

50 W AC-DC (DC-DC) Converters

M-Family

Class I Equipment

Single output: series LM 1000

Dual output: series LM 2000

Triple output: series LM 3000

Class II Equipment (double insulation) 

Single output: series LMZ 1000

Dual output: series LMZ 2000

Triple output: series LMZ 3000

- Extremely wide input voltage range suitable for most AC mains around the world
- Efficient input filter and built-in surge and transient suppression circuitry
- 4 kV_{rms} input to output electric strength test
- Outputs individually isolated and controlled
- Outputs fully protected against overload

Safety according to IEC 950

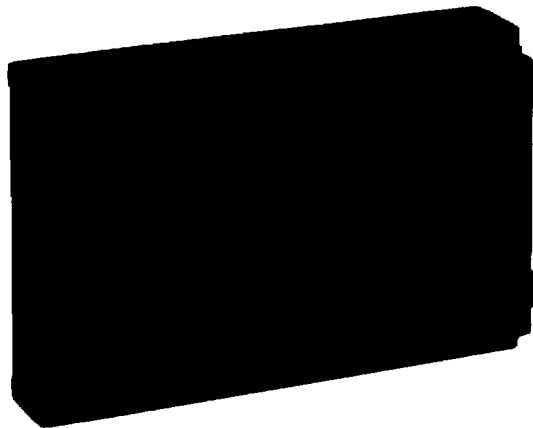


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Description

The M-family of AC-DC (DC-DC) converters represents a broad and flexible range of power supplies for use in advanced industrial electronic systems. Features include high efficiency, reliability, low output voltage noise and excellent dynamic response to load/line changes due to individual regulation of each output.

The converter inputs are protected against surges and transients occurring at the Input. An input over- and under-voltage cut-out circuitry disables the outputs if the input voltage is outside the specified range. These types include an inrush current limitation preventing circuit breakers and fuses from being damaged 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 (i). If the inhibit function is not used pin 2 should be connected with 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 950 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 an ambient temperature of 71°C in free air. If forced cooling is provided, the ambient temperature may exceed 71°C but the case temperature should remain below 95°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.

Case: aluminium, black finish, self cooling.
Dimensions: 38.7 × 111.2 × 168.5 mm. Weight: 770 g

Type Survey

Options see "Descriptions of Options"

General note

The type survey tables provide an overview of the basic input and output configurations. More than 500 different types have been manufactured providing different output configurations and customized specialties. Please consult Melcher's field sales engineers for specific requirements. The best technical solution will carefully be considered and a detailed proposal submitted.

Table 1: Class I equipment

Output 1		Output 2		Output 3		Input Voltage Range and Efficiency ¹		Option
U_o nom	I_o nom	U_o nom	I_o nom	U_o nom	I_o nom	U_i min... U_i max	η min	
V DC	A	V DC	A	V DC	A	85...264 V AC/47...440 Hz (88...372 V DC)	%	
5.1	8.0					LM 1001-7R	73	-9
12.0	4.0					LM 1301-7R	79	E
15.0	3.4					LM 1501-7R	78	P
24.0	2.0					LM 1601-7R	81	D0...D9
48.0	1.0					LM 1901-7R	81	V0,V2,V3
12.0	2.0	12.0	2.0			LM 2320-7	77	A
15.0	1.7	15.0	1.7			LM 2540-7	78	H
5.1	5.0	12.0	0.7	12.0	0.7	LM 3020-7	73	F
5.1	5.0	15.0	0.6	15.0	0.6	LM 3040-7	71	U

Table 2: Class II equipment (double insulation)

Output 1		Output 2		Output 3		Input Voltage Range and Efficiency ¹		Option
U_o nom	I_o nom	U_o nom	I_o nom	U_o nom	I_o nom	U_i min... U_i max	η min	
V DC	A	V DC	A	V DC	A	85...264 V AC/47...65 Hz (88...372 V DC)	%	
5.1	8.0					LMZ 1001-7R	73	-9
12.0	4.0					LMZ 1301-7R	79	E
15.0	3.4					LMZ 1501-7R	78	P
24.0	2.0					LMZ 1601-7R	81	D0...D9
48.0	1.0					LMZ 1901-7R	81	V0,V2,V3
12.0	2.0	12.0	2.0			LMZ 2320-7	77	A
15.0	1.7	15.0	1.7			LMZ 2540-7	78	H
5.1	5.0	12.0	0.7	12.0	0.7	LMZ 3020-7	73	F
5.1	5.0	15.0	0.6	15.0	0.6	LMZ 3040-7	71	U

¹ Efficiency measured at U_i nom and I_o nom

Safety and Installation Instructions

Safety

For safety reasons, the power supply modules must be wired via the female connector H11 (according to DIN 41612, see chapter "Accessories") in order to meet national and international safety requirements!

If the output circuit of an AC-DC converter is operator-accessible according to the IEC 950 related safety standards, it shall be an SELV circuit (Safety Extra Low Voltage circuit, i.e. a circuit, separated from mains by at least basic insulation, that is so designed and protected such that under normal and single fault conditions, the voltage between any two conductors and between any conductor and earth does not exceed 60 V DC).

In the following section an interpretation is provided of the IEC 950 safety standard with respect to the safety status of the output circuit. However, it is the sole responsibility of the installer or user to assure the compliance with the relevant and applicable safety standards:

If the AC-DC converter is installed according to the relevant safety regulations its outputs are considered to be SELV circuits up to a nominal output voltage of 36 V.

LM types correspond to class I equipment, while the LMZ types correspond to class II equipment.

In class I equipment the connector protective earthing pin is leading while it is omitted in class II equipment (no protective earthing is required). Class II equipment provides reinforced insulation between input and output circuitry and also between input and case. There are two class II Y-capacitors connected in series between input and output circuitry instead of having Y-capacitors connected to the case.

During the production process, all transformers and each of the fully assembled modules are individually tested for electric strength and earth continuity (see "Supplementary Data"). All electric strength tests are performed as factory tests.

The UL 1950 recognition limits the maximum ambient operational temperature of the standard modules to $T_A = T_{A,max} - 15$ K. Option U allows the operation in applications where the full operational temperature range according to the relevant data sheet and UL 1950 recognition is required.

Important Advice

Electric strength tests should not be repeated in the field. Improper test methods, for example overshooting or oscillating test voltages, voltage slopes exceeding 1 kV/ μ s, internal Y-capacitors not carefully discharged, etc. can cause severe damage to switching devices and ICs. Melcher AG will not honour any guarantee/warranty claims resulting from high voltage field tests.




Installation Instructions

Installation of the power supply must strictly follow the national safety regulations. To observe the safety requirements according to EN 60950/IEC 950, the module shall be connected via the female connector type H11 (see section "Accessories"). Other installation methods may not meet the safety requirements. A second fuse should be installed in the wiring to pin 29 if:

- Local requirements demand an individual fuse in each source line
- Neutral to earth impedance is high or undefined
- Phase and neutral of the mains are not defined

Whenever the inhibit function is not required, pin 2 (i) should be connected to pin 23 to enable the output(s).

Table 3: H11 connector pin allocation

Electrical Determination	LM 1000		LMZ 1000		LM 2000		LMZ 2000		LM 3000		LMZ 3000	
	Pin	Ident	Pin	Ident	Pin	Ident	Pin	Ident	Pin	Ident	Pin	Ident
Inhibit control input	2	i	2	i	2	i	2	i	2	i	2	i
Safe Data or ACFAIL	5	D or V	5	D or V	5	D or V	5	D or V	5	D or V	5	D or V
Output voltage (positive)	8	Vo1+	8	Vo1+	8		8		8	Vo3+	8	Vo3+
Output voltage (negative)	11	Vo1-	11	Vo1-	11		11		11	Vo3-	11	Vo3-
Control input + ¹	14	R	14	R								
Control input -	17	G	17	G								
Output voltage (positive)					14	Vo2+	14	Vo2+	14	Vo2+	14	Vo2+
Output voltage (negative)					17	Vo2-	17	Vo2-	17	Vo2-	17	Vo2-
Output voltage (positive)	20	Vo1+	20	Vo1+	20	Vo1+	20	Vo1+	20	Vo1+	20	Vo1+
Output voltage (negative)	23	Vo1-	23	Vo1-	23	Vo1-	23	Vo1-	23	Vo1-	23	Vo1-
Protective earthing ²	26				26				26			
AC input voltage ³	29	N \approx	29	N \approx	29	N \approx	29	N \approx	29	N \approx	29	N \approx
AC input voltage	32	P \approx	32	P \approx	32	P \approx	32	P \approx	32	P \approx	32	P \approx

¹ This function is not simultaneously available with option P

² Leading pin (pregrounding)

³ In DC-DC operation pin 29 should be connected to the earth related potential of the input voltage

Degree of Protection

Condition: Female connector fitted to the unit

IP 40: All units, except those with options P, A, K, D or V with potentiometer adjustment.

IP 30: All units, except those with option P, D or V with potentiometer adjustment.

IP 20: All units fitted with options which include potentiometer setting.

Leakage Currents and Insulation

Please refer to "Supplementary Data"

Functional Description

The input voltage is fed via an input fuse, an input filter, a rectifier 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 filter. 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 pri-

mary switching transistor. This signal is fed back via a coupling transformer.

The auxiliary outputs U_{o2} and U_{o3} are individually regulated by means of secondary switching transistors. 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 control circuit.

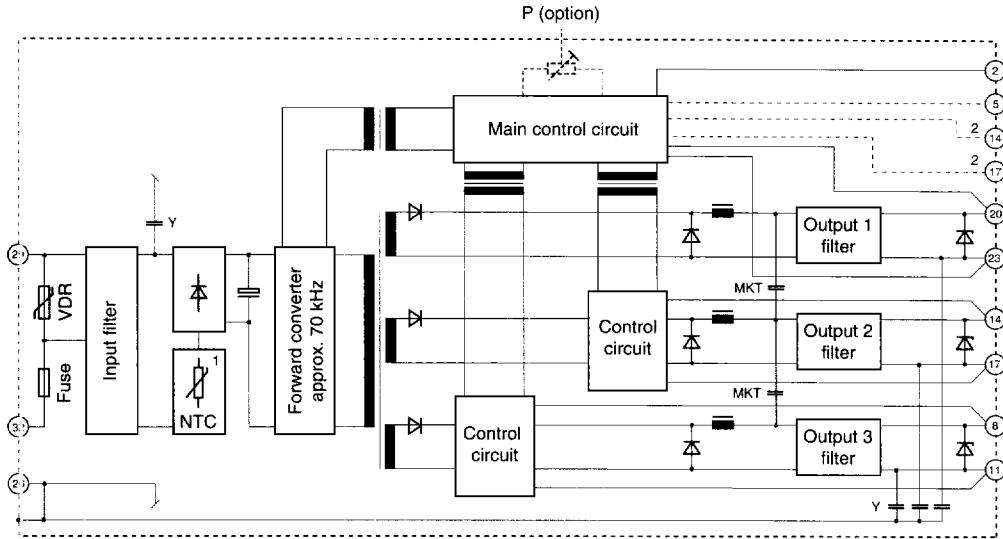


Fig. 1a
AC-DC (DC-DC) converter block diagram, class I equipment

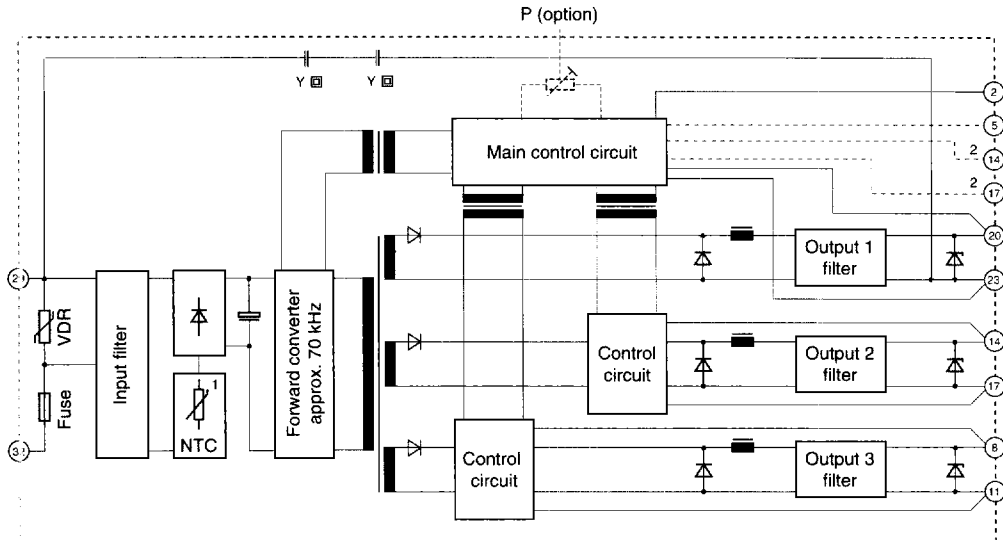


Fig. 1b
AC-DC (DC-DC) converter block diagram,
class II equipment (double insulation)

¹ Inrush current limiter (option E: refer to the description of option E)
² Single output modules LM 1000 and LMZ 1000 with feature R

10.1

Electrical Input Data

General conditions:

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

- Connector pins 2 and 23 interconnected, with option P: $U_o = U_{o, \text{nom}}$, R input not connected.

Table 4: Input data

Input			LM/LMZ			
Characteristics		Conditions	min	typ	max	Unit
U_i	Input voltage range	$I_o = 0 \dots I_{o, \text{nom}}$ $T_C \text{ min} \dots T_C \text{ max}$	85		264	V AC ¹
					372 ⁷	V DC
$U_{i, \text{nom}}$	Nominal input voltage		310 ²			
I_i	Input current	$U_{i, \text{nom}}, I_{o, \text{nom}}$ ³	0.20		A	
P_{i0}	No-load input power: Single output Double output Triple output	$U_{i, \text{nom}}$ $I_{o1,2,3} = 0$		1	1.5	W
				7	9	
				6	9	
$P_{i, \text{inh}}$	Idle input power	inhibit mode			1.5	W
$I_{i, \text{inp}}^4$	Peak inrush current	$U_i = U_{i, \text{max}}$ $R_S = 0 \Omega^5$ $T_C = 25^\circ\text{C}$			60 ⁶	A
$t_{i, \text{rr}}$	Rise time			300		μs
$t_{i, \text{rh}}$	Trailing edge half-life			900		
R_i	Input resistance	$T_C = 25^\circ\text{C}$	6200 ⁶			m Ω
C_i	Input capacitance		140		270	μF
$U_{i, \text{abs}}$	Input voltage limits without any damage		-400		400	V DC
			0		284	V AC

- ¹ In AC powered mode:
LM types: 47...440 Hz;
LMZ types: 47...65 Hz.
- ² 310 V DC corresponds with 220 V AC.
- ³ With multiple output modules, the same condition for each output applies.
- ⁴ $I_{i, \text{inp}} = U_i / (R_S + R_i)$.
- ⁵ R_S = source resistance.
- ⁶ Value for initial switch-on cycle.
- ⁷ With LMZ converters, the maximum rated output voltage of the front end is 250 V according to IEC 950.

Input fuse

A fuse holder containing a slow-blow type fuse (Dimension: 5 x 20 mm) is mounted in the converter's back plate. The fuse protects the module against severe defects. It may not fully protect the module at input voltages exceeding 200 V DC. In applications where the converters operate at DC source voltages above 200 V DC, an external fuse or a circuit breaker at system level should be installed. For applications where the fuse should be inaccessible: see option F.

Input Under-/Overvoltage Cut-out

If the input voltage remains below 0.8 $U_{i, \text{min}}$ or exceeds 1.1 $U_{i, \text{max}}$ (approx. values), an internally generated inhibit signal disables the output(s). When checking this function the absolute maximum input voltage rating $U_{i, \text{abs}}$ must be carefully considered (see table "Input Data").

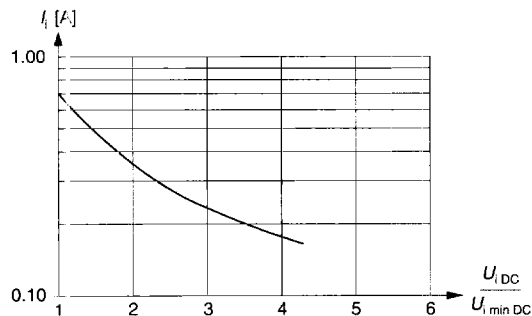


Fig. 2 Typical input current versus relative input voltage at nominal output load

Table 5: Fuse type (slow-blow)

Series	Schurter type	Part number
LM/LMZ 1000...3000	SPT 2.5 A 250 V	0001.2508

Inrush Current

The modules incorporate an NTC resistor in the input circuitry which (during the initial switch-on cycle) limits the peak inrush current to avoid damage to connectors and switching devices. 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. Refer also to option E description.

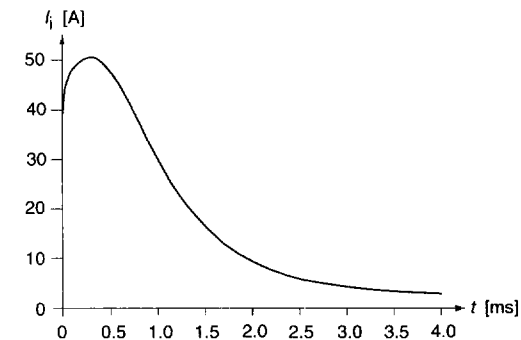


Fig. 3 Typical inrush current at initial switch-on cycle and at $U_{i, \text{max}}$ (DC) versus time

Electrical Output Data

General conditions

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

– Connector pins 2 and 23 interconnected, $U_o = U_{o, \text{nom}}$ (option P), R input not connected.

Table 5: Output data

Output		$U_{o, \text{nom}}$	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
U_o	Output voltage	$U_{i, \text{nom}}, I_{o, \text{nom}}^1$	5.07	5.13	11.93	12.07	14.91	15.09	23.86	24.14	47.72	48.28	V	
$U_{o, L}$	Overvoltage prot.	$I_{o, \text{nom}}$	7.5		21		25		41		85			
$I_{o, \text{nom}}$	Output current	$U_{i, \text{min}} \dots U_{i, \text{max}}$	see tables 1 and 2											
$I_{o, L}$	Output current limitation response	$T_C, \text{min} \dots T_C, \text{max}$	see fig. 4											
$u_{o1/2/3}$	Output voltage noise	$U_{i, \text{nom}}, I_{o, \text{nom}}^1$	2	4	3	6	3	6	3	6	4	8	mV_{rms}	
u_{o1}	Bandwidth = 20 MHz		15	30	25	50	35	70	40	80	50	100	mV_{pp}	
$u_{o2/3}$			60	120	40	80	40	80	40	80	-	-		
$\Delta U_{o, U}$	Static line regulation	$U_{i, \text{min}} \dots U_{i, \text{nom}}$ $U_{i, \text{nom}} \dots U_{i, \text{max}}$ $I_{o, \text{nom}}^1$	$\pm 10 \pm 30$		$\pm 12 \pm 50$		$\pm 15 \pm 60$		$\pm 15 \pm 60$		$\pm 15 \pm 60$		mV	
$\Delta U_{o, I}$	Static load regulation	$U_{i, \text{nom}}$ $I_o = I_{o, \text{nom}} \dots 0^2$	6	25	13	50	17	60	30	80	60	150		
$\Delta U_{o, Ic}$	Static cross load regulation ⁴	$U_{i, \text{nom}}$ $I_o = I_{o, \text{nom}} \dots 0^3$	0	± 15	0	± 20	0	± 30	0	± 40	-	-		
$u_{o, d}$	Dynamic load regulation	$U_{i, \text{nom}}, I_o = 1/0.33/1 \cdot I_{o, \text{nom}}^2$	± 220		± 110		± 150		± 130		± 150			
t_d	Dynamic load regulation time constant	fig. 5	0.6		0.6		0.5		1		2		ms	
$u_{o, dc}$	Dynamic cross load regulation ⁴	$U_{i, \text{nom}}, I_o = 1/0.33/1 \cdot I_{o, \text{nom}}^3$	+10	-100	+10	-75	+10	-140	+20	-200	-	-	mV	
t_{dc}	Dynamic cross load reg. time constant ⁴	fig. 5	0.05	0.5	0.2	0.3	0.5	0.7	1	2	-	-	ms	
α_{U_o}	Output voltage deviation versus case temperature	$T_C, \text{min} \dots T_C, \text{max}$	± 0.02		± 0.02		± 0.02		± 0.02		± 0.02		%/K	
			± 1.0		± 2.4		± 3.0		± 4.8		± 9.6		mV/K	

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 $I_o = I_{o, \text{nom}}$.

³ Condition for non-specified output, individually tested, other output(s) loaded with constant current $I_o = I_{o, \text{nom}}$.

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. A red LED indicates the overload condition of the respective output.

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.

In parallel operation, one or more of the main outputs may operate continuously in current limit 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 voltage noise.

Auxiliary outputs should never be connected in parallel!

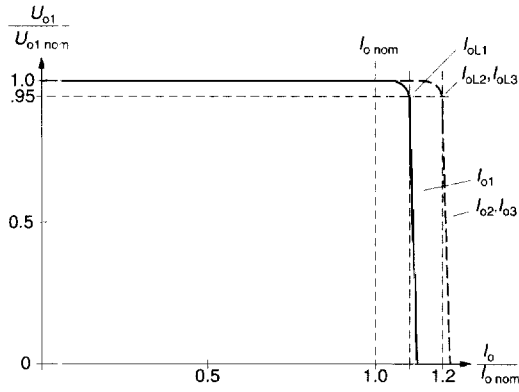


Fig. 4
Typical output voltage U_{o1} versus output currents I_o

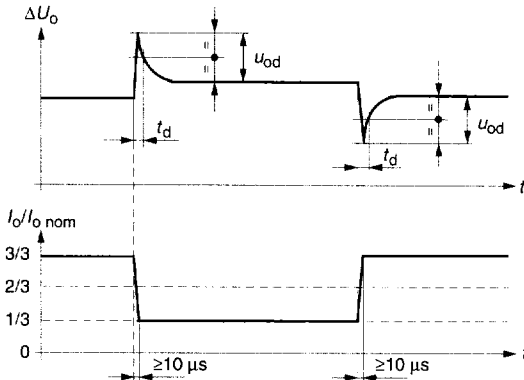


Fig. 5
Control deviation of U_o versus dynamic load change

Output Current Allocation for special Types

Output currents differing from those given for standard types (as per "Type survey") can be provided. A maximum output power of 50 W should be considered, if an ambient temperature range of $-25...71^\circ\text{C}$ is required. The maximum permissible output currents are indicated in the table below. If (upon customer's request) output voltages are different from standard values, the relevant output currents have to be adapted accordingly.

With reduced maximum ambient temperature or with forced cooling, the total output power may exceed 50 W. Customized configurations always need to be checked by a feasibility study first. Please ask Melcher's sales engineers for a proposal appropriate to your specific needs.

Table 7: Current allocation with special types

Output voltage all types $U_{1/2/3 \text{ nom}}$ [V]	Output 1 all types $I_{o1 \text{ max}}$ [A]	Output 2 LM/LMZ 2000 $I_{o2 \text{ max}}$ [A]	Output 2 LM/LMZ 3000 $I_{o2 \text{ max}}$ [A]	Output 3 LM/LMZ 3000 $I_{o3 \text{ max}}$ [A]	Temperature		
					T_A [$^\circ\text{C}$]	T_C [$^\circ\text{C}$]	
5.1	8.0	4.0	1.8 (2.5 ¹)	1.5	-25...71	-25...95	
12	4.0	2.0	1.5	1.2			
15	3.4	1.7	1.2	1.0			
24	2.0	1.0	0.7	0.5			
2	5.1	10.0	4.5	2.1 (2.8 ¹)	1.8	-25...60	-25...90
	12	5.0	2.5	1.7	1.5		
	15	4.0	2.0	1.5	1.3		
	24	2.5	1.3	0.9	0.7		
	5.1	11.0	5.0	2.4 (3.0 ¹)	2.0	-25...50	-25...85
	12	6.0	3.0	2.0	1.7		
	15	4.6	2.3	1.7	1.5		
	24	3.0	1.5	1.0	0.8		

¹ Special high current components required, ² $U_{i \text{ min}}$ has to be increased

Inhibit (i Input)

The outputs of the module may be enabled or disabled by means of a logic signal (TTL, CMOS, etc.) applied to the inhibit input. 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 reference for the inhibit signal is the negative pin of output 1.

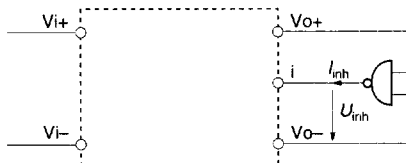


Fig. 6
Definition of inhibit voltage and current

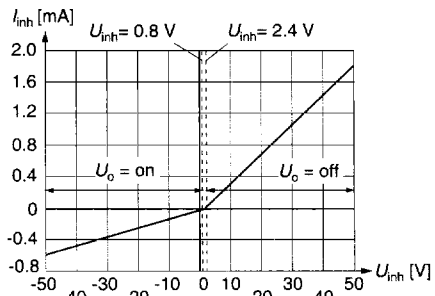


Fig. 7
Typical inhibit current I_{inh} versus inhibit voltage U_{inh}

10.1

Table 8: Inhibit data

Characteristics		Conditions	min	typ	max	Unit
U_{inh}	Inhibit input voltage causing output voltage being...	switched on	-50	0.8	0.8	V DC
		switched off				
I_{inh}	Inhibit current	$U_{inh} = 0$	-60	-100	-220	μA

Hold-up Time and Output Response

When the input voltage is switched off, the output voltage will remain high for a certain hold-up time t_h before the output voltage falls below $0.95 U_{o,nom}$.

The behavior of the outputs is similar with either the input voltage applied or the inhibit switched low.

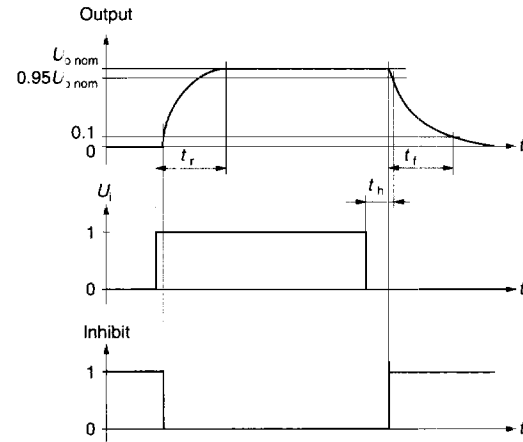


Fig. 8 Output response as a function of input voltage (on/off switching) or inhibit control

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

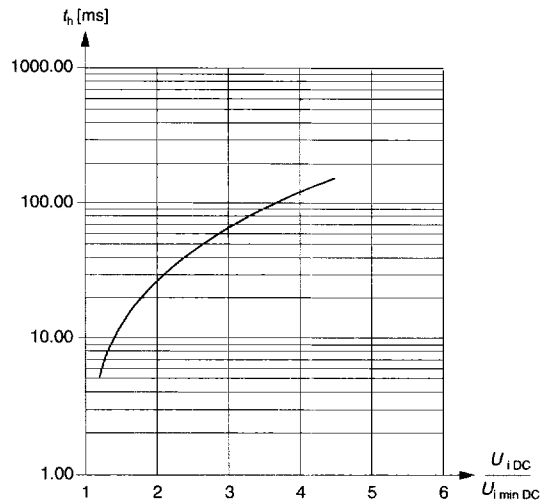


Fig. 9 Typical hold-up time t_h versus relative input voltage at $I_{o,nom}$

Table 9: Output response time t_r , values not applicable for modules 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	
LM/LMZ 1001-7R	5	10	5	10	10	20	ms
LM/LMZ 1301-7R	10	20	15	30	20	40	
LM/LMZ 1501-7R	5	10	10	20	30	60	
LM/LMZ 1601-7R	15	30	25	50	40	80	
LM/LMZ 1901-7R	65	130	100	200	165	330	
LM/LMZ 2320-7	20	40	30	60	50	100	
LM/LMZ 2540-7	15	30	20	40	35	70	
LM/LMZ 3020-7	55	110	85	170	145	290	
LM/LMZ 3040-7	40	80	60	120	100	200	

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 $U_{i,min} \dots U_{i,max}$ does not influence the values.

Programmable Voltage (R Input)

As a standard feature single output modules offer an adjustable output voltage identified by letter R in the type designation. The control input R (pin 14) accepts either a control voltage U_{ext} or a resistor R_{ext} to adjust the desired output voltage. When not connected, the control input automatically sets the output voltage to $U_{o,nom}$. The control input is protected against external overvoltage up to 8 V max.

a) Adjustment by means of an external control voltage U_{ext} between pin 14 (R) and pin 17 (G):

The control voltage range is 0...2.75 V and allows an adjustment in the range of approximately

$$U_o = 0...110\% U_{o,nom}$$

$$U_{ext} \approx \frac{U_o}{U_{o,nom}} \cdot 2.5 \text{ V}$$

b) Adjustment by means of an external resistor:

Depending upon the value of the required output voltage, the resistor shall be connected

either: Between pin 14 and pin 17 ($U_o < U_{o,nom}$) to achieve an output voltage adjustment range of approx.

$$U_o = 0...100\% U_{o,nom}$$

$$R_{ex} \approx 4 \text{ k}\Omega \cdot \frac{U_o}{U_{o,nom} - U_o}$$

or: Between pin 14 and pin 20 ($U_o > U_{o,nom}$) to achieve an output voltage adjustment range of approximately

$$U_o = 100...110\% \text{ of } U_{o,nom}$$

$$R'_{ext} \approx 4 \text{ k}\Omega \cdot \frac{(U_o - 2.5 \text{ V})}{2.5 \text{ V} \cdot (U_o/U_{o,nom} - 1)}$$

For output voltages $U_o > U_{o,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o,nom}$.

Warning

Table 10a: R_{ext} for $U_o < U_{o,nom}$ (conditions: $U_{i,nom}$, $I_{o,nom}$, rounded up to resistor values E 96); $R'_{ext} = \infty$

$U_{o,nom} = 5.1 \text{ V}$		$U_{o,nom} = 12 \text{ V}$		$U_{o,nom} = 15 \text{ V}$		$U_{o,nom} = 24 \text{ V}$		$U_{o,nom} = 48 \text{ V}$	
U_o [V]	R_{ext} [kΩ]	U_o [V]	R_{ext} [kΩ]	U_o [V]	R_{ext} [kΩ]	U_o [V]	R_{ext} [kΩ]	U_o [V]	R_{ext} [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 10b: R'_{ext} for $U_o > U_{o,nom}$ (conditions: $U_{i,nom}$, $I_{o,nom}$, rounded up to resistor values E 96); $R_{ext} = \infty$

$U_{o,nom} = 5.1 \text{ V}$		$U_{o,nom} = 12 \text{ V}$		$U_{o,nom} = 15 \text{ V}$		$U_{o,nom} = 24 \text{ V}$		$U_{o,nom} = 48 \text{ V}$	
U_o [V]	R'_{ext} [kΩ]	U_o [V]	R'_{ext} [kΩ]	U_o [V]	R'_{ext} [kΩ]	U_o [V]	R'_{ext} [kΩ]	U_o [V]	R'_{ext} [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

The value of R'_{ext} should never be less than 47 kΩ to avoid damage to the unit! R inputs may be parallel connected, but $1/R_{tot} = 1/R_1 + 1/R_2 + \dots$ should be considered.

Remark

The R feature excludes option P (output voltage adjustment by potentiometer).

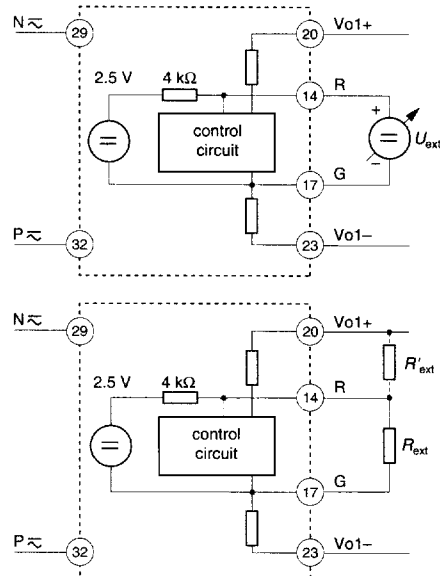


Fig. 10 Output voltage control by means of the R input

EMC and Immunity to Input Transients

A metal oxide VDR 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 M-family has been successfully tested to the following specifications:

Electromagnetic Immunity

Table 11: Immunity type tests

Phenomenon	Standard	Level	Coupling mode ⁴	Value applied	Waveform	Source impedance	Test procedure	In operation	Performance
Impulse voltage	IEC 255-4 App. E4 ⁵ (1976)	III	i/o, i/c, o/c +i/-i, +o/-o	5000 V _p	1.2/50 μs	500 Ω	3 pos. and 3 neg. impulses per coupling mode	no	
High frequency disturbance	IEC 255-4 App. E5 ⁵ (1976)	III	i/o, i/c, o/o, o/c +i/-i, +o/-o	2500 V _p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	1
				1000 V _p					
Voltage surge	IEC 571-1 ³ (1990-07)		i/c, +i/-i	800 V _p	100 μs	100 Ω	1 pos. and 1 neg. voltage surge per coupling mode	yes	1
				1500 V _p	50 μs				
				3000 V _p	5 μs				
				4000 V _p	1 μs				
				7000 V _p	100 ns				
Supply related surge	RIA 12 (1984)	B	+i/-i	1.5 • U _{batt}	1 s	0.2 Ω	1 positive surge	yes	1
Direct transient		C		960 V _p	10/100 μs				
		D	1800 V _p	5/50 μs					
		E	3600 V _p	0.5/5 μs					
		F	4800 V _p	0.1/1 μs					
		G	8400 V _p	0.05/0.1 μs					
Indirect coupled transient		H	i/c	1800 V _p	5/50 μs	100 Ω			
		J		3600 V _p	0.5/5 μs				
		K		4800 V _p	0.1/1 μs				
		L		8400 V _p	0.05/0.1 μs				
Electrostatic discharge	IEC 801-2 (1991-04)	4	contact discharge to case,	8000 V _p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	1
			air dischg. to case	15000 V _p					
Electric field	IEC 801-3 (1984)	3	antenna in 1 m distance	10 V/m	AM modulated 80%, 1 kHz		26...1000 MHz	yes	2
Fast transient/burst	IEC 801-4 (1988)	3	i/c, +i/-i	2000 V _p	bursts of 5/50 ns 5 kHz rep. rate transients with 15 ms burst duration and a 300 ms period	50 Ω	1 min positive 1 min negative bursts per coupling mode	yes	1
		4		4000 V _p					
Transient	IEC 801-5 (Draft 1993-01)	4	i/c	4000 V _p	1.2/50 μs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	1
			+i/-i	2000 V _p		2 Ω			
Conducted disturbance	IEC 801-6 (Draft 1992-12)	3	i/o, signal wires	140 dBμV (10 V _{rms})	AM modulated 80%, 1 kHz	150 Ω	0.15...80 MHz	yes	2

¹ Normal operation, no deviation from specifications

² Normal operation, temporary deviation from specs possible

³ Will be replaced by EN 50155

⁴ i = input, o = output, c = case

⁵ In correspondence with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)

Electromagnetic Emissions

Table 12: Emissions at $U_1 = 230\text{ V AC}$ and $I_{o, nom}$

Types	Level:							
	VDE 0871 6.78		VDE 0875 part 3 12.88		EN 55011, 1991 ¹ EN 55022, 1987 ²		FCC: 47 CFR 15.xxx	
	≤ 30 MHz	≥ 30 MHz	≤ 30 MHz	≥ 30 MHz	≤ 30 MHz	≥ 30 MHz	15.107 ≤ 30 MHz	15.103 ≥ 30 MHz
LM 1000	B	B	N	K	B	B	B	B
LM 2000	B	B	N	K	B	B	B	B
LM 3000	B	A	N	K	B	A	B	A
LMZ 1000	>A	>A	G	K	A	>A	>A	>A
LMZ 2000	-	-	-	-	-	-	-	-
LMZ 3000	A	>A	N	N	B	>A	A	>A

¹ Identical with CISPR 11 (1990-09) and VDE 0875 part 11 (1992-07)

² Identical with CISPR 22 (1985) and VDE 0878 part 3 (1989-11)

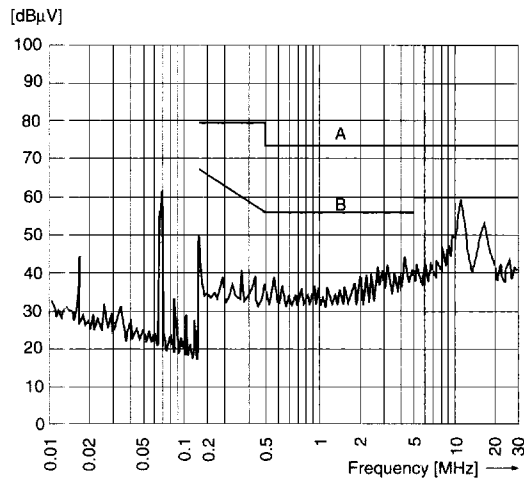


Fig. 11a
Conducted RFI at input according to EN 55011 (quasi peak)

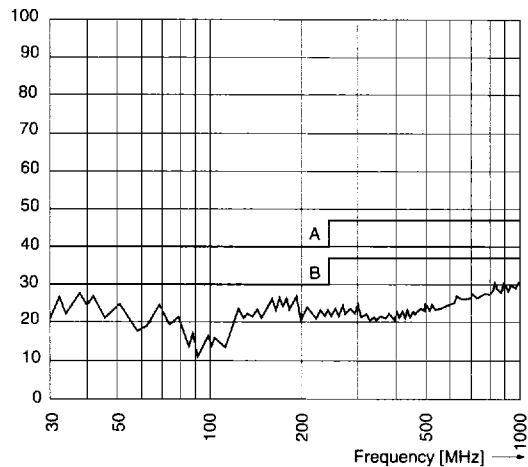


Fig. 11b
Radiated RFI according to EN 55011 (Distance 10 m)

Supplementary Data

Isolation

Input to output electric strength tests, in accordance with the safety standards IEC 950, EN 60950, VDE 0805 and EN 41003 are performed as factory tests and should not be repeated in the field.

Important Advice

Testing by applying AC voltages will result in high and dangerous leakage currents through the Y-capacitors (see fig. 1). Melcher will not honour any guarantee/warranty claims resulting from high voltage field tests. Reference is also made to chapter: "Safety and Installation Instructions".

Table 13: Electric strength test voltage, insulation resistance, clearance and creepage distances

Characteristic	Input/Output	Input/Case Class I		Input/Case Class II		Output/Case		Output/Output		Unit		
		a)	b)	a)	b)	a)	b)	a)	b)			
Electric strength test voltage	DC: 1 s	4243 ¹	5600 ¹	2122	2800	4243	5600	707	1414	-	300	V
	AC: 50 Hz, 1 min	3000 ¹	4000 ¹	1500	2000	3000	4000	500	1000	-	200	
Insulation resistance	at 500 V DC	-	≥300	-	≥300	-	≥300	-	≥100	-	-	MΩ
Clearance and Creepage distances		4.0	8.0	2.0	4.0	4.0	5.0	1.0	2.0	-	0.9	mm

¹ Only subassemblies performance in accordance with IEC 950

Leakage Currents in AC-DC operation

Leakage currents will flow due to internal leakage capacitances and RFI suppression Y-capacitors. The current values are proportional to the mains voltage and nearly proportional to the mains frequency and are specified at an input condition of 264 V/50 Hz where phase, neutral and protective earth are correctly connected as required for class I equipment. Under test conditions the leakage cur-

rents flow through a measurement circuit, consisting of a 1500 Ω resistance with a 150 nF capacitor connected in parallel. The voltage drop across this element is measured and the current value calculated from the measured voltage divided by 1500 Ω.

If inputs of M-units are connected in parallel, their individual leakage currents are added.

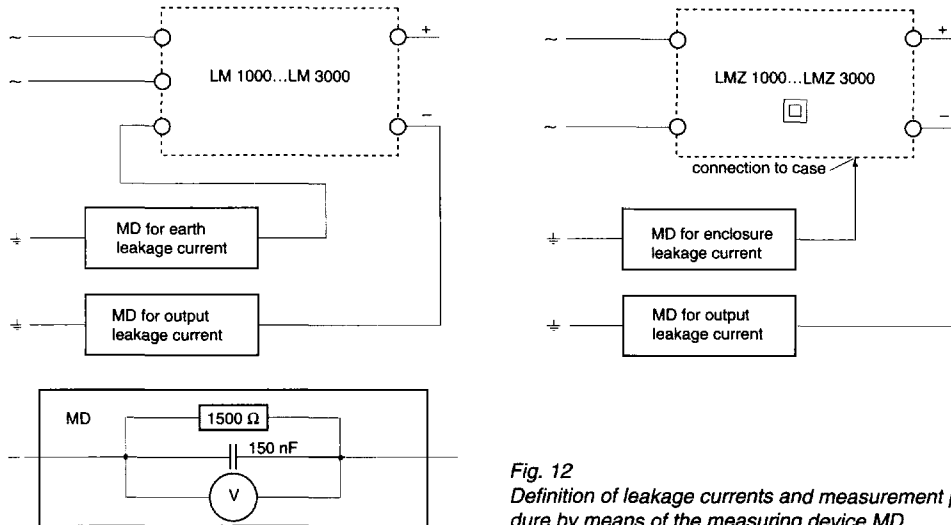


Fig. 12 Definition of leakage currents and measurement procedure by means of the measuring device MD

Table 14: Leakage currents

Characteristic a) permissible according to IEC 850 b) measured value at 264 V, 50 Hz	Class I (LM)		Class II (LMZ)		Unit
	a) max	b) max	a) max	b) max	
Earth leakage current	3.5	1.4	-	-	mA
Enclosure leakage current	-	-	0.25	0.03	
Output leakage current	0.25	0.005	0.25	0.15	

Display Status of LEDs

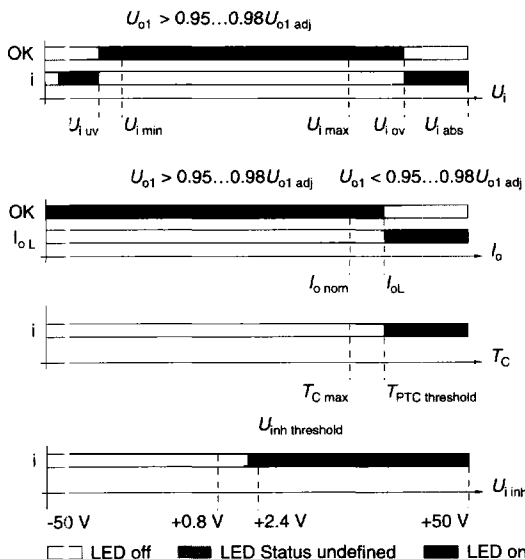


Fig. 13 LEDs "OK" and "i" status versus input voltage
 Conditions: $I_o \leq I_{o \text{ nom}}, T_C \leq T_{C \text{ max}}, U_{\text{inh}} \leq 0.8 \text{ V}$
 $U_{i \text{ UV}}$ = undervoltage lock-out, $U_{i \text{ ov}}$ = overvoltage lock-out

LED "OK" and "I_{oL}" status versus output current
 Conditions: $U_{i \text{ min}} \dots U_{i \text{ max}}, T_C \leq T_{C \text{ max}}, U_{\text{inh}} \leq 0.8 \text{ V}$

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

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

Description of Options

Table 15: Survey of options

Option	Function of Option	Characteristic
-9	Extended operational ambient temperature range	$T_A = -40...71^\circ\text{C}$
E	Electronic inrush current limitation circuitry	Extended inrush current limitation
P ¹	Potentiometer for fine adjustment of output voltage	Adjustment range $\pm 5\%$ of $U_{o,nom}$, excludes R input
D ²	Input and/or output undervoltage monitoring circuitry	Safe data signal output (D0...D9)
V ^{2,3}	Input and/or output undervoltage monitoring circuitry	ACFAIL signal according to VME specifications (V0, V2, V3)
A	Test sockets at front panel for check of output voltage	U_o internally measured at the connector terminals
H	Enhanced output to case electric strength test voltage	2000 V AC (standard: 1000 V AC)
F	Input fuse built-in internally	Fuse not externally accessible
J	UL recognized full ambient temperature range	Full temperature range according to temperature suffix

¹ Function R excludes option P and vice versa

² Option D excludes option V and vice versa

³ Only available if main output voltage $U_{o1} = 5.1\text{ V}$

Option -9 Extended temperature range

Option -9 extends the operational ambient temperature range from $-25...71^\circ\text{C}$ (standard) to $-40...71^\circ\text{C}$. The power supplies provide full nominal output power with convection cooling.

Option A Test sockets

Test sockets (pin $\varnothing = 2\text{ mm}$, distance $d = 5.08\text{ mm}$) are located at the front of the module. The output voltage is sensed at the connector pins inside the module.

Option P Potentiometer

Optionally built-in multi-turn potentiometers provide an output voltage adjustment range of at minimum $\pm 5\%$ of $U_{o,nom}$ and are accessible through holes in the front cover. The compensation of voltage drops across connector and wiring becomes easily achievable. For output voltages $U_o > U_{o,nom}$, the minimum input voltage according to "Electrical Input Data" increases proportionally to $U_o/U_{o,nom}$.

Note: Potentiometers are not recommended for mobile applications.

Table 16: Configuration of option A and option P

Type of option	LM/LMZ 1000	LM/LMZ 2000		LM/LMZ 3000		
	Output 1	Output 1	Output 2	Output 1	Output 2	Output 3
Potentiometer ¹	yes	yes	yes	yes	no	no
Test sockets	yes	yes	yes	yes	no	no

¹ LM/LMZ 1000 types equipped with option P do not provide the R input simultaneously, pins 14 and 17 are not connected.

Option E Extended inrush current limitation

Available for C/E/LM and C/LMZ types.

The standard versions include a passive inrush current limitation in form of a NTC resistor.

For applications which require an extended inrush current limitation, an active electronic circuit as shown in option E "Block diagram" has been developed. Typical inrush current waveforms of units equipped with this option are shown below.

Precautions:

In order to avoid overload of the series resistor R_1 the on/off switching cycle should be limited to 12 s if switched on/off continuously. There should not be more than 10 start-up cycles within 20 s at a case temperature of 25°C .

If the modules are driven by an input voltage below 100 V AC, the maximum case temperature should be derated by 10 K or the total output power should be derated by 20%. Units driven by DC input voltages do not need to be derated within the full specified input voltage range.

Availability:

Option E is available with a nominal output power of 51 W maximum.

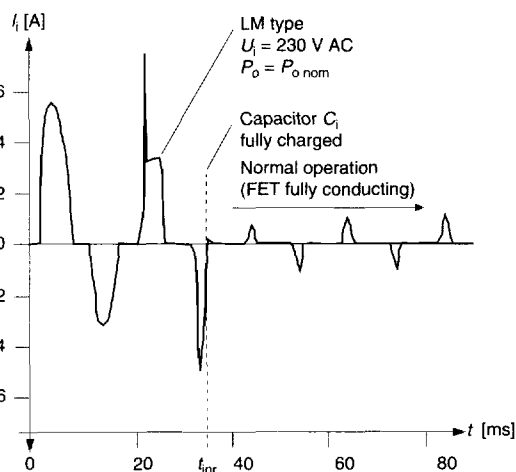


Fig. 14 Typical inrush current waveform of a LM type

10.1

Table 17: Inrush current characteristics with option E

Characteristic		LM/LMZ		Unit
		typ	max	
$U_1 = 230 \text{ VAC}$				
$I_{inr p}$	Peak inrush current	6	10	A
t_{inr}	Inrush current duration	35	50	ms

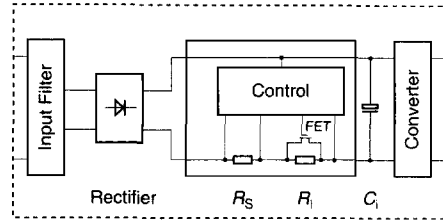


Fig. 15
Option E block diagram

Option D Undervoltage Monitor

The input and/or output undervoltage monitoring circuit operates independently of the built-in input undervoltage lock-out 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 either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a fixed value specified by the customer.

Option D exists in various versions D0...D9 as shown in the following table.

Table 18: Undervoltage monitor functions

Output type		Monitoring		Minimum adjustment range of threshold level U_t		Typical hysteresis U_h for $U_{t \min} \dots U_{t \max}$ [% of U_t]	
JFET	NPN	U_t	U_{o1}	$U_{t \min}$	$U_{t \max}$	$U_{h \min}$	$U_{h \max}$
D ¹	D5	no	yes	—	$3.5 \text{ V} \dots 48 \text{ V}^1$	—	$2.3 \dots 1$
D ²	D6	yes	no	$U_{t \min} \dots U_{t \max}^1$	—	$3.0 \dots 0.5$	—
D ³	D7	yes	yes	$U_{t \min} \dots U_{t \max}^1$	$0.95 \dots 0.98 U_{o1}^2$	$3.0 \dots 0.5$	"0"
D ⁴	D8	no	yes	—	$0.95 \dots 0.98 U_{o1}^2$	—	"0"
D ⁰	D9	no	yes	—	$3.5 \text{ V} \dots 48 \text{ V}^3$	—	$1.8 \dots 1$
		yes	no	$U_{t \min} \dots U_{t \max}^{3,4}$	—	$2.2 \dots 0.4$	—
		yes	yes	$U_{t \min} \dots U_{t \max}^{3,4}$	$0.95 \dots 0.98 U_{o1}^2$	$2.2 \dots 0.4$	"0"

¹ Threshold level adjustable by potentiometer (not recommended for mobile applications)

² Fixed value between 95% and 98% of U_{o1} (tracking)

³ Fixed value, resistor-adjusted according to customer's specifications $\pm 2\%$ at 25°C ; individual type number is determined by Melcher

⁴ Adjusted at $I_{o \text{ nom}}$

JFET output (D0...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. $U_D \leq 0.4 \text{ V}$ (logic low) corresponds to a monitored voltage level (U_t 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_t, U_{o1} status	D output, U_D
U_t or $U_{o1} < U_t$	low, L, $U_D \leq 0.4 \text{ V}$ at $I_D = 2.5 \text{ mA}$
U_t and $U_{o1} > U_t + U_h$	high, H, $I_D \leq 25 \mu\text{A}$ at $U_D = 5.25 \text{ V}$

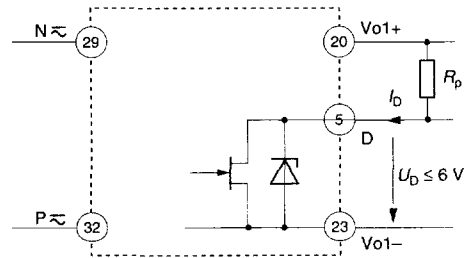


Fig. 16
Options D0...D4, JFET output

NPN output (D5...D9):

Connector pin D is internally connected via the collector-emitter path of a NPN transistor to the negative potential of output 1. $U_D < 0.4 \text{ V}$ (logic low) corresponds to a monitored voltage level (U_t 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_t, U_{o1} status	D output, U_D
U_t or $U_{o1} < U_t$	high, H, $I_D \leq 25 \mu\text{A}$ at $U_D = 40 \text{ V}$
U_t and $U_{o1} > U_t + U_h$	low, L, $U_D \leq 0.4 \text{ V}$ at $I_D = 20 \text{ mA}$

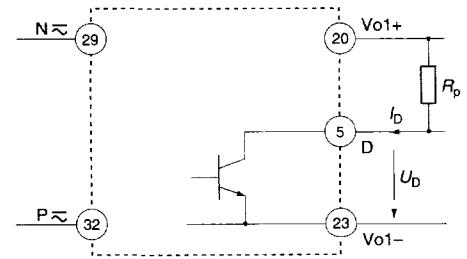


Fig. 17
Options D5...D9, NPN output

Threshold tolerances and hysteresis:

If U_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 ΔU_{ti} across input filter and rectifier. The threshold level of the D0 and D9 options is factory adjusted at nominal output current $I_{o, nom}$ and at $T_A = 25^\circ\text{C}$. The value of ΔU_{ti} depends upon the threshold level U_{ti} , temperature and input current. The input current is a function of the input voltage and the output power.

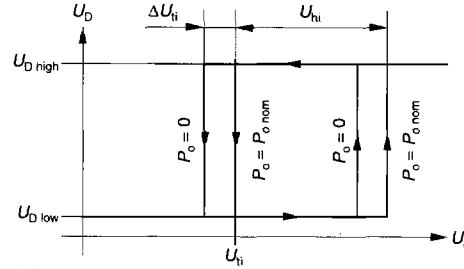
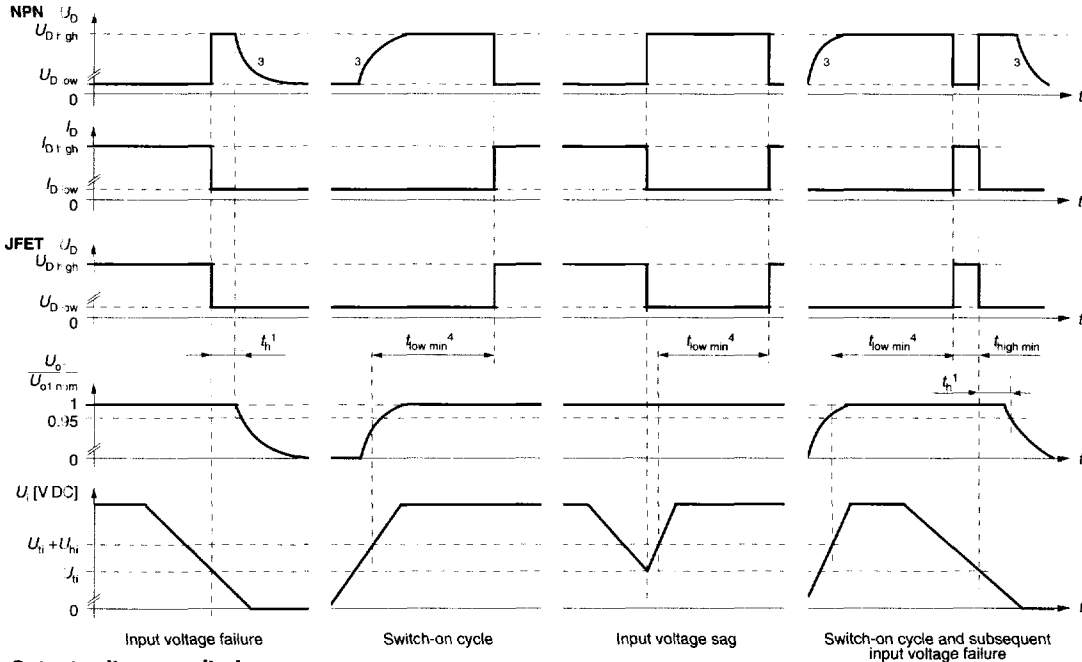
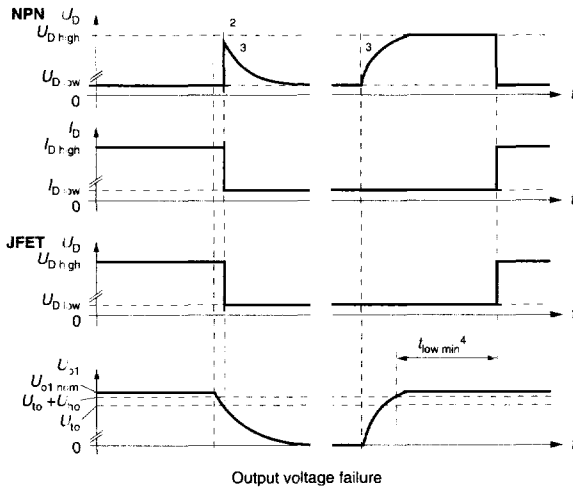


Fig. 18
Definition of U_{ti} , ΔU_{ti} and U_{hi} (JFET output)

Input voltage monitoring



Output voltage monitoring



- 1 See "EI. output data" for 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 $t_{low min} = 40 \dots 200$ ms, typically 80 ms

Fig. 19
Relationship between U_i , U_{o1} , U_D , I_D and $U_{o1}/U_{o,nom}$ versus time.

10.1

Option 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 $U_V \leq 0.6$ V (open-collector output of a NPN transistor). The pull-up resistor feeding the open-collector output should be placed on the VME back-plane.

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

Formula for threshold level for desired value of t_h :

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

Table 19: Available internal input capacitance and factory potentiometer setting of U_{ti} with resulting hold-up time

Types	LM/LMZ	Unit
$C_{i,min}$	0.14	mF
U_{ti}	120	V DC
t_h	8.18	ms

Table 20: Undervoltage monitor functions

V output (VME compatible)	Monitoring		Minimum adjustment range of threshold level U_{ti}		Typical hysteresis U_h [% of U_{ti}] for $U_{ti,min} \dots U_{ti,max}$	
	U_i	U_{O1}	U_{ti}	U_{to}	U_{hi}	U_{ho}
V2	yes	no	$U_{i,min} \dots U_{i,max}^1$	-	3.0...0.5	-
V3	yes	yes	$U_{i,min} \dots U_{i,max}^1$	$0.95 \dots 0.98 U_{O1}^2$	3.0...0.5	"0"
V0	yes	no	$U_{i,min} \dots U_{i,max}^{3,4}$	-	2.2...0.4	-
	yes	yes	$U_{i,min} \dots U_{i,max}^{3,4}$	$0.95 \dots 0.98 U_{O1}^2$	2.2...0.4	"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.
³ Adjusted at I_o nom.
⁴ Fixed value, resistor-adjusted ($\pm 2\%$ at 25°C) acc. to customer's specifications; individual type number is determined by Melcher

V output (V0, 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. $U_V \leq 0.6$ V (logic low) corresponds to a monitored voltage level (U_i and/or U_{O1}) $< U_{ti}$. 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 $U_{O1} < U_{ti}$	low, L, $U_V \leq 0.6$ V at $I_V = 50$ mA
U_i and $U_{O1} > U_{ti} + U_h$	high, H, $I_V \leq 25 \mu\text{A}$ at $U_V = 5.1$ V

If the input voltage is below the required level, an external hold-up capacitor ($C_{i,ext}$) should be added. If the units are AC powered, an external input capacitor cannot be applied unless an additional rectifier is provided.

Formula for additional external input capacitor

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

whereas:

- $C_{i,min}$ = minimum internal input capacitance [mF], according to the table below
- $C_{i,ext}$ = external input capacitance [mF]
- P_o = output power [W]
- 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 the table below.

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_{ti} . The return for this signal is Vo1- (pin 23). The V output recovers when the monitored voltage(s) exceed(s) $U_{ti} + U_h$. The threshold level U_{ti} is either adjustable by a potentiometer, accessible through a hole in the front cover, or is factory adjusted to a determined customer specified value.

Versions V0, V2 and V3 are available as shown below.

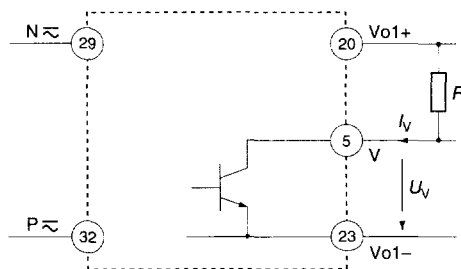


Fig. 20 Output configuration of options V0, V2 and V3

Threshold tolerances and hysteresis:

If U_i is monitored, the internal input voltage is measured after the input filter and rectifier. Consequently this voltage differs from the voltage at the connector pins by the voltage drop ΔU_{ti} across input filter and rectifier. The threshold level of option V0 is factory adjusted at $I_{o,nom}$ and $T_A = 25^\circ\text{C}$. The value of ΔU_{ti} depends upon the threshold level U_{ti} , temperature and input current. The input current is a function of input voltage and output power.

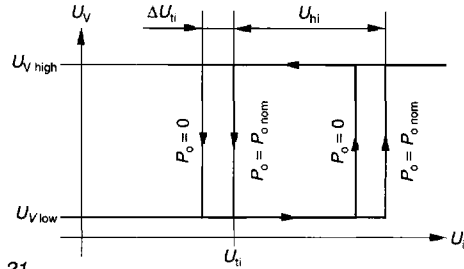
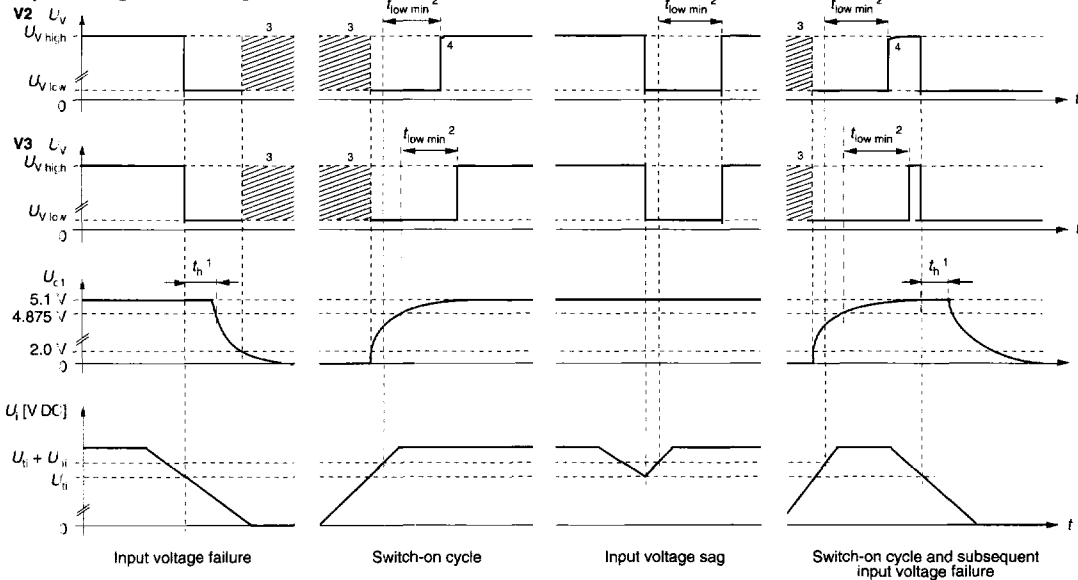
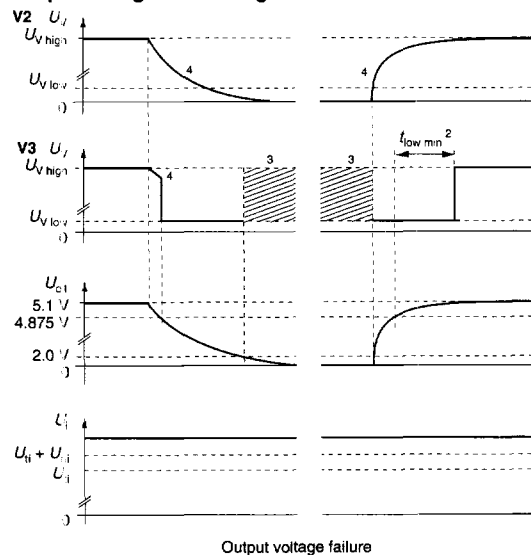


Fig. 21
Definition of U_{ti} , ΔU_{ti} and U_{hi}

Input voltage monitoring



Output voltage monitoring



- ¹ VME request: minimum 4 ms
- ² $t_{low\ min} = 40 \dots 200$ 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. 22
Relationship between U_i , U_{o1} , U_V , I_V and $U_{o1}/U_{o,nom}$ versus time.

Option F Fuse not accessible

The standard M units have a fuseholder containing a 5 × 20 mm fuse which is externally accessible and to be found in the back plate near the connector. Some applications require an inaccessible fuse. Option F provides a fuse mounted directly onto the main PCB inside the case.

The full self-protecting functions of the module do normally not lead to broken fuses, except a power component inside fails (switching transistor, freewheeling diode, etc). In such cases the defective unit has to be returned to Melcher for repair.

Option U UL version

Underwriters Laboratories (UL) have approved the M series converters as recognized components up to an ambient temperature of $T_{A \max} - 15 \text{ K}$ given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A \max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast accepted the converters with the standard PCB material to be operated up to $T_{A \max}$ without any further precautions.

Immunity to Environmental Conditions

Table 21: Mechanical stress

Test Method		Standard	Test Conditions
Ca	Damp heat steady state	DIN 40046 part IEC 68-2-3 MIL-STD-810D section 507.2	Temperature: 40 ±2 °C Relative humidity: 93 +2/-3 % Duration: 56 days Unit not operating
Ea	Shock (half-sinusoidal)	DIN 40046 part 7 IEC 68-2-27 MIL-STD-810D section 516.3	Acceleration amplitude: 100 g _n = 981 m/s ² Bump duration: 6 ms Number of bumps: 18 (3 each direction) Unit operating
Eb	Continuous shock (half-sinusoidal)	DIN 40046 part 26 IEC 68-2-29 MIL-STD-810D section 516.3	Acceleration amplitude: 40 g _n = 392 m/s ² Bump duration: 6 ms Number of bumps: 6000 (1000 each direction) Unit operating
Fc	Vibration (sinusoidal)	DIN 40046 part 8 IEC 68-2-6 MIL-STD-810D section 514.3	Frequency (1 Oct/min): 10...2000 Hz Maximum vibration amplitude: 0.35 mm (10...60 Hz) Acceleration amplitude: 5 g _n = 49 m/s ² Test duration: 7.5 h (2.5 h each axis) Unit operating
Fda	Random vibration wide band reproducibility high	DIN 40046 part 23 IEC 68-2-35	Acceleration spectral density: 0.05 g ² / Hz Frequency band: 20...500 Hz Acceleration magnitude: 4.9 g _{rms} Test duration: 3 h (1 h each axis) Unit not operating
Kb	Salt mist cyclic (sodium chloride NaCl solution)	DIN 40046 part 105 IEC 68-2-52	Concentration: 5% (30°C) Duration: 2 h per cycle Storage: 40°C, 93% rel. humidity Storage duration: 22 h per cycle Number of cycles: 3 Unit not operating

Thermal considerations

Table 22: Temperature specifications, values given are for an air pressure of 800...1200 hPa (800...1200 mbar)

Characteristic		min	max	Unit
T_A	Standard operational ambient temperature range -7, (MIL-STD-810D sections 501.2 and 502.2)	-25	71	°C
T_A	Extended operational ambient temperature range -9, (MIL-STD-810D sections 501.2 and 502.2)	-40	71	
T_C	Standard operational case temperature range -7, overtemp. lock-out (PTC) at $T_C > 95^\circ\text{C}$	-25	95	
T_C	Extended operational case temperature range -9, overtemp. lock-out (PTC) at $T_C > 95^\circ\text{C}$	-40	95	
T_S	Storage temperature range -7, (MIL-STD-810D sections 501.2 and 502.2)	-40	100	
T_S	Extended storage temperature range -9, (MIL-STD-810D sections 501.2 and 502.2)	-55	100	

Basically the available output power is limited by thermal characteristics. Customer specific applications requiring slightly higher output power, i.e. increased voltages or currents are available on request. Usually the maximum ambient and case temperatures are reduced compared with standard types. Operation at higher temperatures with nominal output currents is also possible if forced cooling can be provided (heat sink, fan, etc.).

Example: Sufficient forced cooling allows $T_{A \text{ max}} = 85^\circ\text{C}$. A simple check of the case temperature T_C ($T_C \leq 95^\circ\text{C}$) at full load ensures correct operation of the system (temperature measurement point on the case see "Mechanical Data").

In general: For an ambient temperature of 85°C with only convection cooling, the maximum permissible current for each output is approx. 50% of it's nominal value for -7 and -9 units as per figure.

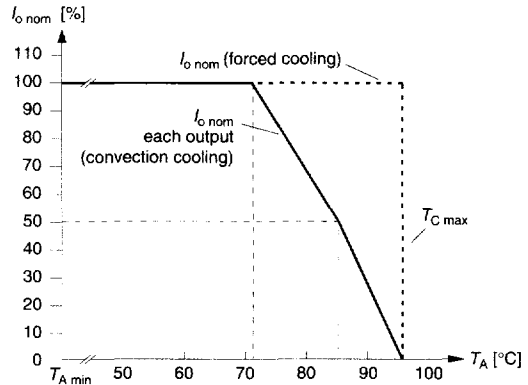


Fig. 23 Output derating versus ambient temperature under convection and forced cooling conditions

Table 23: MTBF

Values at specified Case Temperature	Module Types	Ground Benign 40°C		Ground Fixed 40°C 70°C		Ground Mobile 50°C	Unit
MTBF ¹	LM/LMZ 1000	320'000		130'000	40'000	35'000	h
	LM/LMZ 2000	255'000		105'000	32'000	28'000	
	LM/LMZ 3000	225'000		80'000	28'000	25'000	
Device hours ²	LM/LMZ 1000	880'000					
	LM/LMZ 2000	720'000					
	LM/LMZ 3000	740'000					

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

² Statistical values, based on an average of 4300 working hours per year and in general field use, over 3 years

10.1

Mechanical Data

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

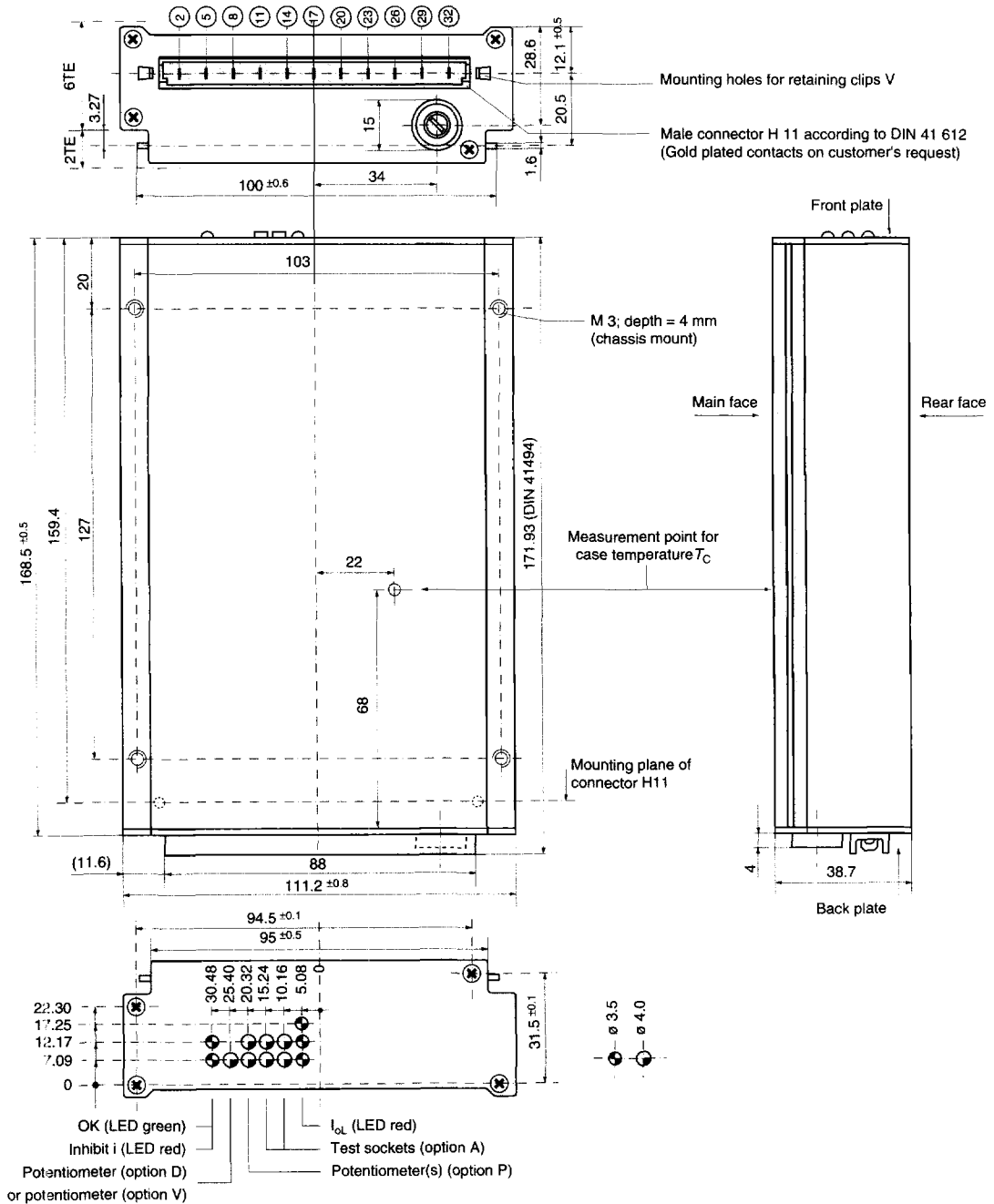
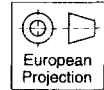


Fig. 24
Case M02, weight 770 g (approx.)

Note: Long case, elongated by 60 mm for 220mm rack depth, is available on request.

Type Key and Product Marking

Type Key

		LMZ	2	5	40	-7	E	R	P	D	V	A	H	F	U
Input voltage range U_i : 85...264 V AC, 88...372 V DC	L														
Family	M														
Class II Equipment	Z														
Blank															
Number of outputs	1...3														
Output 1, $U_{o1 \text{ nom}}$:															
	5.1 V														
	12 V														
	15 V														
	24 V														
	other voltages														
	48 V														
other specs for single output modules	01...99														
Output 2 and 3, $U_{o2 \text{ nom}}$, $U_{o3 \text{ nom}}$:															
	5.1 V														
	12 V														
	15 V														
	24 V														
other voltages for multiple output modules	70...99														
Ambient temperature range T_A :															
(operational)	-25...71 °C														
	-40...71 °C														
	customer specific														
Output voltage control input (single output modules only) R ¹															
Options:															
Inrush current limitation (C/E/LM and C/LMZ only)	E														
Potentiometers for fine adjustment of output voltages	P ¹														
Save data signal (D0...D9, to be specified)	D ²														
ACFAIL. signal (V0, V2, V3, to be specified)	V ²														
Output voltage test sockets	A														
Increased electric strength test voltage (Output/Case) ...	H														
Input fuse built-in (not accessible)	F														
UL recognized component for $T_{A \text{ max}}$	U														

¹ Feature R excludes option P and vice versa

² Option D excludes option V and vice versa

Example: LM 2540-7PD3A: AC-DC converter, input voltage range 85...264 V, providing output 1 with 15 V/1.7 A and output 2 with 15 V/1.7 A; equipped with potentiometers, undervoltage monitoring and test sockets.

Accessories: Front panels, female connectors, mounting facilities, etc. please refer to section "Accessories".

Product Marking (refer also to "Mechanical Data")

Main face: Basic type designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patents and company logo.

Front plate: Identification of LEDs, optional test sockets and potentiometers.

Back plate: Specific type designation, input voltage range, nominal output voltage(s) and current(s), pin allocation of options and auxiliary functions, fuse specification and degree of protection.

Rear face: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB, date of production. Confirmation of successfully passed final test.