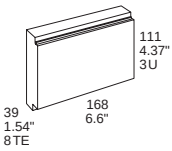
# H Series Data Sheet
# 70 Watt AC-DC Converters


RoHS Compliant

## Features

- Universal operating input voltage range 85 to 255 VAC
- RoHS lead-solder exemption compliant
- Class I equipment
- 1, 2, or 3 isolated outputs up to 64 V
- Input over- and undervoltage lockout
- Outputs: SELV, no load, overload, short-circuit proof, rectangular current limiting characteristic
- Adjustable output voltages with remote on/off
- Immunity according to IEC/EN 61000-4-2, -3, -4, -5, -6
- Emissions according to EN 55011/55022
- PCBs protected by lacquer
- Battery charger models available

Safety according to IEC/EN 60950-1, UL/CSA 60950-1

## Description

The H Series of AC-DC converters represents a flexible range of power supplies for use in advanced industrial electronic systems. Features include high efficiency, reliability, and low output voltage noise.

The converter inputs are protected against surges and transients occuring at the source lines. An input over- and undervoltage lockout circuit disables the outputs, if the input voltage is outside the specified range. An inrush current limitation prevents circuit breakers and fuses from tripping at switch-on.

All outputs are open- and short-circuit proof, and are protected against overvoltages by means of built-in suppressor diodes. The outputs can be inhibited by a logic signal applied to the connector (pin 2). If the inhibit function is not used, pin 2 should be connected to pin 23 to enable the outputs.

LED indicators display the status of the converter and allow visual monitoring of the system at any time.

Full input to output, input to case, output to case, and output to output isolation is provided. The converters are designed and built according to the international safety standards IEC/EN 60950-1 and UL/CSA 60950-1, and they are approved by the safety agencies TÜV and UL.

The case design allows operation at nominal load up to 50 °C in a free-air ambient temperature. If forced cooling is provided, the ambient temperature may exceed 50 °C but the case temperature should remain below 80 °C under all conditions.

A temperature sensor generates an inhibit signal, which disables the outputs, when the case temperature $T_C$ exceeds the limit. The outputs automatically recover, when the temperature drops below the limit.

Two options are available to adapt the converters to individual applications (D, V).

The converters may either be plugged into 19" rack system according to IEC 60927-3 or be mounted onto a chassis or a plate.

## Table of Contents

## Model Selection

Non-standard input/output configurations or special custom adaptions are available on request. Table 1 provides an overview of the basic input and output configurations. More than 1000 different types have been manufactured with different input/output configurations and customized specialities. Please consult Power-One for additional information.

*Table 1a: Standard models*

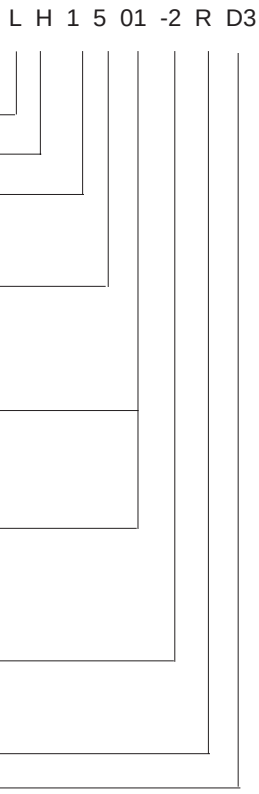
| Output 1 | | Output 2 | | Output 3 | | Operating input voltage range and efficiency[1] | | Options [2] |
|---|---|---|---|---|---|---|---|---|
| $V_{o\ nom}$ [VDC] | $I_{o\ nom}$ [A] | $V_{o\ nom}$ [VDC] | $I_{o\ nom}$ [A] | $V_{nom}$ [VDC] | $I_{o\ nom}$ [A] | $V_{i\ min}$ – $V_{i\ max}$ 85 – 255 VAC, 47 – 63 Hz | $\eta_{min}$ [%] | |
| 5.1 | 11 | - | - | - | - | LH1001-2R | 74 | D1 – D8, V2, V3 |
| 12 | 6 | - | - | - | - | LH1301-2R | 81 | D1 – D8 |
| 15 | 4.5 | - | - | - | - | LH1501-2R | 83 | D1 – D8 |
| 24 | 3 | - | - | - | - | LH1601-2R | 83 | D1 – D8 |
| 48 | 1.5 | - | - | - | - | LH1901-2R | 83 | D1 – D8 |
| 12 | 2 | 12 | 2 | - | - | LH2320-2 | 81 | D1 – D8 |
| 15 | 1.7 | 15 | 1.7 | - | - | LH2540-2 | 81 | D1 – D8 |
| 5.1 | 5 | 12 | 0.7 | 12 | 0.7 | LH3020-2 | 78 | D1 – D8, V2, V3 |
| 5.1 | 5 | 15 | 0.6 | 15 | 0.6 | LH3040-2 | 78 | D1 – D8, V2, V3 |

*Table 1b: Battey charger models*

| Output | | | | Operating input voltage range and efficiency[1] | | Options [2] |
|---|---|---|---|---|---|---|
| $V_{Bat}$ [VDC] | $V_{o\ safe}$ [3] [VDC] | $V_{o\ max}$ [VDC] | $I_{o\ nom}$ [A] | $V_{i\ min}$ – $V_{i\ max}$ 85 – 255 VAC, 47 – 63 Hz | $\eta_{min}$ [%] | |
| 12 | 12.84 | 14.15 – 14.6 | 5.0 | LH1781-2R | 81.5 | D1 – D8 |
| 24 | 25.68 | 28.3 – 29.15 | 2.5 | LH1782-2R | 81.5 | |
| 36 | 38.52 | 42.45 – 43.72 | 1.67 | LH1783-2R | 83.5 | |
| 48 | 51.36 | 56.6 – 58.3 | 1.25 | LH1784-2R | 83.5 | |
| 60 | 64.2 | 70.75 – 72.87 | 1.0 | LH1785-2R | 83.5 | |

[1] Min. efficiency at $V_{i\ nom}$ and $I_{o\ nom}$. Typical values are approx. 2% better.
[2] Ask Power-One for availability!
[3] Setting voltage with open R-input (battery chargers)

### Part Number Description




Operating input range $V_i$:
85 – 255 VAC, 47 – 63 Hz ..... L
Series ..... H
Number of outputs ..... 1, 2, 3
Output 1, $V_{o1\ nom}$:
5.1 V ..... 0, 1, 2
12 V ..... 3
15 V ..... 4, 5
24 V ..... 6
other voltages ..... 7, 8
48 V ..... 9
Single-output models (different specs.) ..... 01 – 99
Outputs 2, 3: $V_{o2\ nom}$, $V_{o3\ nom}$:
5.1 V ..... 01 – 19
12 V ..... 20 – 39
15 V ..... 40 – 59
24 V ..... 60 – 69
other voltages for multiple-output models ..... 70 – 99
Ambient temperature range $T_A$:
–10 to 50 °C ..... -2
customer-specific ..... -0
Auxiliary functions and options:
Output voltage control input (single-output models) .... R
Save data signal (D1 – D8, to be specified) ..... D [1]
ACFAIL signal (V2, V3, to be specified) ..... V [1]

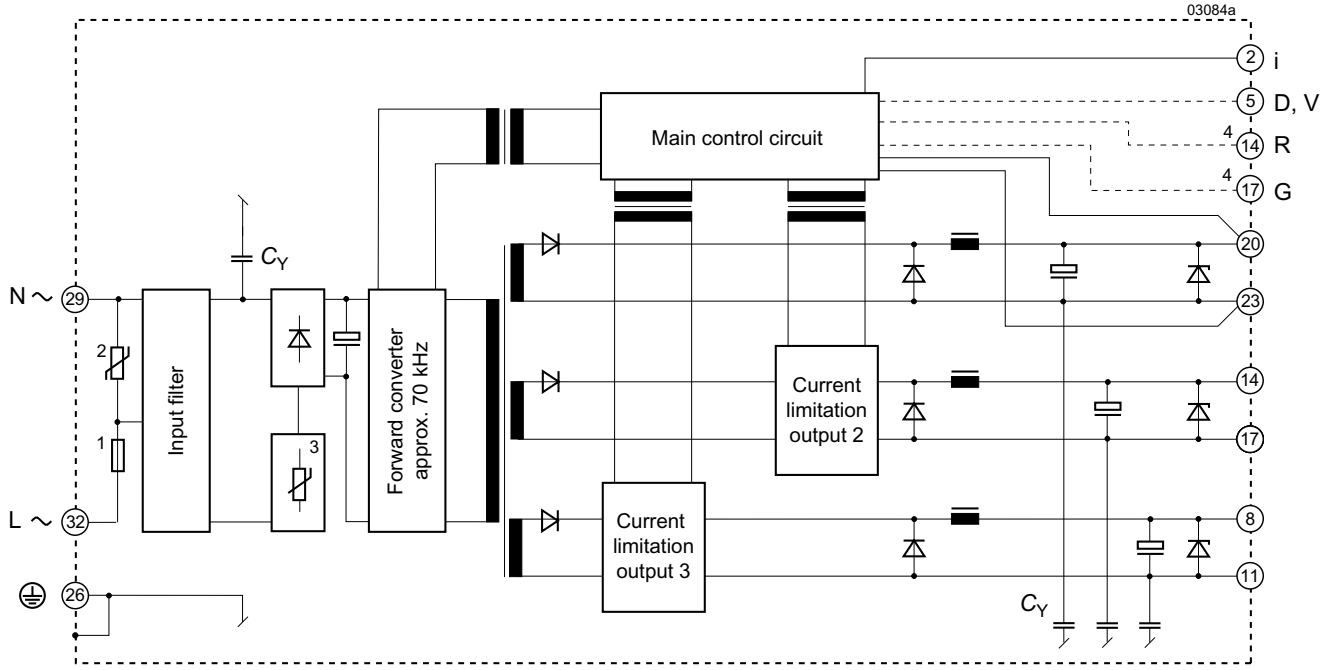
[1] Option D excludes option V and vice versa

Example: LH1501-2D3: AC-DC converter,operating input voltage range 85 – 255 VAC, providing one output with 15 V / 4.5 A, equipped with an output voltage adjust input (R), and undervoltage monitor D3.

## Functional Description

The input voltage is fed via an input fuse, an input filter, and an inrush current limiter to the input capacitor. This capacitor sources a single-transistor forward converter. Each output is powered by a separate secondary winding of the main transformer. The resultant voltages are rectified and their ripples smoothed by a power choke and an output capacitor. The main control circuit senses the main output voltage $V_{o1}$ and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor. This signal is transferred to the primary side by a coupling transformer.

The auxiliary output voltages $V_{o2}$ and $V_{o3}$ are tracking. Each auxiliary output's current is sensed using a current transformer. If one of the outputs is driven into current limit, the other outputs will reduce their output voltages as well, because all output currents are controlled by the same main control circuit.




[1] Input fuse
[2] Transient suppressor
[3] Inrush current limiter (NTC)
[4] Adjust input for single-output models with feature R.

*Fig. 1*
*Block diagram of a triple-output model.*

## Electrical Input Data

General conditions:
– $T_A$ = 25 °C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, R input not connected; with option P: $V_o = V_{o\,nom}$

*Table 2: Input data*

| Input | | | LM | | | Unit |
|---|---|---|---|---|---|---|
| Characteristics | | Conditions | min | typ | max | |
| $V_i$ | Operating input voltage | $I_o$ = 0 – $I_{o\,nom}$<br>$T_{C\,min}$ – $T_{C\,max}$ | 85 | | 255 | VAC[1] |
| $V_{i\,nom}$ | Nominal input voltage | | | 230 | | |
| $I_i$ | Input current | $V_{i\,nom}$, $I_o = I_{o\,nom}$ [2] | | 0.44 | | A |
| $P_{i\,0}$ | No-load input power:<br>Single-output model<br>Double-output model<br>Triple-output model | $V_{i\,nom}$<br>$I_{o1,2,3}$ = 0 | | <br>1<br>7<br>7 | <br>2.5<br>9<br>9 | W |
| $P_{i\,inh}$ | Idle input power | inhibit mode | | | 2.5 | |
| $I_{inr\,p}$ [5] | Peak inrush current | $V_i = V_{i\,max}$<br>$R_S$ = 0 Ω [3]<br>$T_C$ = 25 °C | | | 42 [4] | A |
| $t_{inr\,r}$ | Rise time | | | 300 | | µs |
| $t_{inr\,h}$ | Time to half-value | | | 1600 | | |
| $R_i$ | Input resistance | $T_C$ = 25 °C | 800 | | | mΩ |
| $R_{NTC}$ | NTC resistance | | 8000 [4] | | | |
| $C_i$ | Input capacitance | | 140 | | 270 | µF |
| $V_{i\,abs}$ | Input voltage limits without any damage | | 0 | | 284 | VAC |

[1] Frequency 47 – 63 Hz
[2] With multiple-output models, the same condition for each output applies.
[3] $R_S$ = source resistance.
[4] Value for initial switch-on cycle.
[5] $I_{inr\,p} = V_i / (R_s + R_i + R_{NTC})$; see *Inrush Current*.

### Input Fuse

A slow-blow fuse (Schurter SPT 2.5 A, 250 V, size 5 × 20 mm) mounted inside of the converter protects against severe defects. The fuse is not accessible by the user.

The fuse and a VDR form together with the input filter an effective protection against high input transients.

### Input Under-/Overvoltage Lockout

If the input voltage is below approx. 60 VAC or exceeds approx. 280 VAC, an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $V_{i\,abs}$ must be carefully considered (see table *Input data*).

**Note:** When $V_i$ is between $V_{i\,min}$ and the undervoltage lockout level, the output voltage may be below the value defined in table *Output data*.

### Inrush Current

The converters incorporate an NTC resistor in the input line, which at initial switch-on cycle limits the peak inrush current, in order to prevent the connectors and switching devices from damage. Subsequent switch-on cycles within a short interval will cause an increase of the peak inrush current due to the warming-up of the NTC resistor.

The inrush current at switch-on can be calculated as follows:

$$I_{inr\,p} = \sqrt{2} \bullet V_{i\,rms} / (R_s + R_i + R_{NTC})$$

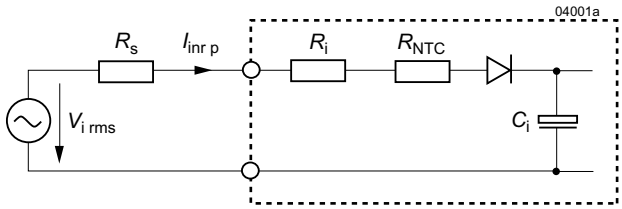



*Fig. 2*
*Equivalent circuit diagram for input impedance*

## Electrical Output Data

General conditions
– $T_A$ = 25 °C, unless $T_C$ is specified.
– Connector pins 2 and 23 interconnected, R input not connected.

*Table 3a: Output data of single-output models*

| **Output** | | | $V_{o\,nom}$ | **5.1 V** | | | **12 V** | | | **15 V** | | | **24 V** | | | **48 V** | | | **Unit** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristics** | | | **Conditions** | **min** | **typ** | **max** | **min** | **typ** | **max** | **min** | **typ** | **max** | **min** | **typ** | **max** | **min** | **typ** | **max** | |
| $V_o$ | Output voltage | | $V_{i\,nom}$, $I_{o\,nom}$ | 5.0 | | 5.20 | 11.76 | | 12.24 | 14.70 | | 15.30 | 23.52 | | 24.48 | 47.04 | | 48.96 | V |
| $V_{o\,p}$ | Output overvoltage protection[1] | | | | 7.5 | | | 21 | | | 25 | | | 41 | | | 85 | | |
| $I_{o\,nom}$ | Output current | | $V_{i\,min}$ – $V_{i\,max}$ $T_{C\,min}$ – $T_{C\,max}$ | 0 | | 11 | 0 | | 6 | 0 | | 4.5 | 0 | | 3 | 0 | | 1.5 | A |
| $I_{o\,L}$ | Output current limit | | | 11.44 | | | 6.24 | | | 4.68 | | | 3.12 | | | 1.56 | | | |
| $v_o$ | Output voltage noise | Switch. freq. | $V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 BW = 20 MHz | | 30 | 50 | | 60 | 100 | | 50 | 80 | | 50 | 80 | | 50 | 100 | $mV_{pp}$ |
| | | Total | | | 60 | 120 | | 40 | 80 | | 40 | 80 | | 40 | 80 | | - | | |
| $\Delta V_{o\,V}$ | Static line regulation | | $V_{i\,min}$ – $V_{i\,nom}$ $V_{i\,nom}$ – $V_{i\,max}$ $I_{o\,nom}$ | | | ±50 | | | ±100 | | | ±100 | | | ±150 | | | ±150 | mV |
| $\Delta V_{o\,l}$ | Static load regulation | | $V_{i\,nom}$, $I_{o\,nom}$ – 0 | | | 50 | | | 150 | | | 150 | | | 150 | | | 150 | |
| $v_{o\,d}$ | Dynamic load regulation[2] | Voltage deviation | $V_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 | | ±220 | | | ±400 | | | ±200 | | | ±200 | | | ±150 | | |
| $t_d$ | | Recovery time | | | 100 | | | 80 | | | 80 | | | 80 | | | 120 | | µs |
| $\alpha_{Vo}$ | Temperature coefficient $\Delta V_o/\Delta T_C$ | | $V_{i\,min}$ – $V_{i\,max}$ 0 – $I_{o\,nom}$ | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | | ±0.02 | | %/K |
| | | | | | ±1.0 | | | ±2.4 | | | ±3.0 | | | ±4.8 | | | ±9.6 | | mV/K |

[1] By suppressor diode
[2] See fig. 4 *Dynamic load regulation.*

*Table 3b: Output data of double-output models. Same general conditions as per table 3a*

| Output | | | $V_{o\,nom}$ | 2 × 12 V | | | | | | 2 × 15 V | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | Conditions | | | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $V_o$ | Output voltage | | $V_{i\,nom}$, $I_{o\,nom}$ | 11.76 | | 12.24 | 11.4 | | 12.6 | 14.7 | | 15.3 | 14.25 | | 15.75 | V |
| | | | $V_{i\,nom}$, $I_{o2}$ = 0 | | | | | | 13.8 | | | | | | 17.25 | |
| $V_{o\,p}$ | Output overvoltage protection | | | | 21 | | | 25 | | | 25 | | | 31 | | |
| $I_{o\,nom}$ | Output current | | $V_{i\,min}$ – $V_{i\,max}$ $T_{C\,min}$ – $T_{C\,max}$ | 0 | | 2 | 0 | | 2 | 0 | | 1.7 | 0 | | 1.7 | A |
| $I_{o\,L}$ | Output current limit | | | 2.08 | | | 2.08 | | | 1.77 | | | 1.77 | | | |
| $v_o$ | Output voltage noise [1] | Switch. freq. | $V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 BW = 20 MHz | | 15 | 30 | | 20 | 40 | | 15 | 30 | | 20 | 40 | $mV_{pp}$ |
| | | Total | | | 50 | 150 | | 50 | 150 | | 40 | 150 | | 40 | 150 | |
| $\Delta V_{o\,V}$ | Static line regulation | | $V_{i\,min}$ – $V_{i\,nom}$ $V_{i\,nom}$ – $V_{i\,max}$ $I_{o\,nom}$ | | | ±50 | | | ±80 | | | ±60 | | | ±180 | mV |
| $\Delta V_{o\,I}$ | Static load regulation | | $V_{i\,nom}$, $I_{o\,nom}$ – 0 [3] | | | 50 | | [2] | | | 60 | | | [2] | | |
| $\alpha_{Vo}$ | Temperature coefficient $\Delta V_o/\Delta T_C$ | | $V_{i\,min}$ – $V_{i\,max}$ 0 – $I_{o\,nom}$ | | ±2.4 | | | | | | ±3.0 | | | | | mV/K |

*Table 3c: Output data of triple-output models. Same general conditions as per table 3a*

| Output | | | $V_{o\,nom}$ | 5.1 V, 2 × 12 V | | | | | | 5.1 V, 2 × 15 V | | | | | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Characteristics | Conditions | | | Output 1 | | | Output 2 | | | Output 1 | | | Output 2 | | | |
| | | | | min | typ | max | min | typ | max | min | typ | max | min | typ | max | |
| $V_o$ | Output voltage | | $V_{i\,nom}$, $I_{o\,nom}$ | 5.0 | | 5.2 | 11.4 | | 12.6 | 5.0 | | 5.2 | 14.25 | | 15.75 | V |
| | | | $V_{i\,nom}$, $I_{o2}$ = $I_{o3}$ = 0 | | | | | | 13.8 | | | | | | 17.25 | |
| $V_{o\,p}$ | Output overvoltage protection | | | | 7.5 | | | 25 | | | 7.5 | | | 31 | | |
| $I_{o\,nom}$ | Output current | | $V_{i\,min}$ – $V_{i\,max}$ $T_{C\,min}$ – $T_{C\,max}$ | 0 | | 5 | 0 | | 0.7 | 0 | | 5 | 0 | | 0.6 | A |
| $I_{o\,L}$ | Output current limit | | | 5.2 | | | 0.73 | | | 5.2 | | | 0.62 | | | |
| $v_o$ | Output voltage noise [1] | Switch. freq. | $V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 BW = 20 MHz | | 15 | 30 | | 10 | 20 | | 15 | 30 | | 10 | 20 | $mV_{pp}$ |
| | | Total | | | 30 | 150 | | 50 | 150 | | 40 | 150 | | 40 | 150 | |
| $\Delta V_{o\,V}$ | Static line regulation | | $V_{i\,min}$ – $V_{i\,nom}$ $V_{i\,nom}$ – $V_{i\,max}$ $I_{o\,nom}$ | | | ±30 | | | ±150 | | | ±30 | | | ±150 | mV |
| $\Delta V_{o\,I}$ | Static load regulation | | $V_{i\,nom}$, $I_{o\,nom}$ – 0 [3] | | | 25 | | [2] | | | 250 | | | [2] | | |
| $\alpha_{Vo}$ | Temperature coefficient $\Delta V_o/\Delta T_C$ | | $V_{i\,min}$ – $V_{i\,max}$ 0 – $I_{o\,nom}$ | | ±1.0 | | | | | | ±1.0 | | | | | mV/K |

[1] Measured with a clamp according to IEC 61204
[2] See *Voltage regulation of tracking outputs*
[3] Condition for the specified output; other outputs loaded with $I_{o\,nom}$

## Output Characteristic and Protection

Each output is protected by a suppressor diode, which under a worst case condition may become a short circuit. The suppressor diodes are not designed to withstand externally applied overvoltages. Overload at any of the outputs will cause a shutdown of all outputs. A red LED indicates the overload condition of the respective output.

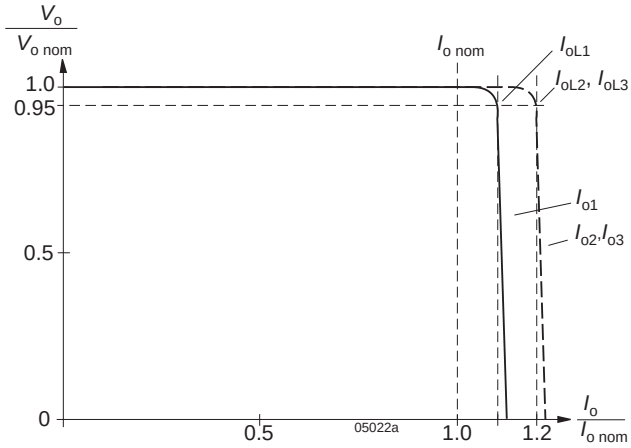



*Fig. 3*

*Typical main output voltage $V_{o1}$ versus current $I_{o1}$*

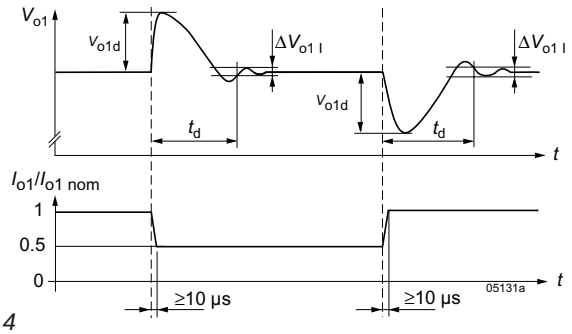



*Fig.4*

*Dynamic load regulation of $V_{o1}$ versus load change.*

## Regulation of Multiple-Output Models

Output 1 is under normal conditions regulated to $V_{o1\,nom}$, regardless of the output current. The voltage of the tracking outputs 2 and 3 depends upon their load and the load on output 1; see fig. 5 to 8.

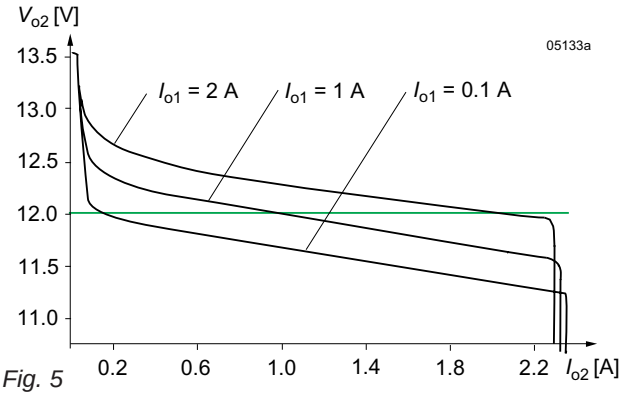



*Fig. 5*

*Static load regulation $V_{o2}$ versus $I_{o1}$ (LH2320-2)*

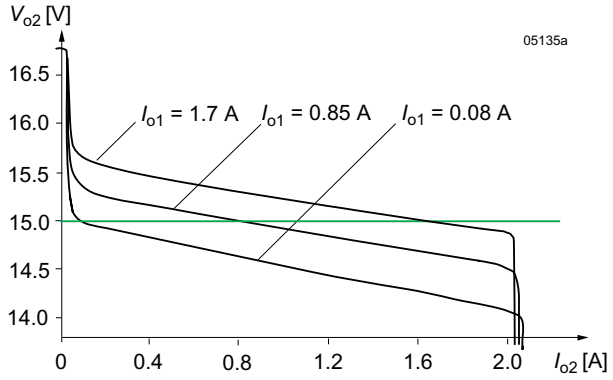



*Fig. 6*

*Static load regulation $V_{o2}$ versus $I_{o1}$ (LH2540-2)*

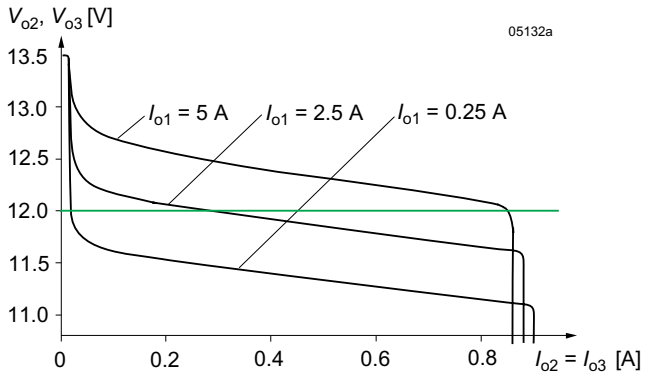



*Fig. 7*

*Static load regulation $V_{o2}$ and $V_{o3}$ versus $I_{o1}$ (LH3020-2, $I_{o2}$ = $I_{o3}$)*

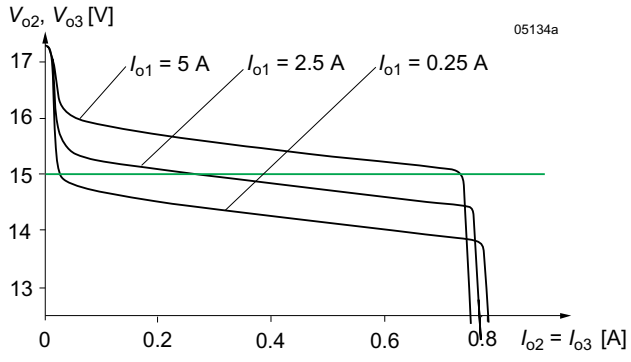



*Fig. 8*

*Static load regulation $V_{o2}$ and $V_{o3}$ versus $I_{o1}$ (LH3040-2, $I_{o2}$ = $I_{o3}$)*

## Thermal Considerations and Protection

If a converter is located in free, quasi-stationary air (convection cooling) at the indicated maximum ambient temperature $T_{A\,max}$ (see table *Temperature specifications)* and is operated at its nominal input voltage and output power, the temperature measured at the measuring point of case temperature $T_C$ (see *Mechanical Data*) will approach the indicated value $T_{C\,max}$ after the warm-up phase. However, the relationship between $T_A$ and $T_C$ depends heavily on the conditions of operation and integration into a system. The thermal conditions are influenced by input voltage, output current, airflow, and temperature of surrounding components and surfaces. $T_{A\,max}$ 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.*

**Notes:** Sufficient forced cooling or an additional heat sink allow $T_A$ to pass over 50 °C, if $T_{C\,max}$ is not exceeded.

At an ambient temperature $T_A$ of 65 °C with only convection cooling, the maximum permissible current for each output is approx. 50% of its nominal value; see fig. 9 .

A temperature sensor generates an internal inhibit signal disabling the outputs, when the case temperature exceeds $T_{C\,max}$. The outputs automatically recover, when the temperature drops below this limit.

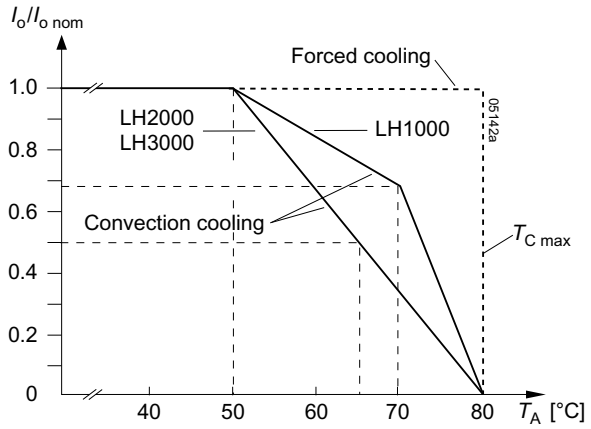



*Fig. 9*

*Output current derating versus temperature*

## Parallel and Series Connection

Main outputs of equal nominal voltage can be connected in parallel. It is important to assure that the main output of a multiple-output converter is forced to supply a minimum current of 10% of $I_{o\,nom}$ to enable correct operation of its own auxiliary outputs.

In parallel operation, one or more of the main outputs may operate continuously in current limitation, causing an increase of the case temperature $T_C$. Consequently, a reduction of the max. ambient temperature by 10 K is recommended.

Both outputs of a **double-output converter** may be connected in parallel without any restriction.

**Note:** If output 2 of a double-output converter is not used, we recommend to connect it in parallel with the main output.

Output 2 and output 3 of a **triple-output converter** may be connected in parallel without any restriction.

**Note:** If the output 2 or 3 of a triple-output converter is not used, we recommend to connect it in parallel with the other auxiliary output.

Main or auxiliary outputs can be connected in series with any other output of the same or another converter. In series connection, the maximum output current is limited by the lowest current limit. Output ripple and regulation values are added. Connection wiring should be kept as short as possible.

If output terminals are connected together in order to establish multi-voltage configurations, e.g., +5.1 V, ±12 V etc., the common-ground connecting point should be as close as possible to the connector of the converter in order to avoid excessive output ripple voltages.

Auxiliary outputs of different converters should not be connected in parallel!

## Auxiliary Functions

### i Inhibit

The outputs of the converters may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied between the inhibit input i and the negative pin of output 1 (Vo1–). In systems with several converters, this feature can be used, for example, to control the activation sequence of the converters. If the inhibit function is not required, connect the inhibit pin 2 to pin 23 to enable the outputs (active low logic, fail safe). The response times are specified in fig. 12.

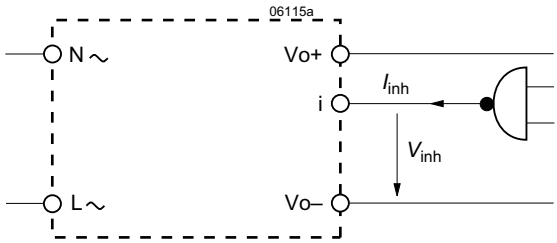



*Fig. 11*
*Definition of $V_{inh}$ and $I_{inh}$.*

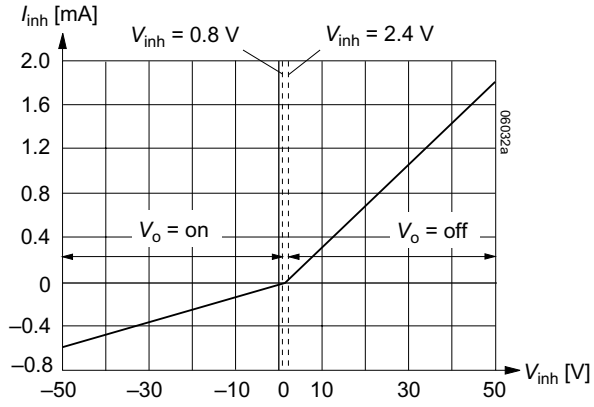



*Fig. 10*
*Typical inhibit current $I_{inh}$ versus inhibit voltage $V_{inh}$*

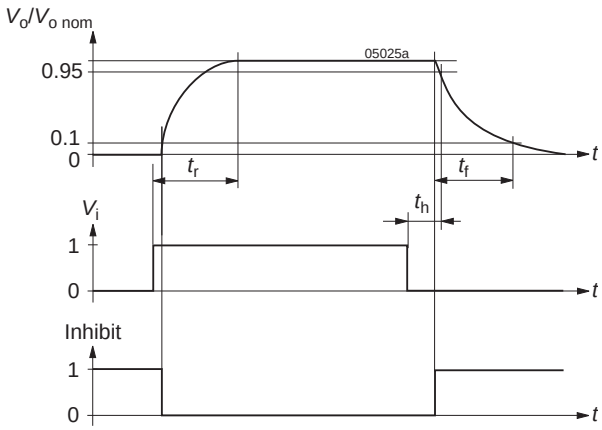



*Fig. 12*
*Output response as a function of $V_i$ or inhibit control*

*Table 4: Inhibit data*

| Characteristics | | | Conditions | min | typ | max | Unit |
|---|---|---|---|---|---|---|---|
| $V_{inh}$ | Inhibit input voltage to keep output voltage | $V_o$ = on | $V_{i\ min} – V_{i\ max}$ $T_{C\ min} – T_{C\ max}$ | –50 | | 0.8 | V |
| | | $V_o$ = off | | 2.4 | | 50 | |
| $I_{inh}$ | Inhibit current | | $V_{inh}$ = 0 | –60 | –100 | –220 | µA |

*Table 5: Output response time $t_r$ and $t_f$ (see fig. 4). Values not applicable for models equipped with option E.*

| Type of converter | $t_r$ at $P_o$ = 0 and $t_f$ at $P_o = P_{o\ nom}$ | | $t_r$ and $t_f$ at $P_o = {}^3/_4 P_{o\ nom}$ | | $t_r$ at $P_o = P_{o\ nom}$ | | Unit |
|---|---|---|---|---|---|---|---|
| | typ | max | typ | max | typ | max | |
| LH1001-2R | 3 | 17 | 3 | 17 | 5 | 25 | ms |
| LH1301-2R | 5 | 25 | 8 | 30 | 10 | 40 | |
| LH1501-2R | 3 | 17 | 5 | 25 | 15 | 50 | |
| LH1601-2R | 8 | 30 | 15 | 45 | 20 | 70 | |
| LH1901-2R | 35 | 100 | 50 | 150 | 85 | 230 | |
| LH2320-9 | 10 | 40 | 15 | 50 | 25 | 80 | |
| LH2540-9 | 8 | 30 | 20 | 40 | 20 | 60 | |
| LH3020-9 | 30 | 85 | 45 | 130 | 75 | 210 | |
| LH3040-9 | 20 | 70 | 30 | 90 | 50 | 150 | |

Conditions:

R input not connected. For multiple-output models the figures indicated in the table relate to the output, which reacts slowest. All outputs are resistively loaded. Variation of the input voltage within $V_{i\ min} – V_{i\ max}$ does not influence the values considerably.

## R Output Voltage Adjustment

As a standard feature, single-output models offer an adjustable output voltage identified by letter R in the type designation.

**Note:** With open R input, $V_o = V_{o\ nom}$.

The output voltage $V_o$ can either be adjusted by an external voltage ($V_{ext}$) or by an external resistor ($R_{ext1}$ or $R_{ext2}$). The adjustment range is approximative 0 – 110% of $V_{o\ nom}$. For output voltages $V_o > V_{o\ nom}$, the minimum input voltage $V_{i\ min}$ specified in *Electrical Input Data* increases proportionally to $V_o/V_{o\ nom}$.

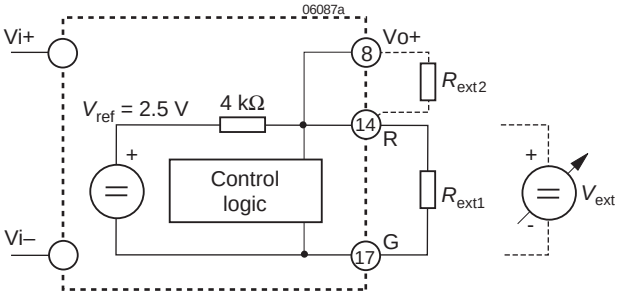



*Fig. 13*
*Output voltage adjustment*

a) Adjustment by means of an external resistor $R_{ext}$:
Depending upon the value of the required output voltage, the resistor shall be connected:
**either:** Between the R and G pin to achieve an output voltage adjustment range of $V_o \approx 0$ to 100% of $V_{o\ nom}$.

$$R_{ext1} \approx 4\ k\Omega \bullet \frac{V_o}{V_{o\ nom} - V_o}$$

**or:** Between the R pin and Vo+ to achieve an output voltage range of $V_o \approx 100$ to 110% of $V_{o\ nom}$.

$$R_{ext2} \approx 4\ k\Omega \bullet \frac{(V_o - 2.5\ V)}{2.5\ V \bullet (V_o/V_{o\ nom} - 1)}$$

**Caution:** To prevent damage, $R_{ext2}$ should never be less than 47 kΩ.

**Note:** R inputs of n converters with paralleled outputs may be paralleled too, but if only one external resistor is used, its value should be $R_{ext1}/n$ or $R_{ext2}/n$ respectively.

b) Adjustment by means of an external control voltage $V_{ext}$ between G and R pin:
The control voltage range is 0 to 2.75 V and allows for adjustment in the range of $V_o \approx 0$ to 110% of $V_{o\ nom}$.

$$V_{ext} \approx \frac{V_o \bullet 2.5\ V}{V_{o\ nom}}$$

**Caution:** The external control voltage should be in the range 0 to +3 V to prevent the converter from damage.

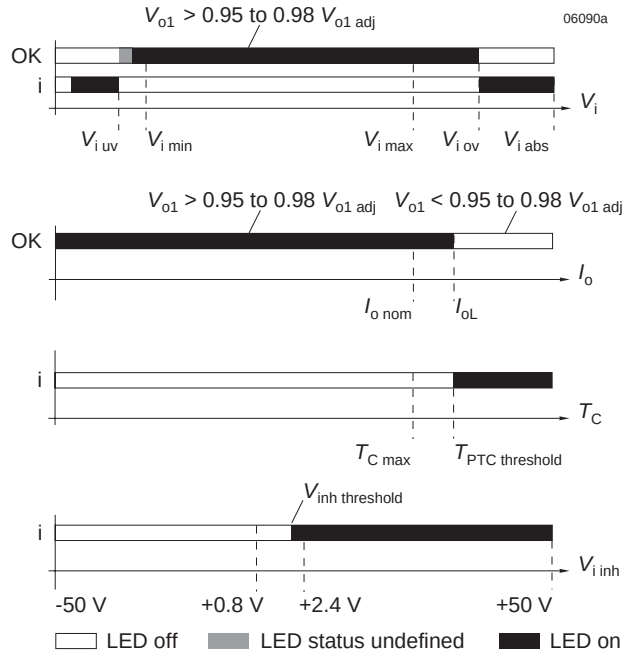
*Table 6a: $R_{ext1}$ for $V_o < V_{o\ nom}$ (conditions: $V_{i\ nom}$, $I_{o\ nom}$, rounded up to resistor values E 96, $R_{ext2}$ is not fitted )*

| $V_{o\ nom}$ = 5.1 V | | $V_{o\ nom}$ = 12 V | | $V_{o\ nom}$ = 15 V | | $V_{o\ nom}$ = 24 V | | $V_{o\ nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $V_o$ [V] | $R_{ext1}$ [kΩ] | $V_o$ [V] | $R_{ext1}$ [kΩ] | $V_o$ [V] | $R_{ext1}$ [kΩ] | $V_o$ [V] | $R_{ext1}$ [kΩ] | $V_o$ [V] | $R_{ext1}$ [kΩ] |
| 0.5 | 0.432 | 2.0 | 0.806 | 2.0 | 0.619 | 4.0 | 0.806 | 8.0 | 0.806 |
| 1.0 | 0.976 | 3.0 | 1.33 | 4.0 | 1.47 | 6.0 | 1.33 | 12.0 | 1.33 |
| 1.5 | 1.65 | 4.0 | 2.0 | 6.0 | 2.67 | 8.0 | 2.0 | 16.0 | 2.0 |
| 2.0 | 2.61 | 5.0 | 2.87 | 8.0 | 4.53 | 10.0 | 2.87 | 20.0 | 2.87 |
| 2.5 | 3.83 | 6.0 | 4.02 | 9.0 | 6.04 | 12.0 | 4.02 | 24.0 | 4.02 |
| 3.0 | 5.76 | 7.0 | 5.62 | 10.0 | 8.06 | 14.0 | 5.62 | 28.0 | 5.62 |
| 3.5 | 8.66 | 8.0 | 8.06 | 11.0 | 11.0 | 16.0 | 8.06 | 32.0 | 8.06 |
| 4.0 | 14.7 | 9.0 | 12.1 | 12.0 | 16.2 | 18.0 | 12.1 | 36.0 | 12.1 |
| 4.5 | 30.1 | 10.0 | 20.0 | 13.0 | 26.1 | 20.0 | 20.0 | 40.0 | 20.0 |
| 5.0 | 200.0 | 11.0 | 44.2 | 14.0 | 56.2 | 22.0 | 44.2 | 44.0 | 44.2 |

*Table 6b: $R_2$ for $V_o > V_{o\ nom}$ (conditions: $V_{i\ nom}$, $I_{o\ nom}$, rounded up to resistor values E 96, $R_{ext1}$ is not fitted )*

| $V_{o\ nom}$ = 5.1 V | | $V_{o\ nom}$ = 12 V | | $V_{o\ nom}$ = 15 V | | $V_{o\ nom}$ = 24 V | | $V_{o\ nom}$ = 48 V | |
|---|---|---|---|---|---|---|---|---|---|
| $V_o$ [V] | $R_{ext2}$ [kΩ] | $V_o$ [V] | $R_{ext2}$ [kΩ] | $V_o$ [V] | $R_{ext2}$ [kΩ] | $V_o$ [V] | $R_{ext2}$ [kΩ] | $V_o$ [V] | $R_{ext2}$ [kΩ] |
| 5.15 | 464 | 12.1 | 1780 | 15.2 | 1470 | 24.25 | 3160 | 48.5 | 6810 |
| 5.20 | 215 | 12.2 | 909 | 15.4 | 750 | 24.50 | 1620 | 49.0 | 3480 |
| 5.25 | 147 | 12.3 | 619 | 15.6 | 511 | 24.75 | 1100 | 49.5 | 2370 |
| 5.30 | 110 | 12.4 | 464 | 15.8 | 383 | 25.00 | 825 | 50.0 | 1780 |
| 5.35 | 90.9 | 12.5 | 383 | 16.0 | 332 | 25.25 | 715 | 50.5 | 1470 |
| 5.40 | 78.7 | 12.6 | 316 | 16.2 | 274 | 25.50 | 590 | 51.0 | 1270 |
| 5.45 | 68.1 | 12.7 | 274 | 16.4 | 237 | 25.75 | 511 | 51.5 | 1100 |
| 5.50 | 61.9 | 12.8 | 249 | 16.5 | 226 | 26.00 | 453 | 52.0 | 953 |
| | | 13.0 | 200 | | | 26.25 | 402 | 52.5 | 845 |
| | | 13.2 | 169 | | | 26.40 | 383 | 52.8 | 806 |

### Display Status of LEDs




*LEDs "OK" and "i" status versus input voltage $V_i$*

*Conditions: $I_o \le I_{o\ nom}$, $T_C \le T_{C\ max}$, $V_{inh} \le 0.8$ V*

*LED "OK" and "$I_{o\ L}$" status versus output current $I_o$*

*Conditions: $V_{i\ min} - V_{i\ max}$, $T_C \le T_{C\ max}$, $V_{inh} \le 0.8$ V*

*LED "i" versus case temperature*

*Conditions: $V_{i\ min} - V_{i\ max}$, $I_o \le I_{o\ nom}$, $V_{inh} \le 0.8$ V*

*LED "i" versus $V_{inh}$*

*Conditions: $V_{i\ min} - V_{i\ max}$, $I_o \le I_{o\ nom}$, $T_C \le T_{C\ max}$*

*Fig. 14*
*Status of LEDs.*
*$V_{i\ uv}$ = undervoltage lockout, $V_{i\ ov}$ = overvoltage lockout*

## Electromagnetic Compatibility (EMC)

A metal oxide VDR (depending upon converter model) together with an input fuse and an input filter form an effective protection against high input transient voltages, which typically occur in most installations, but especially in battery-driven mobile applications. The H series has been successfully tested to the following specifications:

### Electromagnetic Immunity

*Table 7: Immunity type tests*

| Phenomenon | Standard | Level | Coupling mode [2] | Value applied | Waveform | Source imped. | Test procedure | In oper. | Per-form.[3] |
|---|---|---|---|---|---|---|---|---|---|
| Electrostatic discharge (to case) | IEC/EN 61000-4-2 | 2 | contact discharge | 4000 $V_p$ | 1/50 ns | 330 Ω | 10 positive and 10 negative discharges | yes | A |
| Electromagnetic field | IEC/EN 61000-4-3 | x | antenna | 20 V/m | AM 80% 1 kHz | n.a. | 26 to 1000 MHz | yes | A [1] |
| Electrical fast transient/burst | IEC/EN 61000-4-4 | 1 | direct, i/c, +i/–i | 500 $V_p$ | 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 | |
| Surge | IEC/EN 61000-4-5 | 1 | i/c | 500 $V_p$ | 1.2/50 µs | 12 Ω | 5 pos. and 5 neg. surges per | yes | A |
| | | 1 | +i/–i | 500 $V_p$ | | 2 Ω | | | |

[1] For converters with 3 output voltages, temporary deviation from specs possible
[2] i = input, o = output, c = case
[3] A = Normal operation, no deviation from specifications, B = Normal operation, temporary deviation from specs possible

### Electromagnetic Emissions

*Table 8: Emissions at $V_{i\ nom}$ and $I_{o\ nom}$*

| Series | IEC/EN 55022 | |
|---|---|---|
| | ≤30 MHz | ≥30 MHz |
| LH | <A | <B |

## Immunity to Environmental Conditions

*Table 9: Mechanical and climatic stress*

| Test method | | Standard | Test conditions | | Status |
|---|---|---|---|---|---|
| Cab | Damp heat steady state | IEC/EN 60068-2-78<br>MIL-STD-810D section 507.2 | Temperature:<br>Relative humidity:<br>Duration: | 40 $^{\pm 2}$ °C<br>93 $^{+2/-3}$ %<br>21 days | Converter not operating |
| Ea | Shock (half-sinusoidal) | IEC/EN 60068-2-27<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 15 $g_n$ = 147 m/s$^2$<br>6 ms<br>18 (3 each direction) | Converter operating |
| Eb | Bump (half-sinusoidal) | IEC/EN 60068-2-29<br>MIL-STD-810D section 516.3 | Acceleration amplitude:<br>Bump duration:<br>Number of bumps: | 10 $g_n$ = 98 m/s$^2$<br>16 ms<br>6000 (1000 each direction) | Converter operating |
| Fc | Vibration (sinusoidal) | IEC/EN/DIN EN 60068-2-6<br>MIL-STD-810D section 514.3 | Acceleration amplitude:<br><br>Frequency (1 Oct/min):<br>Test duration: | 0.15 mm (10 – 60 Hz)<br>2 $g_n$ = 20 m/s$^2$ (60 – 150 Hz)<br>10 – 150 Hz<br>3.75 h (1.25 h each axis) | Converter operating |

### Temperatures

*Table 10: Temperature specifications, values given are for an air pressure of 800 – 1200 hPa (800 – 1200 mbar)*

| Temperature | | | Standard -2 | | |
|---|---|---|---|---|---|
| Characteristics | | Conditions | min | max | Unit |
| $T_A$ | Ambient temperature | Operational | –10 | 50 [1] | °C |
| $T_C$ | Case temperature | | –10 | 80 | |
| $T_S$ | Storage temperature | Not operational | –25 | 100 | |

[1] Single output models up to 71 °C with derating.

### Reliability

*Table 11: MTBF*

| Values at specified Case Temperature | Model | Ground benign 40 °C | Unit |
|---|---|---|---|
| MTBF [1] | LH1000<br>LH2000<br>LH3000 | 384 000<br>306 000<br>270 000 | h |

[1] Calculated in accordance with MIL-HDBK-217E

## Mechanical Data

Dimensions in mm.

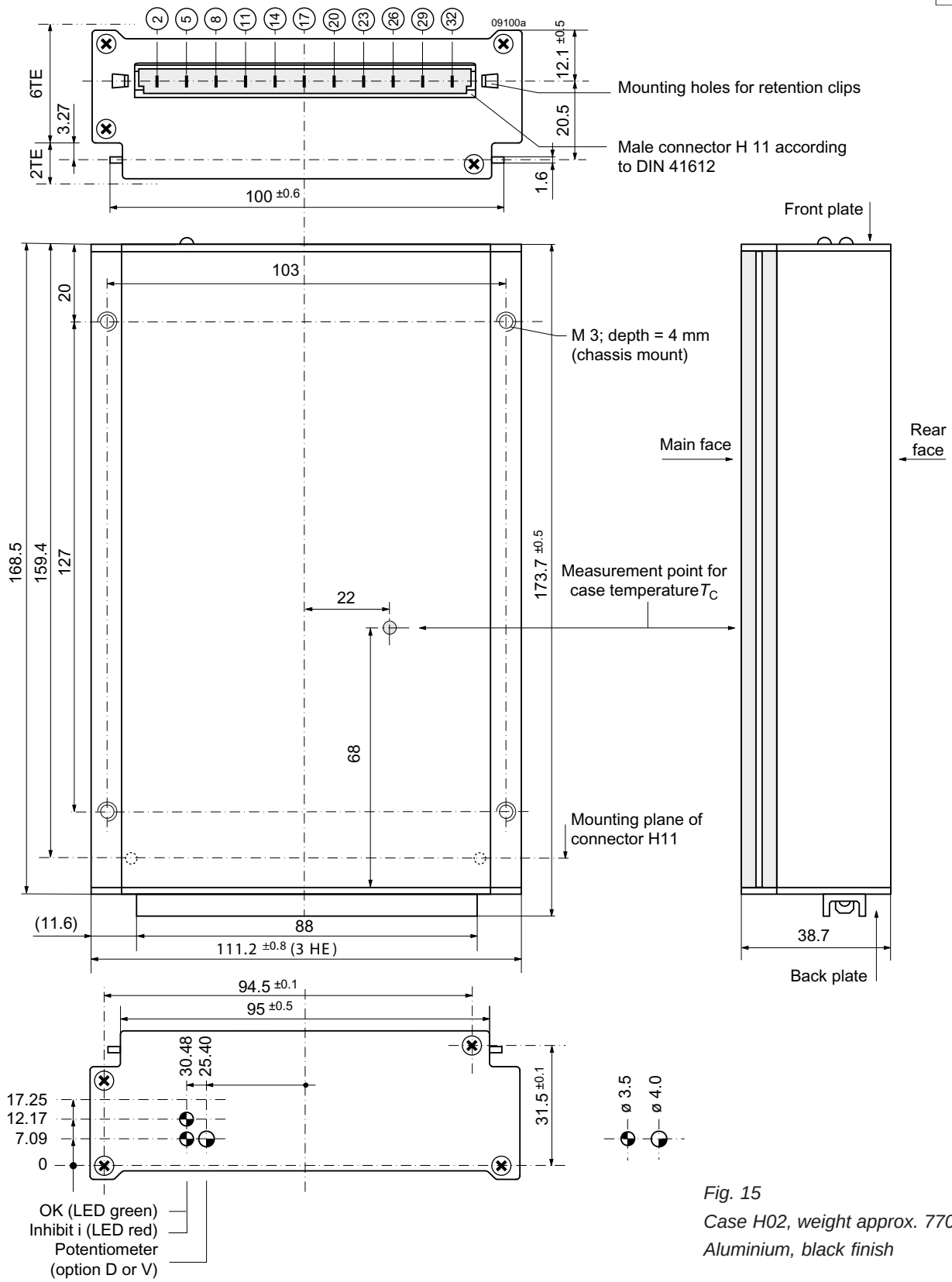



*Fig. 15*
*Case H02, weight approx. 770 g, Aluminium, black finish*

# Safety and Installation Instructions

## Connector Pin Allocation

Pin no. 26 (protective earth) is leading, ensuring that it makes contact with the female connector first.

Table 12: Pin allocation

| Electrical determination | LH1000 | | LH2000 | | LH3000 | |
|---|---|---|---|---|---|---|
| | Pin | Ident | Pin | Ident | Pin | Ident |
| Inhibit<br>Safe Data or ACFAIL | 2<br>5 | i<br>D or V[1] | 2<br>5 | i<br>D or V[1] | 2<br>5 | i<br>D or V[1] |
| Output voltage (positive)<br>Output voltage (negative) | 8<br>11 | Vo+<br>Vo– | 8<br>11 | n.c.<br>n.c. | 8<br>11 | Vo3+<br>Vo3– |
| Voltage adjust<br>Adjust return | 14<br>17 | R<br>G | | | | |
| Output voltage (positive)<br>Output voltage (negative) | | | 14<br>17 | Vo2+<br>Vo2– | 14<br>17 | Vo2+<br>Vo2– |
| Output voltage (positive)<br>Output voltage (negative) | 20<br>23 | Vo+<br>Vo– | 20<br>23 | Vo1+<br>Vo1– | 20<br>23 | Vo1+<br>Vo1– |
| Protective earthing PE[2] | 26 | ⏚ | 26 | ⏚ | 26 | ⏚ |
| AC neutral input<br>AC line input | 29<br>32 | N~<br>L~ | 29<br>32 | N~<br>L~ | 29<br>32 | N~<br>L~ |

[1] Not connected, if option neither option D or V is fitted.
[2] Leading pin

## Installation Instructions

The H Series converters 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.

Connection to the system shall be made via the female connector H11. Other installation methods may not meet the safety requirements.

The converters are provided with pin no. 26 (⏚), which is reliably connected with the case. For safety reasons, it is essential to connect this pin with the protective earth of the supply system.

A non-accessible input fuse is connected in the line to pin 32 (L~). Since this fuse is designed to protect the converter in case of an overcurrent and does not necessarily cover all customer needs, an external fuse suitable for the application and in compliance with the local requirements may be necessary in the wiring to one or both input pins (no. 29 and/or no. 32), particularly if the phase or neutral line cannot be assigned to the corresponding terminals.

**Important:** If the inhibit function is not in use, pin 2 (i) should be connected with pin 23 (Vo–) to enable the output(s).

**Caution:** Do not open the converters, or warranty will be invalidated.

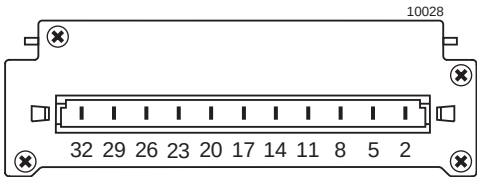



*Fig. 16*
*View of male H11 connector.*

Make sure that there is sufficient air flow possible for convection cooling. This should be verified by measuring the case temperature $T_C$, when the converter is installed and operated in the end-use application. The maximum specified case temperature $T_{C\,max}$ shall not be exceeded. See also *Thermal Considerations.*

## Cleaning Agents

In order to avoid possible damage, any penetration of liquids (e.g., cleaning fluids) has to be prevented, since the power supplies are not hermetically sealed.

**Note:** All boards are coated with a protection lacquer.

## Protection Degree

Condition: Female connector fitted to the converter.

- IP 40: All models, except those with options D or V with a potentiometer.
- IP 20: All models other models.

## Standards and Approvals

The converters correspond to class I equipment and have been approved according to the standards IEC/EN 60950-1 and UL/CSA 60950-1.

The converters have been evaluated for:

- Class I equipment
- Building in
- Basic insulation between input and case and double or reinforced insulation between input and output, based on the input voltage of 250 VAC or 400 VDC
- Functional insulation between output(s) and case
- Functional insulation between the outputs
- Pollution degree 2 environment
- Overvoltage catagory II
- Altitude up to 2000 m

The converters are subject to manufacturing surveillance in accordance with the above mentioned standards and with ISO 9001:2000.

## 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 honor any warranty claims resulting from electric strength field tests.

*Table 12: Isolation*

| Characteristic | | Input to case and output(s) | Output(s) to case | Output to output | Unit |
|---|---|---|---|---|---|
| Electric strength test | Factory test >1 s | 2.8 [1] | 1.4 | 0.3 | kVDC |
| | AC test voltage equivalent to factory test | 2.0 | 1.0 | 0.2 | kVAC |
| Insulation resistance at 500 VDC | | >300 | >300 | >100 [2] | MΩ |

[1] According to EN 50116 and IEC/EN 60950, subassemblies connecting input to output are pre-tested with 5.6 kVDC or 4 kVAC.
[2] Tested at 300 VDC

### Safety of Operator-Accessible Output Circuits

If the output circuit of a DC-DC converter is operator-accessible, it shall be an SELV circuit according to the safety standard IEC/EN 60950.

The table below shows a possible configuration, compliance with which causes the output to be an SELV circuit up to a configured output voltage of 36 V (sum of the nominal voltages connected in series).

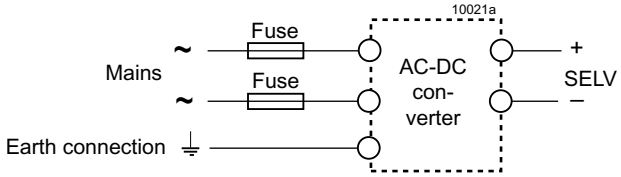



*Fig. 17*
*Schematic safety concept.*

*Table 13: Safety concept leading to an SELV output circuit*

| Conditions | AC-DC converter | Installation | Result |
|---|---|---|---|
| Nominal Supply voltage | Grade of insulation between input and output, provided by the AC-DC converter | Measures to achieve the resulting safety statuts of the output circuit | Safety statuts of the AC-DC converter output circuit |
| Mains ≤250 V AC | Double or reinforced | Earthed case [1] and installation according to the applicable standards | SELV circuit |

[1] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC/EN 60950

## Description of Options

*Table 14: Survey of options*

| Option | Function of Option | Characteristic |
|---|---|---|
| D | Input and/or output undervoltage monitoring circuitry | Safe data signal output (D1 – D8) |
| V [1] | Input and output undervoltage monitoring circuitry | ACFAIL signal according to VME specifications ( V2, V3) |

[1] Option V is only available for models with 5.1 V main output; it excludes option D.

### D Undervoltage Monitor

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lockout circuit. A logic "low" (JFET output) or "high" signal (NPN output) is generated at pin 5, as soon as one of the monitored voltages drops below the preselected threshold level $V_t$. The return for this signal is Vo1– (pin 23). The D output recovers, when the monitored voltages exceeds $V_t + V_h$. The threshold level $V_t$ is adjustable by a potentiometer, accessible through a hole in the front cover.

Option D exists in various versions D1 – D8 as shown in table 15.

*Table 15: Undervoltage monitor functions*

| Output type JFET | Output type NPN | Monitoring $V_i$ | Monitoring $V_{o1}$ | Minimum adjustment range of threshold level $V_t$ $V_{ti}$ | Minimum adjustment range of threshold level $V_t$ $V_{to}$ | Typical hysteresis $V_h$ [% of $V_t$] for $V_{t\,min} - V_{t\,max}$ $V_{hi}$ | Typical hysteresis $V_h$ [% of $V_t$] for $V_{t\,min} - V_{t\,max}$ $V_{ho}$ |
|---|---|---|---|---|---|---|---|
| D1 | D5 | no | yes | – | 3.5 V – 48 V [1] | – | 2.3 – 1 |
| D2 | D6 | yes | no | $V_{i\,min} - V_{i\,max}$ [1] | – | 3.0 – 0.5 | – |
| D3 | D7 | yes | yes | $V_{i\,min} - V_{i\,max}$ [1] | 0.95 – 0.98 $V_{o1}$ [2] | 3.0 – 0.5 | "0" |
| D4 | D8 | no | yes | – | 0.95 – 0.98 $V_{o1}$ [2] | – | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of $V_{o1}$ (tracking)

**JFET output (D1 – D4):**

Connector pin D is internally connected via the drain-source path of a JFET (self-conducting type) to the negative potential of output 1. $V_D$ – 0.4 V (logic low) corresponds to a monitored voltage level ($V_i$ and/or $V_{o1}$) < $V_t$. The current $I_D$ through the JFET should not exceed 2.5 mA. The JFET is protected by a 0.5 W Zener diode of 8.2 V against external overvoltages.

| $V_i$, $V_{o1}$ status | D output, $V_D$ |
|---|---|
| $V_i$ or $V_{o1}$ < $V_t$ | low, L, $V_D$ – 0.4 V at $I_D$ = 2.5 mA |
| $V_i$ and $V_{o1}$ > $V_t$ + $V_h$ | high, H, $I_D$ – 25 µA at $V_D$ = 5.25 V |

**NPN output (D5 – D8):**

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $V_D$ – 0.4 V (logic low) corresponds to a monitored voltage level ($V_i$ and/or $V_{o1}$) > $V_t$ + $V_h$. The current $I_D$ through

| $V_i$, $V_{o1}$ status | D output, $V_D$ |
|---|---|
| $V_i$ or $V_{o1}$ < $V_t$ | high, H, $I_D$ – 25 µA at $V_D$ = 40 V |
| $V_i$ and $V_{o1}$ > $V_t$ + $V_h$ | low, L, $V_D$ – 0.4 V at $I_D$ = 20 mA |

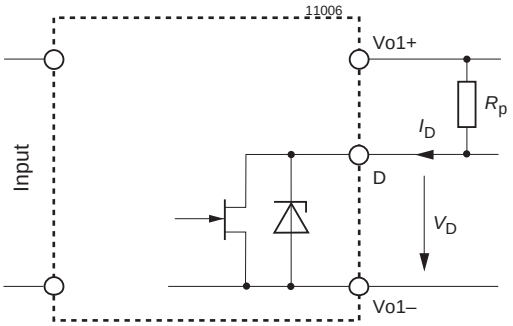



*Fig. 18*
*Options D1 – D4, JFET output*

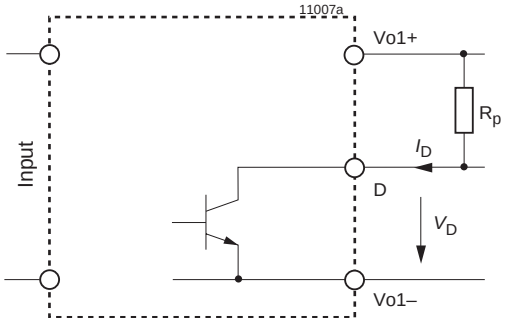



*Fig. 19*
*Options D5 – D8, NPN output*

Threshold tolerances and hysteresis:

If $V_i$ is monitored, the internal input voltage after the input filter and rectifier is measured. Consequently, this voltage differs from the voltage at the connector pins by the voltage drop $\Delta V_{ti}$ across input filter and rectifier. The threshold level of the D1 and D8 options is adjusted in the factory at nominal output current $I_{o\,nom}$ and $T_A$ = 25 °C.

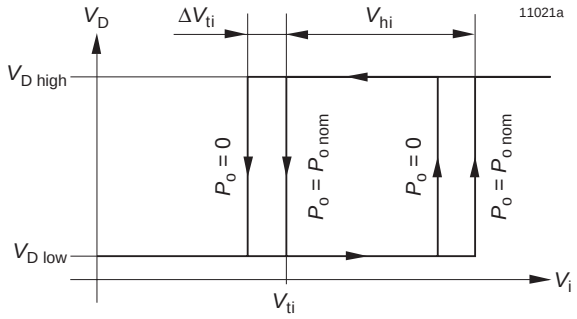
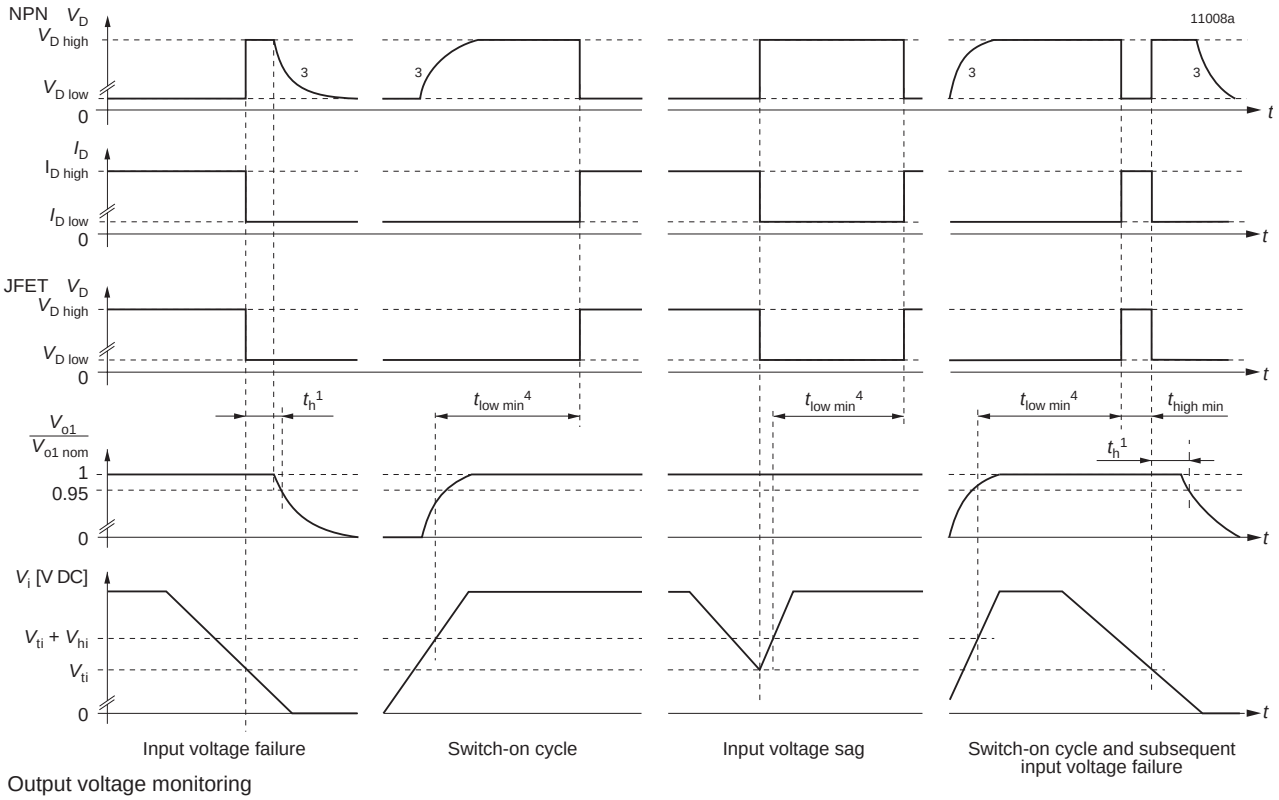
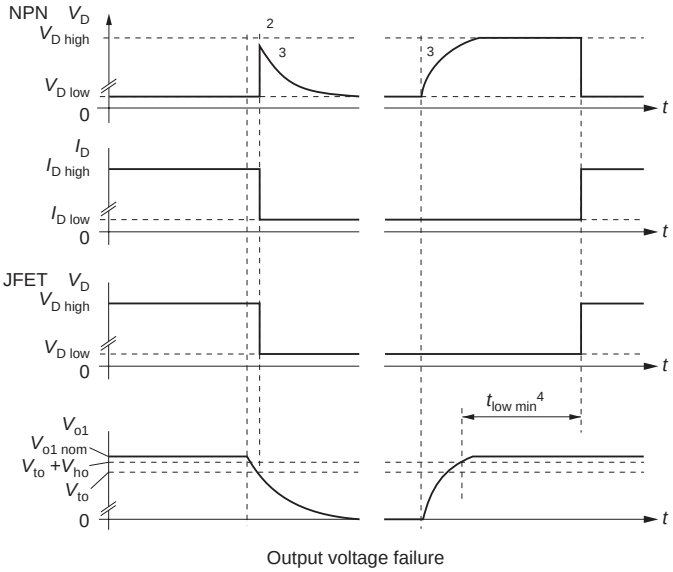



*Fig. 20*
*Definition of $V_{ti}$, $\Delta V_{ti}$, and $V_{hi}$ (JFET output)*

Input voltage monitoring




Output voltage monitoring




1 $t_h$ = hold-up time.
2 With output voltage monitoring the hold-up time $t_h = 0$
3 The D signal remains high, if the D output is connected to an external source.
4 $t_{low\ min}$ = 40 – 200 ms, typically 80 ms

*Fig. 21*

*Relationship between $V_i$, $V_{o1}$, $V_D$, $I_D$, and $V_{o1}/V_{o\ nom}$ versus time.*

## V ACFAIL Signal (VME)

Available for converters with $V_{o1}$ = 5.1 V. This option defines an undervoltage monitoring circuit for the input or the input and main output voltage equivalent to option D and generates the ACFAIL signal (V signal), which conforms to the VME standard. The low state level of the ACFAIL signal is specified at a sink current of $I_V$ = 48 mA to $V_V$ – 0.6 V (open-collector output). The pull-up resistor feeding the open-collector output should be placed on the VME backplane.

After the ACFAIL signal has gone low, the VME standard requires a hold-up time $t_h$ of at least 4 ms before the 5.1 V output drops to 4.875 V, when the 5.1 V output is fully loaded. This hold-up time $t_h$ is provided by the internal input

capacitance. Consequently, the working input voltage and the threshold level $V_{ti}$ should be adequately above the minimum input voltage $V_{i\,min}$ of the converter, so that enough energy is remaining in the input capacitance.

Formula for threshold level for desired value of $t_h$:

$$V_{ti} = \sqrt{\frac{2 \cdot P_o \cdot (t_h + 0.3\ ms) \cdot 100}{C_{i\,min} \cdot \eta} + V_{i\,min}^2}$$

where as:

$C_{i\,min}$ = minimum internal input capacitance [mF], according to the table below
$C_{i\,ext}$ = external input capacitance [mF]
$P_o$ = output power [W]
$\eta$ = efficiency [%]
$t_h$ = hold-up time [ms]
$V_{i\,min}$ = minimum input voltage [V]
$V_{ti}$ = threshold level [V]

**Note:** The threshold level $V_{ti}$ of option V2 and V3 is adjusted in the factory to a value according to table 17.

*Table 16: Available internal input capacitance and factory potentiometer setting of $V_{t\,i}$ with resulting hold-up time*

| Type | LH | Unit |
|---|---|---|
| $C_{i\,min}$ | 0.14 | mF |
| $V_{t\,i}$ | 85 | VDC |
| $t_h$ | 5 | ms |

Option V operates independently of the built-in input undervoltage lockout circuit. A logic "low" signal is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level $V_t$. The return for this signal is Vo1– (pin 23). The V output recovers, when the monitored voltage exceeds $V_t + V_h$. The threshold level $V_t$ is either adjustable by a potentiometer, accessible through a hole in the front cover, or adjusted in the factory to a determined customer-specific value.

Versions V2 and V3 are available as shown below.

*Table 17: Undervoltage monitor functions*

| V output (VME compatible) | Monitoring | | Minimum adjustment range of threshold level $V_t$ | | Typical hysteresis $V_h$ [% of $V_t$] for $V_{t\,min} - V_{t\,max}$ | |
|---|---|---|---|---|---|---|
| | $V_i$ | $V_{o1}$ | $V_{ti}$ | $V_{to}$ | $V_{hi}$ | $V_{ho}$ |
| V2 | yes | no | $V_{i\,min} - V_{i\,max}$ [1] | – | 3.0 – 0.5 | - |
| V3 | yes | yes | $V_{i\,min} - V_{i\,max}$ [1] | 0.95 – 0.98 $V_{o1}$ [2] | 3.0 – 0.5 | "0" |

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications).
[2] Fixed value between 95% and 98% of $V_{o1}$ (tracking), output undervoltage monitoring is not a requirement of VME standard.

**V output (V2, V3):**

Connector pin V is internally connected to the open collector of a NPN transistor. The emitter is connected to the negative potential of output 1. $V_V$ – 0.6 V (logic low) corresponds to a monitored voltage level ($V_i$ and/or $V_{o1}$) < $U_t$. The current $I_V$ through the open collector should not exceed 50 mA. The NPN output is not protected against external overvoltages. $V_V$ should not exceed 60 V.

| $V_i$, $V_{o1}$ status | V output, $V_V$ |
|---|---|
| $V_i$ or $V_{o1} < V_t$ | low, L, $V_V$ - 0.6 V at $I_V$ = 50 mA |
| $V_i$ and $V_{o1} > V_t + V_h$ | high, H, $I_V$ - 25 µA at $V_V$ = 5.1 V |

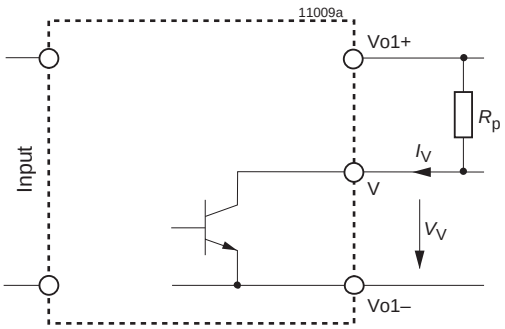



*Fig. 22*
*Output configuration of options V2 and V3*

Threshold tolerances and hysteresis:

$V_i$ is monitored after the input filter and rectifier. Consequently, this voltage differs from the voltage at the connector pins by the voltage drop $\Delta V_{t\,i}$ across input filter and rectifier. The threshold level of option V0 is factory-adjusted at $I_{o\,nom}$ and $T_A$ = 25 °C.

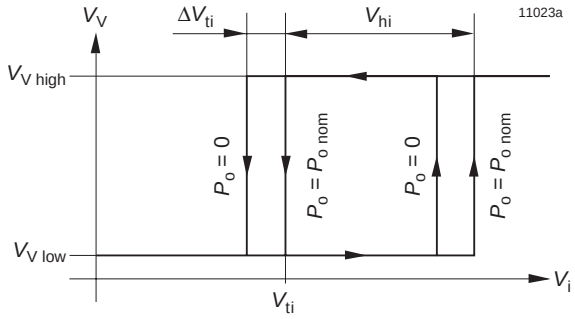



*Fig. 23*
*Definition of $V_{ti}$, $\Delta V_{ti}$ and $V_{hi}$*

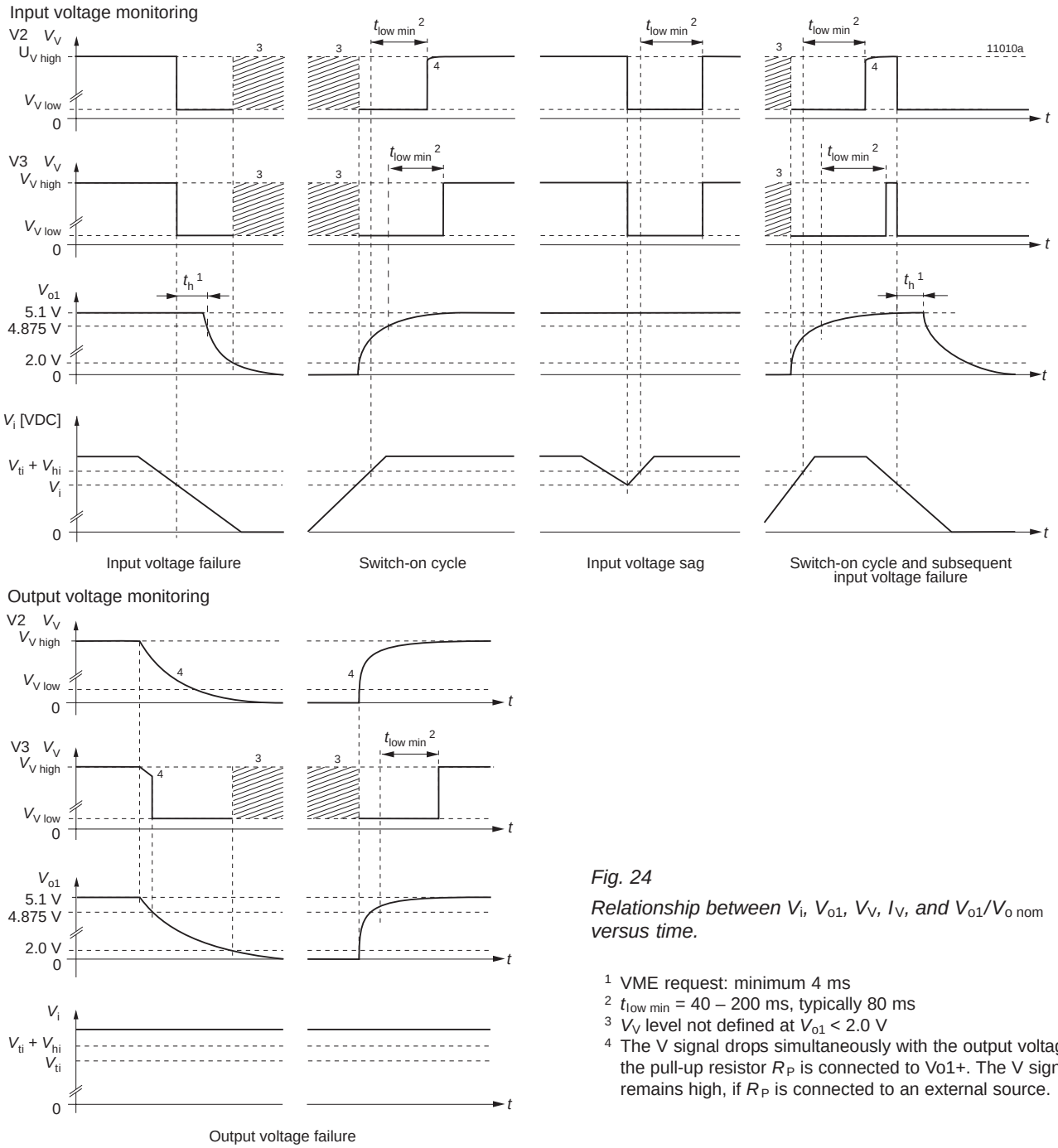



*Fig. 24*

*Relationship between $V_i$, $V_{o1}$, $V_V$, $I_V$, and $V_{o1}/V_{o\,nom}$ versus time.*

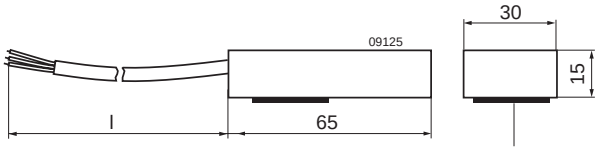
1 VME request: minimum 4 ms
2 $t_{low\,min}$ = 40 – 200 ms, typically 80 ms
3 $V_V$ level not defined at $V_{o1}$ < 2.0 V
4 The V signal drops simultaneously with the output voltage, if the pull-up resistor $R_P$ is connected to Vo1+. The V signal remains high, if $R_P$ is connected to an external source.

## Accessories

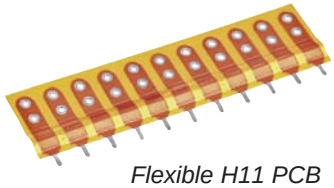
A great variety of electrical and mechanical accessories are available including:

- Various mating H11 connectors STV-H11-xxx including screw, solder, fast-on, or press-fit terminals
- Connector retention clips RETENTIONCLIP(2X) [HZZ01209]
- Code key system for connector coding CODIERKEIL(5X)
- Various front panels for 19" rack mounting, width 8 TE, heigth 3U and 6U, Schroff or Intermas system.
- Flexible H11 PCB for mounting the converter onto a PCB
- Universal mounting bracket UMB-LHMQ [HZZ00610] for chassis mounting or DIN-rail mounting in upright position.
- DIN-rail mounting brackets DMB-MHQ (horizontal position)
- Mounting plate M (black finish) MOUNTINGPLATEM for mounting the converter to a chassis or a wall, where only frontal access is given
- Battery sensor [S-KSMH...] for using the converter as battery charger. Different cell characteristics can be selected.

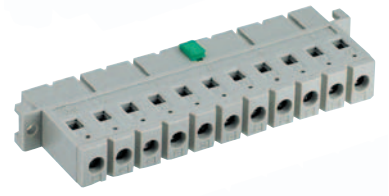
**For additional accessory product information, see the accessory data sheets listed with each product series or individual model listing at *www.power-one.com*.**


*Battery temperature sensor*



*Flexible H11 PCB*



*H11 female connector with screw terminals and code key system*

*Connector retention clip*

*DIN-rail mounting brackets DMB-MHQ*

*Mounting plate M (for wall-mounting), connector with fast-on terminals (STV-H11-F/CO), secured with connector retention clips*

*Universal mounting bracket UMB-LHMQ for DIN-rail mounting.*

*Different front panels*

## EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56, CH-8610 Uster

declare under our sole responsibility that all M and H Series AC-DC and DC-DC converters 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

- IEC 60950-1:2005 (1st Edition) and/or EN60950-1:2003
  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 M and H Series AC-DC and DC-DC converters 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, 24 August 2006 Power-One AG

Rolf Baldauf
Vice President, Engineering

Johann Milavec
Director Projects and IP