

Features

Rugged 35 mm DIN-rail snap-fit design
Class I equipment
Single or double-outputs for 24, 36, or 48 V

- RoHS lead-solder-exemption compliant
- Universal AC-input with single stage conversion AC to DC with PFC, DC input of 66 to 350 V
- Power factor >0.93, harmonics IEC/EN 61000-3-2
- Virtually no inrush current
- Immunity to IEC/EN 61000-4-2, -3, -4, -5, -6, -11
- Emissions according to EN 55011/022
- Very high efficiency; up to 89%
- Short-term output peak power capability, rectangular current limiting characteristic
- Independently regulated outputs
- Outputs: no load, overload, and short-circuit proof
- Ambient operating temperature –40 to 70 °C
- PCBs protected by lacquer
- Very high reliability

Safety according to IEC/EN/UL60950, IEC/EN 50178, IEC 61010-1, UL 508, EN 50155



Description

The Convert Select front end series represents a family of DIN-rail mountable DC-DC and AC-DC converters with power factor correction. The converters have been designed according to the latest industry requirements and standards. The converters are ideal for use in outdoor and other demanding applications to power building control systems, factory automation, industrial controls, instrumentation, electromagnetic drives, fans, and other DC loads. Models are available with single or independently regulated, electrically isolated double outputs for 24, 36, or 48 V loads. Special models for battery charging are available. EW models are particularly suitable for 110 V railway applications.

Key features of the Convert Select line include: power factor correction with low harmonic distortion, negligibly low inrush current, high immunity to transients and surges and low electromagnetic emissions. Internal protection circuits such as input over- and undervoltage lockout, thermal protection, as well as output overvoltage

protection by a second control loop ensure safe operation of the final system.

The outputs deliver an electrically-isolated Safety Extra Low Voltage, SELV, (except models LWR/LWN1740) and low output noise. They are no-load, overload, and short-circuit proof. The electronically controlled short-term peak power capability of up to 150% of the rated output power enables the front end converters to deliver additional power to start-up motors or to safely operate subsequent circuit breakers. Built-in large sized output capacitors absorb possible reverse energy, which may be caused by quick deceleration of electromagnetic drives connected directly to the output. A green LED at the front displays the status of the output(s).

The Convert Select series was designed according to all relevant international safety standards. The converters are approved by TÜV, UL, cUL, and are UL 508 listed. Adequate clearances and creepage distances allow operation in pollution degree 3 environments. All board

Table of Contents

| Table of Contents | Page | Page | |
|---|------|--|----|
| Description | 1 | Immunity to Environmental Conditions | 15 |
| Model Selection | 2 | Mechanical Data | 16 |
| Part Number Description and Product Marking | 3 | Safety and Installation Instruction | 17 |
| Functional Description | 4 | Description of Options | 20 |
| Electrical Input Data | 6 | Accessories | 23 |
| Electrical Output Data | 8 | EC Declaration of Conformity | 24 |
| Electromagnetic Compatibility (EMC) | 13 | EC Declaration of Conformity, Option E | 25 |

assemblies are coated with a protective lacquer.

The thermal concept allows operation at full load up to an ambient temperature of 60 °C (LW models) or 70 °C (EW models) in free air without forced cooling. A rugged DIN snap-fit device allows easy and reliable fixing onto the various 35 mm DIN rail models. The converters are fitted with cage clamp terminals easily accessible from the

front. System connectors with screw terminals for use with pre-assembled harnesses, external adjustment of the output voltage as well as various auxiliary functions are available as options.

The letter E stands for improved EMC performance of LW models.

Model Selection

Table 1: Standard models

| Output 1 | | Output 2 | | Output Power | Operating Input Voltage | Type Designation ⁶ | Options ^{3, 5} |
|-------------------------------|---------------------------|-------------------------------|---------------------------|--------------------------|--|-------------------------------|--------------------------------------|
| $V_{o1\text{nom}}^1$ [VDC] | $I_{o1\text{nom}}$ [A] | $V_{o2\text{nom}}^1$ [VDC] | $I_{o2\text{nom}}$ [A] | $P_{o\text{nom}}$ [W] | $V_{i\text{min}} - V_{i\text{max}}$ | | |
| 24.7 | 5 | - | - | 125 | 85 ² – 264 VAC, 47 – 63 Hz ⁴ , 90 – 350 VDC ⁷ | LWR1601-6E | R D1, D2, D5 M1, M2 F K2 |
| 24.7 | 10 | - | - | 250 | | LWN1601-6E | |
| 37 | 3.3 | - | - | 125 | | LWR1701-6E ³ | |
| 37 | 6.6 | - | - | 250 | | LWN1701-6E ³ | |
| 49.4 | 2.5 | - | - | 125 | | LWR1801-6E | |
| 49.4 | 5 | - | - | 250 | | LWN1801-6E | |
| 24.7 | 5 | 24.7 | 5 | 250 | | LWN2660-6E | |
| 37 | 3.3 | 37 | 3.3 | 250 | | LWN2770-6E ³ | |
| 49.4 | 2.5 | 49.4 | 2.5 | 250 | | LWN2880-6E | |
| 24 | 5 | - | - | 120 | | 66 – 150 VDC | |
| 24 | 5 | 24 | 5 | 240 | EWN2660-0 ⁸ | | |

¹ R-input not connected.

² For derating at low input voltage see section *Output Power Derating*.

³ For minimum quantity and lead times contact Power-One.

⁴ For operating frequency <47 Hz or >63 Hz contact Power-One. The converters have been tested up to 440 Hz.

⁵ On double output models the options R, M2, D1, D2, D5 are related to the second output.

⁶ Improved EMC performance for LWN/LWR models. Former models without E are still available on request.

⁷ $V_i \leq 250$ VDC for models with option F

⁸ EWN and EWR models are designed for railway applications according to EN 50155.

Table 2: Battery charger versions (M1 included)

| Output Volt. Range | Nominal Output Values | | Output Power | Operating Input Voltage | Type Designation ⁶ | Options ³ |
|--------------------------|------------------------------|----------------------------|----------------------------|--|-------------------------------|----------------------|
| V_o [VDC] | $V_{o\text{nom}}^5$ [VDC] | $I_{o\text{nom}}^5$ [A] | $P_{o\text{nom}}^5$ [W] | $V_{i\text{min}} - V_{i\text{max}}$ | | |
| 12.8 ¹ - 16.1 | 13.8 | 10 | 140 | 85 ² – 264 VAC, 47 – 63 Hz ⁴ , 90 – 350 VDC ⁷ | LWN1140-6EM1 ³ | F K2 |
| 25.7 ¹ - 29.3 | 27.3 | 4.2 | 115 | | LWR1240-6EM1 | |
| 25.7 ¹ - 29.3 | 27.3 | 8.45 | 230 | | LWN1240-6EM1 | |
| 51.4 ¹ - 58.6 | 54.5 | 2.1 | 115 | | LWR1740-6EM1 | |
| 51.4 ¹ - 58.6 | 54.5 | 4.2 | 230 | | LWN1740-6EM1 | |

¹ With open R-input the converter delivers the low range output voltage, e.g. 25.7 V for a 24 V battery charger.

² For derating at low input voltage see section *Output Power Derating*.

³ For minimum quantity and lead times consult Power-One. The converters have been tested up to 440 Hz.

⁴ For continuous operating frequency <47 Hz or >63 Hz contact Power-One.

⁵ Nominal output power calculated with a cell voltage of 2.27 V/cell at 20 °C.

⁶ Improved EMC performance. Former models without E are still available on request.

⁷ $V_i \leq 250$ VDC for models with option F.

Part Number Description

| | | L | W | N | 2 | 660 | -6 | E | R | D2 | M2 | F | K2 |
|--|------------|-------|---|---|---|-----|----|---|---|----|----|---|----|
| Input voltage range | E, L | _____ | | | | | | | | | | | |
| Series | W | _____ | | | | | | | | | | | |
| Nominal output power | | _____ | | | | | | | | | | | |
| 125 W | R | _____ | | | | | | | | | | | |
| 250 W | N | _____ | | | | | | | | | | | |
| Number of outputs | 1, 2 | _____ | | | | | | | | | | | |
| Type specification | 000 – 999 | _____ | | | | | | | | | | | |
| Operational ambient temperature range T_A | | _____ | | | | | | | | | | | |
| -40 to 60 °C | -6 | _____ | | | | | | | | | | | |
| EW or customer-specific | -0, -5 | _____ | | | | | | | | | | | |
| Improved EMC performance | E | _____ | | | | | | | | | | | |
| Options | | _____ | | | | | | | | | | | |
| Output voltage control input | R | _____ | | | | | | | | | | | |
| Save data signal | D1, D2, D5 | _____ | | | | | | | | | | | |
| Multiple functions via D-SUB connector | M1, M2 | _____ | | | | | | | | | | | |
| Built-in second fuse, input diode | F, Q | _____ | | | | | | | | | | | |
| System connector | K2 | _____ | | | | | | | | | | | |

Example: LWN2660-6ER: Power factor corrected AC-DC converter, operating input voltage range 85 – 264 VAC, 2 electrically isolated and individually regulated outputs, each providing 24.7 V, 5 A. R-input for adjustment of the second output voltage, improved EMC performance.

Product Marking

Basic type designation, applicable safety approval and recognition marks, CE mark, waste symbol, warnings, pin designation, Power-One company logo.

Specific type designation, input voltage range, nominal output voltages and currents, degree of protection, batch no., serial no. and data code including production site, modification status, and date of production.

Functional Description

The W series converters are primary controlled AC-DC or DC-DC flyback converters with a constant switching frequency of 130 kHz. The power-factor-corrected single-step conversion of the input voltage to a low output voltage results in extremely high efficiency. Depending upon the output power, the converters are fitted with one (125 W) or two (250 W) power trains. Models with two powertrains have one or two outputs.

The input voltage is fed via fuse, filter, and rectifier to the main transformer, designed in planar technique. The input filter with very small input capacitance generates virtually no inrush current. An input transient suppressor protects the unit against high voltage peaks and surges. Input over- and undervoltage lockout as well as input current limitation protect the unit from operation outside of its specification. The input voltage waveform is sensed by the primary control logic to allow active power factor correction, forcing the input current to follow the input voltage waveform.

The secondary side of the main transformer feeds via the rectifier diode into a large electrolytic output storage

capacitor providing for the hold-up time. Both, output voltage and output current, are measured and fed back to the primary control logic via an opto-coupler. A second control loop monitors the output voltage. It disables the output in case of a failure in the control logic and limits the output voltage.

Built-in temperature sensors monitor the internal temperature. If the temperature exceeds the limit, the converter reduces the output power until the internal temperature has returned below the threshold value. A green LED on the front cover confirms the presence of the output voltage(s).

The R input (option) allows for external adjustment of the output voltage by means of a resistor or an external voltage source. An external sensor can be connected to the R input and allows for temperature-controlled battery charging (see: *Accessories*). Further options are AC Fail and various Out OK signals.

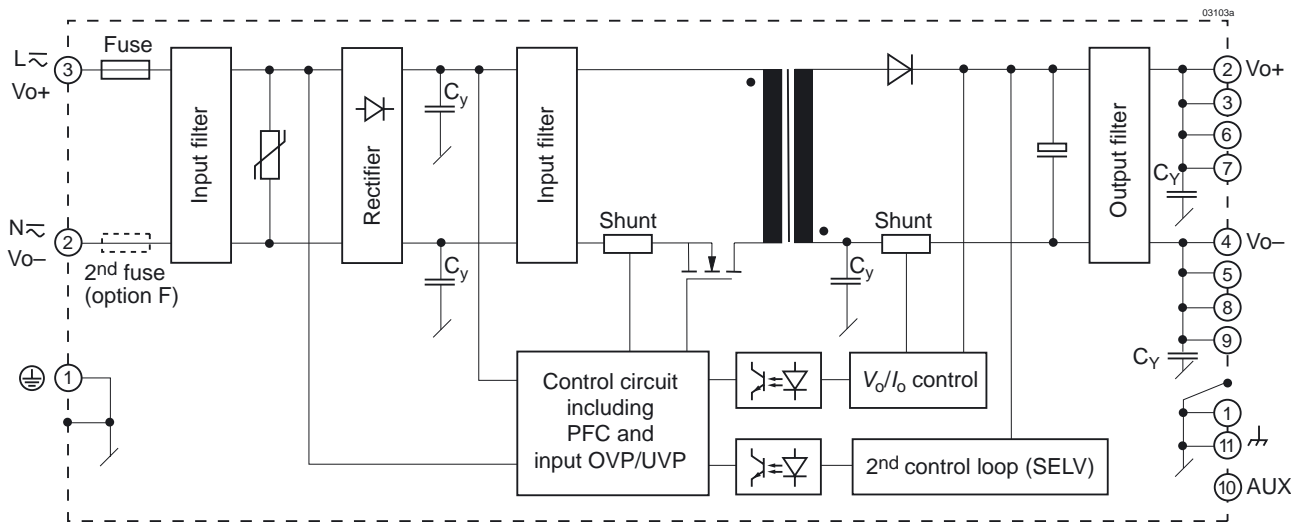


Fig. 1
LWR 125 W and LWN 250 W single-output converters.
EWR and EWN models have a link (standard) or a
decoupling diode (option Q) rather than a bridge rectifier.

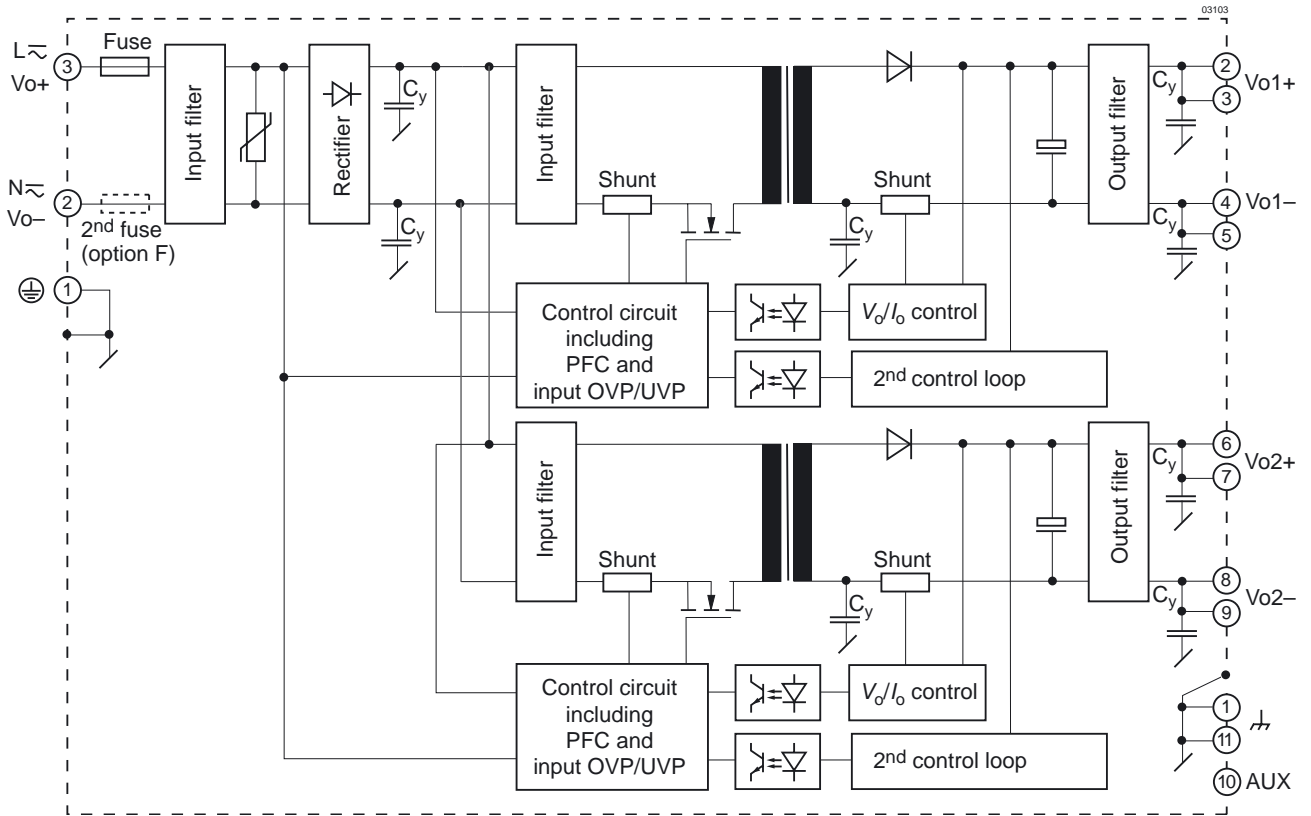


Fig. 2
LWN 250 W double-output converters.
EWN models have a link (standard) or a decoupling diode (option Q) rather than a bridge rectifier.
Pinout of 250 W single-output models: see fig. 1.

Electrical Input Data

General condition:

$T_A = 25\text{ }^\circ\text{C}$, unless T_C is specified.

Table 3a: Input Data LW models

| Input | | | LWR | | | LWN | | | Unit | | | | | | |
|-----------------------|------------------------------------|--|-------------------|-------|----------|-------------------|-----|------------------|-------------------|-------|-----|-------------------|--|------------------|---------------|
| | | | AC-Input | | DC-Input | AC-Input | | DC-Input | | | | | | | |
| Characteristic | Conditions | | min | typ | max | min | typ | max | min | typ | max | | | | |
| V_i | Operating input voltage range | $I_o = 0 - I_{o\text{ nom}}$ T_C to $T_{C\text{ max}}$ | 85 ² | | 264 | 90 ² | | 350 ⁴ | 85 ² | | 264 | 90 ² | | 350 ⁴ | V |
| $V_{i\text{ nom}}$ | Rated input volt. range | | 100 | (230) | 240 | 220 | | | 100 | (230) | 240 | 220 | | | |
| f_i | Rated input frequency ¹ | | 50 – 60 | | | -- | | | 50 – 60 | | | -- | | | Hz |
| I_i | Input current | $I_{o\text{ nom}}, V_i = V_{i\text{ nom}}$ $I_{o\text{ nom}}, V_i = V_{i\text{ min}}$ | 0.63 1.75 | | | 0.65 1.67 | | | 1.25 3.5 | | | 1.3 3.3 | | | A |
| P_{i0} | No-load input power | $V_{i\text{ min}} - V_{i\text{ max}}$ | 1.2 | | | 0.9 | | | 1.3 | | | 1 | | | W |
| $I_{i\text{ inrush}}$ | Inrush current | $V_{i\text{ max}}, t > 0.1\text{ ms}$ | 3 | | | 3 | | | 5 | | | 5 | | | A |
| C_i | Input capacitance | | 5 | | | 5 | | | 6 | | | 6 | | | μF |
| PF | Power factor | $V_{i\text{ nom}} = 230\text{ V}, I_{o\text{ nom}}$ | 0.9 | 0.92 | | -- | | | 0.91 | 0.94 | | -- | | | |
| $V_{i\text{ RFI}}$ | Conducted input RFI | EN 55011/55022 $V_{i\text{ nom}}, I_{o\text{ nom}}$ | A, B ³ | | | A, B ³ | | | A, B ³ | | | A, B ³ | | | |
| | Radiated input RFI | | B ³ | | | B ³ | | | B ³ | | | B ³ | | | |
| f_{switch} | Switching frequency | | 130 | | | 130 | | | 130 | | | 130 | | | kHz |

¹ For operating frequencies <47 Hz and >63 Hz contact Power-One. The converters have been tested up to 440 Hz.

² Output power derating at low input voltage and/or high case temperature T_C (see: *Output power derating*).

³ Only valid for models with Option E (type test with LWN1801-6E)

⁴ $V_i \leq 250\text{ VDC}$ for models with option F.

Table 3b: Input Data EW models

| Input | | | EWR | | | EWN | | | Unit |
|-----------------------|-------------------------------|---|-------------|-----|------------------|------------|-----|------------------|---------------|
| | | | DC-Input | | | DC-Input | | | |
| Characteristic | Conditions | | min | typ | max | min | typ | max | |
| V_i | Operating input voltage range | $I_o = 0 - I_{o\text{ nom}}$ T_C to $T_{C\text{ max}}$ | 66 | | 150 ¹ | 66 | | 150 ¹ | V |
| $V_{i\text{ nom}}$ | Nominal input voltage | | 110 | | | 110 | | | |
| V_{UVT} | Undervoltage trigger | | 54 | | 60 | 54 | | 60 | |
| I_i | Input current | $I_{o\text{ nom}}, V_i = V_{i\text{ nom}}$ $I_{o\text{ nom}}, V_i = 66\text{ V}$ | 1.25 2.2 | | | 2.5 4.4 | | | A |
| P_{i0} | No-load input power | $V_{i\text{ min}} - V_{i\text{ max}}$ | 0.8 | | | 1.3 | | | W |
| $I_{i\text{ inrush}}$ | Inrush current | $V_{i\text{ max}}, t > 0.1\text{ ms}$ | 12 | | | 6 | | | A |
| C_i | Input capacitance | | 2.5 | | | 4.5 | | | μF |
| $V_{i\text{ RFI}}$ | Conducted input RFI | EN 55011/55022 $V_{i\text{ nom}}, I_{o\text{ nom}}$ | A | | | A | | | |
| | Radiated input RFI | | -- | | | -- | | | |
| f_{switch} | Switching frequency | | 130 | | | 130 | | | kHz |

¹ $V_i \leq 168\text{ VDC}$ for 3 s. Overvoltage trigger adjusted to 170 – 182 V.

Output Power Derating

The output power of LW models must be derated at low input voltage and/or powertrain temperature above 125 °C.

The powertrain temperature depends on the output power, the input voltage, and the cooling method. At low input voltage the losses increase. At the maximum specified environment temperature T_A free air convection cooling might be insufficient approaching maximum ambient conditions. As a result, the output power has to be reduced

according to the tables below:

Note: The measurements have been made by the approval boards with free air convection cooling according to UL 60950 (IEC/EN 60950-1) specified ambient temperature T_A and with the converter built in a cardboard box according to UL 508 and a specified temperature outside the box T_{out} . The tables give a correlation between T_A or T_{out} and the case temperature T_C (measuring point T_C see: *Mechanical Data*). For models not specified, please contact Power-One.

EW models have no derating.

Table 4: P_o derating according to UL 60950 at $T_A = 60\text{ °C}$, or according to UL 508 at $T_{out} = 50\text{ °C}$

| Model | $P_{o\text{ nom}}$ [W] | $T_{C\text{ max}}$ [°C] | Derate below | | derate by [W/V] |
|-----------|---------------------------|----------------------------|--------------|-------------|--------------------|
| | | | V_i [VAC] | V_i [VDC] | |
| LWR1601-6 | 125 | 80 | 108 | 98 | -0.67 |
| LWR1801-6 | 125 | 80 | 98 | 93 | -0.67 |
| LWN1601-6 | 250 | 89 | 125 | 115 | -1.25 |
| LWN1801-6 | 250 | 89 | 125 | 115 | -1.25 |
| LWN2660-6 | 250 | 89 | 125 | 115 | -1.25 |
| LWN2880-6 | 250 | 89 | 125 | 115 | -1.25 |

Table 5: P_o derating according to UL 60950 at $T_A = 50\text{ °C}$, or according to UL 508 at $T_{out} = 40\text{ °C}$

| Model | $P_{o\text{ nom}}$ [W] | $T_{C\text{ max}}$ [°C] | Derate below | | derate by [W/V] |
|-----------|---------------------------|----------------------------|--------------|-------------|--------------------|
| | | | V_i [VAC] | V_i [VDC] | |
| LWR1601-6 | 125 | 76 | 98 | no derating | -0.67 |
| LWR1801-6 | 125 | 76 | 93 | no derating | -0.67 |
| LWN1601-6 | 250 | 86 | 115 | 105 | -1.25 |
| LWN1801-6 | 250 | 86 | 105 | 95 | -1.25 |
| LWN2660-6 | 250 | 86 | 115 | 105 | -1.25 |
| LWN2880-6 | 250 | 86 | 105 | 95 | -1.25 |

Input Fuse

A slow blow fuse (T6.3A, 5 × 20 mm), protected by a sleeve, is connected in the line input. EW models have a smaller fuse (250 V, 4 × 9 mm, SOC NT3 6.3A V009, UL-recognized E-39265). For DC input voltage above 250 V observe the *Installation Instruction*.

Converters with option F have 2 small fuses, one in each input line. Converters with option E and F have 2 large fuses (T6.3A, 5 × 20 mm). The DC input voltage for all converters with option F is limited to 250 V.

Input Under- and Overvoltage Lockout

Below $V_{i\text{ min}}$ and beyond $V_{i\text{ max}}$, an internally generated inhibit signal disables the output(s).

Reverse Polarity Protection

The built-in bridge rectifier provides reverse polarity protection at the input if operated from DC.

EW models are protected by the (blowing) input fuse in connection with the body diode of the main transistor. Option Q offers a serial diode, but this affects efficiency by approx. 1%.

Input Transient Protection

A VDR and a symmetrical input filter form an effective protection against input transients.

Efficiency

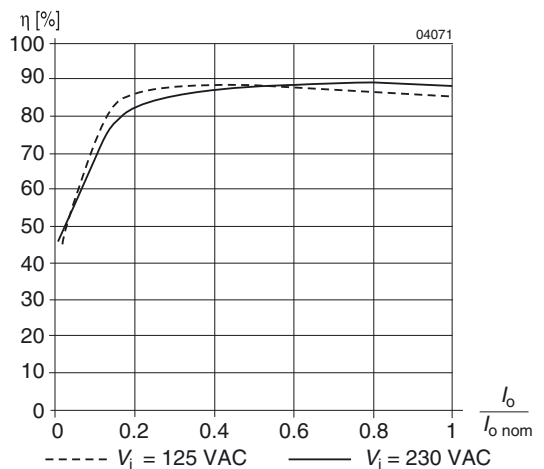


Fig. 3
Efficiency versus load (LWN2660-6)

Power Factor, Harmonics

All converters feature active power factor correction.

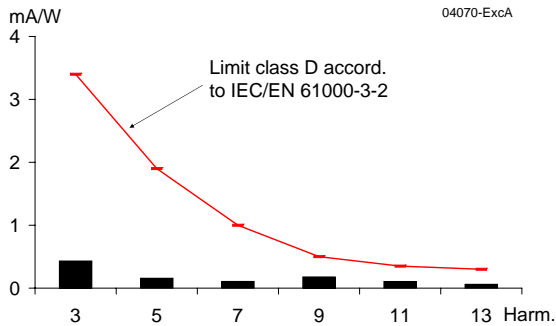


Fig. 4
Harmonic currents at the input current I_i measured at $V_i = 230\text{ VAC}$, $I_o = I_{o\text{ nom}}$ (LWN 1660-6).

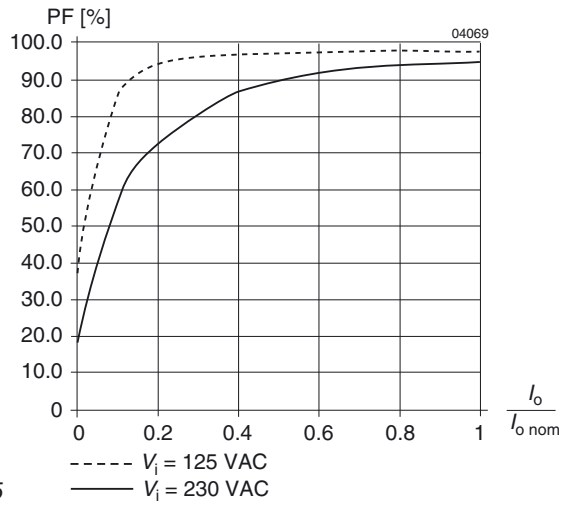


Fig. 5
Power factor versus load (LWN2660-6)

Electrical Output Data

General conditions: $T_A = 25\text{ °C}$, unless T_C is specified.

Table 6a: Output data for 125 Watt models

| Model | | | EWR/LWR1601 | LWR1801 | LWR1240 | LWR1740 | Unit |
|-------------------------|---|--|-------------|-------------|-------------------|-------------------|------------------|
| Characteristic | | Conditions | min typ max | min typ max | min typ max | min typ max | |
| $V_{o\text{ nom}}$ | Output voltage nominal | $V_{i\text{ nom}}, I_{o\text{ nom}}$ | 24.7 | 49.4 | 25.7 ¹ | 51.4 ¹ | V |
| $V_{o\text{ Batt}}$ | Output voltage range for battery chargers | $V_{i\text{ nom}}, I_{o\text{ nom}}$ | n.a. | n.a. | 25.7 29.3 | 51.4 58.6 | |
| $V_{o\text{ worst}}$ | Output voltage range of tolerance | $V_{i\text{ min}} - V_{i\text{ max}}, I_o = (0.1 - 1) I_{o\text{ nom}}$ | 24.0 25.8 | 48.0 51.6 | 4 | 4 | |
| $V_{o\text{ L}}$ | Overvoltage protection | | 28.5 30 | 57.5 60 | 30.5 32.5 | 61 65 | |
| $P_{o\text{ nom}}$ | Nominal output power | | 125 | 125 | 115 | 115 | W |
| $I_{o\text{ nom}}$ | Output current nominal | | 5 | 2.5 | 4.2 | 2.1 | A |
| $I_{o\text{ L}}$ | Output current limit continuous ² | $V_{i\text{ min}} - V_{i\text{ max}}$ | 5.1 5.6 | 2.53 2.8 | 4.3 4.7 | 2.2 2.5 | |
| $I_{o\text{ p}}$ | Output current boost ³ | typ. 1 s | 7.5 | 3.75 | 7 | 3.5 | |
| v_o | Ripple and noise | EWR $V_i = 110\text{ VDC}$, | 500 | | | | mV _{pp} |
| | | LWR $V_i = 230\text{ VAC}$, $f_i = 50\text{ Hz}$, $I_o = I_{o\text{ nom}}$ | 1.1 | 1.2 | 1 | 1.1 | V _{pp} |
| | Superimposed low frequency voltage at $2 f_i$ | | | | 1 | 1.1 | |
| $\Delta V_{o\text{ u}}$ | Static line regulation ¹ | $V_{i\text{ min}} - V_{i\text{ max}}, I_{o\text{ nom}}$ | ±100 | ±150 | ±100 | ±150 | mV |
| $\Delta V_{o\text{ l}}$ | Static load regulation ¹ | $V_{i\text{ nom}}, I_o = (0.1 - 1) I_{o\text{ nom}}$ | 0.4 | 0.8 | 0.4 | 0.8 | V |
| $V_{o\text{ d}}$ | Dynamic load regulation Voltage deviation Recovery time | $V_{i\text{ nom}}, I_o = (0.5 \leftrightarrow 1) I_{o\text{ nom}}$ | ±1.2 | ±1.8 | ±1.2 | ±1.9 | V |
| | | | 35 | 80 | 35 | 80 | ms |
| αV_o | Temperature coefficient ¹ | $T_{C\text{ min}} - T_{C\text{ max}}$ | ±0.1 | ±0.2 | ±0.1 | ±0.2 | mV/K |
| $t_{o\text{ r}}$ | Start-up time | $V_i = 0 \rightarrow V_{i\text{ nom}}, I_{o\text{ nom}}$ | 700 | 700 | 700 | 700 | ms |
| $t_{o\text{ h min}}$ | Hold-up time (LWR) | $I_{o\text{ nom}}, V_{o\text{ nom}} \rightarrow 0.8 V_{o\text{ nom}}$ | 3/7 | 13 | n.a. | n.a. | |
| η | Efficiency | $V_{i\text{ nom}}, I_{o\text{ nom}}$ | 88 | 89 | 88 | 89 | % |

¹ R input open (no temperature sensor)
² Rectangular current limit characteristic
³ Short-term peak power capability 150% of $P_{o\text{ nom}}$ for 1 s
⁴ Depending on battery temperature sensor (see: Accessories)

Table 6b: Output data for 250 Watt single-output models

| Model | | | LWN1601 | LWN1801 | LWN1240 | LWN1740 | |
|-------------------|---|---|-------------|-------------|-------------------|-------------------|------------------|
| Characteristic | | Conditions | min typ max | min typ max | min typ max | min typ max | Unit |
| $V_{o\ nom}$ | Output voltage nominal | $V_{i\ nom}, I_{o\ nom}$ | 24.7 | 49.4 | 25.7 ¹ | 51.4 ¹ | V |
| $V_{o\ Batt}$ | Output voltage range for battery chargers | $V_{i\ nom}, I_{o\ nom}$ | n.a. | n.a. | 25.7 29.3 | 51.4 58.6 | |
| $V_{o\ worst}$ | Output voltage range of tolerance | $V_{i\ min} - V_{i\ max},$ $I_o = (0.1 - 1) I_{o\ nom}$ | 24.0 25.8 | 48.0 51.6 | 4 | 4 | |
| $V_{o\ L}$ | Overvoltage protection | | 28.5 30 | 57.5 60 | 30.5 32.5 | 61 65 | |
| $P_{o\ nom}$ | Nominal output power | | 250 | 250 | 230 | 230 | W |
| $I_{o\ nom}$ | Output current nominal | | 10 | 5 | 8.4 | 4.2 | A |
| $I_{o\ L}$ | Output current limit continuous ² | $V_{i\ min} - V_{i\ max}$ | 10.2 11.2 | 5.1 5.6 | 8.6 9.4 | 4.3 4.8 | |
| I_{op} | Output current boost ³ | typ. 1 s | 15 | 7.5 | 13.5 | 6.75 | |
| v_o | Ripple and noise | $V_i = 230\ VAC,$ | 100 | 100 | 100 | 100 | mV _{pp} |
| | Superimposed low frequency voltage at 2 f_i | $f_i = 50\ Hz, I_{o\ nom}$ | 1.1 | 1.2 | 1 | 1.1 | V _{pp} |
| $\Delta V_{o\ u}$ | Static line regulation ¹ | $V_{i\ min} - V_{i\ max},$ $I_{o\ nom}$ | ±100 | ±150 | ±100 | ±150 | mV |
| $\Delta V_{o\ l}$ | Static load regulation ¹ | $V_{i\ nom},$ $I_o = (0.1 - 1) I_{o\ nom}$ | 0.4 | 0.8 | 0.4 | 0.8 | V |
| V_{od} | Dynamic load regulation | $V_{i\ nom},$ $I_o = (0.5 \leftrightarrow 1) I_{o\ nom}$ | ±1.2 | ±1.8 | ±1.2 | ±1.8 | V |
| | Voltage deviation Recovery time | | 35 | 80 | 35 | 80 | ms |
| αv_o | Temperature coefficient ¹ | $T_{C\ min} - T_{C\ max}$ | ±0.1 | ±0.2 | ±0.1 | ±0.2 | mV/K |
| t_{or} | Start-up time | $V_i = 0 \rightarrow V_{i\ nom}, I_{o\ nom}$ | 700 | 700 | 700 | 700 | ms |
| $t_{oh\ min}$ | Hold-up time | $I_{o\ nom},$ $V_{o\ nom} \rightarrow 0.8 V_{o\ nom}$ | 7 | 13 | n.a. | n.a. | |
| η | Efficiency | $V_{i\ nom}, I_{o\ nom}$ | 88.5 | 88.5 | 88 | 88.5 | % |

¹ R input open (no temperature sensor)

² Rectangular current limit characteristic

³ Short-term peak power capability 150% of $P_{o\ nom}$ for 1 s

⁴ Depending on battery temperature sensor (see: *Accessories*)

Table 6c: Output data for 250 W double-output models

| Model | | | EWN2660 | | | LWN2660 | | | LWN2880 | | | Unit |
|-------------------|---|--|------------------|-----|------|-----------|-----|------|-----------|-----|------|------------------|
| Characteristic | Conditions | min | typ | max | min | typ | max | min | typ | max | | |
| $V_{o\ nom}$ | Output voltage nominal | $V_{i\ nom}, I_{o\ nom}$ | 2 x 24.7 | | | 2 x 24.7 | | | 2 x 49.4 | | | V |
| $V_{o\ worst}$ | Output voltage range of tolerance | $V_{i\ min} - V_{i\ max}, I_o = (0.1 - 1) I_{o\ nom}$ | 24 | | 25.8 | 24 | | 25.8 | 48 | | 51.6 | |
| $V_{o\ vp}$ | Overvoltage protection | | 28.5 | | 30 | 28.5 | | 30 | 57.5 | | 60 | |
| $P_{o\ nom}$ | Nominal output power | | 250 | | | 250 | | | 250 | | | W |
| $I_{o\ nom}$ | Output current nominal | | 2 x 5 | | | 2 x 5 | | | 2 x 2.5 | | | A |
| $I_{o\ L}$ | Output current limit continuous ² | $V_{i\ min} - V_{i\ max}$ | 5.1 | | 5.6 | 5.1 | | 5.6 | 2.53 | | 2.8 | |
| I_{op} | Output current boost ³ | typ 1 s | 7.5 | | | 3.75 | | | | | | |
| v_o | Ripple and noise | $V_i = 230\ VAC,$ $f_i = 50\ Hz, I_{o\ nom}$ | 500 ⁵ | | | 100 | | | 100 | | | mV _{pp} |
| | Superimposed low frequency voltage at 2 f_i | | --- | | | 1.1 | | | 1.2 | | | V _{pp} |
| $\Delta V_{o\ u}$ | Static line regulation ¹ | $V_{i\ min} - V_{i\ max}, I_{o\ nom}$ | ± 100 | | | ± 100 | | | ± 150 | | | mV |
| $\Delta V_{o\ l}$ | Static load regulation ¹ electronically controlled | $V_i,$ $I_o = (0.1 - 1) I_{o\ nom}$ | 0.4 | | | 0.4 | | | 0.8 | | | V |
| V_{od} | Dynamic load regulation Voltage deviation Recovery time | $V_{i\ nom}, I_o = (0.5 \leftrightarrow 1) I_{o\ nom}$ | ± 1.2 | | | ± 1.2 | | | ± 1.8 | | | V |
| | | | 35 | | | 35 | | | 80 | | | ms |
| α_{Vo} | Temperature coefficient ¹ | $T_{C\ min} - T_{C\ max}$ | ± 0.1 | | | ± 0.1 | | | ± 0.2 | | | mV/K |
| t_{or} | Start-up time | $V_i = 0 \rightarrow V_{i\ nom}, I_{o\ nom}$ | 700 | | | 700 | | | 700 | | | ms |
| $t_{oh\ min}$ | Hold-up time | $I_{o\ nom}, V_{o\ nom} \rightarrow 0.8 V_{o\ nom}$ | 3 | | | 7 | | | 13 | | | |
| η | Efficiency | $V_{i\ nom}, I_{o\ nom}$ | 88 | | 89 | 88 | | 89 | 89 | | 89 | % |

¹ R input open (no temperature sensor)

² Rectangular current limit characteristic

³ Short term peak power capability 150% of $P_{o\ nom}$ for 1 s

⁴ Depending on battery temperature (see: Accessories)

⁵ $V_i = 110\ VDC$

Built-in Overtemperature Protection

Each output is independently protected against overtemperature. Exceeding a certain temperature level the relevant power train reduces its available output power until the temperature has dropped below the trigger level.

OVP by Second Control Loop

Each output is independently protected against internal overvoltage by means of a second control loop. When the output voltage exceeds $V_{o\ max}$, the respective output is switched off.

Series Connection

Series connection of several outputs up to 150 V is possible. Exceeding an output voltage of 60 V, the output is not SELV.

Operation in Parallel

Both outputs of double-output models can be connected in parallel, provided that the options S (included in M1) and R are not used, since they influence only the 2nd output.

Up to 3 converters with the same output voltage may be operated in parallel. It is possible to parallel W series with X series converters.

Passive current sharing is achieved by the droop output characteristic. Correct mode of operation is highly

dependent upon the wiring of the converters and the impedance of these wires. Use wires with equal length and equal cross sections of min. 1.5 mm². The best results for parallel operation can be achieved with the wiring shown in fig. 6.

Parallel operation of single-output models using option R (adjustment of the output voltage) is possible, but is not recommended. Refer to fig. 6; the connections from pin 4 to pin 9 (both Vo-) should be as short as possible.

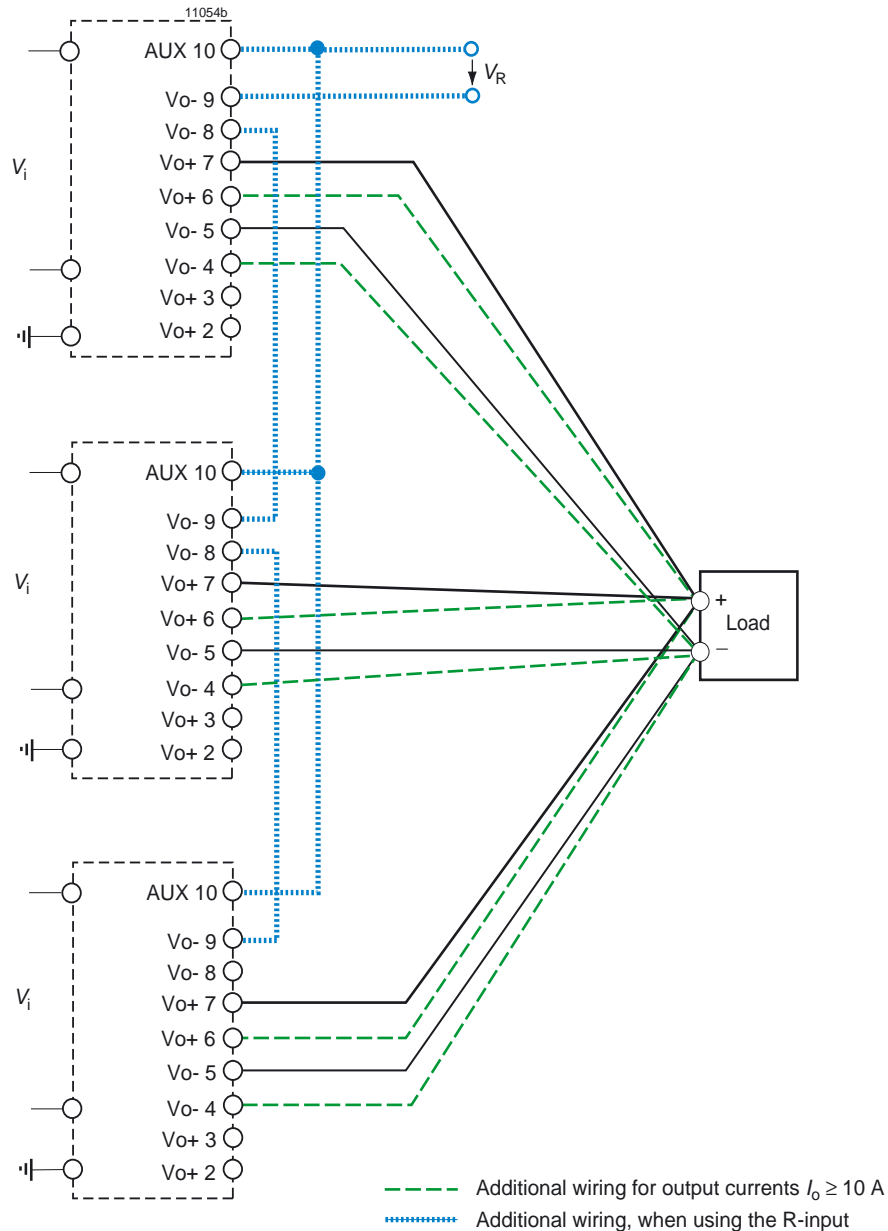


Fig. 6
Wiring for single-output models operated in parallel.
Additional wiring for high output currents and using option R is shown.

Output Characteristic

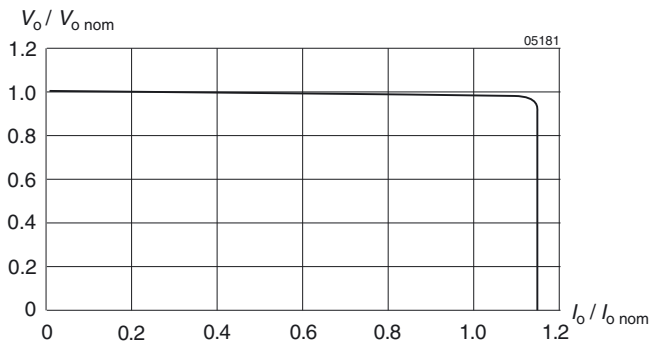


Fig. 7
 V_o versus I_o (single output, typical values).

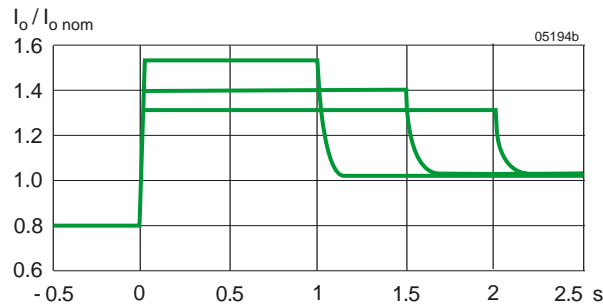


Fig. 8
Short term peak power characteristic: over current versus time (typical values).

Thermal Considerations

The thermal conditions are influenced by input voltage, output current, airflow, and temperature of surrounding components. $T_{A \max}$ is therefore, contrary to $T_{C \max}$, an indicative value only.

Caution: The installer must ensure that under all operating conditions T_C remains within the limits stated in the table *Temperature specifications*.

Note: Sufficient forced cooling allows T_A to be higher than $T_{A \max}$ provided that $T_{C \max}$ is not exceeded. It is recommended that continuous operation under worst case conditions of the following 3 parameters be avoided: Minimum input voltage, maximum output power, and maximum temperature.

Battery Charging and Temperature Sensor

The models LWN1140-6M1, LWN/R1240-6M1 and LWN/R1740-6M1 are designed to charge lead-acid batteries. The R-input allows for connecting a battery-specific temperature sensor, which provides temperature controlled adjustment of the trickle charge voltage. This optimises charging as well as battery lifetime. Depending upon the cell voltage and the temperature coefficient of the battery, different sensor types are available (see *Accessories*).

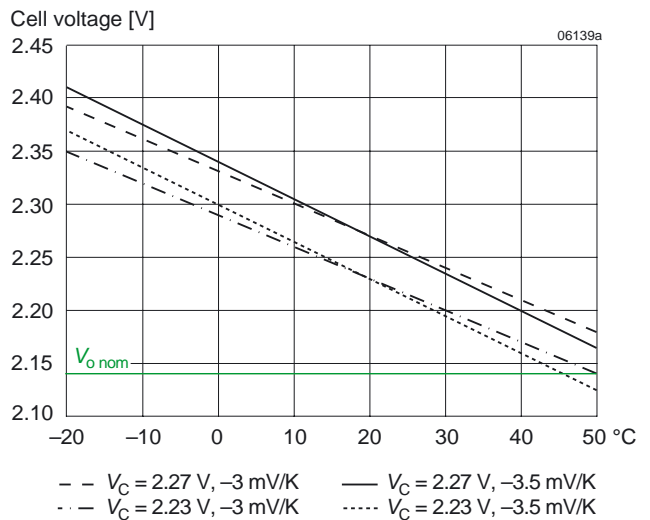


Fig. 9
Trickle charge voltage versus temperature for different temperature coefficients ($V_o \text{ nom}$ with open R-input)

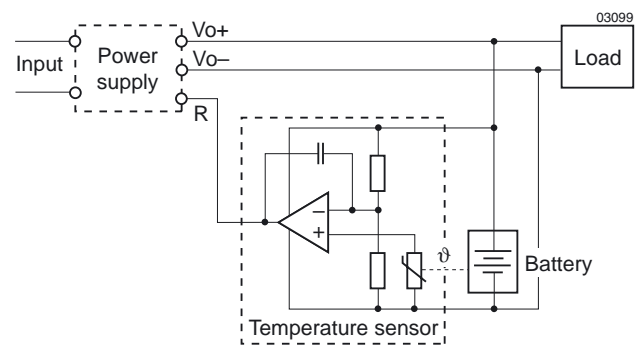


Fig. 10
Schematic circuit diagram of a system with battery backup and temperature-controlled charging.

Electromagnetic Compatibility (EMC)

Immunity

The W series has been successfully tested to the following specifications:

Table 7: Electromagnetic immunity (type tests)

| Phenomenon | Standard | Level | Coupling mode ¹ | Value applied | Waveform | Source imped. | Test procedure | In oper. | Per-form. ² |
|-----------------------------------|-------------------|---------------------|----------------------------|----------------------|--|---------------|---|----------|------------------------|
| Electrostatic discharge (to case) | IEC/EN 61000-4-2 | 4 ³ | contact discharge | 8000 V _p | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | A |
| | | | air discharge | 15000 V _p | | | | | |
| Electromagnetic field RF | IEC/EN 61000-4-3 | 3 ⁴ | antenna | 10 V/m ⁴ | AM 80% 1 kHz | n.a. | 80 – 1000 MHz | yes | A |
| | | 3 | antenna | 10 V/m | 50% duty cycle, 200 Hz repetition frequency | n.a. | 900 ±5 MHz | yes | A |
| Electrical fast transients/burst | IEC/EN 61000-4-4 | 4 ⁵ | capacitive, o/c | 2000 V _p | bursts of 5/50 ns 2.5/5 kHz over 15 ms; burst period: 300 ms | 50 Ω | 60 s positive 60 s negative transients per coupling mode | yes | A |
| | | | i/c, +i/-i direct | 4000 V _p | | | | | |
| Surges | IEC/EN 61000-4-5 | 3 | i/c | 2000 V _p | 1.2/50 μs | 12 Ω | 5 pos. and 5 neg. surges per coupling mode | yes | B |
| | | 4 | +i/-i | 1000 V _p | 1.2/50 μs | 2 Ω | | | |
| Conducted disturbances | IEC/EN 61000-4-6 | 3 ⁶ | i, o, signal wires | 10 VAC (140 dBμV) | AM 80% 1 kHz | 150 Ω | 0.15 – 80 MHz | yes | A |
| Voltage dips and interruptions | IEC/EN 61000-4-11 | ⁷ | | | | | | | -- |
| Surges (EW models) | IEC/EN 50155:2001 | wave A ⁸ | +i/c, -i/c | 1800 V _p | 5/50 μs | 5 Ω | 5 pos. and 5 neg. pulses | yes | B |

¹ i = input, o = output, c = case.

² A = Normal operation, no deviation from specifications, B = Normal operation, temporary loss of function or deviation from specs.

³ Corresponds to EN 50121-3-2:2000, table 9.2.

⁴ EW models withstand to 20 V/m corresponding to EN 50121-3-2:2000, table 9.1.

⁵ Corresponds to EN 50121-3-2:2000, table 7.1.

⁶ Corresponds to EN 50121-3-2:2000, table 7.4.

⁷ LW models with feature E (type tests with LWN1801-6E). Result: passed

⁸ Corresponds to EN 50121-3-2:2000. Covers EN 50155:1995, RIA12, direct transients, waveform D (EW models only).

Emissions

Table 8: Electromagnetic emissions only LW models with Option E: (type tests LWN1801-6E)

| Phenomenon | Standards | Conditions | Results |
|---------------------------------|------------------------|--|------------|
| Harmonics | EN 61000-3-2:2000 | $V_i = 230\text{ V}$, $V_{o\text{ nom}}$, $I_{o\text{ nom}}$ | Class A, D |
| Voltage fluctuation and flicker | EN 61000-3-3 + A1:2001 | $V_i = 230\text{ V}$, $V_{o\text{ nom}}$, $I_{o\text{ nom}}$ | Complied |

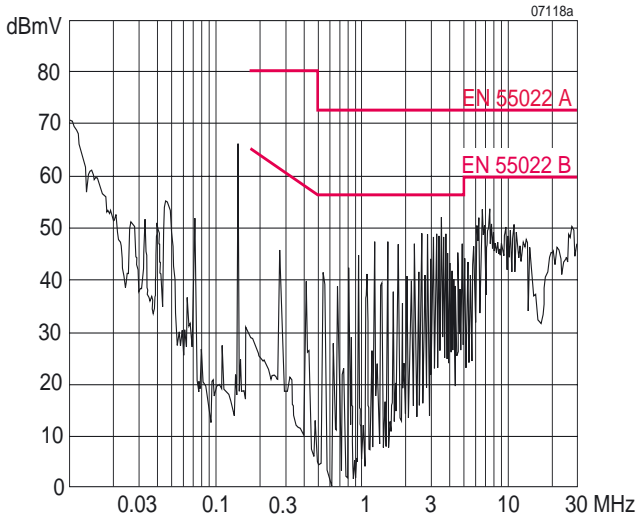


Fig. 11a
Conducted emissions for LW models without feature E:
Typical disturbances (quasi-peak) at the input according to EN 55022, measured at $V_{i\text{ nom}}$ and $I_{o\text{ nom}}$.

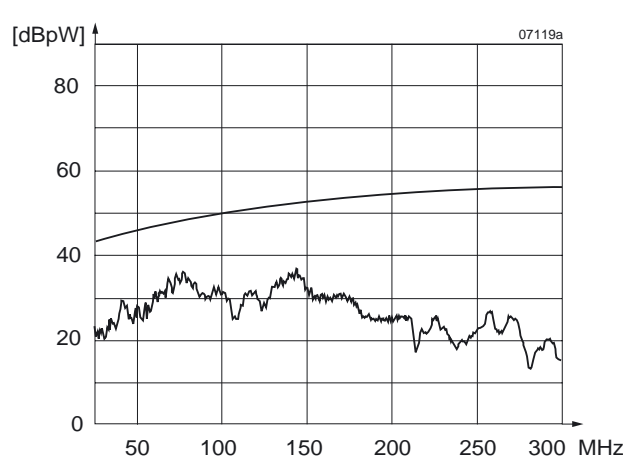


Fig. 11b
Conducted emissions for LW models without feature E:
Typical electromagnetic field strength (quasi-peak) according to EN 55014, measured at $V_{i\text{ nom}}$ and $I_{o\text{ nom}}$.

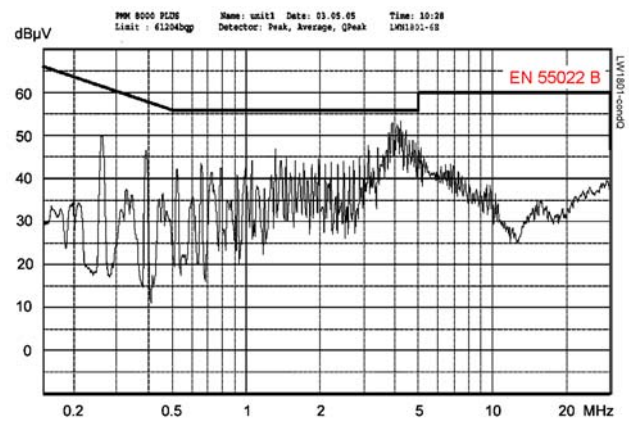


Fig. 12a
Conducted emissions of LW models with feature E:
Disturbances (quasi-peak) at the phase input according to EN 55022, measured at $V_{i\text{ nom}}$ and $I_{o\text{ nom}}$. (LWN1801-6E)

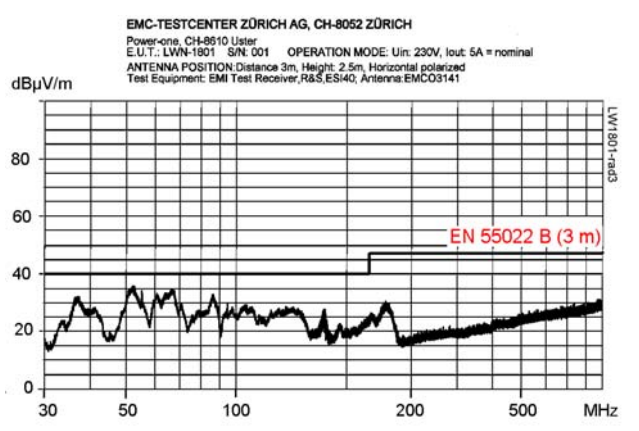


Fig. 12b
Radiated emissions measured according to EN 55022:2001 for LW models with feature E (LWN1801-6E, antenna 3 m distance, horizontal polarized)

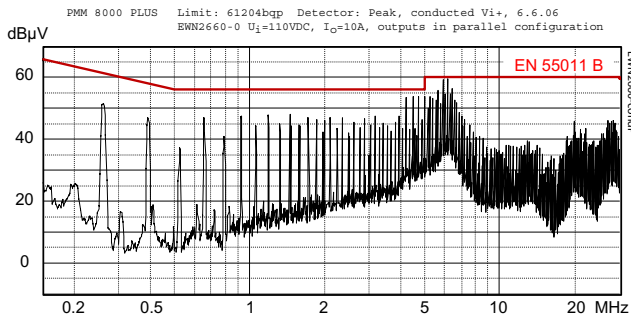


Fig. 13
Conducted emissions of EW models:
Disturbances (peak) at the phase input according to
EN 55011, measured at $V_{i\text{nom}}$ and $I_{o\text{nom}}$. (EWN2660-6)

External EMC Filter for Models with Feature E

An external EMC filter can be wired into the inputs lines of the converters. However, a small choke has to be

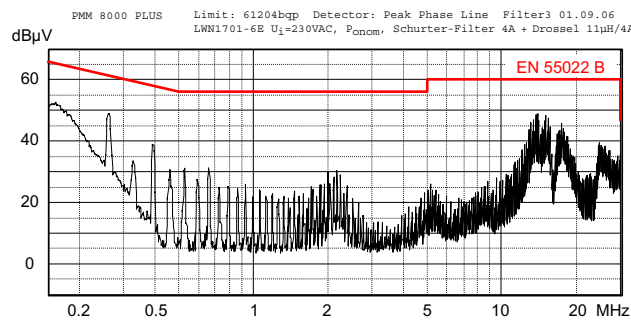


Fig. 14a
Conducted emissions of LW models with external filter:
Disturbances (peak) at the phase input according to
EN 55011/55022, at $V_i = 230\text{ VAC}$, $I_{o\text{nom}}$ (LWN1701-6E).

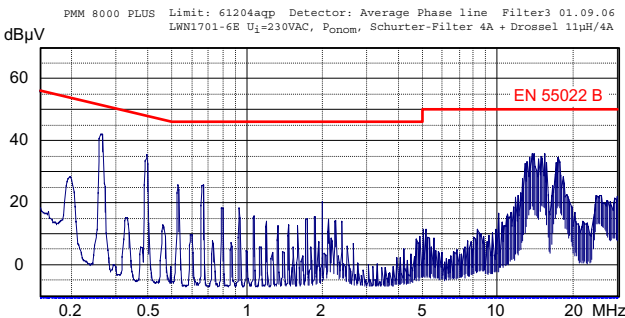


Fig. 14b
Conducted emissions of LW models with feature E:
Disturbances (average) at the phase input according to
EN 55011/55022, at $V_i = 230\text{ VAC}$, $I_{o\text{nom}}$ (LWN1701-6E).

connected in the phase line to avoid interferences between internal and external filter, which would cause dramatically increased low harmonics.

Fig. 14a and 14b show the conducted emissions smoothed by an external filter. The standards EN 55011 and 55022 define limits for conducted (quasi)peak and conducted average emissions. In general the limits for average emissions are more difficult to meet.

The figure below shows the used external filter configuration consisting of the inlet filter KMF1.1241.11 (4 A, Schurter www.schurter.com) and the decoupling choke EPCOS B82111B0000C011, 11 µH, 4 A, 6 × 20 mm.

Note: This filter allows for connection of an IEC inlet and is available with 1 or 2 incorporated fuses.

A similar filter with AMP terminals (6.3 × 20 mm) is also available (Schurter FMLB 5500.2028).

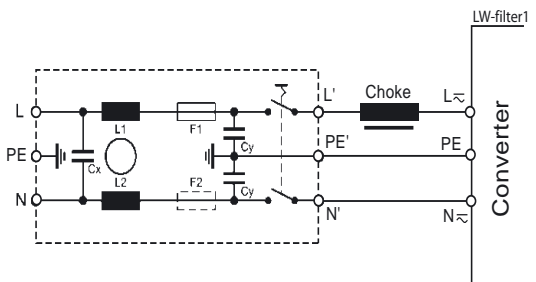


Fig. 15a
External filter to reduce conducted emissions of LW models with feature E ($L1 = L2 = 1.6\text{ mH}$, $Cx = 47\text{ nF}$, $Cy = 2.2\text{ nF}$)



Fig. 15b
External inlet filter

Immunity to Environmental Conditions

Table 9: Mechanical stress and climatic

| Test method | | Standard | Test conditions | | Status |
|-------------|---|---|--|--|---|
| Ca | Damp heat steady state | IEC/EN 60068-2-78 MIL-STD-810D sect. 507.2 | Temperature: Relative humidity: Duration: | 40 ±2 °C 93 +2/-3 % 56 days | Converter not operating |
| Kb | Salt mist, cyclic (sodium chloride NaCl solution) | IEC/EN 60068-2-52 | Concentration: Duration: Conditions: Storage duration: | 5% (30 °C) 2 h per cycle 40 °C, 93% rel. humidity 3 cycles of 22 h | Converter not operating |
| Eb | Bump (half-sinusoidal) | IEC/EN 60068-2-29 MIL-STD-810D sect. 516.3 | Acceleration amplitude: Bump duration: 6000 bumps: | 25 g _n = 245 m/s ² 11 ms 1000 in each direction | Converter not operating, wall-mounted ¹ |
| | | | Acceleration amplitude: Bump duration: 6000 bumps: | 10 g _n = 98.1 m/s ² 11 ms 1000 in each direction | Converter not operating, on DIN-rail ² |
| Fc | Vibration (sinusoidal) | IEC/EN 60068-2-6 MIL-STD-810D sect. 514.3 | Acceleration amplitude and frequency (1 Octave/min): Test duration: | 0.35 mm (10 – 60 Hz) 5 g _n = 49 m/s ² (60 – 2000 Hz) 7.5 h (2.5 h each axis) | Converter operating, wall-mounted ¹ |
| | | | Acceleration amplitude and frequency (1 Octave/min): Test duration: | 0.25 mm (10 – 60 Hz) 2 g _n = 19 m/s ² (60 – 2000 Hz) 7.5 h (2.5 h each axis) | Converter operating, on DIN-rail ² |
| Ea | Shock (half-sinusoidal) | IEC/EN 60068-2-27 MIL-STD-810D sect. 516.3 | Acceleration amplitude: Bump duration: Number of bumps: | 50 g _n = 490 m/s ² 11 ms 18 (3 in each direction) | Converter not operating, wall-mounted ¹ |
| -- | Shock | EN 50155/EN 61373 sect. 10, class A and B body mounted ³ | Acceleration amplitude: Bump duration: Number of bumps: | 5.1 g _n 30 ms 18 (3 in each direction) | Converter operating, on DIN-rail ² |
| Fda | Random vibration wide band Reproducibility high | IEC/EN 60068-2-35 | Acceleration spectral density: Frequency band: Acceleration magnitude: Test duration: | 0.05 g _n ² /Hz 20 – 500 Hz 4.9 g _{n,rms} 3 h (1 h each axis) | Converter operating, wall-mounted ¹ |
| | | | Acceleration spectral density: Frequency band: Acceleration magnitude: Test duration: | 0.01 g _n ² /Hz 20 – 500 Hz 2.2 g _{n,rms} 1.5 h (0.5 h each axis) | Converter operating, mounted on a DIN-rail ² |
| -- | Simulated long life time testing at increased random vibration levels | EN 50155/EN 61373 sect. 9, class B body mounted ³ | Acceleration spectral density: Frequency band: Acceleration magnitude: Test duration: | 0.01 g _n ² /Hz 5 – 150 Hz 0.8 g _{n,rms} 1.5 h (0.5 h each axis) | Converter operating, mounted on a DIN-rail ² |

¹ Wall-mounted with brackets UMB-W [HZZ00618], see *Accessories*

² Fastened on a DIN-rail with 2 additional DIN-rail fixing brackets DMB-EWG, see *Accessories*. This covers also wall-mounting with brackets, because wall mounting performs better in vibration test.

³ Body mounted = chassis of a railway coach.

Temperatures

Table 10: Temperature specifications, valid for an air pressure of 800 - 1200 hPa (800 - 1200 mbar)

| Model | | LW models -6 | | EW models -0 | | Unit | |
|-----------------|---------------------|----------------------------------|-----|-----------------|-----|-----------------|----|
| Characteristics | Conditions | min | max | min | max | | |
| T _A | Ambient temperature | Converter operating ¹ | -40 | 60 | -40 | 70 ³ | °C |
| T _C | Case temperature | | -40 | 90 ² | -40 | 95 ³ | |
| T _S | Storage temperature | Not operating | -40 | 100 | -40 | 100 | |

¹ See: *Thermal Considerations*

² See table: *P_o derating*

³ Mounted in vertical position

Failure Rates

Table 11: MTBF

| Values at specified case temperature | Model | Ground benign 40 °C | | Ground fixed 40 °C | | Ground mobile 50 °C | Unit |
|--------------------------------------|---------|---------------------|---------|--------------------|--------|---------------------|------|
| | | 40 °C | 70 °C | 40 °C | 70 °C | | |
| MTBF ¹ | LWR1601 | 892 000 | 180 000 | 197 000 | 68 000 | h | |
| | LWN1601 | 644 000 | 131 000 | 72 000 | 51 000 | | |
| | LWN2660 | 522 000 | 101 000 | 55 000 | 38 000 | | |

¹ Calculated in accordance with MIL-HDBK-217E, notice 2.

Mechanical Data

Dimensions in mm.

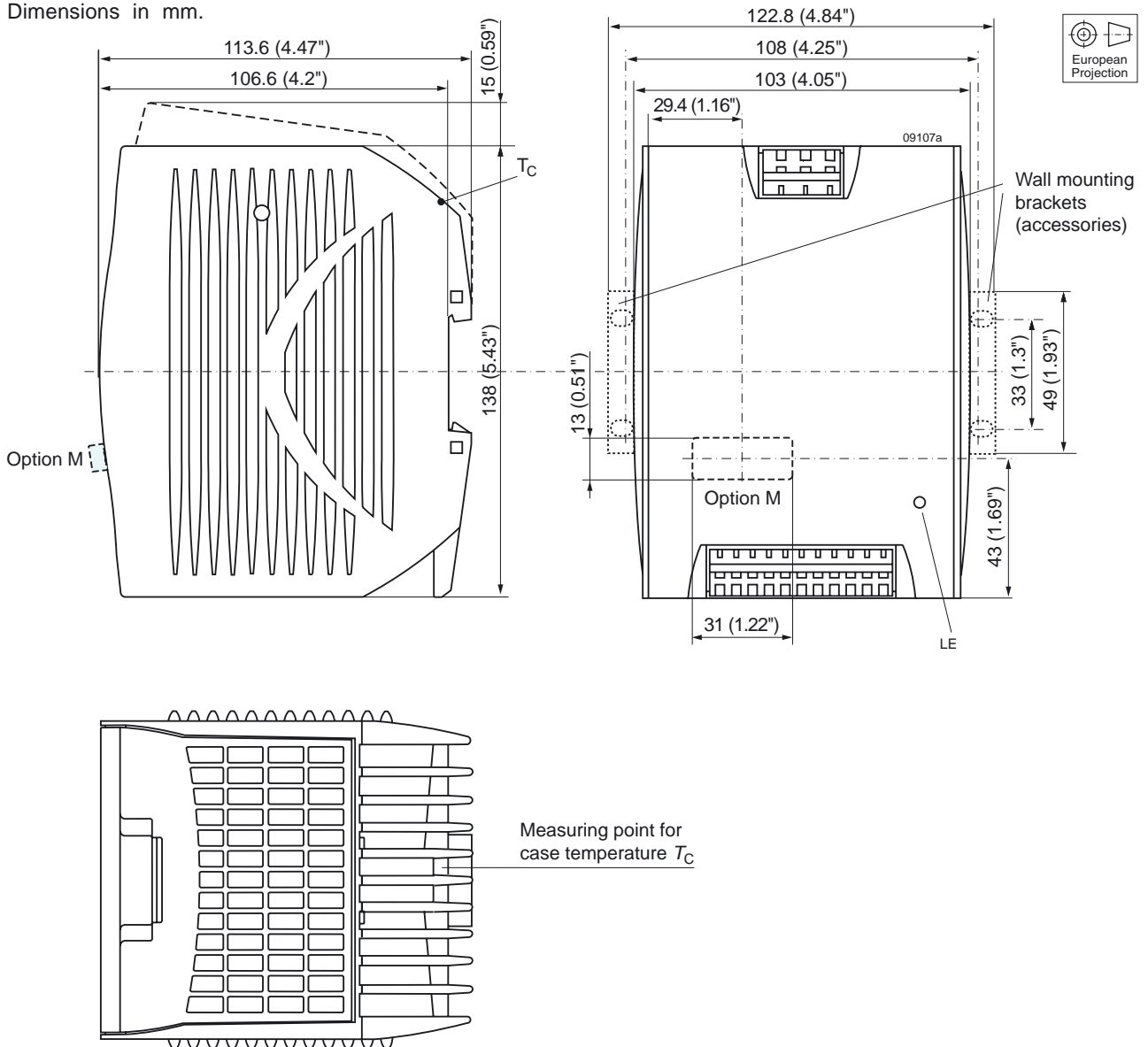


Fig. 16
Case W01
EWN/LWN: weight approx. 1400 g
EWR/LWR: weight approx. 1200 g
Case designed by ATP, Munich.

Safety and Installation Instructions

Terminal Allocation

The terminal allocation tables define the electrical potential of the converters.

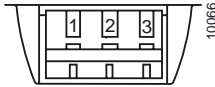


Fig. 17a
View of the input terminals (cage clamp style)

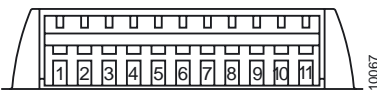


Fig. 17b
View of the output terminals (cage clamp style)

Table 12a: Input terminals of LW models

| Pin no. | Pin designation | Electrical determination |
|---------|-----------------|----------------------------|
| 1 | \oplus | Protective earth PE |
| 2 | N \sim | Input neutral, DC negative |
| 3 | L \sim | Input phase, DC positive |

Table 12b: Input terminals of EW models

| Pin no. | Pin designation | Electrical determination |
|---------|-----------------|--------------------------|
| 1 | \oplus | Protective earth PE |
| 2 | Vi- | Input negative |
| 3 | Vi+ | Input positive |

Table 13: Terminal allocation output side

| Pin no. | Pin des. | Single output | Double output |
|---------|----------|--------------------------|--------------------------|
| 1 | | Functional earth to load | Functional earth to load |
| 2 | + | Output positive | Output 1 positive |
| 3 | + | Output positive | Output 1 positive |
| 4 | - | Output negative | Output 1 negative |
| 5 | - | Output negative | Output 1 negative |
| 6 | + | Output positive | Output 2 positive |
| 7 | + | Output positive | Output 2 positive |
| 8 | - | Output negative | Output 2 negative |
| 9 | - | Output negative | Output 2 negative |
| 10 | AUX | Option | Option |
| 11 | | Functional earth to load | Functional earth to load |

Installation Instructions

The converters of the W series are components, intended exclusively for inclusion within other equipment by professional installers. Installation must strictly follow the national safety regulations in compliance with the enclosure, mounting, creepage, clearance, casualty, markings and segregation requirements of the end-use application.

DIN-rail mounting is possible with the built-in snap-fit device on a DIN-rail. This fulfils the mechanical transport requirements as per ETSI 300019-1-2, class 2 (vertical). To fulfil the requirements of IEC 721-3-2, class 2.1 (vertical), 2 additional fixing brackets DMB-EWG [formerly HZZ00624] (see *Accessories*) on the bottom side of the DIN-rail must be fitted. For heavy duty railway applications, we recommend to install all 4 fixing brackets DMB-EWG.

Wall mounting is possible with the wall-mounting brackets UMB-W [HZZ00618] (see *Accessories*). This complies with IEC 721-3-2, class 2.2 (vertical and horizontal).

Important: Install the converters vertically, and make sure that there is sufficient airflow available for convection cooling. The minimum space to the next device should be: top/bottom: 30 mm, left/right: 20 mm.

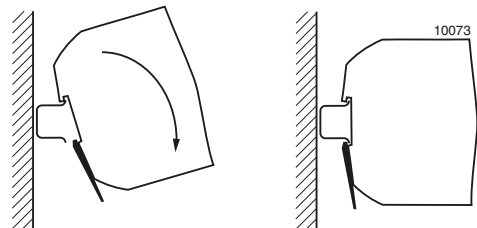


Fig. 18a
Snap-fit mounting to DIN-Rail.

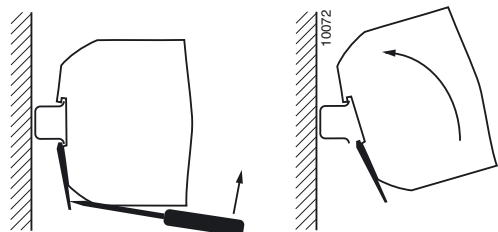


Fig. 18b
Dismounting from DIN-rail. Use proper tool (min. 3 mm screwdriver) and adequate force.

The converters of the W series are class I equipment: Input terminal 1 (\oplus) and the output terminals 1 and 11 ($\opl�$) are reliably connected to the case. For safety reasons it is essential to connect the input terminal 1 (\oplus) to the protective earth of the supply system. Output terminals 1 and 11 can be used to connect the output voltage(s) or the load to functional earth.

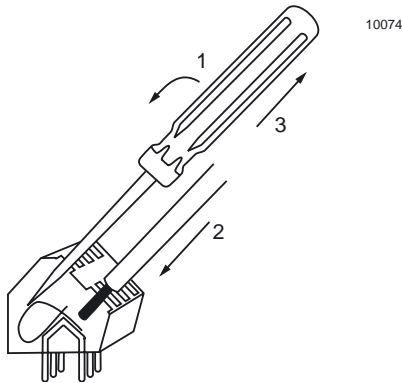


Fig. 19
Cage clamp terminals. Use 0.5 to 2.5 mm² (AWG 20 to 12) solid or stranded wires depending on local requirements.

The phase input (L $\bar{\sim}$ or Vi+) is internally fused, see *Input Fuse*. This fuse is designed to break an overcurrent in case of a malfunction of the converter and is not customer-accessible.

LW-models: External fuses in the wiring to one or both input lines (L $\bar{\sim}$ and/or N $\bar{\sim}$) may be necessary to ensure compliance with local requirements. A built-in second fuse in the neutral path is available as Option F.

A second fuse in the wiring to the neutral terminal N $\bar{\sim}$ or option F is needed if:

- Local requirements demand an individual fuse in each source line
- Neutral and earth impedance is high or undefined
- Phase and neutral of the mains are not defined or cannot be assigned to the corresponding terminals (L $\bar{\sim}$ to phase and N $\bar{\sim}$ to neutral).

Models with Option F: Caution! Double-pole/neutral fusing.

If LW converters operate at source voltages above 250 VDC, an external fuse or a circuit breaker at system level should be installed.

Caution:

- Installation must strictly follow the national safety regulations.
- Do not open this apparatus!

Cleaning Agents

Any penetration of liquid or foreign solid objects is to be prevented, since the converters are not hermetically sealed.

Standards and Approvals

The LW series with feature E was approved by TÜV according to IEC/EN 60950-1:2001 (IEC/EN 60950 for models without E), IEC 61010-1: C11:2002 (models without E: IEC 61010-1), and EN 50178:1997. models without E

The LW series with feature E was further approved by UL according to UL 60950 (models without E: UL1950), CAN/CSA C22.2 No. 950-95 as UL508-listed component.

Safety approvals for EW models are in process.

The converters have been designed in accordance with said standards for:

- Class I equipment
- Power-supply for building-in, vertical mounting on 35 mm DIN-rail or on a wall
- Overvoltage category II (III for 110 VAC supply)
- Basic insulation between input and case, based on 250 VAC
- Double or reinforced insulation between input and output, based on 250 VAC and 350 VDC.
- Functional insulation between outputs and case.
- Functional insulation between outputs.
- Pollution degree 3 environment (AC-input) and degree 2 (DC input).

CB scheme is available (SE-34392).

The converters are subject to manufacturing surveillance in accordance with the above mentioned standards.

For details see the Declaration of Conformity (last pages).

Railway Applications

All W series converters have been designed observing the railway standards EN 50155 and EN 50121. All boards are coated with a protective lacquer.

The EW series is specially suitable for connection to 110 V railway batteries.

Protection Degree

The protection degree of the converters is IP 20. Protective covers over input and output terminals are available on request (see *Accessories*).

Table 14: Isolation

| Characteristic | | Input to case and output(s) | Output(s) to case | Output 1 to output 2 and AUX | Unit |
|----------------------------------|--|-----------------------------|---------------------|------------------------------|------------|
| Electric strength test | Factory test ≥ 1 s | 2.8 ¹ | 1.4 | 0.5 | kVDC |
| | AC test voltage equivalent to factory test | 2.0 | 1.0 | 0.35 | kVAC |
| Insulation resistance at 500 VDC | | >300 ² | >300 ² | >100 | M Ω |

¹ In accordance with EN 50116 and IEC/EN 60950-1, subassemblies are pretested with 4.2 kVDC.

² Tested at 500 VDC.

Isolation

The electric strength test is performed in the factory as routine test in accordance with EN 50116 and IEC/EN 60950 and should not be repeated in the field. Power-One will not honour any warranty claims resulting from electric strength field tests.

Leakage Currents in AC-DC Operation

Leakage currents flow due to internal leakage capacitance and RFI suppression Y-capacitors. The current values are proportional to the mains voltage and nearly proportional to the mains frequency. They are specified at maximum operating input voltage where phase, neutral, and protective earth are correctly connected as required for class I equipment.

Leakage current may exceed 3.5 mA, if $f_i > 63$ Hz.

Safety of Operator-Accessible Output Circuits

If the output circuit of a converter is operator accessible, it shall be a SELV circuit according to IEC/EN 60950 related safety standards.

The converters have SELV output circuits up to an output voltage of 57.5 V. However, if the isolated outputs are connected to another voltage source or connected in series with a total of >57.5 V the outputs are hazardous.

It is the sole responsibility of the installer to ensure the compliance with the relevant and applicable safety regulations.

LED Indicator

A green LED is activated, when the output voltage V_o is within the normal operating tolerance band.

Note: This LED is also activated, when the converter is not powered by the input, but a loaded battery is connected to the output.

Description of Options

E designates LW models with improved EMC performance. Refer to the EC Declaration of Conformity (last page). Feature E is standard for new designs.

Options D1, D2, D5, R are available (as single choice) on the AUX terminal (10), referenced to Vo-.

Option M1 and M2 designate a combination of several options accessible via a D-SUB connector. Double output units: only the output connected to terminals 6, 7, 8, and 9 can be monitored or adjusted. Option M1 includes the function S.

Note: In double-output models, the options D1, D5, R and S concern only output 2.

Single Options Using the AUX Pin

The connection is shown in the figure below. For the description refer to the next section *Multiple Options*.

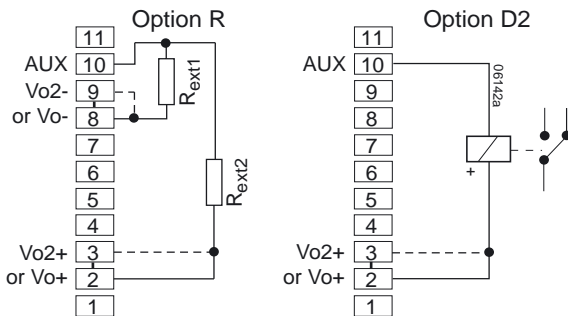


Fig. 20
Connection of R-adjust resistors (Option R) or a relay monitoring the input voltage V_i (Option D2).

Multiple Options M1 or M2 via D-SUB Connector

The option board is suitable for applications, where several options are needed. Option M1 is standard for battery charger models, option M2 is suitable for applications without battery or for simple applications with battery.

Table 15: Pin allocation of the 9 pin D-SUB connector

| Pin | Designation | Description |
|-----|------------------|--|
| 1 | GND ¹ | System ground / common signal return |
| 2 | R | R input ³ |
| 3 | VCC ² | Output 1 positive |
| 4 | D1 | Output voltage monitor $V_{o,low D1}$ ³ |
| 5 | D5 | Output 2 voltage monitor $V_{o,low D5}$ ³ |
| 6 | S | Shut down ³ |
| 7 | D-adjust | Adjustment of threshold values $D1/D5$ |
| 8 | D2 | Input voltage monitor $V_{i,low}$ |
| 9 | Sys-OK | System O.K. (all outputs) |

¹ Do not connect GND1 (pin 1) with the neg. output (-)

² Do not connect VCC (pin 3) with the positive output (+)

³ Concerns only output 2 in double-output models.

Table 16a: Option board M1

| Function | Description |
|----------|--|
| R | Output voltage adjust ¹ |
| D1 | Output voltage monitor $V_{o,low D1}$ ¹ |
| D2 | Input voltage monitor $V_{i,low}$ |
| D5 | Output 2 voltage monitor ¹ (battery deep discharged): $V_{o,low D5}$ |
| Sys-OK | System okay |
| S | Shut down ¹ |
| D-adjust | Adjustment of trigger values D1 and D5 |

¹ Concerns only output 2 in double-output models

Table 16b: Option board M2

| Function | Description |
|----------|--|
| R | Output voltage adjust ¹ |
| D2 | Input voltage monitor $V_{i,low}$ |
| D5 | Output voltage monitor ¹ (battery deep discharged): $V_{o,low D5}$ |
| D-adjust | Adjustment of trigger values D1 and D5 |

¹ Concerns only output 2 in double-output models

D2: Input Voltage Monitor (Power Fail)

D2 monitors the input voltage. If the voltage drops below 65 VAC or 92 VDC, the D2-signal (open-collector) goes to high impedance. $I_D \max < 50 \text{ mA}$. The output is protected by a Zener diode against transients up to 75 V (for models with $V_{o,max} > 50 \text{ V}$ up to 90 V).

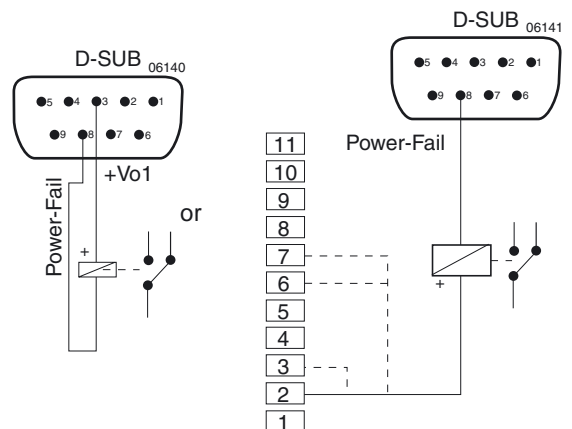


Fig. 21
D2: examples of relay control in case of power failure.

D1: Output Voltage Monitor

D1 is intended for monitoring the bus voltage of a battery-buffered system. It indicates that the system is powered from the battery and can for instance be used as warning signal or to switch off a part of the load. If the output voltage drops below $V_{o\ low\ D1}$, the D1 signal (open-collector) goes to high impedance. $I_{D\ max} < 50\ mA$. The D1 output is protected by a Zener diode against transients up to 75 V (for models with $V_{o\ max} > 50\ V$ up to 90 V). In double-output models D1 monitors only output 2.

In applications without battery-buffering the D1 signal may not be suitable, since smaller dynamic load changes may cause D1 to trigger. For such applications D5 with a trigger level of approx. 85% $V_{o\ nom}$ should be chosen (e.g., for bus voltage 24.7 V, trigger level at 21 V).

Table 17: D1 trigger and switch-on levels

| Model | Battery nom. voltage [V] | D1 $V_{o\ low\ D1}$ trigger level [V] | D1 $V_{o\ low\ D1}$ switch on level [V] |
|-------------|--------------------------|---------------------------------------|---|
| | 12 | 11.5 | 12.5 |
| 1601 / 2660 | 24 | 23 | 24.3 |
| 1701 / 2770 | 36 | 34.5 | 36.5 |
| 1801 / 2880 | 48 | 46 | 48.6 |
| | 72 | 69 | 72.9 |

D5: - System Voltage Monitor / Battery Deep

D5 monitors the output voltage V_o (V_{o2} in double-output models) or the lowest admissible voltage of a connected battery (battery deep discharge). The definition of D5 is similar to D1, but the trigger level is lower. When V_o drops below the value specified in the table below, the D5 signal (open-collector) goes to high impedance. $I_{D\ max} < 50\ mA$. The D5 output is protected by a Zener diode against transients up to 75 V (for models with $V_{o\ max} > 50\ V$ up to 90 V).

In systems without battery support, D5 signals that V_o (or V_{o2}) is going to drop below a safe value.

In battery-buffered systems, D5 indicates that the battery has reached its deepest discharge level prior to getting damaged.

The D5 signal can be used for instance to disable loads, save data, or to start a controlled switch-off of running processes.

Table 18: D5 trigger and switch-on levels

| Model | Battery nom. voltage [V] | D5 $V_{o\ low\ D5}$ trigger level [V] | D5 $V_{o\ low\ D5}$ switch on level [V] |
|-------------|--------------------------|---------------------------------------|---|
| | 12 | 10.5 | 12.2 |
| 1601 / 2660 | 24 | 21.1 | 24.3 |
| 1701 / 2770 | 36 | 31.5 | 36.5 |
| 1801 / 2880 | 48 | 42.2 | 48.6 |
| | 72 | 63.3 | 72.9 |

Adjustment of Threshold Levels (D1/D5)

Pin 7 of the D-SUB connector allows adjustment of the threshold levels of D1 and D5. Both levels are influenced by the voltage divider Rx /Ry. Resistor Rx to pin 3 (VCC) lowers the levels, whereas Ry to pin 1 (GND1) increases them.

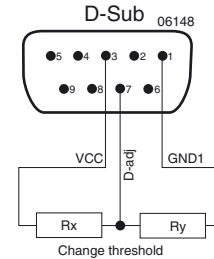


Fig. 22
Wiring to adjust the threshold level D1 or D5

Option S, Shut Down

Reduces the output power to approx. 1 W, i.e., the converter is not fully disabled. In a no-load condition V_o drops below 6.2 V, see fig. below. In double-output models, only output 2 is influenced.

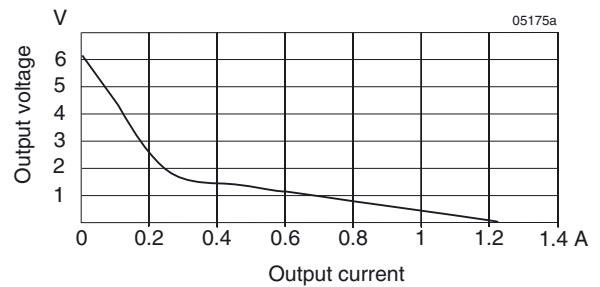


Fig. 23
Output voltage versus output current, while shut down ($V_i = V_{i\ nom}$).

Table 19: Shut Down Conditions

| Voltage V_{SD} on shut-down pin | Result |
|-----------------------------------|---|
| <0.7 V | Converter disabled (P_o approx. 1 W) |
| >1.4 V or open | Converter enabled |

Table 20: System OK (M1 with external battery sensor)

| System Status | Input | V control (sensor signal) | V battery (theoretical) | V battery measured | D5 output |
|---|-------|---------------------------|-------------------------|--------------------|------------|
| System OK | O.K. | 2.7 V | 27 V | 27 V | Low ohmic |
| Battery overcharged / temp. sensor defect / control voltage to high | O.K. | 2.7 V | 27 V | 28 V | High ohmic |
| Overload, converter cannot follow the control signal | O.K. | 2.7 V | 27 V | 24 V | High ohmic |
| Output does not follow control signal, since battery would be overcharged | O.K. | 3.0 V | 30 V | 27 V | High ohmic |
| System O.K. | O.K. | 2.5 V | 25 V | 25V | Low ohmic |

Sys-OK: Status

This function allows for checking in a battery charger application, whether the output follows the external control signal at the R-input (coming for instance from the temperature sensor). Refer to table 20.

The open-collector output Sys-OK is protected by a Zener diode against transients up to 75 V (for models with $V_{O\ max} > 50\ V$ up to 90 V). Current <50 mA.

R: Adjust of V_o

The R input allows external adjustment of the output voltage in the range of 50% to 110% $V_{O\ nom}$. Double-output models allow only an influence on output 2 (connected to the terminals 6, 7, 8 and 9). This enables asymmetric output voltage configuration.

Adjustment can be achieved via a resistor or an external voltage source (in the range of 1.25 – 2.75 V). In battery charging systems, an external battery temperature sensor (see: *Accessories*) can be connected to optimise V_o .

Note: If the R input is not connected: $V_o \approx V_{O\ nom}$.

a) Adjustment by an external resistor:

Resistor R_{ext1} , connected between AUX and GND1

$$V_o = 60 - 100\% V_{O\ nom} \cdot R_{ext1} \approx 4\ k\Omega \cdot \frac{V_o}{V_{O\ nom} - V_o}$$

Resistor R_{ext2} , connected between AUX and V_{o+} or V_{o2+}

$$V_o = 100 - 110\% V_{O\ nom} \cdot R_{ext2} \approx 4\ k\Omega \cdot \frac{V_o - 2.5\ V}{2.5\ V \cdot (V_o / V_{O\ nom} - 1)}$$

Note: If the R function is not included in M1 or M2, refer to figure 20 how to connect R_{ext1} or R_{ext2} .

b) Adjustment by an external control voltage V_{ext} (1.5 – 2.75 V), connected between AUX and GND1 (or V_{o-}):

$$V_{ext} \approx 2.5\ V \cdot \frac{V_o}{V_{O\ nom}} \quad V_o \approx V_{O\ nom} \cdot \frac{V_{ext}}{2.5\ V_o}$$

Caution: To prevent damage, V_{ext} should not exceed 3 V, nor be negative.

Note: If longer wires are used to connect the R input at the D-SUB connector, the wiring to pin 1 (GND1) should be done as star point connection. If wired differently, the output voltage setting may be adversely affected.

Option F: Built-in Second Fuse

A built-in second fuse in the neutral line provides safe phase-to-phase connection at low mains voltages (e.g., USA 120 V/208 V/60 Hz systems).

The built-in second fuse also enables safe connection to the mains, where phase and neutral are not defined or cannot be identified, as e.g., in the case of plug and socket connection to the mains via German Schuko-plugs, see also: *Safety and Installation Instructions*. Option F limits the DC input voltage to $\leq 250\ V$.

Option Q: Reverse Polarity Protection

EW models have no bridge rectifier at the input. To provide reverse polarity protection, an additional diode can be fitted. However this lowers the efficiency by approximately 1%.

Option K2: System Connectors

For installation in systems using pre-assembled harnesses the converters are available with system connectors. They are UL-listed, approved for currents up to 15 A at -40 to $105\ ^\circ\text{C}$.

The mating system connectors with screw terminals and retainers are delivered together with every converter with option K2. Use max. $2.5\ \text{mm}^2$ (AWG 12) solid or stranded wires, or max. $1.5\ \text{mm}^2$ (AWG 14) stranded wires with crimp termination, stripped length 6 mm. Tightening torque of input/output terminals: max. 0.5 Nm (7 lbs.in.).

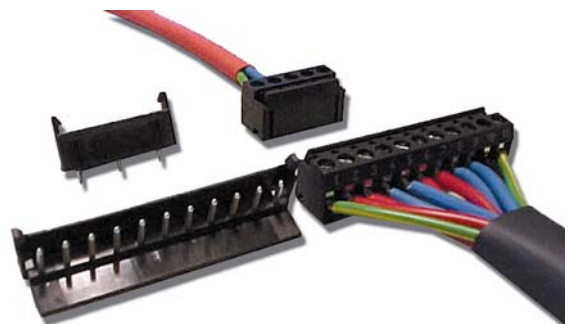


Fig. 24
System connectors Option K2

Accessories

UMB-W: Shock-Resistant Wall Mounting

Set of wall mounting brackets UMB-W [HZZ00618]

Content: 2 clamps, 4 countersunk screws M4, washers and spring washers.

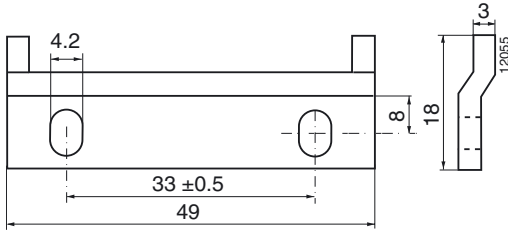


Fig. 25
Brackets UMB-W

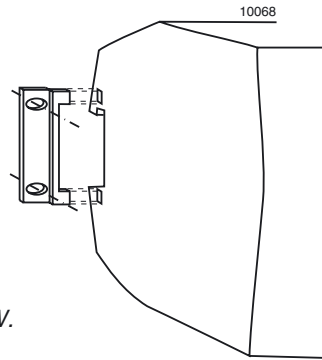


Fig. 26
Wall mounting with mounting brackets UMB-W.

Protective Covers over Terminals

Set of plastic covers COVER-W [HZZ01219]

Content: 2 covers to protect the input and output connector.

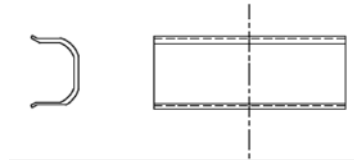


Fig. 28
Protective covers COWER-W

DMB-EWG: DIN-Rail Fixing Brackets

For DIN-Rail vibration-proof fastening, use a set of brackets DMB-EWG (replacement for HZZ00624). For heavy-duty application 2 sets (= 4 brackets) are preferable.



Fig. 27
One of 4 DIN-rail fixing brackets DMB-EWG.

Battery Temperature Sensor

To charge lead-acid batteries according to their temperature different types of temperature sensors are available, (see *Battery Charging and Temperature Sensor* in this data sheet and the *Battery Sensor data sheet* at www.power-one.com).

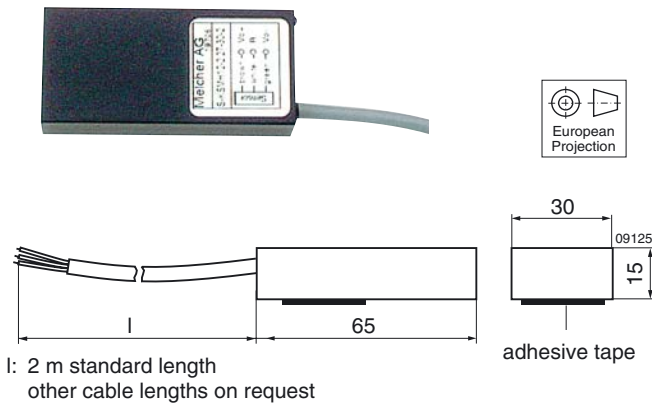


Fig. 29
Temperature sensor

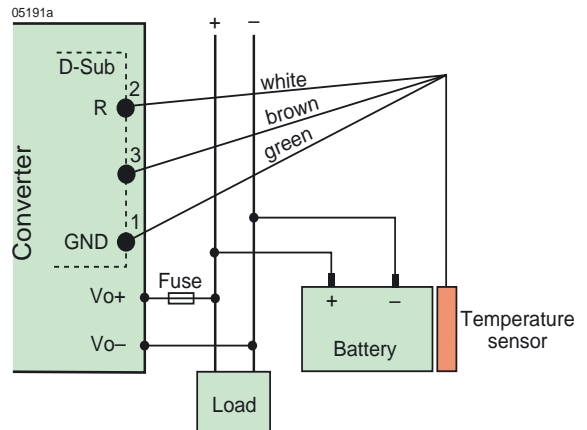


Fig. 30
Connection of a temperature sensor

Table 21: Type survey S-KSMH sensors

| Nominal battery voltage [V] | Model | Cell voltage [V] | Temp. coefficient/cell [mV/K] | Cable length [m] |
|-----------------------------|--------------------|------------------|-------------------------------|------------------|
| 12 | S-KSMH24-2.27-30-2 | 2.27 | -3.0 | 2 |
| 24 | S-KSMH24-2.27-35-2 | 2.27 | -3.5 | 2 |
| 24 | S-KSMH24-2.27-30-2 | 2.27 | -3.0 | 2 |
| 24 | S-KSMH24-2.35-35-0 | 2.35 | -3.5 | 2 |
| 48 | S-KSMH48-2.27-35-2 | 2.27 | -3.5 | 2 |
| 48 | S-KSMH48-2-27-30-2 | 2.27 | -3.0 | 2 |

Other models for different cell voltages, temperature coefficients or cable length are available upon request.

For additional accessory product information, see the accessory data sheets listed with each product series or individually at www.power-one.com through the following menus: "Select Products", "Select Data Sheets & Application Notes".

NUCLEAR AND MEDICAL APPLICATIONS - Power-One products are not designed, intended for use in, or authorized for use as critical components in life support systems, equipment used in hazardous environments, or nuclear control systems without the express written consent of the respective divisional president of Power-One, Inc.

TECHNICAL REVISIONS - The appearance of products, including safety agency certifications pictured on labels, may change depending on the date manufactured. Specifications are subject to change without notice.

EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56, CH-8610 Uster

declare under our sole responsibility that all LW-Series power supplies carrying the CE-mark are in conformity with the provisions of the Low Voltage Directive (LVD) 73/23/EEC of the European Communities.

Conformity with the directive is presumed by conformity with the following harmonized standards:

- EN 61204: 1995 (= IEC 61204: 1993, modified)
Low-voltage power supply devices, DC. output - Performance characteristics and safety requirements
- EN 60950-1: 2001 (IEC 60950-1: 2001)
Safety of information technology equipment.

The installation instructions given in the corresponding data sheet describe correct installation leading to the presumption of conformity of the end product with the LVD. All LW Series power supplies are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or by professional installers. They must not be operated as stand alone products.

Hence conformity with the Electromagnetic Compatibility Directive 89/336/EEC (EMC Directive) needs not to be declared. Nevertheless, guidance is provided in most product application notes on how conformity of the end product with the indicated EMC standards under the responsibility of the installer can be achieved, from which conformity with the EMC directive can be presumed.

Uster, 15 July 2005

Power-One AG



Rolf Baldauf
Vice President, Engineering



Johann Milavec
Director Projects and IP

EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56, CH-8610 Uster

declare under our sole responsibility that all LW-Series power supplies **with Feature E** carrying the CE-mark are in conformity with the provisions of the Low Voltage Directive (LVD) 73/23/EEC and the Electromagnetic Compatibility Directive 89/336/EEC of the European Communities.

Conformity with the directives is presumed by conformity with the following standards:

- EN 61204: 1995 (= IEC 61204: 1993, modified)
Low-voltage power supply devices, DC output - Performance characteristics and safety requirements
- EN 60950-1: 2001 (=IEC 60950-1: 2001)
Safety of information technology equipment
- EN 61000-6-2: 1999 (=IEC 61000-6-2: 1999)
Electromagnetic compatibility - Generic standards - Immunity for industrial environments
- EN 61000-6-3: 2001 (=IEC 61000-6-3: 2001)
Electromagnetic compatibility - Generic emission standards - Residential, commercial and light industry

The installation instructions given in the corresponding data sheet describe correct installation leading to the presumption of conformity of the end product with the LVD. All LW Series power supplies are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or by professional installers. They must not be operated as stand alone products.

It is the responsibility of the installer to ensure compliance of the end product with all provisions of the applicable standards and to declare presumption of conformity with the applicable European directives.

Uster, 15 July 2005

Power-One AG



Rolf Baldauf
Vice President, Engineering



Johann Milavec
Director Projects and IP

EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56, CH-8610 Uster

declare under our sole responsibility that all EW-Series power supplies carrying the CE-mark are in conformity with the provisions of the Low Voltage Directive (LVD) 73/23/EEC of the European Communities.

Conformity with the directives is presumed by conformity with the following standards:

- EN 61204
Low-voltage power supply devices, DC output - Performance characteristics and safety requirements
- EN 60950-1
Safety of information technology equipment

The installation instructions given in the corresponding data sheet describe correct installation leading to the presumption of conformity of the end product with the LVD. All EW Series power supplies are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or by professional installers. They must not be operated as stand alone products.

It is the responsibility of the installer to ensure compliance of the end product with all provisions of the applicable standards and to declare presumption of conformity with the applicable European directives.

Uster, 31 August 2006 Power-One AG



Rolf Baldauf
Vice President, Engineering



Johann Milavec
Director Projects and IP