50 W DC-DC (AC-DC) Converters M-Family

Class I Equipment
Single output: series AM...LM 1000
Dual output: series AM...LM 2000
Triple output: series AM...LM 3000

Class II Equipment (double insulation) ⧈
Single output: series CMZ/DMZ/LMZ 1000
Dual output: series CMZ/DMZ/LMZ 2000
Triple output: series CMZ/DMZ/LMZ 3000

- Extremely wide input voltage range suitable for battery (and AC) operation
- 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 DC-DC (AC-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 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. Certain 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 be regulatory authorities in provinces across Canada.

The case design allows operation at nominal load up to 71°C in a free air ambient temperature. 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 specialities. Please consult Melcher's field sales engineers for specific requirements. The best technical solution will carefully be considered and a detailed proposal submitted.

Table 1a: Class I equipment

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...35 V DC**	η_{min} %	$U_{i\,min}...U_{i\,max}$ **14...70 V DC**	η_{min} %	$U_{i\,min}...U_{i\,max}$ **20...100 V DC**	η_{min} %	
5.1	8.0					AM 1001-7R	72	BM 1001-7R	74	FM 1001-7R	74	–9
12.0	4.0					AM 1301-7R	79	BM 1301-7R	80	FM 1301-7R	80	P
15.0	3.4					AM 1501-7R	79	BM 1501-7R	81	FM 1501-7R	81	D0...D9
24.0	2.0					AM 1601-7R	81	BM 1601-7R	83	FM 1601-7R	82	V0,V2,V3
48.0	1.0					AM 1901-7R	81	BM 1901-7R	83	FM 1901-7R	83	A
12.0	2.0	12.0	2.0			AM 2320-7	77	BM 2320-7	79	FM 2320-7	80	H
15.0	1.7	15.0	1.7			AM 2540-7	78	BM 2540-7	80	FM 2540-7	79	F
5.1	5.0	12.0	0.7	12.0	0.7	AM 3020-7	75	BM 3020-7	76	FM 3020-7	76	U
5.1	5.0	15.0	0.6	15.0	0.6	AM 3040-7	75	BM 3040-7	76	FM 3040-7	76	

Table 1b: Class I equipment

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	$U_{i\,min}...U_{i\,max}$ **28…140 V DC**	η_{min} %	$U_{i\,min}...U_{i\,max}$ **44…220 V DC**	η_{min} %	$U_{i\,min}...U_{i\,max}$ **88...372 V DC** (85...264 V AC)	η_{min} %	
5.1	8.0					CM 1001-7R	74	DM 1001-7R	74	LM 1001-7R	73	–9
12.0	4.0					CM 1301-7R	80	DM 1301-7R	81	LM 1301-7R	79	E
15.0	3.4					CM 1501-7R	82	DM 1501-7R	82	LM 1501-7R	78	P
24.0	2.0					CM 1601-7R	82	DM 1601-7R	83	LM 1601-7R	81	D0...D9
48.0	1.0					CM 1901-7R	82	DM 1901-7R	83	LM 1901-7R	81	V0,V2,V3
12.0	2.0	12.0	2.0			CM 2320-7	79	DM 2320-7	80	LM 2320-7	77	A
15.0	1.7	15.0	1.7			CM 2540-7	80	DM 2540-7	80	LM 2540-7	78	H
5.1	5.0	12.0	0.7	12.0	0.7	CM 3020-7	76	DM 3020-7	77	LM 3020-7	73	F
5.1	5.0	15.0	0.6	15.0	0.6	CM 3040-7	76	DM 3040-7	76	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
$U_{o\,nom}$ V DC	$I_{o\,nom}$ A	$U_{o\,nom}$ V DC	$I_{o\,nom}$ A	$U_{o\,nom}$ V DC	$I_{o\,nom}$ A	$U_{i\,min}...U_{i\,max}$ **28...140 V DC**	η_{min} %	$U_{i\,min}...U_{i\,max}$ **44...220 V DC**	η_{min} %	$U_{i\,min}...U_{i\,max}$ **88...372 V DC** (85...264 V AC)	η_{min} %	
5.1	8.0					CMZ 1001-7R	74	DMZ 1001-7R	74	LMZ 1001-7R	73	–9
12.0	4.0					CMZ 1301-7R	80	DMZ 1301-7R	81	LMZ 1301-7R	79	E
15.0	3.4					CMZ 1501-7R	82	DMZ 1501-7R	82	LMZ 1501-7R	78	P
24.0	2.0					CMZ 1601-7R	82	DMZ 1601-7R	83	LMZ 1601-7R	81	D0…D9
48.0	1.0					CMZ 1901-7R	82	DMZ 1901-7R	83	LMZ 1901-7R	81	V0,V2,V3
12.0	2.0	12.0	2.0			CMZ 2320-7	79	DMZ 2320-7	80	LMZ 2320-7	77	A
15.0	1.7	15.0	1.7			CMZ 2540-7	80	DMZ 2540-7	80	LMZ 2540-7	78	H
5.1	5.0	12.0	0.7	12.0	0.7	CMZ 3020-7	76	DMZ 3020-7	77	LMZ 3020-7	73	F
5.1	5.0	15.0	0.6	15.0	0.6	CMZ 3040-7	76	DMZ 3040-7	76	LMZ 3040-7	71	U

[1] Efficiency measured at $U_{i\,nom}$ and $I_{o\,nom}$

Notes: EM types with an input voltage range of 67...385 V DC are available upon request

Remarks: LM types may be operated in AC mode within a frequency range of 47...440 Hz and LMZ types within a frequency range of 47...65 Hz.

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 section "Accessories") in order to meet national and international safety requirements!

If the output circuit of a DC-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 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.

Since the M-family DC-DC converters provide double or reinforced insulation between input and output, based on an input voltage of 250 V AC and 400 V DC, only operational insulation between the AC mains and the input of the DC-DC converter is needed according to the following table.

If the table below is observed, the output of a DC-DC converter is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Table 3: Insulation concept

Nominal mains supply voltage (AC)	Minimum required grade of isolation, to be provided by the AC-DC front end, including mains supplied battery charger	Maximum output voltage from the front end	Minimum required safety status of the front end output circuit	Minimum required grade of isolation between the input and the output provided by the DC-DC converter	Resulting safety status of the DC-DC output
≤250V	Operational	≤400 V [1]	Primary circuit	Reinforced, based on AC 250 V and DC 400 V [1]	SELV circuit

[1] With LMZ converters, the maximum rated output voltage of the front end is 250 V according to IEC 950.

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AM...LM types correspond to class I equipment, while the C/D/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/µs, 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
– Input to earth impedance is high or undefined
– Phase and neutral of the mains are not defined (AC-DC converters)

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

Reverse polarity at the input of A...D/FM and C/DMZ types will cause the fuse to blow. In E/LM and LMZ types a series diode will protect the module. A series diode is not incorporated in A...D/FM and C/DMZ types to avoid unwanted power loss.

Table 4: H11 connector pin allocation

Electrical Determination	A…LM 1000		C/D/LMZ 1000		A…LM 2000		C/D/LMZ 2000		A…LM 3000		C/D/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	⏚		
DC input voltage [3]	29	Vi+	29	Vi+	29	Vi+	29	Vi+	29	Vi+	29	Vi+
DC input voltage	32	Vi–	32	Vi–	32	Vi–	32	Vi–	32	Vi–	32	Vi–
AC input voltage [4]	29	N ≂	29	N ≂	29	N ≂	29	N ≂	29	N ≂	29	N ≂
AC input voltage	32	P ≂	32	P ≂	32	P ≂	32	P ≂	32	P ≂	32	P ≂

[1] This function is not simultaneously available with option P
[2] Leading pin (pregrounding)
[3] A/B/C/D/E/FM and C/DMZ types
[4] LM/LMZ types

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 [3] and an inrush current limiter [4] 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 primary 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.

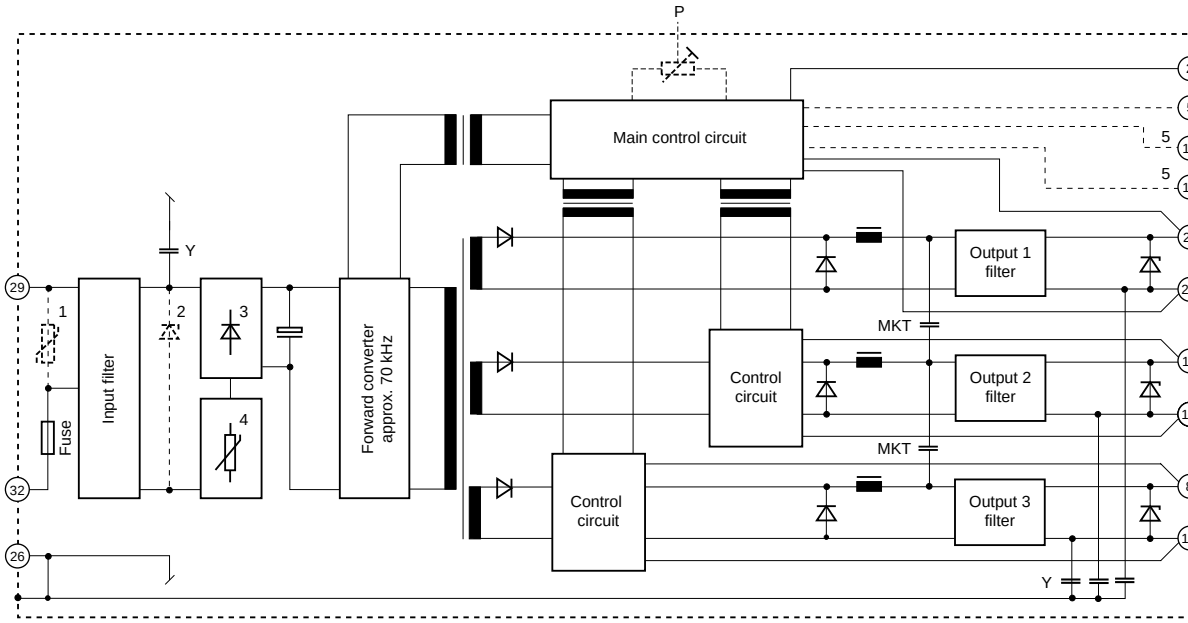


Fig. 1a
DC-DC (AC-DC) converter block diagram, class I equipment

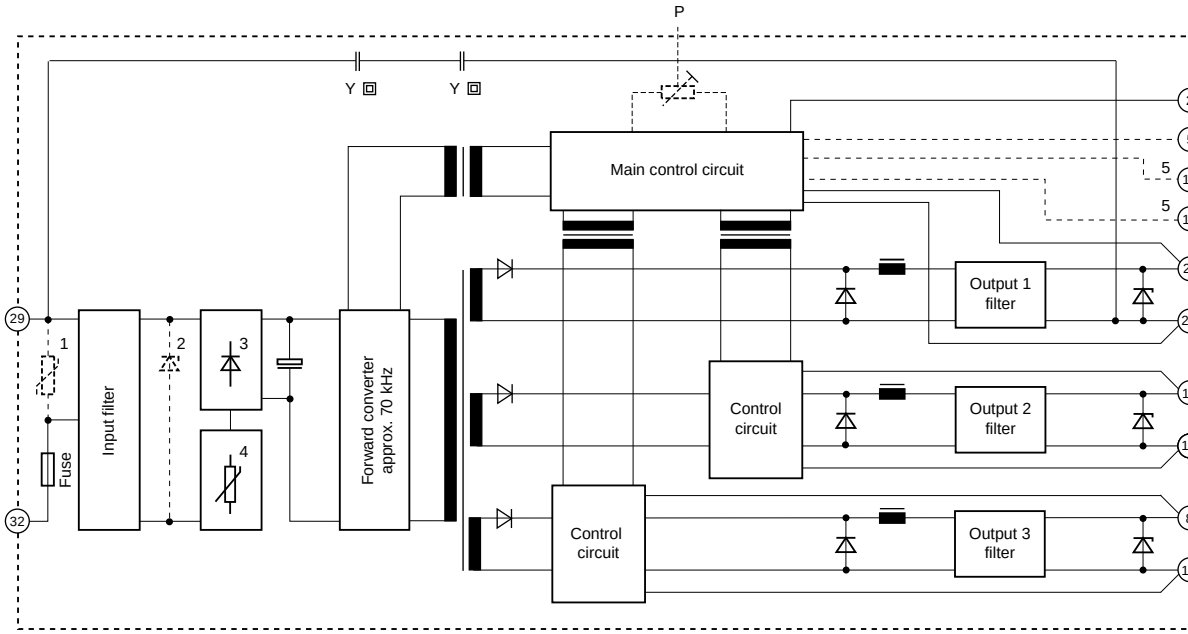


Fig. 1b
DC-DC (AC-DC) converter block diagram, class II equipment (double insulation)

[1] Transient suppressor (VDR) in C/D/E/F/LM and C/D/LMZ
[2] Transient suppressor diode in A/B/C/FM and CMZ types
[3] Bridge rectifier in LM/LMZ, series diode in EM types
[4] Inrush current limiter (NTC) in C/D/E/LM and C/D/LMZ types (option E: refer to the description of option E)
[5] Single output modules A...LM 1000 and C/D/LMZ 1000 with feature R

Electrical Input Data

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

Table 5a: Input data

Input			AM			BM			FM			CM/CMZ			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Input voltage range	I_o = 0…$I_{o\,nom}$ $T_{C\,min}$…$T_{C\,max}$	8		35	14		70	20		100	28		140	V DC
$U_{i\,nom}$	Nominal input voltage			15			30			50			60		
I_i	Input current	$U_{i\,nom}$, $I_{o\,nom}$ [2]		4.0			2.0			2.0			1.0		A
$P_{i\,0}$	No-load input power: Single output Double output Triple output	$U_{i\,nom}$ $I_{o1,2,3}$ = 0		 1 7 6	 1.5 9 9		 1 7 6	 1.5 9 9		 1 7 6	 1.5 9 9		 1 7 6	 1.5 9 9	W
$P_{i\,inh}$	Idle input power	inhibit mode			1.5			1.5			1.5			1.5	W
$I_{inr\,p}$ [6]	Peak inrush current	U_i = $U_{i\,max}$ R_S = 0 Ω [3] T_C = 25°C			400			500			400			170 [4]	A
$t_{inr\,r}$	Rise time			60			50			40			60		µs
$t_{inr\,h}$	Trailing edge half-life			170			100			60			280		
R_i	Input resistance	T_C = 25 °C	87.5			140			250			824 [4]			mΩ
C_i	Input capacitance		2600		4000	670		1100	370		600	370		600	µF
$U_{i\,abs}$	Input voltage limits without any damage		0		40	0		80	0		120	0		160	V DC

Table 5b: Input data

Input			DM/DMZ			EM			LM/LMZ			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Input voltage range	I_o = 0…$I_{o\,nom}$ $T_{C\,min}$…$T_{C\,max}$		-			-		85		264	V AC [1]
			44		220	67		385	88		372	V DC
$U_{i\,nom}$	Nominal input voltage			110			220			310		
I_i	Input current	$U_{i\,nom}$, $I_{o\,nom}$ [2]		0.55			0.275			0.20		A
$P_{i\,0}$	No-load input power: Single output Double output Triple output	$U_{i\,nom}$ $I_{o1,2,3}$ = 0		 1 7 6	 1.5 9 9		 1 7 6	 1.5 9 9		 1 7 6	 1.5 9 9	W
$P_{i\,inh}$	Idle input power	inhibit mode			1.5			1.5			1.5	W
$I_{inr\,p}$ [6]	Peak inrush current	U_i = $U_{i\,max}$ R_S = 0 Ω [3] T_C = 25°C			110 [4]			160 [4]			60 [4]	A
$t_{inr\,r}$	Rise time			40			40			300		µs
$t_{inr\,h}$	Trailing edge half-life			250			240			900		
R_i	Input resistance	T_C = 25°C	2000 [4]			2400 [4]			6200 [4]			mΩ
C_i	Input capacitance		140		270	140		270	140		270	µF
$U_{i\,abs}$	Input voltage limits without any damage		0		400 [5]	-400		400	-400		400	V DC
			–		–	–		–	0		284	V AC

[1] In AC powered mode: LM types: 47...440 Hz; LMZ types: 47...65 Hz
[2] With multiple output modules, the same condition for each output applies.
[3] R_S = source resistance.
[4] Value for initial switch-on cycle.
[5] 1 s max., duty cycle 1% max.
[6] $I_{inr\,p} = U_i/(R_s + R_i)$

Input fuse

A fuse holder containing a slow-blow type fuse (Dimension: 5 × 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.

Table 6: Fuse types (slow-blow)

Series	Schurter type	Part number
AM 1000...3000	SPT 10 A 250 V	0001.2514
BM 1000...3000	SPT 8 A 250 V	0001.2513
FM 1000...3000	SPT 5 A 250 V	0001.2511
CM/CMZ 1000...3000	SPT 3.15 A 250 V	0001.2509
DM/DMZ 1000...3000 EM 1000...3000 LM/LMZ 1000...3000	SPT 2.5 A 250 V	0001.2508

Input Under-/Overvoltage Cut-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 "Input Data").

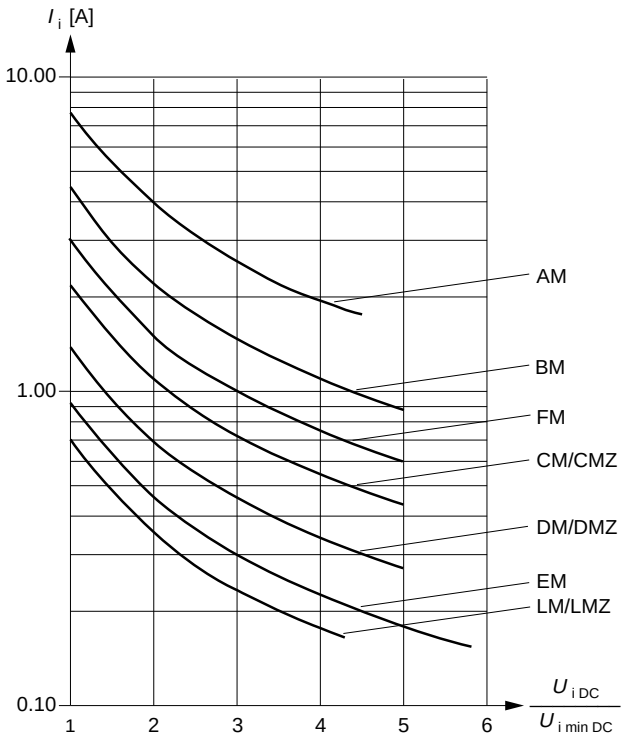


Fig. 2
Typical input current versus relative input voltage at nominal output load

Inrush Current

The C...LM and C/D/LMZ (excluding FM) modules incorporate a 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.

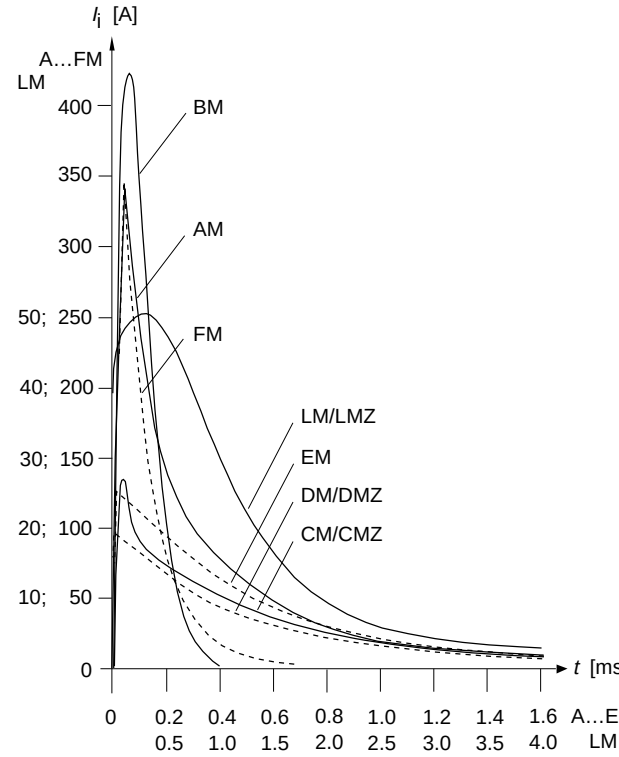


Fig. 3
Typical inrush current at initial switch-on cycle and at $U_{i\ max}$ [DC] versus time

Electrical Output Data

General conditions
– T_A = 25 °C, unless T_C is specified.
– Connector pins 2 and 23 interconnected, U_o = $U_{o\,nom}$ (option P), R input not connected.

Table 7: Output data

Output		$U_{o\,nom}$	5.1 V			12 V			15 V			24 V			48 V			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$ [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.	$I_{o\,nom}$		7.5			21			25			41			85		
$I_{o\,nom}$	Output current	$U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$	see tables 1 and 2															
$I_{o\,L}$	Output current limitation response		see fig. 4															
$u_{o1/2/3}$	Output voltage noise	$U_{i\,nom}$, $I_{o\,nom}$ [1] Bandwidth = 20 MHz		2	4		3	6		3	6		3	6		4	8	mV_{rms}
u_{o1}				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	$U_{i\,min}$...$U_{i\,nom}$ $U_{i\,nom}$...$U_{i\,max}$ $I_{o\,nom}$ [1]		±10	±30		±12	±50		±15	±60		±15	±60		±15	±60	mV
$\Delta U_{o\,I}$	Static load regulation	$U_{i\,nom}$ I_o = $I_{o\,nom}$...0 [2]		6	25		13	50		17	60		30	80		60	150	
$\Delta U_{o\,Ic}$	Static cross load regulation [4]	$U_{i\,nom}$ I_o = $I_{o\,nom}$...0 [3]		0	±15		0	±20		0	±30		0	±40		-		
$u_{o\,d}$	Dynamic load regulation	$U_{i\,nom}$, I_o = 1/0.33/1•$I_{o\,nom}$ [2] fig. 5		±220			±110			±150			±130			±150		
t_d	Dynamic load regulation time constant			0.6			0.6			0.5			1			2		ms
$u_{o\,dc}$	Dynamic cross load regulation [4]	$U_{i\,nom}$, I_o = 1/0.33/1•$I_{o\,nom}$ [3] fig. 5		+10 -100			+10 -75			+10 -140			+20 -200			- -		mV
t_{dc}	Dynamic cross load reg. time constant [4]			0.05 0.5			0.2 0.3			0.5 0.7			1 2			- -		ms
α_{Uo}	Output voltage deviation versus case temperature	$T_{C\,min}$...$T_{C\,max}$		±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 = $I_{o\,nom}$.
[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. 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 ripple voltages.

Auxiliary outputs should never be connected in parallel!

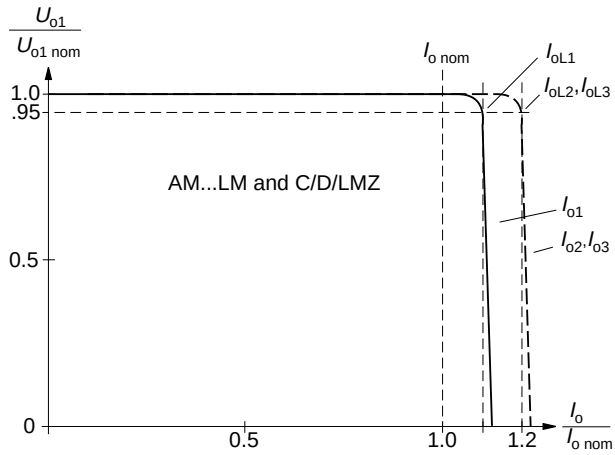


Fig. 4
Typical output voltage U_{o1} versus output currents I_o

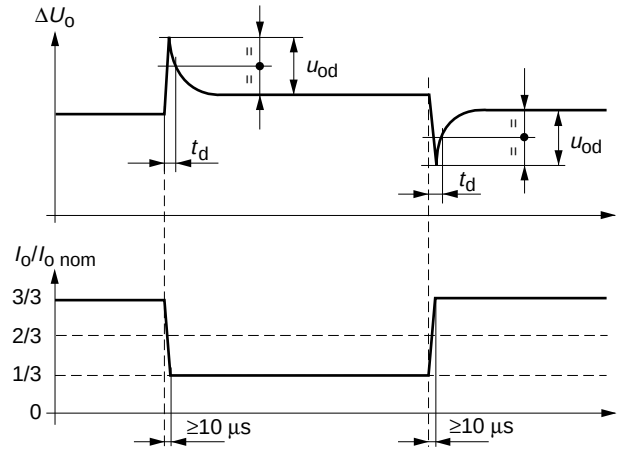


Fig. 5
Control deviation of U_o versus dynamic load change

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 °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 8: Current allocation with special types

	Output voltage all types $U_{o1/2/3\ nom}$ [V]	Output 1 all types $I_{o1\ max}$ [A]	Output 2 A...LM 2000 $I_{o2\ max}$ [A]	Output 2 A...LM 3000 $I_{o2\ max}$ [A]	Output 3 A...LM 3000 $I_{o3\ max}$ [A]	Temperature T_A [°C]	Temperature T_C [°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] $U_{i\ min}$ 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).

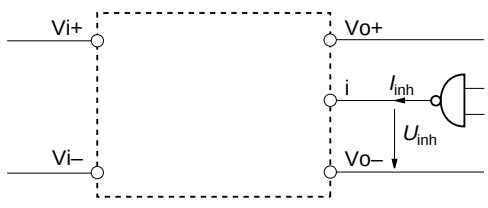


Fig. 6
Definition of inhibit voltage and current

The reference for the inhibit signal is the negative pin of output 1.

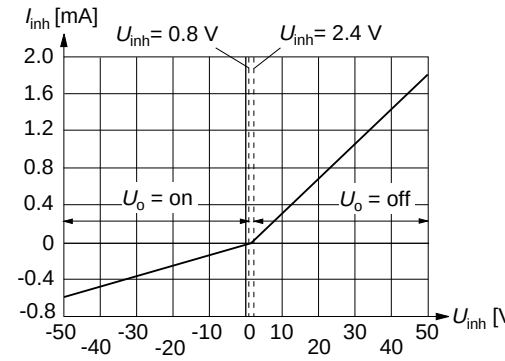


Fig. 7
Typical inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 9: Inhibit data

Characteristics			Conditions	min	typ	max	Unit
U_{inh}	Inhibit input voltage causing output voltage being…	switched on	$U_{i\,min}$...$U_{i\,max}$	–50		0.8	V DC
		switched off		2.4		50	
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 (fig. 8) before the output voltage falls below 0.95 $U_{o\,nom}$. To achieve the hold-up times indicated in fig. 9, A/B/C/D/FM and C/DMZ modules require an external series diode in the input path. This is necessary to prevent the discharge of the input capacitor through the source impedance or other circuits connected to the same source. E/LM and LMZ modules have a built-in series diode. In A/B/C/D/FM and C/DMZ modules, no series diode is built-in, since it would generate up to 10 W of additional power loss inside the converter. Consequently the maximum operational ambient temperature would have to be reduced accordingly.

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

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

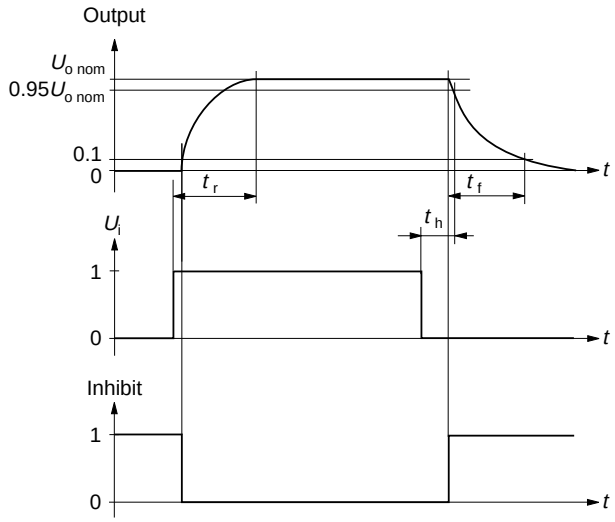


Fig. 8
Output response as a function of input voltage (on/off switching) or inhibit control

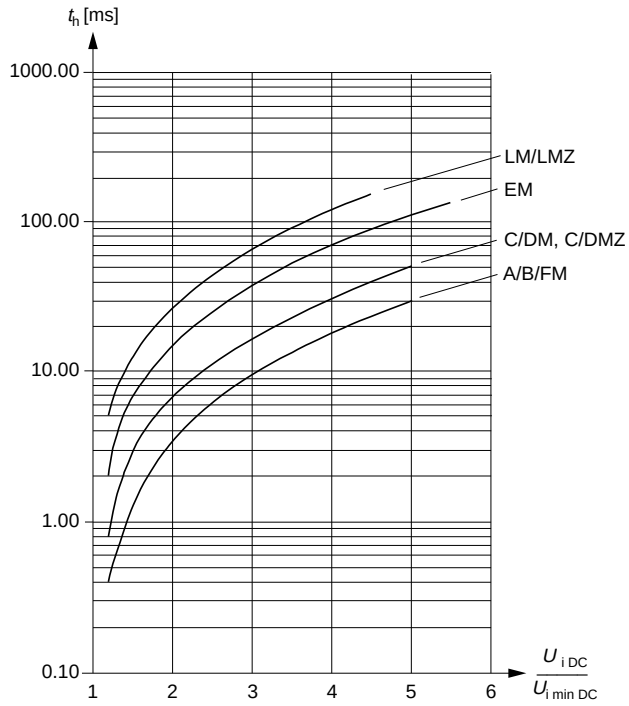


Fig. 9
Typical hold-up time t_h versus relative input voltage at $I_{o\,nom}$

Table 10: 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 = $P_{o\,nom}$ typ	max	t_r and t_f at P_o = $^3/_4$ $P_{o\,nom}$ typ	max	t_r at P_o = $P_{o\,nom}$ typ	max	Unit
A...LM 1001-7R and C/D/LMZ 1001-7R	5	10	5	10	10	20	ms
A...LM 1301-7R and C/D/LMZ 1301-7R	10	20	15	30	20	40	
A...LM 1501-7R and C/D/LMZ 1501-7R	5	10	10	20	30	60	
A...LM 1601-7R and C/D/LMZ 1601-7R	15	30	25	50	40	80	
A...LM 1901-7R and C/D/LMZ 1901-7R	65	130	100	200	165	330	
A...LM 2320-7 and C/D/LMZ 2320-7	20	40	30	60	50	100	
A...LM 2540-7 and C/D/LMZ 2540-7	15	30	20	40	35	70	
A...LM 3020-7 and C/D/LMZ 3020-7	55	110	85	170	145	290	
A...LM 3040-7 and C/D/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 $U_{i\,min}$...$U_{i\,max}$ 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% $U_{o\,nom}$.

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

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% $U_{o\,nom}$

$$R_{ext} \approx 4\ k\Omega \bullet \frac{U_o}{U_{o\,nom} - U_o}$$

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% of $U_{o\,nom}$.

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

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

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 $1/R_{tot} = 1/R_1 + 1/R_2 + ...$ should be considered.

Remark

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

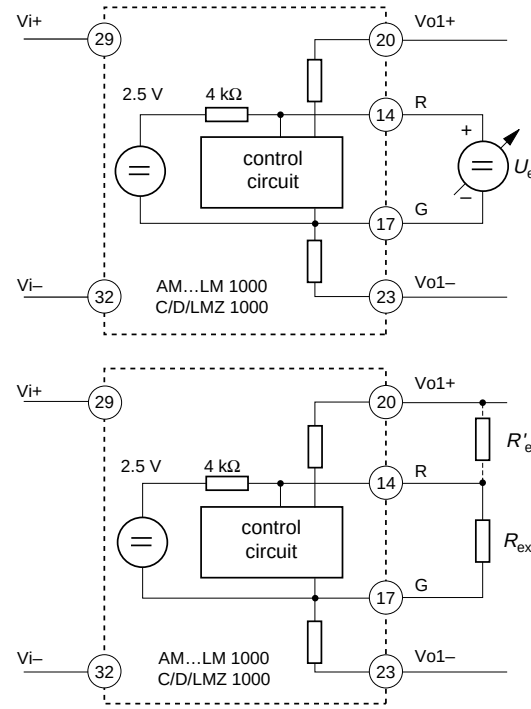


Fig. 10
Output voltage control by means of the R input

Table 11a: 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 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_{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 11b: 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 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'_{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

EMC and Immunity to Input Transients

A suppressor diode or a metal oxide VDR (depending upon the type) 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 12: 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 [6] (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 [6] (1976)	III	i/o, i/c, o/o, o/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	1
			+i/–i, +o/–o	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)	A [5]	+i/–i	3.5 • U_{batt}	20 ms	0.2 Ω	1 positive surge	yes	1
		B		1.5 • U_{batt}	1 s				
Direct transient		C		960 V_p	10/100 µs	5 Ω	5 pos. and 5 neg. impulses		
		D		1800 V_p	5/50 µs				
		E		3600 V_p	0.5/5 µs	100 Ω			
		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				
		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					2
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] Only met with extended input voltage range of BM (24 V battery), CM (48 V battery) and EM (110 V battery) types. These units are available on customer's request. Standard DM units (110 V battery) will not be damaged, but overvoltage lock-out will occur during the surge
[6] In correspondence with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)

Electromagnetic Emissions

Table 13: Emissions at $U_{i\,nom}$ and $I_{o\,nom}$ (LM/LMZ at 230 V AC)

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 15.107	15.103
	≤ 30 MHz	≥30 MHz	≤ 30 MHz	≥30 MHz	≤ 30 MHz	≥30 MHz	≤ 30 MHz	≥30 MHz
AM 1000	B	B	N	K	B	B	B	B
AM 2000	B	B	N	K	B	B	B	B
AM 3000	B	A	N	K	B	A	B	A
BM 1000	B	B	N	K	B	B	B	B
BM 2000	B	B	N	K	B	B	B	B
BM 3000	B	A	N	K	B	A	B	A
CM 1000	B	B	N	K	B	B	B	B
CM 2000	B	B	N	K	B	B	B	B
CM 3000	B	A	N	K	B	A	B	A
DM 1000	B	B	N	K	B	B	B	B
DM 2000	B	B	N	K	B	B	B	B
DM 3000	B	A	N	K	B	A	B	A
EM 1000	B	B	N	K	B	B	B	B
EM 2000	B	B	N	K	B	B	B	B
EM 3000	B	A	N	K	B	A	B	A
FM 1000	A	B	N	K	B	B	A	B
FM 2000	A	B	N	K	B	B	A	B
FM 3000	A	A	N	K	B	A	A	A
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
CMZ 1000	B	A	N	K	B	A	B	A
CMZ 2000	-	-	-	-	-	-	-	-
CMZ 3000	>A	>A	G	G	A	>A	A	>A
DMZ 1000	-	-	-	-	-	-	-	-
DMZ 2000	-	-	-	-	-	-	-	-
DMZ 3000	-	-	-	-	-	-	-	-
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)

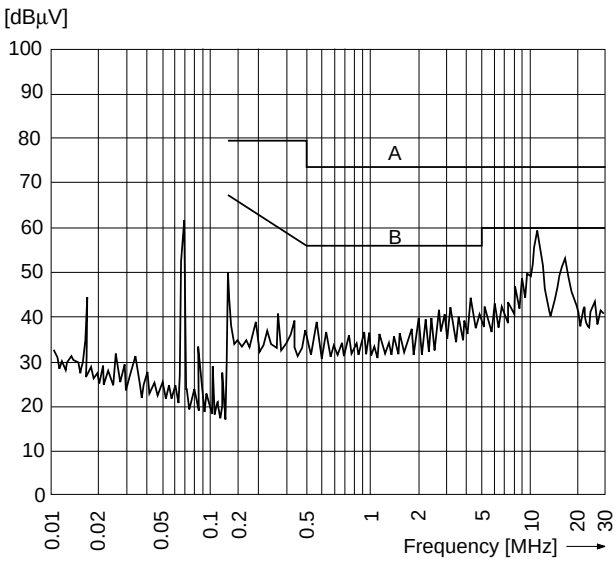


Fig. 11a
Conducted RFI at input according to EN 55011 (quasi peak)

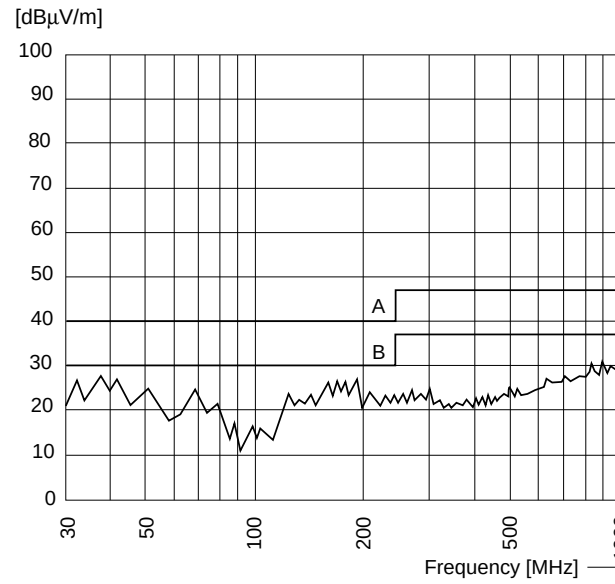


Fig. 11b
Radiated RFI according to EN 55011 (Distance 10 m)

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

Characteristic a) values according to IEC 950, b) Product's performance		Input/Output		Input/Case Class I		Input/Case Class II		Output/Case		Output/Output		Unit
		a)	b)	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	AM/BM	4.0	5.0	2.0	4.0	4.0	5.0	1.0	2.0	–	0.9	mm
	C...LM and C/D/LMZ	4.0	8.0	2.0	4.0	4.0	5.0	1.0	2.0	–	0.9	

[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 currents 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.

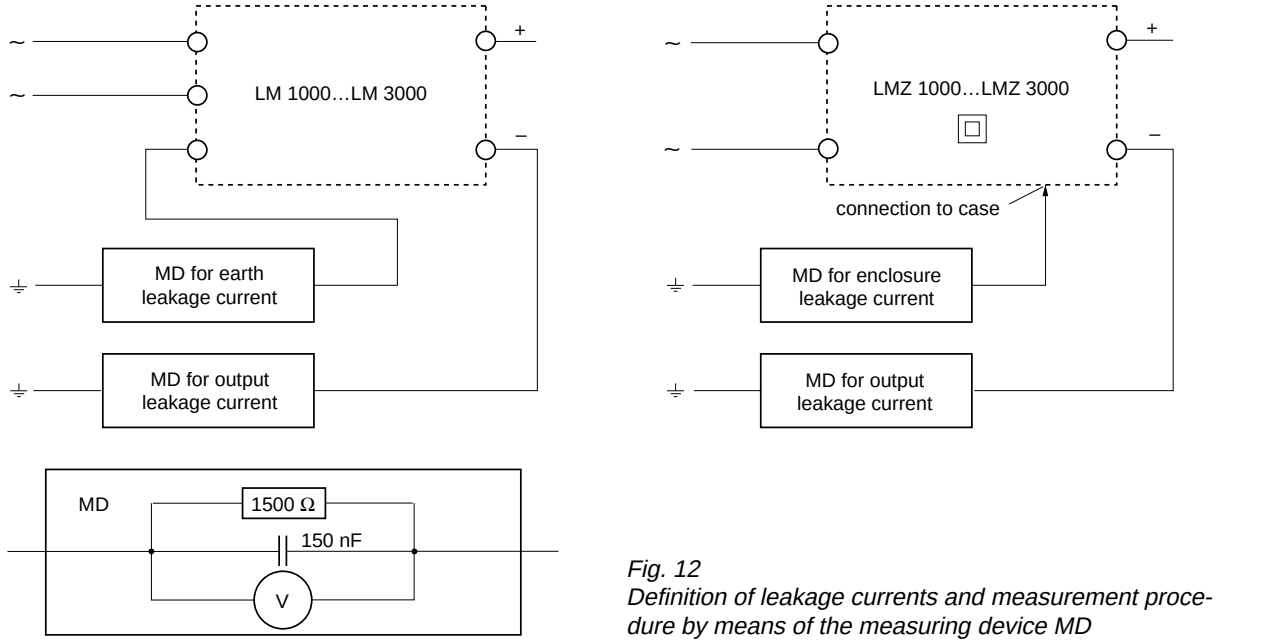


Fig. 12
Definition of leakage currents and measurement procedure by means of the measuring device MD

Table 15: Leakage currents

Characteristic a) permissible according to IEC 950 b) 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

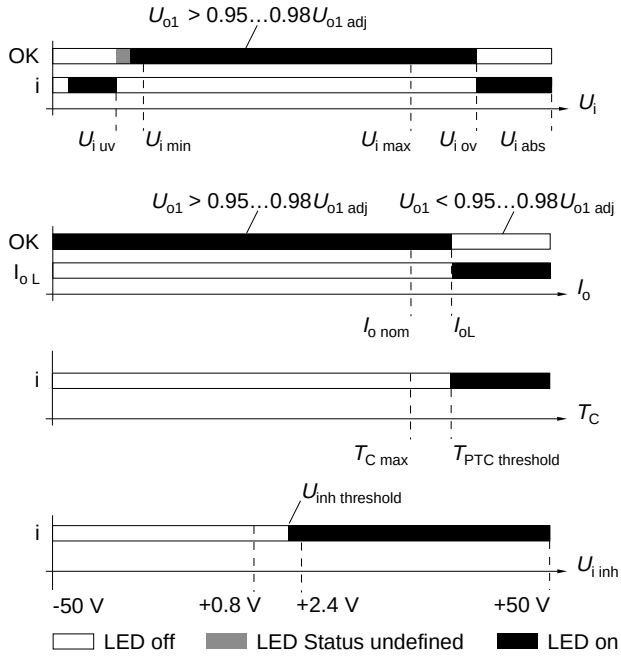


Fig. 13
LEDs "OK" and "i" status versus input voltage
Conditions: $I_o \le I_{o\ nom}$, $T_C \le T_{C\ max}$, $U_{inh} \le 0.8$ V
$U_{i\ uv}$ = undervoltage lock-out, $U_{i\ ov}$ = overvoltage lock-out

LED "OK" and "$I_{o\ L}$" 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: $U_{i\ min}$...$U_{i\ max}$, $I_o \le I_{o\ nom}$, $T_C \le T_{C\ max}$

Description of Options

Table 16: Survey of options

Option	Function of Option	Characteristic
–9	Extended operational ambient temperature range	T_A = –40...71°C
E	Electronic inrush current limitation circuitry	Extended inrush current limitation for C/E/LM, C/LMZ
P [1]	Potentiometer for fine adjustment of output voltage	Adjustment range ±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 inside case	Fuse not externally accessible
U	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 V

Option -9 Extended temperature range

Option -9 extends the operational ambient temperature range from –25...71°C (standard) to –40...71°C. The power supplies provide full nominal output power with convection cooling.

Option A Test sockets

Test sockets (pin Ø = 2 mm, distance d = 5.08 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 minimum ±5% of $U_{o\ nom}$ and are accessible through holes in the front cover. Compensation of voltage drop 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 17: Configuration of option A and option P

Type of option	AM...LM/CMZ...LMZ 1000	AM...LM/CMZ...LMZ 2000		AM...LM/CMZ...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] AM...LM 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 version of the modules C/D/E/LM as well as C/D/LMZ include a passive inrush current limitation in the 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.

CM and CMZ units meet the CEPT/ETSI standards for 48 V DC supply voltage according to prETS 300132-2 if fitted with option E combined with option D6 (input voltage monitoring). Option D6, externally adjustable via potentiometer, is necessary to disable the converter at input voltages below the actual service ranges, avoiding an excessive input current when the input voltage is raised slowly according to prETS 300132-2. Option D6 threshold level $U_{t\,i}$ + $U_{h\,i}$ (refer to description of option D) should be adjusted to 36.0...40.5 V for 48 V DC nominal supply voltage (for 60 V DC systems, threshold should be set to 44.0...50.0 V DC). The D output (pin 5) should be connected to the inhibit (pin 2). For applications where potentiometers are not allowed refer to option D9.

Table 18: Inrush current characteristics with option E

Characteristic CM/CMZ/EM at U_i = 110 V DC LM/LMZ at U_i = 230 VAC		**CM/CMZ** typ	**CM/CMZ** max	**EM** typ	**EM** max	**LM/LMZ** typ	**LM/LMZ** max	**Unit**
$I_{inr\,p}$	Peak inrush current	6.5	8	2.2	4	6	10	A
t_{inr}	Inrush current duration	22	30	19	30	35	50	ms

Precautions:

In order to avoid overload of the series resistor R_I 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 CM and CMZ types are driven by input voltages below 35 V DC or LM and LMZ types below 100 V AC, the maximum case temperature should be derated by 10 K or the total output power should be derated by 20%. EM, LM and LMZ units driven by DC input voltages do not need to be derated within the full specified input voltage range.

Availability:

Option E is available for C/E/LM and CMZ/LMZ modules with a nominal output power of 51 W maximum.

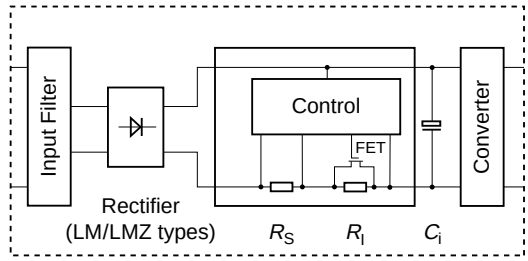


Fig. 14
Option E block diagram

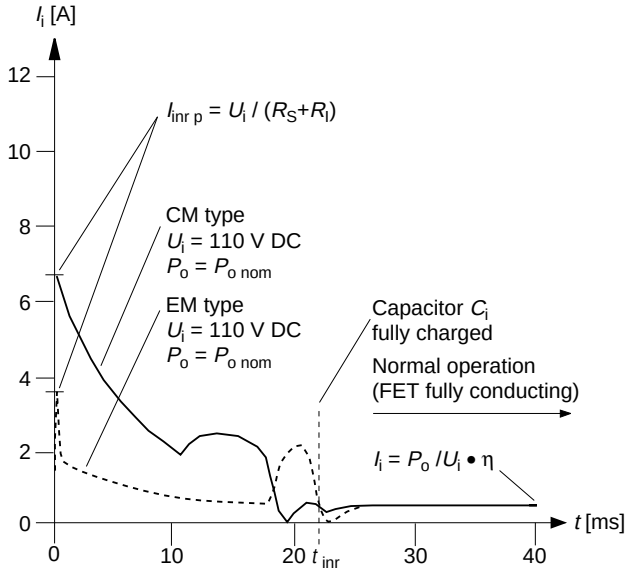


Fig. 15
Typical inrush current waveforms of a CM and an EM type

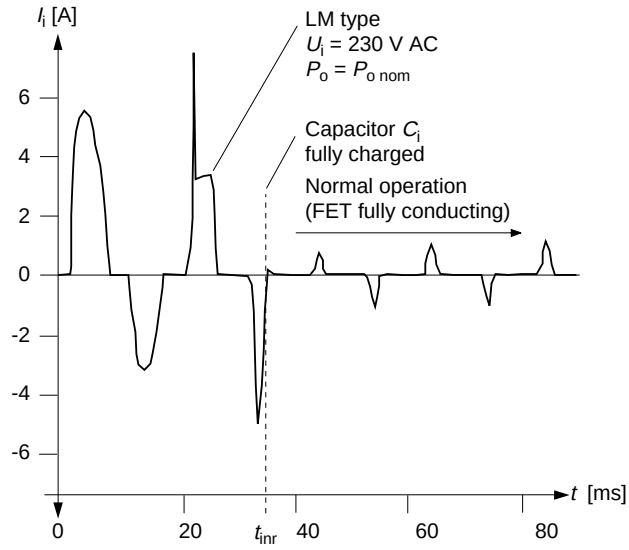


Fig. 16
Typical inrush current waveform of a LM type

Option 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 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 19: 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"
D0	D9	no	yes	–	3.5 V...48 V [3]	–	1.8...1
		yes	no	$U_{i\,min}...U_{i\,max}$ [3 4]	–	2.2...0.4	–
		yes	yes	$U_{i\,min}...U_{i\,max}$ [3 4]	0.95...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)
[3] Fixed value, resistor-adjusted according to customer's specifications ±2% at 25°C; individual type number is determined by Melcher
[4] Adjusted at $I_{o\,nom}$

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. $U_D \leq 0.4$ 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, $U_D \leq 0.4$ V at $I_D = 2.5$ mA
U_i and $U_{o1} > U_t + U_h$	high, H, $I_D \leq 25$ µA at $U_D = 5.25$ V

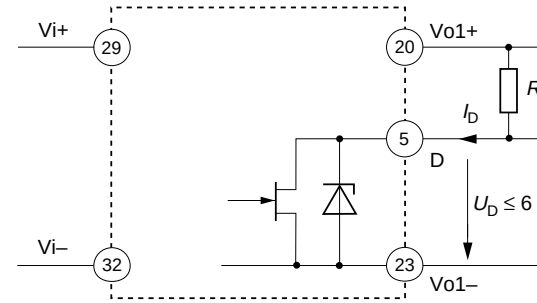


Fig. 17
Options D0...D4, JFET output

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. $U_D < 0.4$ 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, $I_D \leq 25$ µA at $U_D = 40$ V
U_i and $U_{o1} > U_t + U_h$	low, L, $U_D \leq 0.4$ V at $I_D = 20$ mA

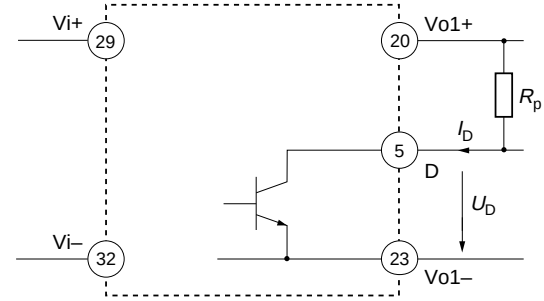


Fig. 18
Options D5...D9, NPN output

Threshold tolerances and hysteresis:

If U_i is monitored, the internal input voltage after the input filter and rectifier (E/LM and LMZ types) 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°C. The value of ΔU_{ti} depends upon the input voltage range (AM, BM, ...), threshold level U_t, temperature and input current. The input current is a function of the input voltage and the output power.

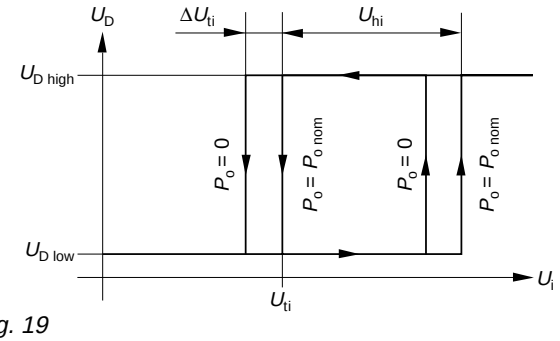
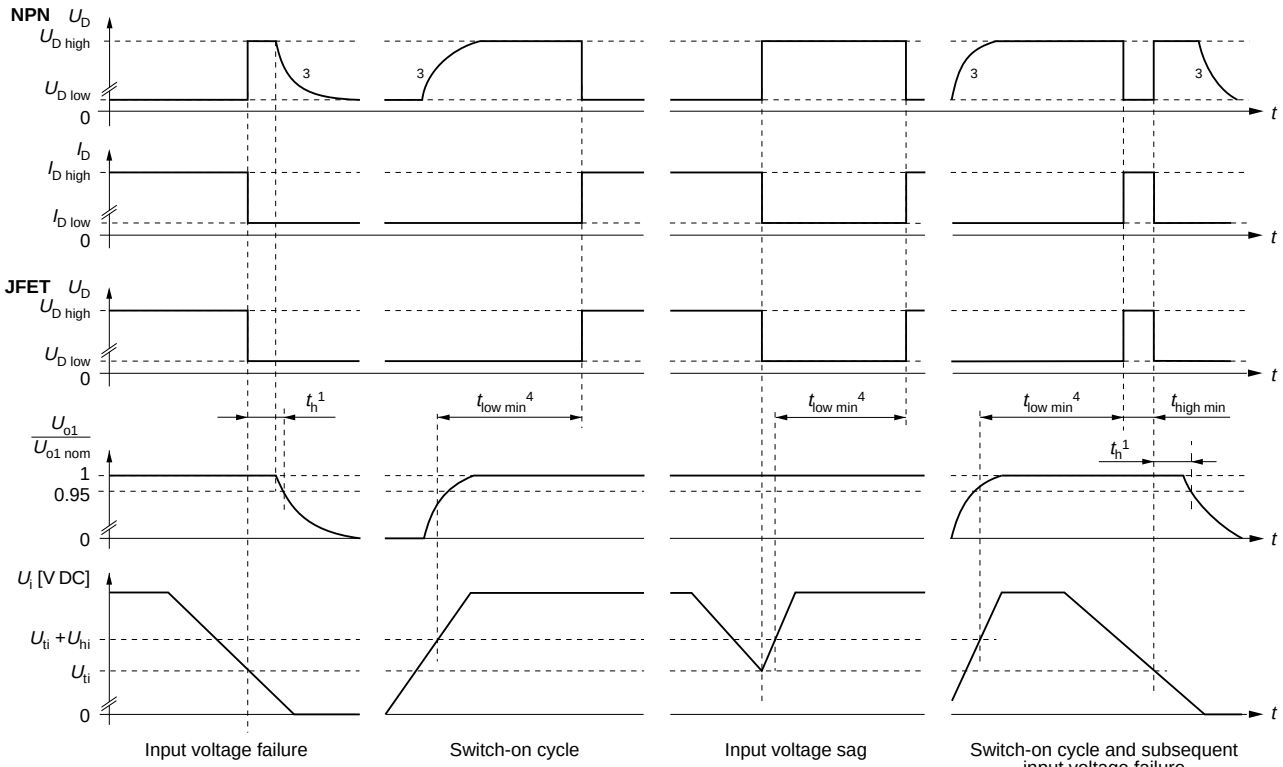


Fig. 19
Definition of U_{ti}, ΔU_{ti} and U_{hi} (JFET output)

Input voltage monitoring



Output voltage monitoring

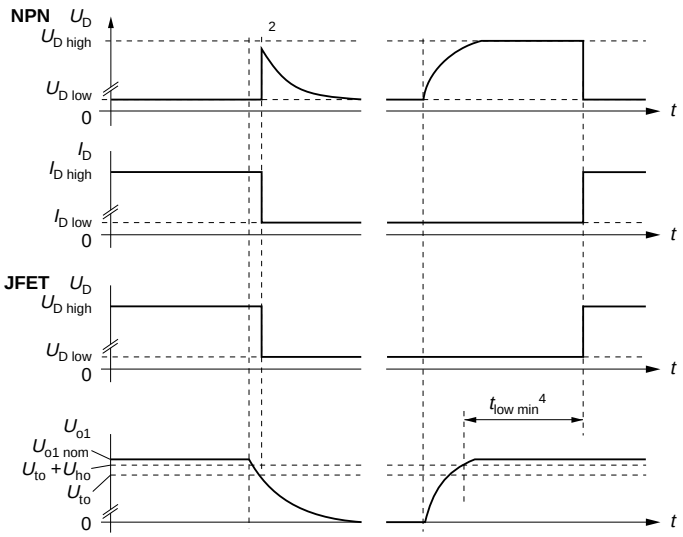


Fig. 20
Relationship between U_i, U_{o1}, U_D, I_D and $U_{o1}/U_{o\,nom}$ versus time.

[1] See "El. 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...200 ms, typically 80 ms

7.1

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 $U_V \le 0.6$ 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 is provided by the internal 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 the input capacitance. If the input voltage is below the required level, an external hold-up capacitor ($C_{i\,ext}$) should be added.

Formula for threshold level for desired value of t_h:

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

Formula for additional external input capacitor

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

where as:

$C_{i\,min}$ = minimum internal input capacitance [mF], according to the table below
$C_{i\,ext}$ = external input capacitance [mF]
P_o = output power [W]
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. A decoupling diode should be connected in series with the input of A...D/FM converters to avoid the input capacitance discharging through other loads connected to the same source voltage. If LM or LMZ units are AC powered, an external input capacitor cannot be applied unless an additional rectifier is provided.

Table 20: Available internal input capacitance and factory potentiometer setting of $U_{t\,i}$ with resulting hold-up time

Types	AM	BM	FM	CM/CMZ	DM/DMZ	EM	LM/LMZ	Unit
$C_{i\,min}$	2.6	0.67	0.37	0.37	0.14	0.14	0.14	mF
$U_{t\,i}$	9.5	19.5	39	39	61	104	120	V DC
t_h	0.34	0.69	2.92	1.92	1.73	6.69	8.18	ms

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 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.

Table 21: 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"
V0	yes	no	$U_{i\,min}...U_{i\,max}$ [3 4]	-	2.2...0.4	-
	yes	yes	$U_{i\,min}...U_{i\,max}$ [3 4]	0.95...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 (±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. $U_V \le 0.6$ 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

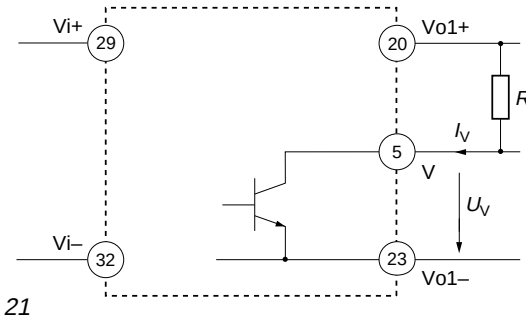


Fig. 21
Output configuration of options V0, V2 and V3

Threshold tolerances and hysteresis:

If U_i is monitored, the internal input voltage is measured after the input filter and rectifier (E/LM and LMZ types). 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 $T_A = 25\,°C$. The value of ΔU_{ti} depends upon the input voltage range (AM, BM, ...), threshold level U_{ti}, temperature and input current. The input current is a function of input voltage and output power.

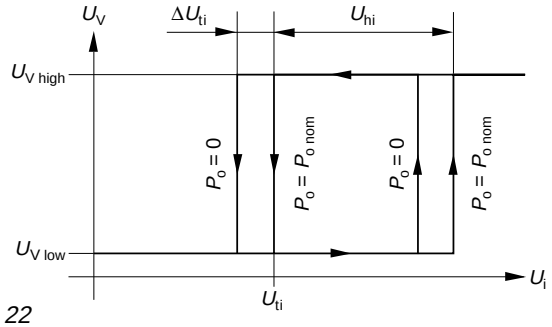
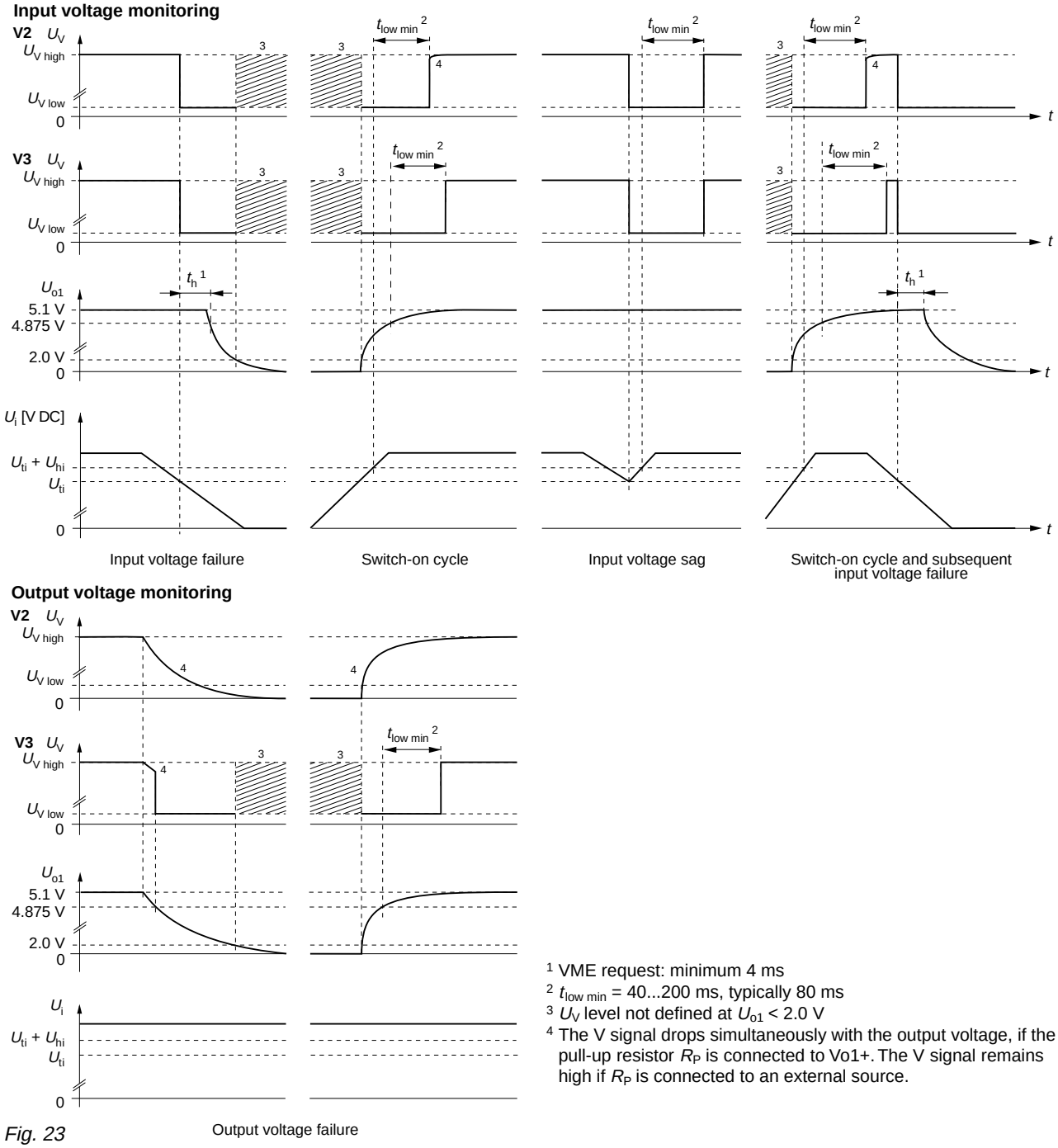


Fig. 22
Definition of U_{ti}, ΔU_{ti} and U_{hi}



[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. 23
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 as a result of inverse polarity at the input of an A/B/C/D/FM or C/DMZ type or if 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 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 22: 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: Relative humidity: Duration:	40 $^{\pm 2}$ °C 93 $^{+2/-3}$ % 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: Bump duration: Number of bumps:	100 g_n = 981 m/s^2 6 ms 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: Bump duration: Number of bumps:	40 g_n = 392 m/s^2 6 ms 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): Maximum vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) 5 g_n = 49 m/s^2 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: Frequency band: Acceleration magnitude: Test duration:	0.05 g^2/Hz 20...500 Hz 4.9 g_{rms} 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: Duration: Storage: Storage duration: Number of cycles:	5% (30°C) 2 h per cycle 40°C, 93% rel. humidity 22 h per cycle 3 Unit not operating

Thermal considerations

Table 23: 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°C	–25	95	
T_C	Extended operational case temperature range -9, overtemp. lock-out (PTC) at T_C > 95°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 $T_{A\,max}$ = 85°C. A simple check of the case temperature T_C ($T_C \leq 95$°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 or -9 units as per figure.

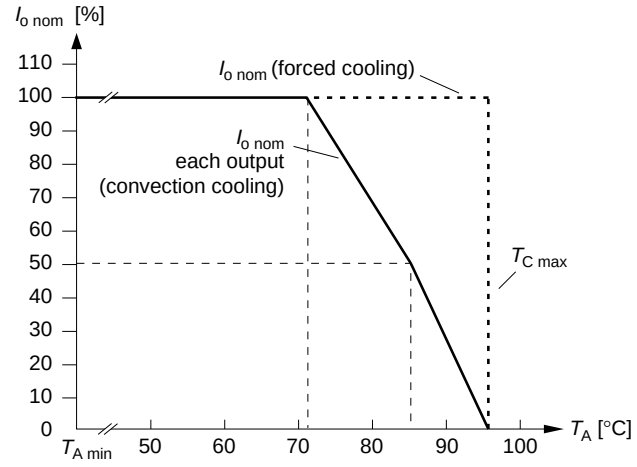


Fig. 24
Output derating versus ambient temperature under convection and forced cooling conditions

Table 24: MTBF

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

[1] Calculated in accordance with MIL-HDBK-217E (calculation according to edition F would show even better results)
[2] Statistical values, based on an average of 4300 working hours per year and in general field use, over 3 years

Mechanical Data

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

European Projection

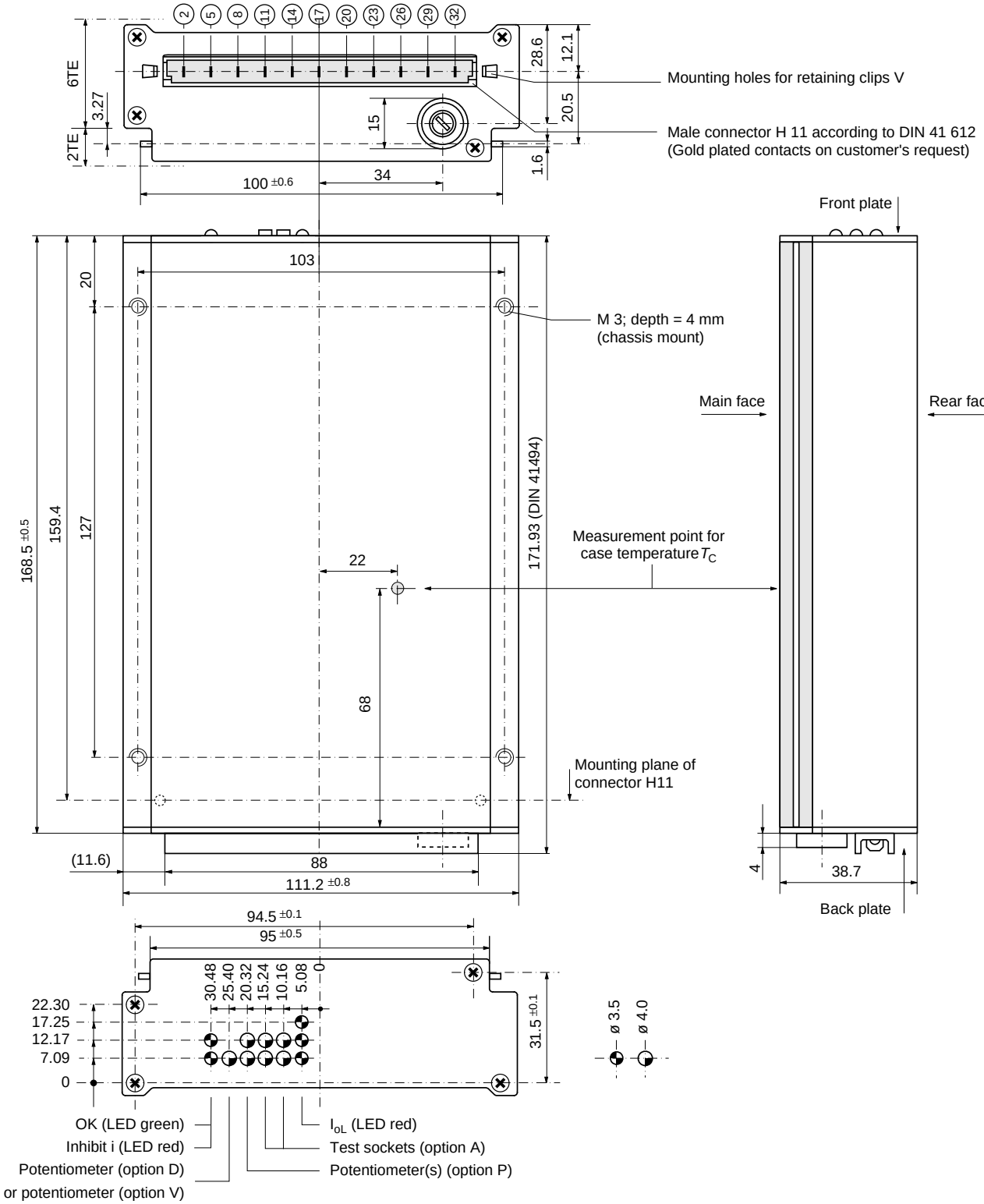


Fig. 25
Case M02, weight 770 g (approx.)

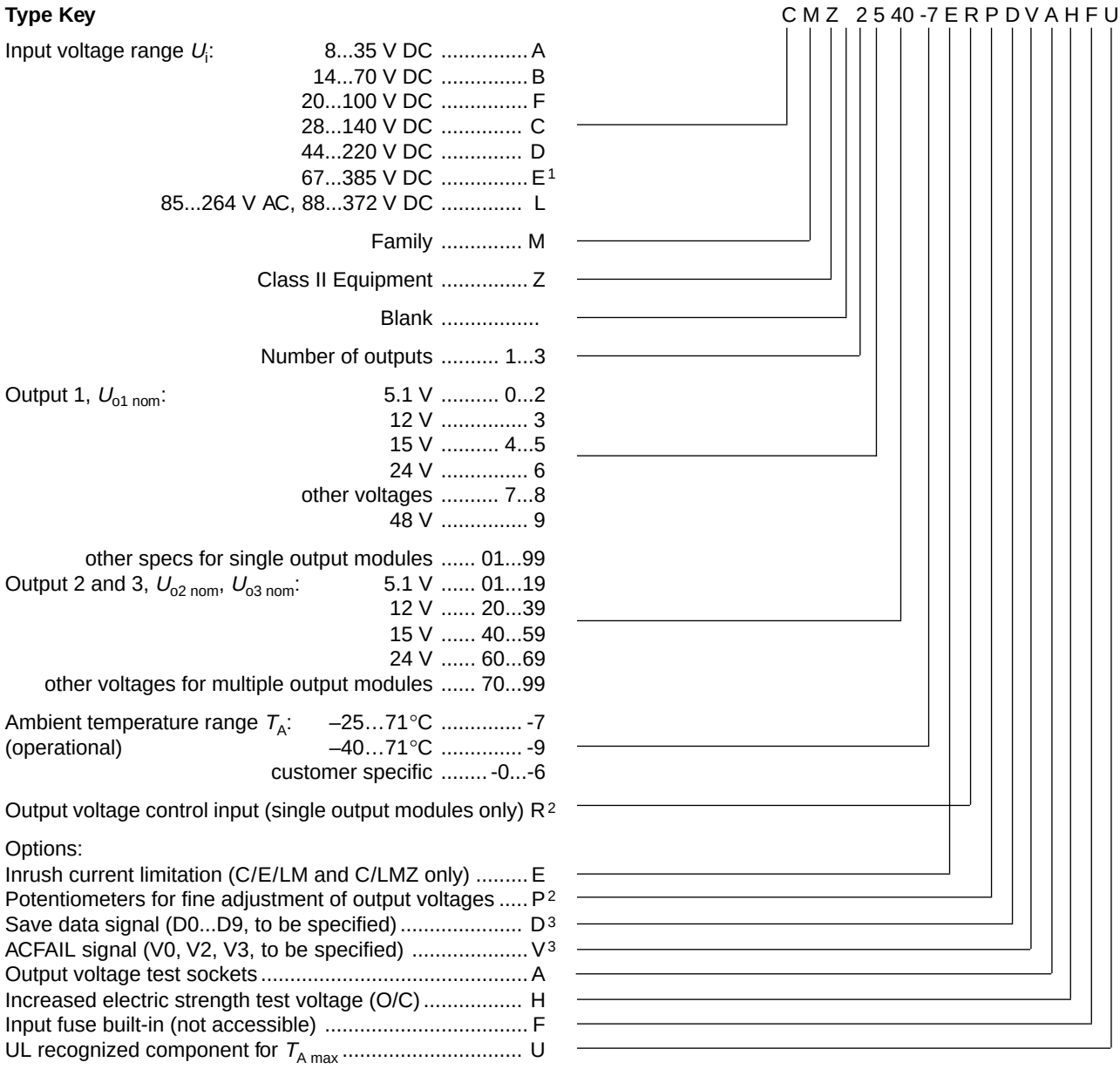
Note: Long case, elongated by 60 mm for 220 mm rack depth, is available on request.

7.1

MELCHER The Power Partners.

Type Key and Product Marking

Type Key



[1] EM types upon custom specifications available
[2] Feature R excludes option P and vice versa
[3] Option D excludes option V and vice versa

Example: CM 2540-7PD3A: DC-DC converter, input voltage range 28...140 V, providing output 1 with 15 V/1.7 A and output 2 with 15 V/1.7 A; equipped with potentiometers, undervoltage monitor 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.