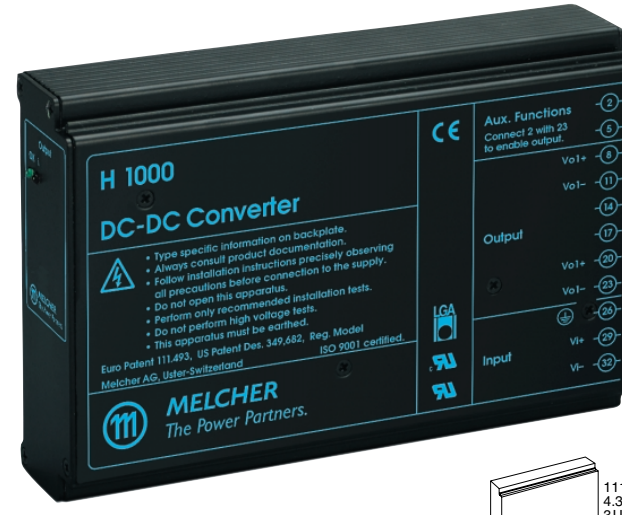
50 Watt DC-DC Converters

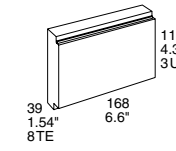
H Series

Single output: series 12H/24H/48H1000
Double output: series 12H/24H/48H2000
Triple output: series 12H/24H/48H3000

- Wide input voltage range suitable for battery operation
- Efficient input filter and built-in surge and transient suppression circuitry
- 3 kV_{rms} input to output electric strength test
- Outputs individually isolated
- Outputs fully protected against overload

Safety according to IEC/EN 60950





Summary

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

The converter inputs are protected against surges and transients occuring at the source lines. An input over- and undervoltage cut-out circuitry disables the outputs if the input voltage is outside the specified range.

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 (i). 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 modules are designed and built according to the international safety standard IEC/EN 60950 and have been approved by the safety agencies LGA (Germany) and UL (USA). The UL Mark for Canada has been officially recognized by regulatory authorities in provinces across Canada.

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 if the case temperature T_C exceeds the limit. The outputs are automatically re-enabled when the temperature drops below the limit.

Various options are available to adapt the converters to individual applications.

The modules may either be plugged into 19 inch rack systems according to DIN 41494, or be chassis mounted.

Table of Contents

Type Survey and Key Data

Table 1: Type survey

Output 1		Output 2		Output 3		Input Voltage Range and Efficiency [1]						Option
$U_{o\,nom}$ [V DC]	$I_{o\,nom}$ [A]	$U_{o\,nom}$ [V DC]	$I_{o\,nom}$ [A]	$U_{o\,nom}$ [V DC]	$I_{o\,nom}$ [A]	$U_{i\,min}...U_{i\,max}$ **8...15 V DC** [2]	η_{min} [%]	$U_{i\,min}...U_{i\,max}$ **14...30 V DC** [2]	η_{min} [%]	$U_{i\,min}...U_{i\,max}$ **28...60 V DC** [2]	η_{min} [%]	
5.1	8.0	-	-	-	-	12H1001-2R	73	24H1001-2R	75	48H1001-2R	76	V2, V3
12.0	4.0	-	-	-	-	12H1301-2R	79	24H1301-2R	82	48H1301-2R	82	D1...D8
15.0	3.4	-	-	-	-	12H1501-2R	80	24H1501-2R	82	48H1501-2R	83	-7
24.0	2.0	-	-	-	-	12H1601-2R	81	24H1601-2R	83	48H1601-2R	85	
48.0	1.0	-	-	-	-	12H1901-2R [2]	83	24H1901-2R [2]	85	48H1901-2R [2]	86	
12.0	2.0	12.0	2.0	-	-	12H2320-2	79	24H2320-2	80	48H2320-2	82	
15.0	1.7	15.0	1.7	-	-	12H2540-2	80	24H2540-2	81	48H2540-2	83	
5.1	5.0	12.0	0.7	12.0	0.7	12H3020-2	77	24H3020-2	78	48H3020-2	79	
5.1	5.0	15.0	0.6	15.0	0.6	12H3040-2	77	24H3040-2	79	48H3040-2	80	

[1] Efficiency measured at $U_{i\,nom}$ and $I_{o\,nom}$
[2] Input voltage range 12H1901-2R: 9...15 V DC, 24H1901-2R: 18...30 V DC, 48H1901-2R: 36...60 V DC

Type Key and Product Marking

Type Key

48 H 2 5 40 -2 R D V

Input voltage range U_i:
- 8...15 V DC 12
- 14...30 V DC 24
- 28...60 V DC 48

Series ..... H

Number of outputs ..... 1...3

Output 1, $U_{o1\,nom}$:
- 5.1 V 0
- 12 V 3
- 15 V 5
- 24 V 6
- 48 V 9

Single output modules 01

Output 2 and 3, $U_{o2\,nom}$, $U_{o3\,nom}$:
- 12 V 20
- 15 V 40

Options and features:
- Ambient temperature range T_A –10...50 °C ..... -2
- Extended temperature range T_A –25...71 °C ..... -7
- Output voltage control input (single output modules only) R
- Save data signal (D1...D8, to be specified) ..... D [1]
- ACFAIL signal (V2, V3, to be specified) ..... V [1]

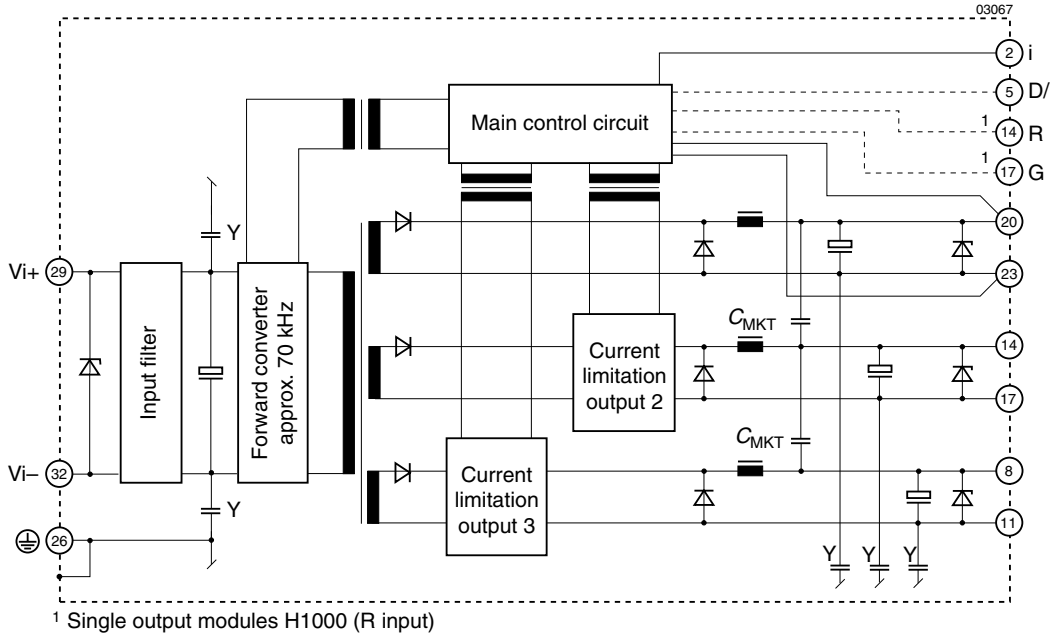
[1] Option D excludes option V and vice versa

Example: 48H1501-2RD3: DC-DC converter, input voltage range 28...60 V, providing output with 15 V/3.4 A; equipped with an output voltage control input and undervoltage monitoring.

Functional Description

The input voltage is fed via an input filter 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. The control logic senses the main output voltage U_{o1} and generates, with respect to the maximum admissible output currents, the control signal for the primary switching transistor. This signal is fed back via a coupling transformer.

The auxiliary outputs U_{o2} and U_{o3} are unregulated. Each auxiliary output's current is sensed and transferred to the main control circuit 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 control circuit.



[1] Single output modules H1000 (R input)

Fig. 1
DC-DC converter block diagram

Electrical Input Data

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

Table 2: Input data

Input			12H			24H			48H			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Operating input voltage	I_o = 0…$I_{o\,nom}$ $T_{C\,min}$…$T_{C\,max}$	8		15	14		30	28		60	V DC
	..H1901-2R		9		15	18		30	36		60	
$U_{i\,nom}$	Nominal input voltage			12			24			48		
I_i	Input current	$U_{i\,nom}$, $I_{o\,nom}$ [1]		5.0			2.5			1.3		A
$P_{i\,0}$	No-load input power: Single output Double output Triple output	$U_{i\,nom}$ $I_{o1,2,3}$ = 0		 1 4 4	 1.5 6 6		 1 4 4	 1.5 6 6		 1 4 4	 1.5 6 6	W
$P_{i\,inh}$	Idle input power	inhibit mode			2			2			2	
$I_{inr\,p}$ [3]	Peak inrush current	U_i = $U_{i\,max}$ R_S = 0 Ω [2] T_C = 25 °C			380			380			350	A
$t_{inr\,r}$	Rise time			60			50			20		µs
$t_{inr\,h}$	Time to half value			110			75			40		
R_i	Input resistance	T_C = 25 °C	40			80			175			mΩ
C_i	Input capacitance		2200		3300	750		1200	190		300	µF
$U_{i\,abs}$	Input voltage limits without any damage		0		20	0		40	0		80	V DC

[1] With multiple output modules, the same condition for each output applies.
[2] R_S = source resistance
[3] $I_{inr\,p} = U_i/(R_s + R_i)$

Input Under-/Overvoltage Lock-out

If the input voltage remains below 0.8 $U_{i\,min}$ or exceeds 1.1 $U_{i\,max}$ (approx. values), an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i\,abs}$ must be carefully considered (see table: *Electrical Input Data*). Between $U_{i\,min}$ and the undervoltage lock-out level the output voltage may be below the value defined in table: *Output data* (see: *Technical Information: Measuring and Testing*).

Reverse Polarity

The unit is not protected against reverse polarity at the input. (Reverse polarity will cause the external fuse to blow.)

Input Fuse

The modules do not incorporate any fuse. External fuses installed in the wiring to the inputs are essential.

Table 3: Recommended fuse types

Series	Schurter type			Part number
12H	SPT	10 A	250 V	0001.2514
24H	SPT	8 A	250 V	0001.2513
48H	SPT	3.15 A	250 V	0001.2509

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 4a: Output data

Output				5.1 V			12 V			15 V			Unit
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	
U_{o1}	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$ [1]	5.00		5.20	11.76		12.24	14.70		15.30	V
$U_{o2/3}$					-		11.10		12.90	13.90		16.10	
$U_{o2/3\,0}$			$U_{i\,min}$...$U_{i\,max}$ $I_{o2/3}$ = 0		-				13.80			17.25	
$U_{o1\,P}$	Output overvoltage protection				7.5			21			25		
$U_{o2/3\,P}$					-			25			31		
$I_{o\,nom}$	Output current		$U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$	see: *Type Survey and Key Data*									
$I_{o\,L}$	Output current limitation response			see fig.: *Typical output voltage U_{o1} versus output currents I_o*									
$u_{o1/2/3}$	Output voltage noise	Switch. freq.	$U_{i\,nom}$, $I_{o\,nom}$ [1] IEC/EN 61204 BW = 20 MHz		30	50		60	100		50	80	mV_{pp}
		Total			60	200		70	200		75	200	
$\Delta U_{o1\,U}$	Static line regulation		$U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ [1]			±50			±100			±100	mV
$\Delta U_{o2/3\,U}$					-				±150			±150	
$\Delta U_{o1\,I}$	Static load regulation		$U_{i\,nom}$ I_o = $I_{o\,nom}$...0 [2]			50			150			150	
$\Delta U_{o2/3\,I}$					-		see: *H2320/H3020 = $\Delta U_{o\,2/3}$ vers. $I_{o\,2/3}$*			see: *H2540/H3040 = $\Delta U_{o\,2/3}$ vers. $I_{o\,2/3}$*			
$\Delta U_{o1\,Ic}$	Static cross load regulation [3]		$U_{i\,nom}$ I_o = $I_{o\,nom}$...0 [4]		±5	±15		±10	±30		±15	±45	
$\Delta U_{o2/3\,Ic}$					-		see: *H2320/H3020 = $\Delta U_{o\,2/3}$ vers. $I_{o\,2/3}$*			see: *H2540/H3040 = $\Delta U_{o\,2/3}$ vers. $I_{o\,2/3}$*			

Table 4b: Output data

Output				24 V			48 V			Unit
Characteristics			Conditions	min	typ	max	min	typ	max	
U_{o1}	Output voltage		$U_{i\,nom}$, $I_{o1\,nom}$	23.52		24.48	47.04		48.96	V
$U_{o\,P}$	Overvoltage prot.				41			85		
$I_{o1\,nom}$	Output current		$U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$	see: *Type Survey and Key Data*						
$I_{o1\,L}$	Output current limitation response			see: *Typical output voltage U_{o1} versus output currents I_o*						
$u_{o1/2/3}$	Output voltage noise	Switch. freq.	$U_{i\,nom}$, $I_{o\,nom}$ [1] IEC/EN 61204 BW = 20 MHz		30	50		20	40	mV_{pp}
		Total			75	200		35	150	
$\Delta U_{o1\,U}$	Static line regulation		$U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o1\,nom}$			±150			±150	mV
$\Delta U_{o1\,I}$	Static load regulation		$U_{i\,nom}$ I_{o1} = $I_{o1\,nom}$...0			150			150	

[1] With multiple output modules, the same condition for each output applies.
[2] Condition for specified output. With multiple output modules, other output(s) loaded with constant current I_o = $I_{o\,nom}$.
[3] Condition for non-specified output, individually tested, other output(s) loaded with constant current I_o = $I_{o\,nom}$.
[4] Multiple output modules.

Output Protection

Each output is protected against overvoltages which could occur due to a failure of the internal control circuit. Voltage suppressor diodes (which under worst case condition may become a short circuit) provide the required protection. The suppressor diodes are not designed to withstand externally applied overvoltages. Overload at any of the outputs will cause a shut-down of all outputs.

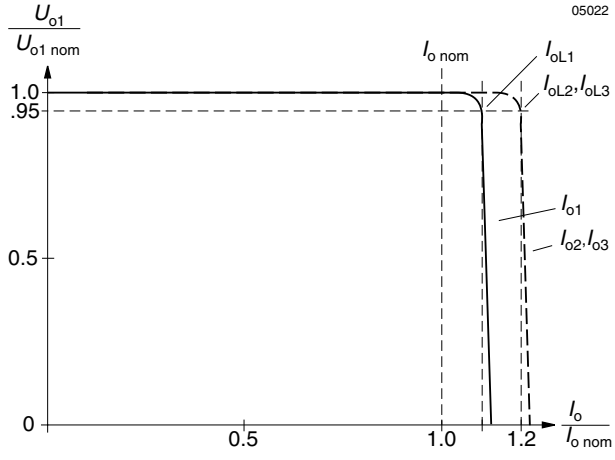


Fig. 2
Typical output voltage U_{o1} versus output currents I_o

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 module is forced to supply a minimum current of 0.1 A to enable correct operation of its own auxiliary outputs.

Outputs one and two of a double output unit may be connected in parallel without a minimum current requirement at the main output. Outputs two and three of a triple output unit can be connected in parallel.

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

Main or auxiliary outputs can be connected in series with any other output of the same or another module. 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 to avoid excessive output ripple voltages.

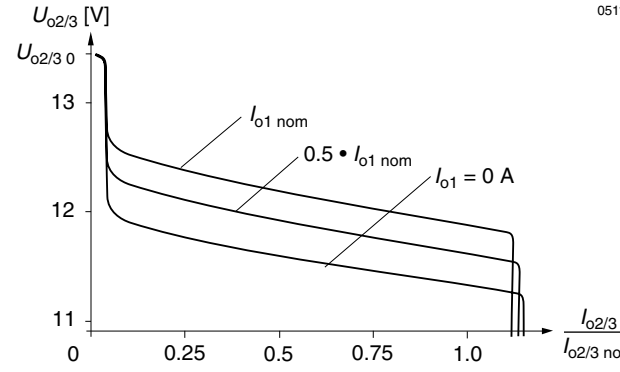


Fig. 3
H2320/H3020: $\Delta U_{o2/3}$ (typ.) versus $I_{o2/3}$ with different I_{o1}

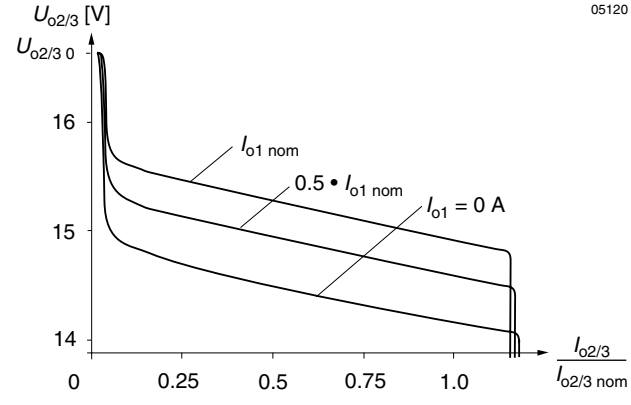


Fig. 4
H2540/H3040: $\Delta U_{o2/3}$ (typ.) versus $I_{o2/3}$ with different I_{o1}

Thermal Considerations

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 allows T_A to be higher than 50°C (e.g. 65°C) if $T_{C\,max}$ is not exceeded.

For -2 units 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 as per figure.

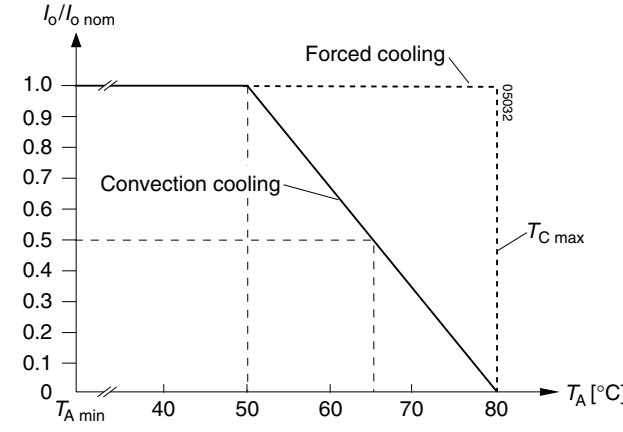


Fig. 5
Output current derating versus temperature for -2 units.

Thermal Protection

A temperature sensor generates an internal inhibit signal which disables the outputs if the case temperature exceeds $T_{C\,max}$. The outputs are automatically re-enabled if the temperature drops below this limit.

Output Response

The reaction of the outputs is similar whether the input voltage is applied or the inhibit is switched low.

An output voltage overshoot will not occur when the module is turned on or off.

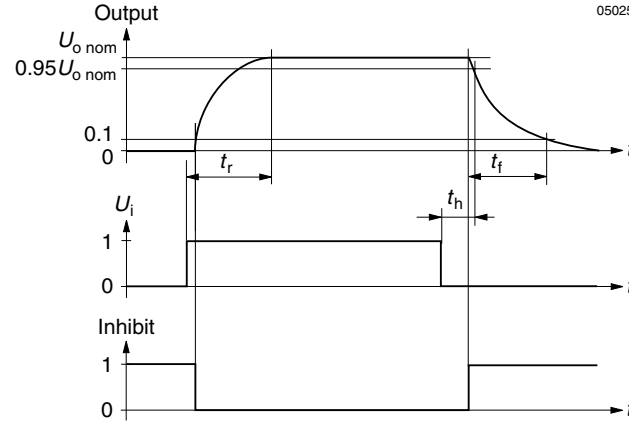


Fig. 6
Output response as a function of input voltage (on/off switching) or inhibit control

Table 5: Output response time t_r and t_f

Type of Converter	t_r at P_o = 0 and t_f at P_o = $P_{o\,nom}$ typ	max	t_r and t_f at P_o = ¾ $P_{o\,nom}$ typ	max	t_r at P_o = $P_{o\,nom}$ typ	max	Unit
H1001-2R	3	7	3	7	5	15	ms
H1301-2R	5	15	8	20	10	30	
H1501-2R	3	7	5	15	15	40	
H1601-2R	8	20	15	35	20	60	
H1901-2R	35	90	50	140	85	220	
H2320-2	10	30	15	40	25	70	
H2540-2	8	20	10	30	20	50	
H3020-2	30	75	45	120	75	200	
H3040-2	20	60	30	80	50	140	

Conditions: R input not used. For multiple output modules the figures indicated in the table above relate to the output which reacts slowest. All outputs are resistively loaded. Variation of the input voltage within $U_{i\,min}$...$U_{i\,max}$ does not influence the values.

Auxiliary Functions

i Inhibit for Remote On and Off

Note: With open i input: Output is disabled (U_o = off).

The outputs of the module 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 units, 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). For output response refer to: *Output Response*.

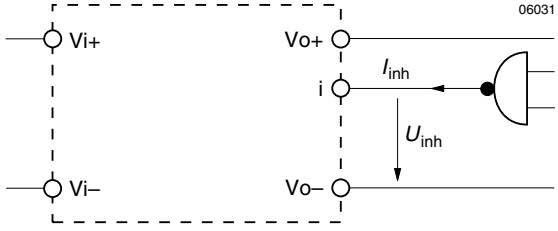


Fig. 7
Definition of U_{inh} and I_{inh}.

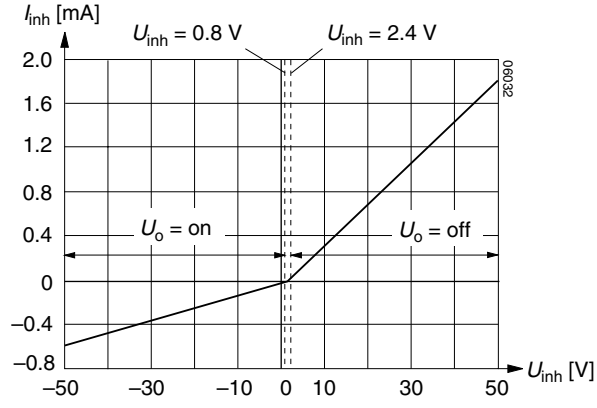


Fig. 8
Typical inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 6: Inhibit data

Characteristics			Conditions	min	typ	max	Unit
U_{inh}	Inhibit input voltage to keep output voltage	U_o = on	$U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$	–50		0.8	V DC
		U_o = off		2.4		50	
I_{inh}	Inhibit current		U_{inh} = 0	–60	–100	–220	µA

R-Control for Output Voltage Adjustment

Note: With open R input, $U_o \approx U_{o\,nom}$.

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

The output voltage U_{o1} can either be adjusted with an external voltage (U_{ext}) or with an external resistor (R_1 or R_2). The adjustment range is approximative 0...110% of $U_{o\,nom}$. For output voltages $U_o > U_{o\,nom}$, the minimum input voltage according to *Electrical Input Data* increases proportionally to $U_o/U_{o\,nom}$.

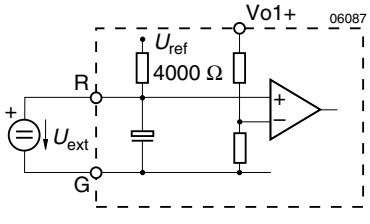


Fig. 9
Voltage adjustment with external voltage U_{ext}

a) $U_o \approx$ 0...110% $U_{o\,nom}$, using U_{ext} between R (14) and G (17):

$$U_{ext} \approx 2.5\ V \bullet \frac{U_o}{U_{o\,nom}} \qquad U_o \approx U_{o\,nom} \bullet \frac{U_{ext}}{2.5\ V}$$

Caution: To prevent damage, U_{ext} should not exceed 8 V, nor be negative.

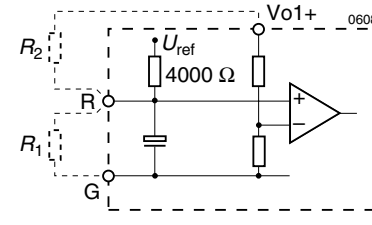


Fig. 10
Voltage adjustment with external resistor R_1 or R_2

b) $U_o \approx$ 0...100% $U_{o\,nom}$, using R_1 between R (14) and G (17):

$$U_o \approx U_{o\,nom} \bullet \frac{R_1}{R_1 + 4000\ \Omega} \qquad R_1 \approx \frac{4000\ \Omega \bullet U_o}{U_{o\,nom} - U_o}$$

c) $U_o \approx U_{o\,nom}$...$U_{o\,max}$, using R_2 between R (14) and Vo1+ (20):

$$U_{o\,max} = U_{o\,nom} + 10\%$$

$$R_2 \approx \frac{4000\ \Omega \bullet U_o \bullet (U_{o\,nom} - 2.5\ V)}{2.5\ V \bullet (U_o - U_{o\,nom})}$$

$$U_o \approx \frac{U_{o\,nom} \bullet 2.5\ V \bullet R_2}{2.5\ V \bullet (R_2 + 4000\ \Omega) - U_{o\,nom} \bullet 4000\ \Omega}$$

Caution: To prevent damage, R_2 should never be less than 47 kΩ.

Note: R inputs of n units with paralleled outputs may be paralleled, too, but if only one external resistor is to be used, its value should be R_1/n, or R_2/n respectively.

Table 7a: R_1 for $U_o < U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96); $R_2 = \infty$

$U_{o\,nom}$ = 5.1 V		$U_{o\,nom}$ = 12 V		$U_{o\,nom}$ = 15 V		$U_{o\,nom}$ = 24 V		$U_{o\,nom}$ = 48 V	
U_o [V]	R_1 [kΩ]	U_o [V]	R_1 [kΩ]	U_o [V]	R_1 [kΩ]	U_o [V]	R_1 [kΩ]	U_o [V]	R_1 [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 7b: R_2 for $U_o > U_{o\,nom}$ (conditions: $U_{i\,nom}$, $I_{o\,nom}$, rounded up to resistor values E 96); $R_1 = \infty$

$U_{o\,nom}$ = 5.1 V		$U_{o\,nom}$ = 12 V		$U_{o\,nom}$ = 15 V		$U_{o\,nom}$ = 24 V		$U_{o\,nom}$ = 48 V	
U_o [V]	R_2 [kΩ]	U_o [V]	R_2 [kΩ]	U_o [V]	R_2 [kΩ]	U_o [V]	R_2 [kΩ]	U_o [V]	R_2 [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

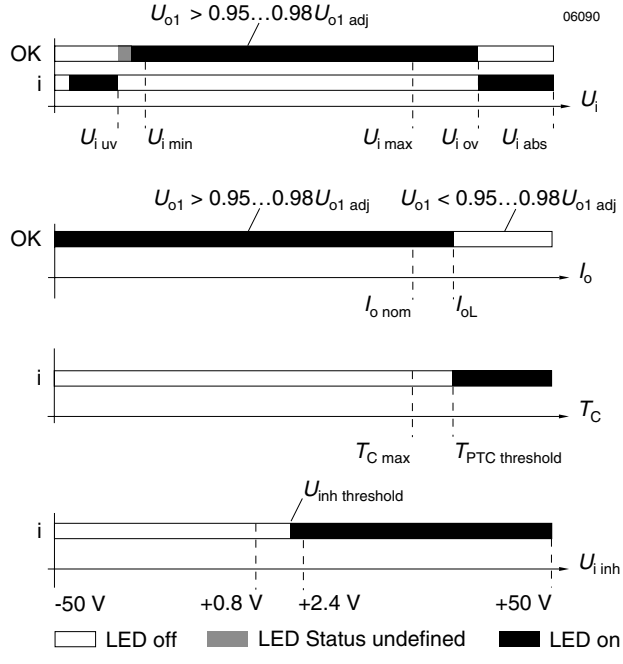


Fig. 11
LEDs "OK" and "i" status versus input voltage
Conditions: $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V
$U_{i\,uv}$ = undervoltage lock-out, $U_{i\,ov}$ = overvoltage lock-out

LED "OK" status versus output current
Conditions: $U_{i\,min}$...$U_{i\,max}$, $T_C \le T_{C\,max}$, $U_{inh} \le 0.8$ V

LED "i" versus case temperature
Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $U_{inh} \le 0.8$ V

LED "i" versus U_{inh}
Conditions: $U_{i\,min}$...$U_{i\,max}$, $I_o \le I_{o\,nom}$, $T_C \le T_{C\,max}$

Electromagnetic Compatibility (EMC)

A suppressor diode together with an input filter form an effective protection against 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 8: Immunity type tests

Phenomenon	Standard [1]	Level	Coupling mode [2]	Value applied	Waveform	Source imped.	Test procedure	In oper.	Perform. [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…1000 MHz	yes	A
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	1 min positive 1 min 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
			+i/–i			2 Ω			

[1] Related and previous standards are referenced in: *Technical Information: Standards*.
[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 9: Emissions at $U_{i\,nom}$ and $I_{o\,nom}$

Series	Standard CISPR 11/EN 55011, 1991 CISPR 22/EN 55022, 1987	
	≤30 MHz	≥30 MHz
12H	<A	<B
24H	<B	<B
48H	<B	<B

Mechanical Data

Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection

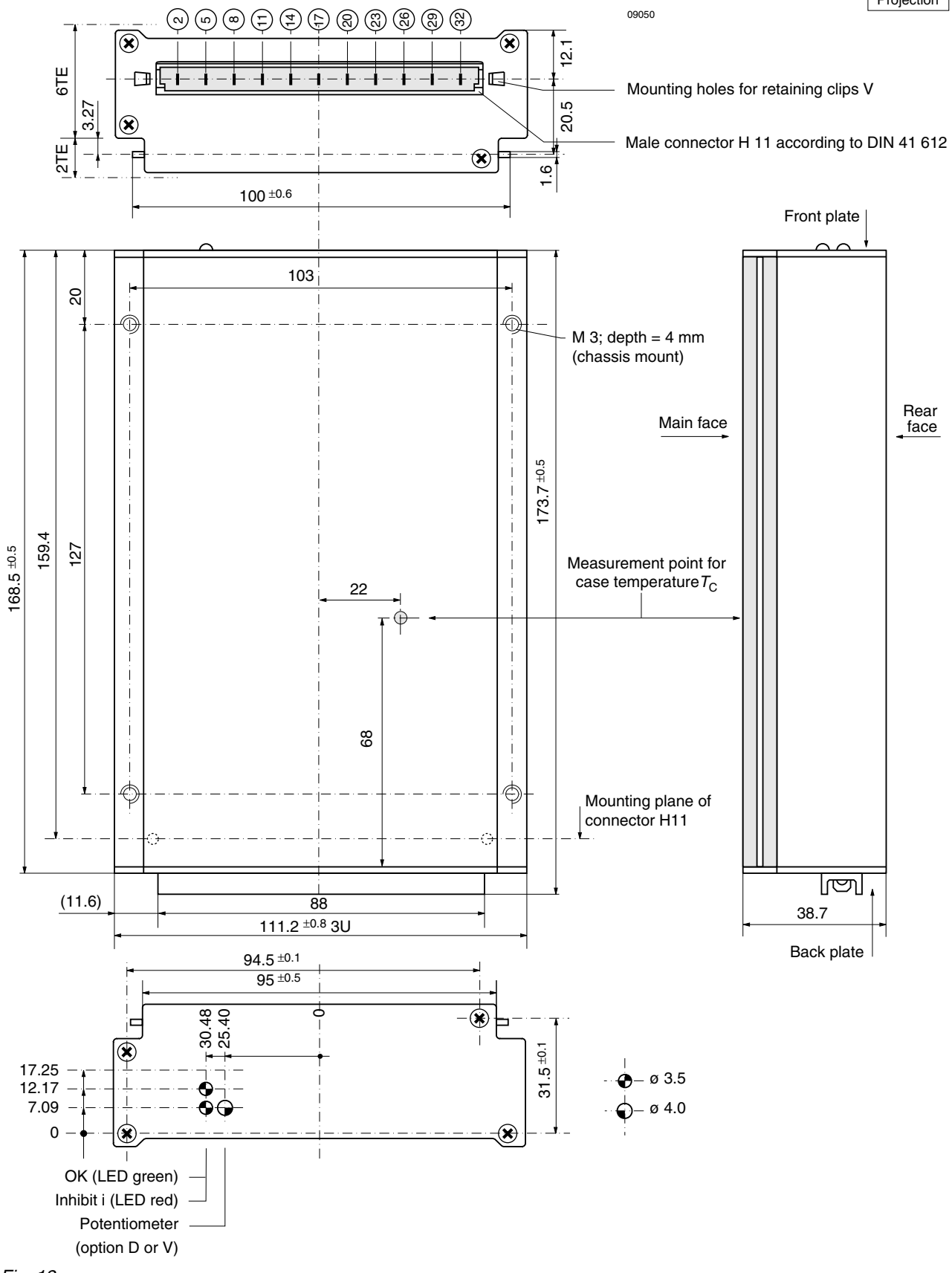


Fig. 12
DC-DC converter in case H02, weight 770 g (approx.)
Case aluminium, black finish and self cooling.

Immunity to Environmental Conditions

Table 10: Mechanical stress

Test method		Standard	Test conditions		Status
Ca	Damp heat steady state	IEC/DIN IEC 60068-2-3 MIL-STD-810D section 507.2	Temperature: Relative humidity: Duration:	40 $^{\pm 2}$ °C 93 $^{+2/-3}$ % 21 days	Unit not operating
Ea	Shock (half-sinusoidal)	IEC/EN/DIN EN 60068-2-27 MIL-STD-810D section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	15 g_n = 147 m/s^2 11 ms 18 (3 each direction)	Unit operating
Eb	Bump (half-sinusoidal)	IEC/EN/DIN EN 60068-2-29 MIL-STD-810D section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	10 g_n = 98 m/s^2 16 ms 6000 (1000 each direction)	
Fc	Vibration (sinusoidal)	IEC/EN/DIN EN 60068-2-6 MIL-STD-810D section 514.3	Acceleration amplitude: Frequency (1 Oct/min): Test duration:	0.15 mm (10...60 Hz) 2 g_n = 20 m/s^2 (60...150 Hz) 10...150 Hz 3.75 h (1.25 h each axis)	

Table 11: Temperature specifications, values given are for an air pressure of 800...1200 hPa (800...1200 mbar)

Temperature			Standard -2		Option -7		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature [1]	Operational [2]	–10	50	–25	71	°C
T_C	Case temperature [3]		–10	80	–25	95	
T_S	Storage temperature [1]	Not operational	–25	100	–40	100	

[1] MIL STD 810D section 501.2 and 502.2. [2] See: *Thermal considerations.* [3] Overtemperature lock-out at T_C >95°C (PTC).

Table 12: MTBF

Values at specified Case Temperature	Module Types	Ground Benign 40°C	Unit
MTBF [1]	H1000 H2000 H3000	384'000 306'000 270'000	h

[1] Calculated in accordance with MIL-HDBK-217E (calculation according to edition F would show even better results)

Safety and Installation Instructions

Connector pin Allocation

The connector pin allocation table defines the electrical potentials and the physical pin positions on the H11 connector. Pin no. 26, the protective earth pin present on all 12H…48H DC-DC converters is leading, ensuring that it makes contact with the female connector first.

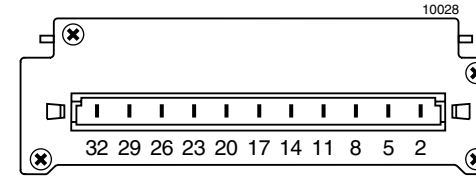


Fig. 13
View of male H11 connector.

Table 13: H11 connector pin allocation and designation

Electrical Determination	H1000		H2000		H3000	
	Pin	Ident	Pin	Ident	Pin	Ident
Inhibit control input Safe Data or ACFAIL	2 5	i D or V	2 5	i D or V	2 5	i D or V
Output voltage (positive) Output voltage (negative)	8 11	Vo1+ Vo1–	8 11		8 11	Vo3+ Vo3–
Control input + Control input –	14 17	R G				
Output voltage (positive) Output voltage (negative)			14 17	Vo2+ Vo2–	14 17	Vo2+ Vo2–
Output voltage (positive) Output voltage (negative)	20 23	Vo1+ Vo1–	20 23	Vo1+ Vo1–	20 23	Vo1+ Vo1–
Protective earthing [1]	26	⏚	26	⏚	26	⏚
DC input voltage DC input voltage	29 32	Vi+ Vi–	29 32	Vi+ Vi–	29 32	Vi+ Vi–

[1] Leading pin (pregrounding)

Installation Instructions

The H series DC-DC converters are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or 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. See also: *Technical Information: Installation and Application.*

Connection to the system shall be made via the female connector H11 (see: *Accessories*). Other installation methods may not meet the safety requirements.

All DC-DC converters are provided with pin no. 26 (⏚), which is reliably connected with their case. For safety reasons it is essential to connect this pin with the protective earth of the supply system if required in: *Safety of operator accessible output circuit*.

Ensure that a unit failure (e.g. by an internal short-circuit) does not result in a hazardous condition. See also: *Safety of operator accessible output circuit.*

To prevent excessive current flowing into the unit (e.g. by an internal short-circuit), an external fuse suitable for the application and in compliance with the local requirements should be installed in the wiring to one or both input pins (no. 29 and/or no. 32). See also: *Input Fuse*.

Important: Whenever the inhibit function is not in use, pin no. 2 (i) should be connected to pin no. 23 (Vo1–) to enable the output(s).

Do not open the modules, or guarantee will be invalidated.

Make sure that there is sufficient air flow possible for convection cooling. This should be verified by measuring the case temperature when the unit 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.*

If the end-product is to be UL certified, the temperature of the main isolation transformer should be evaluated as part of the end-product investigation.

Cleaning Agents

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

Standards and approvals

12H…48H DC-DC converters correspond to class I equipment. All types are UL recognized according to UL 1950, UL recognized for Canada to CAN/CSA C22.2 No. 950-95 and LGA approved to IEC/EN 60950 standards.

The units have been evaluated for:

- Building in
- Supplementary insulation between input and case and double or reinforced insulation between input and output, based on 250 V AC and 400 V DC
- Operational insulation between output(s) and case
- Operational insulation between the outputs
- The use in a pollution degree 2 environment
- Connecting the input to a primary or secondary circuit with a maximum transient rating of 2500 V.

The DC-DC converters are subject to manufacturing surveillance in accordance with the above mentioned UL, CSA, EN and with ISO 9001 standards.

Protection Degree

Condition: Female connector fitted to the unit.

IP 40: All units, except those with option D or V with potentiometer.

IP 20: All units fitted with option D or V with potentiometer.

Isolation

The electric strength test is performed as a factory test in accordance with IEC/EN 60950 and UL 1950 and should not be repeated in the field. Melcher will not honour any guarantee/warranty claims resulting from electric strength field tests.

Table 14: Isolation

Characteristic		Input to case	Input to output	Output to case	Output to output	Unit
Electric strength test voltage	Required according to IEC/EN 60950	1.5	3.0 [1]	0.5	-	kV_{rms}
		2.1	4.2 [1]	0.7	-	kV DC
	Actual factory test 1 s	2.8	5.6 [1]	1.4	0.3	
	AC test voltage equivalent to actual factory test	2.0	4.0 [1]	1.0	0.2	kV_{rms}
Insulation resistance at 500 V DC		>300	>300	>300	>100 [2]	MΩ

[1] In accordance with IEC/EN 60950 only subassemblies are tested in factory with this voltage.
[2] Tested at 300 V DC.

For creepage distances and clearances refer to: *Technical Information: Safety.*

Safety of operator accessible output circuit

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

Since the H series DC-DC converters provide double or reinforced insulation between input and output, based on a rated primary input voltage of 250 V AC and 400 V DC only operational insulation is needed between the AC mains and the input of the DC-DC converter. This means that there is no need for an electrical isolation between the AC mains circuit and the DC-DC converter input circuit to cause the output of an H series DC-DC converter to be an SELV circuit. Only voltage adaption and rectification to the specified input voltage range of the DC-DC converter is needed.

The following table shows some possible installation configurations, compliance with which causes the output circuit of the DC-DC converter to be an SELV circuit according to IEC/EN 60950 up to a configured output voltage (sum of nominal voltages if in series or +/– configuration) of 36 V.

However, it is the sole responsibility of the installer to assure the compliance with the relevant and applicable safety regulations. More information is given in: *Technical Information: Safety*.

Table 15: Safety concept leading to an SELV output circuit

Conditions	Front end			DC-DC converter	Result
Nominal supply voltage	Minimum required grade of isolation, to be provided by the AC-DC front end, including mains supplied battery charger	Nominal DC output voltage from the front end	Minimum required safety status of the front end output circuit	Measures to achieve the specified safety status of the output circuit	Safety status of the DC-DC converter output circuit
Mains ≤250 V AC	Operational (i.e. there is no need for electrical isolation between the mains supply voltage and theDC-DC converter input voltage)	≤400 V [1] (The rated voltage between any input pin and earth can be up to 250 V AC or 400 V DC)	Primary circuit	Double or reinforced insulation, based on 250 V AC and 400 V DC (provided by the DC-DC converter) and earthed case [2]	SELV circuit
		≤400 V	Unearthed hazardous voltage secondary circuit	Supplementary insulation, based on 250 V AC and 400 V DC and double or reinforced insulation, based on the maximum nominal output voltage from the front end (both provided by the DC-DC converter) and earthed case [3]	

[1] The front end output voltage should match the specified operating input voltage range of the DC-DC converter.
[2] The earth connection has to be provided by the installer according to the relevant safety standard, e.g. IEC/EN 60950.
[3] The earth connection has to be provided by the installer according to the relevant safety standard, e.g. IEC/EN 60950. If the converter case shall not be connected with earth, the front end output circuit has to be insulated from earth according to the relevant safety standard by at least basic insulation, based on the maximum nominal output voltage from the front end, and insulated from the converter case by at least supplementary insulation, based on the maximum nominal mains voltage. The converter case is then considered to be a double insulated accessible part

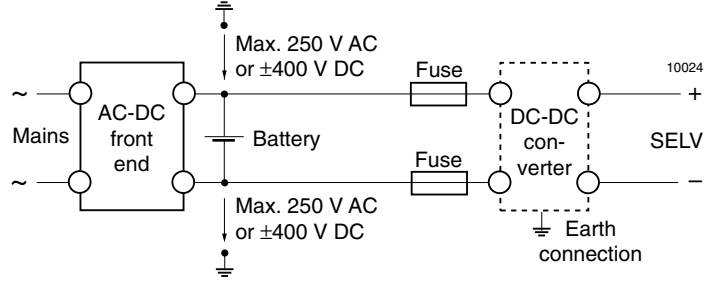


Fig. 14
Schematic safety concept.
Use earth connection as per table: *Safety concept leading to an SELV output circuit*. Use fuse according to: *Installation Instructions.*

Description of Options

Table 16: Survey of options

Option	Function of Option	Characteristic
-7	Extended operational ambient temperature range	T_A = –25...71 °C
D [1]	Input and/or output undervoltage monitoring circuitry	Safe data signal output (D1...D8)
V [1 2]	Input and output undervoltage monitoring circuitry	ACFAIL signal according to VME specifications (V2, V3)

[1] Option D excludes option V and vice versa
[2] Only available with main output voltage U_{o1} = 5.1 V

-7 Extended Temperature Range

Option -7 extends the operational ambient temperature range from –10...50 °C (standard) to –25...71 °C. The power supplies provide full nominal output power with convection cooling.

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 U_t. The return for this signal is Vo1– (pin 23). The D output recovers when the monitored voltage(s) exceed(s) U_t+U_h. The threshold level U_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 the following table.

Table 17: Undervoltage monitor functions

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

[1] Threshold level adjustable by potentiometer (not recommended for mobile applications)
[2] Fixed value between 95% and 98% of U_{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. $U_D \le 0.4$ V (logic low) corresponds to a monitored voltage level (U_i and/or U_{o1}) $<U_t$. 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.

U_i, U_{o1} status	D output, U_D
U_i or $U_{o1} < U_t$	low, L, $U_D \le 0.4$ V at I_D = 2.5 mA
U_i and $U_{o1} > U_t + U_h$	high, H, $I_D \le 25$ µA at U_D = 5.25 V

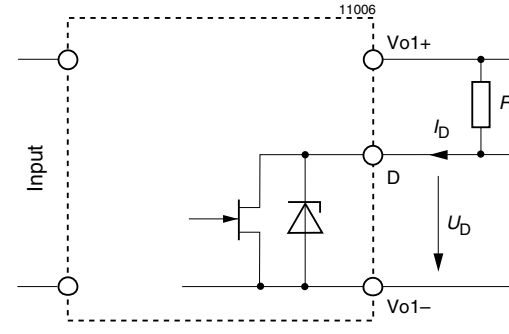


Fig. 15
Options D1...D4, JFET output

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. $U_D \le 0.4$ V (logic low) corresponds to a monitored voltage level (U_i and/or U_{o1}) $>U_t + U_h$. The current I_D through the open collector should not exceed 20 mA. The NPN output is not protected against external overvoltages. U_D should not exceed 40 V.

U_i, U_{o1} status	D output, U_D
U_i or $U_{o1} < U_t$	high, H, $I_D \le 25$ µA at U_D = 40 V
U_i and $U_{o1} > U_t + U_h$	low, L, $U_D \le 0.4$ V at I_D = 20 mA

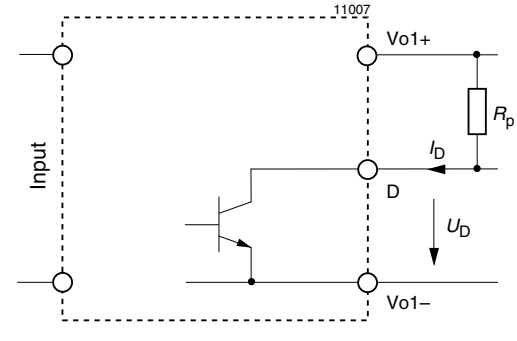


Fig. 16
Options D5...D8, NPN output

Threshold tolerances and hysteresis:

If U_i is monitored, the internal input voltage after the input filter is measured. Consequently this voltage differs from the voltage at the connector pins by the voltage drop $\Delta U_{t\,i}$ across the input filter. The value of ΔU_{ti} depends upon the input voltage range, threshold level U_t, temperature and input current. The input current is a function of the input voltage and the output power.

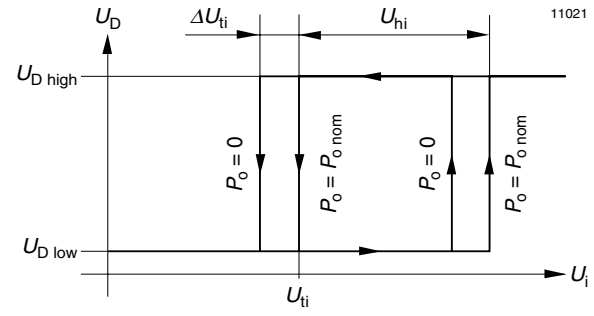
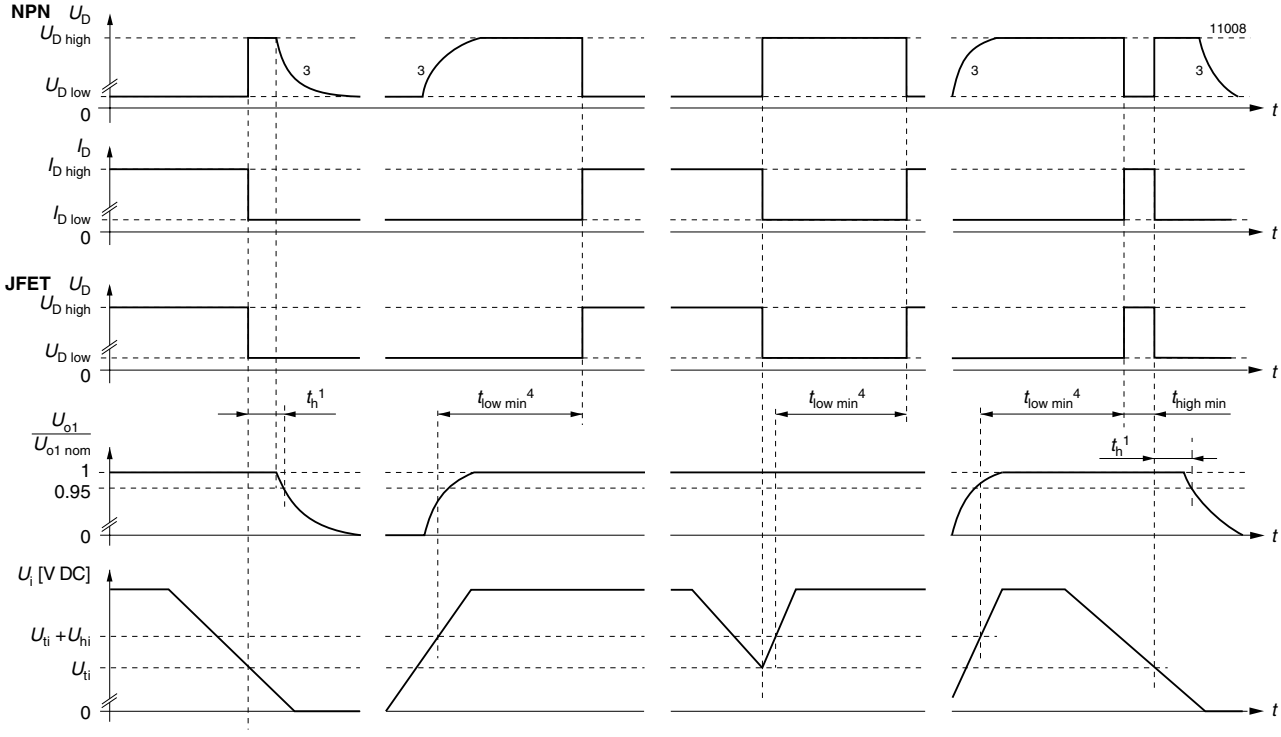


Fig. 17
Definition of U_{ti}, ΔU_{ti} and U_{hi} (JFET output)

Input voltage monitoring



Output voltage monitoring

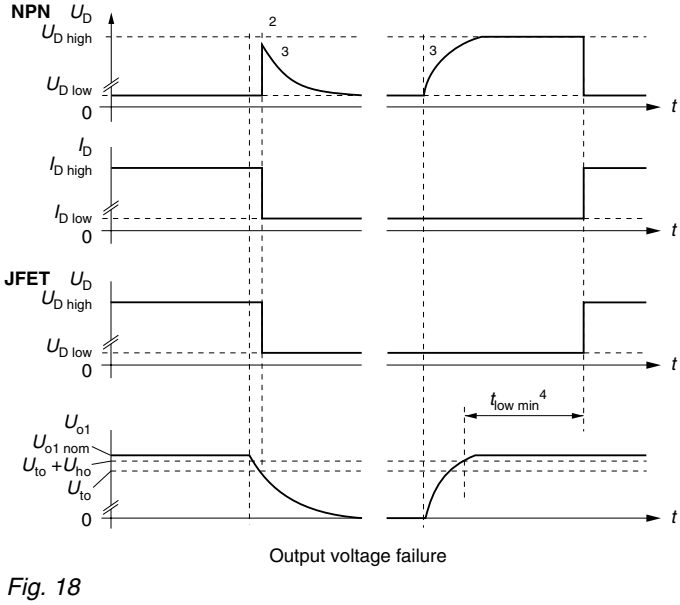


Fig. 18
Relationship between U_i, U_{o1}, U_D, I_D and $U_{o1}/U_{o\,nom}$ versus time.

[1] n.a.
[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

V ACFAIL signal (VME)

Available for units with U_{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 U_V ≤0.6 V (open-collector output of a NPN transistor). 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 should be provided by an external input capacitance. Consequently the working input voltage and the threshold level $U_{t\,i}$ should be adequately above the minimum input voltage $U_{i\,min}$ of the converter so that enough energy is remaining in this capacitance.

If the input voltage is below the required level, an external hold-up capacitor ($C_{i\,ext}$) should be added.

Table 18: Available internal input capacitance and factory potentiometer setting of U_{ti} with resulting hold-up time.

Types	12H	24H	48H	Unit
$C_{i\,min}$	2.2	0.75	0.19	mF
$U_{t\,i}$	9.5	19.5	39	V DC
t_h	0.19	0.87	0.89	ms

Formula for threshold level for desired value of t_h:

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

Formula for additional external input capacitor

$$C_{i\,ext} = \frac{2 \bullet P_o \bullet (t_h + 0.3\ \text{ms}) \bullet 100}{\eta \bullet (U_{ti}^2 - U_{i\,min}^2)} - C_{i\,min}$$

where as:

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

Remarks: The threshold level U_{ti} of option V2 and V3 is adjusted during manufacture to a value according to table *Undervoltage monitor functions*, section *Option D*.

A decoupling diode should be connected in series with the input to avoid the input capacitance discharging through other loads connected to the same source voltage.

Option V operates independently of the built-in input undervoltage lock-out circuit. A logic "low" signal is generated at pin 5 as soon as one of the monitored voltages drops below the preselected threshold level U_t. The return for this signal is Vo1– (pin 23). The V output recovers when the monitored voltage(s) exceed(s) $U_t + U_h$. The threshold level U_t is adjustable by a potentiometer accessible through a hole in the front cover.

Versions V2 and V3 are available as shown below.

Table 19: Undervoltage monitor functions

V output (VME compatible)	Monitoring		Minimum adjustment range of threshold level U_t		Typical hysteresis U_h [% of U_t] for $U_{t\,min}$...$U_{t\,max}$	
	U_i	U_{o1}	U_{ti}	U_{to}	U_{hi}	U_{ho}
V2	yes	no	$U_{i\,min}$...$U_{i\,max}$ [1]	–	3.0...0.5	–
V3	yes	yes	$U_{i\,min}$...$U_{i\,max}$ [1]	0.95...0.98 U_{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 U_{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. $U_V \le 0.6$ V (logic low) corresponds to a monitored voltage level (U_i and/or U_{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. U_V should not exceed 80 V.

U_i, U_{o1} status	V output, U_V
U_i or $U_{o1} < U_t$	low, L, $U_V \le 0.6$ V at I_V = 50 mA
U_i and $U_{o1} > U_t + U_h$	high, H, $I_V \le 25$ µA at U_V = 5.1 V

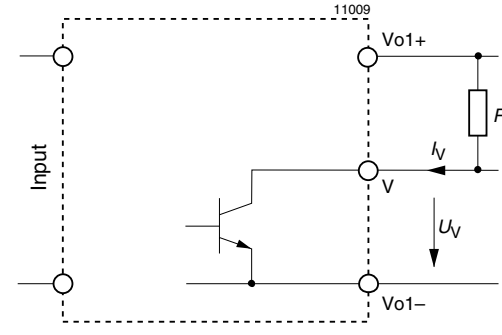


Fig. 19
Output configuration of options V2 and V3

Threshold tolerances and hysteresis:

If U_i is monitored, the internal input voltage is measured after the input filter. Consequently this voltage differs from the voltage at the connector pins by the voltage drop ΔU_{ti} across input filter and rectifier. The value of ΔU_{ti} depends upon the input voltage range, threshold level U_t, temperature and input current. The input current is a function of input voltage and output power.

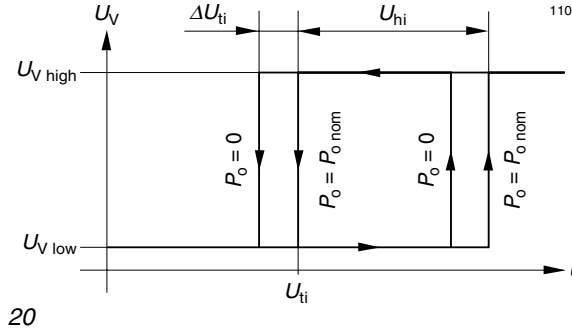
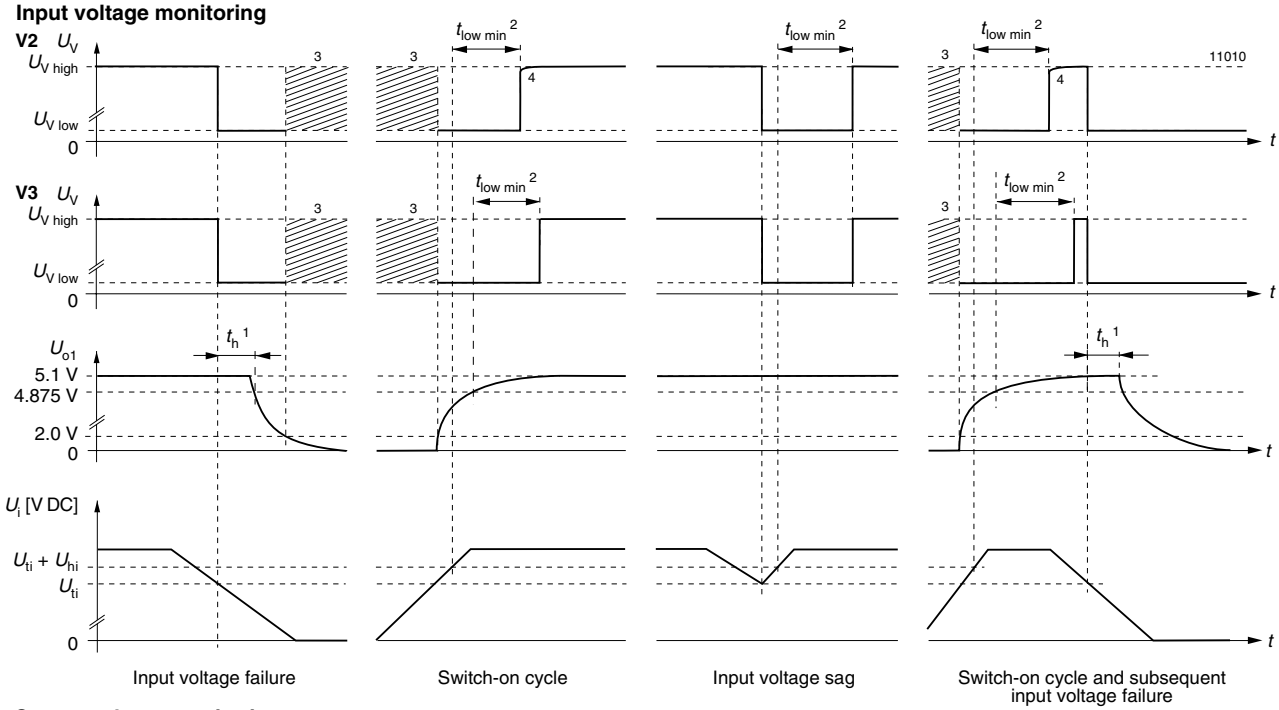


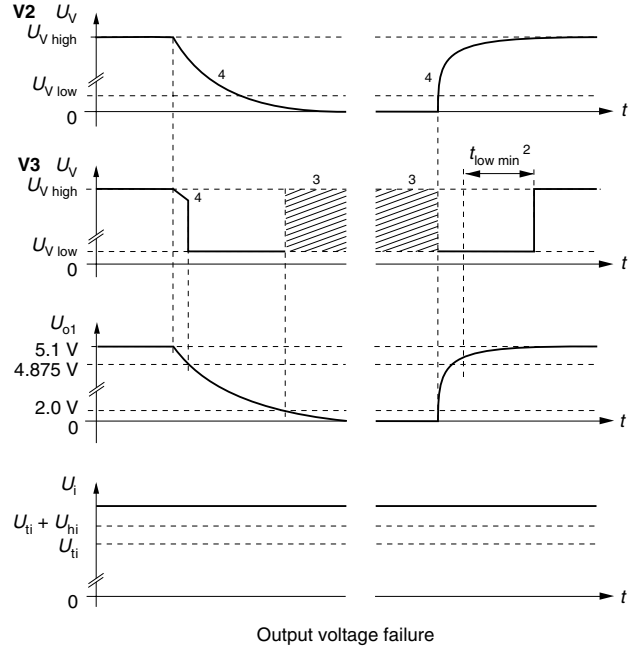
Fig. 20
Definition of U_{ti}, ΔU_{ti} and U_{hi}

Input voltage monitoring



Input voltage failure | Switch-on cycle | Input voltage sag | Switch-on cycle and subsequent input voltage failure

Output voltage monitoring



Output voltage failure

[1] VME request: minimum 4 ms
[2] $t_{low\ min}$ = 40...200 ms, typically 80 ms
[3] U_V level not defined at U_{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.

Fig. 21
Relationship between U_i, U_{o1}, U_V, I_V and $U_{o1}/U_{o\ nom}$ versus time.

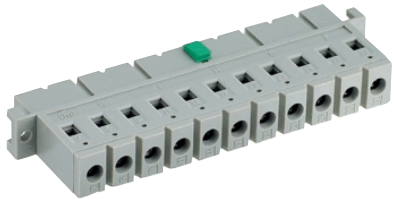
Accessories

A variety of electrical and mechanical accessories are available including:

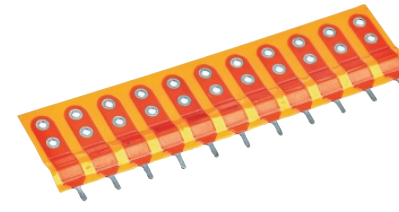
- Front panels for 19" rack mounting, Schroff and Intermas systems.
- Mating H11 connectors with screw, solder, fast-on or press-fit terminals.
- Connector retention facilities.
- Code key system for connector coding.
- Flexible H11 PCB for mounting of the unit onto a PCB.
- Chassis mounting plates for mounting the 19" cassette to a chassis/wall where only frontal access is given.
- Universal mounting bracket for DIN-rail or chassis mounting.

For more detailed information please refer to *Accessory Products*.

Front panels



H11 female connector,
Code key system



Flexible H11 PCB

Mounting plate,
Connector retention clips

Universal mounting bracket for DIN-rail mounting.