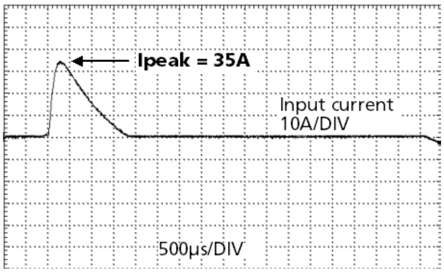


Fig. 5-2 **Input inrush current, zoom into first peak 230Vac input, 24V 10A output, 25°C ambient**

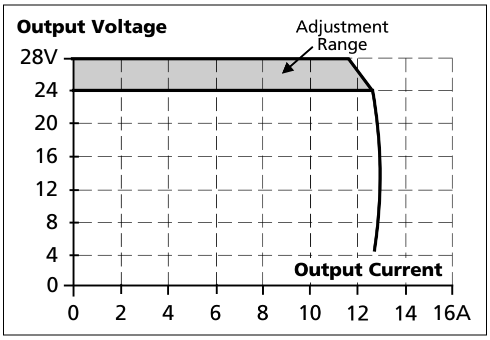


6. OUTPUT

Output voltage	nom.	DC 24V	
Adjustment range		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.	50mV	187-264Vac
Load regulation	max.	150mV	static value, 0A → 10A; see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	10A	at 24V, ambient temperature <55°C, see Fig. 6-1
	nom.	6.25A	at 24V, ambient temperature <70°C, see Fig. 6-1
	nom.	8.6A	at 28V, ambient temperature <55°C, see Fig. 6-1
	nom.	5.4A	at 28V, ambient temperature <70°C, see Fig. 6-1
Output power	nom.	240W	ambient temperature <55°C
	nom.	150W	ambient temperature <70°C
Overload behaviour		continuous current	see Fig. 6-1
Short-circuit current	max.	16A*)	load impedance 50mOhm
Output capacitance	typ.	4 400µF	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, typ.**



7. HOLD-UP TIME

Hold-up Time	typ.	75ms	at 24V, 5A, 230Vac, see Fig. 7-1
	min.	59ms	at 24V, 5A, 230Vac, see Fig. 7-1
	typ.	33ms	at 24V, 10A, 230Vac, see Fig. 7-1
	min.	25ms	at 24V, 10A, 230Vac, see Fig. 7-1

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

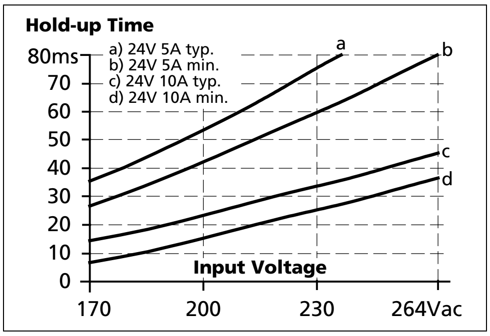
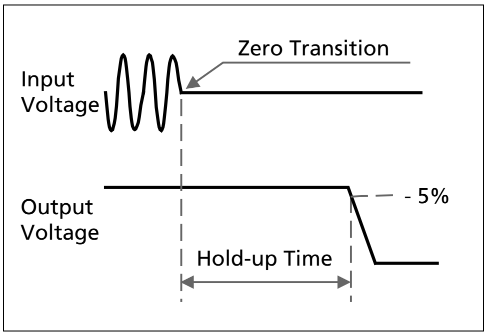


Fig. 7-2 **Shut-down behavior, definitions**

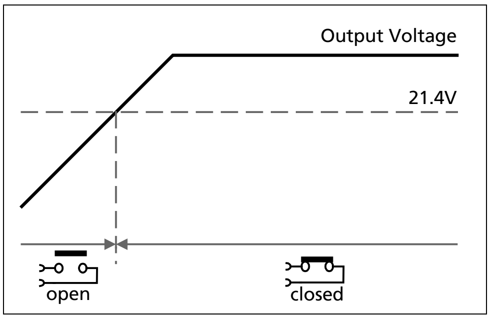


8. DC-OK RELAY CONTACT

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).

Threshold voltage	typ.	21.4V (fixed)	
Contact closes	As soon as the output voltage reaches 21.4V.		
Contact opens	As soon as the output voltage falls below 21.4V.		
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**



9. EFFICIENCY AND POWER LOSSES

Efficiency	typ.	91.4%	at 24V, 10A, 230Vac
Average efficiency*)	typ.	90.9%	25% at 2.5A, 25% at 5A, 25% at 7.5A. 25% at 10A
Power losses	typ.	5.5W	at 24V, 0A, 230Vac
	typ.	11.0W	at 24V, 5A, 230Vac
	typ.	22.6W	at 24V, 10A, 230Vac

*) 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.**

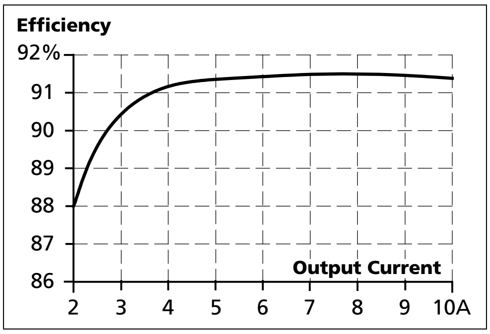
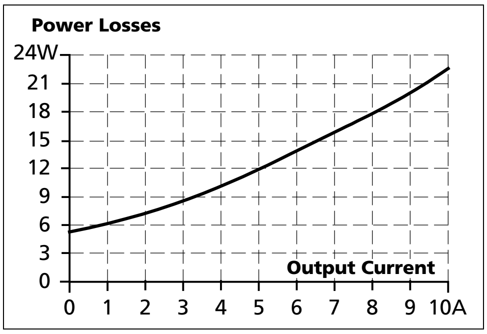


Fig. 9-2 **Losses vs. output current at 24V, typ.**



10. LIFETIME EXPECTANCY AND MTBF

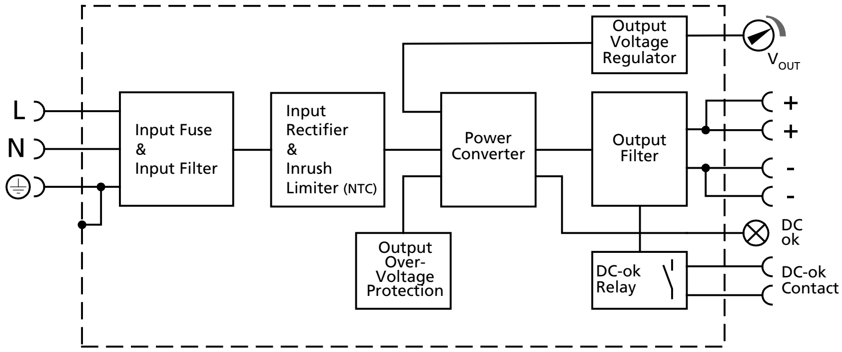
Lifetime expectancy*)	84 000h	at 24V, 5A and 40°C, 230Vac
	236 000h*)	at 24V, 5A and 25°C, 230Vac
	38 000h	at 24V, 10A and 40°C, 230Vac
	107 000h	at 24V, 10A and 25°C, 230Vac
MTBF**) SN 29500, IEC 61709	791 000h	at 24V, 10A and 40°C, 230Vac
	1 588 000h	at 24V, 10A and 25°C, 230Vac
MTBF**) MIL HDBK 217F	568 000h	at 24V, 10A and 40°C, 230Vac; Ground Benign GB40
	765 000h	at 24V, 10A and 25°C, 230Vac; Ground Benign GB25
	151 000h	at 24V, 10A and 40°C, 230Vac; Ground Fixed GF40
	194 000h	at 24V, 10A and 25°C, 230Vac; 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 PIC240.241C**



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. 6mm^2	max. 1.5mm^2
Stranded wire	max. 4mm^2	max. 1.5mm^2
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 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. Restrictions apply on public mains (PFC), see chapter 1.

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 200Vac 0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A <8A Criterion B >8A Criterion C Criterion C
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 200Vac (160Vac) 70% of 200Vac (140Vac) 50% of 200Vac (100Vac)	 1000ms 500ms 200ms	 Criterion A Criterion C 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 55032, FCC Part 15, CISPR 11, CISPR 32	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 55032	Class B fulfilled
Harmonic input current	EN 61000-3-2	not 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
**) for information only, not mandatory for EN 61000-6-3

Switching frequency	75kHz to 120kHz	Main converter, input voltage and output current dependent

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	6W/°C	55°C to 70°C (131°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. 15-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	15W/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.

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

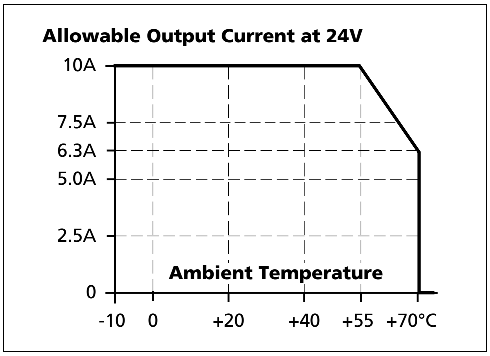
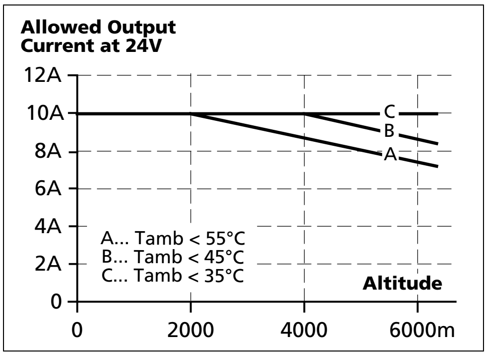


Fig. 15-2 **Output current vs. altitude**



16. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits*)	
Output over-voltage protection	typ. 31.5Vdc max. 34Vdc	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.
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.

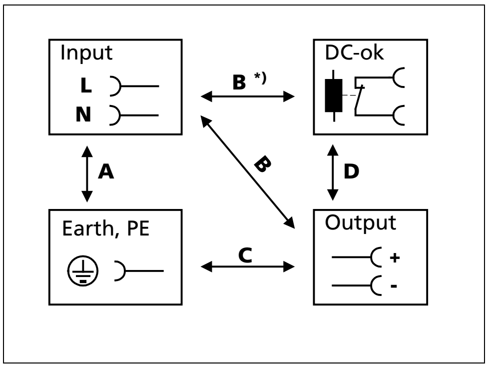
17. SAFETY FEATURES

Input / output separation	SELV PELV double or reinforced insulation	IEC/EN 60950-1 IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MOhm	input to output, 500Vdc
Touch current (leakage current)	typ. 0.35mA / 0.73mA max. 0.46mA / 0.97mA	230Vac, 50Hz, TN-,TT-mains / IT-mains 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**



		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		> 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.

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 AND FULFILLED STANDARDS

UL 61010	c UL US LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61010	IECEE CB SCHEME	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	IECEE CB SCHEME	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
Marine (DNV GL)	DNV·GL dnvgl.com/af	DNV-GL Certificate DNV-GL Type approved product Certificate: TAA00002JT Temperature: Class B Humidity: Class B Vibration: Class C EMC: Class A Enclosure: Class A
Marine (ABS)	ABS	ABS Design Assessment Certificate ABS (American Bureau of Shipment) assessed product Certificate: 17-HG1599236-PD
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

20. Regulatory Compliance

EU Declaration of Conformity		The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Directive		Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Directive		Manufacturer's Statement EU-Regulation on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products.
RoHS (China RoHS 2)		Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration		EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	49mm 1.93''
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	550g / 1.2lb
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**

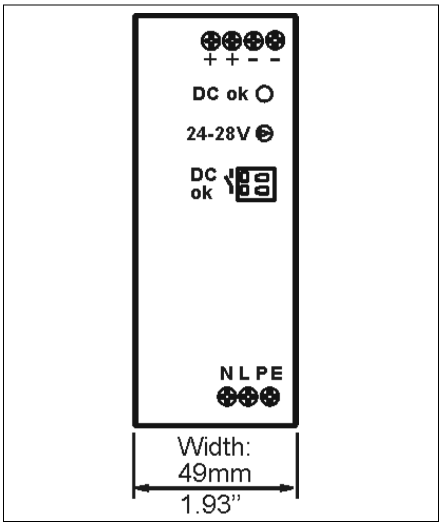
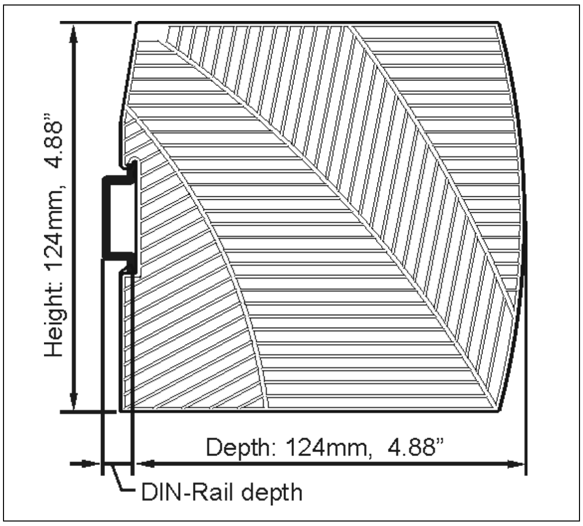


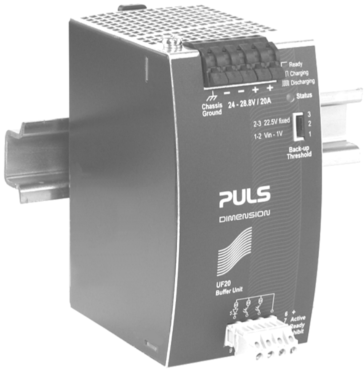
Fig. 21-2 **Side view**



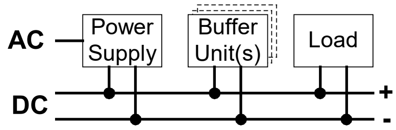
22. ACCESSORY

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.



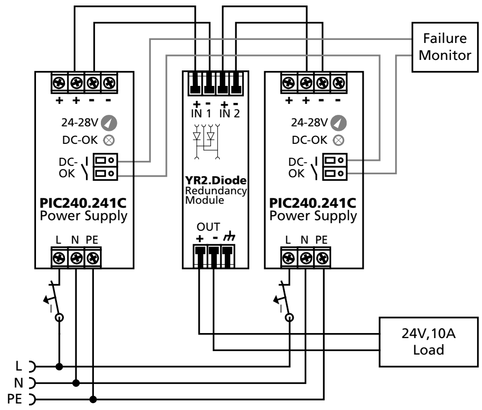
The buffer unit does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer units can be added in parallel to increase the output ampacity or the hold-up time.



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. 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.

23.2. 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.

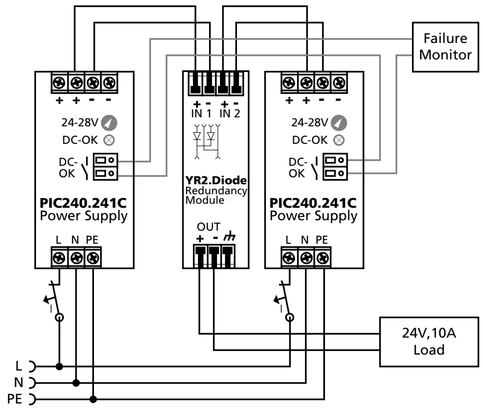
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 16A B- or 10A C-Characteristic breaker should be used.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. PARALLEL USE FOR 1+1 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.

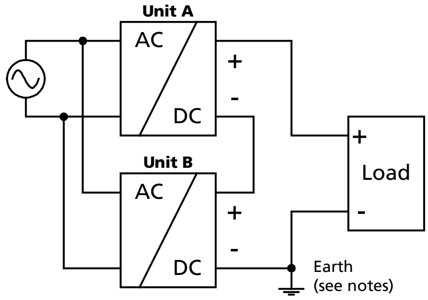


Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only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

Recommendations for building redundant power systems:

a) Monitor the individual power supply units. Therefore, use the DC-OK relay contact of the PIC240.241C power supply.
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.

23.5. 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.

23.6. INDUCTIVE AND CAPACITIVE LOADS

No limitations for inductive loads

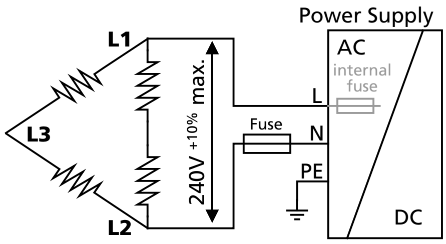
No limitations for capacitive loads

23.7. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.8. 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$^{+10\%}$.



23.9. 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 9519 100, plastic, 180x180x165mm
Input:	230Vac

Case A:

Load:	24V, 10A; load is placed outside the box
Temperature inside the box:	54.4°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	25.2°C
Temperature rise:	29.2K

Case B:

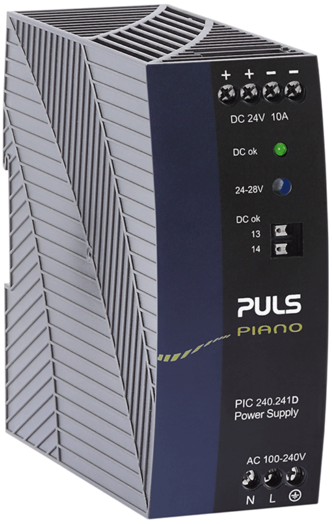
Load:	24V, 8A; (=80%) load is placed outside the box
Temperature inside the box:	51.3°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	27.0°C
Temperature rise:	24.3K

PULS

PIANO-Series

PIC240.241D

24V, 10A, 240W, SINGLE PHASE INPUT



POWER SUPPLY

- AC 100-240V Wide-range Input
- Active PFC
- Width only 49mm
- Efficiency up to 95.2%
- Safe Hiccup^{PLUS} Overload Mode
- Full Power Between -25°C and +55°C
- DC-OK Relay Contact
- 3 Year Warranty

PRODUCT 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 wide-range input voltage stage, many safety approvals and a wide operational temperature range, which makes the unit applicable for global use.

The addition of a DC-OK signal makes the unit suitable for many industry applications such as process control, factory automation or many other critical applications, where preventive function monitoring can help to avoid long downtimes.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24 – 28V	Factory setting 24.1V
Output current	10.0 – 8.6A	Below +55°C amb.
	6.25 – 5.4A	At +70°C ambient
	Derate linearly between +55°C and +70°C	
Input voltage AC	AC 100-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	2.15 / 1.15A	At 120 / 230Vac
Power factor	0.99 / 0.95	At 120 / 230Vac
AC Inrush current	14 / 26A pk	At 120 / 230Vac, 40°C, cold start
Efficiency	94.0 / 95.2%	At 120 / 230Vac
Losses	15.3 / 12.1W	At 120 / 230Vac
Hold-up time	37 / 37ms	At 120 / 230Vac
Temperature range	-25 to +70°C	
Size (WxHxD)	49x124x124mm	
Weight	540g / 1.2lb	

ORDER NUMBERS

Power Supply	**PIC240.241D**	
Accessory	YR2.DIODE	Redundancy module
	UF20.241	Buffer Module

MAIN APPROVALS

IECEE CB SCHEME — IEC 61010-2-201

c UL us LISTED — UL 61010-2-201

IECEE CB SCHEME — IEC 62368

INDEX

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 commercial use, such as in industrial control, process control, monitoring, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

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.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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.

2. Installation Instructions

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 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 device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The isolation of the 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac.

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 5000m (16400ft). Above 2000m (6560ft) the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A 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.

3. AC-INPUT

The device is suitable to be supplied from TN, TT or IT mains networks with AC voltage.

AC input	Nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		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.	81Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	Typ.	63Vac / 71Vac	At no load / nominal load, steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	AC 120V	AC 230V	
Input current	Typ.	2.6A	2.15A	1.15A	At 24V, 10A, see Fig. 3-3
Power factor	Typ.	0.99	0.99	0.95	At 24V, 10A, see Fig. 3-4
Crest factor	Typ.	1.6	1.7	2.0	At 24V, 10A, The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
Start-up delay	Typ.	460ms	320ms	250ms	See Fig. 3-2
Rise time	Typ.	60ms	60ms	60ms	At 24V, 10A const. current load, 0mF load capacitance, see Fig. 3-2
	Typ.	230ms	230ms	230ms	At 24V, 10A const. current load, 10mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	200mV	200mV	See Fig. 3-2

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

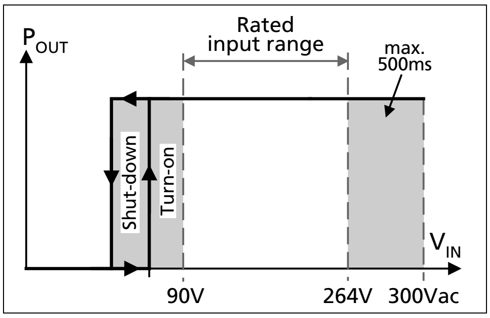


Fig. 3-2 **Turn-on behavior, definitions**

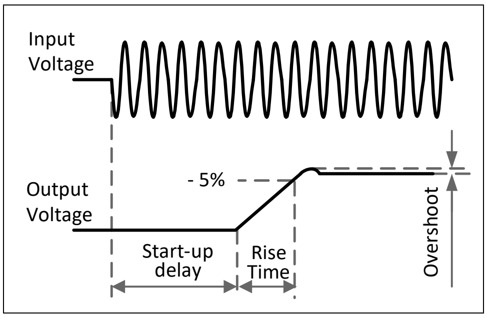


Fig. 3-3 **Input current vs. output load at 24V**

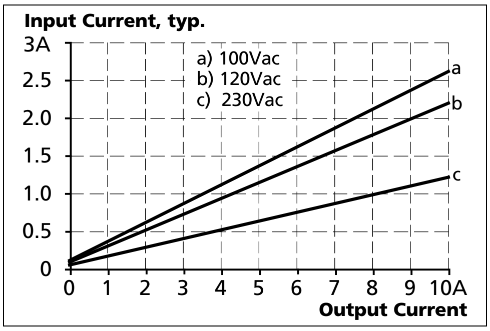
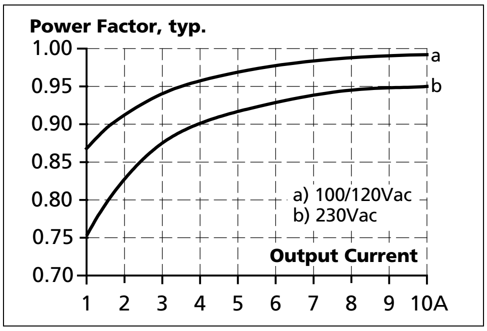


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not operate this power supply with DC-input voltage.

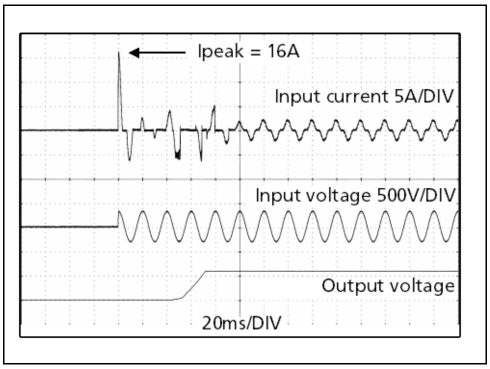
5. INPUT INRUSH CURRENT

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.	$14.5A_{peak}$	$17A_{peak}$	$32A_{peak}$	At 40°C, cold start
	Typ.	$7A_{peak}$	$8.5A_{peak}$	$16A_{peak}$	At 25°C, cold start
	Typ.	$11.5A_{peak}$	$14A_{peak}$	$26A_{peak}$	At 40°C, cold start
Inrush energy	Max.	$1A^2s$	$1A^2s$	$1A^2s$	At 40°C, cold start

Fig. 5-1 **Input inrush current, typical behavior**
230Vac input, 24V 10A output, 25°C ambient



6. OUTPUT

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

The output is designed to supply any kind of loads, including capacitive and inductive loads. The output can supply any kind of loads, including unlimited inductive and capacitive loads. If capacitors with a capacitance >2F are connected, 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.	DC 24V	
Adjustment range		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 settings	Typ.	24.1V	±0.2%, at full load and cold unit
Line regulation	Max.	10mV	Between 90 and 300Vac
Load regulation	Max.	100mV	Between 0A and 10A, static value, see Fig. 6-1
Ripple and noise voltage	Max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	10.0A	At 24V and an ambient temperatures below 55°C
	Nom.	6.25A	At 24V and 70°C ambient temperature
	Nom.	8.6A	At 28V and an ambient temperatures below 55°C
	Nom.	5.4A	At 28V and 70°C ambient temperature
		Derate linearly between +55°C and +70°	
Overload behaviour		Continuous current	For output voltage above 13Vdc, see Fig. 6-1
		Intermittent current 1)	For output voltage below 13Vdc, see Fig. 6-1
Overload/ short-circuit current	Max.	13.0A	Continuous current, see Fig. 6-1
	Typ.	14.5A	Intermittent current peak value for typ. 1s Load impedance 50mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	Max.	5.5A	Intermittent current average value (R.M.S.) Load impedance 50mOhm, see Fig. 6-2
Output capacitance	Typ.	2 850µF	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) At heavy overloads (when output voltage falls below 13V), the power supply delivers continuous output current for 2-5s. After this, the output is switched off for approx. 7s before a new start attempt with duration of 1s is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally.

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

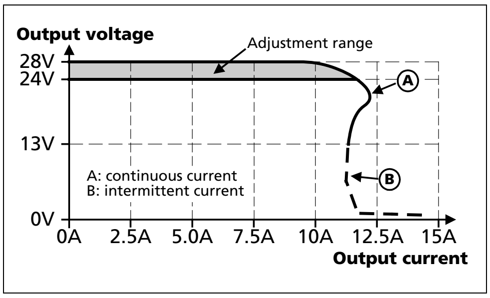
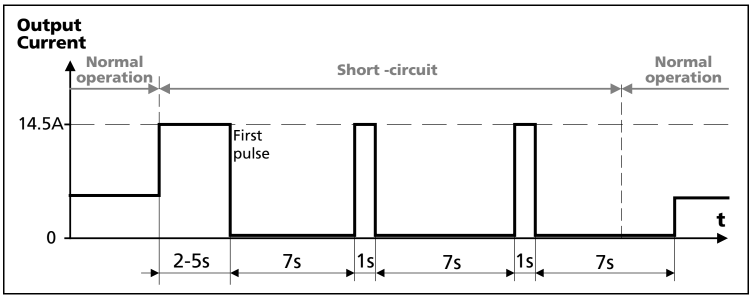


Fig. 6-2 **Short-circuit on output, intermittent current, typ.**



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.	74ms	74ms	74ms	At 24V, 5A, see Fig. 7-1
	Min.	58ms	58ms	58ms	At 24V, 5A, see Fig. 7-1
	Typ.	37ms	37ms	37ms	At 24V, 10A, see Fig. 7-1
	Min.	29ms	29ms	29ms	At 24V, 10A, see Fig. 7-1

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

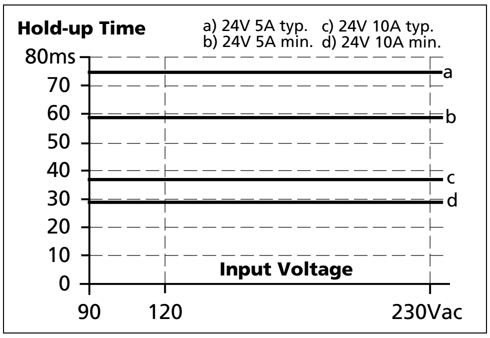
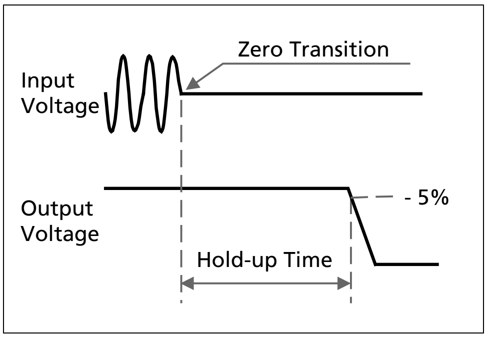


Fig. 7-2 **Shut-down behavior, definitions**

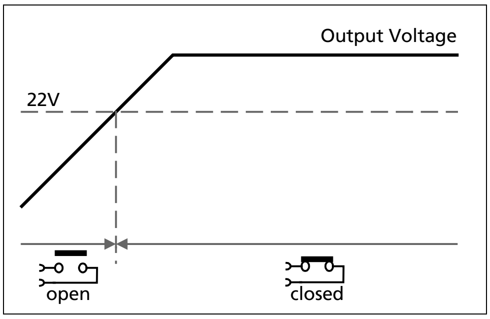


8. DC-OK RELAY CONTACT

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

Contact closes	As soon as the output voltage reaches 22V.
Contact opens	As soon as the output voltage falls below 22V.
Switching hysteresis	Typically 0.3V
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.	93.2%	94.0%	95.2%	At 24V, 10A
Average efficiency*)	Typ.	92.7%	93.1%	93.9%	25% at 2.5A, 25% at 5A, 25% at 7.5A. 25% at 10A
Power losses	Typ.	2.8W	2.8W	2.6W	At 24V, 0A
	Typ.	9.6W	8.5W	7.3W	At 24V, 5A
	Typ.	17.5W	15.3W	12.1W	At 24V, 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 24V, typ.**

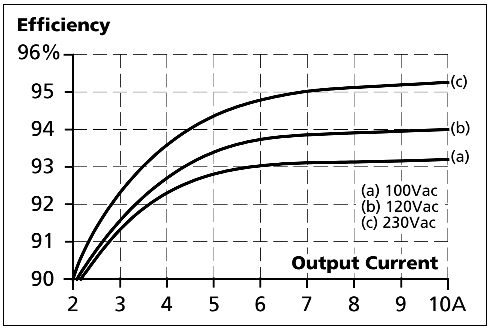


Fig. 9-2 **Losses vs. output current at 24V, typ.**

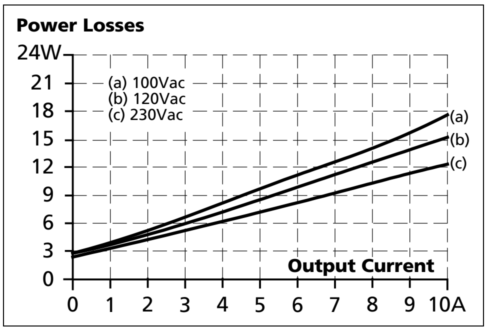


Fig. 9-3 **Efficiency vs. input voltage at 24V, 10A, typ.**

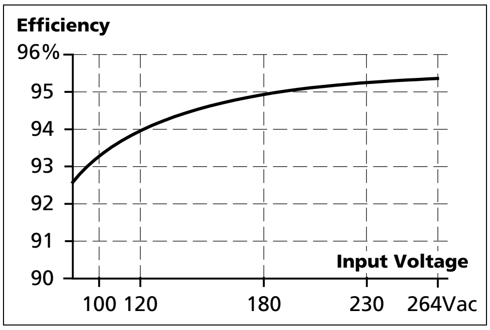
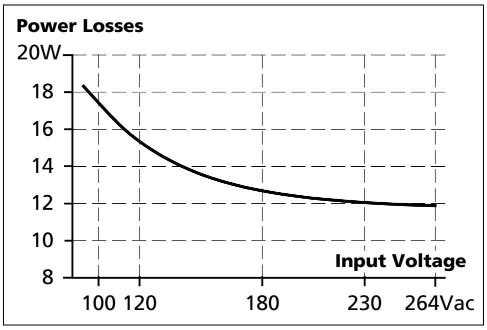
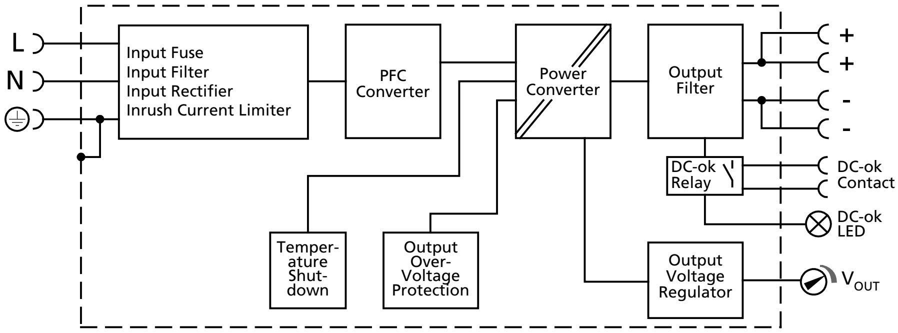


Fig. 9-4 **Losses vs. input voltage at 24V, 10A, typ.**



10. FUNCTIONAL DIAGRAM

Fig. 10-1 **Functional diagram**



11. FRONT SIDE AND USER ELEMENTS

Fig. 11-1 **Front side**

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

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

C DC-OK LED (green)
On, when the output voltage is above 18V.

D Output Voltage Adjustment Potentiometer

E DC-OK Relay Contact
The DC-OK relay contact is not synchronized with the DC-OK LED.
See chapter 8 for details.

12. CONNECTION TERMINALS

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

	Input	Output	DC-OK-Signal
Type	Screw termination	Screw termination	Push-in termination
Solid wire	Max. 6mm^2	Max. 6mm^2	Max. 1.5mm^2
Stranded wire	Max. 4mm^2	Max. 4mm^2	Max. 1.5mm^2
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

13. 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	47 000h	55 000h	74 000h	At 24V, 10A and 40°C
	89 000h	93 000h	103 000h	At 24V, 5A and 40°C
	133 000h	156 000h	209 000h	At 24V, 10A and 25°C
	252 000h	262 000h	291 000h	At 24V, 5A and 25°C

14. 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.

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	655 000h	736 000h	822 000h	At 24V, 10A and 40°C
	1 149 000h	1 267 000h	1 391 000h	At 24V, 10A and 25°C
MTBF MIL HDBK 217F	323 000h	345 000h	374 000h	At 24V, 10A and 40°C, Ground Benign GB40
	441 000h	471 000h	508 000h	At 24V, 10A and 25°C, Ground Benign GB25
	72 000h	78 000h	85 000h	At 24V, 10A and 40°C, Ground Fixed GF40
	94 000h	101 000h	111 000h	At 24V, 10A and 25°C, Ground Fixed GF25

15. EMC

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

The device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3.

The 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.

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 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 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	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	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 0.3ms	Criterion A

Performance 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 55032, FCC Part 15, CISPR 11, CISPR 32	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 not fulfilled
Radiated emission	EN 55011, EN 55032	Class B
Harmonic input current	EN 61000-3-2	Fulfilled, Class A limits
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with constant current loads, non pulsing

Switching frequencies:

PFC converter	60kHz to 140kHz	Input voltage and load dependent
Main converter	65kHz to 150kHz	Output voltage and load dependent

16. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	6W/°C 15W/1000m or 5°C/1000m	Between +55°C and +70°C (131°F to 140°F) For altitudes >2000m (6560ft), see Fig. 16-2
	The de-rating is not hardware controlled. The user has to take this into consideration 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	110-54kPa	See Fig. 16-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 16-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes up to 5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes up to 2000m
Degree of pollution	2	According to IEC 60664-1, 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 per 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.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

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

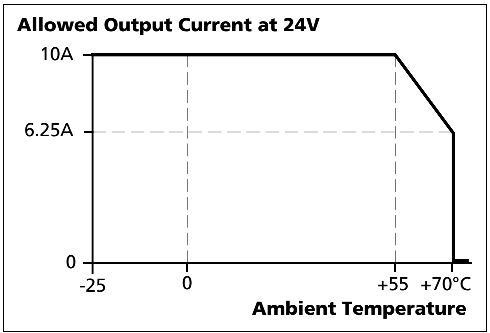
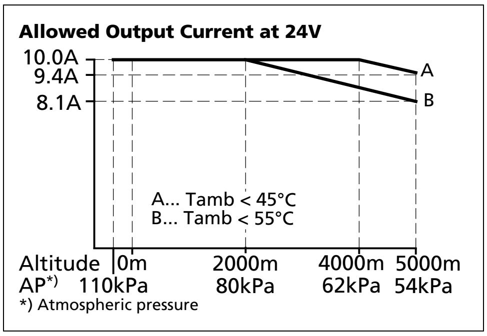


Fig. 16-2 **Output current vs. altitude**



17. 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
Output over-voltage protection	Typ.	30.5Vdc	
	Max.	32.0Vdc	
		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
Ingress protection		IP20	According to EN/IEC 60529
Over-temperature protection		Included	Output shut-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 15 (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.30mA / 0.79mA	At 100Vac, 50Hz, TN-,TT-mains / IT-mains
	Typ.	0.42mA / 1.1mA	At 120Vac, 60Hz, TN-,TT-mains / IT-mains
	Typ.	0.67mA / 1.7mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.37mA / 0.94mA	At 110Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.54mA / 1.33mA	At 132Vac, 60Hz, TN-,TT-mains / IT-mains
	Max.	0.88mA / 2.18mA	At 264Vac, 50Hz, TN-,TT-mains / IT-mains

18. DIELECTRIC STRENGTH

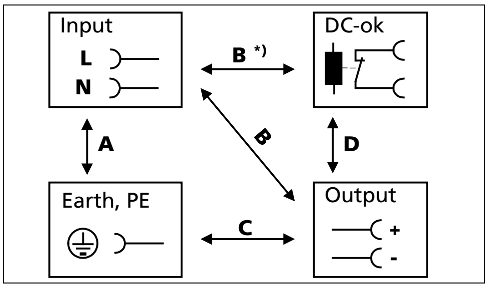
The output voltage is floating and has no ohmic connection to the ground.

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 cannot be switched off when unnoticed earth faults occur.

Fig. 18-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Routine test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Field test cut-off current settings		> 15mA	> 15mA	> 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.

19. APPROVALS AND FULFILLED STANDARDS

UL 61010	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61010	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
ISA-71.04-1985	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

20. REGULATORY COMPLIANCE

EU Declaration of Conformity	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Directive	Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Directive	Manufacturer's Statement EU-Regulation on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products.
RoHS (China RoHS 2)	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	49mm 1.93''
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	540g / 1.2lb
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
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4mm

Fig. 21-1 **Front view**

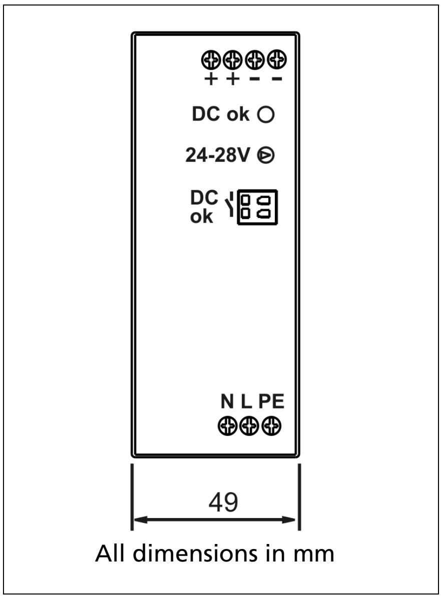
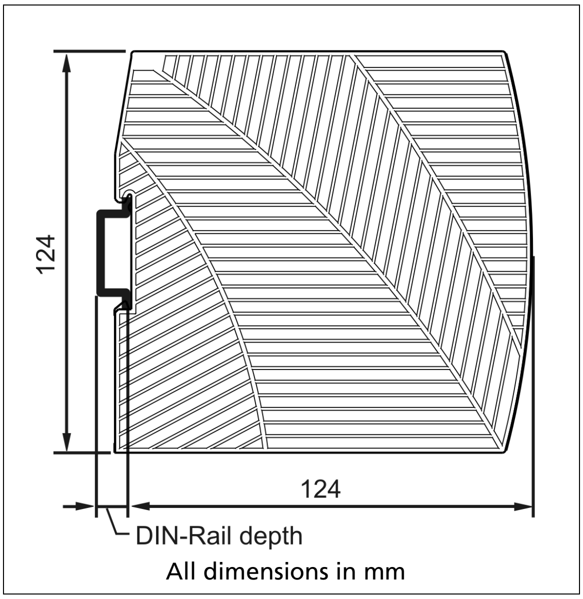


Fig. 21-2 **Side view**



22. ACCESSORY

22.1. PIRD20.241 REDUNDANCY MODULE

The PIRD20.241 is a dual redundancy module, which can be used to build 1+1 or N+1 redundant systems.

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

The device 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 narrow and only requires 39mm width on the DIN-rail.

See chapter 23.4 for wiring information.

22.2. 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.

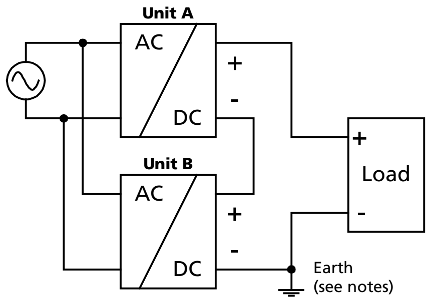
For longer hold-up times the UF40.241 might also be an option.

23. APPLICATION NOTES

23.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.2. 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.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. PARALLEL USE FOR 1+1 REDUNDANCY

The device can be used to built 1+1 redundant systems.

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.

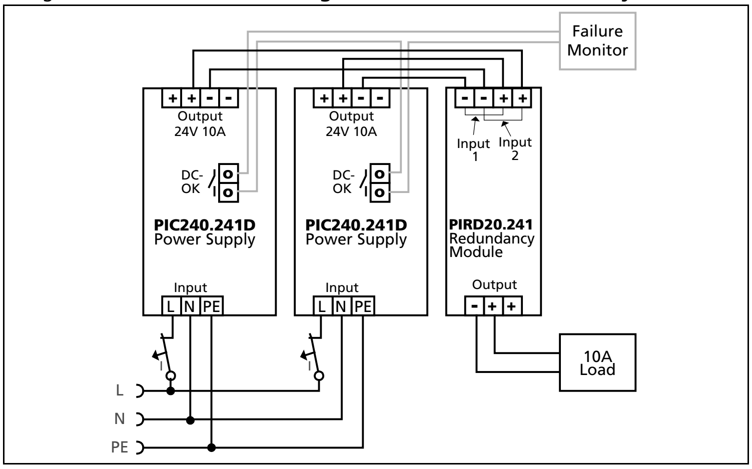
Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

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.

Wiring examples:

Fig. 23-1 **1+1 Redundant wiring with a PIRD20.241 redundancy module**

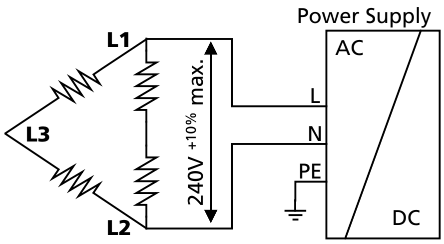


23.5. OPERATION ON TWO PHASES

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.



23.6. 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.

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, 8A; (=80%)	24V, 10A; (=100%)
Temperature inside the box	39.8°C	44.7°C
Temperature outside the box	21.0°C	21.0°C
Temperature rise	18.8K	23.7K

POWER SUPPLY

- AC 200-240V Regional Input
- Cost Optimized without Compromising Quality or Reliability
- Optional with Conformal Coated PC-Boards
- Active PFC
- Width only 49mm
- Efficiency 95.7%
- Full Power Between -25°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.

Since typical industrial applications do not require multiple mains inputs, the reduction to a regional input voltage range (AC 200-240V) simplifies the circuitry and has significant advantages for reliability, efficiency and cost.

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.

The PIC480.241C-C1 device is the same as the PIC480.241C but with conformal coated pc-boards.

SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	20A	at 24V, amb <55°C
	15A	at 24V, amb <70°C
	17.1A	at 28V, amb <55°C
	12.8A	at 28V, amb <70°C
Output power	480W	ambient <55°C
	360W	ambient <70°C
Output ripple	< 100mVpp	20Hz to 20MHz
AC Input voltage	AC 200-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	2.2A	at 230Vac
Power factor	0.99	at 230Vac
AC Inrush current	26A peak	at 230Vac, 40°C
Efficiency	95.7%	at 230Vac
Losses	21.6W	at 230Vac
Temperature range	-25°C to +70°C	operational
Derating	8W/°C	+55 to +70°C
Hold-up time	30ms	at 230Vac
Dimensions	49x124x124mm	WxHxD
Weight	620g / 1.37lb	

ORDER NUMBERS

Power Supply	**PIC480.241C**	
	PIC480.241C-C1	With conformal coated pc-boards
Accessory	YR40.242	Redundancy module
	PIRD20.241	Redundancy module

MARKINGS

IECEE CB SCHEME — IEC 61010-2-201

c UL us LISTED — UL 61010-2-201

IECEE CB SCHEME — IEC 62368

CE

EAC

Mar. 2021 / Rev. 1.2 DS-PIC480.241C-EN

All parameters are typical values specified at 24V, 20A output, 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 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, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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 industrial, residential, commercial and light-industrial environments

2. INSTALLATION INSTRUCTIONS

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 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 device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The isolation of the 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminals and the PE potential must not exceed 300Vac.

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 5000m (16400ft). Above 2000m (6560ft) the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A 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.

3. AC-INPUT

AC input	nom.	AC 200-240V	suitable for TN-, TT- and IT mains networks
AC input range		180-264Vac	continuous operation
		264-300Vac	< 500ms
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	150Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	130Vac	steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 23.3.		

Input current	typ.	2.2A	at 24V, 20A, 230Vac, see Fig. 3-3
Power factor*)	typ.	0.99	at 24V, 20A, 230Vac, see Fig. 3-4
Crest factor**)	typ.	1.6	at 24V, 20A, 230Vac
Start-up delay	typ.	400ms	see Fig. 3-2
Rise time	typ.	60ms	at 24V, 20A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	240ms	at 24V, 20A const. current load, 20mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	200mV	resistive load, 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.**

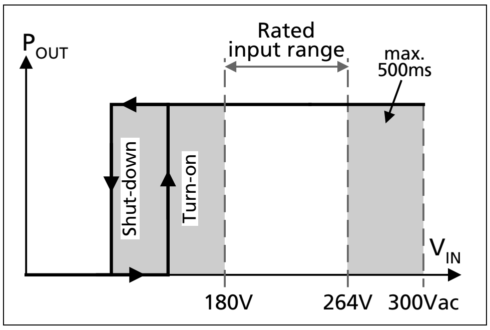


Fig. 3-2 **Turn-on behavior, definitions**

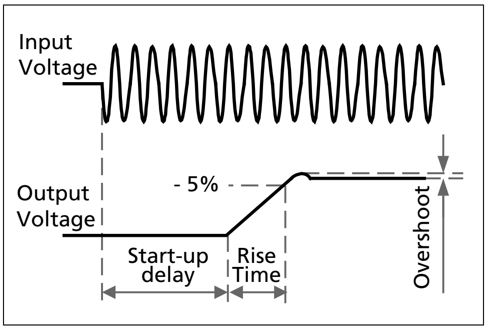


Fig. 3-3 **Input current vs. output load at 24V**

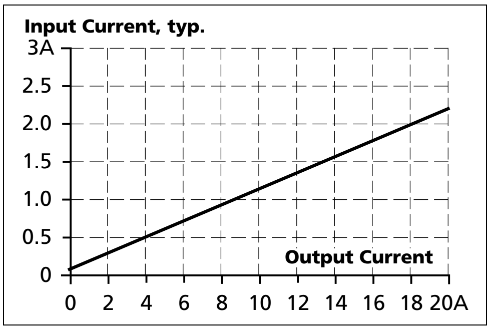
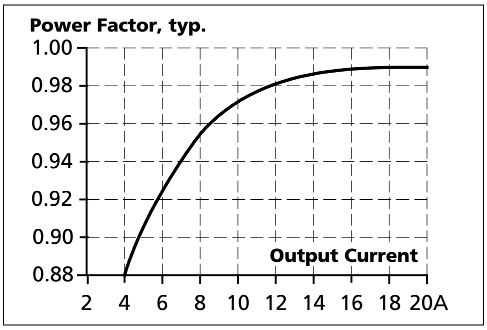


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not operate this power supply with DC-input voltage.

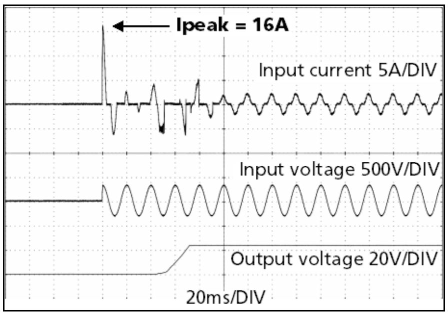
5. INPUT INRUSH CURRENT

A NTC inrush limiter, which is bypassed by a relay contact during normal operation, limits the input inrush current after turn-on of the input voltage.

Inrush current*)	max.	$32A_{peak}$	40°C ambient, 230Vac, cold start
	typ.	$26A_{peak}$	40°C ambient, 230Vac, cold start
	typ.	$16A_{peak}$	25°C ambient, 230Vac, cold start
Inrush energy*)	max.	$2.1A^2s$	40°C ambient, 230Vac, 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, 20A output, 25°C ambient



6. OUTPUT

Output voltage	nom.	DC 24V	
Adjustment range		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.	50mV	187-264Vac
Load regulation	max.	150mV	static value, 0A → 20A; see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	20A	at 24V, ambient temperature <55°C, see Fig. 6-1
	nom.	15A	at 24V, ambient temperature <70°C, see Fig. 6-1
	nom.	17.1A	at 28V, ambient temperature <55°C, see Fig. 6-1
	nom.	12.8A	at 28V, ambient temperature <70°C, see Fig. 6-1
Output power	nom.	480W	ambient temperature <55°C
	nom.	360W	ambient temperature <70°C
Overload behaviour		cont. current	output voltage > 13.5Vdc, see Fig. 6-1
		Hiccup*PLUS* mode**)	output voltage < 13.5Vdc, see Fig. 6-1
Short-circuit current	min.	21A*)	load impedance 50mOhm, see Fig. 6-1
	max.	25A*)	load impedance 50mOhm, see Fig. 6-1
	typ.	8.1A	average (R.M.S.) current, load impedance 50mOhm, see Fig. 6-1
Output capacitance	typ.	4 300µF	included inside the power supply

*) Discharge current of output capacitors is not included.

**) Hiccup*PLUS* Mode
At heavy overloads (when output voltage falls below 13.5V), the power supply delivers continuous output current for 5s. After this, the output is switched off for approx. 8s before a new start attempts with duration of 1s are automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally.

***) 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, typ.

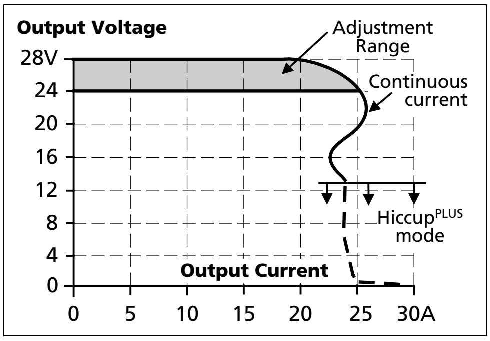
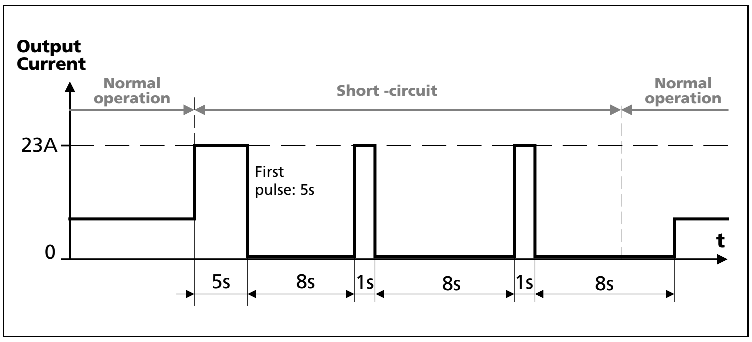


Fig. 6-2
Short-circuit (50mOhm) on output, Hiccup*PLUS* mode, typ.



7. HOLD-UP TIME

Hold-up Time	typ.	65ms	at 24V, 10A, 230Vac, see Fig. 7-1
	min.	55ms	at 24V, 10A, 230Vac, see Fig. 7-1
	typ.	30ms	at 24V, 20A, 230Vac, see Fig. 7-1
	min.	23ms	at 24V, 20A, 230Vac, see Fig. 7-1

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

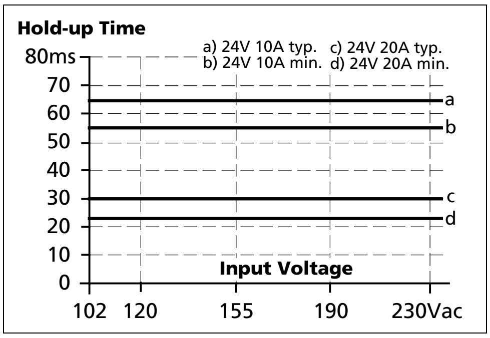
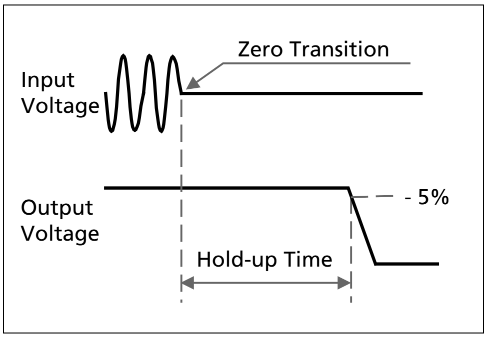


Fig. 7-2 **Shut-down behavior, definitions**

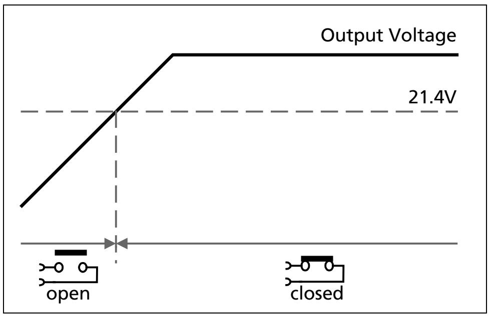


8. DC-OK RELAY CONTACT

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).

Threshold voltage	typ.	21.4V (fixed)	
Contact closes	As soon as the output voltage reaches 21.4V.		
Contact opens	As soon as the output voltage falls below 21.4V.		
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**



9. EFFICIENCY AND POWER LOSSES

Efficiency	typ.	95.7%	at 24V, 20A, 230Vac
Average efficiency*)	typ.	95.2%	25% at 5A, 25% at 10A, 25% at 15A. 25% at 20A
Power losses	typ.	1.35W	at 24V, 0A, 230Vac
	typ.	10.7W	at 24V, 10A, 230Vac
	typ.	21.6W	at 24V, 20A, 230Vac

*) 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.**

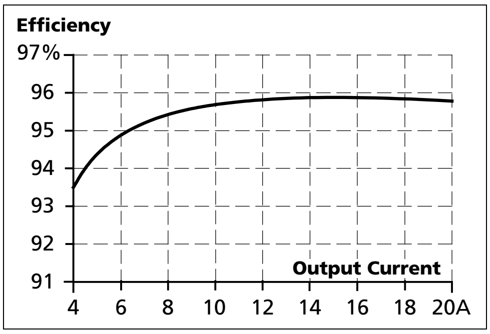
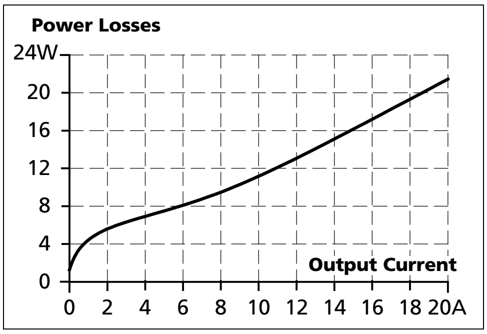


Fig. 9-2 **Losses vs. output current at 24V, typ.**



10. LIFETIME EXPECTANCY AND MTBF

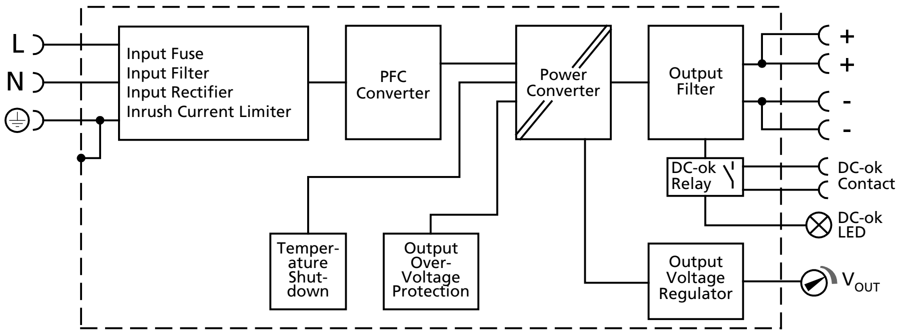
Lifetime expectancy*)	93 000h	at 24V, 10A and 40°C, 230Vac
	264 000h*)	at 24V, 10A and 25°C, 230Vac
	51 000h	at 24V, 20A and 40°C, 230Vac
	144 000h*)	at 24V, 20A and 25°C, 230Vac
MTBF**) SN 29500, IEC 61709	482 000h	at 24V, 20A and 40°C, 230Vac
	894 000h	at 24V, 20A and 25°C, 230Vac
MTBF**) MIL HDBK 217F	207 000h	at 24V, 20A and 40°C, 230Vac; Ground Benign GB40
	279 000h	at 24V, 20A and 25°C, 230Vac; Ground Benign GB25
	45 000h	at 24V, 20A and 40°C, 230Vac; Ground Fixed GF40
	57 000h	at 24V, 20A and 25°C, 230Vac; 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. 6mm^2	max. 1.5mm^2
Stranded wire	max. 4mm^2	max. 1.5mm^2
American Wire Gauge	AWG20-10	AWG28-16
Maximal 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 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) Unused terminal compartments should be securely tightened.

e) 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.
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	10V/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	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion C
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 200Vac (160Vac) 70% of 200Vac (140Vac) 50% of 200Vac (100Vac)	1000ms 500ms 200ms	Criterion A Criterion C Criterion C
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.
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 61000-6-3, EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR 32	Class B fulfilled
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 55032	Class B fulfilled
Harmonic input current	EN 61000-3-2	Class A fulfilled between 0A and 20A load Class C fulfilled between 7A and 20A load
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 Frequencies	The power supply has two converters with two different switching frequencies included.	
Switching frequency 1	40-120kHz	PFC converter, input voltage and output power dependent
Switching frequency 2	80-140kHz	Main converter, output voltage and output power 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°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	8W/°C	55°C to 70°C (131°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. 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 62477-1, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	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.	

*) 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.

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

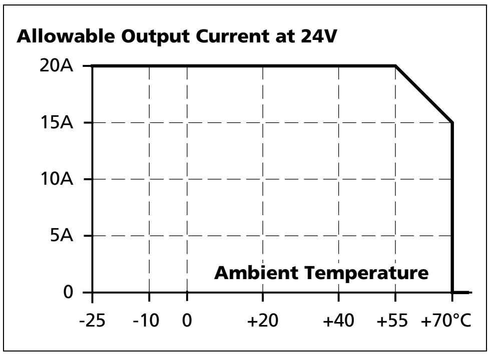
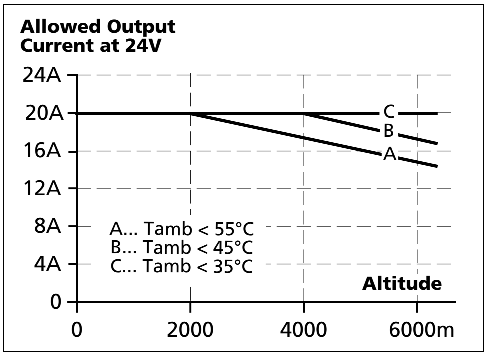


Fig. 15-2 **Output current vs. altitude**



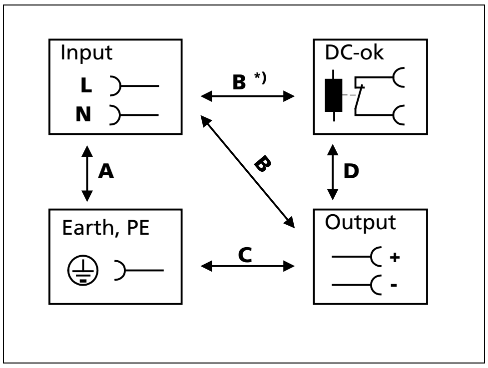
16. SAFETY AND PROTECTION FEATURES

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
Output over-voltage protection	Typ.	30.5Vdc	
	Max.	32.0Vdc	
		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
Ingress protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shut-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 **Fehler! Verweisquelle konnte nicht gefunden werden.** (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.33mA / 0.69mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.43mA / 0.89mA	At 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	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		10mA	10mA	10mA	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.

18. APPROVALS AND FULFILLED STANDARDS

UL 61010	c UL US LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61010	IECEE CB SCHEME	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	IECEE CB SCHEME	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H_2S: 100ppb NOx: 1250ppb Cl_2: 20ppb SO_2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. REGULATORY COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Directive	REACH	Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Directive		Manufacturer's Statement EU-Regulation on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products.
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

20. PHYSICAL DIMENSIONS AND WEIGHT

Width	49mm 1.93''
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	620g / 1.37lb
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. 20-1 **Front view**

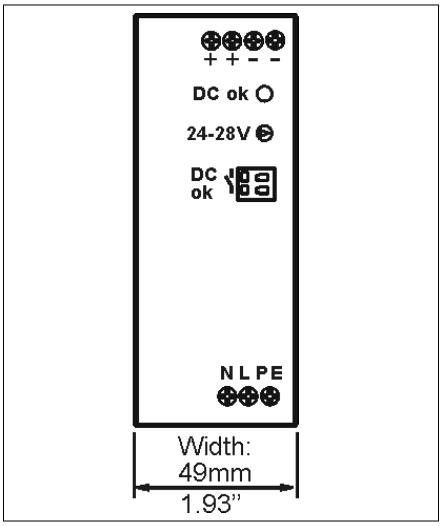
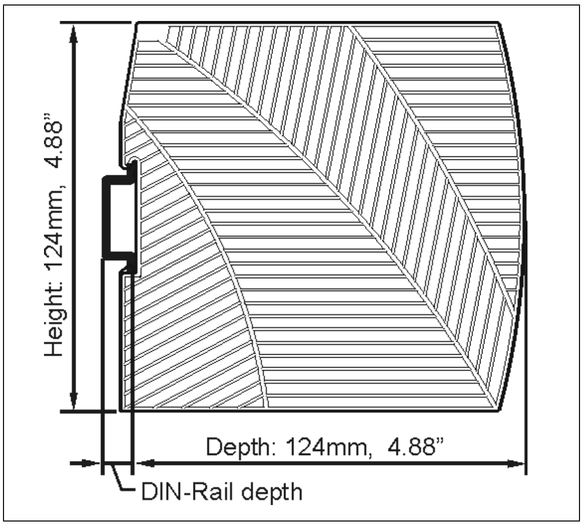


Fig. 20-2 **Side view**



21. ACCESSORY

21.1. YR40.242 REDUNDANCY MODULE

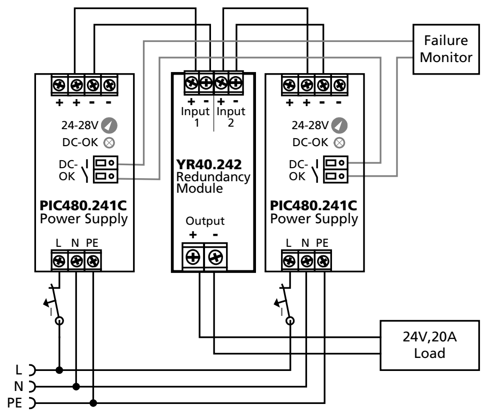
The YR40.242 is the preferred redundancy module for PIC480.241C power supplies. It is equipped with two input channels (20A each), which are individually decoupled by utilizing MOSFET technology. The output current can go as high as 40A.

Using MOSFETs instead of diodes reduces the heat generation and the voltage drop between input and output.

The YR40.242 does not require an additional auxiliary voltage.

Due to the low power losses, the unit is very slender and only requires 36mm width on the DIN-rail.

See chapter 22.5 for instructions how to build a redundant system.



21.2. PIRD20.241 REDUNDANCY MODULE

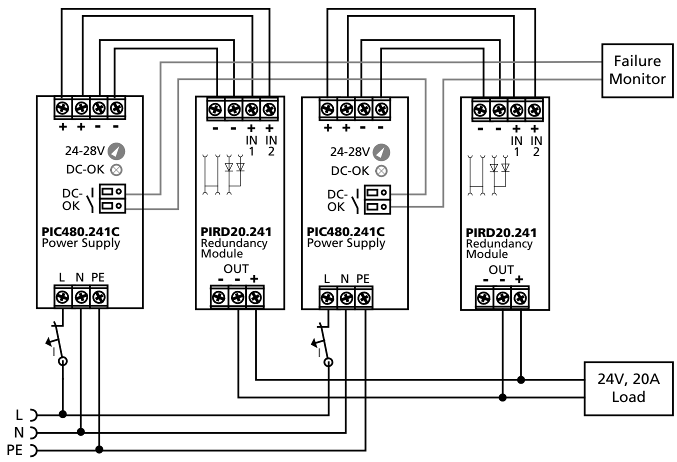
The PIRD20.241 is a very cost effective diode redundancy module, which can be used to build 1+1 and N+1 redundant systems. It is equipped with two input channels, which can be connected to power supplies with up to 10A output current and one output, which can carry nominal currents up to 20A.

If 20A power supplies are utilized, it is recommended to connect the power supply output to both inputs of the redundancy module. Therefore, two redundancy modules are required to build a 20A redundant power system.

The PIRD20.241 is the perfect solution to use in a redundant system, if the power supply itself is equipped with a DC-OK signal.

The PIRD20.241 does not require an additional auxiliary voltage and is self- powered even in case of a short circuit across the output.

See chapter 22.5 for instructions how to build a redundant system.



22. APPLICATION NOTES

22.1. 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.

22.2. 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.

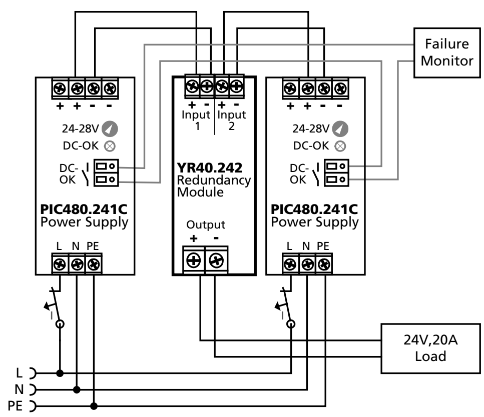
22.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

22.4. PARALLEL USE FOR 1+1 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.

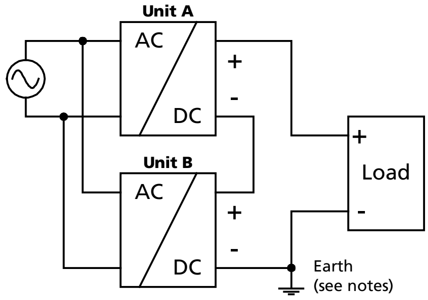
Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module YR40.241.



Recommendations for building redundant power systems:

a) Monitor the individual power supply units. Therefore, use the DC-OK relay contact of the PIC480.241C power supply.
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.

22.5. 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.

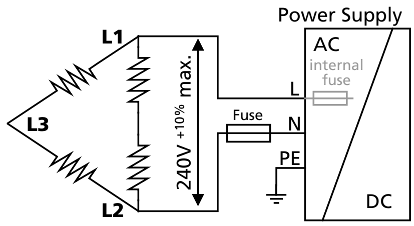
22.6. INDUCTIVE AND CAPACITIVE LOADS

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 1.5F are connected to the output, the unit might charge the capacitor in the Hiccup^{PLUS} mode (see chapter 6).

22.7. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

22.8. 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$^{+10\%}$.

22.9. 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 9519 100, plastic, 180x180x165mm
Input:	230Vac
Load:	24V, 16A; (=80%) load is placed outside the box
Temperature inside the box:	51.5°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	25.5°C
Temperature rise:	26.0K

PIC480.241C, PIC480.241C-C1

PIANO-Series

24V, 20A, 480W, Single Phase Input

Power Supply

- AC 200-240V Regional Input
- Cost Optimized without Compromising Quality or Reliability
- Optional with Conformal Coated PC-Boards
- Active PFC
- Width only 49mm
- Efficiency 95.7%
- Full Power Between -25°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.

Since typical industrial applications do not require multiple mains inputs, the reduction to a regional input voltage range (AC 200-240V) simplifies the circuitry and has significant advantages for reliability, efficiency and cost.

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.

The PIC480.241C-C1 device is the same as the PIC480.241C but with conformal coated pc-boards.

Short-form Data

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	20A	at 24V, amb <55°C
	15A	at 24V, amb <70°C
	17.1A	at 28V, amb <55°C
	12.8A	at 28V, amb <70°C
Output power	480W	ambient <55°C
	360W	ambient <70°C
Output ripple	< 100mVpp	20Hz to 20MHz
AC Input voltage	AC 200-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	2.2A	at 230Vac
Power factor	0.99	at 230Vac
AC Inrush current	26A peak	at 230Vac, 40°C
Efficiency	95.7%	at 230Vac
Losses	21.6W	at 230Vac
Temperature range	-25°C to +70°C	operational
Derating	8W/°C	+55 to +70°C
Hold-up time	30ms	at 230Vac
Dimensions	49x124x124mm	WxHxD
Weight	620g / 1.37lb	

Order Numbers

Power Supply	**PIC480.241C**	
	PIC480.241C-C1	With conformal coated pc-boards
Accessory	YR40.242	Redundancy module
	PIRD20.241	Redundancy module

Markings

IEC 61010-2-201 — UL 61010-2-201 — IEC 62368

All parameters are typical values specified at 24V, 20A output, 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 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, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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 industrial, residential, commercial and light-industrial environments

2. INSTALLATION INSTRUCTIONS

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 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 device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The isolation of the 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminals and the PE potential must not exceed 300Vac.

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 5000m (16400ft). Above 2000m (6560ft) the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A 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.

3. AC-INPUT

AC input	nom.	AC 200-240V	suitable for TN-, TT- and IT mains networks
AC input range		180-264Vac	continuous operation
		264-300Vac	< 500ms
Allowed voltage L or N to earth	max.	300Vac	continuous, IEC 62103
Input frequency	nom.	50–60Hz	±6%
Turn-on voltage	typ.	150Vac	steady-state value, see Fig. 3-1
Shut-down voltage	typ.	130Vac	steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 23.3.		

Input current	typ.	2.2A	at 24V, 20A, 230Vac, see Fig. 3-3
Power factor*)	typ.	0.99	at 24V, 20A, 230Vac, see Fig. 3-4
Crest factor**)	typ.	1.6	at 24V, 20A, 230Vac
Start-up delay	typ.	400ms	see Fig. 3-2
Rise time	typ.	60ms	at 24V, 20A const. current load, 0mF load capacitance, see Fig. 3-2
	typ.	240ms	at 24V, 20A const. current load, 20mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	200mV	resistive load, 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.**

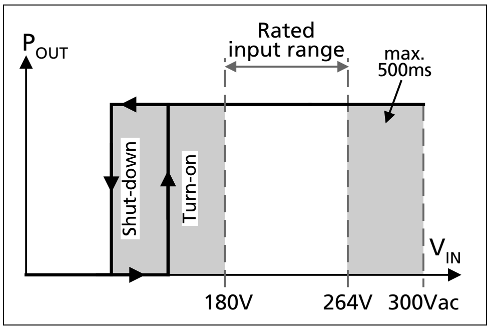


Fig. 3-2 **Turn-on behavior, definitions**

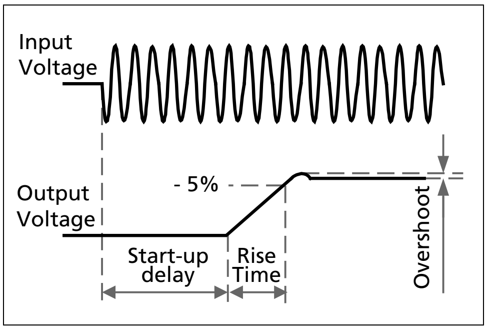


Fig. 3-3 **Input current vs. output load at 24V**

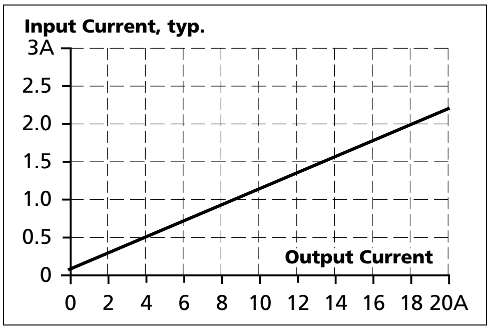
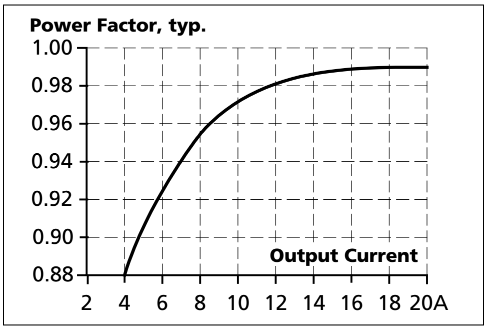


Fig. 3-4 **Power factor vs. output load**



All parameters are typical values specified at 24V, 20A output, 230Vac input , 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-INPUT

Do not operate this power supply with DC-input voltage.

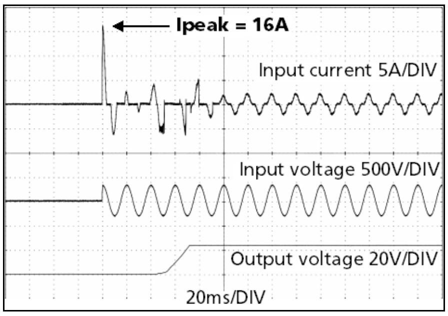
5. INPUT INRUSH CURRENT

A NTC inrush limiter, which is bypassed by a relay contact during normal operation, limits the input inrush current after turn-on of the input voltage.

Inrush current*)	max.	$32A_{peak}$	40°C ambient, 230Vac, cold start
	typ.	$26A_{peak}$	40°C ambient, 230Vac, cold start
	typ.	$16A_{peak}$	25°C ambient, 230Vac, cold start
Inrush energy*)	max.	$2.1A^2s$	40°C ambient, 230Vac, 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, 20A output, 25°C ambient



6. OUTPUT

Output voltage	nom.	DC 24V	
Adjustment range		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.	50mV	187-264Vac
Load regulation	max.	150mV	static value, 0A → 20A; see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	20A	at 24V, ambient temperature <55°C, see Fig. 6-1
	nom.	15A	at 24V, ambient temperature <70°C, see Fig. 6-1
	nom.	17.1A	at 28V, ambient temperature <55°C, see Fig. 6-1
	nom.	12.8A	at 28V, ambient temperature <70°C, see Fig. 6-1
Output power	nom.	480W	ambient temperature <55°C
	nom.	360W	ambient temperature <70°C
Overload behaviour		cont. current	output voltage > 13.5Vdc, see Fig. 6-1
		Hiccup*PLUS* mode**)	output voltage < 13.5Vdc, see Fig. 6-1
Short-circuit current	min.	21A*)	load impedance 50mOhm, see Fig. 6-1
	max.	25A*)	load impedance 50mOhm, see Fig. 6-1
	typ.	8.1A	average (R.M.S.) current, load impedance 50mOhm, see Fig. 6-1
Output capacitance	typ.	4 300µF	included inside the power supply

*) Discharge current of output capacitors is not included.

**) Hiccup*PLUS* Mode
At heavy overloads (when output voltage falls below 13.5V), the power supply delivers continuous output current for 5s. After this, the output is switched off for approx. 8s before a new start attempts with duration of 1s are automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally.

***) 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, typ.

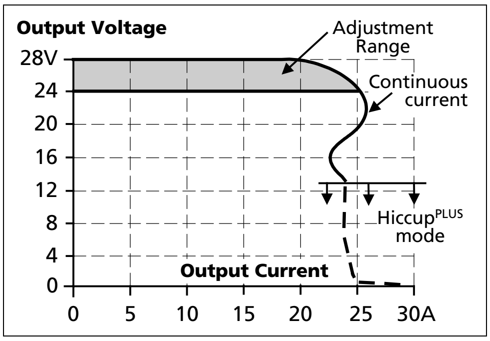
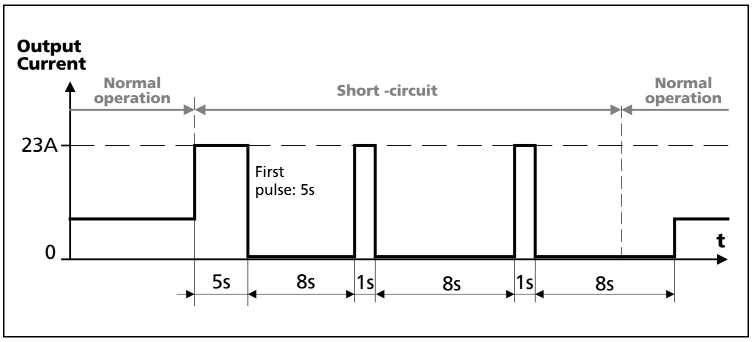


Fig. 6-2
Short-circuit (50mOhm) on output, Hiccup*PLUS* mode, typ.



7. HOLD-UP TIME

Hold-up Time	typ.	65ms	at 24V, 10A, 230Vac, see Fig. 7-1
	min.	55ms	at 24V, 10A, 230Vac, see Fig. 7-1
	typ.	30ms	at 24V, 20A, 230Vac, see Fig. 7-1
	min.	23ms	at 24V, 20A, 230Vac, see Fig. 7-1

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

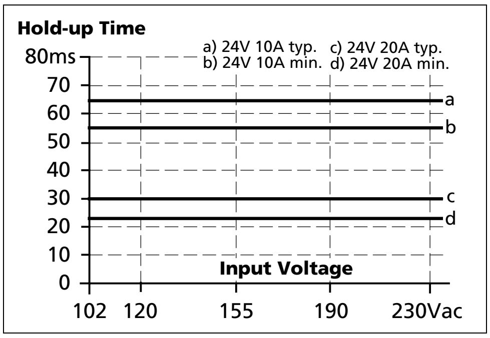
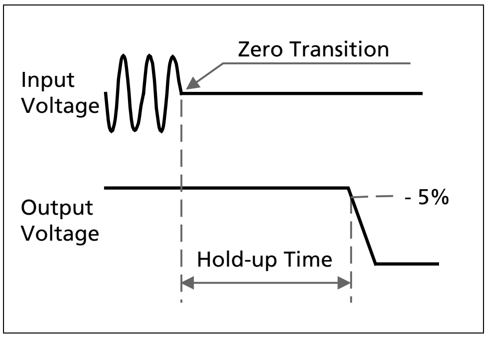


Fig. 7-2 **Shut-down behavior, definitions**

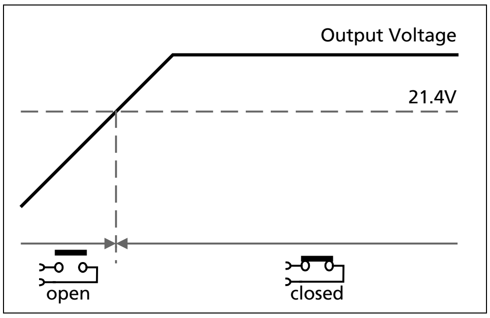


8. DC-OK RELAY CONTACT

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).

Threshold voltage	typ.	21.4V (fixed)	
Contact closes	As soon as the output voltage reaches 21.4V.		
Contact opens	As soon as the output voltage falls below 21.4V.		
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**



9. EFFICIENCY AND POWER LOSSES

Efficiency	typ.	95.7%	at 24V, 20A, 230Vac
Average efficiency*)	typ.	95.2%	25% at 5A, 25% at 10A, 25% at 15A. 25% at 20A
Power losses	typ.	1.35W	at 24V, 0A, 230Vac
	typ.	10.7W	at 24V, 10A, 230Vac
	typ.	21.6W	at 24V, 20A, 230Vac

*) 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.**

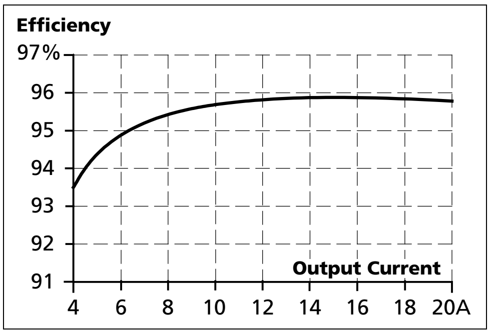
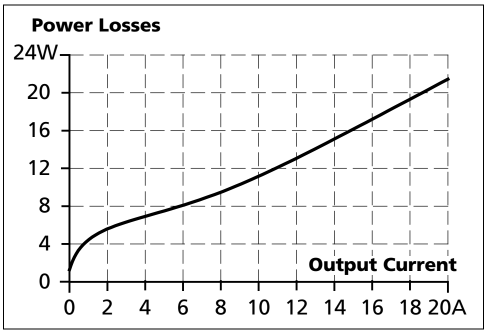


Fig. 9-2 **Losses vs. output current at 24V, typ.**



10. LIFETIME EXPECTANCY AND MTBF

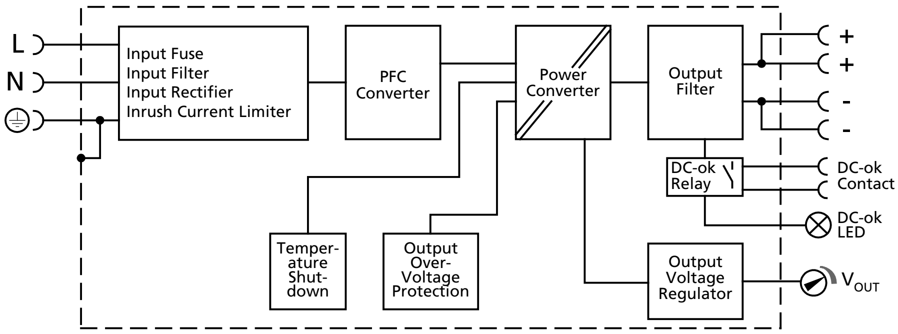
Lifetime expectancy*)	93 000h	at 24V, 10A and 40°C, 230Vac
	264 000h*)	at 24V, 10A and 25°C, 230Vac
	51 000h	at 24V, 20A and 40°C, 230Vac
	144 000h*)	at 24V, 20A and 25°C, 230Vac
MTBF**) SN 29500, IEC 61709	482 000h	at 24V, 20A and 40°C, 230Vac
	894 000h	at 24V, 20A and 25°C, 230Vac
MTBF**) MIL HDBK 217F	207 000h	at 24V, 20A and 40°C, 230Vac; Ground Benign GB40
	279 000h	at 24V, 20A and 25°C, 230Vac; Ground Benign GB25
	45 000h	at 24V, 20A and 40°C, 230Vac; Ground Fixed GF40
	57 000h	at 24V, 20A and 25°C, 230Vac; 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
Maximal 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 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) Unused terminal compartments should be securely tightened.

e) 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.
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	10V/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	10V	Criterion A
Mains voltage dips	EN 61000-4-11	0% of 200Vac 40% of 200Vac 70% of 200Vac	0Vac, 20ms 80Vac, 200ms 140Vac, 500ms	Criterion A Criterion C Criterion C
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 200Vac (160Vac) 70% of 200Vac (140Vac) 50% of 200Vac (100Vac)	1000ms 500ms 200ms	Criterion A Criterion C Criterion C
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.
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 61000-6-3, EN 61000-6-4	
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR 32	Class B fulfilled
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 55032	Class B fulfilled
Harmonic input current	EN 61000-3-2	Class A fulfilled between 0A and 20A load Class C fulfilled between 7A and 20A load
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 Frequencies	The power supply has two converters with two different switching frequencies included.	
Switching frequency 1	40-120kHz	PFC converter, input voltage and output power dependent
Switching frequency 2	80-140kHz	Main converter, output voltage and output power 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°C to +85°C (-40°F to 185°F)	for storage and transportation
Output de-rating	8W/°C	55°C to 70°C (131°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. 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 62477-1, altitudes up to 2000m
	II	altitudes from 2000m to 6000m
Degree of pollution	2	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.	

*) 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.

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

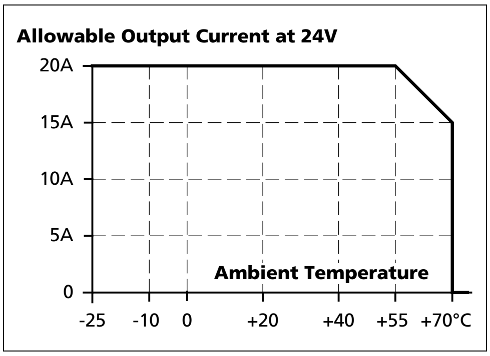
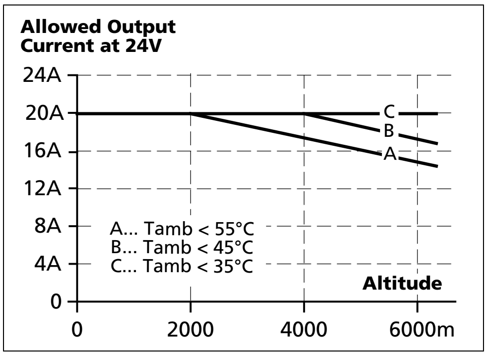


Fig. 15-2 **Output current vs. altitude**



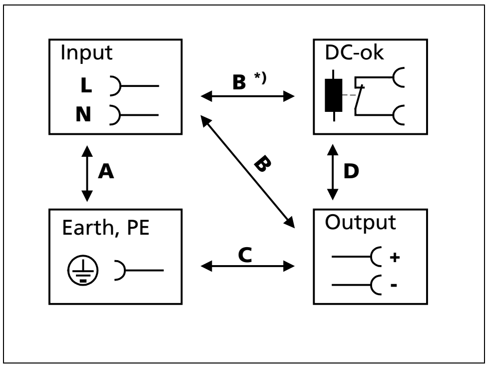
16. SAFETY AND PROTECTION FEATURES

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
Output over-voltage protection	Typ.	30.5Vdc	
	Max.	32.0Vdc	
		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
Ingress protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shut-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 **Fehler! Verweisquelle konnte nicht gefunden werden.** (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.33mA / 0.69mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.43mA / 0.89mA	At 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	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		10mA	10mA	10mA	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.

18. APPROVALS AND FULFILLED STANDARDS

UL 61010	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61010	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
ISA-71.04-1985	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. REGULATORY COMPLIANCE

EU Declaration of Conformity	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Directive	Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Directive	Manufacturer's Statement EU-Regulation on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products.
RoHS (China RoHS 2)	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

20. PHYSICAL DIMENSIONS AND WEIGHT

Width	49mm 1.93''
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	620g / 1.37lb
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. 20-1 **Front view**

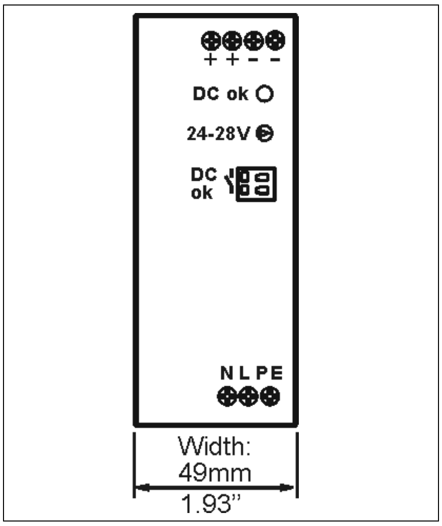
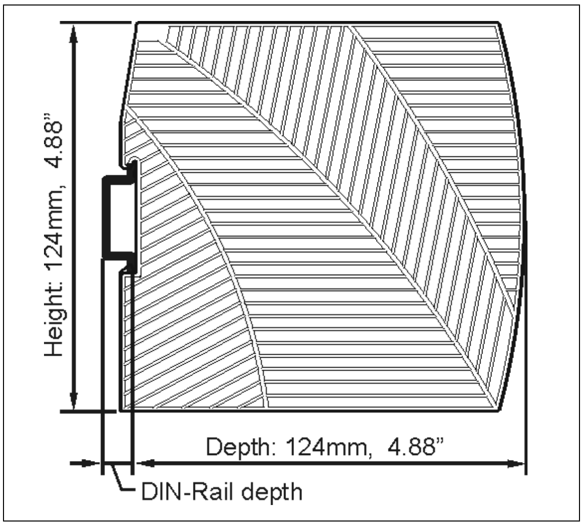


Fig. 20-2 **Side view**



21. ACCESSORY

21.1. YR40.242 REDUNDANCY MODULE

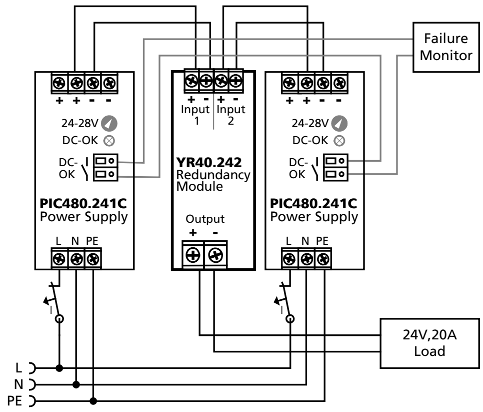
The YR40.242 is the preferred redundancy module for PIC480.241C power supplies. It is equipped with two input channels (20A each), which are individually decoupled by utilizing MOSFET technology. The output current can go as high as 40A.

Using MOSFETs instead of diodes reduces the heat generation and the voltage drop between input and output.

The YR40.242 does not require an additional auxiliary voltage.

Due to the low power losses, the unit is very slender and only requires 36mm width on the DIN-rail.

See chapter 22.5 for instructions how to build a redundant system.



21.2. PIRD20.241 REDUNDANCY MODULE

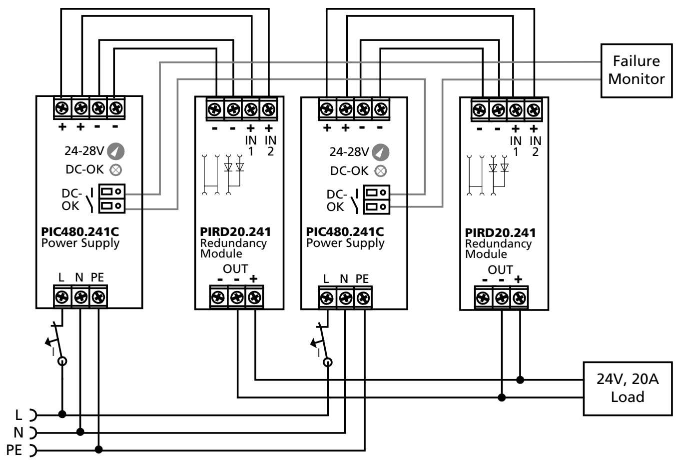
The PIRD20.241 is a very cost effective diode redundancy module, which can be used to build 1+1 and N+1 redundant systems. It is equipped with two input channels, which can be connected to power supplies with up to 10A output current and one output, which can carry nominal currents up to 20A.

If 20A power supplies are utilized, it is recommended to connect the power supply output to both inputs of the redundancy module. Therefore, two redundancy modules are required to build a 20A redundant power system.

The PIRD20.241 is the perfect solution to use in a redundant system, if the power supply itself is equipped with a DC-OK signal.

The PIRD20.241 does not require an additional auxiliary voltage and is self- powered even in case of a short circuit across the output.

See chapter 22.5 for instructions how to build a redundant system.



22. APPLICATION NOTES

22.1. 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.

22.2. 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.

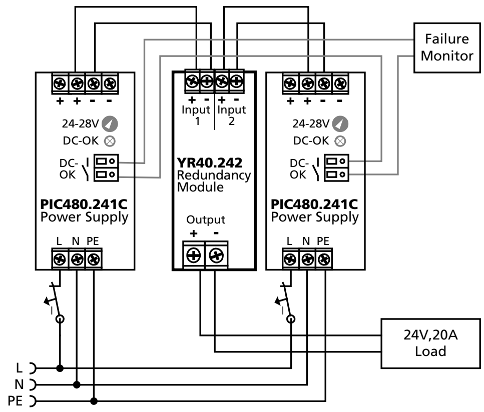
If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or 6A C-Characteristic breaker should be used.

22.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

22.4. PARALLEL USE FOR 1+1 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.

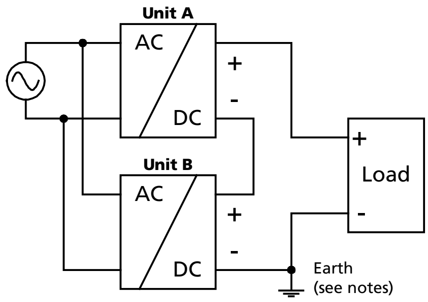


Please note: This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a case, the defect unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can only be avoided by utilizing decoupling diodes which are included in the redundancy module YR40.241.

Recommendations for building redundant power systems:

a) Monitor the individual power supply units. Therefore, use the DC-OK relay contact of the PIC480.241C power supply.
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.

22.5. 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.

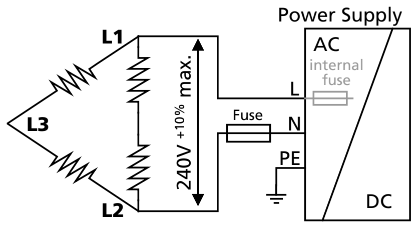
22.6. INDUCTIVE AND CAPACITIVE LOADS

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 1.5F are connected to the output, the unit might charge the capacitor in the Hiccup*PLUS* mode (see chapter 6).

22.7. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

22.8. 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 $240V^{+10\%}$.

22.9. 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 9519 100, plastic, 180x180x165mm
Input:	230Vac
Load:	24V, 16A; (=80%) load is placed outside the box
Temperature inside the box:	51.5°C (in the middle of the right side of the power supply with a distance of 1cm)
Temperature outside the box:	25.5°C
Temperature rise:	26.0K

PIC480.241D

24V, 20A, 480W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-240V Wide-range Input
- Active PFC
- Width only 59mm
- Efficiency up to 95.3%
- Safe Hiccup^{PLUS} Overload Mode
- Full Power Between -25°C and +55°C
- DC-OK Relay Contact
- 3 Year Warranty

PRODUCT 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 unit is equipped with a wide-range input voltage stage, many safety approvals and a wide operational temperature range, which makes the unit applicable for global use.

The addition of a DC-OK signal makes the unit suitable for many industry applications such as process control, factory automation or many other critical applications, where preventive function monitoring can help to avoid long downtimes.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24 – 28V	Factory setting 24.1V
Output current	20.0 – 17.1A	Below +55°C ambient
	12.5 – 10.7A	At +70°C ambient
	Derate linearly between +55°C and +70°C	
Input voltage AC	AC 100-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	4.3 / 2.3A	At 120 / 230Vac
Power factor	0.99 / 0.97	At 120 / 230Vac
AC Inrush current	15 / 35A pk	At 120 / 230Vac, 40°C, cold start
Efficiency	94.2 / 95.3%	At 120 / 230Vac
Losses	29.6 / 23.7W	At 120 / 230Vac
Hold-up time	27 / 27ms	At 120 / 230Vac
Temperature range	-25 to +70°C	
Size (WxHxD)	59x124x127mm	
Weight	810g / 1.97lb	

ORDER NUMBERS

Power Supply	**PIC480.241D**	
Accessory	YR40.242	Redundancy module
	PIRD20.241	Redundancy module
	UF20.481	Buffer Module

MAIN APPROVALS

IECEE CB SCHEME — IEC 61010-2-201

c UL US LISTED — UL 61010-2-201

IECEE CB SCHEME — IEC 62368

INDEX

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 commercial use, such as in industrial control, process control, monitoring, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

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 industrial, residential, commercial and light-industrial environments.

2. INSTALLATION INSTRUCTIONS

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 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 device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°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. Use ferrules for wires on the input terminals.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.

The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The isolation of the 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminals and the PE potential must not exceed 300Vac.

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 5000m (16400ft). Above 2000m (6560ft) the overvoltage category is reduced to level II and a reduction in output current is required.

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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A 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.

3. AC-INPUT

The device is suitable to be supplied from TN, TT or IT mains networks with AC voltage.

AC input	Nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		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.	81Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	Typ.	63Vac / 71Vac	At no load / nominal load, steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	Typ.	5.2A	4.3A	2.3A	At 24V, 20A, see Fig. 3-3
Power factor	Typ.	0.99	0.99	0.97	At 24V, 20A, see Fig. 3-4
Crest factor	Typ.	1.6	1.7	2.0	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.	420ms	300ms	230ms	See Fig. 3-2
Rise time	Typ.	100ms	100ms	100ms	At 24V, 20A const. current load, 0mF load capacitance, see Fig. 3-2
	Typ.	140ms	140ms	140ms	At 24V, 20A const. current load, 20mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	200mV	200mV	See Fig. 3-2

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

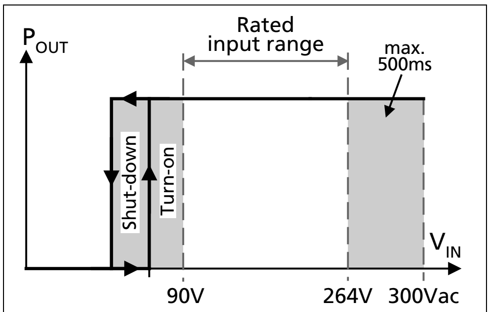


Fig. 3-2 **Turn-on behavior, definitions**

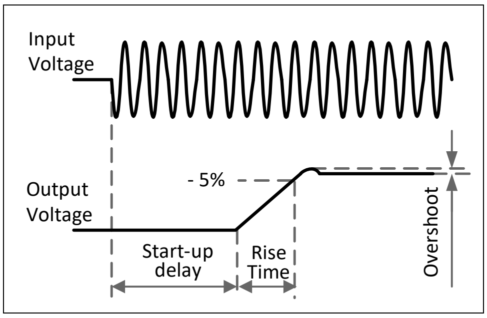


Fig. 3-3 **Input current vs. output load at 24V**

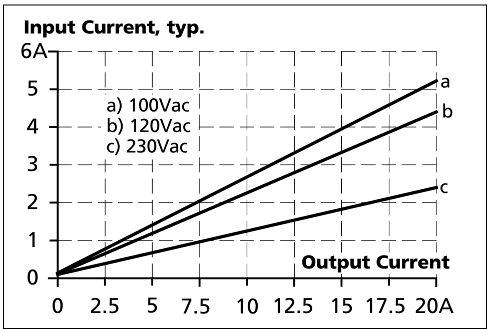
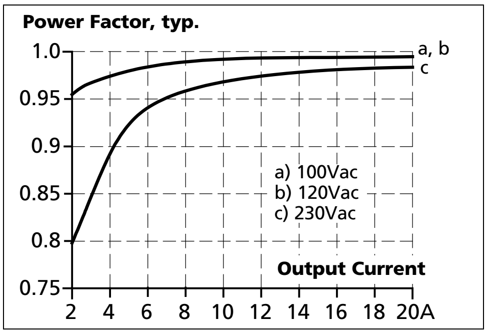


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not operate this power supply with DC-input voltage.

5. INPUT INRUSH CURRENT

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.	$15A_{peak}$	$18A_{peak}$	$42A_{peak}$	At 40°C, cold start
	Typ.	$13A_{peak}$	$13A_{peak}$	$25A_{peak}$	At 25°C, cold start
	Typ.	$13A_{peak}$	$15A_{peak}$	$35A_{peak}$	At 40°C, cold start
Inrush energy	Max.	$3A^2s$	$3A^2s$	$3A^2s$	At 40°C, cold start

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

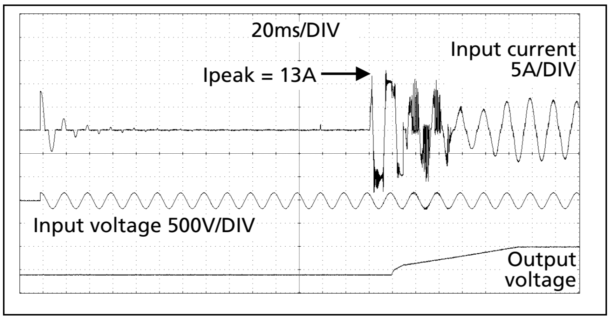
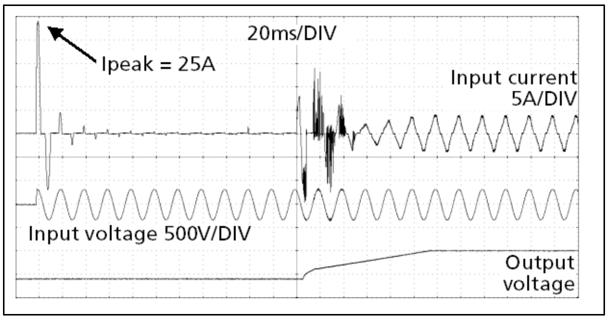


Fig. 5-2 **Typical turn-on behaviour at nominal load, 230Vac input and 25°C ambient**



6. OUTPUT

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

The output 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 > 3F 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.	DC 24V	
Adjustment range		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 settings	Typ.	24.1V	±0.2%, at full load and cold unit
Line regulation	Max.	10mV	Between 90 and 300Vac
Load regulation	Max.	100mV	Between 0A and 20A, static value, see Fig. 6-1
Ripple and noise voltage	Max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	20.0A	At 24V and an ambient temperature below 55°C
	Nom.	12.5A	At 24V and 70°C ambient temperature
	Nom.	17.1A	At 28V and an ambient temperature below 55°C
	Nom.	10.7A	At 28V and 70°C ambient temperature
		Derate linearly between +55°C and +70°	
Overload behaviour		Continuous current	For output voltage above 13Vdc, see Fig. 6-1
		Intermittent current[1)]	For output voltage below 13Vdc, see Fig. 6-1
Overload/ short-circuit current	Max.	27.5A	Continuous current, see Fig. 6-1
	Typ.	30A	Intermittent current peak value for typ. 1s Load impedance 50mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	Max.	11A	Intermittent current average value (R.M.S.) Load impedance 50mOhm, see Fig. 6-2
Output capacitance	Typ.	6 800µF	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) At heavy overloads (when output voltage falls below 13V), the power supply delivers continuous output current for 2-5s. After this, the output is switched off for approx. 7s before a new start attempt with duration of 1s is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally.

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

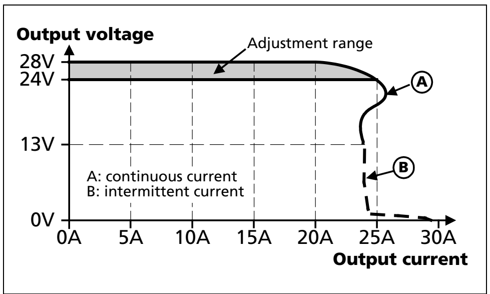
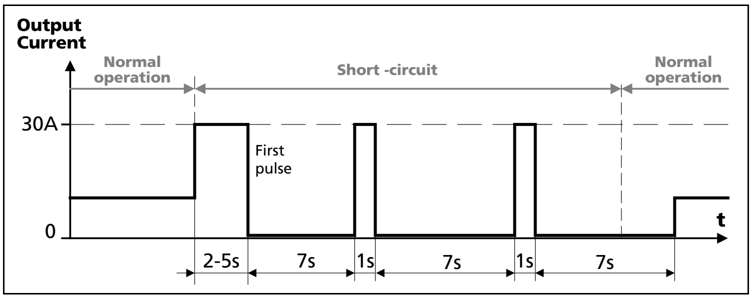


Fig. 6-2 **Short-circuit on output, intermittent current, typ.**



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.	54ms	54ms	54ms	At 24V, 10A, see Fig. 7-1
	min.	44ms	44ms	44ms	At 24V, 10A, see Fig. 7-1
	typ.	27ms	27ms	27ms	At 24V, 20A, see Fig. 7-1
	min.	22ms	22ms	22ms	At 24V, 20A, see Fig. 7-1

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

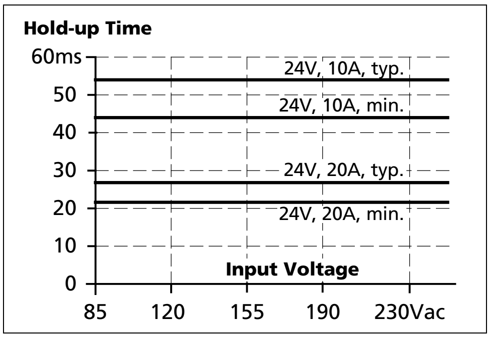
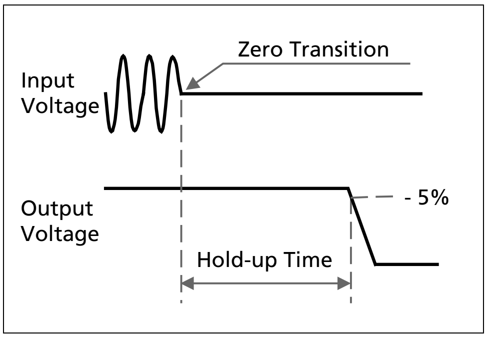


Fig. 7-2 **Shut-down behavior, definitions**

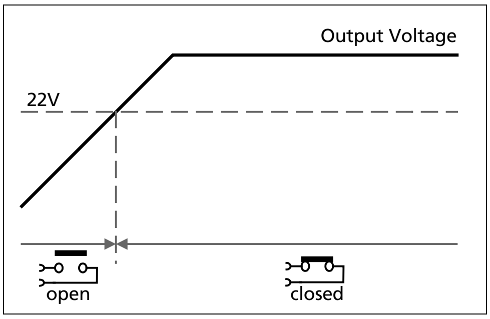


8. DC-OK RELAY CONTACT

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

Contact closes	As soon as the output voltage reaches 22V.
Contact opens	As soon as the output voltage falls below 22V.
Switching hysteresis	Typically 0.3V
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.	93.6%	94.2%	95.3%	At 24V, 20A
Average efficiency*)	Typ.	93.4%	93.8%	94.5%	25% at 5A, 25% at 10A, 25% at 15A, 25% at 20A
Power losses	Typ.	5.7W	4.6W	3.5W	At 24V, 0A
	Typ.	15.6W	14.8W	13.2W	At 24V, 10A
	Typ.	32.8W	29.6W	23.7W	At 24V, 20A

*) 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.**

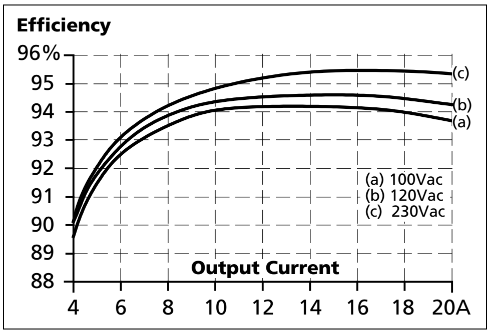


Fig. 9-2 **Losses vs. output current at 24V, typ.**

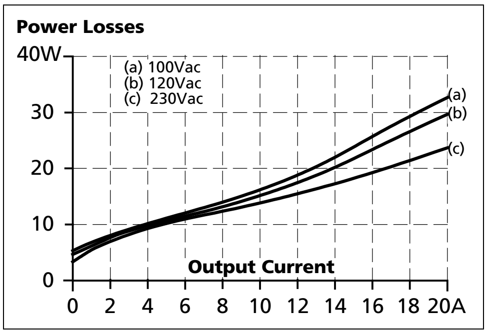


Fig. 9-3 **Efficiency vs. input voltage at 24V, 20A, typ.**

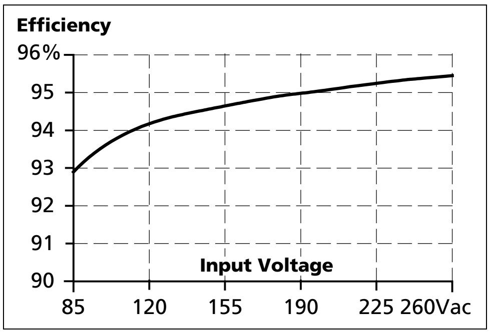
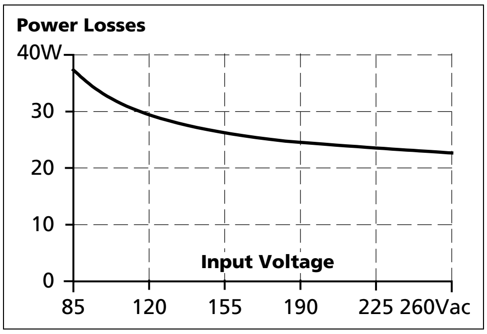
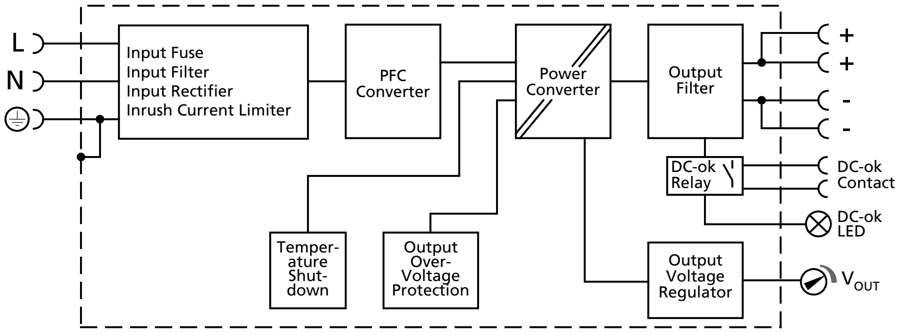


Fig. 9-4 **Losses vs. input voltage at 24V, 20A, typ.**



10. FUNCTIONAL DIAGRAM

Fig. 10-1 **Functional diagram**



11. FRONT SIDE AND USER ELEMENTS

Fig. 11-1 **Front side**

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

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

C DC-OK LED (green)
On, when the output voltage is above 18V.

D Output Voltage Adjustment Potentiometer

E DC-OK Relay Contact
The DC-OK relay contact is not synchronized with the DC-OK LED.
See chapter 8 for details.

12. CONNECTION TERMINALS

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

	Input	Output	DC-OK-Signal
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

13. 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	72 000h	79 000h	102 000h	At 24V, 20A and 40°C
	167 000h	171 000h	197 000h	At 24V, 10A and 40°C
	203 000h	223 000h	288 000h	At 24V, 20A and 25°C
	472 000h	485 000h	557 000h	At 24V, 10A and 25°C

14. 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	595 000h	611 000h	704 000h	At 24V, 20A and 40°C
	1 090 000h	1 116 000h	1 252 000h	At 24V, 20A and 25°C
MTBF MIL HDBK 217F	274 000h	275 000h	289 000h	At 24V, 20A and 40°C, Ground Benign GB40
	368 000h	370 000h	386 000h	At 24V, 20A and 25°C, Ground Benign GB25
	59 000h	59 000h	63 000h	At 24V, 20A and 40°C, Ground Fixed GF40
	76 000h	76 000h	80 000h	At 24V, 20A and 25°C, Ground Fixed GF25

15. EMC

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

The device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3.

The 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.

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 industrial, residential, commercial and light-industrial environments.

EMC Immunity

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	1kV 2kV	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 A Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 0.3ms	Criterion A

Performance 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 55032, FCC Part 15, CISPR 11, CISPR 32	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 not fulfilled
Radiated emission	EN 55011, EN 55032	Class B
Harmonic input current	EN 61000-3-2	Fulfilled, Class A limits
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with constant current loads, non pulsing

Switching frequencies:

PFC converter	80kHz to 130kHz	Input voltage and load dependent
Main converter	75kHz to 180kHz	Output voltage and load dependent
Auxiliary converter	60kHz	Fixed frequency

16. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	12W/°C 30W/1000m or 5°C/1000m	Between +55°C and +70°C (131°F to 140°F) For altitudes >2000m (6560ft), see Fig. 16-2
	The de-rating is not hardware controlled. The user has to take this into consideration 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	110-54kPa	See Fig. 16-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 16-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes up to 5000m
Impulse withstand voltages	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes up to 2000m
Degree of pollution	2	According to IEC 60664-1, 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 per 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.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

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

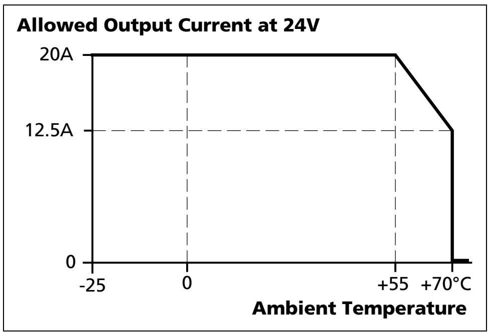
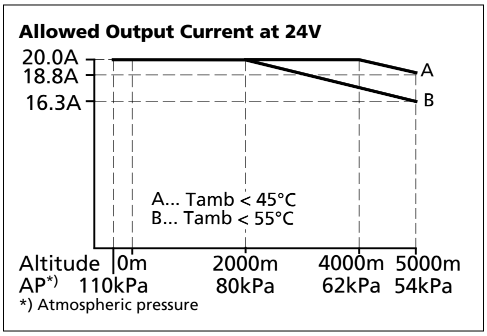


Fig. 16-2 **Output current vs. altitude**



17. 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.	32.0Vdc	
		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
Ingress protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shut-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 15 (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.12mA / 0.30mA	At 100Vac, 50Hz, TN-,TT-mains / IT-mains
	Typ.	0.17mA / 0.45mA	At 120Vac, 60Hz, TN-,TT-mains / IT-mains
	Typ.	0.27mA / 0.71mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.15mA / 0.38mA	At 110Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.21mA / 0.56mA	At 132Vac, 60Hz, TN-,TT-mains / IT-mains
	Max.	0.35mA / 0.91mA	At 264Vac, 50Hz, TN-,TT-mains / IT-mains

18. DIELECTRIC STRENGTH

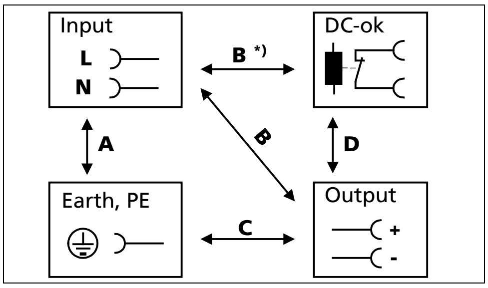
The output voltage is floating and has no ohmic connection to the ground.

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. 18-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Routine test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Field test cut-off current settings		> 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.

19. APPROVALS AND FULFILLED STANDARDS

UL 61010	c UL US LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61010	IECEE CB SCHEME	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	IECEE CB SCHEME	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

20. REGULATORY COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Directive	REACH	Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Directive		Manufacturer's Statement EU-Regulation on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products.
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

21. PHYSICAL DIMENSIONS AND WEIGHT

Width	59mm 2.32''
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	810g / 1.79lb
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 4.5mm

Fig. 21-1 **Front view**

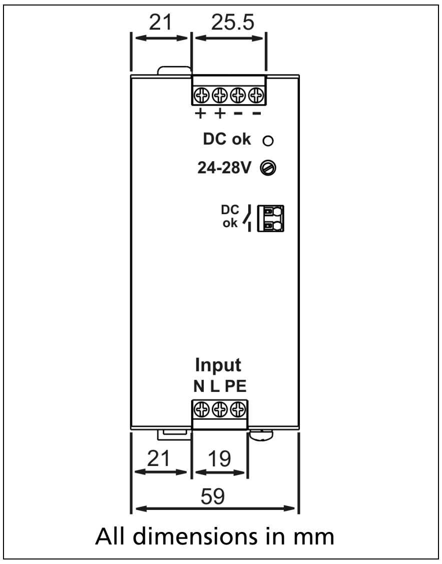
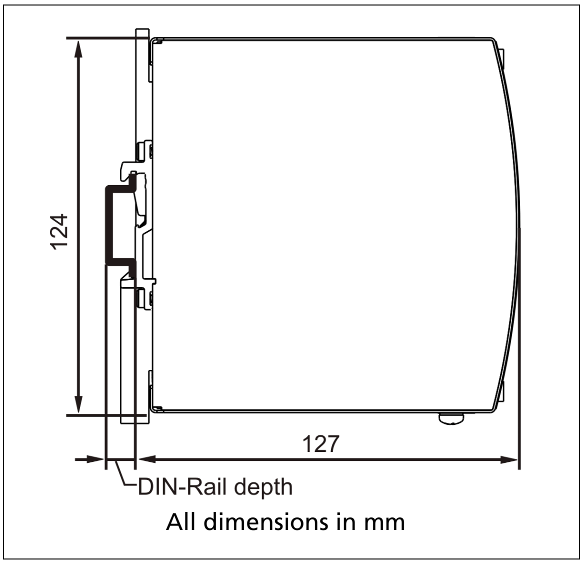


Fig. 21-2 **Side view**



22. ACCESSORY

22.1. 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 23.4 for wiring information.

22.2. PIRD20.241 REDUNDANCY MODULE

The PIRD20.241 is a dual redundancy module, which can be used to build 1+1 or N+1 redundant systems.

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

The device 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 narrow and only requires 39mm width on the DIN-rail.

See chapter 23.4 for wiring information.

22.3. 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.

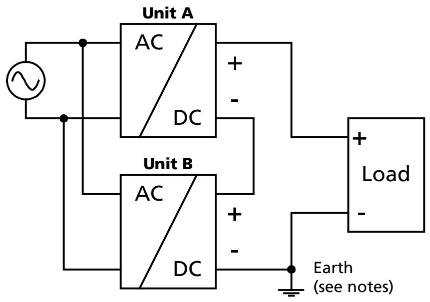
For longer hold-up times the UF40.241 might also be an option.

23. APPLICATION NOTES

23.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.2. 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.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. PARALLEL USE FOR 1+1 REDUNDANCY

The device can be used to built 1+1 redundant systems.

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.

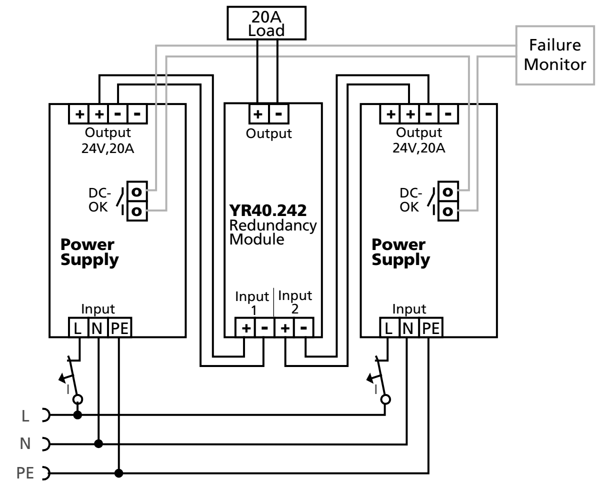
Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

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.

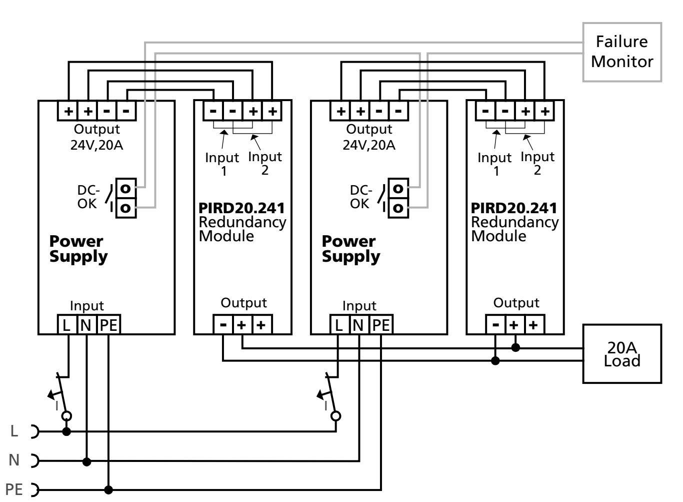
Wiring examples:

Fig. 23-1 **1+1 Redundant wiring with 1 YR40.242**



Optionally a YR40.241 can be used, which has the input terminals on top and output on bottom

Fig. 23-2 **1+1 Redundant wiring with 2 PIRD20.241**

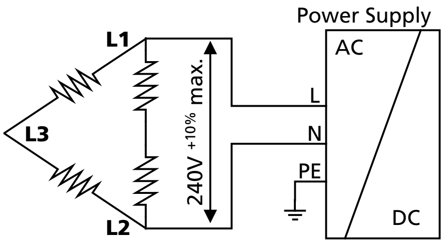


23.5. OPERATION ON TWO PHASES

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.



23.6. 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.

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	48.3°C	55.3°C
Temperature outside the box	21.0°C	21.0°C
Temperature rise	27.3K	34.3K

PULS

PIANO-Series

PIC480.481D

48V, 10A, 480W, SINGLE PHASE INPUT

POWER SUPPLY

- AC 100-240V Wide-range Input
- Active PFC
- Width only 59mm
- Efficiency up to 95.7%
- Safe Hiccup*PLUS* Overload Mode
- Full Power Between -25°C and +55°C
- DC-OK Relay Contact
- 3 Year Warranty

PRODUCT 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 unit is equipped with a wide-range input voltage stage, many safety approvals and a wide operational temperature range, which makes the unit applicable for global use.

The addition of a DC-OK signal makes the unit suitable for many industry applications such as process control, factory automation or many other critical applications, where preventive function monitoring can help to avoid long downtimes.

SHORT-FORM DATA

Output voltage	DC 48V	Nominal
Adjustment range	48 – 56V	Factory setting 48.0V
Output current	10.0 – 8.6A	Below +55°C ambient
	6.3 – 5.4A	At +70°C ambient
	Derate linearly between +55°C and +70°C	
Input voltage AC	AC 100-240V	±10%
Mains frequency	50-60Hz	±6%
AC Input current	4.3 / 2.3A	At 120 / 230Vac
Power factor	0.99 / 0.97	At 120 / 230Vac
AC Inrush current	15 / 35A pk	At 120 / 230Vac, 40°C, cold start
Efficiency	94.6 / 95.7%	At 120 / 230Vac
Losses	27.4 / 21.6W	At 120 / 230Vac
Hold-up time	27 / 27ms	At 120 / 230Vac
Temperature range	-25 to +70°C	
Size (WxHxD)	59x124x127mm	
Weight	810g / 1.79lb	

ORDER NUMBERS

Power Supply	**PIC480.481D**	
Accessory	YR40.482	Redundancy module
	UF20.481	Buffer Module

MAIN APPROVALS

IECEE CB SCHEME — IEC 61010-2-201

c UL us LISTED — UL 61010-2-201

IECEE CB SCHEME — IEC 62368

CE

INDEX

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 commercial use, such as in industrial control, process control, monitoring, measurement, Audio/Video, information or communication equipment or the like. Do not use this device in equipment where malfunction may cause severe personal injury or threaten human life.
If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.
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 industrial, residential, commercial and light-industrial environments.

2. INSTALLATION INSTRUCTIONS

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 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 device in an enclosure providing protection against electrical, mechanical and fire hazards.
Install the device onto a DIN-rail according to EN 60715 with the input terminals on the bottom of the device.
Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +55°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. Use ferrules for wires on the input terminals.
The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed.
The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.
The isolation of the 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.
The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminals and the PE potential must not exceed 300Vac.
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 5000m (16400ft). Above 2000m (6560ft) the overvoltage category is reduced to level II and a reduction in output current is required.
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 20A without additional protection device. For higher branch circuits use an additional protection device. If an external input protection device is utilized, do not use one smaller than a 10A B- or 6A 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.

3. AC-INPUT

The device is suitable to be supplied from TN, TT or IT mains networks with AC voltage.

AC input	Nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		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.	81Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	Typ.	63Vac / 71Vac	At no load / nominal load, steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	AC 120V	AC 230V	
Input current	Typ.	5.2A	4.3A	2.3A	At 48V, 10A, see Fig. 3-3
Power factor	Typ.	0.99	0.99	0.97	At 48V, 10A, see Fig. 3-4
Crest factor	Typ.	1.6	1.7	2.0	At 48V, 10A, The crest factor is the mathematical ratio of the peak value to RMS value of the input current waveform.
Start-up delay	Typ.	420ms	300ms	230ms	See Fig. 3-2
Rise time	Typ.	170ms	170ms	170ms	At 48V, 10A const. current load, 0mF load capacitance, see Fig. 3-2
	Typ.	330ms	330ms	330ms	At 48V, 10A const. current load, 10mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	200mV	200mV	See Fig. 3-2

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

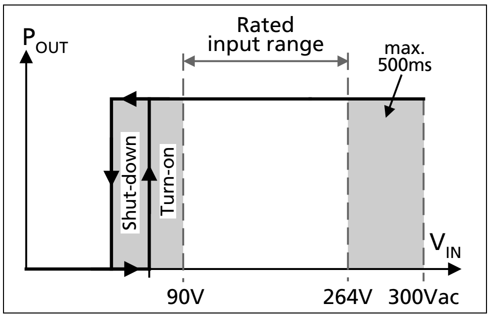


Fig. 3-2 **Turn-on behavior, definitions**

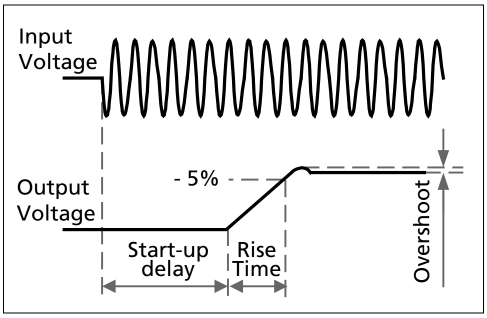


Fig. 3-3 **Input current vs. output load at 48V**

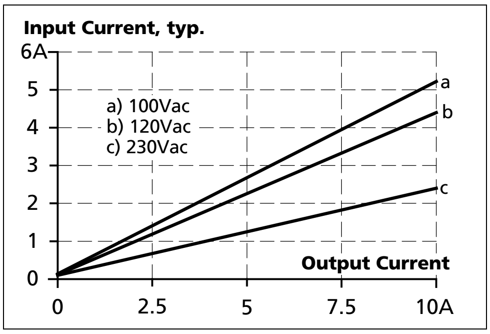
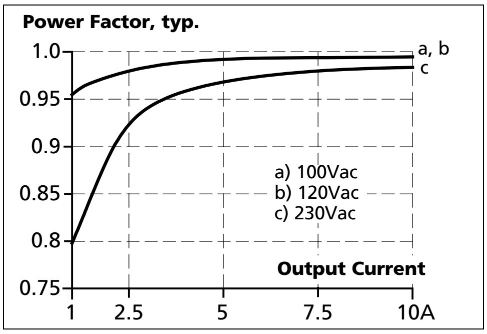


Fig. 3-4 **Power factor vs. output load**



4. DC-INPUT

Do not operate this power supply with DC-input voltage.

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.	$15A_{peak}$	$18A_{peak}$	$42A_{peak}$	At 40°C, cold start
	Typ.	$13A_{peak}$	$13A_{peak}$	$25A_{peak}$	At 25°C, cold start
	Typ.	$13A_{peak}$	$15A_{peak}$	$35A_{peak}$	At 40°C, cold start
Inrush energy	Max.	$3A^2s$	$3A^2s$	$3A^2s$	At 40°C, cold start

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

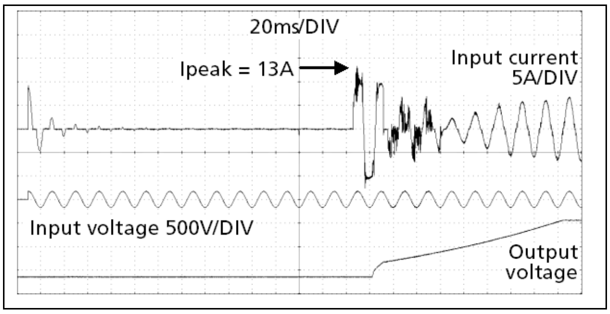
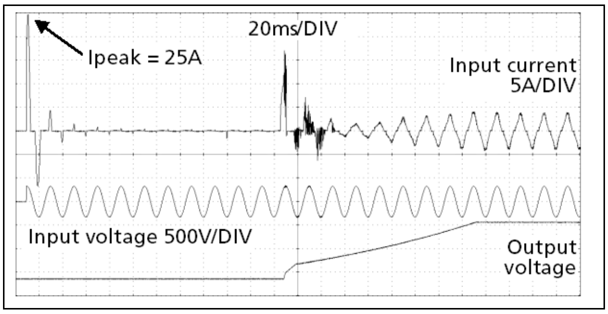


Fig. 5-2 **Typical turn-on behaviour at nominal load, 230Vac input and 25°C ambient**



6. OUTPUT

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

The output 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.	DC 48V	
Adjustment range		48-56V	Guaranteed value
	Max.	60V	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 90 and 300Vac
Load regulation	Max.	100mV	Between 0A and 10A, static value, see Fig. 6-1
Ripple and noise voltage	Max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	10.0A	At 48V and an ambient temperature below 55°C
	Nom.	6.3A	At 48V and 70°C ambient temperature
	Nom.	8.6A	At 56V and an ambient temperature below 55°C
	Nom.	5.4A	At 56V and 70°C ambient temperature
		Derate linearly between +55°C and +70°	
Overload behaviour		Continuous current	For output voltage above 19Vdc, see Fig. 6-1
		Intermittent current 1)	For output voltage below 19Vdc, see Fig. 6-1
Overload/ short-circuit current	Max.	14.5A	Continuous current, see Fig. 6-1
	Typ.	19A	Intermittent current peak value for typ. 1s Load impedance 50mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	Max.	7.0A	Intermittent current average value (R.M.S.) Load impedance 50mOhm, see see Fig. 6-2
Output capacitance	Typ.	2 500µF	Included inside the power supply
Back-feeding loads	Max.	63V	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) At heavy overloads (when output voltage falls below 19V), the power supply delivers continuous output current for 2-5s. After this, the output is switched off for approx. 7s before a new start attempt with duration of 1s is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally.

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

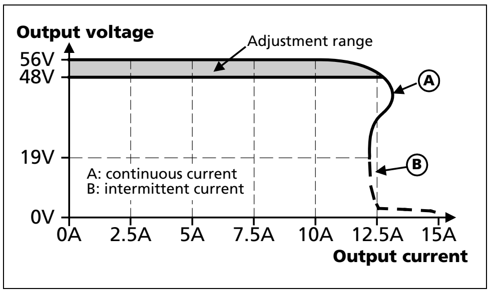
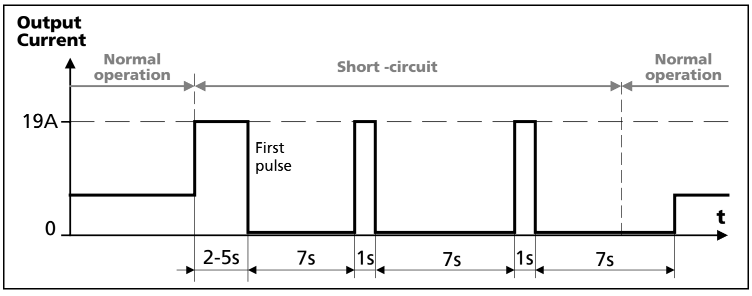


Fig. 6-2 **Short-circuit on output, intermittent current, typ.**



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.	54ms	54ms	54ms	At 48V, 5A, see Fig. 7-1
	min.	44ms	44ms	44ms	At 48V, 5A, see Fig. 7-1
	typ.	27ms	27ms	27ms	At 48V, 10A, see Fig. 7-1
	min.	22ms	22ms	22ms	At 48V, 10A, see Fig. 7-1

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

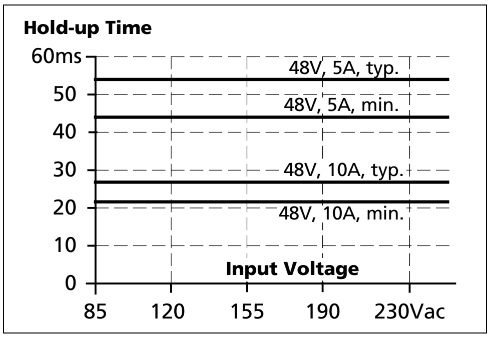
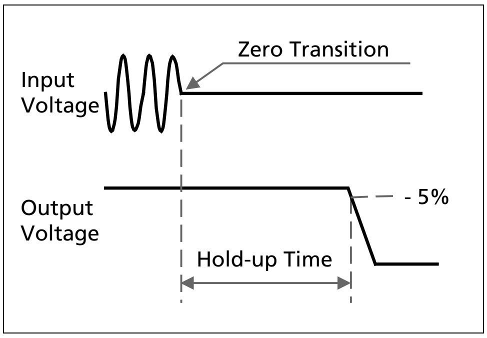


Fig. 7-2 **Shut-down behavior, definitions**

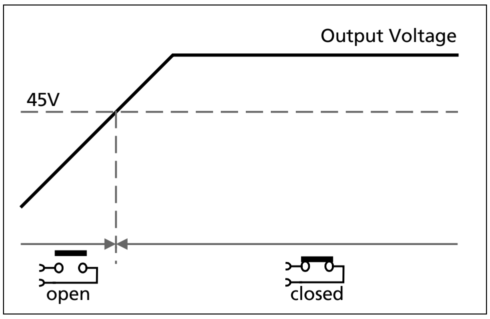


8. DC-OK RELAY CONTACT

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

Contact closes	As soon as the output voltage reaches 45V.
Contact opens	As soon as the output voltage falls below 45V.
Switching hysteresis	Typically 0.4V
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.	94.0%	94.6%	95.7%	At 48V, 10A
Average efficiency*)	Typ.	93.5%	93.8%	94.6%	25% at 2.5A, 25% at 5A, 25% at 7.5A, 25% at 10A
Power losses	Typ.	6.3W	5.5W	3.7W	At 48V, 0A
	Typ.	16.5W	15.2W	12.1W	At 48V, 5A
	Typ.	30.6W	27.4W	21.6W	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.**

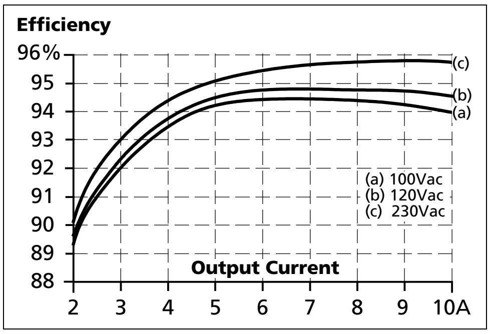


Fig. 9-2 **Losses vs. output current at 48V, typ.**

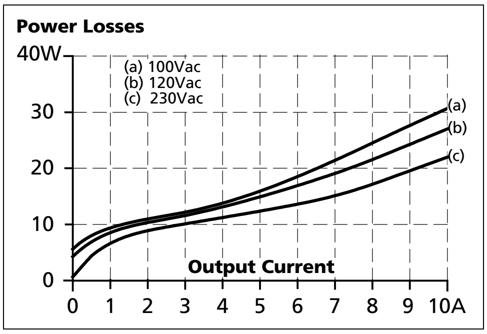


Fig. 9-3 **Efficiency vs. input voltage at 48V, 10A, typ.**

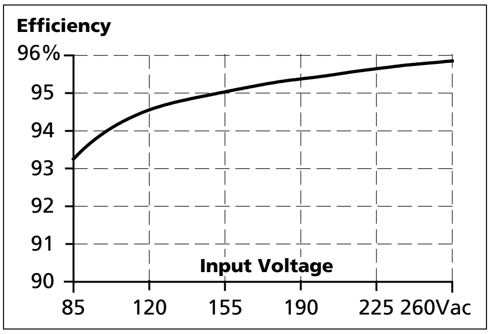
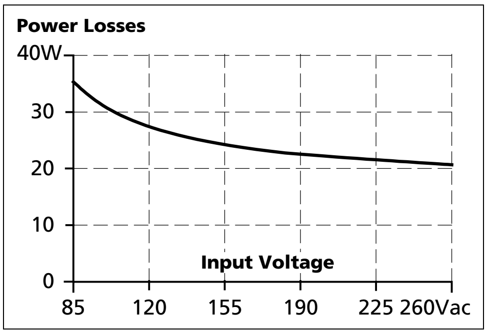
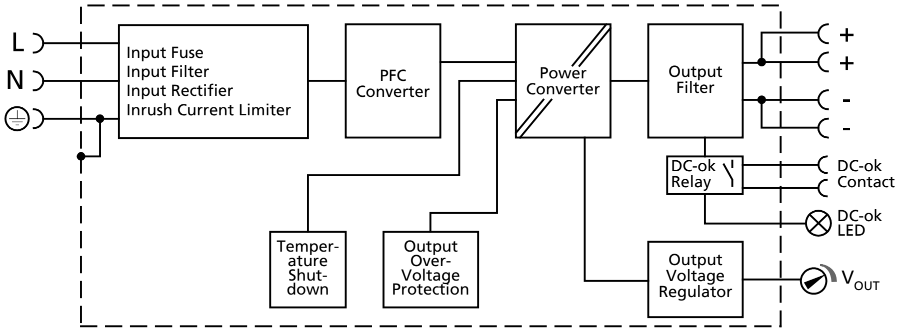


Fig. 9-4 **Losses vs. input voltage at 48V, 10A, typ.**



10. FUNCTIONAL DIAGRAM

Fig. 10-1 **Functional diagram**



11. FRONT SIDE AND USER ELEMENTS

Fig. 11-1 **Front side**

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

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

C **DC-OK LED** (green)
On, when the output voltage is above 42V.

D **Output Voltage Adjustment Potentiometer**

E **DC-OK Relay Contact**
The DC-OK relay contact is not synchronized with the DC-OK LED.
See chapter 8 for details.

12. CONNECTION TERMINALS

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

	Input	Output	DC-OK-Signal
Type	Screw termination	Screw termination	Push-in termination
Solid wire	Max. $6mm^2$	Max. $6mm^2$	Max. $1.5mm^2$
Stranded wire	Max. $4mm^2$	Max. $4mm^2$	Max. $1.5mm^2$
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

13. 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	84 000h	101 000h	138 000h	At 48V, 10A and 40°C
	178 000h	185 000h	210 000h	At 48V, 5A and 40°C
	238 000h	284 000h	391 000h	At 48V, 10A and 25°C
	502 000h	523 000h	593 000h	At 48V, 5A and 25°C

14. 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.

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	595 000h	611 000h	704 000h	At 48V, 10A and 40°C
	1 090 000h	1 116 000h	1 252 000h	At 48V, 10A and 25°C
MTBF MIL HDBK 217F	274 000h	275 000h	289 000h	At 48V, 10A and 40°C, Ground Benign GB40
	368 000h	370 000h	386 000h	At 48V, 10A and 25°C, Ground Benign GB25
	59 000h	59 000h	63 000h	At 48V, 10A and 40°C, Ground Fixed GF40
	76 000h	76 000h	80 000h	At 48V, 10A and 25°C, Ground Fixed GF25

15. EMC

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

The device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3.

The 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.

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 industrial, residential, commercial and light-industrial environments.

EMC Immunity

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 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	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	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 0.3ms	Criterion A

Performance 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 55032, FCC Part 15, CISPR 11, CISPR 32	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 not fulfilled
Radiated emission	EN 55011, EN 55032	Class B
Harmonic input current	EN 61000-3-2	Fulfilled, Class A limits
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with constant current loads, no pulsing

Switching frequencies:

PFC converter	80kHz to 130kHz	Input voltage and load dependent
Main converter	75kHz to 180kHz	Output voltage and load dependent
Auxiliary converter	60kHz	Fixed frequency

16. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	12W/°C 30W/1000m or 5°C/1000m	Between +55°C and +70°C (131°F to 140°F) For altitudes >2000m (6560ft), see Fig. 16-2
	The de-rating is not hardware controlled. The user has to take this into consideration 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	110-54kPa	See Fig. 16-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 16-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes up to 5000m
Impulse withstand voltages	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes up to 2000m
Degree of pollution	2	According to IEC 60664-1, 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 per 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.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

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

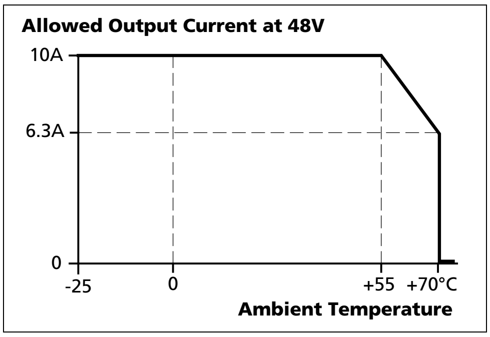
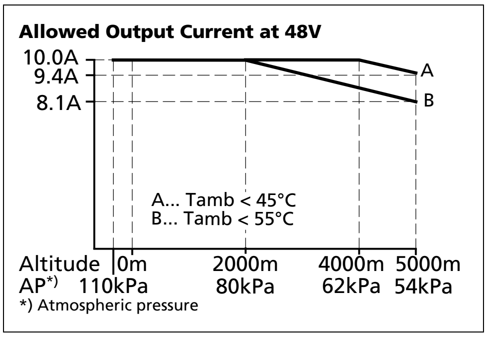


Fig. 16-2 **Output current vs. altitude**



17. 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.	58.8Vdc	
	Max.	60Vdc	
		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
Ingress protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shut-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 15 (EMC).
Internal input fuse		Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	Typ.	0.12mA / 0.30mA	At 100Vac, 50Hz, TN-,TT-mains / IT-mains
	Typ.	0.17mA / 0.45mA	At 120Vac, 60Hz, TN-,TT-mains / IT-mains
	Typ.	0.27mA / 0.71mA	At 230Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.15mA / 0.38mA	At 110Vac, 50Hz, TN-,TT-mains / IT-mains
	Max.	0.21mA / 0.56mA	At 132Vac, 60Hz, TN-,TT-mains / IT-mains
	Max.	0.35mA / 0.91mA	At 264Vac, 50Hz, TN-,TT-mains / IT-mains

18. DIELECTRIC STRENGTH

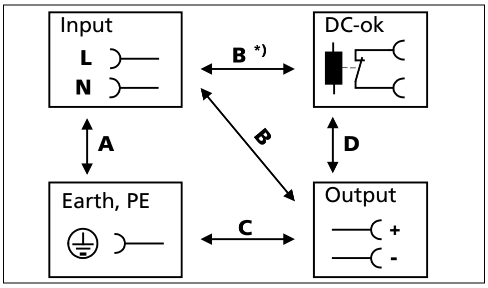
The output voltage is floating and has no ohmic connection to the ground.

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. 18-1 **Dielectric strength**



		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Routine test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Field test cut-off current settings		> 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.

19. APPROVALS AND FULFILLED STANDARDS

UL 61010	c UL US LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61010	IECEE CB SCHEME	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	IECEE CB SCHEME	CB Scheme Certificate IEC 62368-1 Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

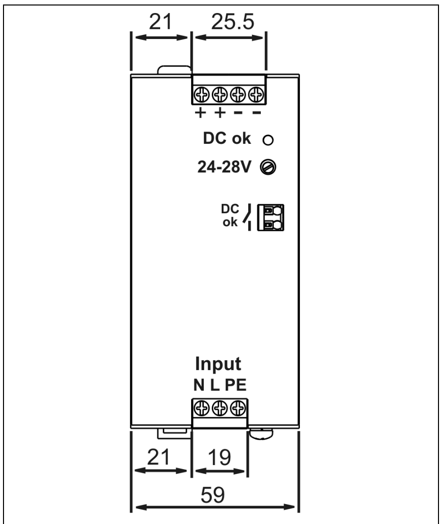
20. REGULATORY COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Directive	REACH	Manufacturer's Statement EU-Directive regarding the Registration, Evaluation, Authorization and Restriction of Chemicals
WEEE Directive		Manufacturer's Statement EU-Regulation on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products.
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

21. PHYSICAL DIMENSIONS AND WEIGHT

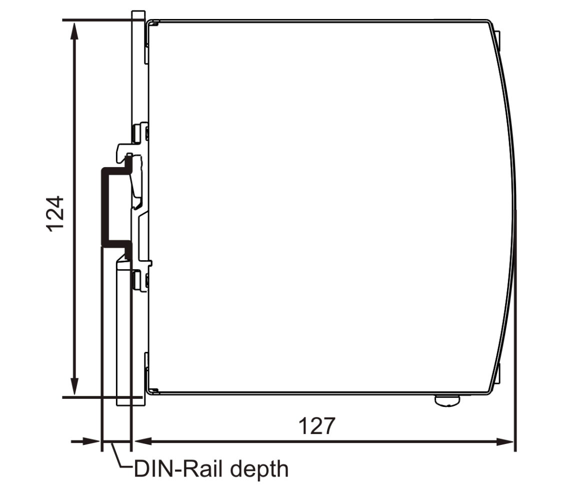
Width	59mm 2.32''
Height	124mm 4.88''
Depth	127mm 5.0'' The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	810g / 1.79lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: zinc-plated steel
Installation clearances	See chapter 2
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.5mm

Fig. 21-1 **Front view**



All dimensions in mm

Fig. 21-2 **Side view**



All dimensions in mm

22. ACCESSORY

22.1. YR40.482 REDUNDANCY MODULE

The YR40.482 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 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 suitable power supplies on the input, where the sum of the continuous short circuit current stays below 45A. This is typically achieved when the power supplies are featured with an intermittent overload behavior (Hiccup Mode).

See chapter 23.4 for wiring information.

22.2. UF20.481 BUFFER MODULE

The UF20.481 buffer module is a supplementary device for DC 48V 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.

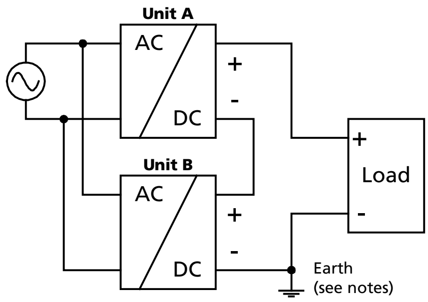
One buffer module can deliver 20A additional current and can be added in parallel to increase the output ampacity or the hold-up time.

23. APPLICATION NOTES

23.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

23.2. 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.

23.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use the power supply in parallel to increase the output power.

23.4. PARALLEL USE FOR 1+1 REDUNDANCY

The device can be used to built 1+1 redundant systems.

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.

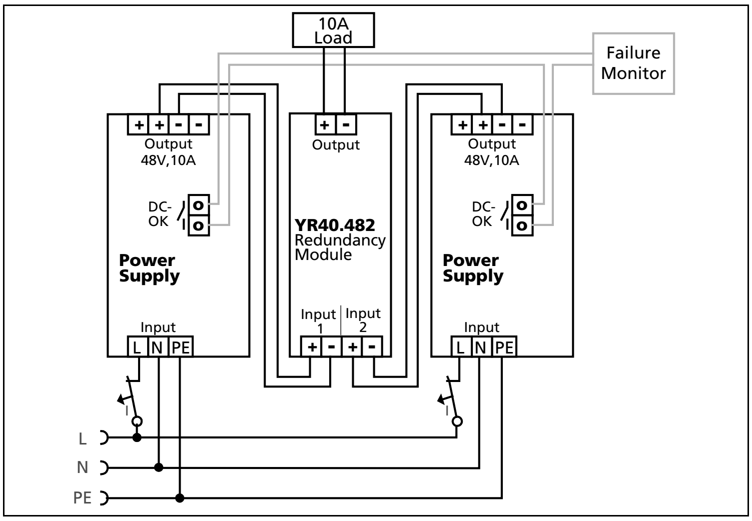
Pay attention that leakage current, EMI, inrush current, harmonics will increase when using multiple devices.

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.

Wiring examples:

Fig. 23-1 **1+1 Redundant wiring with 1 YR40.482**

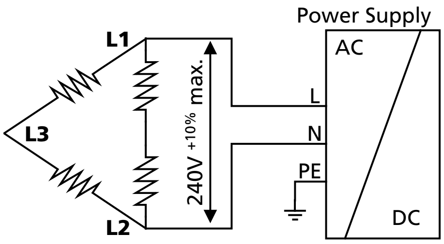


23.5. OPERATION ON TWO PHASES

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.



23.6. 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.

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	48V, 8A; (=80%)	48V, 10A; (=100%)
Temperature inside the box	46.8°C	51.9°C
Temperature outside the box	21.0°C	21.0°C
Temperature rise	25.8K	30.9K

22mm

POWER SUPPLY 1AC 24V 36W

- AC 100-240V Wide-range input
- NEC CLASS 2 compliant
- Cost optimized without compromising quality or reliability
- No PE connection required
- Width only 22.5mm
- Efficiency up to 90.6%
- Low no-load power losses
- Full power between -10°C and +60°C
- Push-in terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM36.241 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage. The output fulfils the requirements for a limited power source according to NEC CLASS 2.

The device is equipped with push-in terminals, which are optimized for automated wiring.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The unit is designed as "Class of Protection" II unit and fulfills the safety and EMC requirements without an input PE connection. This saves wiring costs.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today's industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24-28V	Factory setting 24.1V
Output current	1.5-1.2A	Below +60°C ambient
	1.1-0.95A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	0.63 / 0.38A	At 120 / 230Vac
Power factor	0.53 / 0.46	At 120 / 230Vac
Input inrush current	14 / 40A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	90.5 / 90.6%	At 120 / 230Vac
Power losses	3.8 / 3.7W	At 120 / 230Vac
Hold-up time	37 / 162ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	22.5x90x91mm	Without DIN rail
Weight	140g / 0.31lb	

ORDER NUMBERS

Description: Power supply PIM36.241-xx
Order Number:
PIM36.241

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL US LISTED
Ind. Cont. Eq.

NEC CLASS 2

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Index

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 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.

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC III according to IEC 60664-1.

The device is designed as "Class of Protection" II equipment according to IEC 61140.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		264-300Vac	For maximum 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.	56Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	typ.	45Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	AC 120V	AC 230V	
Input current	typ.	0.72A	0.63A	0.38A	At 24V, 1.5A, see Fig. 3-1
Power factor	typ.	0.55	0.53	0.46	At 24V, 1.5A, see Fig. 3-4
Start-up delay	typ.	90ms	90ms	90ms	See Fig. 3-2
Rise time	typ.	23ms	18ms	19ms	At 24V, 1.5A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	56ms	56ms	57ms	At 24V, 1.5A resistive load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

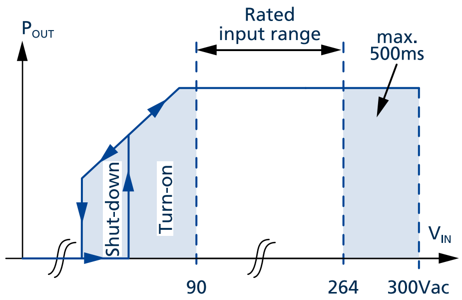


Fig. 3-1: Input voltage range

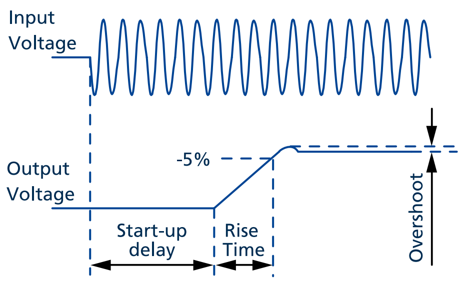


Fig. 3-2: Turn-on behavior, definitions

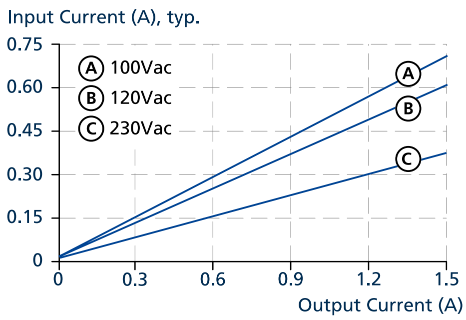


Fig. 3-3: Input current vs. output load at 24V output voltage

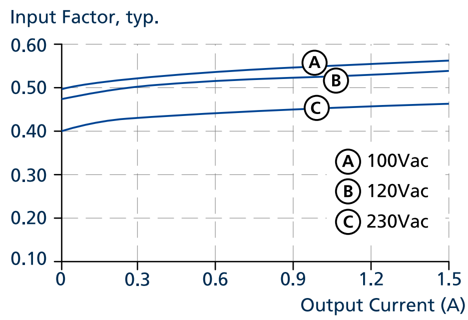


Fig. 3-4: Power factor vs. output load at 24V output voltage

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.
The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	11A	14A	40A	At 40°C, ambient, cold start
	typ.	8A	10A	32A	At 25°C, ambient, cold start
	max.	13A	17A	48A	At 40°C, ambient, cold start
	max.	10A	13A	39A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	$0.3A^2s$	$0.5A^2s$	$2A^2s$	At 40°C, ambient, cold start

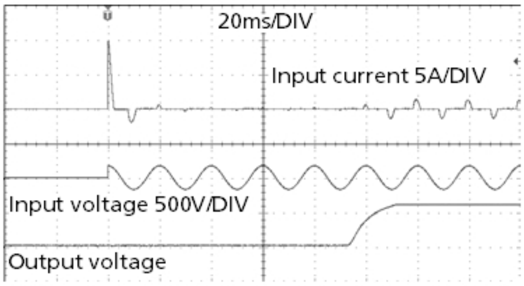


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

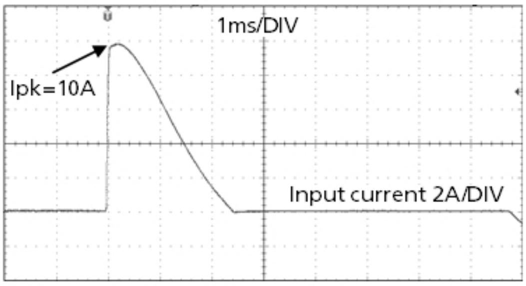


Fig. 5-2: Zoom into the first inrush peak

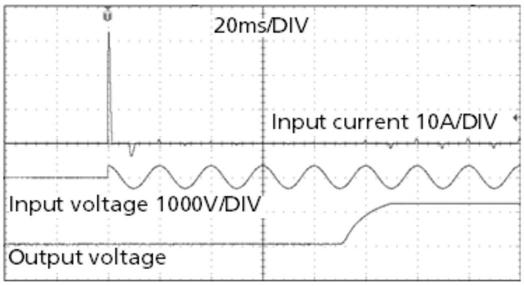


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

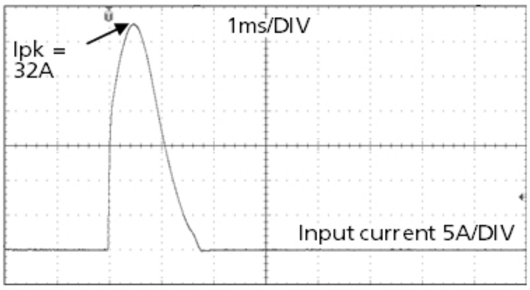


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 4 000µF with 1.5A or 5 000µF with 0.75A additional resistive load.

At heavy overloads (when output voltage falls below 14V), the device delivers continuous output current for 55ms. After this, the output is switched off for approx. 340ms 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.

Output voltage	nom.	DC 24V	
Adjustment range		24-28V	Guaranteed value
	max.	29.2V	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.	24.1V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	50mV	Between 0 and 1.5A, static value, see Fig. 6-1
Ripple and noise voltage	max.	50mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	1.5A	At 24V and an ambient temperature below 60°C
	nom.	1.1A	At 24V and 70°C ambient temperature
	nom.	1.2A	At 28V and an ambient temperature below 60°C
	nom.	0.95A	At 28V and 70°C ambient temperature
Overload protection	Included		Electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.
Overload behaviour	Continuous current		For output voltage above 14Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 14Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	1.7A	Continuous current, see Fig. 6-1
	typ.	3.5A	Intermitted current peak value for typ. 55ms Load impedance 100mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	1.4A	Intermitted current average value (R.M.S.) Load impedance 100mOhm, see Fig. 6-2
Output capacitance	typ.	1 200µF	Included inside the device
Back-feeding loads	max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

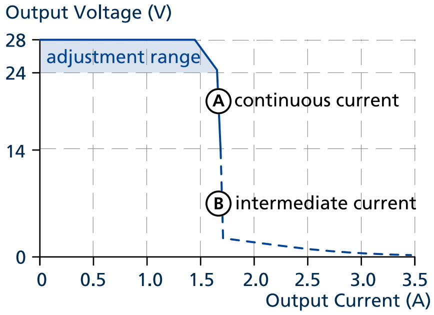


Fig. 6-1: Output voltage vs. output current, typ.

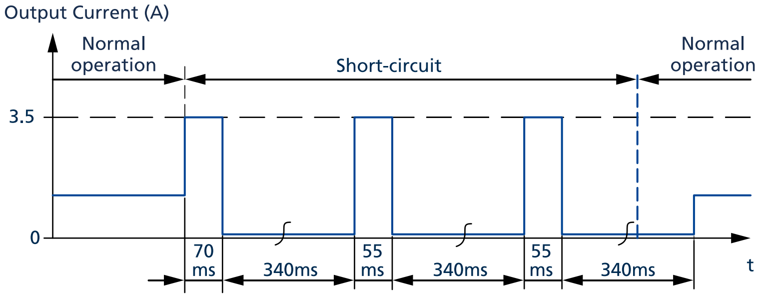


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	23ms	37ms	162ms	At 24V, 1.5A
	typ.	55ms	83ms	330ms	At 24V, 0.75A
	min.	20ms	30ms	130ms	At 24V, 1.5A
	min.	44ms	66ms	260ms	At 24V, 0.75A

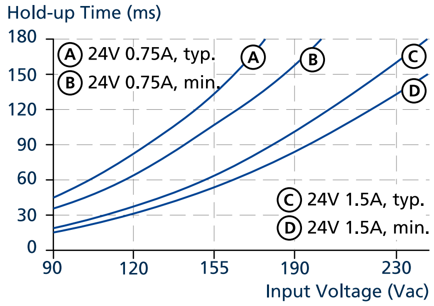


Fig. 7-1: Hold-up time vs. input voltage

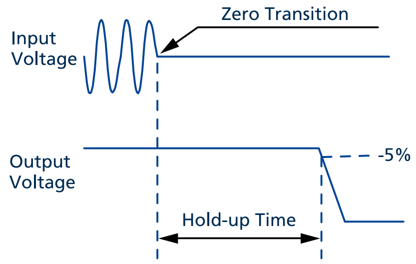


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	89.4%	90.5%	90.6%	At 24V, 1.5A (full load)
Average efficiency	typ.	89%	89.6%	88.2%	25% at 0.38A, 25% at 0.75A, 25% at 1.13A, 25% at 1.5A
Power losses	typ.	0.25W	0.25W	0.4W	At no load
	typ.	2.2W	2.1W	2.4W	At 24V, 0.75A (half load)
	typ.	4.3W	3.8W	3.7W	At 24V, 1.5A (full load)

The average efficiency is an assumption for a typical application where the device 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.

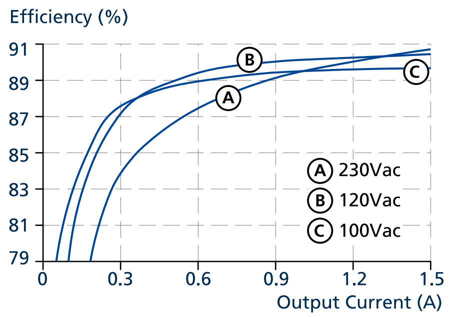


Fig. 8-1: Efficiency vs. output current at 24V, typ.

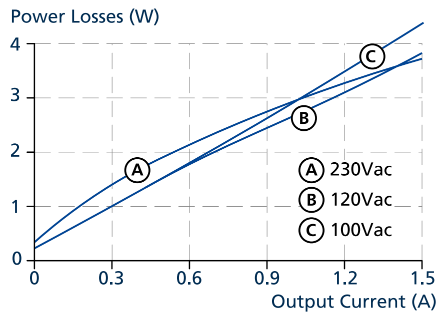


Fig. 8-2: Losses vs. output current at 24V, typ.

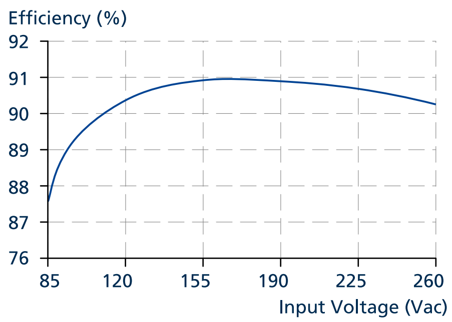


Fig. 8-3: Efficiency vs. input voltage at 24V, 1.5A, typ.

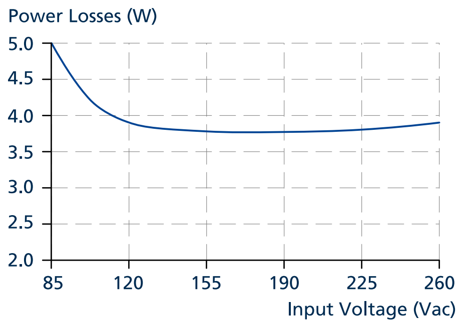


Fig. 8-4: Losses vs. input voltage at 24V, 1.5A, typ.

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	146 000h	162 000h	161 000h	At 24V, 1.5A and 40°C
	320 000h	329 000h	277 000h	At 24V, 0.75A and 40°C
	414 000h	459 000h	456 000h	At 24V, 1.5A and 25°C
	905 000h	931 000h	782 000h	At 24V, 0.75A and 25°C

10. 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.

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	1 973 000h	2 088 000h	2 081 000h	At 24V, 1.5A and 40°C
	3 349 000h	3 500 000h	3 498 000h	At 24V, 1.5A and 25°C
MTBF MIL HDBK 217F	812 000h	826 000h	748 000h	At 24V, 1.5A and 40°C; Ground Benign GB40
	1 122 000h	1 144 000h	1 044 000h	At 24V, 1.5A and 25°C; Ground Benign GB25
	194 000h	200 000h	191 000h	At 24V, 1.5A and 40°C; Ground Fixed GF40
	253 000h	261 000h	251 000h	At 24V, 1.5A and 25°C; Ground Fixed GF25

11. Functional Diagram

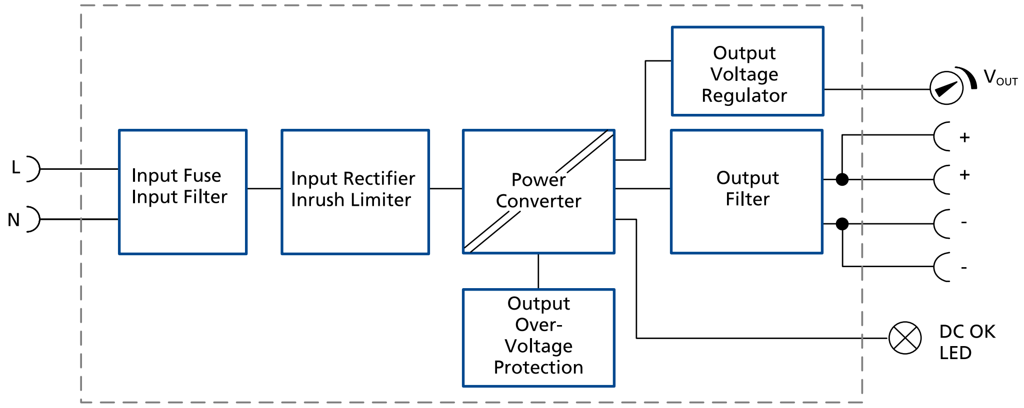


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Push-in terminals
Solid wire	max. 2.5mm²
Stranded wire	max. 2.5mm²
Stranded wire with ferrules	max. 1.5mm²
American Wire Gauge	AWG 24-12
Max. wire diameter (including ferrules)	2.3mm
Wire stripping length	10mm / 0.4inch
Screwdriver	3mm slotted to open the spring

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

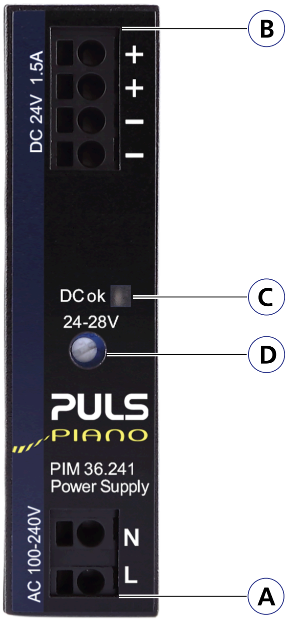


Fig. 13-1: Front side

A **Input Terminals**

- **N** Neutral conductor input
- **L** Phase (Line) input

B **OutputTerminals**
Dual terminals for the negative and positive pole.
Both poles are internally connected.

- **+** Positive output
- **-** Negative (return) output

C **DC OK LED (green)**
The LED is on, when the output voltage is above 18V.

D **Output voltage potentiometer**

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

EMC Immunity				
Electrostatic discharge	EN 61000-4-2	Contact discharge	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → Earthed output	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) → (–) Earthed	1kV	Criterion A
		(–) → (+) Earthed	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	2kHz-130kHz	Input voltage and output load dependent

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.04A/°C	Between +60°C and +70°C (140°F to 158°F)
	2.3W/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

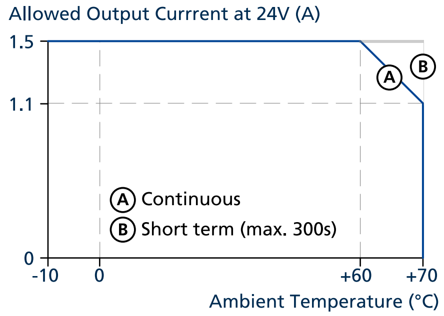


Fig. 15-1: Output power vs. ambient temp.

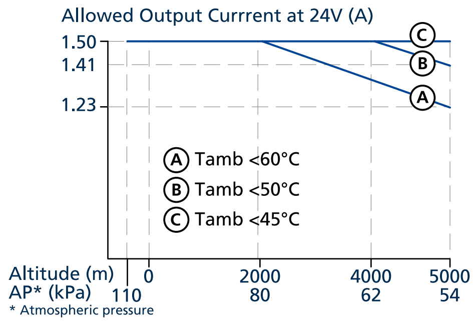


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

Isolation resistance	>500MOhm	At delivered condition between input and output, measured with 500Vdc
Output over-voltage protection	typ. 30.5Vdc max. 32Vdc In case of an internal defect, a redundant circuit limits the maximum output voltage to 32V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	II	According to IEC 61140
Degree of protection	IP 20	According to EN/IEC 60529
Over-temperature protection	Not Included	
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. 28uA / 79uA typ. 36uA / 101uA typ. 41uA / 115uA max. 32uA / 90uA max. 41uA / 115uA max. 49uA / 137uA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains At 120Vac, 60Hz, TN-, TT-mains / IT-mains At 230Vac, 50Hz, TN-, TT-mains / IT-mains At 110Vac, 50Hz, TN-, TT-mains / IT-mains At 132Vac, 60Hz, TN-, TT-mains / IT-mains At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

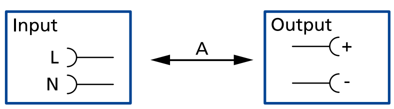


Fig. 17-1: Dielectric strength

		A
Type test	60s	3000Vac
Factory test	5s	2500Vac
Field test	5s	2000Vac
Field test cut-off current settings		>10mA

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
NEC Class 2	NEC CLASS 2	UL Certificate Limited Power Source Listed in the UL 61010-2-201 approval report, investigated according to UL 1310
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
REACH Regulation	REACH	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

20. Physical Dimensions And Weight

Width	22.5mm / 0.86''
Height	90mm / 3.54''
Depth	91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
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.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 3.7mm.

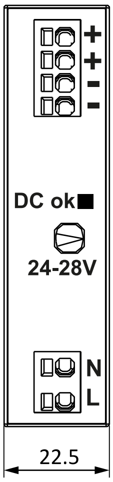


Fig. 20-1: Front view

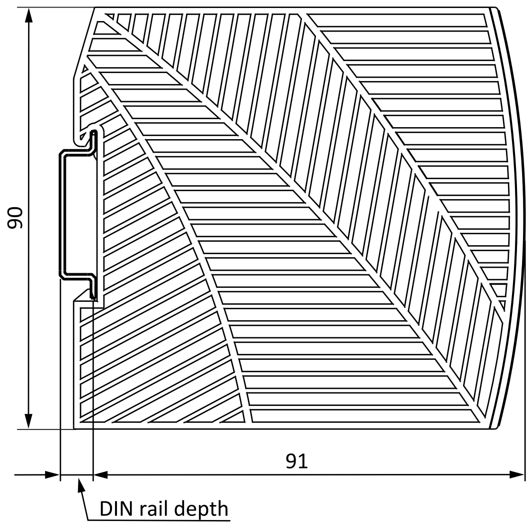


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 1.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

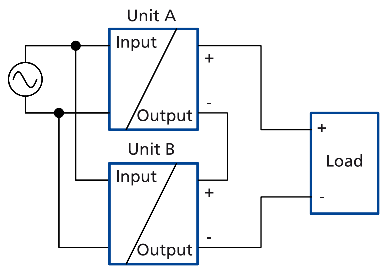
21.2. SERIES OPERATION

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 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.

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



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

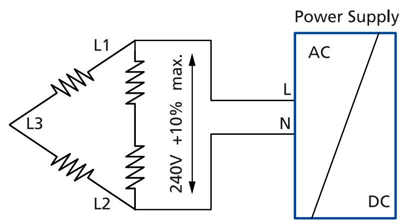
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems since there is no monitoring (DC-OK signal) included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



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

	Case A	**Case B**
Enclosure size	**130**x130x75mm Rittal Typ IP66 Box PK 9510 100 plastic	**130**x130x75mm Rittal Typ IP66 Box PK 9510 100 plastic
Input voltage	230Vac	230Vac
Load	24V, 1.2A; (=**80**%)	24V, 1.5A; (=**100**%)
Temperature inside the box	27.9°C	28.5°C
Temperature outside the box	21°C	21°C
Temperature rise	6.9K	7.5K

POWER SUPPLY 1AC 12V 60W

- AC 100-240V Wide-range input
- NEC CLASS 2 compliant
- Cost optimized without compromising quality or reliability
- No PE connection required
- Width only 36mm
- Efficiency up to 90.7%
- Low no-load power losses
- Full power between -10°C and +60°C
- Push-in terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM60.121 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage. The output fulfils the requirements for a limited power source according to NEC CLASS 2.

The device is equipped with push-in terminals, which are optimized for automated wiring.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The unit is designed as “Class of Protection” II unit and fulfills the safety and EMC requirements without an input PE connection. This saves wiring costs.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today’s industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 12V	Nominal
Adjustment range	12-15V	Factory setting 12V
Output current	5-4A	Below +60°C ambient
	3.8-3A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1 / 0.6A	At 120 / 230Vac
Power factor	0.55 / 0.47	At 120 / 230Vac
Input inrush current	15 / 36A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	90.2 / 90.7%	At 120 / 230Vac
Power losses	6.5 / 6.2W	At 120 / 230Vac
Hold-up time	23 / 107ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	225g / 0.5lb	

ORDER NUMBERS

Description: Power supply PIM60.121-xx
Order Number:
PIM60.121

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL US LISTED — NEC CLASS 2

Ind. Cont. Eq.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Index

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 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.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 3.6A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

2. Installation Instructions

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

– Turn power off before working on the device. Protect against inadvertent re-powering.
– Do not open, modify or repair the device.
– 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC III according to IEC 60664-1.

The device is designed as "Class of Protection" II equipment according to IEC 61140.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		264-300Vac	For maximum 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.	75Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	typ.	54Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.15A	1A	0.6A	At 12V, 5A, see Fig. 3-1
Power factor	typ.	0.58	0.55	0.47	At 12V, 5A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	60ms	See Fig. 3-2
Rise time	typ.	18ms	18ms	18ms	At 12V, 5A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	30ms	30ms	30ms	At 12V, 5A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

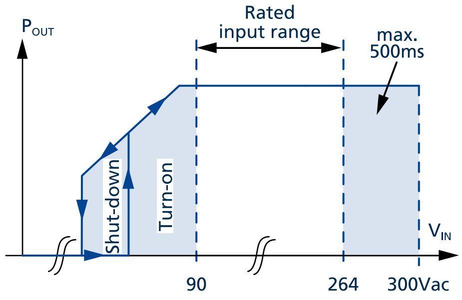


Fig. 3-1: Input voltage range

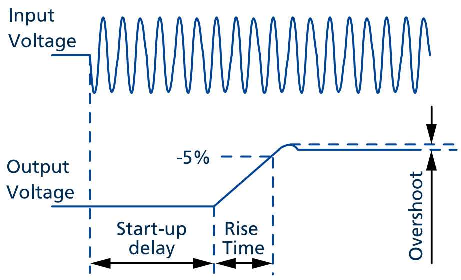


Fig. 3-2: Turn-on behavior, definitions

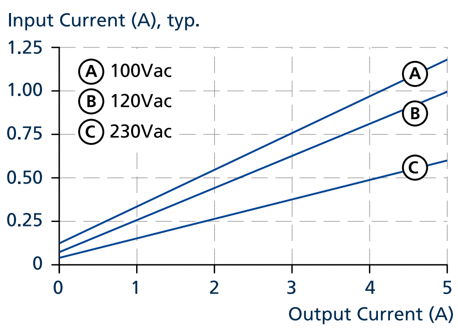


Fig. 3-3: Input current vs. output load at 12V output voltage

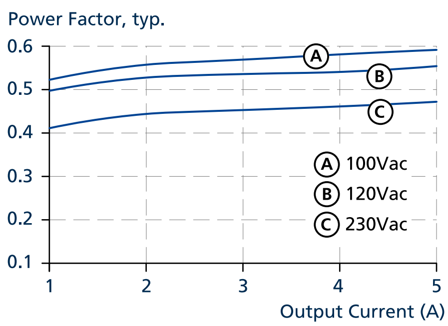


Fig. 3-4: Power factor vs. output load at 12V output voltage

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.

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

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	12A	15A	36A	At 40°C, ambient, cold start
	typ.	10A	12A	30A	At 25°C, ambient, cold start
	max.	15A	18A	44A	At 40°C, ambient, cold start
	max.	12A	15A	36A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	0.2A²s	0.3A²s	1.4A²s	At 40°C, ambient, cold start

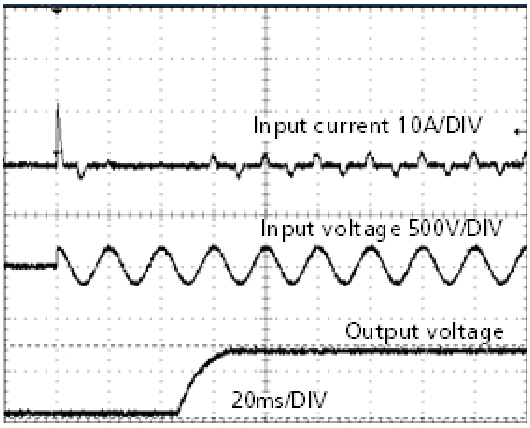


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

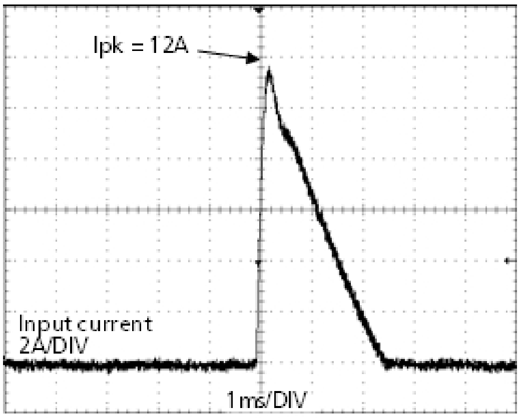


Fig. 5-2: Zoom into the first inrush peak

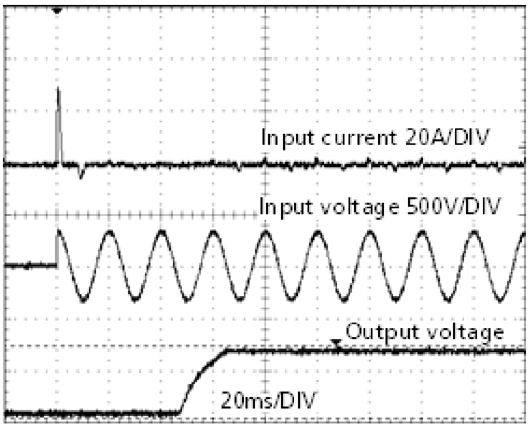


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

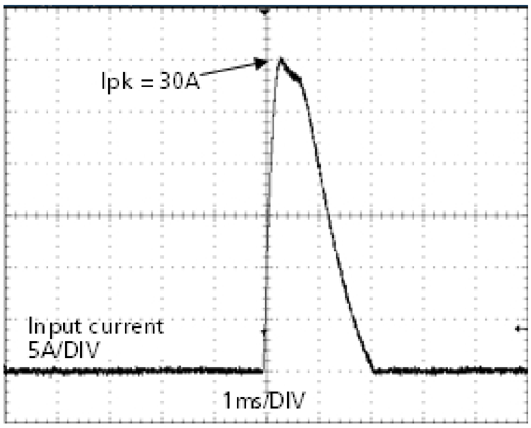


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 2 200µF with 5A or 8 000µF with 2.5A additional current load.

At heavy overloads (when output voltage falls below 8V), the device delivers continuous output current for 20ms. After this, the output is switched off for approx. 170ms 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.

Output voltage	nom.	DC 12V	
Adjustment range		12-15V	Guaranteed value
	max.	15.5V	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.	12V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 5A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	5A	At 12V and an ambient temperature below 60°C
	nom.	3.8A	At 12V and 70°C ambient temperature
	nom.	4A	At 15V and an ambient temperature below 60°C
	nom.	3A	At 15V and 70°C ambient temperature
Overload behaviour	Continuous current		For output voltage above 8Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 8Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	7A	Continuous current, see Fig. 6-1
	typ.	9A	Intermitted current peak value for typ. 20ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	3.2A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	2 200µF	Included inside the device
Back-feeding loads	max.	16V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

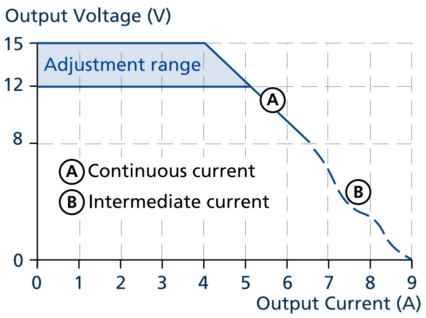


Fig. 6-1: Output voltage vs. output current, typ.

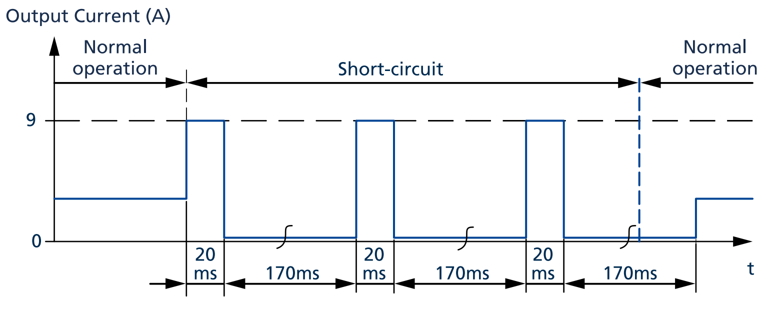


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	13ms	23ms	107ms	At 12V, 5A
	typ.	36ms	55ms	219ms	At 12V, 2.5A
	min.	10.5ms	18ms	85ms	At 12V, 5A
	min.	28.5ms	43ms	175ms	At 12V, 2.5A

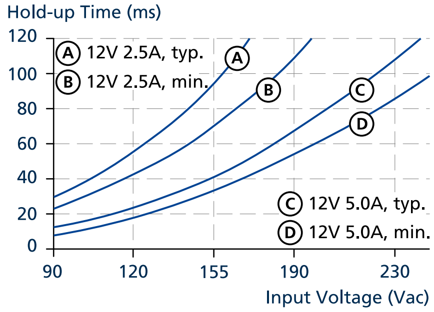


Fig. 7-1: Hold-up time vs. input voltage

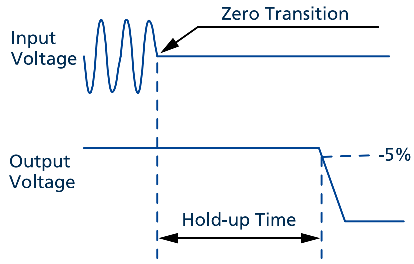


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	88.9%	90.2%	90.7%	At 12V, 5A (full load)
Average efficiency	typ.	88.9%	89.7%	89.6%	25% at 1.25A, 25% at 2.5A, 25% at 3.75A, 25% at 5A
Power losses	typ.	0.2W	0.2W	0.3W	At no load
	typ.	3.6W	3.4W	3.4W	At 12V, 2.5A (half load)
	typ.	7.5W	6.5W	6.2W	At 12V, 5A (full load)

The average efficiency is an assumption for a typical application where the device 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.

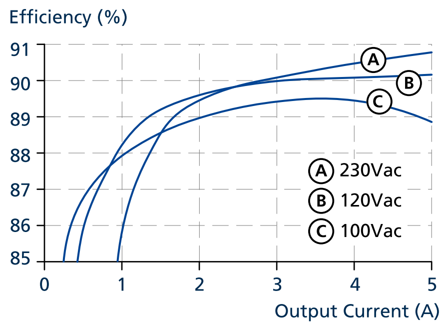


Fig. 8-1: Efficiency vs. output current at 12V, typ.

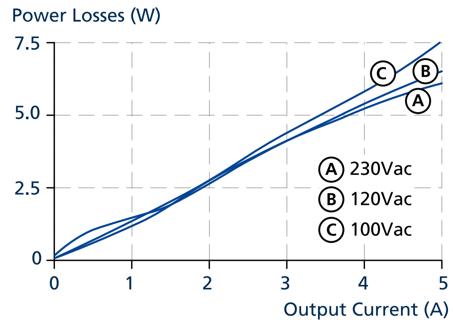


Fig. 8-2: Losses vs. output current at 12V, typ.

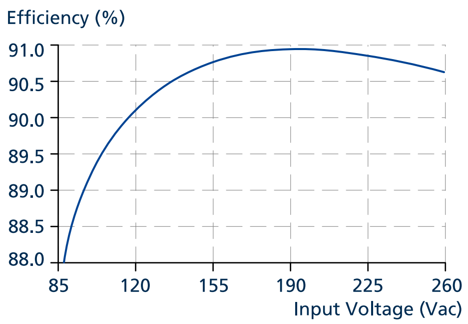


Fig. 8-3: Efficiency vs. input voltage at 12V, 5A, typ.

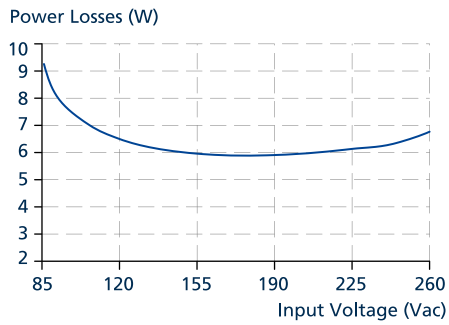


Fig. 8-4: Losses vs. input voltage at 12V, 5A, typ.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	89 000h	103 000h	119 000h	At 12V, 5A and 40°C
	241 000h	249 000h	256 000h	At 12V, 2.5A and 40°C
	252 000h	292 000h	335 000h	At 12V, 5A and 25°C
	680 000h	704 000h	724 000h	At 12V, 2.5A and 25°C

10. 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.

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	1 542 000h	1 649 000h	1 673 000h	At 12V, 5A and 40°C
	2 768 000h	2 911 000h	2 925 000h	At 12V, 5A and 25°C
MTBF MIL HDBK 217F	695 000h	707 000h	685 000h	At 12V, 5A and 40°C; Ground Benign GB40
	993 000h	1 008 000h	982 000h	At 12V, 5A and 25°C; Ground Benign GB25
	189 000h	192 000h	197 000h	At 12V, 5A and 40°C; Ground Fixed GF40
	246 000h	250 000h	258 000h	At 12V, 5A and 25°C; Ground Fixed GF25

11. Functional Diagram

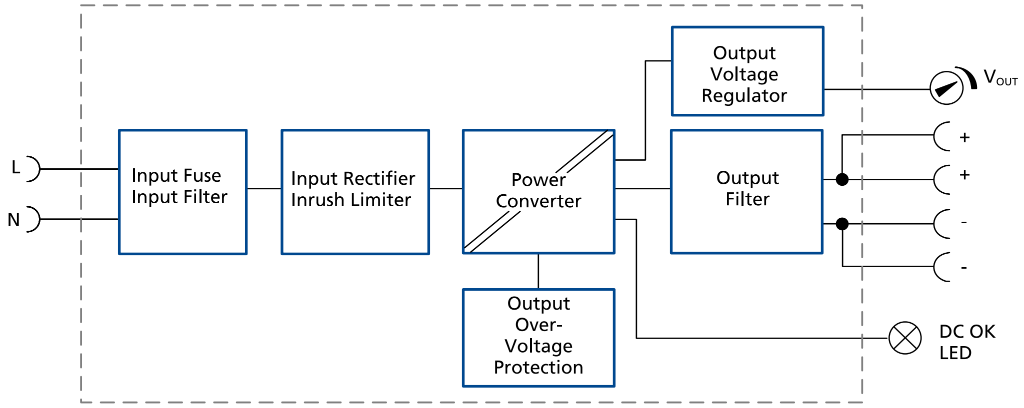


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Push-in terminals
Solid wire	max. 2.5mm²
Stranded wire	max. 2.5mm²
Stranded wire with ferrules	max. 1.5mm²
American Wire Gauge	AWG 24-12
Max. wire diameter (including ferrules)	2.3mm
Wire stripping length	10mm / 0.4inch
Screwdriver	3mm slotted to open the spring

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

Fig. 13-1: Front side

A **Input Terminals**

- **N** Neutral conductor input
- **L** Phase (Line) input

B **OutputTerminals**
Dual terminals for the negative and positive pole.
Both poles are internally connected.

- **+** Positive output
- **-** Negative (return) output

C **DC OK LED (green)**
The LED is on, when the output voltage is above 9V.

D **Output voltage adustment potentiometer**

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 3.6A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

EMC Immunity				
Electrostatic discharge	EN 61000-4-2	Contact discharge	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → Earthed output	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) → (–) Earthed	1kV	Criterion A
		(–) → (+) Earthed	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 3.6A and criterion C for output currents above 3.6A.

EMC Emission		
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	1kHz to 130kHz	Input voltage and output load dependent

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.12A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.3A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

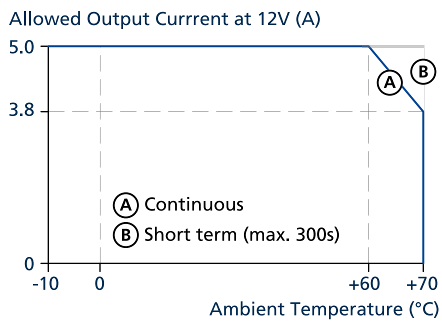


Fig. 15-1: Output power vs. ambient temp.

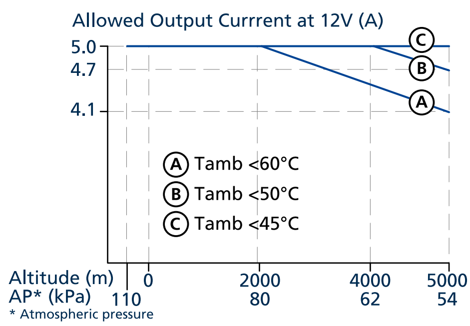


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

Isolation resistance	>500MOhm	At delivered condition between input and output, measured with 500Vdc
Output over-voltage protection	typ. 16.5Vdc max. 17Vdc In case of an internal defect, a redundant circuit limits the maximum output voltage to 17V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	II	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 40µA / 80µA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 60µA / 120µA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 100µA / 200µA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 60µA / 100µA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 80µA / 150µA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 140µA / 260µA	At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

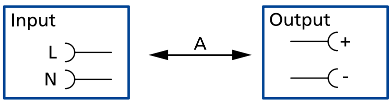


Fig. 17-1: Dielectric strength

		A
Type test	60s	3000Vac
Factory test	5s	2500Vac
Field test	5s	2000Vac
Field test cut-off current settings		>5mA

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
NEC Class 2	NEC CLASS 2	UL Certificate Limited Power Source Listed in the UL 61010-2-201 approval report, investigated according to UL 1310
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
REACH Regulation	REACH	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

20. Physical Dimensions And Weight

Width	36mm / 1.42''
Height	90mm / 3.54''
Depth	91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	225g / 0.5lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

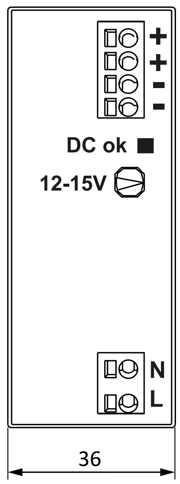


Fig. 20-1: Front view

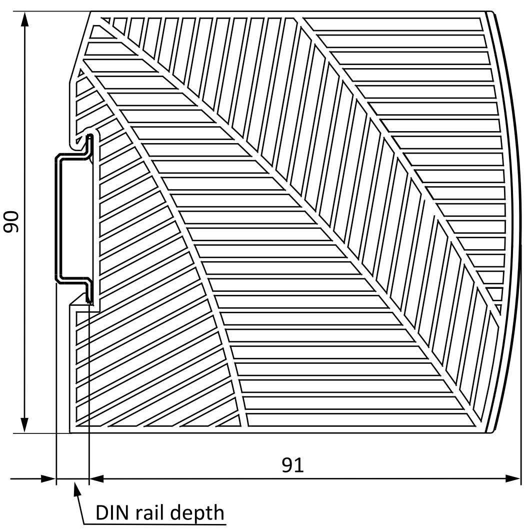


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

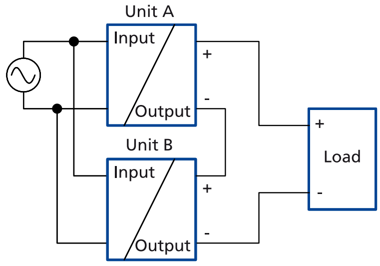
21.2. SERIES OPERATION

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 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.

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



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

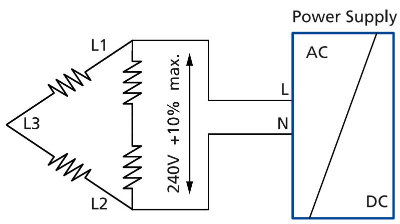
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems since there is no monitoring (DC-OK signal) included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



21.6. USE IN A TIGHTLY SEALED ENCLOSURE

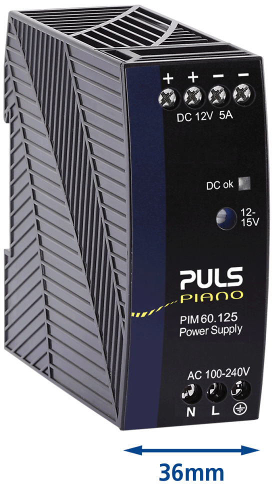
When the power supply is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than outside. In such situations, the inside temperature defines the ambient temperature for the power supply.

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

	Case A	**Case B**
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	12V, 4A; (=**80**%)	12V, 5A; (=**100**%)
Temperature inside the box	30.9°C	32.3°C
Temperature outside the box	21°C	21°C
Temperature rise	9.9K	11.3K

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

POWER SUPPLY 1AC 12V 60W



- AC 100-240V Wide-range input
- NEC CLASS 2 compliant
- Cost optimized without compromising quality or reliability
- Width only 36mm
- Efficiency up to 90.7%
- Low no-load power losses
- Full power between -10°C and +60°C
- Large screw terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM60.125 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage. The output fulfils the requirements for a limited power source according to NEC CLASS 2.

The device is equipped with screw terminals, which are optimized for large wire sizes.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today's industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 12V	Nominal
Adjustment range	12-15V	Factory setting 12V
Output current	5-4A	Below +60°C ambient
	3.8-3A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1 / 0.6A	At 120 / 230Vac
Power factor	0.55 / 0.47	At 120 / 230Vac
Input inrush current	15 / 36A$_{peak}$	At 120 / 230Vac, +40°C, cold start
Efficiency	90.2 / 90.7%	At 120 / 230Vac
Power losses	6.5 / 6.2W	At 120 / 230Vac
Hold-up time	23 / 107ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	235g / 0.5lb	

ORDER NUMBERS

Description: Power supply PIM60.125-xx
Order Number:
PIM60.125

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL us LISTED
Ind. Cont. Eq.

NEC CLASS 2

All parameters are specified at 24V, 5A, 230Vac, 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 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.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 3.6A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

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.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		264-300Vac	For maximum 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.	75Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	typ.	54Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.15A	1A	0.6A	At 12V, 5A, see Fig. 3-1
Power factor	typ.	0.58	0.55	0.47	At 12V, 5A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	60ms	See Fig. 3-2
Rise time	typ.	18ms	18ms	18ms	At 12V, 5A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	30ms	30ms	30ms	At 12V, 5A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

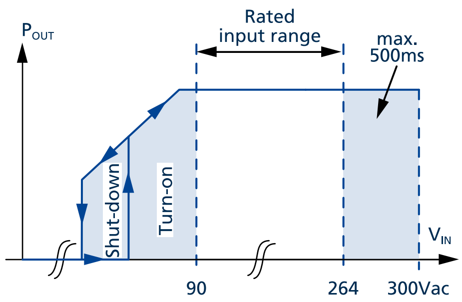


Fig. 3-1: Input voltage range

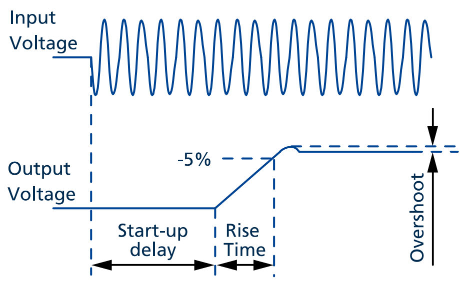


Fig. 3-2: Turn-on behavior, definitions

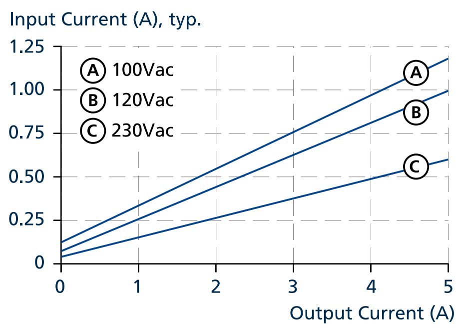


Fig. 3-3: Input current vs. output load at 12V output voltage

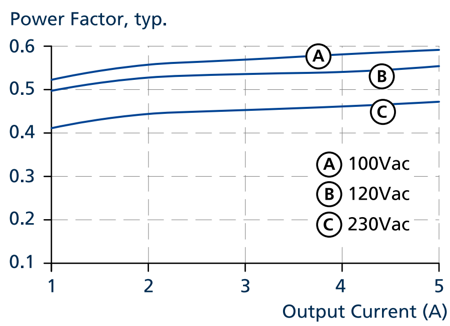


Fig. 3-4: Power factor vs. output load at 12V output voltage

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.
The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	12A	15A	36A	At 40°C, ambient, cold start
	typ.	10A	12A	30A	At 25°C, ambient, cold start
	max.	15A	18A	44A	At 40°C, ambient, cold start
	max.	12A	15A	36A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	$0.2A^2s$	$0.3A^2s$	$1.4A^2s$	At 40°C, ambient, cold start

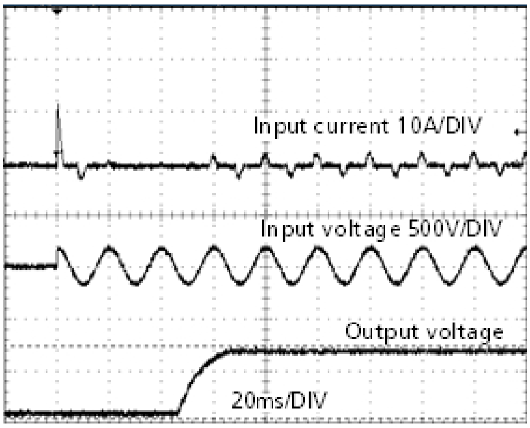


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

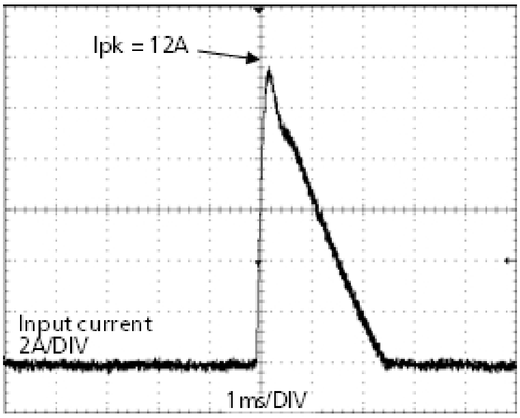


Fig. 5-2: Zoom into the first inrush peak

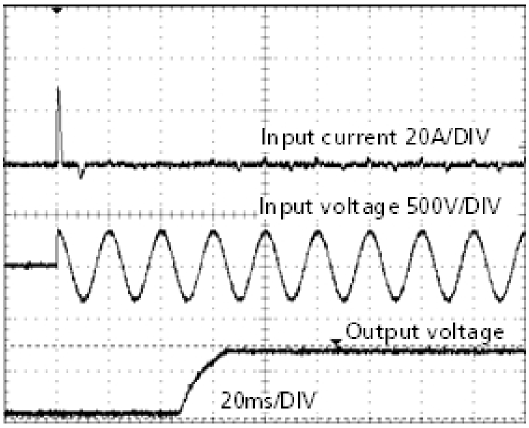


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

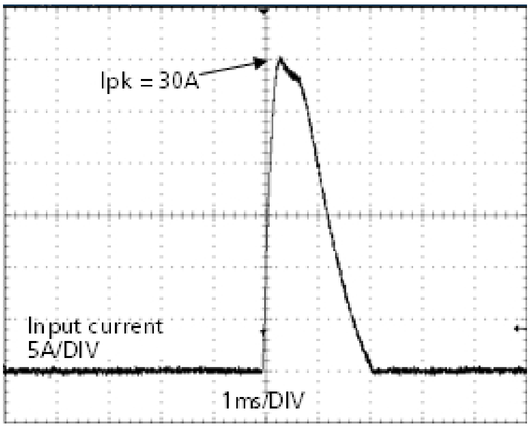


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 2 200µF with 5A or 8 000µF with 2.5A additional current load.

At heavy overloads (when output voltage falls below 8V), the device delivers continuous output current for 20ms. After this, the output is switched off for approx. 170ms 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.

Output voltage	nom.	DC 12V	
Adjustment range		12-15V	Guaranteed value
	max.	15.5V	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.	12V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 5A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	5A	At 12V and an ambient temperature below 60°C
	nom.	3.8A	At 12V and 70°C ambient temperature
	nom.	4A	At 15V and an ambient temperature below 60°C
	nom.	3A	At 15V and 70°C ambient temperature
Overload behaviour	Continuous current		For output voltage above 8Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 8Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	7A	Continuous current, see Fig. 6-1
	typ.	9A	Intermitted current peak value for typ. 20ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	3.2A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	2 200µF	Included inside the device
Back-feeding loads	max.	16V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

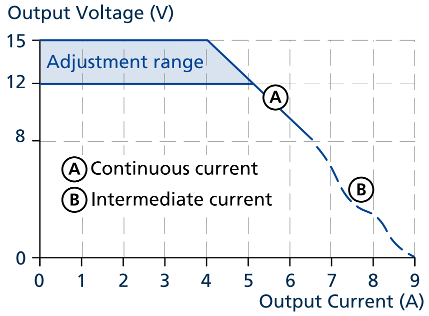


Fig. 6-1: Output voltage vs. output current, typ.

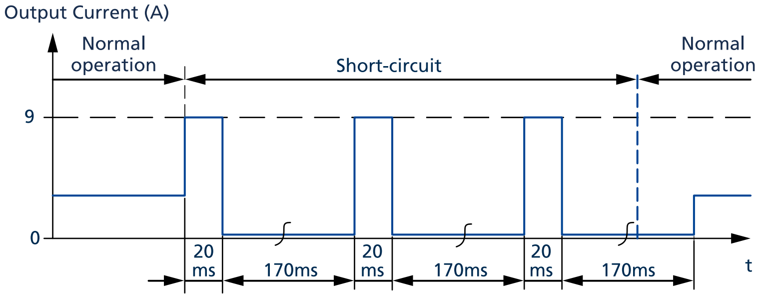


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	13ms	23ms	107ms	At 12V, 5A
	typ.	36ms	55ms	219ms	At 12V, 2.5A
	min.	10.5ms	18ms	85ms	At 12V, 5A
	min.	28.5ms	43ms	175ms	At 12V, 2.5A

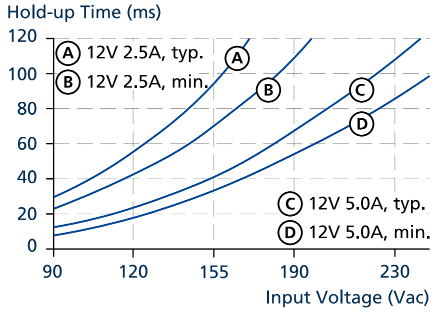


Fig. 7-1: Hold-up time vs. input voltage

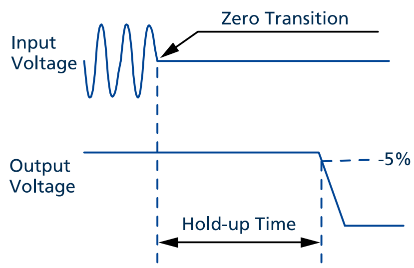


Fig. 7-2: Shut-down behaviour, definitions

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	88.9%	90.2%	90.7%	At 12V, 5A (full load)
Average efficiency	typ.	88.9%	89.7%	89.6%	25% at 1.25A, 25% at 2.5A, 25% at 3.75A, 25% at 5A
Power losses	typ.	0.2W	0.2W	0.3W	At no load
	typ.	3.6W	3.4W	3.4W	At 12V, 2.5A (half load)
	typ.	7.5W	6.5W	6.2W	At 12V, 5A (full load)

The average efficiency is an assumption for a typical application where the device 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.

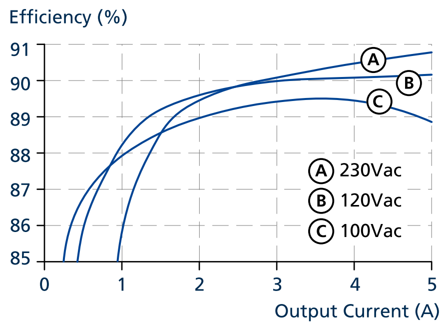


Fig. 8-1: Efficiency vs. output current at 12V, typ.

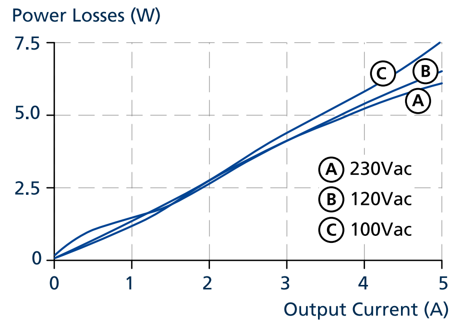


Fig. 8-2: Losses vs. output current at 12V, typ.

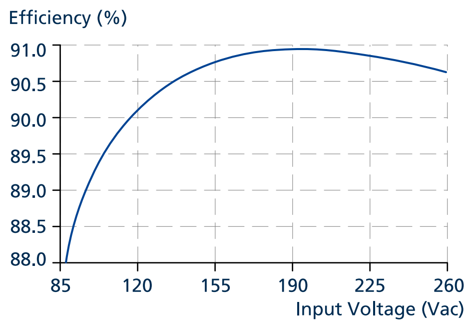


Fig. 8-3: Efficiency vs. input voltage at 12V, 5A, typ.

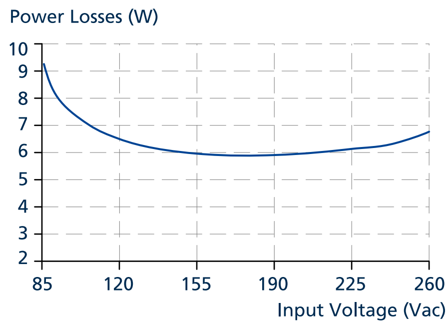


Fig. 8-4: Losses vs. input voltage at 12V, 5A, typ.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	89 000h	103 000h	119 000h	At 12V, 5A and 40°C
	241 000h	249 000h	256 000h	At 12V, 2.5A and 40°C
	252 000h	292 000h	335 000h	At 12V, 5A and 25°C
	680 000h	704 000h	724 000h	At 12V, 2.5A and 25°C

10. 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.

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	1 542 000h	1 649 000h	1 673 000h	At 12V, 5A and 40°C
	2 768 000h	2 911 000h	2 925 000h	At 12V, 5A and 25°C
MTBF MIL HDBK 217F	695 000h	707 000h	685 000h	At 12V, 5A and 40°C; Ground Benign GB40
	993 000h	1 008 000h	982 000h	At 12V, 5A and 25°C; Ground Benign GB25
	189 000h	192 000h	197 000h	At 12V, 5A and 40°C; Ground Fixed GF40
	246 000h	250 000h	258 000h	At 12V, 5A and 25°C; Ground Fixed GF25

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

11. Functional Diagram

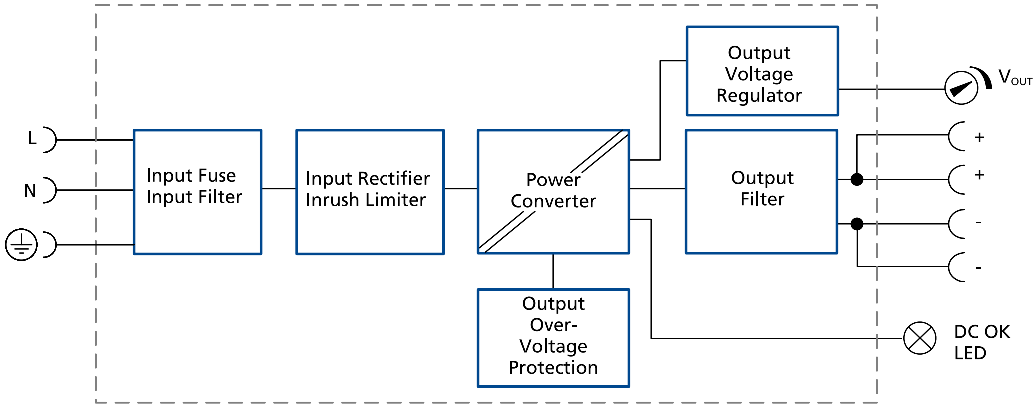


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Screw terminals
Solid wire	max. 6mm²
Stranded wire	max. 4mm²
American Wire Gauge	AWG 20-10
Max. wire diameter (including ferrules)	2.8mm
Wire stripping length	7mm / 0.28inch
Recommended tightening torque	1Nm., 9lb.in
Screwdriver	3mm slotted or Phillips No 1

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

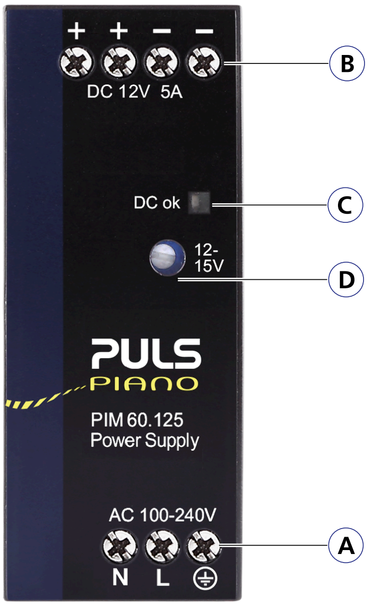


Fig. 13-1: Front side

A **Input Terminals**

- **N** Neutral conductor input
- **L** Phase (Line) input
- ⏚ PE (Protective Earth)

B **OutputTerminals**
Dual terminals for the negative and positive pole.
Both poles are internally connected.

- **+** Positive output
- \- Negative (return) output

C **DC OK LED (green)**
The LED is on, when the output voltage is above 9V.

D **Output voltage adustment potentiometer**

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 3.6A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms. 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	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → PE	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) / (–)→ PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 3.6A and criterion C for output currents above 3.6A.

EMC Emission		
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks not fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	1kHz to 130kHz	Input voltage and output load dependent

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.12A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.3A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

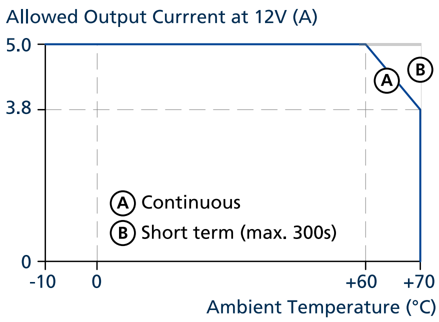


Fig. 15-1: Output power vs. ambient temp.

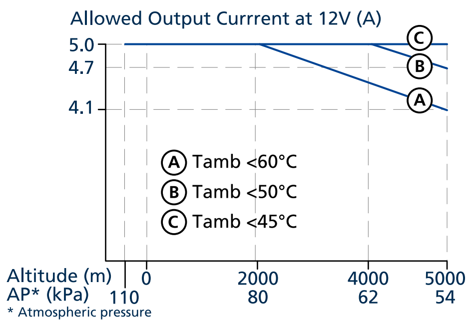


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

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
Output over-voltage protection	typ. 16.5Vdc	
	max. 17Vdc	
	In case of an internal defect, a redundant circuit limits the maximum output voltage to 17V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	I	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 30µA / 60µA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 40µA / 90µA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 70µA / 140µA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 40µA / 70µA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 50µA / 110µA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 100µA / 180µA	At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

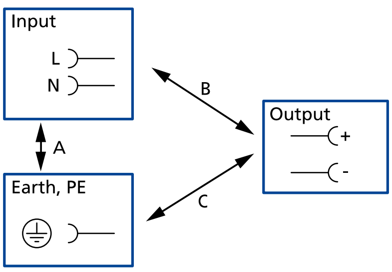


Fig. 17-1: Dielectric strength

		A	B	C
Type test	60s	2500Vac	3000Vac	1000Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Field test cut-off current settings		>5mA	>5mA	>10mA

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
NEC Class 2	NEC CLASS 2	UL Certificate Limited Power Source Listed in the UL 61010-2-201 approval report, investigated according to UL 1310
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H_2S: 100ppb NO_x: 1250ppb Cl_2: 20ppb SO_2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
REACH Regulation	REACH ✓	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

20. Physical Dimensions And Weight

Width	36mm / 1.42''
Height	90mm / 3.54''
Depth	91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	235g / 0.5lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

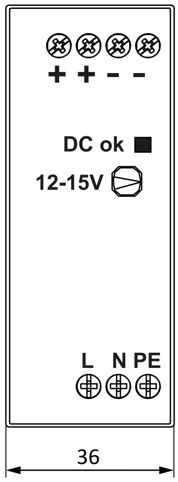


Fig. 20-1: Front view

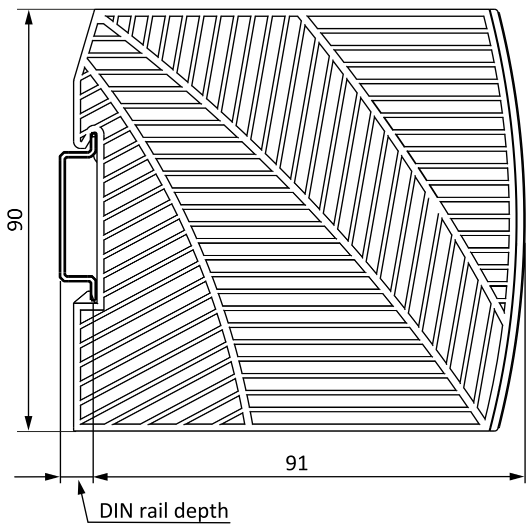


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

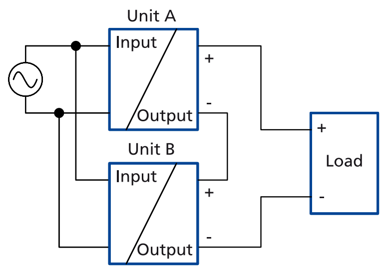
21.2. SERIES OPERATION

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 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.

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



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

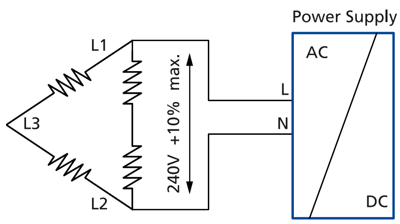
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems since there is no monitoring (DC-OK signal) included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



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

	Case A	Case B
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	12V, 4A; (=**80**%)	12V, 5A; (=**100**%)
Temperature inside the box	30.9°C	32.3°C
Temperature outside the box	21°C	21°C
Temperature rise	9.9K	11.3K

POWER SUPPLY 1AC 24V 60W

- AC 100-240V Wide-range input
- NEC CLASS 2 compliant
- Cost optimized without compromising quality or reliability
- No PE connection required
- Width only 36mm
- Efficiency up to 91.8%
- Low no-load power losses
- Full power between -10°C and +60°C
- Push-in terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM60.241 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage. The output fulfils the requirements for a limited power source according to NEC CLASS 2.

The device is equipped with Push-in terminals, which are optimized for automated wiring.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The unit is designed as “Class of Protection” II unit and fulfills the safety and EMC requirements without an input PE connection. This saves wiring costs.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today’s industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24-28V	Factory setting 24.1V
Output current	2.5-2.1A	Below +60°C ambient
	1.9-1.6A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1 / 0.6A	At 120 / 230Vac
Power factor	0.55 / 0.47	At 120 / 230Vac
Input inrush current	15 / 36A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	90.7 / 91.8%	At 120 / 230Vac
Power losses	6.2 / 5.4W	At 120 / 230Vac
Hold-up time	24 / 113ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	225g / 0.5lb	

ORDER NUMBERS

Description: Power supply PIM60.241-xx
Order Number:
PIM60.241

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL US LISTED — NEC CLASS 2

Ind. Cont. Eq.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Index

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 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.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 1.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC III according to IEC 60664-1.

The device is designed as "Class of Protection" II equipment according to IEC 61140.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		264-300Vac	For maximum 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.	75Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	typ.	54Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.15A	1A	0.6A	At 24V, 2.5A, see Fig. 3-1
Power factor	typ.	0.58	0.55	0.47	At 24V, 2.5A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	48ms	See Fig. 3-2
Rise time	typ.	18ms	18ms	18ms	At 24V, 2.5A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	52ms	52ms	50ms	At 24V, 2.5A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

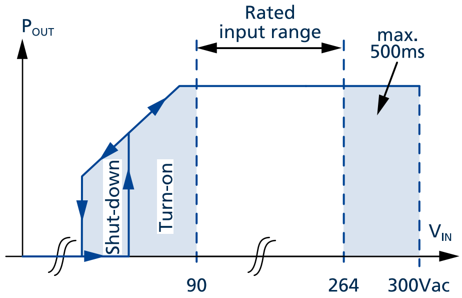


Fig. 3-1: Input voltage range

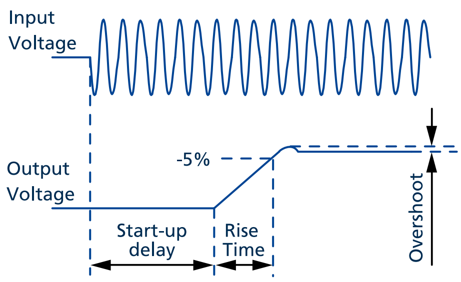


Fig. 3-2: Turn-on behavior, definitions

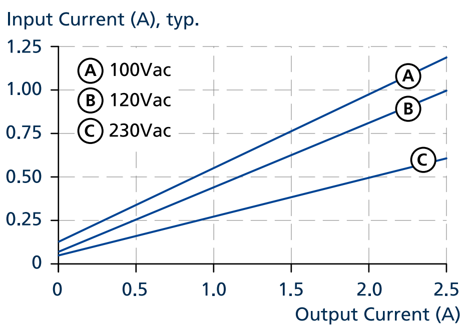


Fig. 3-3: Input current vs. output load at 24V output voltage

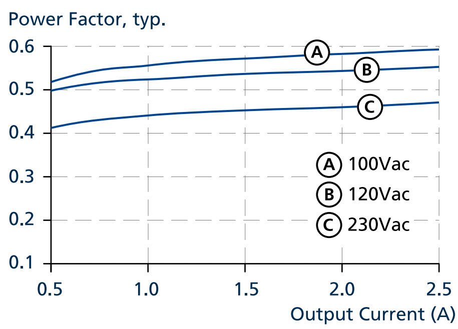


Fig. 3-4: Power factor vs. output load at 24V output voltage

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.

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

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	12A	15A	36A	At 40°C, ambient, cold start
	typ.	10A	12A	30A	At 25°C, ambient, cold start
	max.	15A	18A	44A	At 40°C, ambient, cold start
	max.	12A	15A	36A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	$0.2A^2s$	$0.3A^2s$	$1.4A^2s$	At 40°C, ambient, cold start

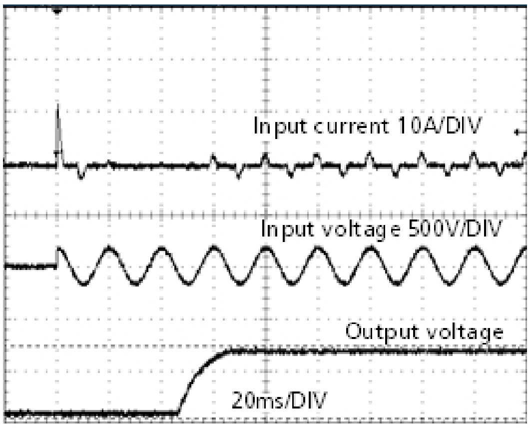


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

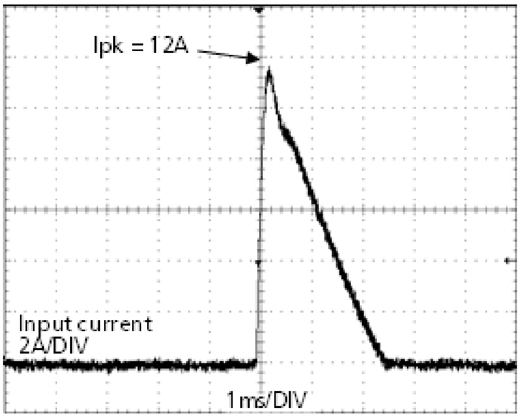


Fig. 5-2: Zoom into the first inrush peak

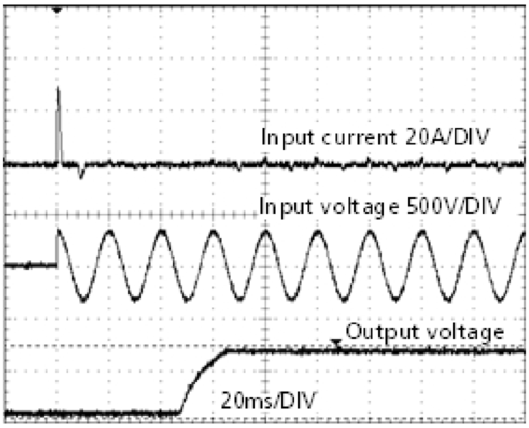


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

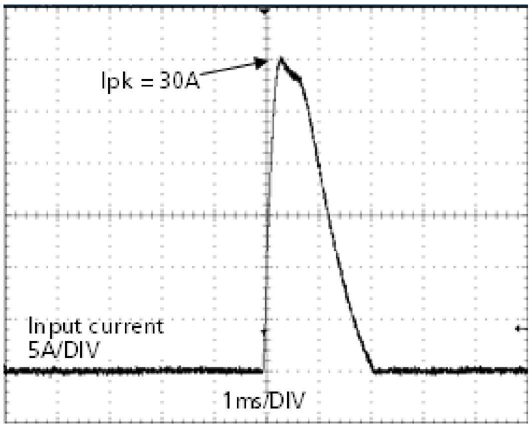


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 4 400µF with 2.5A or 5 000µF with 1.25A additional resistive load.

At heavy overloads (when output voltage falls below 14V), the device delivers continuous output current for 25ms. After this, the output is switched off for approx. 145ms 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.

Output voltage	nom.	DC 24V	
Adjustment range		24-28V	Guaranteed value
	max.	29V	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.	24.1V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 2.5A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	2.5A	At 24V and an ambient temperature below 60°C
	nom.	1.9A	At 24V and 70°C ambient temperature
	nom.	2.1A	At 28V and an ambient temperature below 60°C
	nom.	1.6A	At 28V and 70°C ambient temperature
Overload behaviour	Continuous current		For output voltage above 14Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 14Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	4A	Continuous current, see Fig. 6-1
	typ.	6A	Intermitted current peak value for typ. 25ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	2.5A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	900µF	Included inside the device
Back-feeding loads	max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

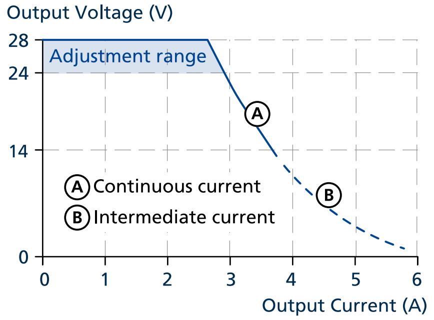


Fig. 6-1: Output voltage vs. output current, typ.

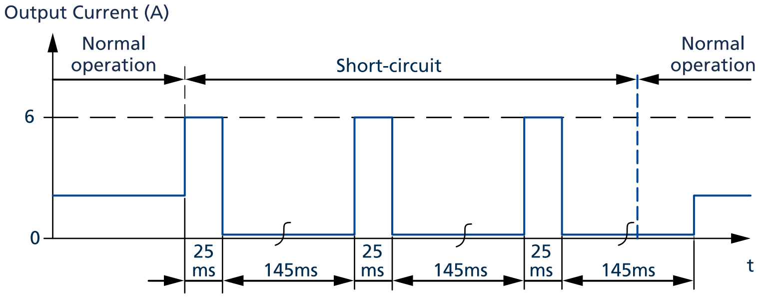


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	14ms	24ms	113ms	At 24V, 2.5A
	typ.	38ms	58ms	230ms	At 24V, 1.25A
	min.	11ms	19ms	90ms	At 24V, 2.5A
	min.	30ms	46ms	184ms	At 24V, 1.25A

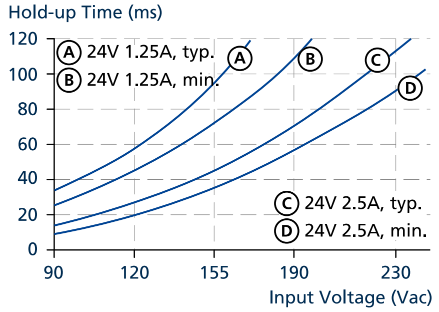


Fig. 7-1: Hold-up time vs. input voltage

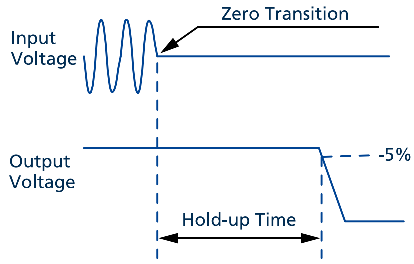


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	89.4%	90.7%	91.8%	At 24V, 2.5A (full load)
Average efficiency	typ.	89.3%	90.1%	90.7%	25% at 0.68A, 25% at 1.25A, 25% at 1.88A, 25% at 2.5A
Power losses	typ.	0.3W	0.3W	0.4W	At no load
	typ.	3.8W	3.5W	3.4W	At 24V, 1.25A (half load)
	typ.	7.1W	6.2W	5.4W	At 24V, 2.5A (full load)

The average efficiency is an assumption for a typical application where the device 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.

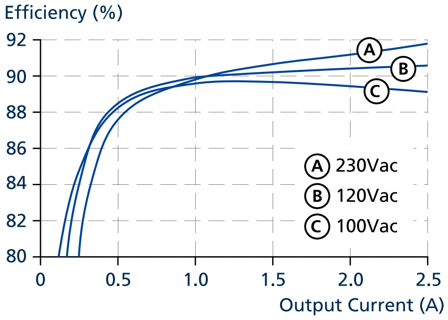


Fig. 8-1: Efficiency vs. output current at 24V, typ.

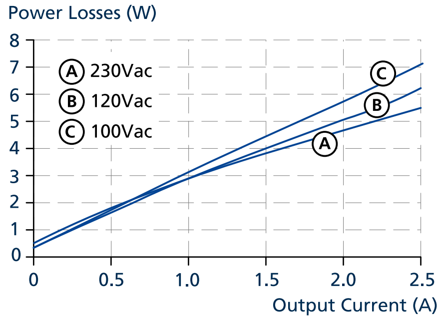


Fig. 8-2: Losses vs. output current at 24V, typ.

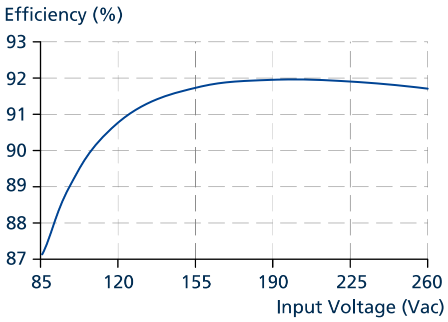


Fig. 8-3: Efficiency vs. input voltage at 24V, 2.5A, typ.

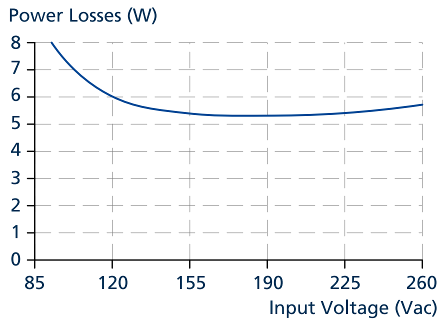


Fig. 8-4: Losses vs. input voltage at 24V, 2.5A, typ.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	115 000h	131 000h	148 000h	At 24V, 2.5A and 40°C
	260 000h	263 000h	263 000h	At 24V, 1.25A and 40°C
	324 000h	370 000h	419 000h	At 24V, 2.5A and 25°C
	734 000h	744 000h	744 000h	At 24V, 1.25A and 25°C

10. 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.

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	1 797 000h	1 858 000h	1 982 000h	At 24V, 2.5A and 40°C
	3 093 000h	3 186 000h	3 378 000h	At 24V, 2.5A and 25°C
MTBF MIL HDBK 217F	868 000h	886 000h	803 000h	At 24V, 2.5A and 40°C; Ground Benign GB40
	1 257 000h	1 278 000h	1 175 000h	At 24V, 2.5A and 25°C; Ground Benign GB25
	247 000h	252 000h	247 000h	At 24V, 2.5A and 40°C; Ground Fixed GF40
	325 000h	331 000h	328 000h	At 24V, 2.5A and 25°C; Ground Fixed GF25

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

11. Functional Diagram

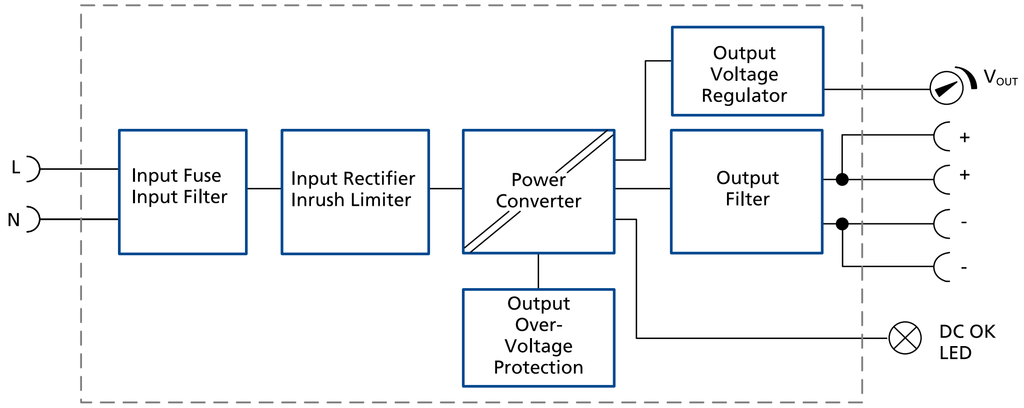


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Push-in terminals
Solid wire	max. 2.5mm²
Stranded wire	max. 2.5mm²
Stranded wire with ferrules	max. 1.5mm²
American Wire Gauge	AWG 24-12
Max. wire diameter (including ferrules)	2.3mm
Wire stripping length	10mm / 0.4inch
Screwdriver	3mm slotted to open the spring

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

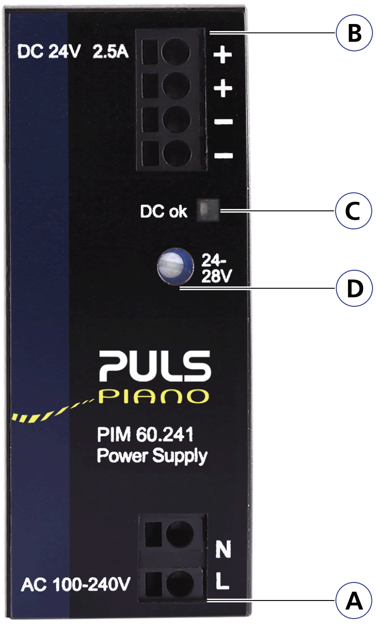


Fig. 13-1: Front side

A **Input Terminals**
- **N** Neutral conductor input
- **L** Phase (Line) input

B **OutputTerminals**
Dual terminals for the negative and positive pole.
Both poles are internally connected.
- **+** Positive output
- **-** Negative (return) output

C **DC OK LED (green)**
The LED is on, when the output voltage is above 18V.

D **Output voltage adustment potentiometer**

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 1.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

EMC Immunity

Electrostatic discharge	EN 61000-4-2	Contact discharge	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → Earthed output	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) → (–) Earthed	1kV	Criterion A
		(–) → (+) Earthed	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 1.9A and criterion C for output currents above 1.9A.

EMC Emission

Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies

Main converter	2kHz to 130kHz	Input voltage and output load dependent

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.06A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.15A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

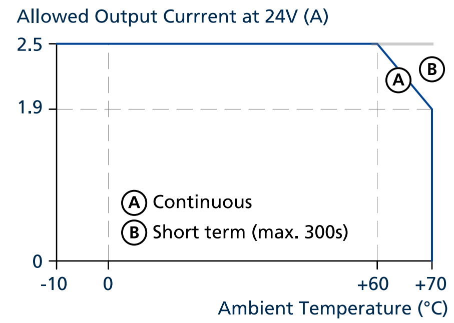


Fig. 15-1: Output power vs. ambient temp.

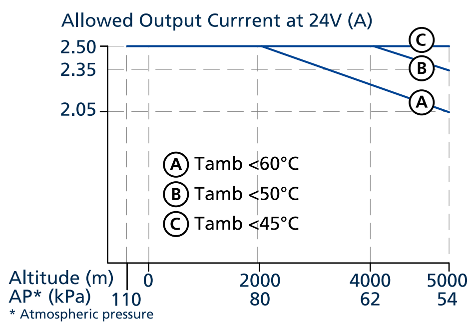


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

Isolation resistance	>500MOhm	At delivered condition between input and output, measured with 500Vdc
Output over-voltage protection	typ. 30.5Vdc max. 32Vdc In case of an internal defect, a redundant circuit limits the maximum output voltage to 32V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	II	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 40µA / 80µA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 60µA / 120µA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 100µA / 200µA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 60µA / 100µA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 80µA / 150µA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 140µA / 260µA	At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

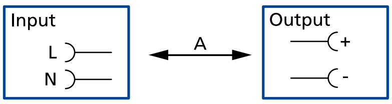


Fig. 17-1: Dielectric strength

		A
Type test	60s	3000Vac
Factory test	5s	2500Vac
Field test	5s	2000Vac
Field test cut-off current settings		>2mA

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
NEC Class 2	NEC CLASS 2	UL Certificate Limited Power Source Listed in the UL 61010-2-201 approval report, investigated according to UL 1310
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H_2S: 100ppb NO_x: 1250ppb Cl_2: 20ppb SO_2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
REACH Regulation	REACH	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

20. Physical Dimensions And Weight

Width Height Depth	36mm / 1.42'' 90mm / 3.54'' 91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	225g / 0.5lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

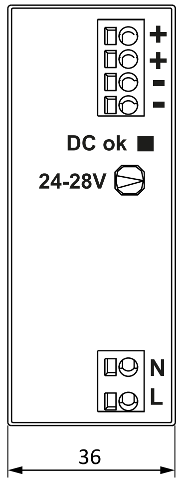


Fig. 20-1: Front view

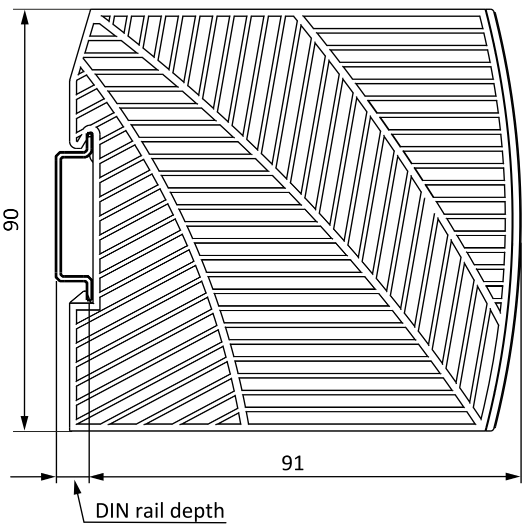


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

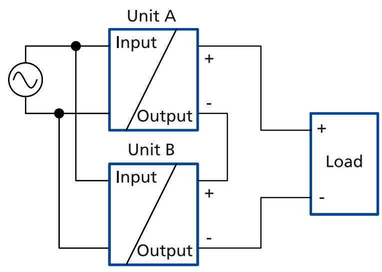
21.2. SERIES OPERATION

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 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.

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



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

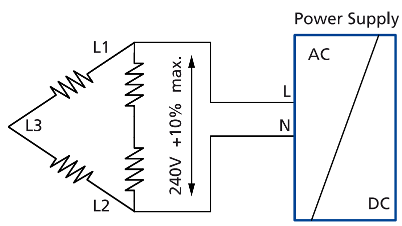
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems since there is no monitoring (DC-OK signal) included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



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

	Case A	**Case B**
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	24V, 2A; (=**80**%)	24V, 2.5A; (=**100**%)
Temperature inside the box	28.6°C	30.2°C
Temperature outside the box	21°C	21°C
Temperature rise	7.6K	9.2K

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

POWER SUPPLY 1AC 24V 60W

- AC 100-240V Wide-range input
- NEC CLASS 2 compliant
- Cost optimized without compromising quality or reliability
- Width only 36mm
- Efficiency up to 91.8%
- Low no-load power losses
- Full power between -10°C and +60°C
- Large Screw terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM60.245 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage. The output fulfils the requirements for a limited power source according to NEC CLASS 2.

The device is equipped with Screw terminals, which are optimized for large wire sizes.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today's industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24-28V	Factory setting 24.1V
Output current	2.5-2.1A	Below +60°C ambient
	1.9-1.6A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1 / 0.6A	At 120 / 230Vac
Power factor	0.55 / 0.47	At 120 / 230Vac
Input inrush current	15 / 36A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	90.7 / 91.8%	At 120 / 230Vac
Power losses	6.2 / 5.4W	At 120 / 230Vac
Hold-up time	24 / 113ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	235g / 0.5lb	

ORDER NUMBERS

Description: Power supply PIM60.245-xx
Order Number:
PIM60.245

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL US LISTED NEC CLASS 2

Ind. Cont. Eq.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Index

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 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.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 1.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

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.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V			
AC input range		90-264Vac	Continuous operation		
		264-300Vac	For maximum 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.	75Vac	Steady-state value, see Fig. 3-1		
Shut-down voltage	typ.	54Vac	Steady-state value, see Fig. 3-1		
External input protection	See recommendations in chapter 2.				
		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.15A	1A	0.6A	At 24V, 2.5A, see Fig. 3-1
Power factor	typ.	0.58	0.55	0.47	At 24V, 2.5A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	48ms	See Fig. 3-2
Rise time	typ.	18ms	18ms	18ms	At 24V, 2.5A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	52ms	52ms	50ms	At 24V, 2.5A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

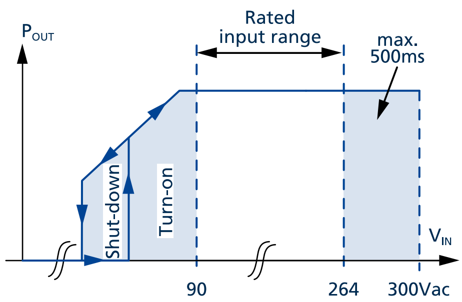


Fig. 3-1: Input voltage range

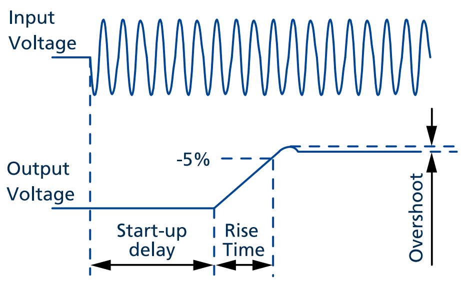


Fig. 3-2: Turn-on behavior, definitions

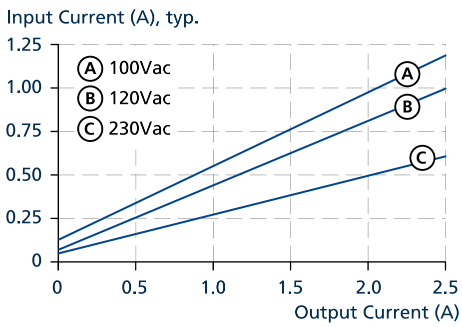


Fig. 3-3: Input current vs. output load at 24V output voltage

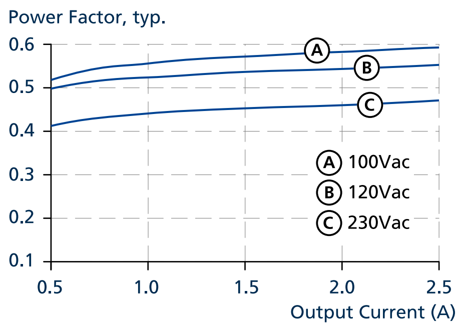


Fig. 3-4: Power factor vs. output load at 24V output voltage

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.

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

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	12A	15A	36A	At 40°C, ambient, cold start
	typ.	10A	12A	30A	At 25°C, ambient, cold start
	max.	15A	18A	44A	At 40°C, ambient, cold start
	max.	12A	15A	36A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	$0.2A^2s$	$0.3A^2s$	$1.4A^2s$	At 40°C, ambient, cold start

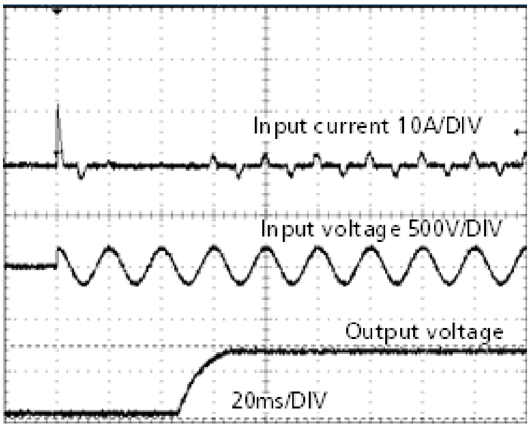


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

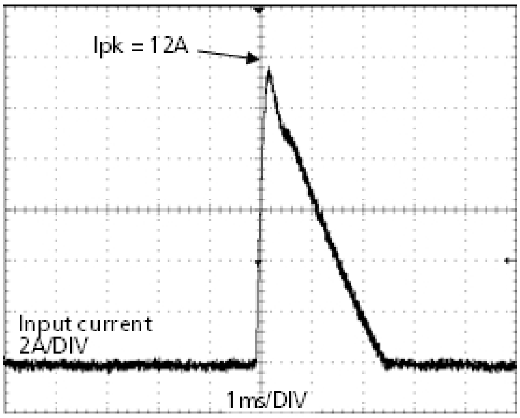


Fig. 5-2: Zoom into the first inrush peak

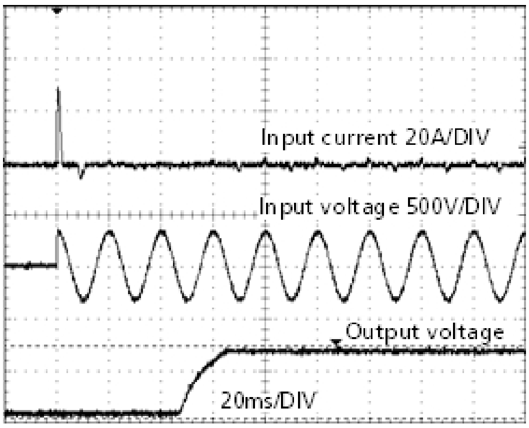


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

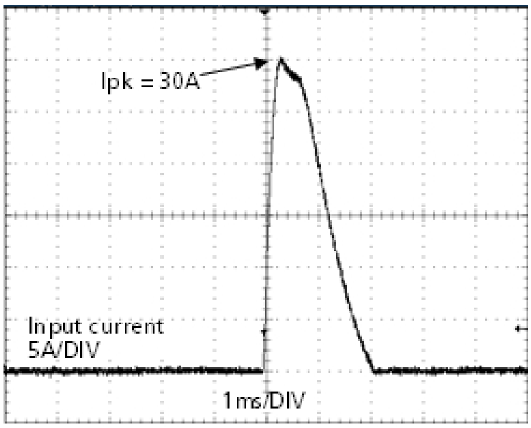


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 4 400µF with 2.5A or 5 000µF with 1.25A additional resistive load.

At heavy overloads (when output voltage falls below 14V), the device delivers continuous output current for 25ms. After this, the output is switched off for approx. 145ms 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.

Output voltage	nom.	DC 24V	
Adjustment range		24-28V	Guaranteed value
	max.	29V	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.	24.1V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 2.5A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	2.5A	At 24V and an ambient temperature below 60°C
	nom.	1.9A	At 24V and 70°C ambient temperature
	nom.	2.1A	At 28V and an ambient temperature below 60°C
	nom.	1.6A	At 28V and 70°C ambient temperature
Overload behaviour	Continuous current		For output voltage above 14Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 14Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	4A	Continuous current, see Fig. 6-1
	typ.	6A	Intermitted current peak value for typ. 25ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	2.5A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	900µF	Included inside the device
Back-feeding loads	max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

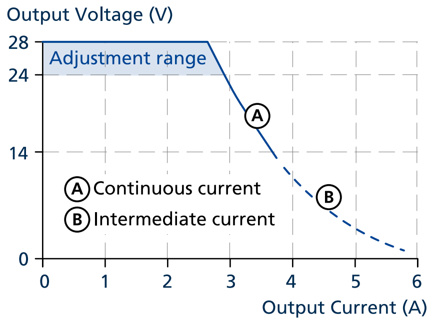


Fig. 6-1: Output voltage vs. output current, typ.

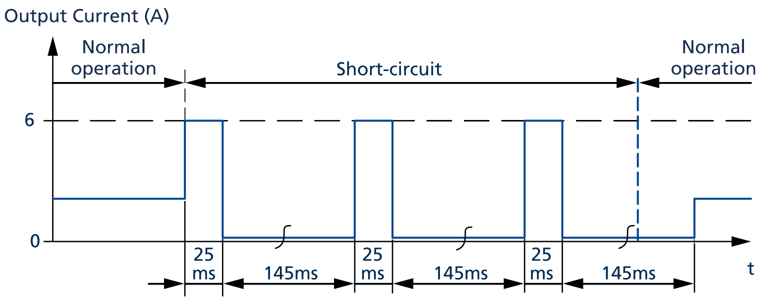


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	14ms	24ms	113ms	At 24V, 2.5A
	typ.	38ms	58ms	230ms	At 24V, 1.25A
	min.	11ms	19ms	90ms	At 24V, 2.5A
	min.	30ms	46ms	184ms	At 24V, 1.25A

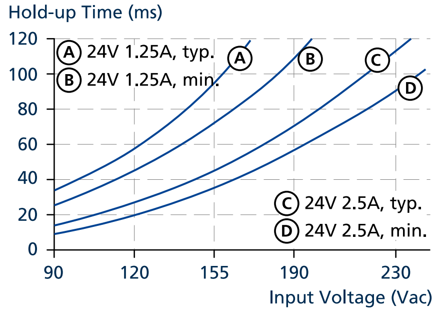


Fig. 7-1: Hold-up time vs. input voltage

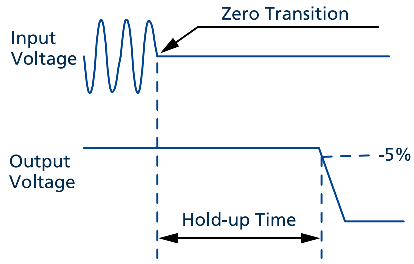


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	89.4%	90.7%	91.8%	At 24V, 2.5A (full load)
Average efficiency	typ.	89.3%	90.1%	90.7%	25% at 0.68A, 25% at 1.25A, 25% at 1.88A, 25% at 2.5A
Power losses	typ.	0.3W	0.3W	0.4W	At no load
	typ.	3.8W	3.5W	3.4W	At 24V, 1.25A (half load)
	typ.	7.1W	6.2W	5.4W	At 24V, 2.5A (full load)

The average efficiency is an assumption for a typical application where the device 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.

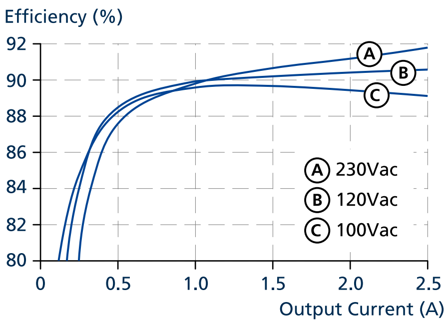


Fig. 8-1: Efficiency vs. output current at 24V, typ.

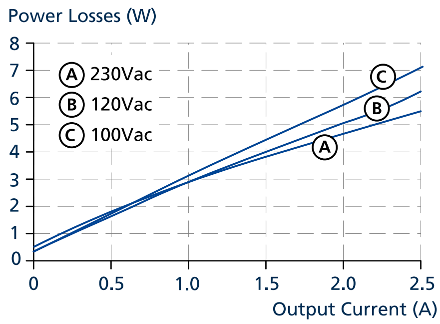


Fig. 8-2: Losses vs. output current at 24V, typ.

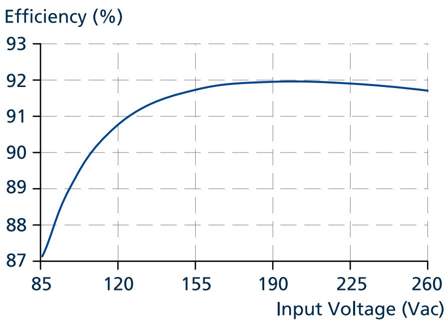


Fig. 8-3: Efficiency vs. input voltage at 24V, 2.5A, typ.

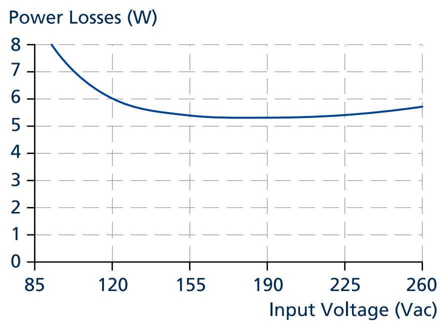


Fig. 8-4: Losses vs. input voltage at 24V, 2.5A, typ.

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	115 000h	131 000h	148 000h	At 24V, 2.5A and 40°C
	260 000h	263 000h	263 000h	At 24V, 1.25A and 40°C
	324 000h	370 000h	419 000h	At 24V, 2.5A and 25°C
	734 000h	744 000h	744 000h	At 24V, 1.25A and 25°C

10. 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.

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	1 797 000h	1 858 000h	1 982 000h	At 24V, 2.5A and 40°C
	3 093 000h	3 186 000h	3 378 000h	At 24V, 2.5A and 25°C
MTBF MIL HDBK 217F	868 000h	886 000h	803 000h	At 24V, 2.5A and 40°C; Ground Benign GB40
	1 257 000h	1 278 000h	1 175 000h	At 24V, 2.5A and 25°C; Ground Benign GB25
	247 000h	252 000h	247 000h	At 24V, 2.5A and 40°C; Ground Fixed GF40
	325 000h	331 000h	328 000h	At 24V, 2.5A and 25°C; Ground Fixed GF25

11. Functional Diagram

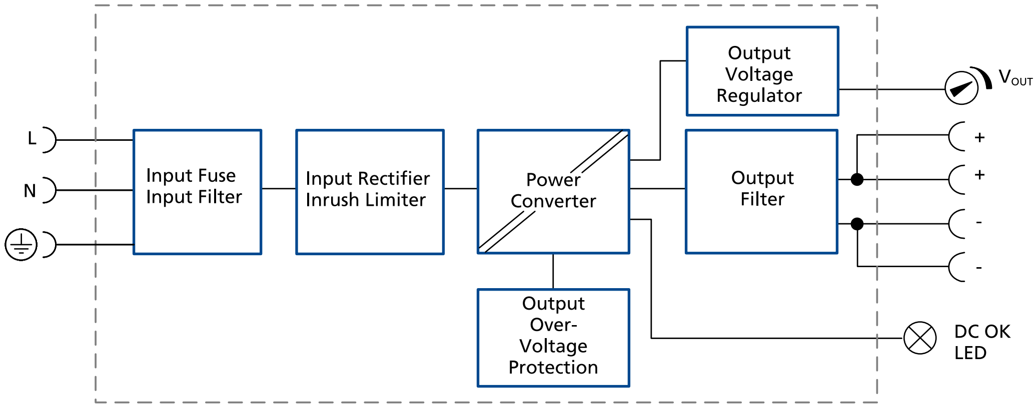


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Screw terminals
Solid wire	max. 6mm²
Stranded wire	max. 4mm²
American Wire Gauge	AWG 20-10
Max. wire diameter (including ferrules)	2.8mm
Wire stripping length	7mm / 0.28inch
Recommended tightening torque	1Nm., 9lb.in
Screwdriver	3mm slotted or Phillips No 1

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

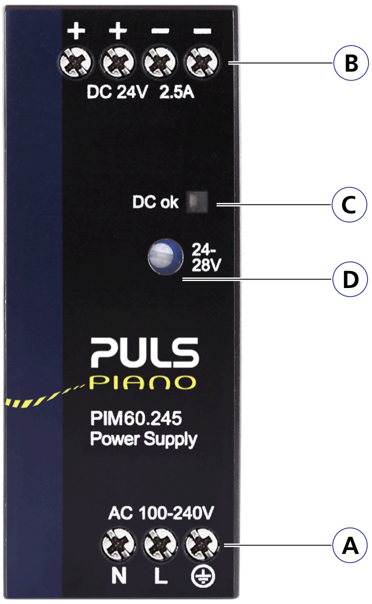


Fig. 13-1: Front side

A Input Terminals

- **N** Neutral conductor input
- **L** Phase (Line) input
- ⏚ PE (Protective Earth)

B OutputTerminals

Dual terminals for the negative and positive pole.
Both poles are internally connected.

- **+** Positive output
- **-** Negative (return) output

C DC OK LED (green)

The LED is on, when the output voltage is above 18V.

D Output voltage adustment potentiometer

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 1.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms. 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	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → PE	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) / (–)→ PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 1.9A and criterion C for output currents above 1.9A.

EMC Emission		
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks not fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	2kHz to 130kHz	Input voltage and output load dependent

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.06A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.15A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

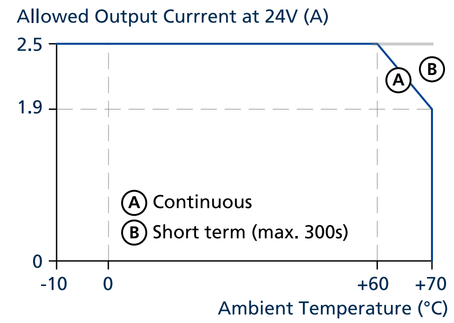


Fig. 15-1: Output power vs. ambient temp.

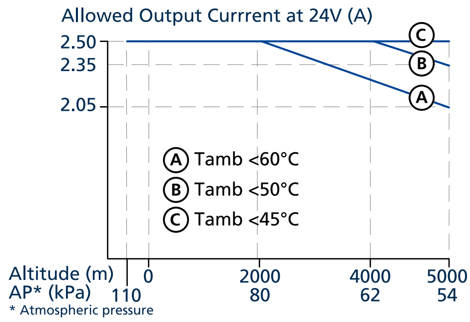


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

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
Output over-voltage protection	typ. 30.5Vdc	
	max. 32Vdc	
	In case of an internal defect, a redundant circuit limits the maximum output voltage to 32V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	I	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 30µA / 60µA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 40µA / 90µA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 70µA / 140µA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 40µA / 70µA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 50µA / 110µA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 100µA / 180µA	At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

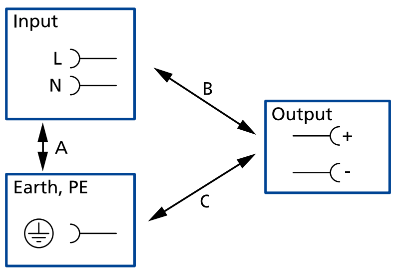


Fig. 17-1: Dielectric strength

		A	B	C
Type test	60s	2500Vac	3000Vac	1000Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Field test cut-off current settings		>5mA	>5mA	>10mA

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
NEC Class 2	NEC CLASS 2	UL Certificate Limited Power Source Listed in the UL 61010-2-201 approval report, investigated according to UL 1310
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04 ✓	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
KC		KC Registration Korean registration of Broadcasting and Communication Equipment Registered under Clause 3, Article 58-2 of Radio Waves Act.
REACH Regulation	REACH ✓	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

20. Physical Dimensions And Weight

Width Height Depth	36mm / 1.42'' 90mm / 3.54'' 91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	235g / 0.5lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

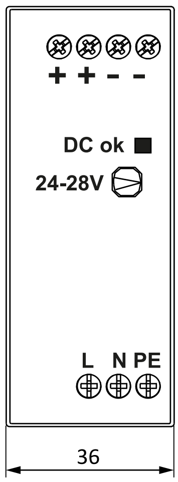


Fig. 20-1: Front view

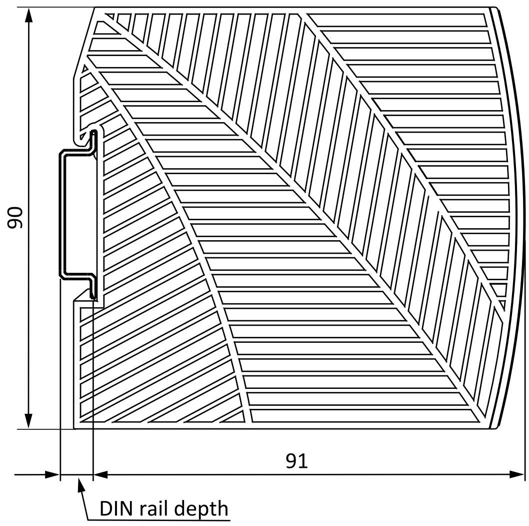


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

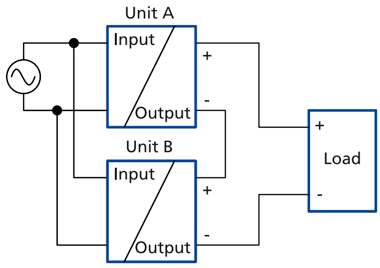
21.2. SERIES OPERATION

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 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.

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



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

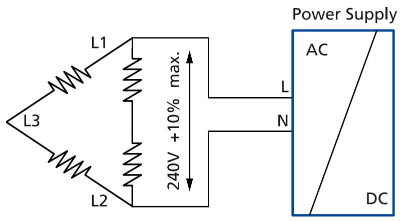
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems since there is no monitoring (DC-OK signal) included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



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

	Case A	Case B
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	24V, 2A; (=**80**%)	24V, 2.5A; (=**100**%)
Temperature inside the box	28.6°C	30.2°C
Temperature outside the box	21°C	21°C
Temperature rise	7.6K	9.2K

All parameters are specified at 24V, 2.5A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

POWER SUPPLY 1AC 24V 90W

- AC 100-240V Wide-range input
- Cost optimized without compromising quality or reliability
- No PE connection required
- Width only 36mm
- Efficiency up to 93.8%
- Low no-load power losses
- Full power between -10°C and +60°C
- Push-in terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM90.241 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage.

The device is equipped with push-in terminals, which are optimized for automated wiring.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The unit is designed as “Class of Protection” II unit and fulfills the safety and EMC requirements without an input PE connection. This saves wiring costs.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today’s industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24-28V	Factory setting 24.1V
Output current	3.8-3.2A	Below +60°C ambient
	2.8-2.4A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1.45 / 0.95A	At 120 / 230Vac
Power factor	0.58 / 0.45	At 120 / 230Vac
Input inrush current	18 / 40A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	92.1 / 93.8%	At 120 / 230Vac
Power losses	7.9 / 6W	At 120 / 230Vac
Hold-up time	25 / 119ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	270g / 0.6lb	

ORDER NUMBERS

Description: Power supply PIM90.241-xx
Order Number:
PIM90.241

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL US LISTED

Ind. Cont. Eq.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Index

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 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.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 2.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC III according to IEC 60664-1.

The device is designed as "Class of Protection" II equipment according to IEC 61140.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		264-300Vac	For maximum 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.	75Vac	Steady-state value, see Fig. 3-1
Shut-down voltage	typ.	54Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.69A	1.45A	0.95A	At 24V, 3.8A, see Fig. 3-1
Power factor	typ.	0.6	0.58	0.45	At 24V, 3.8A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	50ms	See Fig. 3-2
Rise time	typ.	21ms	21ms	20ms	At 24V, 3.8A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	42ms	42ms	40ms	At 24V, 3.8A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

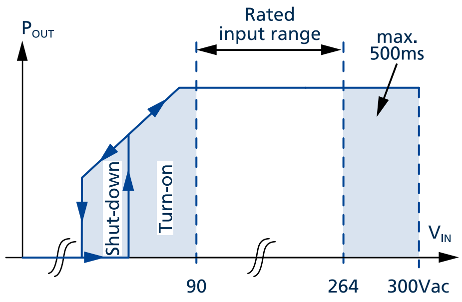


Fig. 3-1: Input voltage range

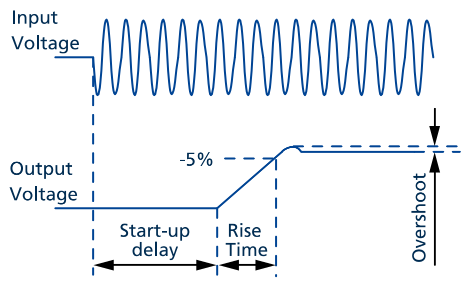


Fig. 3-2: Turn-on behavior, definitions

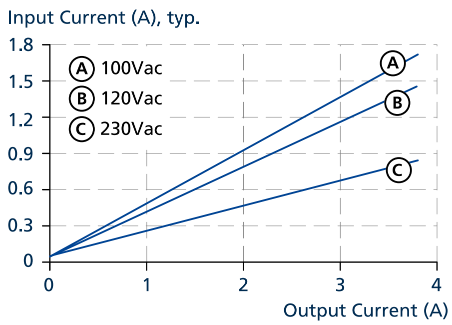


Fig. 3-3: Input current vs. output load at 24V output voltage

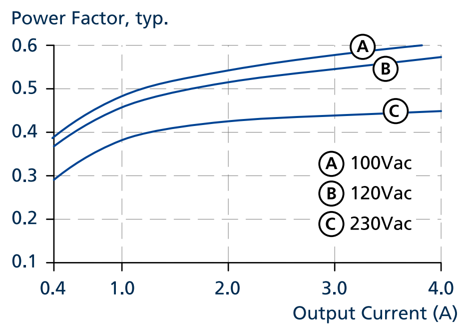


Fig. 3-4: Power factor vs. output load at 24V output voltage

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.

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

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	14A	18A	40A	At 40°C, ambient, cold start
	typ.	12A	16A	35A	At 25°C, ambient, cold start
	max.	17A	22A	48A	At 40°C, ambient, cold start
	max.	15A	20A	43A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	$0.3A^2s$	$0.4A^2s$	$1.7A^2s$	At 40°C, ambient, cold start

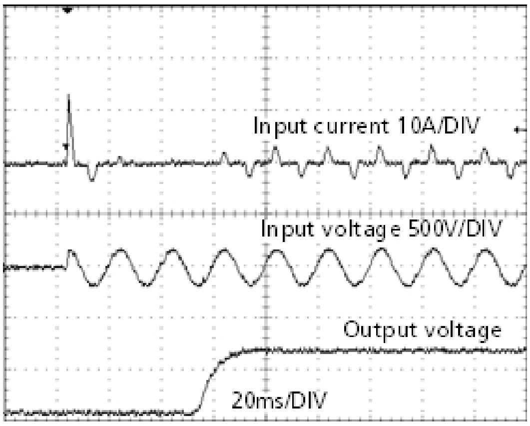


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

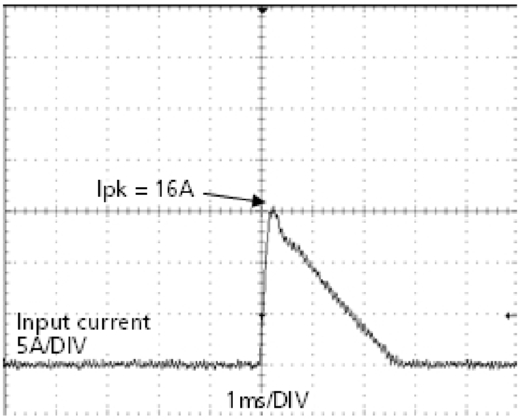


Fig. 5-2: Zoom into the first inrush peak

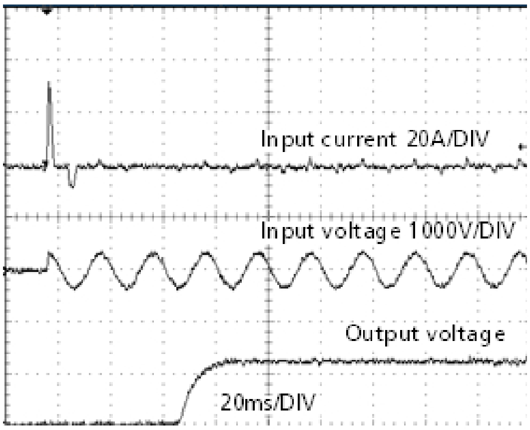


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

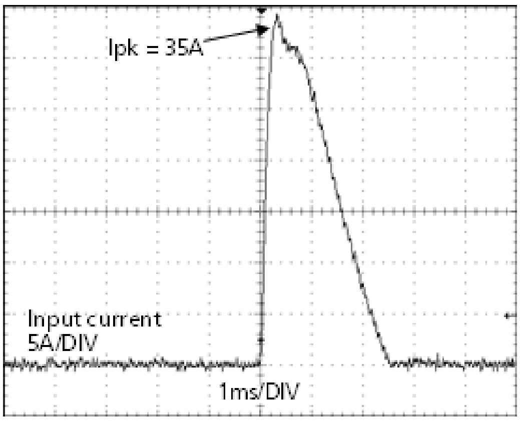


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 4 000µF with 3.8A or 5 000µF with 1.9A additional resistive load.

At heavy overloads (when output voltage falls below 14V), the device delivers continuous output current for 20ms. After this, the output is switched off for approx. 160ms 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.

Output voltage	nom.	DC 24V	
Adjustment range		24-28V	Guaranteed value
	max.	29.5V	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.	24.1V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 3.8A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	3.8A	At 24V and an ambient temperature below 60°C
	nom.	2.8A	At 24V and 70°C ambient temperature
	nom.	3.2A	At 28V and an ambient temperature below 60°C
	nom.	2.4A	At 28V and 70°C ambient temperature
Overload protection	Included		Electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.
Overload behaviour	Continuous current		For output voltage above 14Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 14Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	6.7A	Continuous current, see Fig. 6-1
	typ.	8.6A	Intermitted current peak value for typ. 20ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	3.2A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	1 600µF	Included inside the device
Back-feeding loads	max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

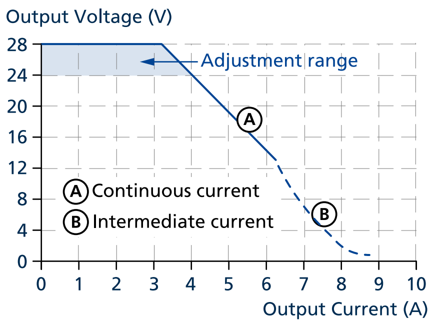


Fig. 6-1: Output voltage vs. output current, typ.

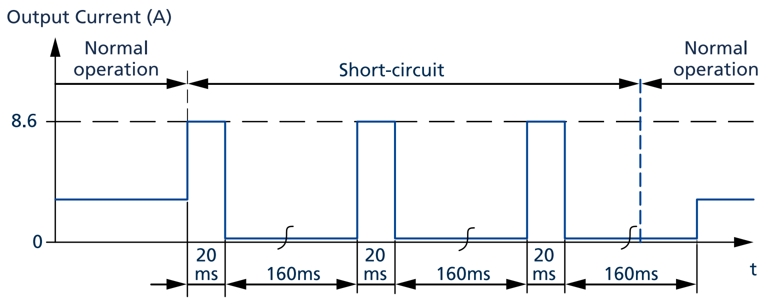


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	14ms	25ms	119ms	At 24V, 3.8A
	typ.	40ms	60ms	242ms	At 24V, 1.9A
	min.	11.5ms	20ms	95ms	At 24V, 3.8A
	min.	32ms	48ms	194ms	At 24V, 1.9A

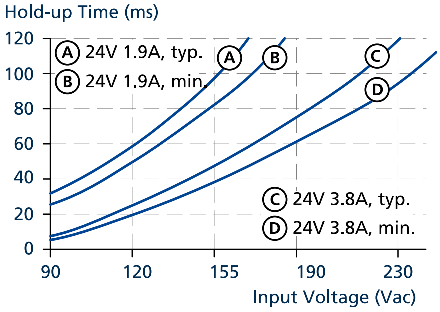


Fig. 7-1: Hold-up time vs. input voltage

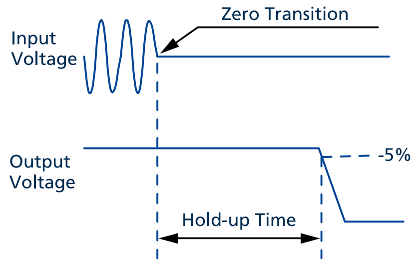


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	90.6%	92.1%	93.8%	At 24V, 3.8A (full load)
Average efficiency	typ.	90.5%	91.6%	92%	25% at 0.95A, 25% at 1.9A, 25% at 2.85A, 25% at 3.8A
Power losses	typ.	0.3W	0.3W	0.4W	At no load
	typ.	5W	4.3W	3.8W	At 24V, 1.9A (half load)
	typ.	9.5W	7.9W	6W	At 24V, 3.8A (full load)

The average efficiency is an assumption for a typical application where the device 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.

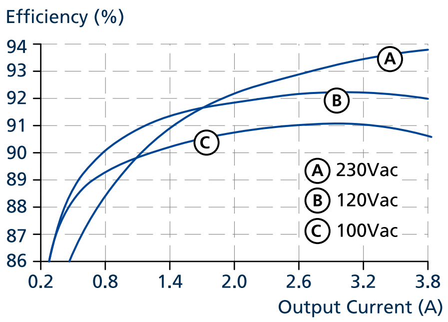


Fig. 8-1: Efficiency vs. output current at 24V, typ.

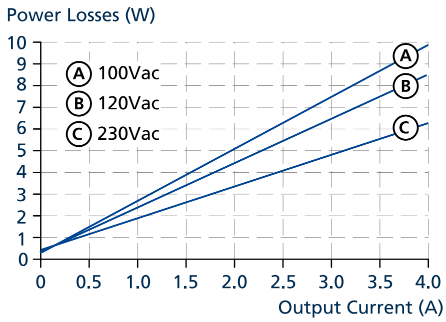


Fig. 8-2: Losses vs. output current at 24V, typ.

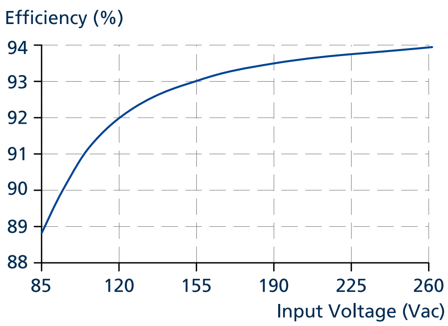


Fig. 8-3: Efficiency vs. input voltage at 24V, 3.8A, typ.

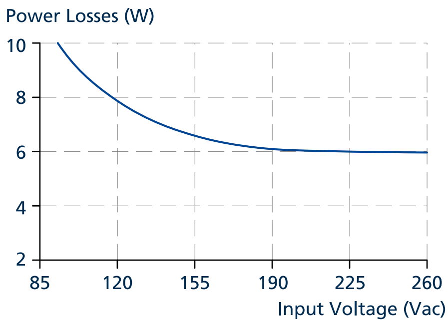


Fig. 8-4: Losses vs. input voltage at 24V, 3.8A, typ.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	39 000h	64 000h	102 000h	At 24V, 3.8A and 40°C
	260 000h	292 000h	309 000h	At 24V, 1.9A and 40°C
	91 000h	147 000h	287 000h	At 24V, 3.8A and 25°C
	640 000h	720 000h	815 000h	At 24V, 1.9A and 25°C

10. 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.

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	1 174 000h	1 273 000h	1 507 000h	At 24V, 3.8A and 40°C
	2 251 000h	2 406 000h	2 752 000h	At 24V, 3.8A and 25°C
MTBF MIL HDBK 217F	751 000h	760 000h	698 000h	At 24V, 3.8A and 40°C; Ground Benign GB40
	1 085 000h	1 099 000h	1 018 000h	At 24V, 3.8A and 25°C; Ground Benign GB25
	219 000h	224 000h	220 000h	At 24V, 3.8A and 40°C; Ground Fixed GF40
	288 000h	294 000h	293 000h	At 24V, 3.8A and 25°C; Ground Fixed GF25

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

11. Functional Diagram

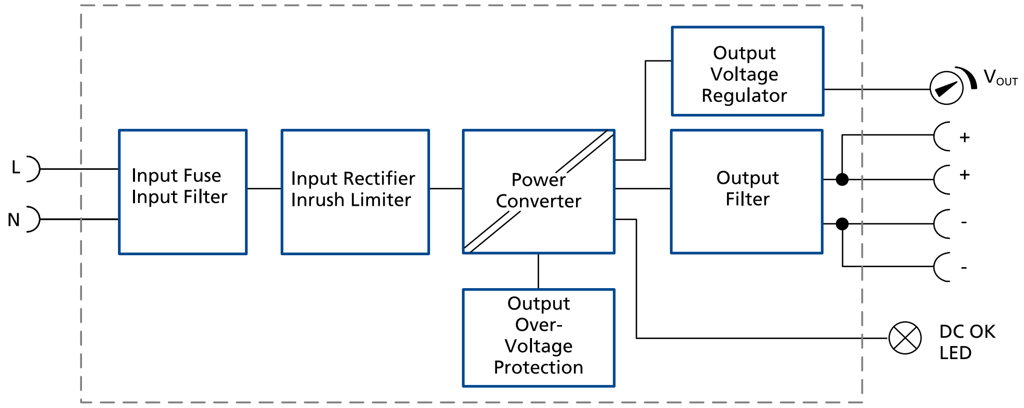


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Push-in terminals
Solid wire	max. 2.5mm²
Stranded wire	max. 2.5mm²
Stranded wire with ferrules	max. 1.5mm²
American Wire Gauge	AWG 24-12
Max. wire diameter (including ferrules)	2.3mm
Wire stripping length	10mm / 0.4inch
Screwdriver	3mm slotted to open the spring

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

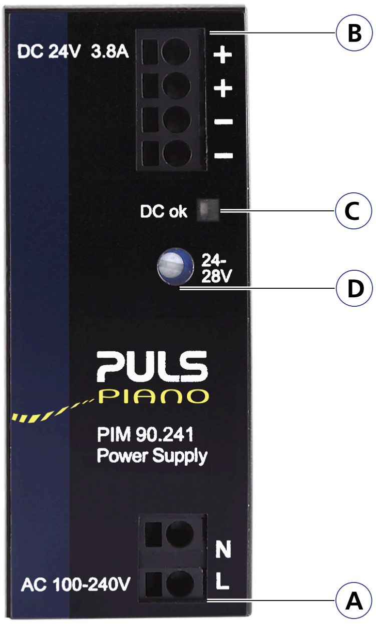


Fig. 13-1: Front side

A Input Terminals
- **N** Neutral conductor input
- **L** Phase (Line) input

B OutputTerminals
Dual terminals for the negative and positive pole.
Both poles are internally connected.
- **+** Positive output
- **-** Negative (return) output

C DC OK LED (green)
The LED is on, when the output voltage is above 18V.

D Output voltage adustment potentiometer

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 2.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

EMC Immunity				
Electrostatic discharge	EN 61000-4-2	Contact discharge	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → Earthed output	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) → (–) Earthed	1kV	Criterion A
		(–) → (+) Earthed	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 2.9A and criterion C for output currents above 2.9A.

EMC Emission		
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	5kHz to 120kHz	Input voltage and output load dependent

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.1A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.25A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

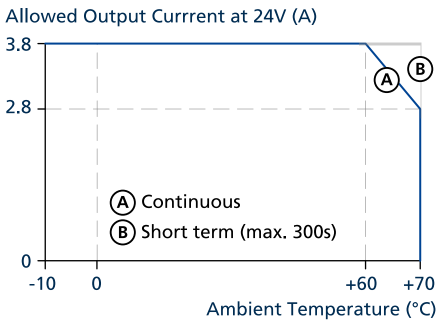


Fig. 15-1: Output power vs. ambient temp.

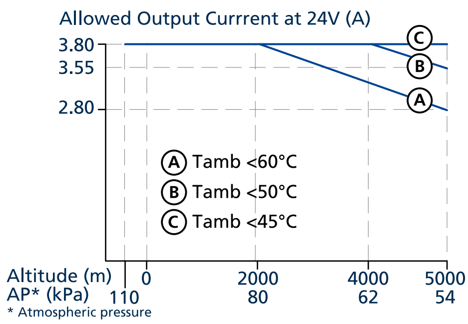


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

Isolation resistance	>500MOhm	At delivered condition between input and output, measured with 500Vdc
Output over-voltage protection	typ. 30.5Vdc max. 32Vdc In case of an internal defect, a redundant circuit limits the maximum output voltage to 32V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	II	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 50µA / 120µA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 75µA / 170µA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 130µA / 270µA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 80µA / 190µA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 120µA / 270µA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 210µA / 400µA	At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

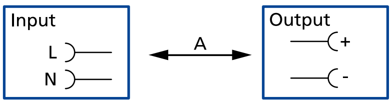


Fig. 17-1: Dielectric strength

		A
Type test	60s	3000Vac
Factory test	5s	2500Vac
Field test	5s	2000Vac
Field test cut-off current settings		>4mA

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
REACH Regulation	REACH ✓	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years
EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

20. Physical Dimensions And Weight

Width Height Depth	36mm / 1.42'' 90mm / 3.54'' 91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	270g / 0.6lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

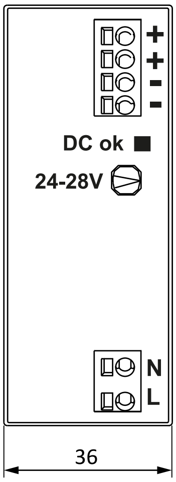


Fig. 20-1: Front view

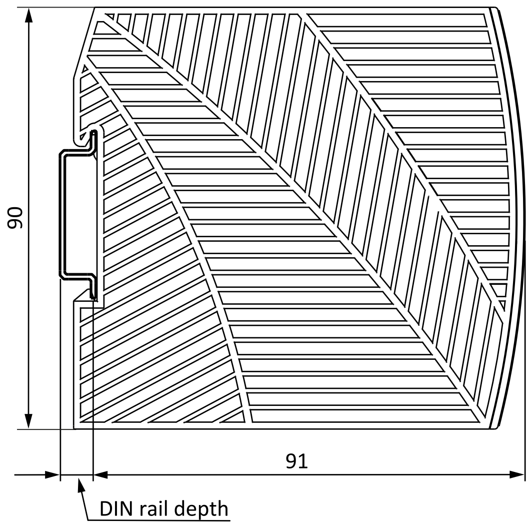


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

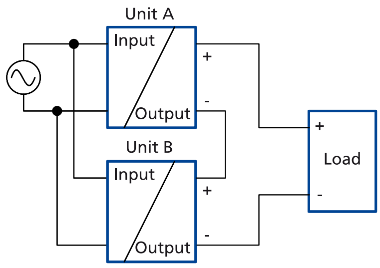
21.2. SERIES OPERATION

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 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.

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



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

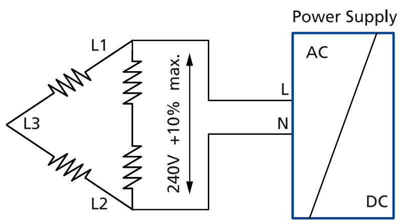
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems since there is no monitoring (DC-OK signal) included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



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

	Case A	**Case B**
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	24V, 3.04A; (=**80**%)	24V, 3.8A; (=**100**%)
Temperature inside the box	30.3°C	31.7°C
Temperature outside the box	21°C	21°C
Temperature rise	9.3K	10.7K

36mm

POWER SUPPLY 1AC 24V 90W

- AC 100-240V Wide-range input
- NEC CLASS 2 compliant
- Cost optimized without compromising quality or reliability
- Width only 36mm
- Efficiency up to 93.8%
- Low no-load power losses
- Full power between -10°C and +60°C
- Large Screw terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM90.245-L1 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage. The output fulfils the requirements for a limited power source according to NEC CLASS 2.

The device is equipped with Screw terminals, which are optimized for large wire sizes.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today's industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24-28V	Factory setting 24.1V
Output current	3.8-3.2A	Below +60°C ambient
	2.8-2.4A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1.45 / 0.95A	At 120 / 230Vac
Power factor	0.58 / 0.45	At 120 / 230Vac
Input inrush current	18 / 40A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	92.1 / 93.8%	At 120 / 230Vac
Power losses	7.9 / 6W	At 120 / 230Vac
Hold-up time	25 / 119ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	270g / 0.6lb	

ORDER NUMBERS

Description: Power supply PIM90.245-L1-xx
Order Number:
PIM90.245-L1

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL us LISTED

Ind. Cont. Eq.

NEC CLASS 2

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

Index

Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

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 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.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 2.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

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.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V	
AC input range		90-264Vac	Continuous operation
		264-300Vac	For maximum 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.	62Vac	Steady-state value, see Fig. 3-1
External input protection	See recommendations in chapter 2.		

		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.69A	1.45A	0.95A	At 24V, 3.8A, see Fig. 3-1
Power factor	typ.	0.6	0.58	0.45	At 24V, 3.8A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	50ms	See Fig. 3-2
Rise time	typ.	21ms	21ms	20ms	At 24V, 3.8A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	42ms	42ms	40ms	At 24V, 3.8A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

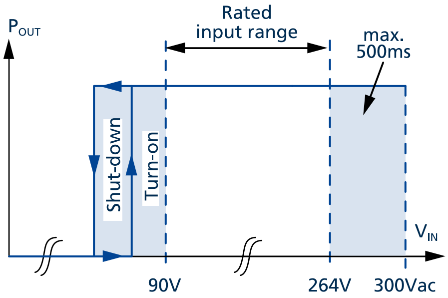


Fig. 3-1: Input voltage range

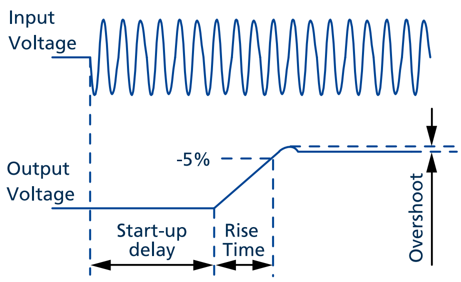


Fig. 3-2: Turn-on behavior, definitions

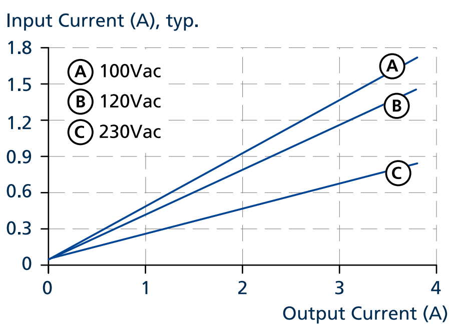


Fig. 3-3: Input current vs. output load at 24V output voltage

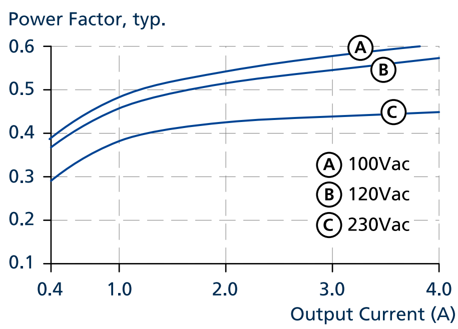


Fig. 3-4: Power factor vs. output load at 24V output voltage

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.

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

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	14A	18A	40A	At 40°C, ambient, cold start
	typ.	12A	16A	35A	At 25°C, ambient, cold start
	max.	17A	22A	48A	At 40°C, ambient, cold start
	max.	15A	20A	43A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	$0.3A^2s$	$0.4A^2s$	$1.7A^2s$	At 40°C, ambient, cold start

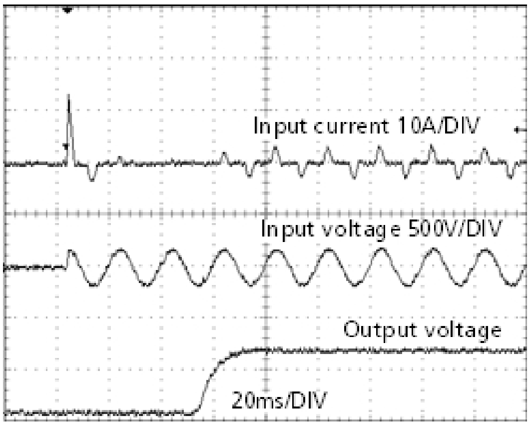


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

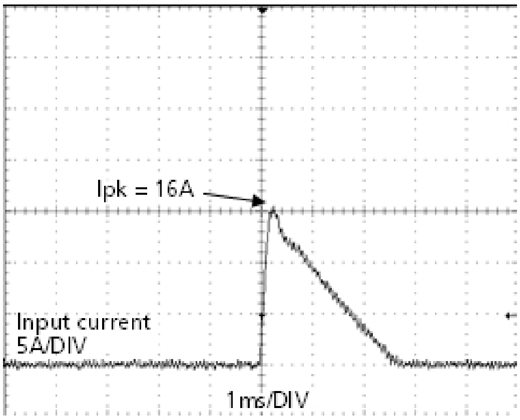


Fig. 5-2: Zoom into the first inrush peak

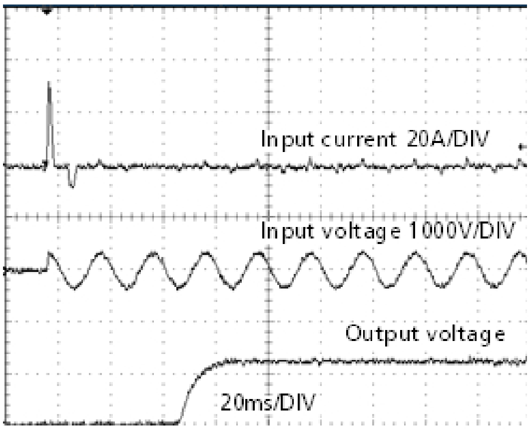


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

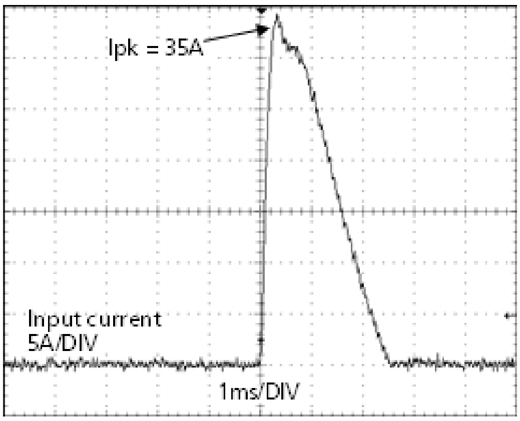


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including unlimited inductive loads. Capacitive loads should not be larger than 3 300 µF with 3.8A or 4 200 µF with 1.9A additional resistive load.

At heavy overloads (when output voltage falls below 14V), the device delivers continuous output current for 20ms. After this, the output is switched off for approx. 160ms 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.

Output voltage	nom.	DC 24V	
Adjustment range		24-28V	Guaranteed value
	max.	29V	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.	24.1V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 3.8A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	3.8A	At 24V and an ambient temperature below 60°C
	nom.	2.8A	At 24V and 70°C ambient temperature
	nom.	3.2A	At 28V and an ambient temperature below 60°C
	nom.	2.4A	At 28V and 70°C ambient temperature
Overload protection	Included		Electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.
Overload behaviour	Continuous current		For output voltage above 14Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 14Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	6.7A	Continuous current, see Fig. 6-1
	typ.	8.6A	Intermitted current peak value for typ. 20ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	3.2A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	1 600µF	Included inside the device
Back-feeding loads	max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

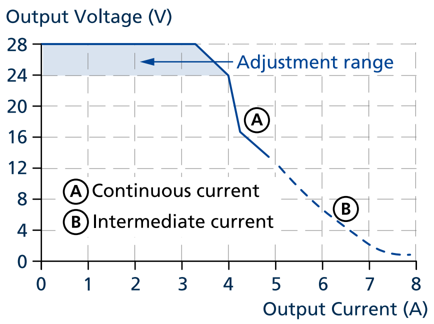


Fig. 6-1: Output voltage vs. output current, typ.

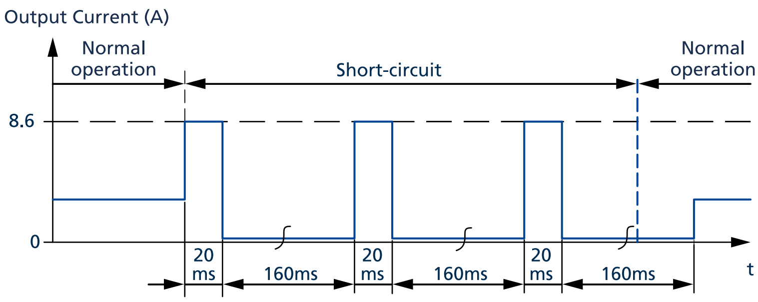


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	14ms	25ms	119ms	At 24V, 3.8A
	typ.	40ms	60ms	242ms	At 24V, 1.9A
	min.	11.5ms	20ms	95ms	At 24V, 3.8A
	min.	32ms	48ms	194ms	At 24V, 1.9A

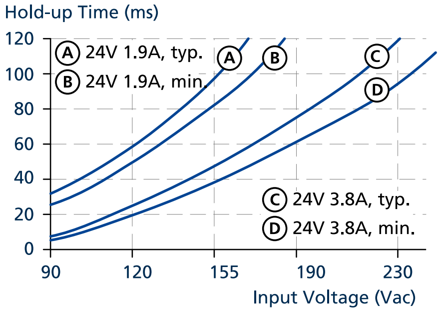


Fig. 7-1: Hold-up time vs. input voltage

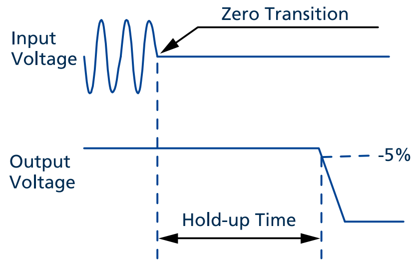


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	90.6%	92.1%	93.8%	At 24V, 3.8A (full load)
Average efficiency	typ.	90.5%	91.6%	92%	25% at 0.95A, 25% at 1.9A, 25% at 2.85A, 25% at 3.8A
Power losses	typ.	0.3W	0.3W	0.4W	At no load
	typ.	5W	4.3W	3.8W	At 24V, 1.9A (half load)
	typ.	9.5W	7.9W	6W	At 24V, 3.8A (full load)

The average efficiency is an assumption for a typical application where the device 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.

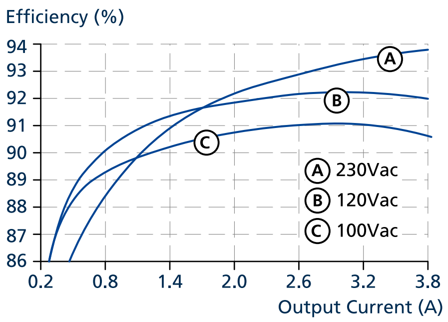


Fig. 8-1: Efficiency vs. output current at 24V, typ.

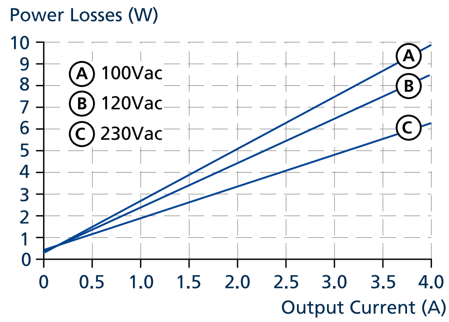


Fig. 8-2: Losses vs. output current at 24V, typ.

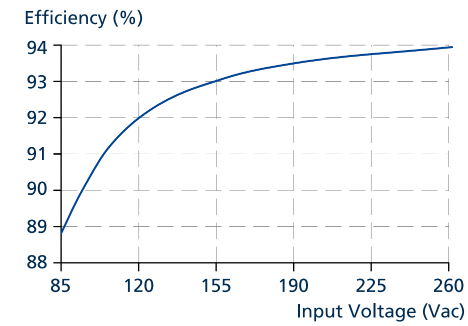


Fig. 8-3: Efficiency vs. input voltage at 24V, 3.8A, typ.

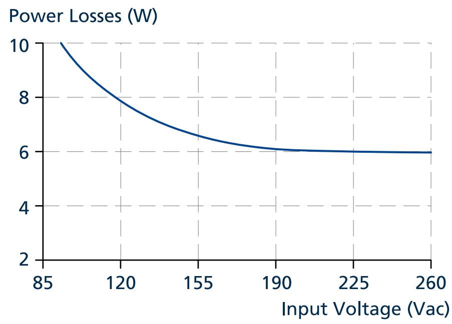


Fig. 8-4: Losses vs. input voltage at 24V, 3.8A, typ.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	39 000h	64 000h	102 000h	At 24V, 3.8A and 40°C
	260 000h	292 000h	309 000h	At 24V, 1.9A and 40°C
	91 000h	147 000h	287 000h	At 24V, 3.8A and 25°C
	640 000h	720 000h	815 000h	At 24V, 1.9A and 25°C

10. 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.

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	1 127 000h	1 222 000h	1 446 000h	At 24V, 3.8A and 40°C
	2 161 000h	2 310 000h	2 642 000h	At 24V, 3.8A and 25°C
MTBF MIL HDBK 217F	721 000h	730 000h	670 000h	At 24V, 3.8A and 40°C; Ground Benign GB40
	1 042 000h	1 055 000h	977 000h	At 24V, 3.8A and 25°C; Ground Benign GB25
	210 000h	215 000h	211 000h	At 24V, 3.8A and 40°C; Ground Fixed GF40
	276 000h	282 000h	281 000h	At 24V, 3.8A and 25°C; Ground Fixed GF25

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

11. Functional Diagram

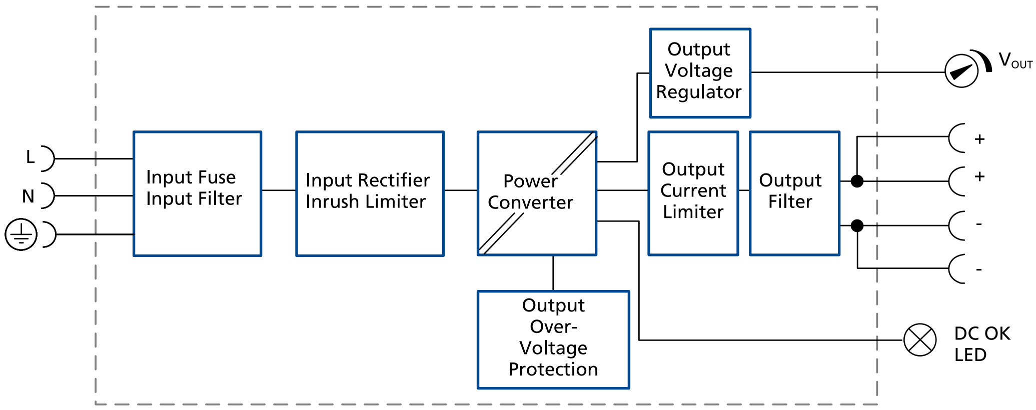


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Screw terminals
Solid wire	max. $6mm^2$
Stranded wire	max. $4mm^2$
American Wire Gauge	AWG 20-10
Max. wire diameter (including ferrules)	2.8mm
Wire stripping length	7mm / 0.28inch
Recommended tightening torque	1Nm, 9lb.in
Screwdriver	3mm slotted or Phillips No 1

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

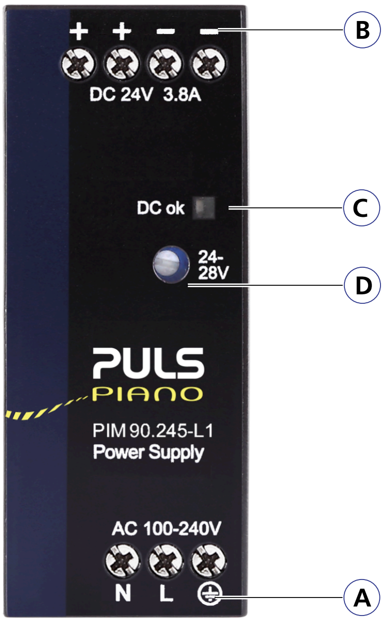


Fig. 13-1: Front side

A **Input Terminals**

- **N** Neutral conductor input
- **L** Phase (Line) input
- ⏚ PE (Protective Earth)

B **OutputTerminals**

Dual terminals for the negative and positive pole.
Both poles are internally connected.

- **+** Positive output
- \- Negative (return) output

C **DC OK LED (green)**

The LED is on, when the output voltage is above 18V.

D **Output voltage adustment potentiometer**

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 2.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms. 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	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → PE	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) / (–)→ PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 2.9A and criterion C for output currents above 2.9A.

EMC Emission		
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks not fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	5kHz to 120kHz	Input voltage and output load dependent

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.1A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.25A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-54kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	II	According to IEC 60664-1, for altitudes <5000m
Impulse withstand voltage	4kV (according to over-voltage category III)	Input to PE According to IEC 60664-1, for altitudes <2000m
Degree of pollution	2	According to IEC 60664-1, non 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.	

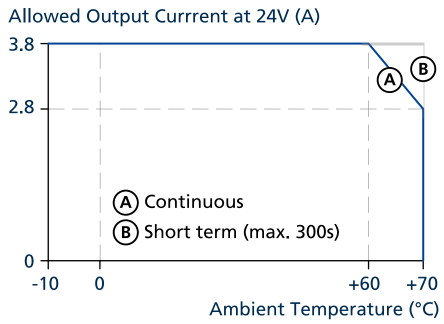


Fig. 15-1: Output power vs. ambient temp.

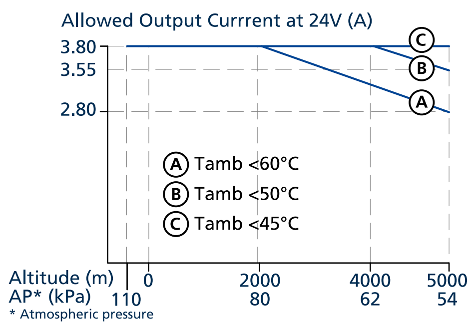


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

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
Output over-voltage protection	typ. 30.5Vdc max. 32Vdc In case of an internal defect, a redundant circuit limits the maximum output voltage to 32V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	I	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 30µA / 60µA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 40µA / 90µA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 70µA / 140µA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 40µA / 70µA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 50µA / 110µA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 90µA / 180µA	At 264Vac, 50Hz, TN-, TT-mains / IT-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 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.

It is recommended 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 cannot be switched off when unnoticed earth faults occur.

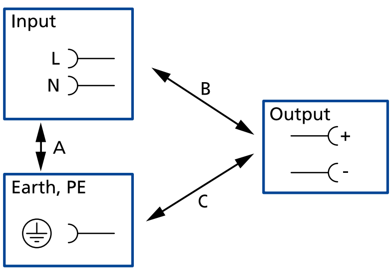


Fig. 17-1: Dielectric strength

		A	B	C
Type test	60s	2500Vac	3000Vac	1000Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Field test cut-off current settings		>2mA	>2mA	>6mA

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
NEC Class 2	NEC CLASS 2	UL Certificate Limited Power Source Listed in the UL 61010-2-201 approval report, investigated according to UL 1310
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H_2S: 100ppb NO_x: 1250ppb Cl_2: 20ppb SO_2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
REACH Regulation	REACH	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
WEEE Regulation		Manufacturer's Declaration EU Directive on Waste Electrical and Electronic Equipment Registered in Germany as business to business (B2B) products. EU Directive 2012/19/EU
RoHS (China RoHS 2)	25	Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

20. Physical Dimensions And Weight

Width Height Depth	36mm / 1.42'' 90mm / 3.54'' 91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	270g / 0.6lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

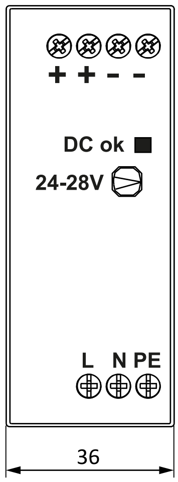


Fig. 20-1: Front view

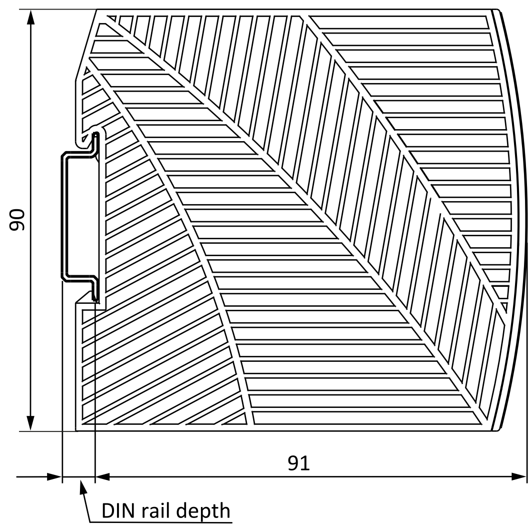


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

21.2. SERIES OPERATION

Do not connect outputs of devices in a series connection for higher output voltages.

21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use parallel devices for higher output currents.

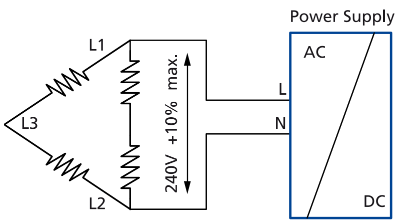
21.4. PARALLEL USE FOR 1+1 REDUNDANCY

Do not use this device to build redundant systems.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



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

	Case A	**Case B**
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	24V, 3.04A; (=**80**%)	24V, 3.8A; (=**100**%)
Temperature inside the box	30.3°C	31.7°C
Temperature outside the box	21°C	21°C
Temperature rise	9.3K	10.7K

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

36mm

POWER SUPPLY 1AC 24V 90W

- AC 100-240V Wide-range input
- Cost optimized without compromising quality or reliability
- Width only 36mm
- Efficiency up to 93.8%
- Low no-load power losses
- Full power between -10°C and +60°C
- Large screw terminals
- 3 Year warranty

PRODUCT DESCRIPTION

The PIM90.245 is a DIN rail mountable single-phase-input power supply, which provides a floating, stabilized and galvanically separated SELV/PELV/ES1 output voltage.

The device is equipped with screw terminals, which are optimized for large wire sizes.

The mechanically robust housing is made of a high-grade, reinforced molded material, which permits surrounding temperatures up to +70°C.

The PIANO family is a compact industrial grade DIN rail power supply series that focuses on the essential features needed in today's industrial applications. The excellent cost/performance ratio does not compromise quality or reliability.

SHORT-FORM DATA

Output voltage	DC 24V	Nominal
Adjustment range	24-28V	Factory setting 24.1V
Output current	3.8-3.2A	Below +60°C ambient
	2.8-2.4A	At +70°C ambient
	Derate between +60°C and +70°C	
Input voltage AC	AC 100-240V	± 10%
Mains frequency	50-60Hz	±6%
Input current AC	1.45 / 0.95A	At 120 / 230Vac
Power factor	0.58 / 0.45	At 120 / 230Vac
Input inrush current	18 / 40A_{peak}	At 120 / 230Vac, +40°C, cold start
Efficiency	92.1 / 93.8%	At 120 / 230Vac
Power losses	7.9 / 6W	At 120 / 230Vac
Hold-up time	25 / 119ms	At 120 / 230Vac
Temperature range	-10°C to +70°C	
Size (w x h x d)	36x90x91mm	Without DIN rail
Weight	270g / 0.6lb	

ORDER NUMBERS

Description: Power supply PIM90.245-xx
Order Number:
PIM90.245

MAIN APPROVALS

For details and the complete approval list, see chapter 18.

c UL US LISTED
Ind. Cont. Eq.

All parameters are specified at 24V, 3.8A, 230Vac, 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 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.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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, measurement, Audio/Video, information or communication equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the end-application. If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

Do not use this device on AC 100V mains with more than 2.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms.

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.

2. Installation Instructions

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- 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 device in an enclosure providing protection against electrical, mechanical and fire hazards. Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of +60°C for ambient temperatures up to +45°C, +75°C for ambient temperatures up to +60°C and +90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection. Unused screw terminals should be securely tightened.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost is allowed. The enclosure of the device provides a degree of protection of IP20. The enclosure does not provide protection against spilled liquids.

The device is designed for overvoltage category II zones. Below 2000m altitude the device is tested for impulse withstand voltages up to 4kV, which corresponds to OVC 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.

The device is suitable to be supplied from TN, TT or IT mains networks. The continuous voltage between the input terminal and the PE potential must not exceed 300Vac. 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 5000m (16 400ft). Above 2000m (6560ft) a reduction in output current is required.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 0mm left and right side. Increase the 0mm to 15mm in case the adjacent device is a heat source.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A 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.

3. AC-Input

The device is suitable to be supplied from TN, TT or IT mains networks.

AC input	nom.	AC 100-240V			
AC input range		90-264Vac	Continuous operation		
		264-300Vac	For maximum 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.	75Vac	Steady-state value, see Fig. 3-1		
Shut-down voltage	typ.	54Vac	Steady-state value, see Fig. 3-1		
External input protection	See recommendations in chapter 2.				
		AC 100V	**AC 120V**	**AC 230V**	
Input current	typ.	1.69A	1.45A	0.95A	At 24V, 3.8A, see Fig. 3-1
Power factor	typ.	0.6	0.58	0.45	At 24V, 3.8A, see Fig. 3-4
Start-up delay	typ.	50ms	50ms	50ms	See Fig. 3-2
Rise time	typ.	21ms	21ms	20ms	At 24V, 3.8A constant current load, 0mF load capacitance, see Fig. 3-2
	typ.	42ms	42ms	40ms	At 24V, 3.8A constant current load, 2mF load capacitance, see Fig. 3-2
Turn-on overshoot	max.	100mV	100mV	100mV	See Fig. 3-2

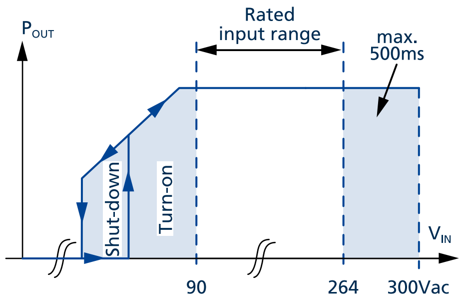


Fig. 3-1: Input voltage range

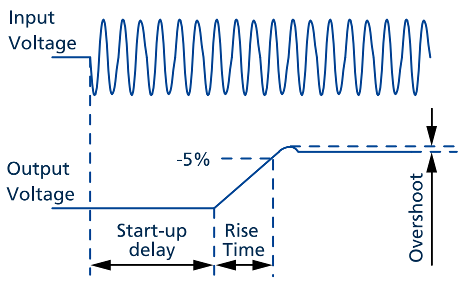


Fig. 3-2: Turn-on behavior, definitions

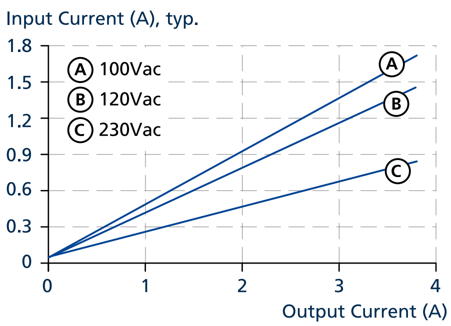


Fig. 3-3: Input current vs. output load at 24V output voltage

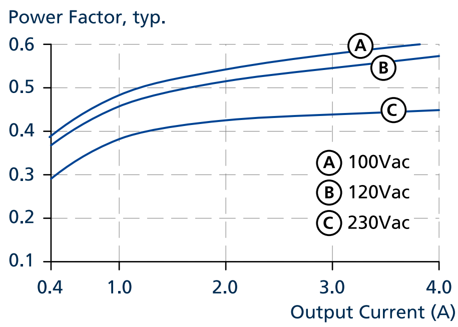


Fig. 3-4: Power factor vs. output load at 24V output voltage

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

4. DC-Input

Do not operate this device with DC-input voltage.

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 output load has no impact on the inrush current value.
The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

		AC 100V	AC 120V	AC 230V	
Inrush current I_{peak}	typ.	14A	18A	40A	At 40°C, ambient, cold start
	typ.	12A	16A	35A	At 25°C, ambient, cold start
	max.	17A	22A	48A	At 40°C, ambient, cold start
	max.	15A	20A	43A	At 25°C, ambient, cold start
Inrush energy I^2t	max.	0.3A²s	0.4A²s	1.7A²s	At 40°C, ambient, cold start

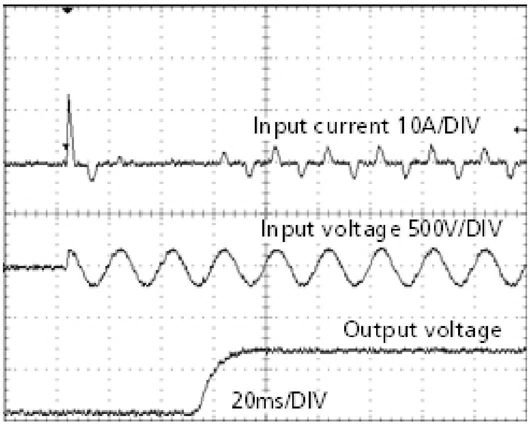


Fig. 5-1: Typical turn-on behavior at 120Vac and 25°C ambient

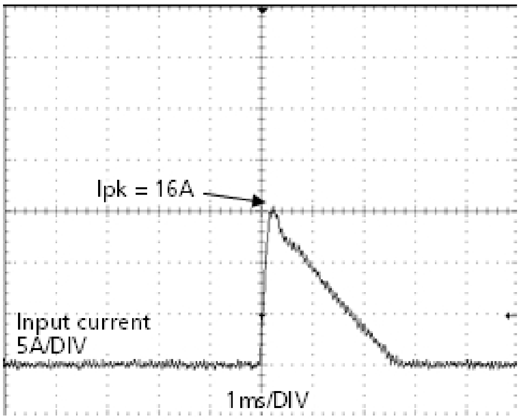


Fig. 5-2: Zoom into the first inrush peak

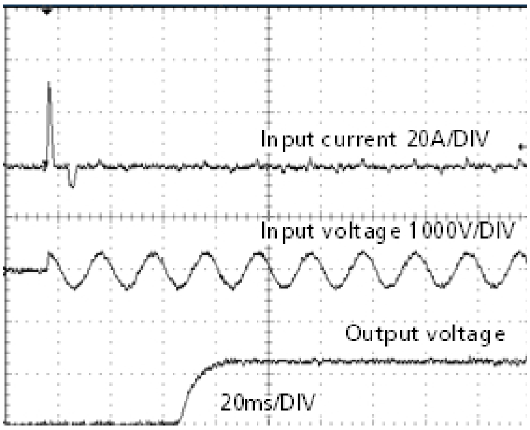


Fig. 5-3: Typical turn-on behavior at 230Vac and 25°C ambient

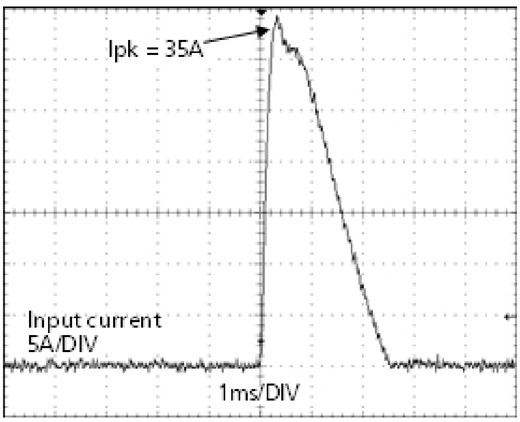


Fig. 5-4: Zoom into the first inrush peak

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

6. Output

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage. The output is electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.

The output is designed to supply any kind of loads, including inductive and capacitive loads. Capacitive loads should not be larger than 4 000µF with 3.8A or 5 000µF with 1.9A additional resistive load.

At heavy overloads (when output voltage falls below 14V), the device delivers continuous output current for 20ms. After this, the output is switched off for approx. 160ms 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.

Output voltage	nom.	DC 24V	
Adjustment range		24-28V	Guaranteed value
	max.	29.5V	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.	24.1V	±0,2%, at full load, cold unit
Line regulation	max.	10mV	Between 90 and 300Vac
Load regulation	max.	100mV	Between 0 and 3.8A, static value, see Fig. 6-1
Ripple and noise voltage	max.	100mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	nom.	3.8A	At 24V and an ambient temperature below 60°C
	nom.	2.8A	At 24V and 70°C ambient temperature
	nom.	3.2A	At 28V and an ambient temperature below 60°C
	nom.	2.4A	At 28V and 70°C ambient temperature
Overload protection	Included		Electronically protected against no-load, overload and short circuit. In case of a protection event, audible noise may occur.
Overload behaviour	Continuous current		For output voltage above 14Vdc, see Fig. 6-1
	Intermittent current		For output voltage below 14Vdc, see Fig. 6-2
Overload/ short-circuit current	max.	6.7A	Continuous current, see Fig. 6-1
	typ.	8.6A	Intermitted current peak value for typ. 20ms Load impedance 150mOhm, see Fig. 6-2 Discharge current of output capacitors is not included.
	max.	3.2A	Intermitted current average value (R.M.S.) Load impedance 150mOhm, see Fig. 6-2
Output capacitance	typ.	1 600µF	Included inside the device
Back-feeding loads	max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the device. It does not matter whether the device is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

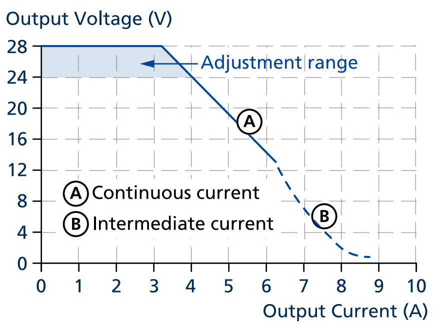


Fig. 6-1: Output voltage vs. output current, typ.

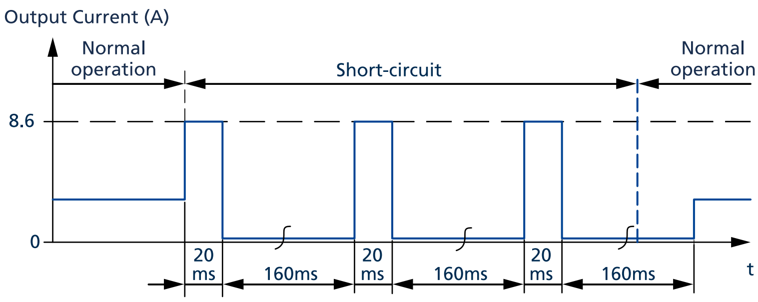


Fig. 6-2: Intermittend current at short circuit, typ.*)

*) with cold devices the times are about 15% longer.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

7. Hold-up Time

The hold-up time is the time during which a device'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 LED is also on during this time.

		AC 100V	AC 120V	AC 230V	
Hold-up time	typ.	14ms	25ms	119ms	At 24V, 3.8A
	typ.	40ms	60ms	242ms	At 24V, 1.9A
	min.	11.5ms	20ms	95ms	At 24V, 3.8A
	min.	32ms	48ms	194ms	At 24V, 1.9A

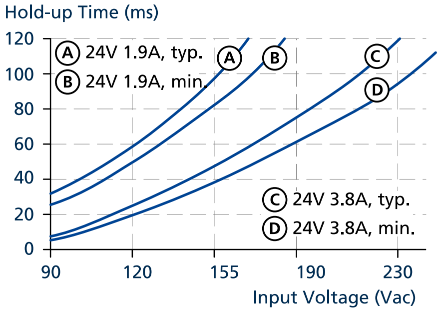


Fig. 7-1: Hold-up time vs. input voltage

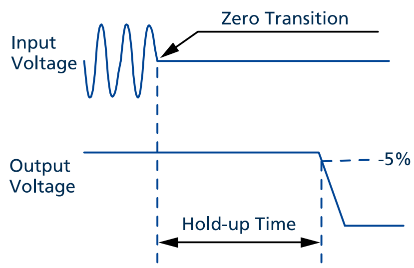


Fig. 7-2: Shut-down behaviour, definitions

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

8. Efficiency and Power Losses

		AC 100V	AC 120V	AC 230V	
Efficiency	typ.	90.6%	92.1%	93.8%	At 24V, 3.8A (full load)
Average efficiency	typ.	90.5%	91.6%	92%	25% at 0.95A, 25% at 1.9A, 25% at 2.85A, 25% at 3.8A
Power losses	typ.	0.3W	0.3W	0.4W	At no load
	typ.	5W	4.3W	3.8W	At 24V, 1.9A (half load)
	typ.	9.5W	7.9W	6W	At 24V, 3.8A (full load)

The average efficiency is an assumption for a typical application where the device 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.

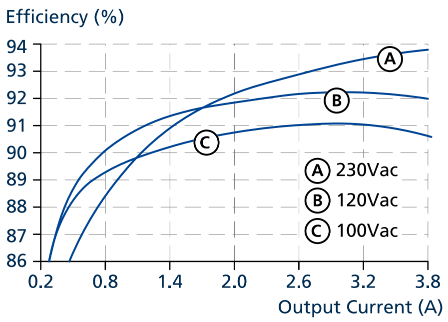


Fig. 8-1: Efficiency vs. output current at 24V, typ.

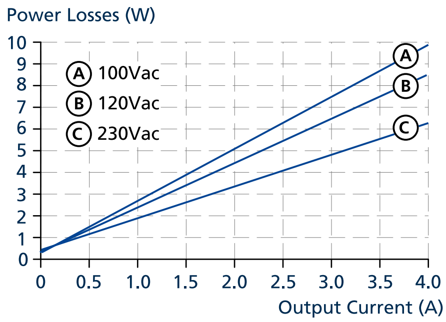


Fig. 8-2: Losses vs. output current at 24V, typ.

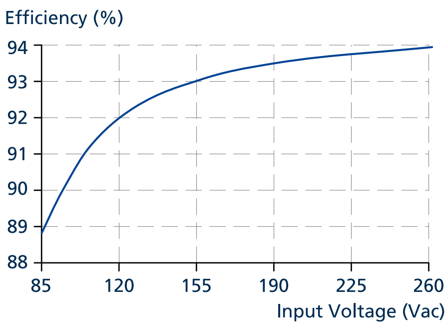


Fig. 8-3: Efficiency vs. input voltage at 24V, 3.8A, typ.

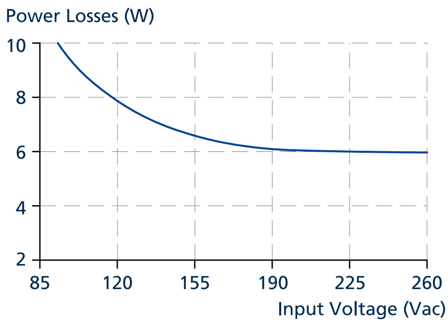


Fig. 8-4: Losses vs. input voltage at 24V, 3.8A, typ.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

9. 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.

Please note: 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	39 000h	64 000h	102 000h	At 24V, 3.8A and 40°C
	260 000h	292 000h	309 000h	At 24V, 1.9A and 40°C
	91 000h	147 000h	287 000h	At 24V, 3.8A and 25°C
	640 000h	720 000h	815 000h	At 24V, 1.9A and 25°C

10. 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.

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	1 174 000h	1 273 000h	1 507 000h	At 24V, 3.8A and 40°C
	2 251 000h	2 406 000h	2 752 000h	At 24V, 3.8A and 25°C
MTBF MIL HDBK 217F	751 000h	760 000h	698 000h	At 24V, 3.8A and 40°C; Ground Benign GB40
	1 085 000h	1 099 000h	1 018 000h	At 24V, 3.8A and 25°C; Ground Benign GB25
	219 000h	224 000h	220 000h	At 24V, 3.8A and 40°C; Ground Fixed GF40
	288 000h	294 000h	293 000h	At 24V, 3.8A and 25°C; Ground Fixed GF25

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

11. Functional Diagram

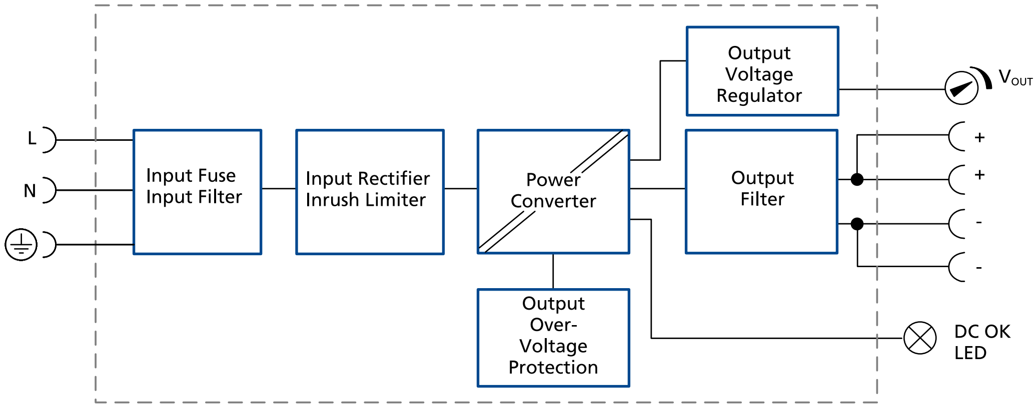


Fig. 11-1: Functional diagram

12. Terminals And Wiring

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

	All Terminals
Type	Screw terminals
Solid wire	max. 6mm^2
Stranded wire	max. 4mm^2
American Wire Gauge	AWG 20-10
Max. wire diameter (including ferrules)	2.8mm
Wire stripping length	7mm / 0.28inch
Recommended tightening torque	1Nm, 9lb.in
Screwdriver	3mm slotted or Phillips No 1

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

13. Front Side And User Elements

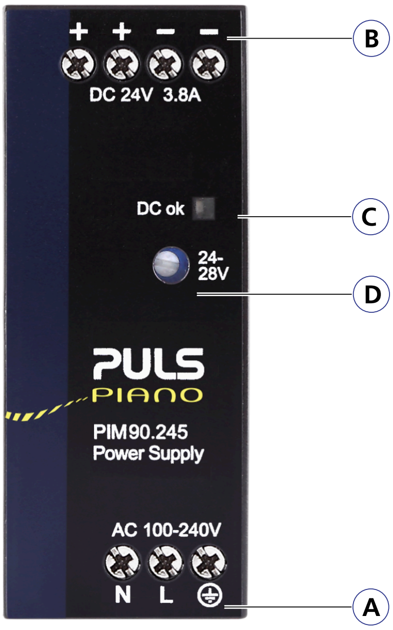


Fig. 13-1: Front side

A **Input Terminals**

- **N** Neutral conductor input
- **L** Phase (Line) input
- ⏚ PE (Protective Earth)

B **OutputTerminals**

Dual terminals for the negative and positive pole.
Both poles are internally connected.

- **+** Positive output
- **-** Negative (return) output

C **DC OK LED (green)**

The LED is on, when the output voltage is above 18V.

D **Output voltage adustment potentiometer**

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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 device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3. The 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.

Do not use this device on AC 100V mains with more than 2.9A load when the application is sensitive to short output voltage dips during mains interruptions even with a length shorter than 20ms. 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	8kV	Criterion A
		Air discharge	8kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz - 6GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	L → N	2kV	Criterion A
		N / L → PE	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (–)	1kV	Criterion A
		(+) / (–)→ PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15 - 80MHz	10V	Criterion A
Voltage dips	EN 61000-4-11	0% of 100Vac	0Vac, 20ms	Criterion A/C
		40% of 100Vac	40Vac, 200ms	Criterion C
		70% of 100Vac	70Vac, 500ms	Criterion A
		0% of 120Vac	0Vac, 20ms	Criterion A
		40% of 120Vac	48Vac, 200ms	Criterion C
		70% of 120Vac	84Vac, 500ms	Criterion A
		0% of 200Vac	0Vac, 20ms	Criterion A
		40% of 200Vac	80Vac, 200ms	Criterion A
		70% of 200Vac	140Vac, 500ms	Criterion A
Voltage interruptions	EN 61000-4-11	0V	5000ms	Criterion C
Powerful transients	VDE 0160	Over entire load range	750V, 1.3ms	Criterion A

Performance criterions:

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

B: The device operates continuously during and after the test. During the test minor temporary impairments may occur, which will be corrected by the device itself.

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.

A/C: Criterion A for output current below 2.9A and criterion C for output currents above 2.9A.

EMC Emission		
Conducted emission input lines	EN 55011, EN 55032, FCC Part 15, CISPR 11, CISPR32	Class B
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	Limits for local DC power networks not fulfilled.
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32	Class B
Harmonic input current	EN 61000-3-2	Fulfilled (Class A)
Voltage fluctuations, flicker	EN 61000-3-3	Fulfilled, tested with non pulsing constant current loads.

Switching Frequencies		
Main converter	5kHz to 120kHz	Input voltage and output load dependent

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

15. Environment

Operational temperature	-10°C to +70°C (14°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 derating	0.1A/°C	Between +60°C and +70°C (140°F to 158°F)
	0.25A/1000m or 5°C/1000m	For altitudes >2000m (6560ft), see Fig. 15-2
	The derating is not hardware controlled. The user has to take this into consideration to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 No condensation allowed.
Atmospheric pressure	110-47kPa	See Fig. 15-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 15-2 for details
Over-voltage category	III	According to IEC 60664-1, for altitudes <2000m
	II	According to IEC 60664-1, for altitudes >2000m
Degree of pollution	2	According to 62477-1, non 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.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

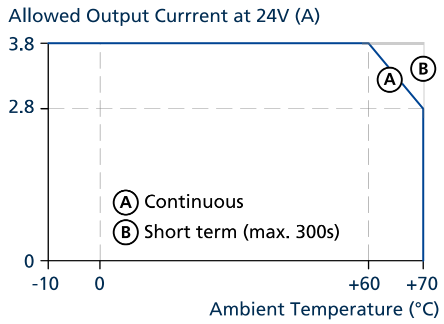


Fig. 15-1: Output power vs. ambient temp.

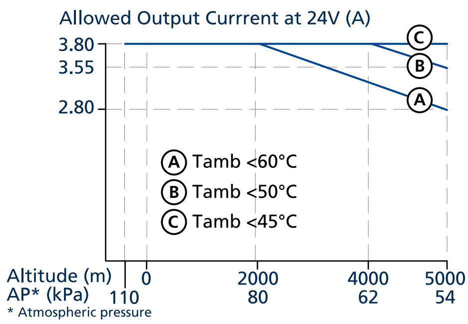


Fig. 15-2: Output power vs. altitude

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

16. Safety and Protection Features

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
Output over-voltage protection	typ. 30.5Vdc max. 32Vdc	
	In case of an internal defect, a redundant circuit limits the maximum output voltage to 32V. The output shuts down. To attempt a restart, turn the input power off for at least 90s.	
Class of protection	I	According to IEC 61140
Degree of protection	IP20	According to EN/IEC 60529
Over-temperature protection	Not Included	
Input transient protection	MOV (Metal Oxide Varistor)	For protection values see chapter 14 (EMC).
Internal input fuse	Included	Not user replaceable slow-blow high-braking capacity fuse
Touch current (leakage current)	typ. 30μA / 60μA	At 100Vac, 50Hz, TN-, TT-mains / IT-mains
	typ. 40μA / 90μA	At 120Vac, 60Hz, TN-, TT-mains / IT-mains
	typ. 70μA / 140μA	At 230Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 40μA / 70μA	At 110Vac, 50Hz, TN-, TT-mains / IT-mains
	max. 50μA / 110μA	At 132Vac, 60Hz, TN-, TT-mains / IT-mains
	max. 90μA / 180μA	At 264Vac, 50Hz, TN-, TT-mains / IT-mains

17. Dielectric Strength

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

It is recommended 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.

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 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.

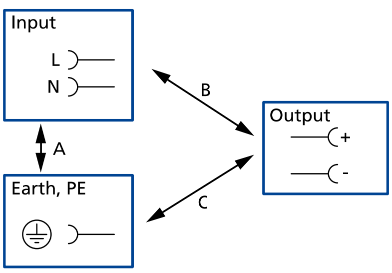


Fig. 17-1: Dielectric strength

		A	B	C
Type test	60s	2500Vac	3000Vac	1000Vac
Factory test	5s	2500Vac	2500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac
Field test cut-off current settings		>2mA	>2mA	>6mA

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

18. Approved, Fulfilled or Tested Standards

IEC 61010	CB Report	CB Scheme Certificate IEC 61010-2-201 - Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 62368	CB Report	CB Scheme Certificate IEC 62368-1 - Audio/video, information and communication technology equipment - Safety requirements Output safety level: ES1
UL 61010	c UL us LISTED	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 - Electrical equipment for measurement, control and laboratory use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 61558-2-16 (Annex BB)	Safety Isolating Transformer	Test Certificate IEC 61558-2-16 - Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100V Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units
ISA-71.04-1985	Corrosion G3-ISA-71.04	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, which simulates a service life of at least 10 years
VDMA 24364	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and Test Class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

19. Regulatory Product Compliance

EU Declaration of Conformity	CE	The CE mark indicates conformance with the European – EMC directive – Low-voltage directive (LVD) – RoHS directive
KC	KC	KC Registration Korean registration of Broadcasting and Communication Equipment Registered under Clause 3, Article 58-2 of Radio Waves Act.
REACH Regulation	REACH ✓	Manufacturer's Declaration EU Regulation regarding the Registration, Evaluation, Authorization and Restriction of Chemicals EU Regulation 1907/2006
EAC TR Registration	EAC	EAC Certificate EAC EurAsian Conformity - Registration Russia, Kazakhstan and Belarus 8504408200, 8504409000

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

20. Physical Dimensions And Weight

Width	36mm / 1.42''
Height	90mm / 3.54''
Depth	91mm / 3.58'' The DIN rail height must be added to the unit depth to calculate the total required installation depth.
Weight	270g / 0.6lb
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	High-grade polycarbonate / ABS blend material
Installation clearances	See chapter 2.
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4.2mm.

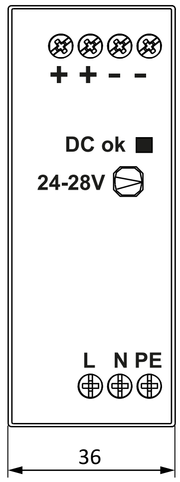


Fig. 20-1: Front view

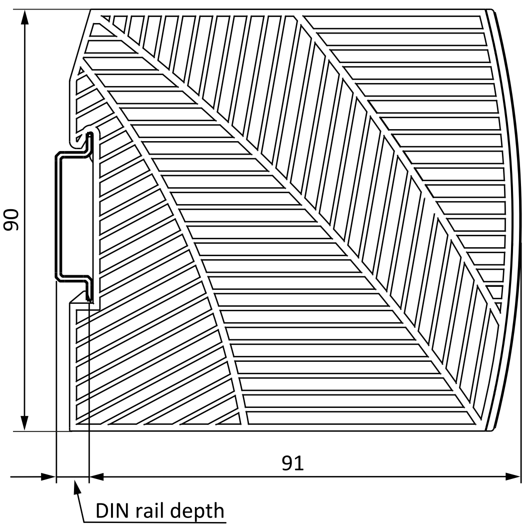


Fig. 20-2: Side view

All dimensions in mm unless otherwise noted.

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

21. Application Notes

21.1. CHARGING OF BATTERIES

Do not use the power supply to charge batteries.

21.2. SERIES OPERATION

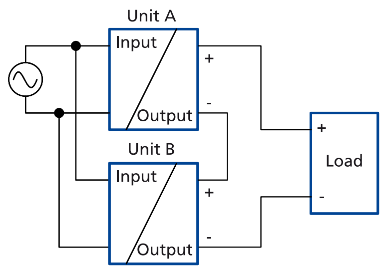
Power supplies of the same type can be connected in series for higher output voltages. It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc. Voltages with a potential above 60Vdc must be installed with a protection against touching.

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 power supplies.



21.3. PARALLEL USE TO INCREASE OUTPUT POWER

Do not use this devices in parallel to increase the output power.

21.4. PARALLEL USE FOR 1+1 REDUNDANCY

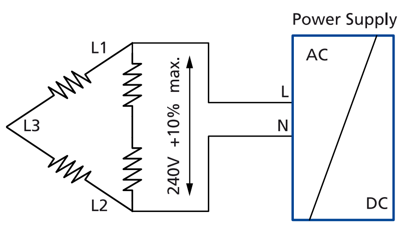
Devices can be paralleled for 1+1 redundancy to gain higher system availability. Redundant systems require a certain amount of extra power to support the load in case one device fails. The simplest way is to put two devices in parallel. This is called a 1+1 redundancy. In case one device fails, the other 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.

This device does not incorporate means to report a defective or non functional power supply. Since this is essential for redundant systems, chose a redundancy module which monitors and reports an insufficient input voltage or use a power supply, which has a DC-OK signal included.

21.5. TWO PHASE OPERATION

The power supply can also be operated 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.



All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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

	Case A	**Case B**
Enclosure size	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic	**110**x180x165mm Rittal Typ IP66 Box PK 9516 100 plastic
Input voltage	230Vac	230Vac
Load	24V, 3.04A; (=**80**%)	24V, 3.8A; (=**100**%)
Temperature inside the box	34.2°C	35.9°C
Temperature outside the box	24.9°C	25.2°C
Temperature rise	9.3K	10.7K

All parameters are specified at 24V, 3.8A, 230Vac, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.