



### POWER SUPPLY

- AC 100-240V Wide Range Input
- NEC Class 2 Compliant
- Adjustable Output Voltage
- Efficiency up to 89%
- Compact Design, Width only 45mm
- Full Output Power Between -10°C and +60°C
- DC-OK Signal Included
- Large International Approval Package
- DIN-Rail Bracket for Wall or Panel Mount Included
- 3 Year Warranty

## 1. GENERAL DESCRIPTION

A compact size, light weight, simple mounting on the DIN-rail and the quick connect spring-clamp terminals are what makes the MiniLine power supplies so easy to use and installs in seconds.

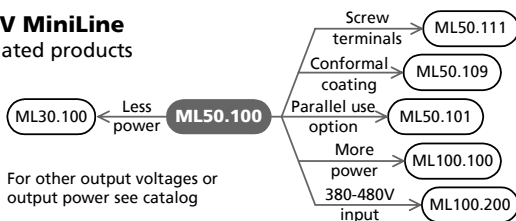
A rugged electrical and mechanical design as well as a high immunity against electrical disturbances on the mains provides reliable output power. This offers superior protection for equipment which is connected to the public mains network or is exposed to a critical industrial environment.

The MiniLine series offers output voltages from 5 to 56Vdc and a power rating of up to 100W. A DC-OK signal allows remote diagnostics.

The supplementary MiniLine decoupling diode module MLY02.100 allows building of redundant systems or to protect against back-feed voltages.

### 24V MiniLine

Related products



## 2. SHORT-FORM DATA

|                   |                   |   |
|-------------------|-------------------|---|
| Output voltage    | DC 24V            |   |
| Adjustment range  | 24-28V            |   |
| Output current    | 2.1-1.8A          | 24-28V  |
| Output power      | 50W               |   |
| Output ripple     | < 50mVpp          | 20Hz to 20MHz                                       |
| Input voltage     | AC 100-240V       | Wide Range Input                                    |
| Mains frequency   | 50-60Hz           | ±6%   |
| AC Input current  | typ. 0.77 / 0.44A | at 120 / 230Vac                                     |
| Power factor      | typ. 0.56 / 0.52  | at 120 / 230Vac                                     |
| AC Inrush current | 17 / 35A          | typ. peak value at 120 / 230Vac 40°C and cold start |
| DC Input          | 85-375Vdc         |   |
| Efficiency        | typ. 88.4 / 89.0% | at 120 / 230Vac                                     |
| Losses            | typ. 6.6 / 6.2W   | at 120 / 230Vac                                     |
| Temperature range | -10°C to +70°C    | operational   |
| Derating          | 1.3W/°C           | +60 to +70°C  |
| Hold-up time      | typ. 35 / 190ms   | at 120 / 230Vac                                     |
| Dimensions        | 45x75x91mm        | WxHxD   |

## 3. ORDER NUMBERS

|              |                 |                                |
|--------------|-----------------|--------------------------------|
| Power Supply | <b>ML50.100</b> | Standard unit                  |
|              | <b>ML50.109</b> | Conformal coated unit          |
| Accessory    | MLY02.100       | Decoupling / Redundancy module |

## 4. MARKINGS



Marine



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## INTENDED USE

The power supply shall only be installed and put into operation by qualified personnel.

This power supply is designed for installation in an enclosure and is intended for the general use, such as in industrial control, office, communication, and instrumentation equipment. Do not use this device in aircraft, trains and nuclear equipment, where malfunctioning of the power supply may cause severe personal injury or threaten human life.

## TERMINOLOGY AND ABBREVIATIONS

|  |   |
|--|---|
| <b>PE and <math>\oplus</math> symbol</b> | PE is the abbreviation for <b>Protective Earth</b> and has the same meaning as the symbol $\oplus$ .  |
| <b>Earth, Ground</b>                     | This document uses the term "earth" which is the same as the U.S. term "ground".  |
| <b>T.b.d.</b>                            | To be defined, value or description will follow later.  |
| <b>AC 230V</b>                           | A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually $\pm 15\%$ ) included.<br>E.g.: DC 12V describes a 12V battery regardless whether it is charged (13.7V) or discharged (10V). As long as not otherwise stated, AC 100V and AC 230V parameters are valid at 50Hz and AC 120V parameters are valid at 60Hz mains frequency. |
| <b>230Vac</b>                            | A figure with the unit (Vac) at the end is a momentary figure without any additional tolerances included.   |

## DISCLAIMER

The information presented in this document is believed to be accurate and reliable and may change without notice.  
The housing is patent by PULS (US patent No US D442,923S)

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### 5. AC-INPUT

|                   |      |                                     |   |
|-------------------|------|-------------------------------------|---|
| AC input          | nom. | AC 100-240V                         | Wide-range input, TN-, TT-, IT-Mains, see Fig. 5-1                                    |
| AC input range    |      | 85-264Vac<br>60-85Vac<br>264-300Vac | Continuous operation<br>Full power for 200ms, no damage between 0 and 85Vac<br>< 0.5s |
| Input frequency   | nom. | 50 – 60Hz                           | ±6%   |
| Turn-on voltage   | typ. | 65Vac                               | Steady-state value, see Fig. 5-1  |
| Shut-down voltage | typ. | 55Vac                               | Steady-state value, see Fig. 5-1  |

|                   |      | AC 100V | AC 120V | AC 230V |                              |
|-------------------|------|---------|---------|---------|------------------------------|
| Input current     | typ. | 0.91A   | 0.77A   | 0.47A   | at 24V, 2.1A see Fig. 5-3    |
| Power factor *)   | typ. | 0.58    | 0.56    | 0.52    | at 24V, 2.1A see Fig. 5-3    |
| Crest factor **)  | typ. | 3.05    | 3.26    | 3.91    | at 24V, 2.1A                 |
| Start-up delay    | typ. | 32ms    | 32ms    | 32ms    | See Fig. 5-2                 |
| Rise time         | typ. | 33ms    | 33ms    | 48ms    | 0mF, 24V, 2.1A, see Fig. 5-2 |
|                   | typ. | 45ms    | 45ms    | 60ms    | 2mF, 24V, 2.1A, see Fig. 5-2 |
| Turn-on overshoot | max. | 400mV   | 400mV   | 400mV   | See Fig. 5-2                 |

\*) 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. 5-1 Input voltage range

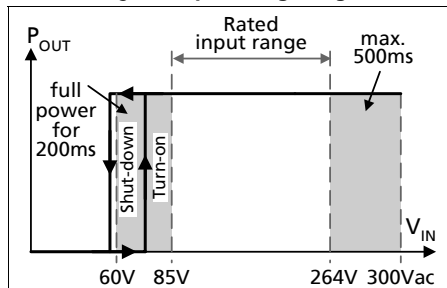


Fig. 5-2 Turn-on behavior, definitions

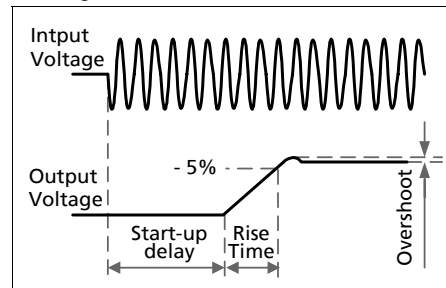


Fig. 5-3 Input current vs. output load

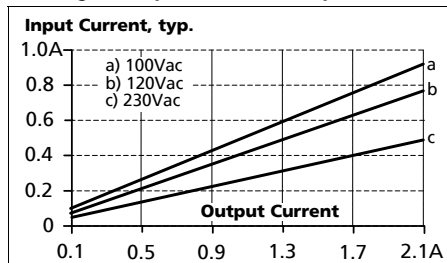
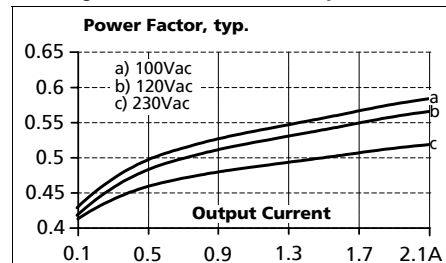


Fig. 5-4 Power Factor vs. output load

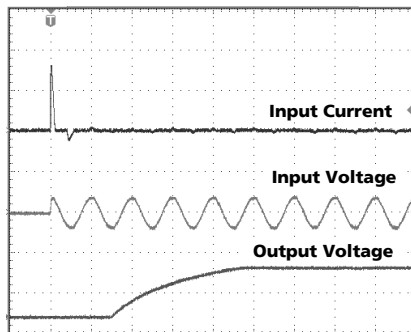


## 6. INPUT INRUSH CURRENT SURGE

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

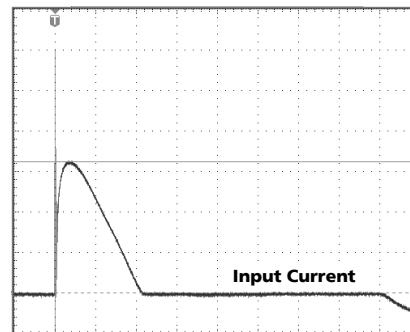
|                |      | AC 100V             | AC 120V             | AC 230V             |                          |
|----------------|------|---------------------|---------------------|---------------------|--------------------------|
| Inrush current | max. | 18A <sub>peak</sub> | 23A <sub>peak</sub> | 48A <sub>peak</sub> | 40°C ambient, cold start |
|                | typ. | 14A <sub>peak</sub> | 17A <sub>peak</sub> | 35A <sub>peak</sub> | 40°C ambient, cold start |
| Inrush energy  | typ. | 0.3A <sup>2</sup> s | 0.4A <sup>2</sup> s | 1.5A <sup>2</sup> s | 40°C ambient, cold start |

Fig. 6-1 Input inrush current, typical behavior



Input: 230Vac  
 Output: 24V, 2.1A  
 Ambient: 40°C  
 Upper curve: Input current 20A / DIV  
 Middle curve: Input voltage 1000V / DIV  
 Lower curve: Output voltage 20V / DIV  
 Time scale: 20ms / DIV

Fig. 6-2 Input inrush current, zoom into the first peak

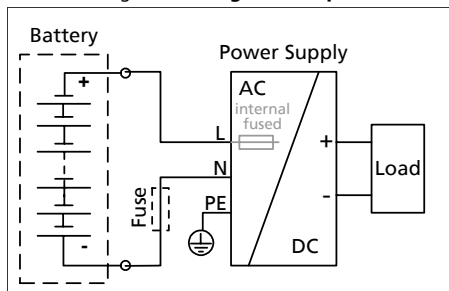


Input: 230Vac  
 Output: 24V, 2.1A  
 Ambient: 40°C  
 Input current curve: 10A / DIV, 1ms / DIV  
**I<sub>peak</sub> 32.4A**  
 The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

## 7. DC-INPUT

|                   |      |               |                                 |
|-------------------|------|---------------|---------------------------------|
| DC input          | nom. | DC 110-290V   | -25%/+30%                       |
| DC input range    | min. | 85-375Vdc     | Continuous operation            |
| DC input current  | typ. | 0.50A / 0.19A | 110Vdc / 300Vdc at 24V and 2.1A |
| Turn-on voltage   | typ. | 81Vdc         | Steady state value              |
| Shut-down voltage | typ. | 58Vdc         | Steady state value              |

Fig. 7-1 Wiring for DC Input



### Instructions for DC use:

- Use a battery or similar DC source.
- Connect +pole to L and – pole to N.
- Connect the PE terminal to a earth wire or to the machine ground.
- In case the – pole of the battery is not connected to earth, use an appropriate fuse to protect the N terminal.

## 8. HOLD-UP TIME

|              |      | AC 100V | AC 120V | AC 230V |                          |
|--------------|------|---------|---------|---------|--------------------------|
| Hold-up Time | typ. | 54ms    | 82ms    | 360ms   | 1.05A, 24V, see Fig. 8-1 |
|              | typ. | 26ms    | 40ms    | 180ms   | 2.1A, 24V, see Fig. 8-1  |

Fig. 8-1 Hold-up time vs. input voltage

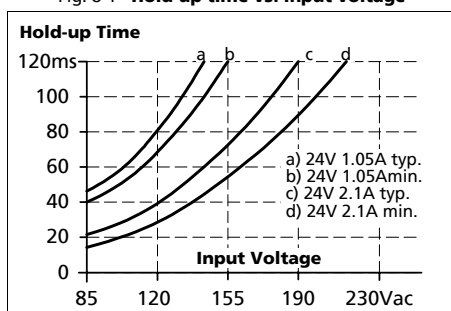
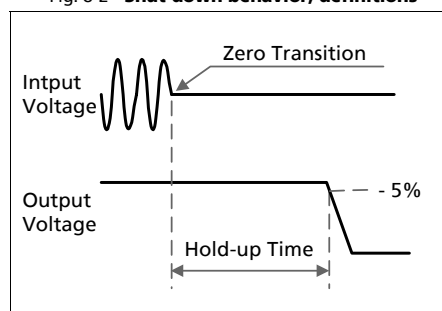


Fig. 8-2 Shut-down behavior, definitions



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

## 9. DC-OK OUTPUT

This feature monitors the output voltage, which is present on the output terminals.

The signal is a source output which can feed loads up to 30mA. Loads can be a 24V relay ( $R_{coil} < 700\Omega$ ), a LED or the input of a PLC system. The relays operates or the LED is on if output voltage exceeds the threshold level. A free-wheeling diode (necessary when the load is a relay) is already included in the power supply.

|                 |      |                           |  |
|-----------------|------|---------------------------|--|
| Threshold value |      | 20V +/-4%                 |  |
| Output current  | min. | 30mA                      | For typical values see Fig. 9-2  |
| Output voltage  | min  | $V_{out} - 1V$<br>at 30mA | The open collector is internally linked to the positive output pole. The DC-OK voltage is approximately the output voltage if the output voltage is higher than the threshold level. |

Fig. 9-1 DC-ok wiring diagram

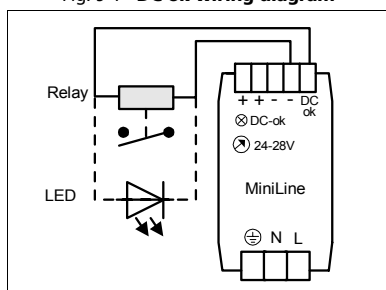
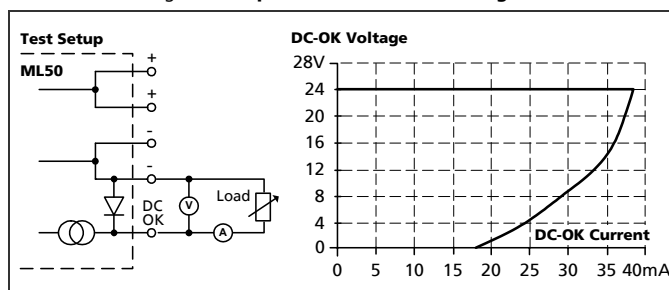


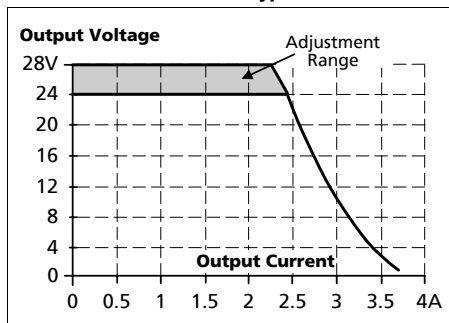
Fig. 9-2 Output characteristic DC-OK signal



### 10. OUTPUT

|                          |      |        |  |
|--------------------------|------|--------|--|
| Output voltage           | nom. | 24V    |  |
| Adjustment range         | min. | 24-28V | Guaranteed                                 |
|                          | max. | 30V    | At clockwise end position of potentiometer |
| Factory setting          |      | 24.5V  | ±0.2%, at full load, cold unit             |
| Line regulation          | max. | 10mV   | 85 to 264Vac                               |
| Load regulation          | max. | 100mV  | Static value, 0A → 2.1A → 0A               |
| Ripple and noise voltage | max. | 50mVpp | 20Hz to 20MHz, 50Ohm                       |
| Output capacitance       | typ. | 1600µF |  |
| Output current           | nom. | 2.1A   | At 24V, see Fig. 10-1                      |
|                          | nom. | 1.8A   | At 28V, see Fig. 10-1                      |
| Output power             | nom. | 50W    |  |
| Short-circuit current    | min. | 3.1A   | Load impedance 400mOhm, see Fig. 10-1      |
|                          | max. | 5A     | Load impedance 400mOhm, see Fig. 10-1      |

Fig. 10-1 Output voltage vs. output current, 230Vac, typ.



#### Peak current capability (up to several ms)

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

The extra current is supplied by the output capacitors inside the power supply. During this event, the capacitors will be discharged and cause a voltage dip on the output. Detailed curves can be found in chapter 27.1.

|                           |      |                   |                                  |
|---------------------------|------|-------------------|----------------------------------|
| Peak current voltage dips | typ. | from 24V to 16V   | at 4.2A for 50ms, resistive load |
|                           | typ. | from 24V to 15V   | at 10.5A for 2ms, resistive load |
|                           | typ. | from 24V to 10.5V | at 10.5A for 5ms, resistive load |

### 11. EFFICIENCY AND POWER LOSSES

|              |      | AC 100V | AC 120V | AC 230V |            |
|--------------|------|---------|---------|---------|------------|
| Efficiency   | typ. | 87.5%   | 88.4%   | 89.0%   | 2.1A, 24V  |
| Power losses | typ. | 0.6W    | 0.7W    | 1.3W    | 0A         |
|              | typ. | 4.0W    | 4.1W    | 4.4W    | 1.05A, 24V |
|              | typ. | 7.2W    | 6.6W    | 6.2W    | 2.1A, 24V  |

Fig. 11-1 Efficiency vs. output current at 24V

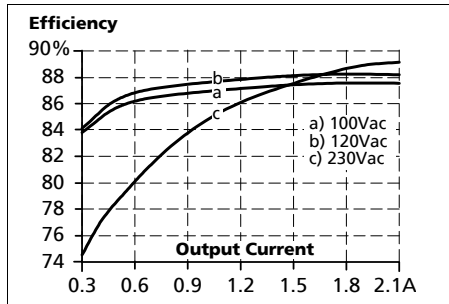


Fig. 11-2 Losses vs. output current at 24V

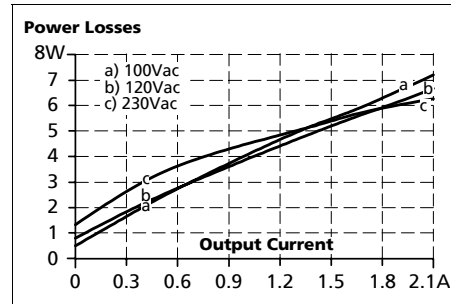


Fig. 11-3 Efficiency vs. input voltage, 24V, 2.1A

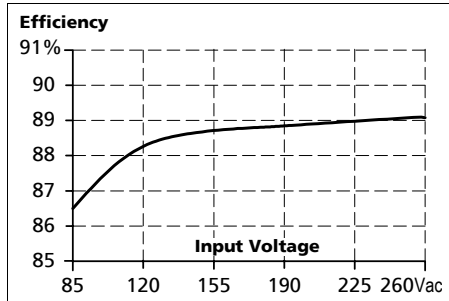
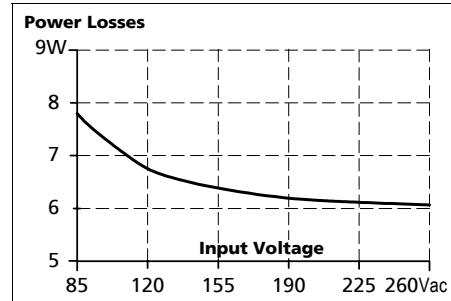
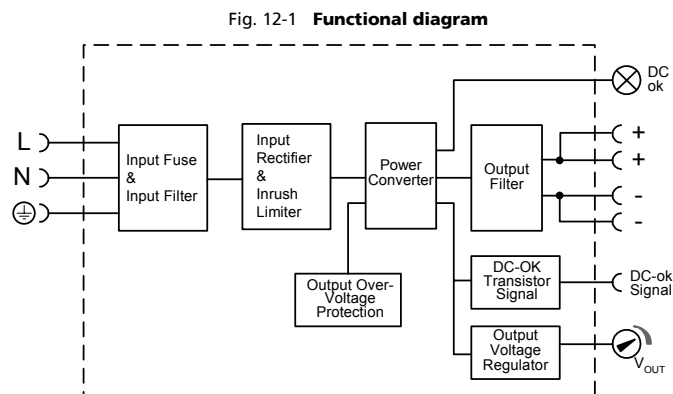


Fig. 11-4 Losses vs. input voltage, 24V, 2.1A



## 12. FUNCTIONAL DIAGRAM



## 13. RELIABILITY

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

|                          |      | AC 100V    | AC 120V    | AC 230V    |                                     |
|--------------------------|------|------------|------------|------------|-------------------------------------|
| Lifetime expectancy      | min. | 34 000h    | 44 000h    | 54 000h    | 40°C, 24V, 2.1A                     |
|                          | min. | 112 000h   | 117 000h   | 111 000h   | 40°C, 24V, 1.05A                    |
|                          | min. | 96 000h    | 125 000h   | 152 000h   | 25°C, 24V, 2.1A                     |
| MTBF SN 29500, IEC 61709 |      | 2 383 000h | 2 456 000h | 2 613 000h | 40°C, 24V, 2.1A                     |
|                          |      | 3 977 000h | 4 100 000h | 4 362 000h | 25°C, 24V, 2.1A                     |
| MTBF MIL HDBK 217F       |      | 1 021 000h | 1 053 000h | 1 120 000h | 40°C, 24V, 2.1A, Ground Benign GB40 |
|                          |      | 1 370 000h | 1 413 000h | 1 503 000h | 25°C, 24V, 2.1A, Ground Benign GB25 |

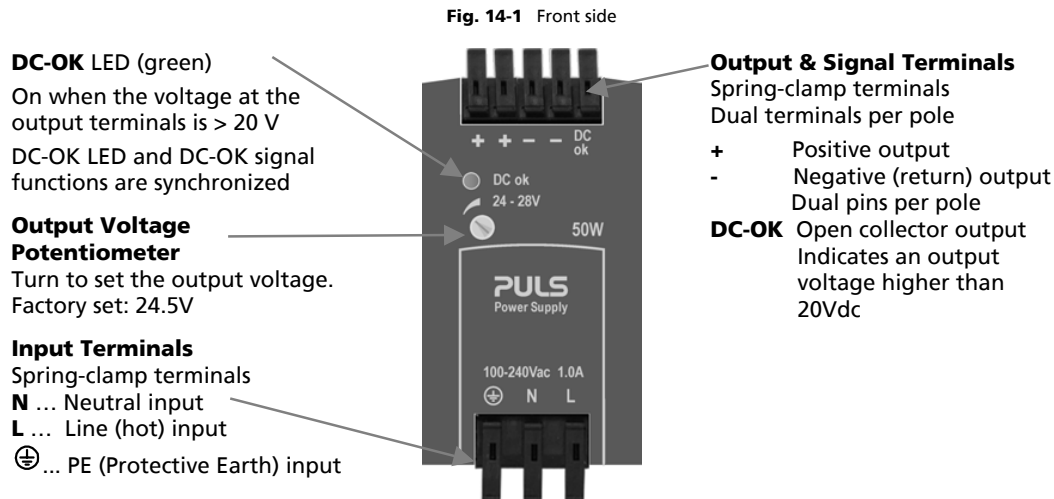
The **Lifetime expectancy** shown in the table indicates the operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors.

Lifetime expectancy is specified in operational hours. Lifetime expectancy is calculated according to the capacitor's manufacturer specification. The prediction model allows a calculation of up to 15 years from date of shipment.

**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.



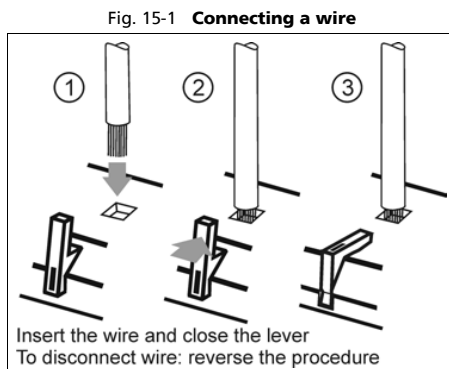
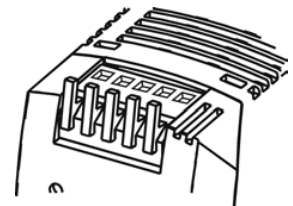
## 14. FRONT SIDE AND USER ELEMENTS



## 15. TERMINALS AND WIRING

All terminals are easy to access when mounted on the panel. Input and output terminals are separated from each other (input below, output above) to help in error-free wiring. Mounting and wiring do not require any screwdriver.

| Type                  | Quick-connect spring-clamp terminals                     |
|-----------------------|--|
| Solid wire            | 0.3-4mm <sup>2</sup>                                     |
| Stranded wire         | 0.3-2.5mm <sup>2</sup>                                   |
| American wire gauge   | 26-12 AWG  |
| Ferrules              | Allowed, but not required                                |
| Wire stripping length | 6mm / 0.25inch   |
| Pull-out force        | 12AWG:60N, 14AWG:50N, 16AWG:40N<br>(according to UL486E) |



### Instructions:

- Use appropriate copper cables
- Follow local and national installation codes and regulations!
- Ensure that all strands of a stranded wire enter the terminal connection!
- Do not use the unit without PE connection.

## 16. EMC

The CE mark indicates conformance with EMC guideline 89/336/EEC, 93/68/EEC and the low-voltage directive (LVD) 73/23/EWG. A detailed EMC Report is available on request.

| <b>EMC Immunity</b>      | EN 61000-6-2, EN 61000-6-1 |  | Generic standards   |  |
|--------------------------|----------------------------|--|---|--|
| Electrostatic discharge  | EN 61000-4-2               | Contact discharge<br>Air discharge   | 8kV<br>8kV  | Criterion A<br>Criterion A   |
| Electromagnetic RF field | EN 61000-4-3               | 80MHz-1GHz   | 10V/m   | Criterion A  |
| Fast transients (Burst)  | EN 61000-4-4               | Input lines<br>Output lines  | 4kV<br>2kV  | Criterion A<br>Criterion A   |
| Surge voltage on input   | EN 61000-4-5               | L → N<br>N / L → PE  | 2kV<br>4kV  | Criterion A<br>Criterion A   |
| Surge voltage on output  | EN 61000-4-5               | + → -<br>+ / - → PE  | 500V<br>500V  | Criterion A<br>Criterion A   |
| Conducted disturbance    | EN 61000-4-6               | 0,15-80MHz   | 10V   | Criterion A  |
| Mains voltage dips       | EN 61000-4-11              | 0% of 100Vac<br>40% of 100Vac<br>70% of 100Vac<br>0% of 200Vac<br>40% of 200Vac<br>70% of 200Vac | 0Vac, 20ms<br>40Vac, 200ms<br>70Vac, 500ms<br>0Vac, 20ms<br>80Vac, 200ms<br>140Vac, 500ms | Criterion A<br>Criterion C<br>Criterion A<br>Criterion A<br>Criterion A<br>Criterion A |
| Voltage interruptions    | EN 61000-4-11              |  | 0Vac, 5000ms  | Criterion C  |
| Input voltage swells     | PULS internal standard     |  | 300Vac, 500ms   | Criterion A  |
| Powerful transients      | VDE 0160                   | over entire load range   | 750V, 1.3ms   | Criterion A  |

### Criteria:

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

**C:** Temporary loss of function is possible. Power supply might shut-down and restarts by itself. No damages or hazards to the power supply will occur.

| <b>EMC Emission</b>           | EN 61000-6-3, EN 61000-6-4                                      |  | Generic standards                             |  |
|-------------------------------|---|--|---|--|
| Conducted emission            | EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22<br>EN 55022 |  | Class B, input lines<br>Class B, output lines |  |
| Radiated emission             | EN 55011, EN 55022  |  | Class B                                       |  |
| Harmonic input current        | EN 61000-3-2  |  | Fulfilled                                     |  |
| Voltage fluctuations, flicker | EN 61000-3-3  |  | Fulfilled                                     |  |

This device complies with FCC Part 15 rules.

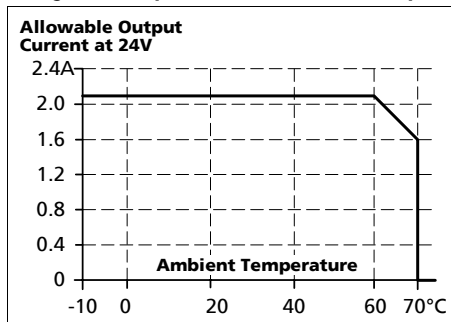
Operation is subjected to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

|                            |                                    |   |
|----------------------------|------------------------------------|---|
| <b>Switching frequency</b> | variable, typ. 100kHz, (60-275kHz) | Input voltage and output load dependent |
|----------------------------|------------------------------------|---|

## 17. ENVIRONMENT

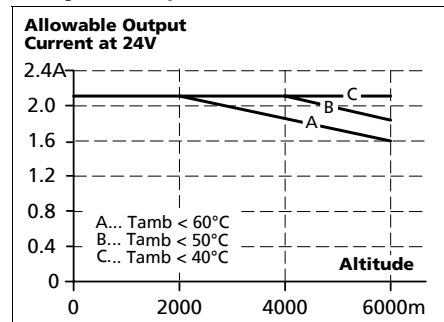
|                                 |   |   |
|---------------------------------|---|---|
| Operational temperature         | -10°C to +70°C (14°F to 158°F)                              | Reduce output power according to Fig. 17-1                        |
| Output de-rating                | 1.3W/°C   | 60-70°C (140°F to 158°F), see Fig. 17-1                           |
| Storage temperature             | -40 to +85°C (-40°F to 185°F)                               | Storage and transportation  |
| Humidity                        | 5 to 95% r.H.   | IEC 60068-2-30<br>Do not energize while condensation is present   |
| Vibration sinusoidal            | 2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g<br>2 hours / axis          | IEC 60068-2-6   |
| Shock                           | 20g 6ms, 10g 11ms<br>3 bumps / direction, 18 bumps in total | IEC 60068-2-27  |
| Altitude                        | 0 to 6000m (0 to 20000ft)                                   | Reduce output power or ambient temperature above 2000m sea level. |
| Output de-rating (for altitude) | 3W/1000m or 5°C/1000m                                       | Above 2000m (6500ft), see Fig. 17-2                               |
| Over-voltage category           | III   | EN 50178, IEC 62103 altitudes < 2000m                             |
|                                 | II  | Altitudes from 2000m to 6000m                                     |
| Degree of pollution             | 2   | EN 50178, IEC 62103, non conductive                               |

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



The ambient temperature is defined 2cm below the unit.

Fig. 17-2 Output current vs. altitude, 24V



## 18. PROTECTION FEATURES

|                                |   |  |
|--------------------------------|---|--|
| Output protection              | Electronically protected against overload, no-load and short-circuits |  |
| Output over-voltage protection | typ. 36V<br>max. 39V  | In case of an internal power supply fault, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart. |
| Output over-current protection | electronically limited  | see Fig. 10-1  |
| Degree of protection           | IP 20   | EN/IEC 60529   |
| Penetration protection         | > 2.5mm in diameter   | E.g. screws, small parts   |
| Over-temperature protection    | not included  |  |
| Input transient protection     | MOV   | Metal Oxide Varistor   |
| Internal input fuse            | T3.15A H.B.C.   | Not user replaceable   |

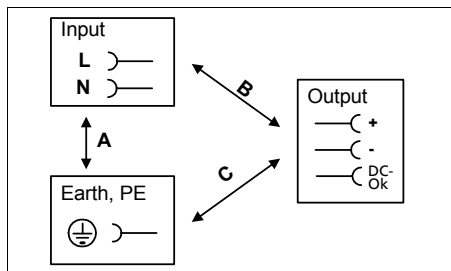
Note: In case of a over-voltage, overload, no-load or short-circuit event, an audible noise may be heard.

## 19. SAFETY

|                                 |   |  |
|---------------------------------|---|--|
| Input / output separation       | SELV<br>PELV<br>double or reinforced insulation                               | IEC/EN 60950-1<br>EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41  |
| Class of protection             | I   | PE (Protective Earth) connection required  |
| Isolation resistance            | > 5MΩ   | input to output, 500Vdc  |
| Touch current (leakage current) | typ. 0.12mA<br>typ. 0.17mA<br>typ. 0.29mA<br>< 0.16mA<br>< 0.23mA<br>< 0.40mA | 100Vac, 50Hz, TN mains<br>120Vac, 60Hz, TN mains<br>230Vac, 50Hz, TN mains<br>110Vac, 50Hz, TN mains<br>132Vac, 60Hz, TN mains<br>264Vac, 50Hz, TN mains |

## 20. DIELECTRIC STRENGTH

Fig. 20-1 Dielectric strength



|              |     | A       | B       | C      |
|--------------|-----|---------|---------|--------|
| Type test    | 60s | 2500Vac | 3000Vac | 500Vac |
| Factory test | 5s  | 2500Vac | 2500Vac | 500Vac |
| Field test   | 5s  | 2000Vac | 2000Vac | 500Vac |

### Type tests and factory tests:

Conducted by the manufacturer. Do not repeat test in field!







### Rules for field test:

Use appropriate test equipment which applies the voltage with a slow ramp! Connect L and N together as well as all output poles.

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

To fulfill the PELV requirements according to EN60204-1 § 6.4.1, it is recommended that either the + pole, the – pole or any other part of the output circuit should 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 an unnoticed earth faults occur.

## 21. APPROVALS

|   |   |  |
|---|---|--|
| IEC 60950-1   | <b>IECEE</b><br><b>CB SCHEME</b>  | CB Scheme,<br>Information Technology Equipment   |
| IEC 60601-1   | <b>IECEE</b><br><b>CB SCHEME</b>  | CB Scheme,<br>Medical, Basic Insulation  |
| UL 508  |    | LISTED as Industrial Control Equipment E198865   |
| UL2601  |    | LISTED as Medical  |
| UL 60950-1  |    | RECOGNIZED E137006 recognized for the use in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950). Information Technology Equipment, Level 3   |
| NEC Class 2   |   | Listed as Limited Power Source (LPS) in the UL 60950-1 UL report.  |
| UL 1604   |    | RECOGNIZED E246877 recognized for use in U.S.A. (UL 1604) and Canada (C22.2 No. 213-M1987) Hazardous Location Class I Div 2 T4 Groups A,B,C,D and Class I Zone 2 Groups IIA, IIB and IIC |
| <p>The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations as well as for Class I Zone 2 Groups IIA, IIB and IIC locations. Substitution of components may impair suitability for Class I Division 2 environment. Do not disconnect equipment unless power has been switched off. Wiring must be in accordance with Class I, Division 2 wiring methods of the National Electrical Code, NFPA 70, and in accordance with other local or national codes.</p> |   |  |
| Marine  |  | GL (Germanischer Lloyd) classified and ABS (American Bureau for Shipping) PDA for marine and offshore applications. Environmental category: C, EMC2                                      |
| SEMI F47  |  | SEMI F47-0200 Power Quality Star<br>Ride-through compliance for semiconductor industry.<br>Full SEMI range compliance (Input: 120Vac or 208Vac)  |

## 22. FULFILLED STANDARDS

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

## 23. USED SUBSTANCES

Electrolytic capacitors included in this unit do not use electrolytes such as Quaternary Ammonium Salt Systems.  
Plastic housings and other molded plastic materials are free of halogens, wires and cables are not PVC insulated.

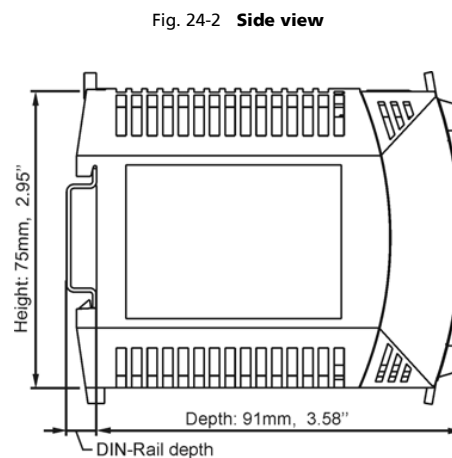
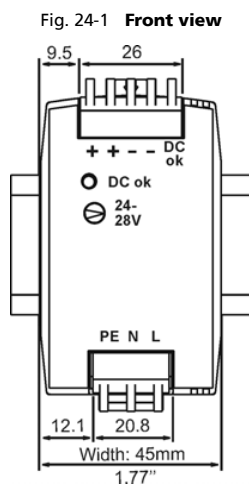
The unit conforms to the RoHS directive 2002/96/EC

The materials used in our production process do not include the following toxic chemicals:  
Polychlorinated Biphenyl (PCB), Pentachlorophenol (PCP), Polychlorinated naphthalene (PCN), Polybrominated Biphenyl (PBB), Polybrominated Biphenyl Oxide (PBO), Polybrominated Diphenyl Ether (PBDE), Polychlorinated Diphenyl Ether (PCDE), Polybrominated Diphenyl Oxide (PBDO), Cadmium, Asbestos, Mercury, Silica

## 24. PHYSICAL DIMENSIONS AND WEIGHT

|          |  |
|----------|--|
| Weight   | 240g / 0.53lb  |
| DIN-Rail | Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the depth (91mm) to calculate the total required installation depth. |

Electronic files with mechanical data can be downloaded at [www.pulspower.com](http://www.pulspower.com)



## 25. INSTALLATION AND OPERATION INSTRUCTIONS

### Mounting:

Output terminal must be located on top and input terminal on the bottom. For other orientations see chapter 27.12. An appropriate electrical and fire end-product enclosure should be considered in the end use application.

### Cooling:

Convection cooled, no forced cooling required. Do not cover ventilation grill (e.g. cable conduits) by more than 30%!

### Installation clearances:

25mm on top and bottom.

### Risk of electrical shock, fire, personal injury or death!

Do not use the unit without proper earth connection (Protective Earth).

Turn power off before working on the power supply. Protect against inadvertent re-powering.

Make sure the wiring is correct by following all local and national codes.

Do not open, modify or repair the unit.

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.

### Service parts:

The unit does not contain any service parts. The tripping of an internal fuse is caused by an internal fault. If damage or malfunctioning should occur during operation, immediately turn power off and send unit to the factory for inspection!

## 26. ACCESSORY

### DIN-Rail bracket for wall or panel mount

A DIN-rail bracket is included in each shipping box.

Fig. 26-1 DIN-Rail Bracket

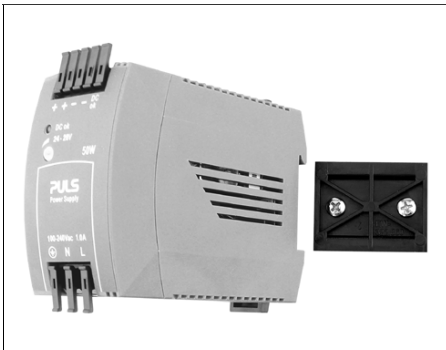
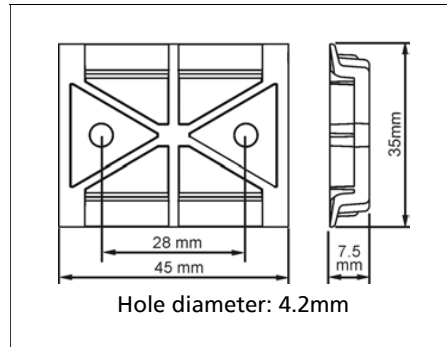


Fig. 26-2 DIN-Rail Bracket Dimensions



### MLY02.100 Dual decoupling module 2x5A

Fig. 26-3 MLY02.100 Dual Decoupling Module

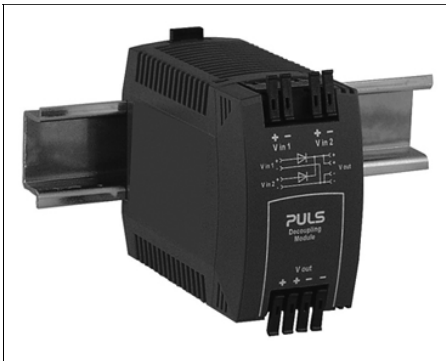
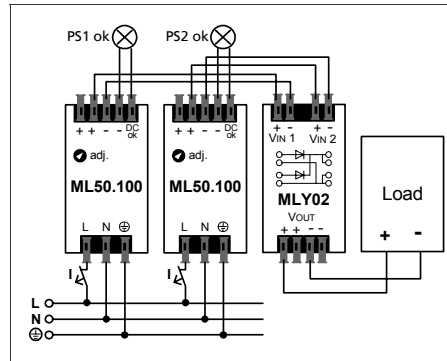


Fig. 26-4 Redundant System with Two ML50.100 and One MLY02.100



## 27. APPLICATION NOTES

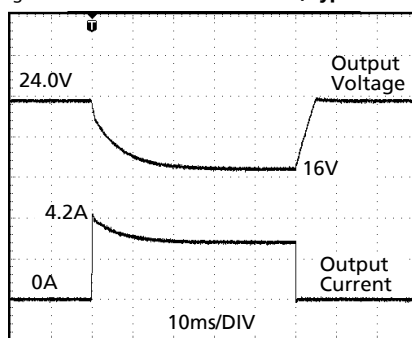
### 27.1. PEAK CURRENT CAPABILITY

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

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

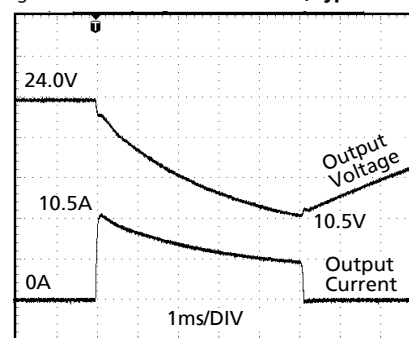
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the power supply can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 27-1 Peak load 4.2A for 50ms, typ.



Peak load 4.2A (resistive) for 50ms  
Output voltage dips from 24V to 16V.

Fig. 27-2 Peak load 10.5A for 5ms, typ.



Peak load 10.5A (resistive) for 5ms  
Output voltage dips from 24V to 10.5V.

### 27.2. BACK-FEEDING LOADS

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

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

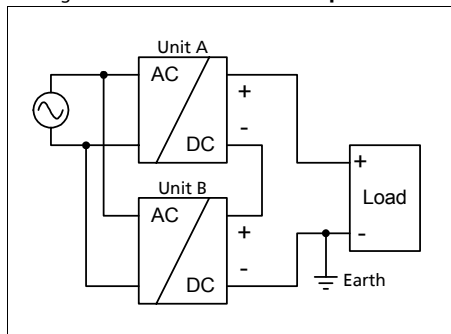
The maximum allowed feed back voltage is 35Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 10.



### 27.3. SERIES OPERATION

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

Fig. 27-3 Schematic for series operation



#### Instructions for use in series:

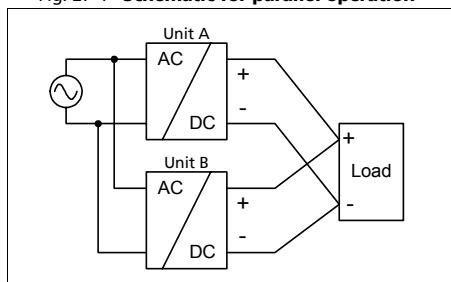
- It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc.
- Voltages with a potential above 60Vdc are not SELV any more and can be dangerous. Such voltages must be installed with a protection against touching.
- For serial operation use power supplies of the same type.
- Earthing of the output is required when the sum of the output voltage is above 60Vdc.

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

### 27.4. PARALLEL USE TO INCREASE OUTPUT POWER

Several power supplies can be paralleled to increase the output power. The ML50.100 has no feature included which balances the load current between the power supplies. Usually the power supply with the higher adjusted output voltage draws current until it goes into current limitation. This means no harm to this power supply as long as the ambient temperature stays below 50°C. If a current sharing feature is required, choose the ML50.101 or ML50.111.

Fig. 27-4 Schematic for parallel operation



#### Instructions for parallel use:

- Use only power supplies from the same series (ML-Series).
- Adjust the output voltages of all power supplies to approximately the same value ( $\pm 200\text{mV}$ ).
- A fuse (or diode) on the output is only required if more than three units are connected in parallel.
- Do not load terminals with more than 13A. Follow wiring instructions according to chapter 27.6
- Ensure that the ambient temperature of the power supply does not exceed 50°C.

### 27.5. PARALLEL USE FOR REDUNDANCY

Power supplies can be paralleled for redundancy to gain a higher system reliability. 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 MiniLine power supplies in parallel. This is called a 1+1 redundancy. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. Five power supplies, each rated for 2.1A are paralleled to build a 8A redundant system. If one unit fails, the 8A can still be drawn.

**Please note:** This simple way to build a redundant system has two major disadvantages:

- The faulty power supply can not be recognized. The green LED will still be on since it is reverse-powered from the other power supply.
- It does not cover failures such as an internal short circuit in the secondary side of the power supply. In such a situation the defective unit becomes a load for the other power supplies and the output voltage can not be maintained any more.

This above conditions can be avoided by utilizing decoupling diodes which are included in the decoupling module MLY02.100.

Other recommendations for building redundant power systems:

- a) Use separate input fuses for each power supply.
- b) Monitor the individual power supply units. A DC-ok output is included in the ML50.100, ML50.101 and ML50.111. In all other cases, use the redundancy module YRM2.DIODE which has a monitoring circuit for each input included.
- c) When possible, connect each power supply to different phases of the mains network.

## 27.6. DAISY CHAINING OF OUTPUTS

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

Fig. 27-5 Daisy chaining of outputs

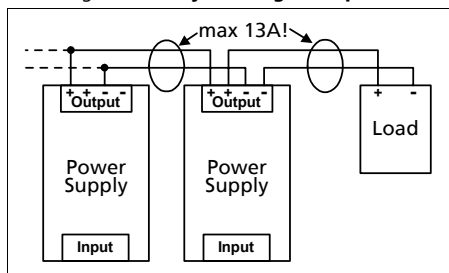
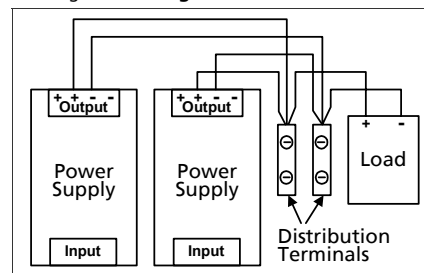


Fig. 27-6 Using distribution terminals



## 27.7. CHARGING OF BATTERIES

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

**Instructions for charging batteries:**

- a) Ensure that the ambient temperature of the power supply does not exceed 50°C.
- b) Set the output voltage on a disconnected load, very precisely to the end-of-charge voltage according to the expected battery temperature.

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

- c) Use a 4A or 6A circuit breaker (or blocking diode) between the power supply and the battery.
- d) Ensure that the output current of the power supply is below the allowed charging current of the battery.
- e) Use only matched batteries when putting 12V types in series.
- f) The return current to the power supply is typ. 10.7mA at 25Vdc when the power supply is switched off (except in case a blocking diode is utilized).

### 27.8. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 15A (UL) or 16A (IEC). External protection is only required if the supplying branch has an ampacity greater than this. In some countries local regulations might apply so check local codes and requirements.

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

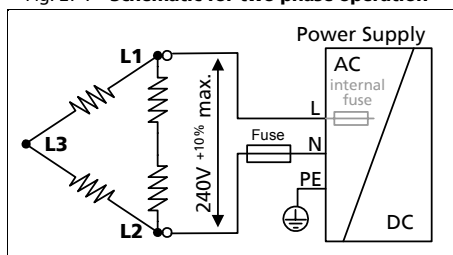
|          | B-Characteristic         | C-Characteristic    |
|----------|--------------------------|---------------------|
| Ampacity | max. 15A (UL), 16A (IEC) | 15A (UL), 16A (IEC) |
|          | min. 10A                 | 6A                  |

### 27.9. INDUCTIVE AND CAPACITIVE LOADS

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

### 27.10. OPERATION ON TWO PHASES

Fig. 27-7 Schematic for two phase operation



#### Instructions for two phase operation:

- A phase to phase connection is allowed as long as the supplying voltage is below 240V<sup>+10%</sup>.
- Use a fuse or a circuit breaker to protect the N input. The N input is internally not protected and is in this case connected to a hot wire.

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

### 27.11. USE IN A TIGHTLY SEALED ENCLOSURE

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

Results from such an installation:

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

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

|                              |   |
|------------------------------|---|
| Load:                        | 24V, <u>2.1A</u> ; load is placed outside the box                                   |
| Temperature inside the box:  | 40.8°C (in the middle of the right side of the power supply with a distance of 1cm) |
| Temperature outside the box: | 21.9°C  |
| Temperature rise:            | 18.9K   |
| Load:                        | 24V, <u>1.7A</u> ; (=80%) load is placed outside the box                            |
| Temperature inside the box:  | 38.7°C (in the middle of the right side of the power supply with a distance of 1cm) |
| Temperature outside the box: | 21.7°C  |
| Temperature rise:            | 17.0K   |

### 27.12. MOUNTING ORIENTATIONS

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

**Curve A1** Recommended output power.

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

Fig. 27-8

**Mounting Orientation A**  
Standard Orientation

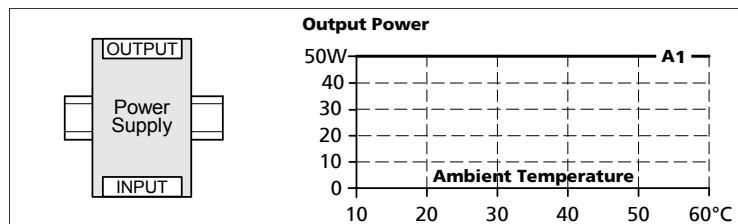


Fig. 27-9

**Mounting Orientation B**  
(Upside down)

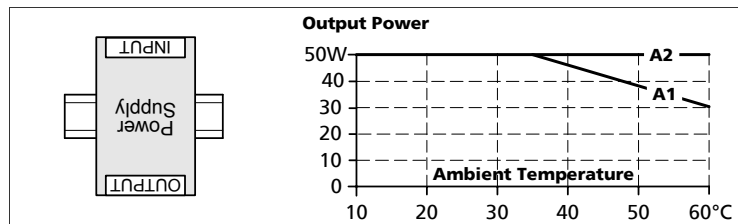


Fig. 27-10

**Mounting Orientation C**  
(Table-top mounting)

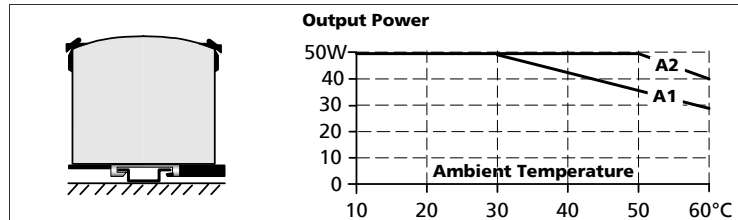


Fig. 27-11

**Mounting Orientation D**  
(Horizontal cw)

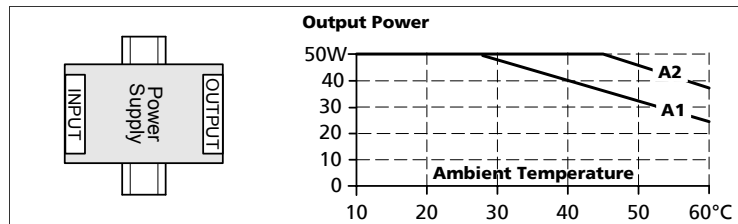


Fig. 27-12

**Mounting Orientation E**  
(Horizontal ccw)

