5 Switching Regulators 19"

5.1 Rugged Environment

Output [A] 4 8 12 16 20 25	Output [V DC] 3 5 12 15 24 36 48	Input [V DC] 5 10 40 60 80 144	Product Family	Case	Page
			PSL	L04	5 - 2
			PSS	S01	5 - 13
			PSK	K01	5 - 25

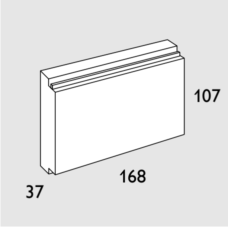
5.2 Industrial Environment

Output [A] 4 8 12 16 20 25	Output [V DC] 3 5 12 15 24 36 48	Input [V DC] 5 10 40 60 80 144	Product Family	Case	Page
			PSL	L04	5 - 37
			PSS	S01	5 - 48
			PSK	K01	5 - 60

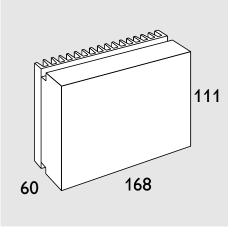
5.3 Benign Environment

Output [A] 4 8 12 16 20 25	Output [V DC] 3 5 12 15 24 36 48	Input [V DC] 5 10 40 60 80 144	Product Family	Case	Page
			PSL	L04	5 - 72
			PSS	S01	5 - 79
			PSK	K01	5 - 89

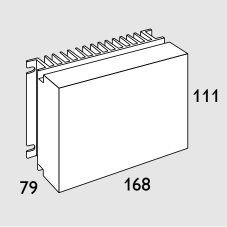
Case L04



Case S01



Case K01



PSR: Positive Switching Regulators

PSL-Family

No input to output isolation
Single output of 12, 15, 24, 36 or 48 V DC/72...288 W
Input voltage up to 144 V DC

- High efficiency up to 96%
- Extremely wide input voltage range
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Two temperature ranges
- Continuous no-load and short-circuit proof
- No derating

Safety according to IEC 950

5.1

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i [1]	Nominal input voltage $U_{i\,nom}$	Efficiency η	Type designation	Options
12 V	6 A	18...144 V	60 V	89%	PSL 126-7R	-9, L, i, P, C, D, A
15 V		22...144 V		90%	PSL 156-7R	
24 V		31...144 V		94%	PSL 246-7R	
36 V		44...144 V	80 V	95%	PSL 366-7R	
48 V		58...144 V		96%	PSL 486-7R	

[1] Surges up to 156 V for 2 sec. See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

Description

The PSL family of positive swiching regulators is designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 144 V are specially designed for battery driven mobile applications.
Case L04: Aluminium, black finish and self cooling.

External input circuitry

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

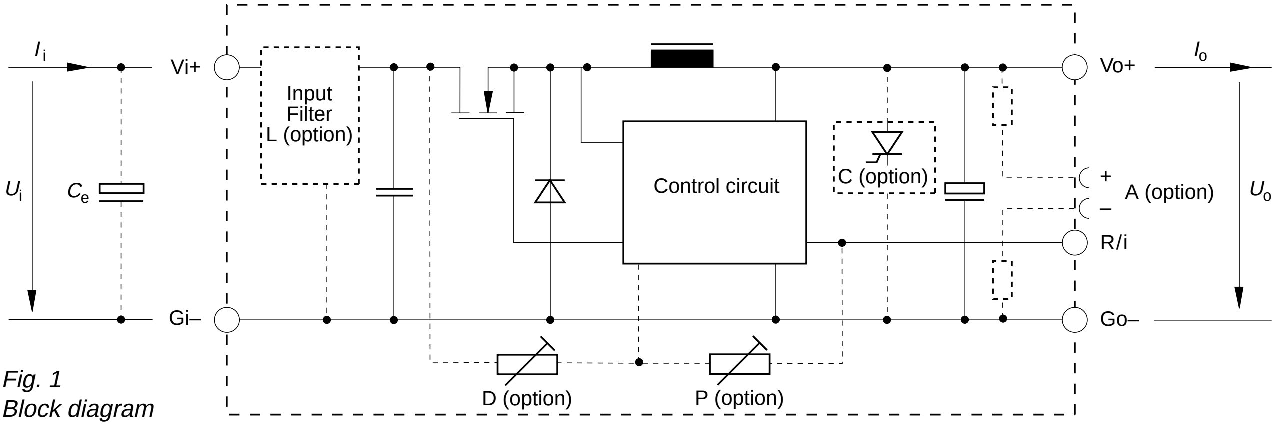

Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V, or up to 48 V if option C is fitted.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
		≤144 V	Hazardous voltage battery circuit [2]	Input fuse [1] and unearthed, non operator-accessible case [2]	SELV circuit
			Hazardous voltage battery circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [3]	SELV circuit
			ELV circuit	Input fuse [1] and earthed output circuit [3]	Earthed SELV circuit
		≤144 V	Hazardous voltage secondary circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤144 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [2]	Input fuse [1] and unearthed and non operator-accessible case [2]	SELV circuit

[1] The installer shall provide an approved fuse (slow blow type with lowest rating suitable for the application, max. 12.5 A) in the positive or negative input conductor directly at the input of the switching regulator. For UL's purpose, the fuse needs to be UL-listed. If option C is fitted, a suitable fuse is built-in.
[2] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum input voltage of the switching regulator (contrary to case marking: "This apparatus must be earthed.").
[3] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

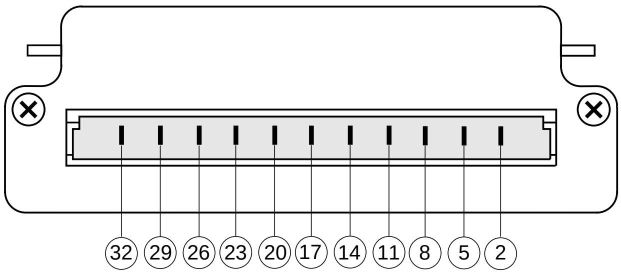

Fig. 2
View of male H11 connector

Protection Degree

The protection degree is defined by IP 30 (equipped with any potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

Table 3: H11 connector pin allocation and designation

Electrical Determination	Type H11 Pin No.	Type H11 Design.
R-input (or inhibit input) [1]	2	R (i)
Undervoltage monitor (Option D)	5	D
Output voltage (negative)	8	Go–
Output voltage (negative)	11	Go–
Output voltage(positive)	14	Vo+
Output voltage (positive)	17	Vo+
Input voltage (negative)	20	Gi–
Input voltage (negative)	23	Gi–
Input voltage (positive)	26	Vi+
Input voltage (positive)	29	Vi+
Protective ground (protruding pin)	32	⏚

[1] R-input (output voltage programming) not available with option P (potentiometer) or option i (inhibit)

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) 5 g_n = 49 m/s^2 (60...2000 Hz) 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

Table 5: Temperature specifications

Temperature			Standard -7		Option -9		Unit
Characteristics		Conditions	min	max	min	max	
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature	Not operational	–40	100	–55	100	

Table 6: MTBF and device hours

MTBF	Ground Fixed		Ground Mobile		Device Hours [1]
MTBF acc. to MIL-HDBK-217D	T_C = 40°C	T_C = 70°C	T_C = 40°C	T_C = 70°C	
	130'000 h	58'000 h	36'000 h	17'000 h	3'900'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Impulse voltage	IEC 255-4 App. E4 [5] (1976)	III	i/o, i/c, o/c +i/–i	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/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	[1]
			+i/–i	1000 V_p					
Voltage surge	IEC 571-1 (1990-07)		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	[2]
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
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	[1,3,6]
Electric field	IEC 801-3 (1984)	3	antenna in 1m distance	10 V/m	sine wave mod-ulated w. 1 kHz		26…1000 MHz	yes	[1]
Fast transient/ burst	IEC 801-4 (1988)	4	i/c, +i/–i	4000 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	[1,3,6]
Transient	IEC 801-5 (Draft 1993-01)	III	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	[1,6]
			+i/–i	1000 V_p		2 Ω			
Immunity to conducted disturbances	IEC 801-6	3	i, o, signal wires	10 V_{rms} [7]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	[1]

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] With option C: manual reset
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Option L neccessary
[7] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

Electrical Input and Output Data

General Conditions

- T_A = 25°C, unless T_C is specified.
- With R or option P, output voltage U_o = $U_{o\ nom}$ at $I_{o\ nom}$

Table 8a: Input and output data

	Characteristics	Conditions	PSL 126 min	PSL 126 typ	PSL 126 max	PSL 156 min	PSL 156 typ	PSL 156 max	PSL 246 min	PSL 246 typ	PSL 246 max	Unit
Output												
$U_{o\ nom}$	Output voltage	$U_{i\ nom}$, $I_{o\ nom}$	11.92		12.07	14.91		15.09	23.85		24.14	V
$I_{o\ nom}$	Output current	$U_{i\ min}...U_{i\ max}$ $T_{C\ min}...T_{C\ max}$		6.0			6.0			6.0		A
I_{oL}	Output current limitation response		6.0		7.8	6.0		7.8	6.0		7.8	
u_o	Ripple at output (BW = 20 MHz)	$U_{i\ nom}$ $I_{o\ nom}$		55	75		80	100		80	120	mV_{pp}
$\Delta U_{o\ U}$	Static control deviation versus input voltage U_i	$U_{i\ min}...U_{i\ max}$ $I_{o\ nom}$		25	40		25	40		80	100	mV
$\Delta U_{o\ I}$	Static control deviation versus output current I_o	$U_{i\ nom}$ $I_o = 0...I_{o\ nom}$		30	50		30	50		60	100	
$u_{o\ d}$	Dynamic control deviation [1]	$U_{i\ nom}$ $I_{o\ nom} \leftrightarrow {}^1/_3\ I_{o\ nom}$		100			100			120		
t_r	Dynamic load transient time recovery [1]			60			60			80		µs
α_{uo}	Temperature coefficient $\Delta U_o/\Delta T_C$	$U_{i\ min}...U_{i\ max}$ $T_{C\ min}...T_{C\ max}$ $I_o = 0...I_{o\ nom}$			±2			±3			±5	mV/K
					±0.02			±0.02			±0.02	%/K
Input												
U_i	Input voltage [5]	$I_o = 0...I_{o\ nom}$ $T_{C\ min}...T_{C\ max}$	18		144	22		144	31		144	V DC
$\Delta U_{io\ min}$	Minimum differential voltage $U_i - U_o$ [2]			6			7			7		V
$U_{i\ o}$	Undervoltage cut-out			12			15			19		
$I_{i\ 0}$	No load input current	$I_o = 0$ $U_{i\ min}...U_{i\ max}$		35			35			35		mA
$I_{i\ m}$	Peak value of inrush current [3]	$U_{i\ nom}$		250			250			250		A
$t_{i\ s}$	Rise time [3]			5			5			5		µs
$t_{i\ r}$	Tail half value time [3]			40			40			40		
$I_{i\ m}$	Peak value of inrush current [3]	$U_{i\ nom}$ with option L		350			350			350		A
$t_{i\ s}$	Rise time [3]			25			25			25		µs
$t_{i\ r}$	Tail half value time [3]			125			125			125		
$u_{i\ rfi}$	RFI level at input, [4] 0.01...30 MHz	VDE 0871 (6.78) $U_{i\ min...max}$, $I_{o\ nom}$			B			B			B	dB (µV)
Efficiency												
η	Efficiency	$U_{i\ nom}$, $I_{o\ nom}$		89			90			94		%
Isolation												
U_{is}	Isolation test voltage electronics to case	Inputs/outputs interconnected		1500			1500			1500		V DC

[1] See "Dynamic characteristics"

[2] The minimum differential voltage $\Delta U_{io\ min}$ between input and output increases linearly from 0 to 1 V at T_A = 46°C and 71°C (T_C = 70°C and 95°C)

[3] Definitions according to VDE 0433, part 3

[4] With option L and additional external input capacitor C_e = 470 µF/200 V, e.g. Chemicon, KME-series or equivalent

[5] Surges up to 156 V for 2 sec. (complying to LES-DB standard for U_N = 110 V)

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Table 8b: Input and output data

Characteristics		Conditions	PSL 366 min	PSL 366 typ	PSL 366 max	PSL 486 min	PSL 486 typ	PSL 486 max		Unit
Output										
$U_{o\,nom}$	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	35.78		36.22	47.70		48.29		V
$I_{o\,nom}$	Output current	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$		6.0			6.0			A
I_{oL}	Output current limitation response		6.0		7.8	6.0		7.8		
u_o	Ripple at output (BW = 20 MHz)	$U_{i\,nom}$ $I_{o\,nom}$		80	150		100	200		mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$		200	300		100	200		mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0...I_{o\,nom}$		120	200		180	250		
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$		140			150			
t_r	Dynamic load transient time recovery [1]			100			100			µs
α_{uo}	Temperature coefficient $\Delta U_o/\Delta T_C$	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$			±8			±10		mV/K
					±0.02			±0.02		%/K
Input										
U_i	Input voltage [5]	$I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$	44		144	58		144		V DC
$\Delta U_{io\,min}$	Minimum differential voltage $U_i - U_o$ [2]			8			10			V
$U_{i\,o}$	Undervoltage cut-out			29			40			
$I_{i\,0}$	No load input current	$I_o = 0$ $U_{i\,min}...U_{i\,max}$		40			45			mA
$I_{i\,m}$	Peak value of inrush current [3]	$U_{i\,nom}$		250			250			A
$t_{i\,s}$	Rise time [3]			5			5			µs
$t_{i\,r}$	Tail half value time [3]			40			40			
$I_{i\,m}$	Peak value of inrush current [3]	$U_{i\,nom}$ with option L		350			350			A
$t_{i\,s}$	Rise time [3]			25			25			µs
$t_{i\,r}$	Tail half value time [3]			125			125			
$u_{i\,rfi}$	RFI level at input, [4] 0.01...30 MHz	VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$			B			B		dB (µV)
Efficiency										
η	Efficiency	$U_{i\,min...max}$, $I_{o\,nom}$		95			96			%
Isolation										
U_{is}	Isolation test voltage electronics to case	Inputs/outputs interconnected		1500			1500			V DC

[1] See "Dynamic characteristics"
[2] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly from 0 to 1 V at T_A = 46°C and 71°C (T_C = 70°C and 95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor C_e = 470 µF/200 V, e.g. Chemicon, KME-series or equivalent
[5] Surges up to 156 V for 2 sec. (complying to LES-DB standard for U_N = 110 V)

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

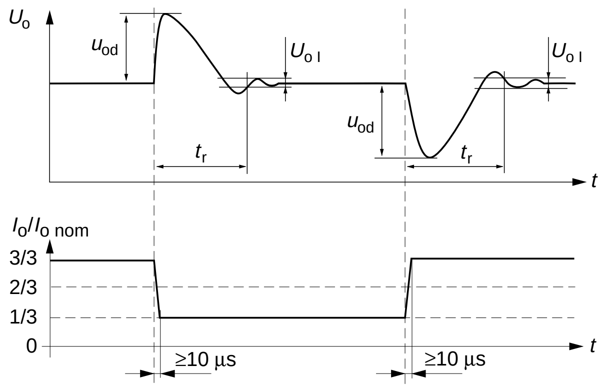


Fig. 3
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 71°C and is operated at its nominal output power, the case temperature T_C will be about 95°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 71°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C (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

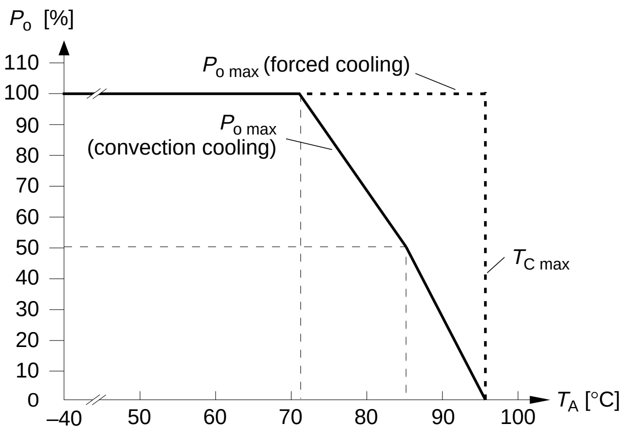


Fig. 4
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

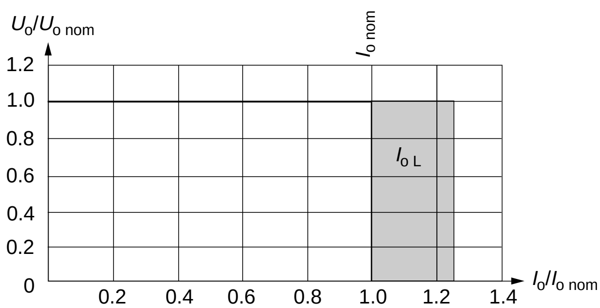


Fig. 5
Overload, short-circuit behaviour U_o versus I_o

Standard Features

R External Output Voltage Adjustment

Note: With open R input, $U_o = U_{o\,nom}$.
R-input together with option i or option P cannot be supported simultaneously.

The output voltage U_o can either be adjusted with an external resistor (R_1 or R_2) or with an external voltage (U_{ex}). The adjustment range is 0…1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

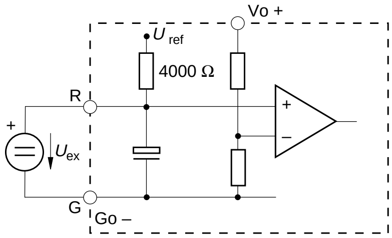


Fig. 6
Voltage adjustment with U_{ex} [V] between R and G (Go-):

a) $U_o \approx U_{ex} \bullet \dfrac{U_{o\,nom}}{U_{ref}}$ (U_{ref} = 2.5 V ±4%)

Caution: To prevent damage U_{ex} should not exceed 2.7 V, nor be negative.

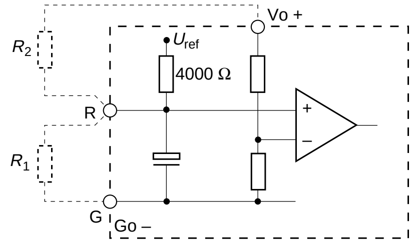


Fig. 7
Voltage adjustment with external resistor R_1 or R_2 [Ω]

b) U_o = 0...100% $U_{o\,nom}$, using R_1 between R and G (Go-):

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

c) $U_o = U_{o\,nom} ... U_{o\,max}$, using R_2 between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \bullet \frac{R_2}{k \bullet (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \bullet \frac{U_o \bullet (1\text{-}k)}{k \bullet U_o - U_{ref}} \qquad (U_{ref} = 2.5\text{ V} \pm 4\%)$$

All formulae give approximate values only.

Description of Options

Option i Inhibit

Note: With open i-input, output is enabled (U_o = on)
Inhibit excludes R function.

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

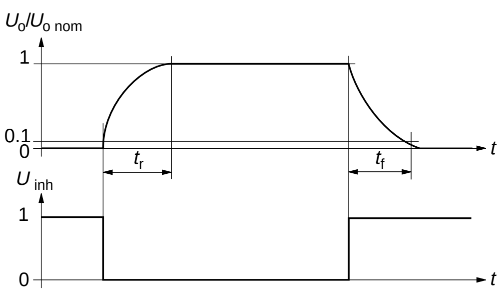


Fig. 9
Output response as a function of inhibit signal

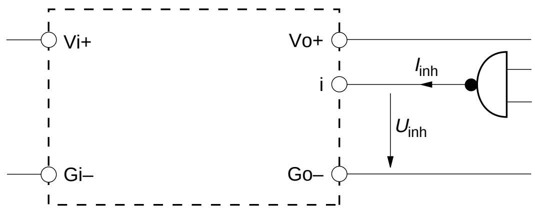


Fig. 8
Definition of I_{inh} and U_{inh}

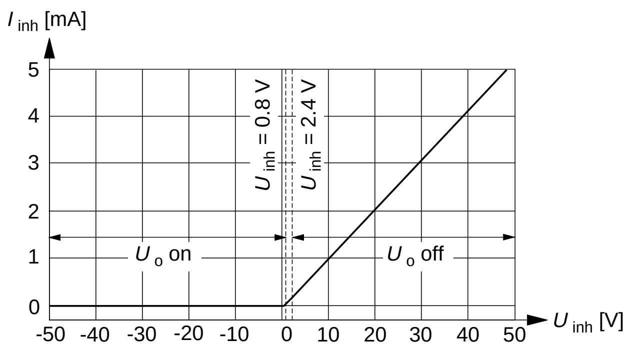


Fig. 10
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Data

Table 9: Inhibit characteristics

Characteristics			Conditions	min	typ	max	Unit
U_{inh}	Inhibit input voltage to keep regulator output voltage...	U_o = on	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	–50		+0.8	V DC
		U_o = off		+2.4		+50	
t_r	Switch-on time after inhibit command		$U_i = U_{i\,nom}$ $R_L = U_{o\,nom} / I_{o\,nom}$		5		ms
t_f	Switch-off time after inhibit command				10		
$I_{i\,off}$	Input current when inhibited		$I_o = 0$, $U_i = U_{i\,nom}$		10		mA

Option -9 Extended Temperature Range

The operational ambient temperature range is extended to T_A = –40...71°C.

Option L Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 mV_{rms}.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\ Hz \text{ or } V_{pp} = 1000\ Hz / f_i \bullet 1\ V$$

Option P Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage U_o can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

Option U Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSL family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 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 to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71°C without any further precautions.

Option C Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage U_o. When the trigger voltage U_{oc} is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excessive current.

Note: As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

Table 10: Crowbar trigger levels

Characteristics		Conditions	12 V		15 V		24 V		36 V		48 V		Unit
			min	max	min	max	min	max	min	max	min	max	
$U_{o\,c}$	Trigger voltage	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$	13.5	16	16.5	19	27	31	40	45.5	55	60	V
t_s	Delay time			1.5		1.5		1.5		1.5		1.5	µs

Option D "Save Data", input undervoltage monitor

Note: Output instead of input undervoltage monitor is available on request (option D1).

If the input voltage U_i is below the adjustable threshold voltage U_t, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

The voltage U_t can be externally adjusted with a trim potentiometer by means of a screwdriver. The hysteresis U_H of U_t is <2%. Terminal D stays low for a minimum time $t_{low\,min}$, in order to prevent any oscillation. U_t can be set to a value between $U_{i\,min}$ and $U_{i\,max}$ according to fig. 10. It is important to note that the FET can become conductive again when $U_D > U_i$ – 3V.

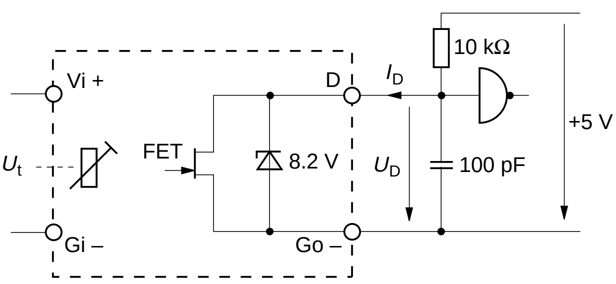


Fig. 11
Test circuit with definition of voltage U_D and current I_D on Terminal D.

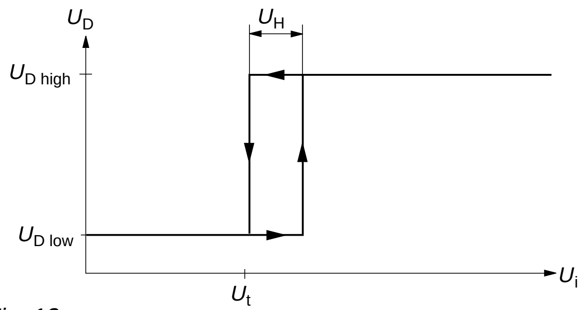


Fig. 12
Definition of U_t and U_H

Data

Table 11: Option D data

Characteristics		Conditions	PSL			Unit
			min	typ	max	
$U_{D\ low}$	Voltage - Terminal D at low impedance	$U_i < U_t$, $I_D \leq 2.5$ mA			0.8	V
$U_{D\ high}$	Voltage - Terminal D at high impedance	$U_i > U_t + U_H$, $I_D > 25$ µA	4.75			
$t_{low\ min}$	Minimum duration $U_{D\ low}$			30		ms
$t_{D\ f}$	Response time to $U_{D\ low}$			1		µs
$I_{D\ max}$	Maximum current - Terminal D				20	mA

Application examples

a) The signal U_D can be utilized in battery powered systems to provide a warning in case of **low batteries**.

b) In case of power failure, the signal can serve to initiate **data save** routines.

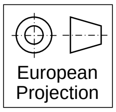
Option A Test sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage are located at the front panel of the module. The output voltage is measured internally directly at the connector pins.

5.1

Mechanical Data

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



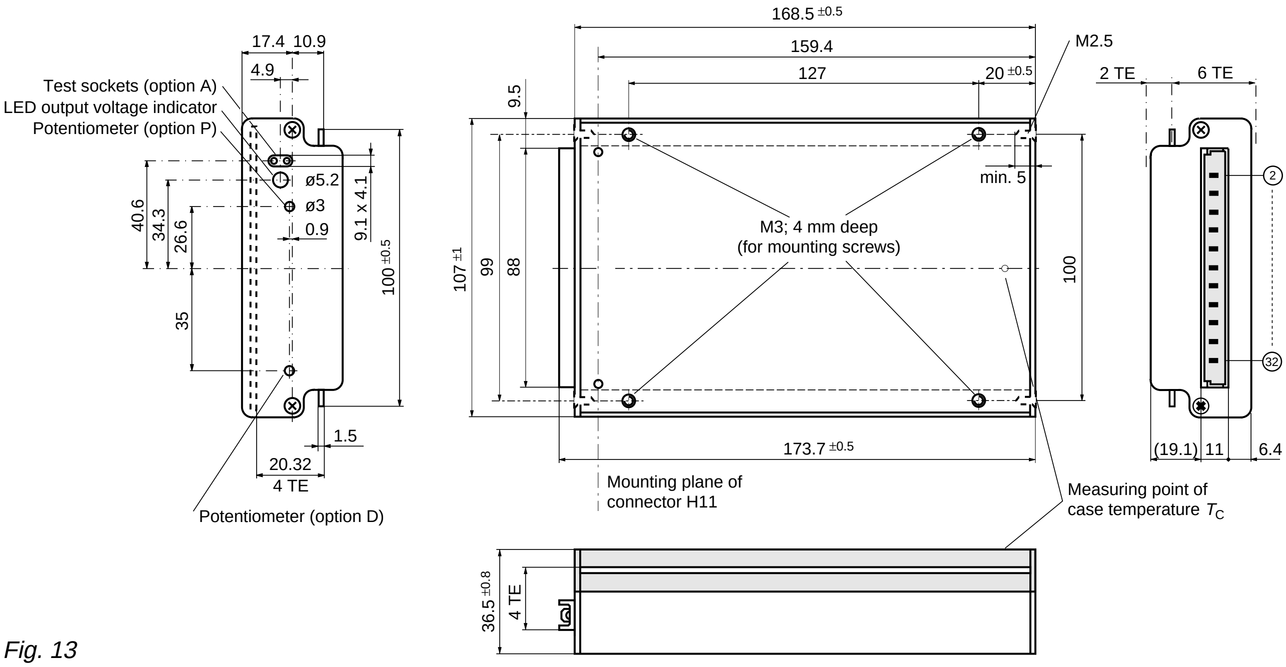


Fig. 13
Case L04 (weight 550 g)

Type Key and Product Marking

Type Key

PSL 12 6 -7 L i R P C D A

Positive switching regulator in case L04	PSL
Blank	
Nominal output voltage in volt	12...48
Nominal output current in ampere	6
Ambient temperature range	
T_A = –25...71°C	-7
T_A = –40...71°C	-9
Input filter	L
Inhibit input	i
External output voltage adjustment	R
Potentiometer	P
Thyristor-Crowbar	C
"Save Data" undervoltage monitor	D
Test sockets	A

Example:PSL 126-7LiPC = A positive switching regulator with a 12 V, 6 A output, ambient temperature range of –25…71°C, input filter, inhibit input, potentiometer and thyristor-crowbar.

Produkt Marking

Main face: Family designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

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

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

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

Positive Switching Regulators | PSS-Family

No input to output isolation
Single output of 12, 15, 24, 36 or 48 V DC/108...432 W
Input voltage up to 144 V DC

- Extremely wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no-load and short-circuit proof
- Output current sharing
- No derating

Safety according to IEC 950

5.1

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i [2]	Nominal input voltage $U_{i\,nom}$	Efficiency η [3]	Type designation	Options
12 V [1]	9 A	18...144 V	60 V	90%	PSS 129-7	-9, E, P, C, B, B1
24 V		31...144 V		94%	PSS 249-7	
36 V		44...144 V	80 V		PSS 369-7	
48 V		58...144 V		96%	PSS 489-7	

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Surges up to 156 V for maximum 2 s
[3] Including option E, T_A = 25°C

Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. The maximum input voltage is as high as 144 V DC (120 V +20%) with surges up to 156 V for 2 sec. This allows operation in the majority of battery driven mobile applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case S01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

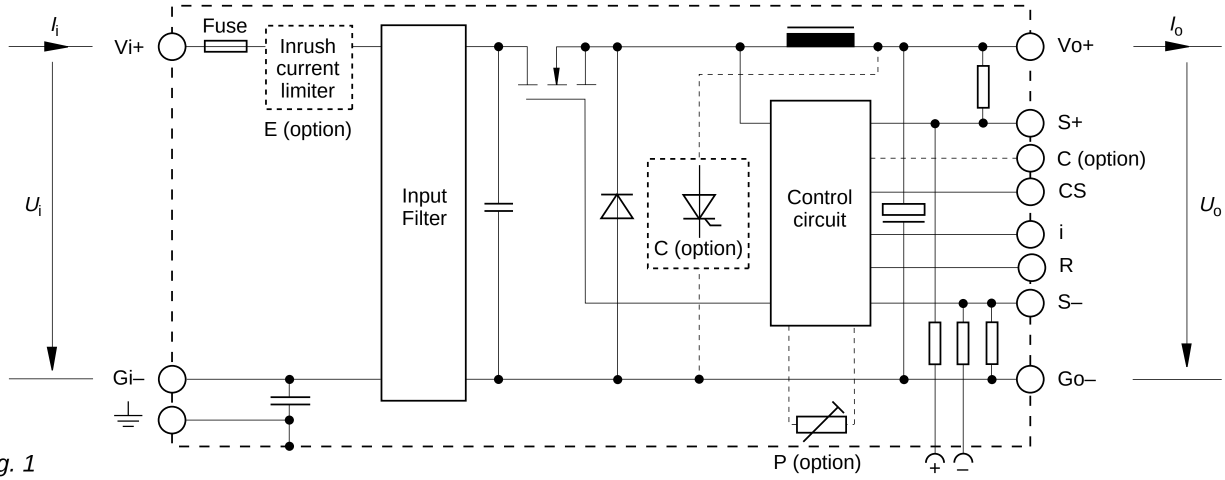


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V, or up to 48 V if option C is fitted.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
		≤144 V	Hazardous voltage battery circuit [2]	Input fuse [1] and unearthed, non operator-accessible case [2]	SELV circuit
			Hazardous voltage battery circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [3]	SELV circuit
			ELV circuit	Input fuse [1] and earthed output circuit [3]	Earthed SELV circuit
		≤144 V	Hazardous voltage secondary circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤144 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [2]	Input fuse [1] and unearthed and non operator-accessible case [2]	SELV circuit

[1] A suitable fuse is standard built-in.
[2] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum input voltage of the switching regulator (contrary to case marking: "This apparatus must be earthed.")
[3] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

Table 3: H15 connector pin allocation

Electrical Determination	Type H15	
	Pin No.	Ident.
Output voltage (positive)	4	Vo+
Output voltage (positive)	6	Vo+
Output voltage (negative)	8	Go–
Output voltage (negative)	10	Go–
Crowbar trigger input (option C)	12	C
Inhibit input	14	i
R-input (output voltage programming) [1]	16	R
Sense line (negative)	18	S–
Sense line (positive)	20	S+
Current sharing control input	22	CS
Protective ground (protruding pin)	24	⏚
Input voltage (negative)	26	Gi–
Input voltage (negative)	28	Gi–
Input voltage (positive)	30	Vi+
Input voltage (positive)	32	Vi+

[1] Not available with option P

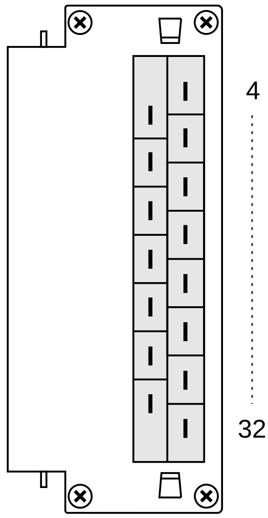


Fig. 2
View of male connector H15

5.1

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) $5\ g_n = 49\ m/s^2$ (60...2000 Hz) 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

Table 5: Temperature specifications

Temperature			Standard -7		Option -9		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature	not operational	–40	100	–55	100	

Table 6: MTBF values and device hours

MTBF	Ground Benign	Ground Fixed		Ground Mobile	Device Hours [1]
MTBF according to MIL-HDBK-217F	T_C = 40 °C	T_C = 40 °C	T_C = 70 °C	T_C = 50°C	
	335'000 h	138'000 h	35'000 h	33'000 h	2'100'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Impulse voltage	IEC 255-4 App. E4 [5] (1976)	III	i/o, i/c, o/c +i/–i	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/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	[1]
			+i/–i	1000 V_p					
Voltage surge	IEC 571-1 (1990-07)		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	[2]
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
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]
Electric field	IEC 801-3 (1984)	3	antenna in 1m distance	10 V/m	sine wave modulated w. 1 kHz		26…1000 MHz	yes	[1]
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] [3]
Transient	IEC 801-5 (Draft 1993-01)	III	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	[1]
			+i/–i	1000 V_p		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	3	i, o, signal wires	10 V_{rms} [6]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	[1]

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] With option C: manual reset
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

Standard Features

Note:
Additional information on input circuitry, grounding and parallel operation of units is given in section “Application Note”

Inhibit (i)

If the inhibit pin is not connected, the power supply is enabled (U_o = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

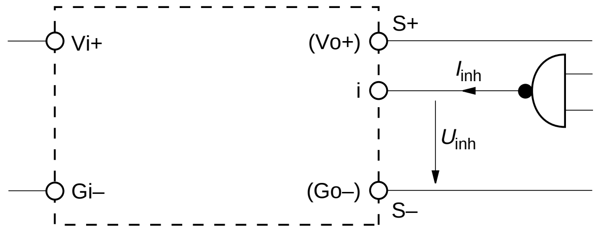


Fig. 3
Definition of inhibit voltage and current

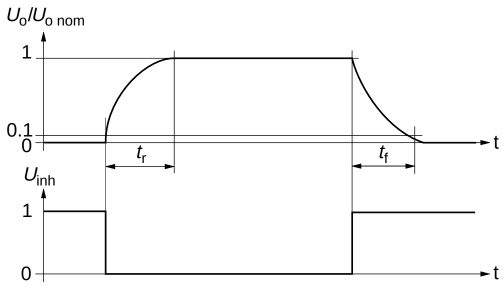


Fig. 4
Output response as a function of inhibit signal

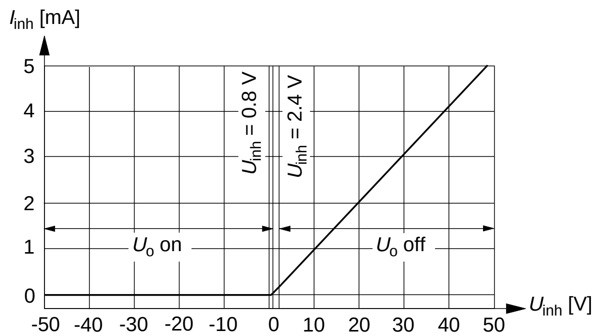


Fig. 5
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 8: Inhibit characteristics

Characteristics			Conditions	PSS 129			PSS 249			PSS 369			PSS 489			Unit
				min	typ	max	min	typ	max	min	typ	max	min	typ	max	
U_{inh}	Inhibit input voltage to keep output voltage...	U_o = on	$U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$	-50		+0.8	-50		+0.8	-50		+0.8	-50		+0.8	V DC
		U_o = off		+2.4		+50	+2.4		+50	+2.4		+50	+2.4		+50	
t_r	Switch-on time after inhibit command		$U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,nom}$ (resistive load)		100			100			100			100		ms
t_f	Switch-off time after inhibit command				15			20			15			40		
$I_{i\,off}$	Input current with converter inhibited		$I_o = 0$ $U_{i\,nom}$		25			25			25			25		mA

Input Filter and Fuse

An input filter and a fuse are incorporated in all PSS modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\text{ Hz, or } V_{pp} = 1000\ \text{Hz}/f_i \bullet 1\ V$$

Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage U_o internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

Current Sharing (CS)

Note: Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Sense Lines (S)

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSS connector) should not exceed the following values:

Output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
12 , 24, 36, 48 V	< 1.0 V	< 0.25 V

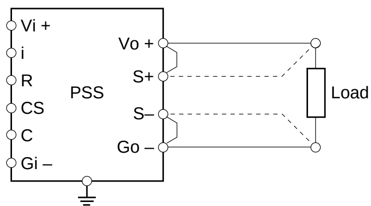


Fig. 6
Sense lines connection

External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage U_o can either be adjusted with an external resistor R_1 or R_2, or with an external voltage U_{ex} referenced to S–. The adjustment range is 0...$U_{o\,max}$ (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor (R_1 resp. R_2). Option P is not recommended for parallel operation mode.

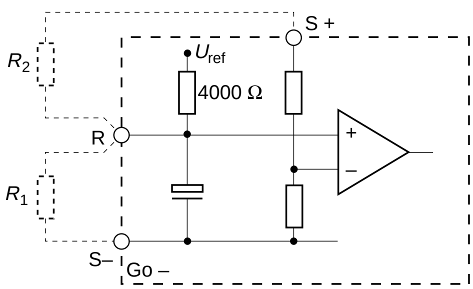


Fig. 7
Voltage adjustment with external resistor R_1 or R_2

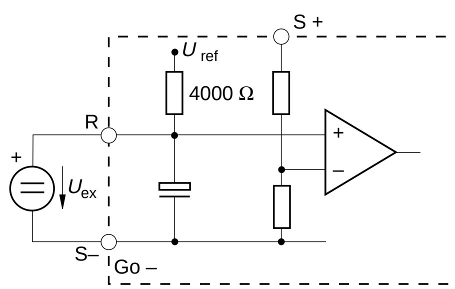


Fig. 8
Voltage adjustment with external voltage U_{ex} [V]

a) $U_o = 0...U_{o\,nom}$, using R_1 [Ω] between R and S–:

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

b) $U_o = U_{o\,nom}...U_{o\,max}$, using R_2 [Ω] between R and S+

$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \bullet \frac{R_2}{k \bullet (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \bullet \frac{U_o \bullet (1\text{-}k)}{k \bullet U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o = 0...U_{o\,max}$, using U_{ex} [V] between R and S–:

$$U_o = U_{o\,nom} \bullet \left[\frac{U_{ex}}{U_{ref}} \bullet 0.98 + 0.02\right]$$

$(U_{ref} = 2.48\ V \pm 1\%)$

All formulae give approximate values only.

Caution: To prevent damage U_{ex} should not exceed 20 V nor be negative!

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

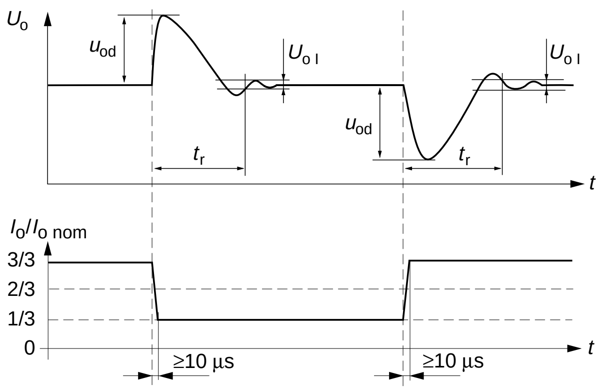


Fig. 9
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 71°C and is operated at its nominal output power, the case temperature T_C will be about 95°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 71°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C (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

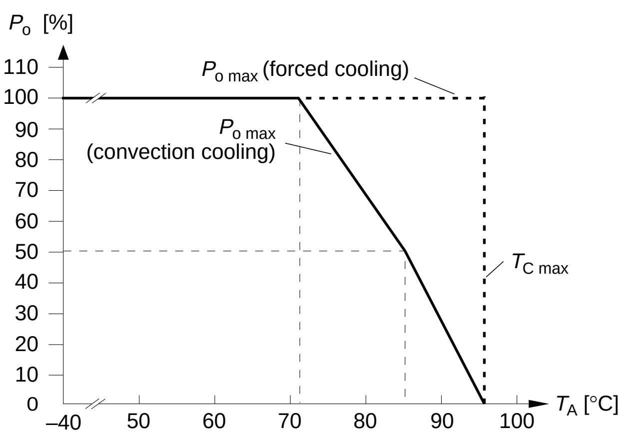


Fig. 10
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

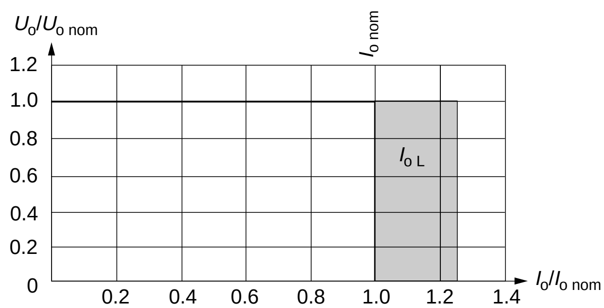


Fig. 11
Overload, short-circuit behaviour U_o versus I_o

5.1

Electrical Input and Output Data

General Conditions
- T_A = 25°C, unless T_C is specified
- With R or option P, output voltage U_o = $U_{o\ nom}$ at $I_{o\ nom}$

Table 9: Input and output data

Characteristics		Conditions	PSS 129			PSS 249			PSS 369			PSS 489			Unit
Output			min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\ nom}$, $I_{o\ nom}$	11.92		12.07	23.85		24.14	35.78		36.22	47.71		48.29	V
$U_{o\ max}$	Maximum adjustable output voltage utilizing R input	$U_{i\ nom}$, $I_{o\ nom}$ sense lines linked at the connector			16.0			26.0			42.5			52.8	
$I_{o\ nom}$	Output current	$U_{i\ min}$...$U_{i\ max}$ $T_{C\ min}$...$T_{C\ max}$		9			9			9			9		A
$I_{o\ L}$	Output current limitation response (% of $I_{o\ nom}$)		100		125	100		125	100		125	100		125	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\ nom}$, $I_{o\ nom}$		40	80		50	110		60	110		60	100	mV_{pp}
$\Delta U_{o\ U}$	Static control deviation versus input voltage U_i	$U_{i\ min}$...$U_{i\ max}$ $I_{o\ nom}$		40	70		80	170		120	250		100	200	mV
$\Delta U_{o\ I}$	Static control deviation versus output current I_o	$U_{i\ nom}$ I_o = 0...$I_{o\ nom}$		30	50		50	120		60	120		40	120	
$u_{o\ d}$	Dynamic control deviation [1]	$U_{i\ nom}$ $I_o \leftrightarrow {}^1/_3\ I_{o\ nom}$		140			180			200			200		
t_r	Dynamic load transient time recovery [1]			60			60			70			70		µs
α_{Uo}	Temperature coefficient $\Delta U_o / \Delta T_C$	$U_{i\ min}$...$U_{i\ max}$ $T_{C\ min}$...$T_{C\ max}$ I_o = 0...$I_{o\ nom}$		±3			±5			±8			±10		mV/K
				±0.02			±0.02			±0.02			±0.02		%/K
Input															
U_i	Input voltage range [2]	$T_{C\ min}$...$T_{C\ max}$ I_o = 0...$I_{o\ nom}$	18		144	31		144	44		144	58		144	V DC
$\Delta U_{io\ min}$	Minimum differential voltage U_i - U_o			6			7			8			10		
U_{io}	Undervoltage cut-out			12			24			36			48		
$I_{i\ o}$	No load input current	I_o = 0 $U_{i\ nom}$		36			36			36			36		mA
I_{im}	Peak value of inrush current	$U_{i\ nom}$ with option E [3]			5			5			7			7	A
u_{rfi}	RFI level at input, 0.01...30 MHz	VDE0871, part 11 EN 55011/55022 $U_{i\ nom}$, $I_{o\ nom}$			B			B			B			B	dB (µV)
Efficiency															
η	Efficiency with option E	$U_{i\ nom}$, $I_{o\ nom}$		90			94			94			96		%
Isolation															
$U_{i\ s}$	Isolation test voltage electronic to case	All input and output terminals interconnected		1500			1500			1500			1500		V DC

[1] See "Dynamic Characteristics"
[2] Surges up to 156 V for 2 s
[3] See also option E

Description of Options

Option -9 Extended Temperature Range

This option defines an extended operational ambient temperature range of T_A = –40...71 °C.

Option E Inrush Current Limitation

Note: This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of U_i/15 Ω and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

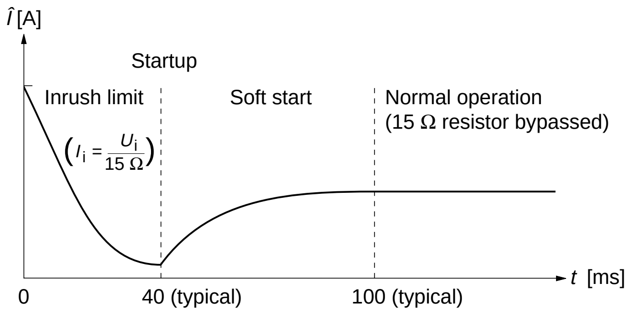


Fig. 12
Option E: Inrush current versus time

Option P Potentiometer

Note: Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\ nom}$.

The minimum differential voltage, $\Delta U_{io\ min}$ between input and output voltages should be maintained.

Option C Thyristor Crowbar

Note: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\ C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage U_o and when the trigger voltage $U_{o\ C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\ max}$ (between Vo+ and Go–) is not exceeded.

Table 10: Crowbar trigger levels

Characteristics		Condition	PSS 129			PSS 249			PSS 369			PSS 489			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$U_{o\ C}$	Crowbar trigger voltage	$T_{C\ min}...T_{C\ max}$ $U_{i\ min}...U_{i\ max}$ $I_o = 0...I_{o\ nom}$		17.8 14.3	18.9 15.2 [1]		28.89	30.6		47.0 43.0	50.0 45.5 [1]		58.0	60.0	V DC
t_s	Delay time			1.5			1.5			1.5			1.5		µs

[1] Crowbar Trigger voltage with option P

5.1

Option B, Option B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\ max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \bullet (U_o \bullet I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110°C approximately. The output is automatically enabled again after temperature has droped below $T_{C\ max}$.

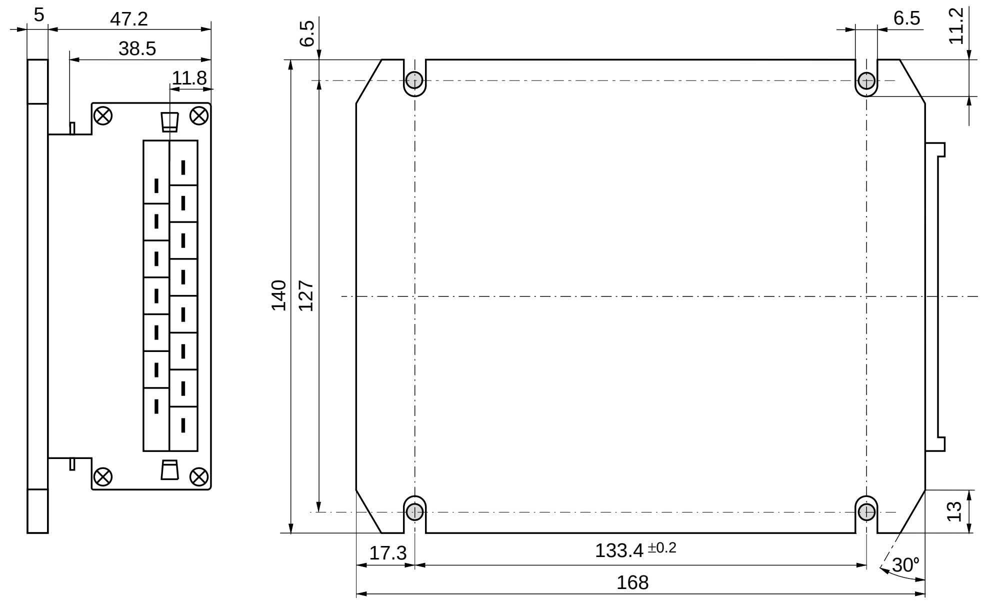


Fig. 13
Case S01 with option B (cooling plate)
Weight: 1.2 kg

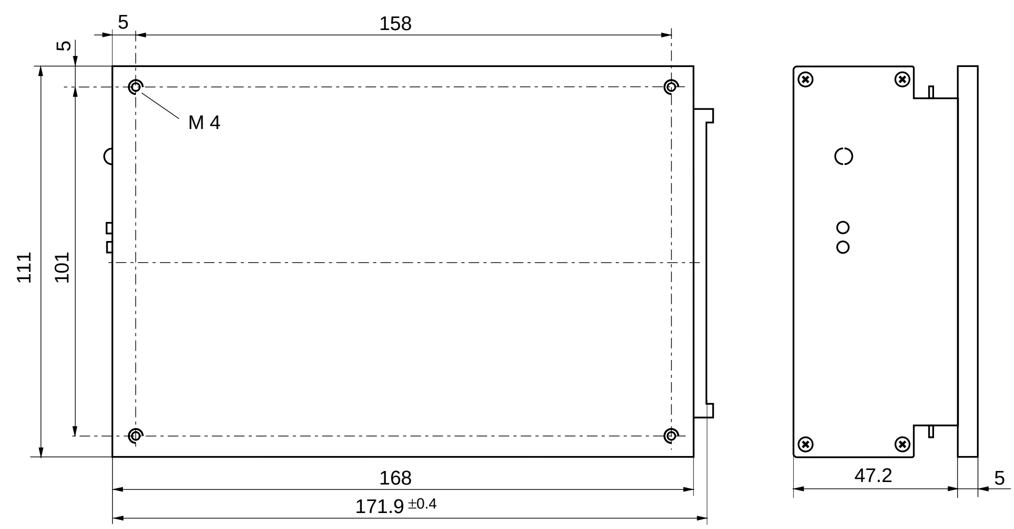


Fig. 14
Case S01 with option B1 (cooling plate)
Weight: 1.2 kg

Option U Ambient Temp. Range acc. UL Recognition

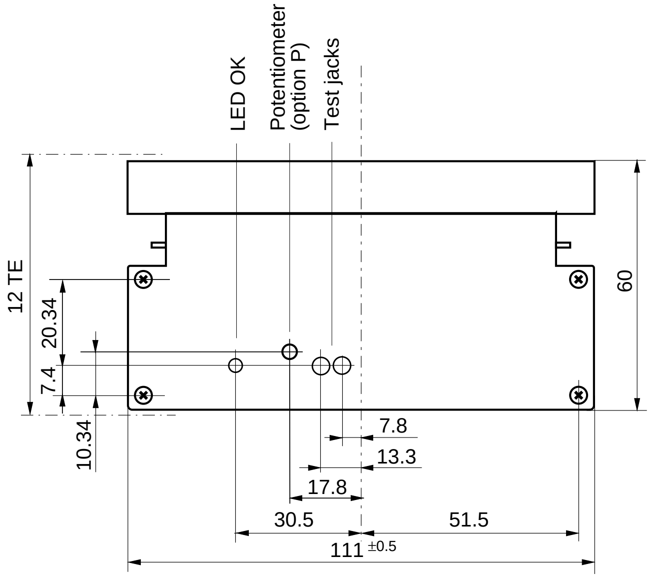
Underwriters Laboratories (UL) have approved the PSS family as recognized components up to an ambient temperature of $T_{A\ max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\ max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\ max}$ = 71°C without any further precautions.

Mechanical Data

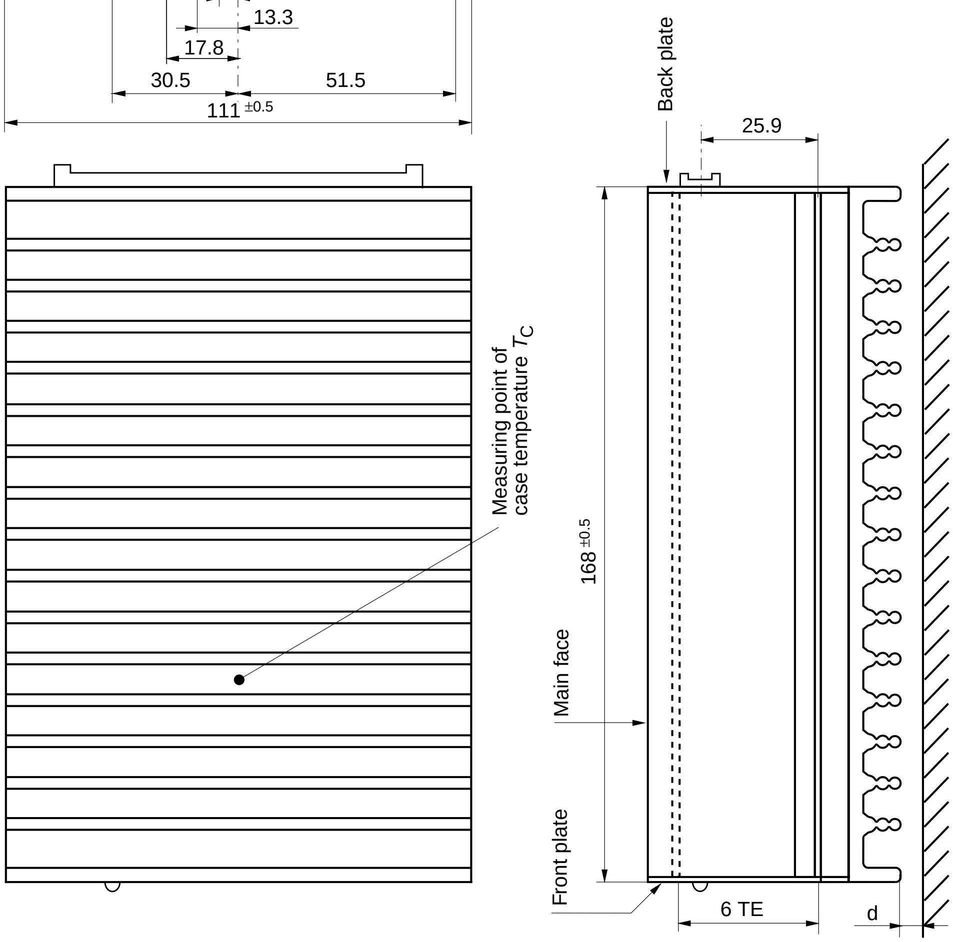
Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.

European Projection



Note:

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted in vertical position to achieve a maximum air flow through heat sink



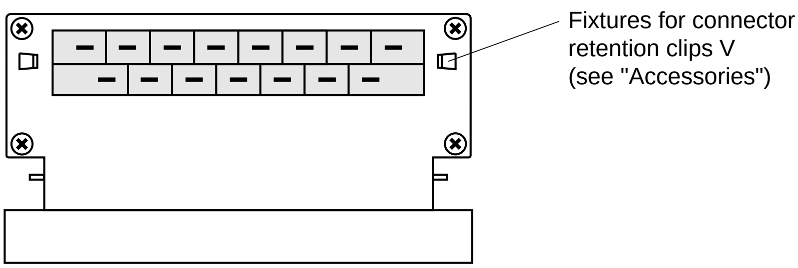


Fig. 15
Case S01 with heatsink
Weight: 1.3 kg

Type Key and Product Marking

Type Key

PSS 12 9 -7 E P C B1

Positive switching regulator in case S01	PSS
Blank	
Nominal output voltage in volt	12...48
Nominal output current in ampere	9
Ambient temperature range	
T_A = –25...71 °C	-7
T_A = –40...71 °C	-9
Inrush current limitation	E
Potentiometer	P
Thyristor-Crowbar	C
Cooling plate	B, B1

Example:PSS 129-7EPCB = A positive switching regulator with a 12 V, 9 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, crowbar, and cooling plate B.

Product Marking

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

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

Positive Switching Regulators — PSK-Family

No input to output isolation
Single output of 12, 15, 24, 36 or 48 V DC/144...576 W
Input voltage up to 144 V DC

- Extremely wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no-load and short-circuit proof
- Output current sharing
- No derating

Safety according to IEC 950

5.1

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i [2]	Nominal input voltage $U_{i\,nom}$	Efficiency η [3]	Type designation	Options
12 V [1]	12 A	18...144 V	60 V	90%	PSK 1212-7	-9, E, P, C, B, B1
24 V		31...144 V		94%	PSK 2412-7	
36 V		44...144 V	80 V		PSK 3612-7	
48 V		58...144 V		96%	PSK 4812-7	

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Surges up to 156 V for maximum 2 s
[3] Including option E, T_A = 25 °C

Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. The maximum input voltage is as high as 144 V DC (120 V +20%) with surges up to 156 V for 2 sec. This allows operation in the majority of battery driven mobile applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case K01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

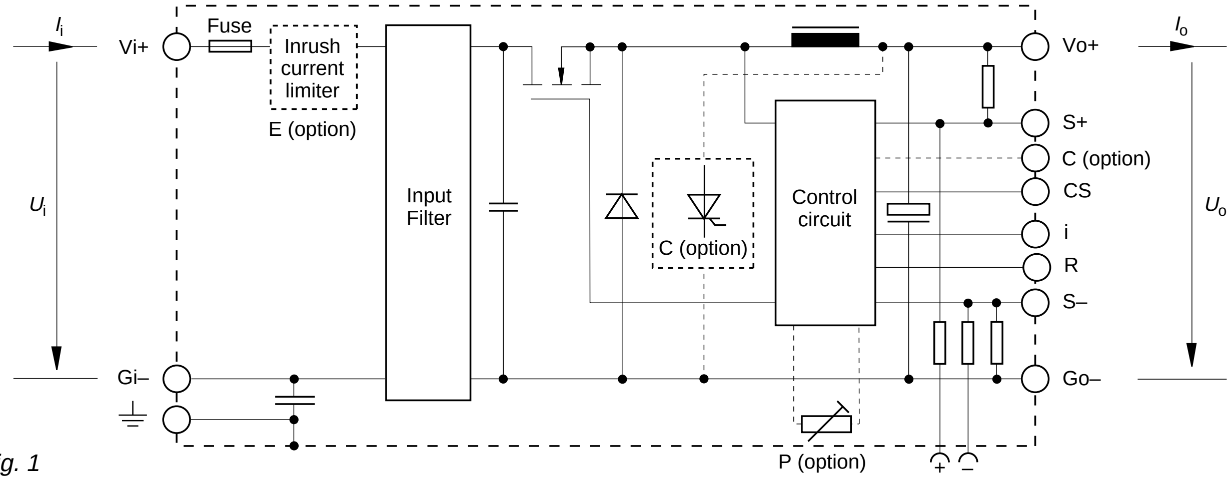


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V, or up to 48 V if option C is fitted.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
		≤144 V	Hazardous voltage battery circuit [2]	Input fuse [1] and unearthed, non operator-accessible case [2]	SELV circuit
			Hazardous voltage battery circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [3]	SELV circuit
			ELV circuit	Input fuse [1] and earthed output circuit [3]	Earthed SELV circuit
		≤144 V	Hazardous voltage secondary circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤144 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [2]	Input fuse [1] and unearthed and non operator-accessible case [2]	SELV circuit

[1] A suitable fuse is standard built-in.
[2] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum input voltage of the switching regulator (contrary to case marking: "This apparatus must be earthed.")
[3] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/ CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

Table 3: H15 connector pin allocation

Electrical Determination	Type H15	
	Pin No.	Ident.
Output voltage (positive)	4	Vo+
Output voltage (positive)	6	Vo+
Output voltage (negative)	8	Go–
Output voltage (negative)	10	Go–
Crowbar trigger input (option C)	12	C
Inhibit input	14	i
R-input (output voltage programming) [1]	16	R
Sense line (negative)	18	S–
Sense line (positive)	20	S+
Current sharing control input	22	CS
Protective ground (protruding pin)	24	⏚
Input voltage (negative)	26	Gi–
Input voltage (negative)	28	Gi–
Input voltage (positive)	30	Vi+
Input voltage (positive)	32	Vi+

[1] Not available with option P

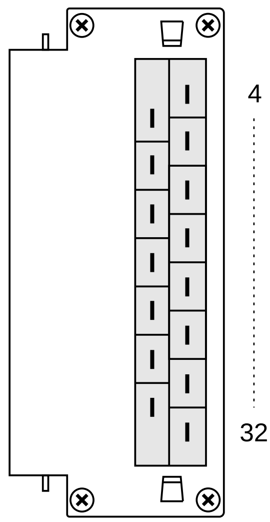


Fig. 2
View of male connector H15

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) 5 g_n = 49 m/s^2 (60...2000 Hz) 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

Table 5: Temperature specifications

Temperature			Standard -7		Option -9		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature	Not operational	–40	100	–55	100	

Table 6: MTBF values and device hours

MTBF	Ground Benign	Ground Fixed		Ground Mobile	Device Hours [1]
MTBF according to MIL-HDBK-217F	T_C = 40 °C	T_C = 40 °C	T_C = 70 °C	T_C = 50°C	
	335'000 h	138'000 h	35'000 h	33'000 h	2'100'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Impulse voltage	IEC 255-4 App. E4 [5] (1976)	III	i/o, i/c, o/c +i/–i	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/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	1
			+i/–i	1000 V_p					
Voltage surge	IEC 571-1 (1990-07)		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	2
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
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
Electric field	IEC 801-3 (1984)	3	antenna in 1m distance	10 V/m	sine wave mod-ulated w. 1 kHz		26…1000 MHz	yes	1
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 3
Transient	IEC 801-5 (Draft 1993-01)	III	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	1
			+i/–i	1000 V_p		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	3	i, o, signal wires	10 V_{rms} [6]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	1

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] With option C: manual reset
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

Standard Features

Note:
Additional information on input circuitry, grounding and parallel operation of units is given in section “Application Note”

Inhibit (i)

If the inhibit pin is not connected, the power supply is enabled (U_o = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

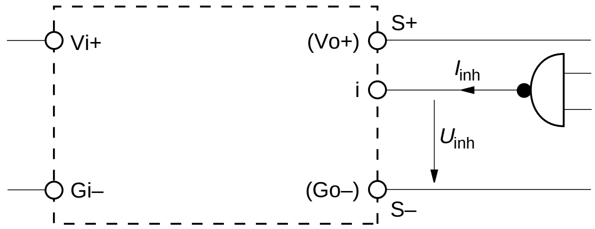


Fig. 3
Definition of inhibit voltage and current

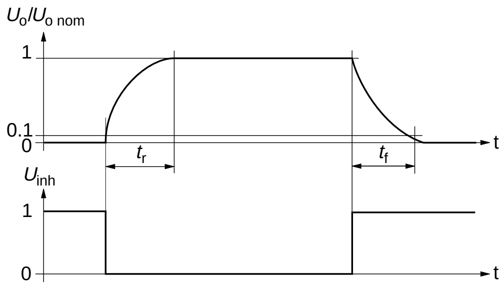


Fig. 4
Output response as a function of inhibit signal

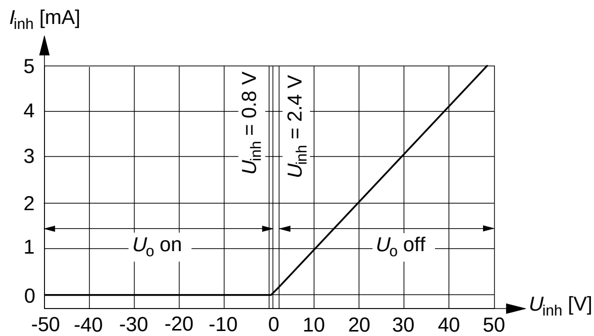


Fig. 5
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 8: Inhibit characteristics

Characteristics			Conditions	PSK 1212			PSK 2412			PSK 3612			PSK 4812			Unit
				min	typ	max	min	typ	max	min	typ	max	min	typ	max	
U_{inh}	Inhibit input voltage to keep output voltage...	U_o = on	$U_{i\ min}...U_{i\ max}$ $T_{C\ min}...T_{C\ max}$	-50		+0.8	-50		+0.8	-50		+0.8	-50		+0.8	V DC
		U_o = off		+2.4		+50	+2.4		+50	+2.4		+50	+2.4		+50	
t_r	Switch-on time after inhibit command		$U_{i\ nom}$ $R_L = U_{o\ nom}/I_{o\ nom}$ (resistive load)		100			100			100			100		ms
t_f	Switch-off time after inhibit command				15			20			15			40		
$I_{i\ off}$	Input current with converter inhibited		$I_o = 0$ $U_{i\ nom}$		25			25			25			25		mA

5.1

Input Filter and Fuse

An input filter and a fuse are incorporated in all PSK modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\ Hz, \text{ or } V_{pp} = 1000\ Hz/f_i \cdot 1\ V$$

Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage U_o internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

Current Sharing (CS)

Note: Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Sense Lines (S)

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSK connector) should not exceed the following values:

Output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
12 , 24, 36, 48 V	< 1.0 V	< 0.25 V

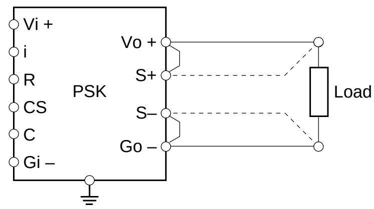


Fig. 6
Sense lines connection

External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage U_o can either be adjusted with an external resistor R_1 or R_2, or with an external voltage U_{ex} referenced to S–. The adjustment range is 0...$U_{o\,max}$ (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor (R_1 resp. R_2). Option P is not recommended for parallel operation mode.

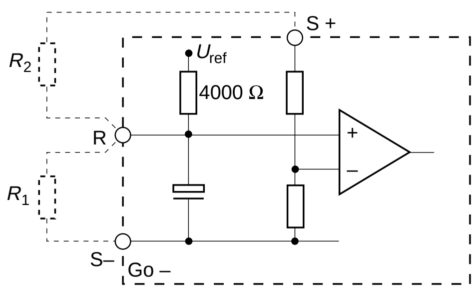


Fig. 7
Voltage adjustment with external resistor R_1 or R_2

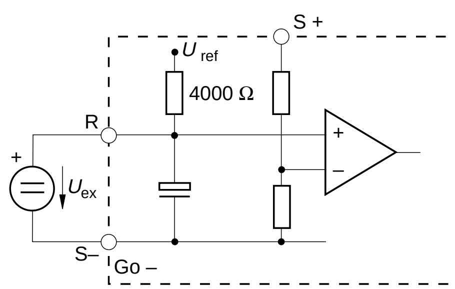


Fig. 8
Voltage adjustment with external voltage U_{ex} [V]

a) $U_o = 0...U_{o\,nom}$, using R_1 [Ω] between R and S–:

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

b) $U_o = U_{o\,nom}...U_{o\,max}$, using R_2 [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1\text{-}k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o = 0...U_{o\,max}$, using U_{ex} [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \left[\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02\right]$$

$(U_{ref} = 2.48\ V \pm 1\%)$

All formulae give approximate values only.

Caution: To prevent damage U_{ex} should not exceed 20 V nor be negative!

Electrical Input and Output Data

General Conditions

- T_A = 25°C, unless T_C is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

Table 9: Input and output data

Characteristics		Conditions	PSK 1212			PSK 2412			PSK 3612			PSK 4812			Unit
Output			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	11.92		12.07	23.85		24.14	35.78		36.22	47.71		48.29	V
$U_{o\,max}$	Maximum adjustable output voltage utilizing R input	$U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector			16.0			26.0			42.5			52.8	
$I_{o\,nom}$	Output current	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$		12			12			12			12		A
$I_{o\,L}$	Output current limitation response (% of $I_{o\,nom}$)		100		125	100		125	100		125	100		125	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\,nom}$, $I_{o\,nom}$		40	80		50	110		60	110		60	100	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$		40	70		80	170		120	250		100	200	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0...I_{o\,nom}$		30	50		50	120		60	120		40	120	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_o \leftrightarrow {}^1/_3\, I_{o\,nom}$		140			180			200			200		
t_r	Dynamic load transient time recovery [1]			60			60			70			70		µs
α_{Uo}	Temperature coefficient $\Delta U_o / \Delta T_C$	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$		±3			±5			±8			±10		mV/K
				±0.02			±0.02			±0.02			±0.02		%/K
Input															
U_i	Input voltage range [2]	$T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$	18		144	31		144	44		144	58		144	V DC
$\Delta U_{io\,min}$	Minimum differential voltage U_i - U_o			6			7			8			10		
U_{io}	Undervoltage cut-out			12			24			36			48		
$I_{i\,o}$	No load input current	$I_o = 0$ $U_{i\,nom}$		36			36			36			36		mA
I_{im}	Peak value of inrush current	$U_{i\,nom}$ with option E [3]			5			5			7			7	A
u_{rfi}	RFI level at input, 0.01...30 MHz	VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$			B			B			B			B	dB (µV)
Efficiency															
η	Efficiency with option E	$U_{i\,nom}$, $I_{o\,nom}$		90			94			94			96		%
Isolation															
$U_{i\,s}$	Isolation test voltage electronic to case	All input and output terminals interconnected		1500			1500			1500			1500		V DC

[1] See "Dynamic Characteristics"
[2] Surges up to 156 V for 2 s
[3] See also option E

5.1

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

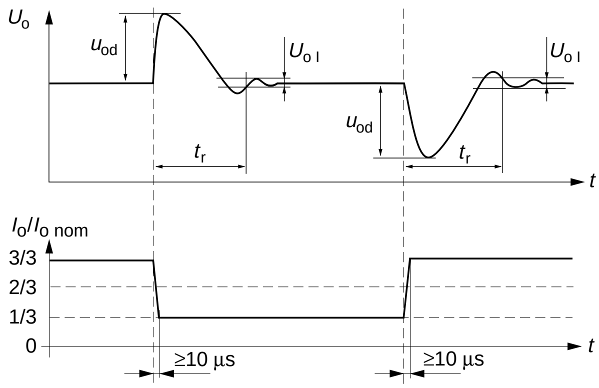


Fig. 9
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 71°C and is operated at its nominal output power, the case temperature T_C will be about 95°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 71°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C (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

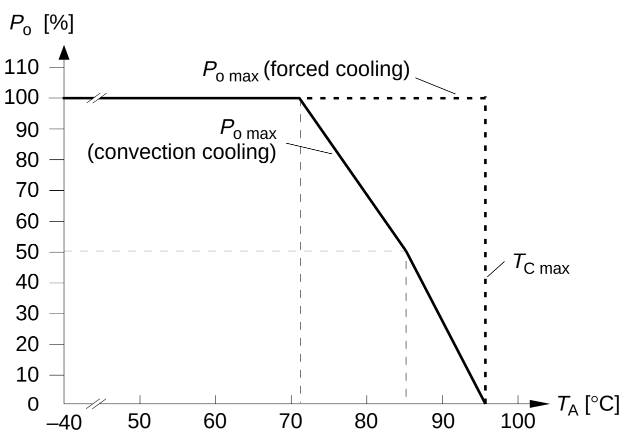


Fig. 10
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

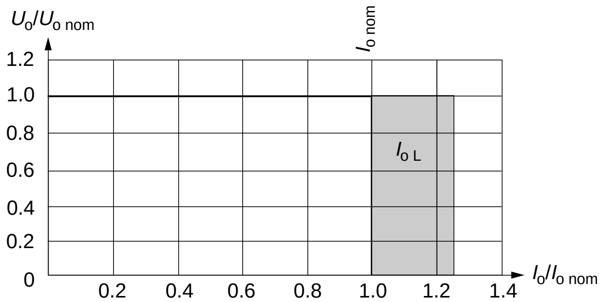


Fig. 11
Overload, short-circuit behaviour U_o versus I_o

Description of Options

Option -9 Extended Temperature Range

This option defines an extended operational ambient temperature range of $T_A = –40...71\,°C$.

Option E Inrush Current Limitation

Note: This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of $U_i/15\,\Omega$ and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

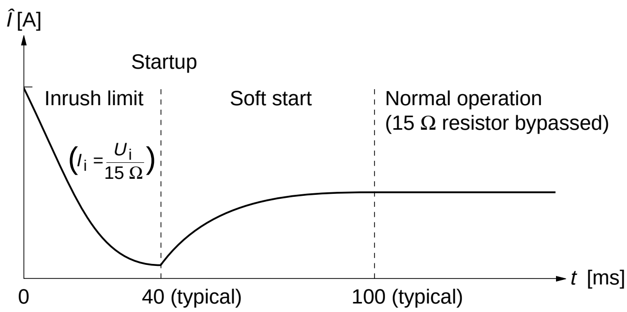


Fig. 12
Option E: Inrush current versus time

Option P Potentiometer

Note: Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\,nom}$.

The minimum differential voltage, $\Delta U_{io\,min}$ between input and output voltages should be maintained.

Option C Thyristor Crowbar

Note: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage U_o and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Table 10: Crowbar trigger levels

Characteristics		Condition	PSK 1212			PSK 2412			PSK 3612			PSK 4812			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$U_{o\,C}$	Crowbar trigger voltage	$T_{C\,min}...T_{C\,max}$ $U_{i\,min}...U_{i\,max}$		17.8 14.3	18.9 15.2 [1]		28.89	30.6		47.0 43.0	50.0 45.5 [1]		58.0	60.0	V DC
t_s	Delay time	$I_o = 0...I_{o\,nom}$		1.5			1.5			1.5			1.5		µs

[1] Crowbar Trigger voltage with option P

Option B, Option B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\ max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110°C approximately. The output is automatically enabled again after temperature has droped below $T_{C\ max}$.

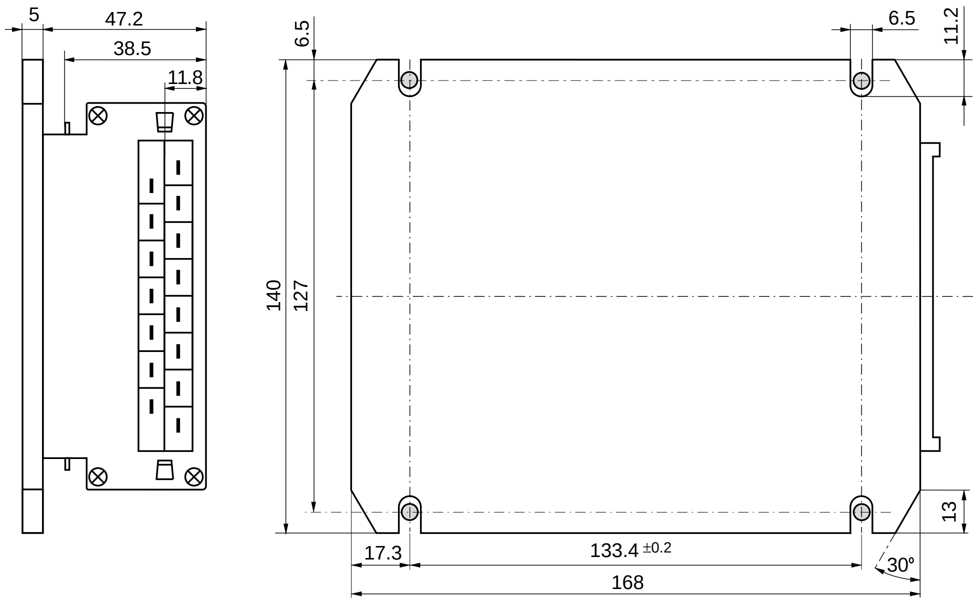


Fig. 13
Case K01 with option B (cooling plate)
Weight: 1.2 kg

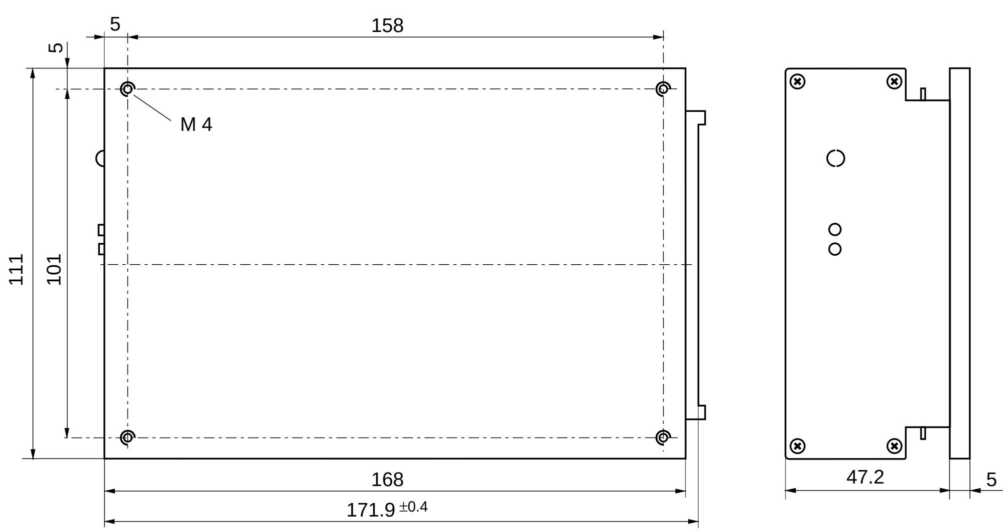


Fig. 14
Case K01 with option B1 (cooling plate)
Weight: 1.2 kg

Option U Ambient Temp. Range acc. UL Recognition

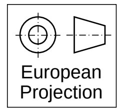
Underwriters Laboratories (UL) have approved the PSK family as recognized components up to an ambient temperature of $T_{A\ max}$ – 10 K given by the upper temperature limit of the standard PCB material. If the full maximum ambient temperature $T_{A\ max}$ is required with UL approval, option U should be requested. It consists of an alternative PCB material with a higher maximum temperature specification.

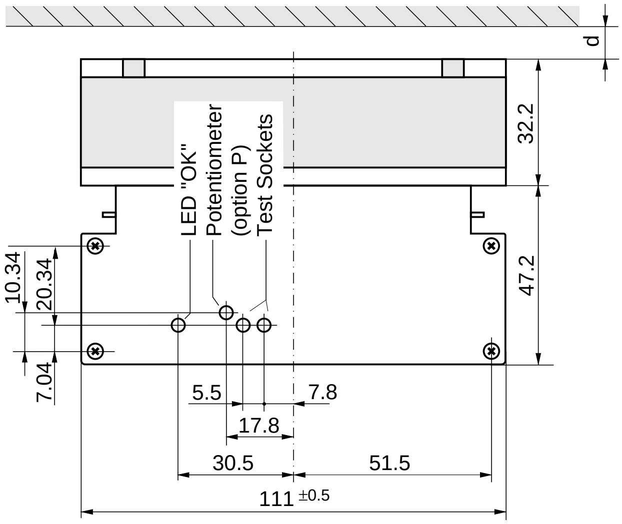
The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\ max}$ = 71°C without any further precautions.

MELCHER The Power Partners.

Mechanical Data

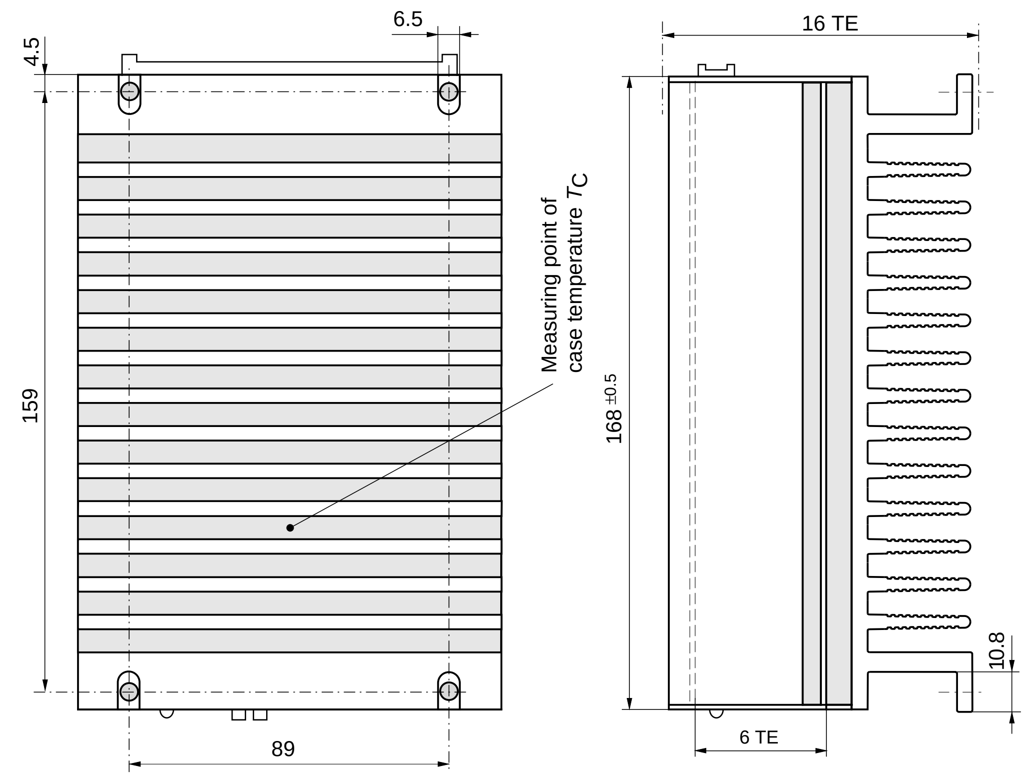
Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.





Note:

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink



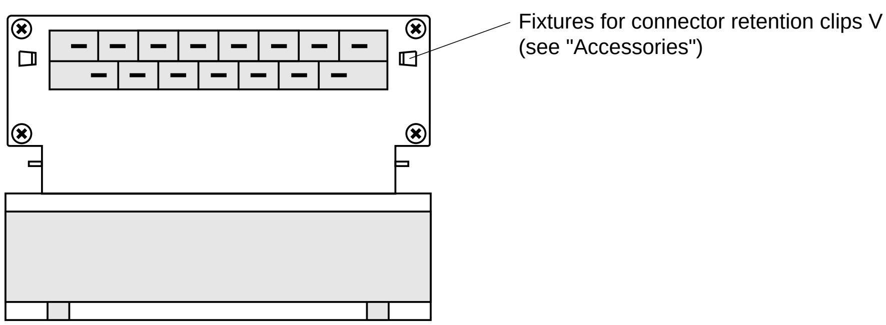


Fig. 15
Case K01 with heatsink
Weight: 1.6 kg

Type Key and Product Marking

Type Key

PSK 12 12 -7 E P C B1

Positive switching regulator in case K01 .... PSK
Blank ....
Nominal output voltage in volt .... 12...48
Nominal output current in ampere 12
Ambient temperature range
T_A = –25...71 °C .... -7
T_A = –40...71 °C .... -9
Inrush current limitation .... E
Potentiometer .... P
Thyristor-Crowbar C
Cooling plate .... B, B1

Example: PSK 1212-7EPCB = A positive switching regulator with a 12 V, 12 A output, ambient temperature range of –25...71 °C, inrush current limitation, potentiometer, crowbar, and cooling plate B.

Product Marking

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

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

PSR: Positive Switching Regulators PSL-Family

No input to output isolation
Single output of 5.1, 12, 15, 24 or 36 V DC/51...288 W
Input voltage up to 80 V DC

- High efficiency up to 94%
- Wide input voltage range
- Low input-to-output differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- External output voltage adjustment and inhibit
- Continuous no-load and short-circuit proof
- No derating

Safety according to IEC 950

5.2

Table of Contents

Page

Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i [1]	Nominal input voltage $U_{i\,nom}$	Efficiency η	Type designation	Options	Superseded old type (phase-out)
5.1 V	12 A	7...40 V	20 V	83%	PSL 5A12-7R	-9, L, i, P, C, D, A	PSR 512E-7
5.1 V	10 A	8...80 V	40 V	76%	PSL 5A10-7R		PSR 510E-7
12 V	8 A	15...80 V		89%	PSL 128-7R		PSR 128E-7
15 V		19...80 V		90%	PSL 158-7R		PSR 158E-7
24 V		29...80 V	50 V	92%	PSL 248-7R		PSR 248E-7
36 V		42...80 V	60 V	94%	PSL 368-7R		PSR 368E-7

[1] See data $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$)

Description

The PSL family of positive swiching regulators is designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 80 V are specially designed for secondary switched and battery driven applications.
Case L04: Aluminium, black finish and self cooling.

External input circuitry

An external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input (without option L) is greater than approx. 5 m. For long connection lines the use of option L is recommended in order to reduce superimposed interference voltages or currents and to prevent oscillation.

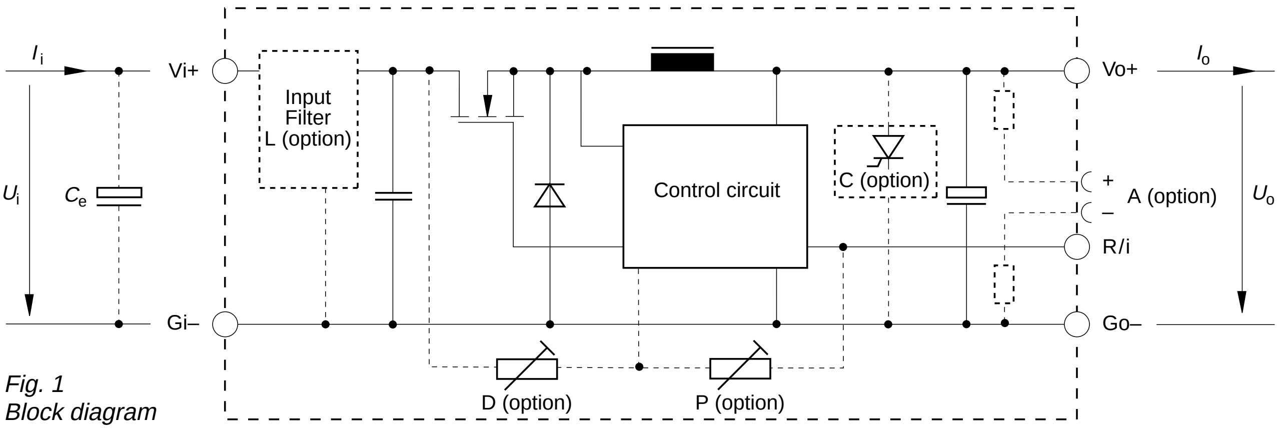


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
		≤80 V	Hazardous voltage battery circuit [2]	Input fuse [1] and unearthed, non operator-accessible case [2]	SELV circuit
			Hazardous voltage battery circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [3]	SELV circuit
			ELV circuit	Input fuse [1] and earthed output circuit [3]	Earthed SELV circuit
		≤80 V	Hazardous voltage secondary circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤80 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [2]	Input fuse [1] and unearthed and non operator-accessible case [2]	SELV circuit

[1] The installer shall provide an approved fuse (slow blow type with lowest rating suitable for the application, max. 12.5 A) in the positive or negative input conductor directly at the input of the switching regulator. For UL's purpose, the fuse needs to be UL-listed. If option C is fitted, a suitable fuse is built-in.

[2] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum input voltage of the switching regulator (contrary to the case marking: "This apparatus must be earthed.").

[3] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

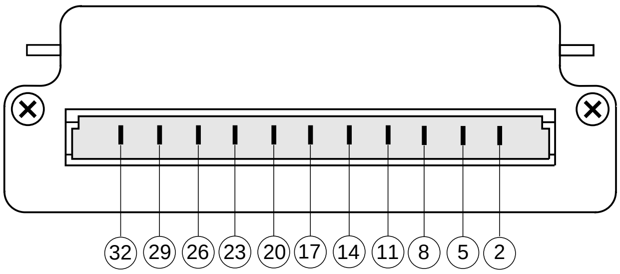


Fig. 2
View of male H11 connector

Protection Degree

The protection degree is defined by IP 30 (equipped with any potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

Table 3: H11 connector pin allocation and designation

Electrical Determination	Type H11 Pin No.	Type H11 Design.
R-input (or inhibit input) [1]	2	R (i)
Undervoltage monitor (Option D)	5	D
Output voltage (negative)	8	Go–
Output voltage (negative)	11	Go–
Output voltage(positive)	14	Vo+
Output voltage (positive)	17	Vo+
Input voltage (negative)	20	Gi–
Input voltage (negative)	23	Gi–
Input voltage (positive)	26	Vi+
Input voltage (positive)	29	Vi+
Protective ground (protruding pin)	32	⏚

[1] R-input (output voltage programming) not available with option P (potentiometer) or option i (inhibit)

5.2

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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/s² 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/s² 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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) 5 g_n = 49 m/s² (60...2000 Hz) 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

Table 5: Temperature specifications

Temperature			Standard -7		Option -9		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature	Not operational	–40	100	–55	100	

Table 6: MTBF and device hours

MTBF	Ground Fixed		Ground Mobile		Device Hours [1]
MTBF acc. to MIL-HDBK-217D	T_C = 40°C	T_C = 70°C	T_C = 40°C	T_C = 70°C	
	130'000 h	58'000 h	36'000 h	17'000 h	3'900'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Impulse voltage	IEC 255-4 App. E4 [5] (1976)	III	i/o, i/c, o/c +i/–i	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/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	1
			+i/–i	1000 V_p					
Voltage surge	IEC 571-1 (1990-07)		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	2
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
Electrostatic discharge	IEC 801-2 (1991-04)	3	contact discharge to case	6000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	1 6
Electric field	IEC 801-3 (1984)	2	antenna in 1m distance	3 V/m	sine wave modulated w. 1 kHz		26…1000 MHz	yes	1
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 3 6
		4		4000 V_p					2 3 6
Transient	IEC 801-5 (Draft 1993-01)	III	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	2 6
			+i/–i	1000 V_p		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	3	i, o, signal wires	10 V_{rms} [7]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	1

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] With option C: manual reset
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Option L neccessary
[7] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

5.2

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

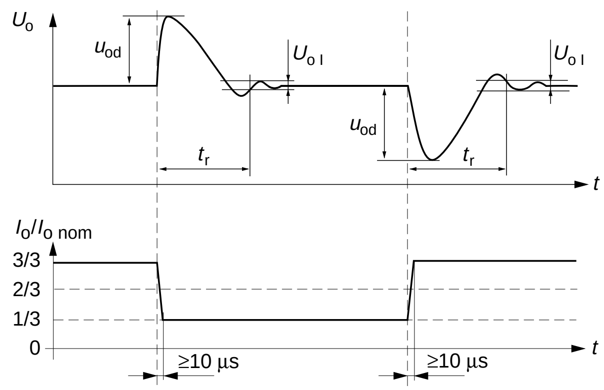


Fig. 3
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 71°C and is operated at its nominal output power, the case temperature T_C will be about 95°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 71°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C (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

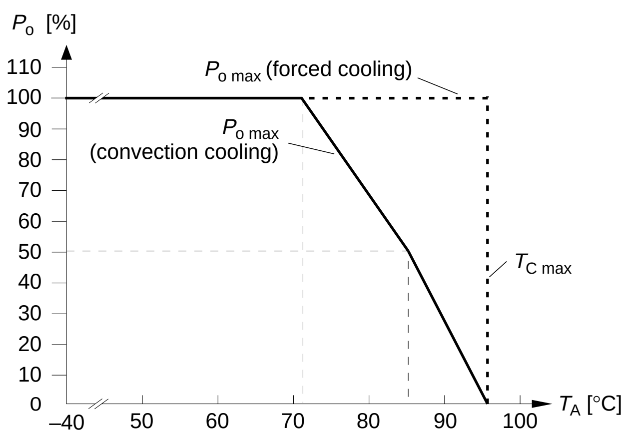


Fig. 4
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

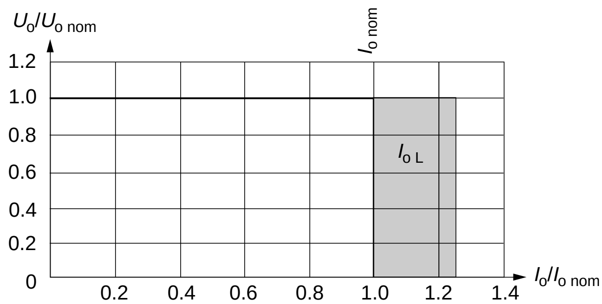


Fig. 5
Overload, short-circuit behaviour U_o versus I_o

5.2

Electrical Input and Output Data

General Conditions

- T_A = 25°C, unless T_C is specified.
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

Table 8a: Input and output data

Characteristics		Conditions	PSL 5A12			PSL 5A10			PSL 128			Unit
			min	typ	max	min	typ	max	min	typ	max	
Output												
$U_{o\,nom}$	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	5.07		5.13	5.07		5.13	11.92		12.07	V
$I_{o\,nom}$	Output current	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$		12.0			10.0			8.0		A
I_{oL}	Output current limitation response		12.0		15.6	10.0		13.0	8.0		10.4	
u_o	Ripple at output (BW = 20 MHz)	$U_{i\,nom}$ $I_{o\,nom}$		50			35	50		80	150	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$		45			30	45		50	75	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0...I_{o\,nom}$		25			20	25		28	35	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$		130			130			130		
t_r	Dynamic load transient time recovery [1]			40			50			60		µs
α_{uo}	Temperature coefficient $\Delta U_o/\Delta T_C$	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$			±1			±1			±2	mV/K
					±0.02			±0.02			±0.02	%/K
Input												
U_i	Input voltage	$I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$	7		40	8		80	15		80	V DC
$\Delta U_{io\,min}$	Minimum differential voltage $U_i - U_o$ [2]			2			3			3		V
$U_{i\,o}$	Undervoltage cut-out			6.3			7.3			7.3		
$I_{i\,0}$	No load input current	$I_o = 0$ $U_{i\,min}...U_{i\,max}$		45				40			35	mA
$I_{i\,m}$	Peak value of inrush current [3]	$U_{i\,nom}$		150			250			250		A
$t_{i\,s}$	Rise time [3]			5			5			5		µs
$t_{i\,r}$	Tail half value time [3]			40			40			40		
$I_{i\,m}$	Peak value of inrush current [3]	$U_{i\,nom}$ with option L		250			350			350		A
$t_{i\,s}$	Rise time [3]			25			25			25		µs
$t_{i\,r}$	Tail half value time [3]			125			125			125		
$u_{i\,rfi}$	RFI level at input, [4] 0.01...30 MHz	VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$			B			B			B	dB(µV)
Efficiency												
η	Efficiency	$U_{i\,nom}$, $I_{o\,nom}$		83			76			89		%
Isolation												
U_{is}	Isolation test voltage electronics to case	Inputs/outputs interconnected		750			750			750		V DC

[1] See "Dynamic characteristics"
[2] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly from 0 to 1 V at T_A = 46°C and 71°C (T_C = 70°C and 95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor C_e = 120 µF/100 V, e.g. Nichicon, PF(M) series, or equivalent

Table 8b: Input and output data

Characteristics		Conditions	PSL 158			PSL 248			PSL 368			Unit
			min	typ	max	min	typ	max	min	typ	max	
Output												
$U_{o\,nom}$	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	14.91		15.09	23.85		24.14	35.78		36.22	V
$I_{o\,nom}$	Output current	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$		8.0			8.0			8.0		A
I_{oL}	Output current limitation response		8.0		10.4	8.0		10.4	8.0		10.4	
u_o	Ripple at output (BW = 20 MHz)	$U_{i\,nom}$ $I_{o\,nom}$		80	150		100	250		150	300	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$		70	100		150	220		200	270	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0...I_{o\,nom}$		33	45		120	160		125	160	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$		130			150			220		
t_r	Dynamic load transient time recovery [1]			60			80			100		µs
α_{uo}	Temperature coefficient $\Delta U_o/\Delta T_C$	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$			±3			±5			±8	mV/K
					±0.02			±0.02			±0.02	%/K
Input												
U_i	Input voltage	$I_o = 0...I_{o\,nom}$ $T_{C\,min}...T_{C\,max}$	19		80	29		80	42		80	V DC
$\Delta U_{io\,min}$	Minimum differential voltage $U_i - U_o$ [2]			4			5			6		V
$U_{i\,o}$	Undervoltage cut-out			7.3			12			19		
$I_{i\,0}$	No load input current	$I_o = 0$ $U_{i\,min}...U_{i\,max}$			35			35			40	mA
$I_{i\,m}$	Peak value of inrush current [3]	$U_{i\,nom}$		250			250			250		A
$t_{i\,s}$	Rise time [3]			5			5			5		µs
$t_{i\,r}$	Tail half value time [3]			40			40			40		
$I_{i\,m}$	Peak value of inrush current [3]	$U_{i\,nom}$ with option L		350			350			350		A
$t_{i\,s}$	Rise time [3]			25			25			25		µs
$t_{i\,r}$	Tail half value time [3]			125			125			125		
$u_{i\,rfi}$	RFI level at input, [4] 0.01...30 MHz	VDE 0871 (6.78) $U_{i\,nom}$, $I_{o\,nom}$			B			B			B	dB(µV)
Efficiency												
η	Efficiency	$U_{i\,nom}$, $I_{o\,nom}$		90			92			94		%
Isolation												
U_{is}	Isolation test voltage electronics to case	Inputs/outputs interconnected		750			750			750		V DC

[1] See "Dynamic characteristics"
[2] The minimum differential voltage $\Delta U_{io\,min}$ between input and output increases linearly from 0 to 1 V at T_A = 46°C and 71°C (T_C = 70°C and 95°C)
[3] Definitions according to VDE 0433, part 3
[4] With option L and additional external input capacitor C_e = 120 µF/100 V, e.g. Nichicon, PF(M) series, or equivalent

Standard Features

R External Output Voltage Adjustment

Note: With open R input, $U_o = U_{o\,nom}$.
(For superseded PSR types, $U_o = 1.08 \cdot U_{o\,nom}$)
R-input together with option i or option P cannot be supported simultaneously.

The output voltage U_o can either be adjusted with an external resistor (R_1 or R_2) or with an external voltage (U_{ex}). The adjustment range is 0...1.08 of $U_{o\,nom}$. The minimal differential voltage $\Delta U_{io\,min}$ between input and output should be maintained (see data). Min. input = Undervoltage cut-out.

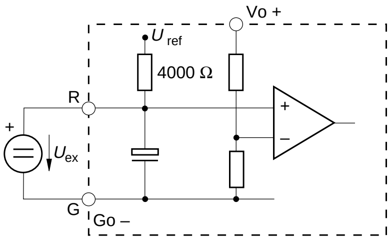


Fig. 6
Voltage adjustment with U_{ex} [V] between R and G (Go-):

a) $U_o \approx U_{ex} \cdot \dfrac{U_{o\,nom}}{U_{ref}}$ (U_{ref} = 2.5 V ±4%)

Caution: To prevent damage U_{ex} should not exceed U_{ref}, nor be negative.

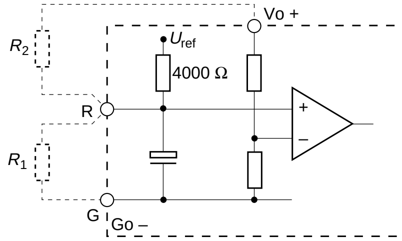


Fig. 7
Voltage adjustment with external resistor R_1 or R_2 [Ω]

b) U_o = 0...100% $U_{o\,nom}$, using R_1 between R and G (Go-):

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

c) $U_o = U_{o\,nom} \ldots U_{o\,max}$, using R_2 between R and Vo+:

$U_{o\,max} = U_{o\,nom} + 8\%$

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.5\ \text{V} \pm 4\%)$$

All formulae give approximate values only.

Description of Options

Option i Inhibit

Note: With open i-input, output is enabled (U_o = on).
Inhibit excludes R function!

The inhibit input allows the switching regulators to be disabled via a control signal. In systems with several units, this feature can be used, for example, to control the activation sequence of the regulators by a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the units are switched on or off.

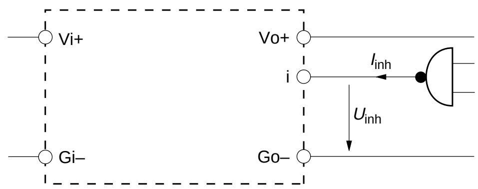


Fig. 8
Definition of I_{inh} and U_{inh}

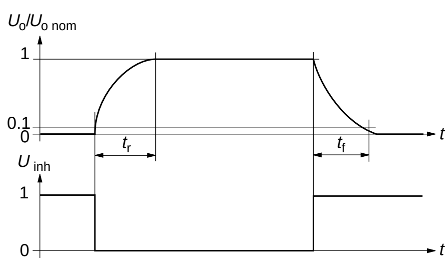


Fig. 9
Output response as a function of inhibit signal

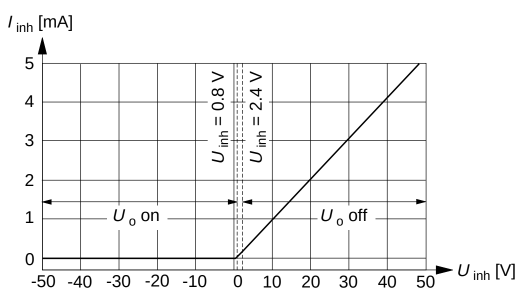


Fig. 10
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Data

Table 9: Inhibit characteristics

Characteristics			Conditions	min	typ	max	Unit
U_{inh}	Inhibit input voltage to keep regulator output voltage...	U_o = on	$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$	–50		+0.8	V DC
		U_o = off		+2.4		+50	
t_r	Switch-on time after inhibit command		$U_i = U_{i\,nom}$ $R_L = U_{o\,nom} / I_{o\,nom}$		5		ms
t_f	Switch-off time after inhibit command				10		
$I_{i\,off}$	Input current when inhibited		$I_o = 0$, $U_i = U_{i\,nom}$		10		mA

Option -9 Extended Temperature Range

The operational ambient temperature range is extended to T_A = –40...71°C.

Option L Input filter

Option L is recommended to reduce superimposed interference voltages, and to prevent oscillations, if input lines exceed approx. 5 m in total length. The fundamental wave (approx. 120 kHz) of the reduced interference voltage between Vi+ and Gi– has, with an input line inductance of 5 µH a maximum magnitude of 4 mV_{rms}.

The input impedance of the switching regulator at 120 kHz is about 50 mΩ. The harmonics are small in comparison with the fundamental wave. See also data: RFI.

With option L, the maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

Input voltage up to 40 V:

$u_{i\,max}$ = 12 V_{pp} at 100 Hz or V_{pp} = 1200 Hz/f_i • 1V

Input voltage up to 80 V:

$u_{i\,max}$ = 22 V_{pp} at 100 Hz or V_{pp} = 2200 Hz/f_i • 1V

Option P Potentiometer

Option P and the R-function cannot be supported simultaneously. The output voltage U_o can be adjusted with a screwdriver in the range from 0.92...1.08 of the nominal output voltage $U_{o\,nom}$.

However, the minimum differential voltage $\Delta U_{i\,o\,min}$ between input and output voltages as specified in "Electrical Input and Output Data" should be maintained.

Option U Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSL family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 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 to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71°C without any further precautions.

5.2

Option C Thyristor Crowbar

This option is recommended to protect the load against power supply malfunction, but it is not designed to sink external currents.

A fixed-value monitoring circuit checks the output voltage U_o. When the trigger voltage U_{oc} is reached, the thyristor crowbar triggers and disables the output. It may be deactivated by removal of the input voltage. In case of a switching transistor defect, an internal fuse prevents excessive current.

Note: As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

Table 10: Crowbar trigger levels

Characteristics		Conditions	5.1 V		12 V		15 V		24 V		36 V		Unit
			min	max	min	max	min	max	min	max	min	max	
$U_{o\,c}$	Trigger voltage	$U_{i\,min}$...$U_{i\,max}$ I_o = 0...$I_{o\,nom}$ $T_{C\,min}$...$T_{C\,max}$	5.8	6.8	13.5	16	16.5	19	27	31	40	45.5	V
t_s	Delay time			1.5		1.5		1.5		1.5		1.5	µs

Option D ("Save Data", input undervoltage monitor)

Note: Output instead of input undervoltage monitor is available on request (option D1).

If the input voltage U_i is below the adjustable threshold voltage U_t, the control circuit for terminal D has low impedance. Terminal D and Go– are connected to a self-conducting field effect transistor (FET). A 0.5 W Zener diode provides protection against overvoltages.

The voltage U_t can be externally adjusted with a trim potentiometer by means of a screwdriver. The hysteresis U_H of U_t is <2%. Terminal D stays low for a minimum time $t_{low\,min}$, in order to prevent any oscillation. U_t can be set to a value between $U_{i\,min}$ and $U_{i\,max}$ according to fig. 10. It is important to note that the FET can become conductive again when U_D > U_i – 3V.

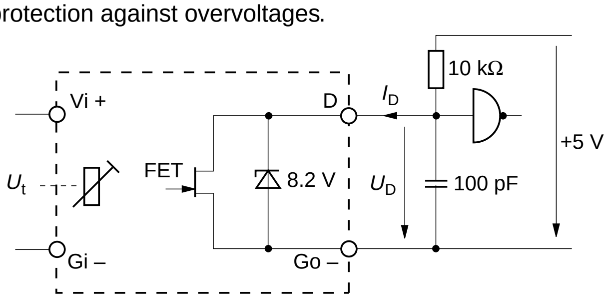


Fig. 11
Test circuit with definition of voltage U_D and current I_D on Terminal D.

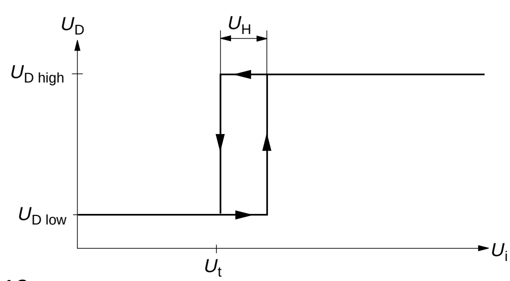


Fig. 12
Definition of U_t and U_H

Data

Table 11: Option D data

Characteristics		Conditions	PSL			Unit
			min	typ	max	
$U_{D\ low}$	Voltage - Terminal D at low impedance	$U_i < U_t$, $I_D \leq 2.5$ mA			0.8	V
$U_{D\ high}$	Voltage - Terminal D at high impedance	$U_i > U_t + U_H$, $I_D > 25$ µA	4.75			
$t_{low\ min}$	Minimum duration $U_{D\ low}$			30		ms
$t_{D\ f}$	Response time to $U_{D\ low}$			1		µs
$I_{D\ max}$	Maximum current - Terminal D				20	mA

Application examples

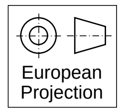
a) The signal U_D can be utilized in battery powered systems to provide a warning in case of **low batteries**.
b) In case of power failure, the signal can serve to initiate **data save** routines.

Option A Test sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage are located at the front panel of the module. The output voltage is measured internally directly at the connector pins.

Mechanical Data

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



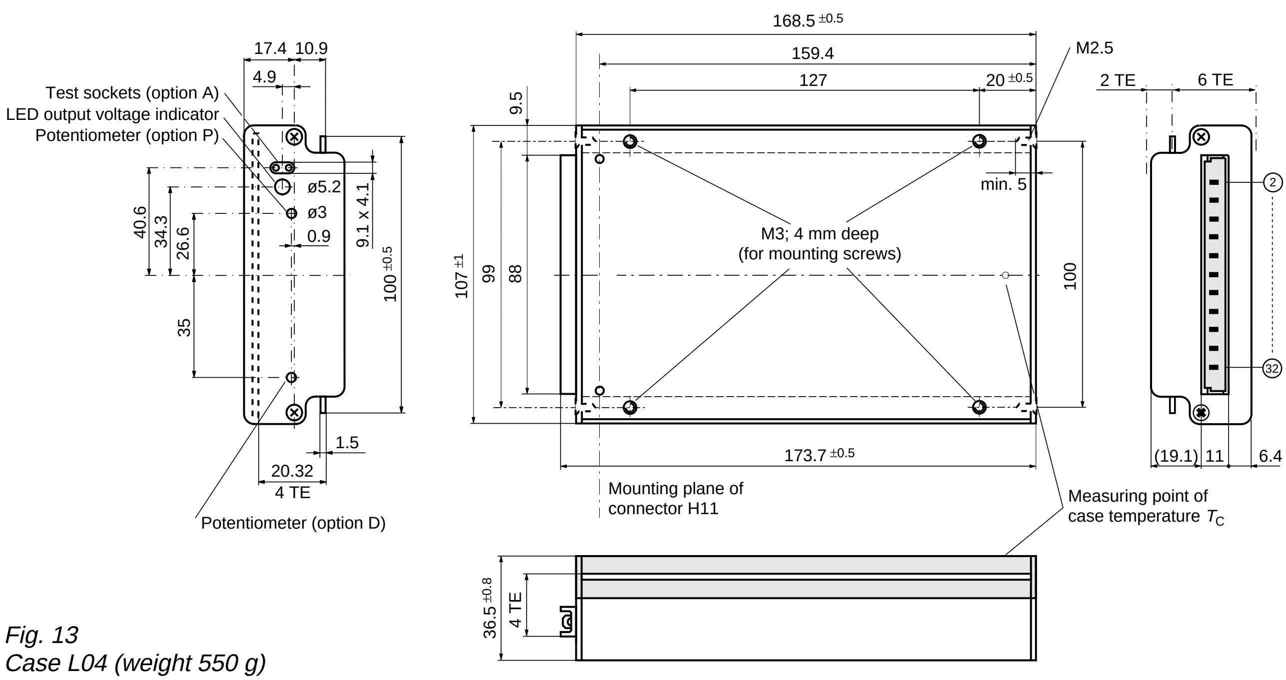


Fig. 13
Case L04 (weight 550 g)

Type Key and Product Marking

Type Key

PSL 12 8 -7 L i R P C D A

Positive switching regulator in case L04	PSL
Blank	
Nominal output voltage in volt (5A –> 5.1)	5.1...36
Nominal output current in ampere	8...12
Ambient temperature range	
T_A = –25...71°C	-7
T_A = –40...71°C	-9
Input filter	L
Inhibit input	i
External output voltage adjustment	R
Potentiometer	P
Thyristor-Crowbar	C
"Save Data" undervoltage monitor	D
Test sockets	A

Example:PSL 128-7LiPC = A positive switching regulator with a 12 V, 8 A output, ambient temperature range of –25…71°C, input filter, inhibit input, potentiometer and thyristor-crowbar.

Produkt Marking

Main face: Family designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

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

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

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

Positive Switching Regulators PSS-Family

No input to output isolation
Single output of 5.1, 12, 15, 24 or 36 V DC/60...432 W
Input voltage up to 80 V DC

- Wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no-load and short-circuit proof
- Output current sharing
- No derating

Safety according to IEC 950

5.2

Table of Contents

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\ nom}$	Nominal output current $I_{o\ nom}$	Input voltage range U_i	Nominal input voltage $U_{i\ nom}$	Efficiency η [2]	Type designation	Options
5.1 V	12 A	8...80 V	40 V	80%	PSS 5A12-7	-9, E, P, C, B, B1
12 V [1]		15...80 V		90%	PSS 1212-7	
24 V		29...80 V	50 V	94%	PSS 2412-7	
36 V		42...80 V	60 V	96%	PSS 3612-7	

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")
[2] Including option E, T_A = 25°C

Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case S01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

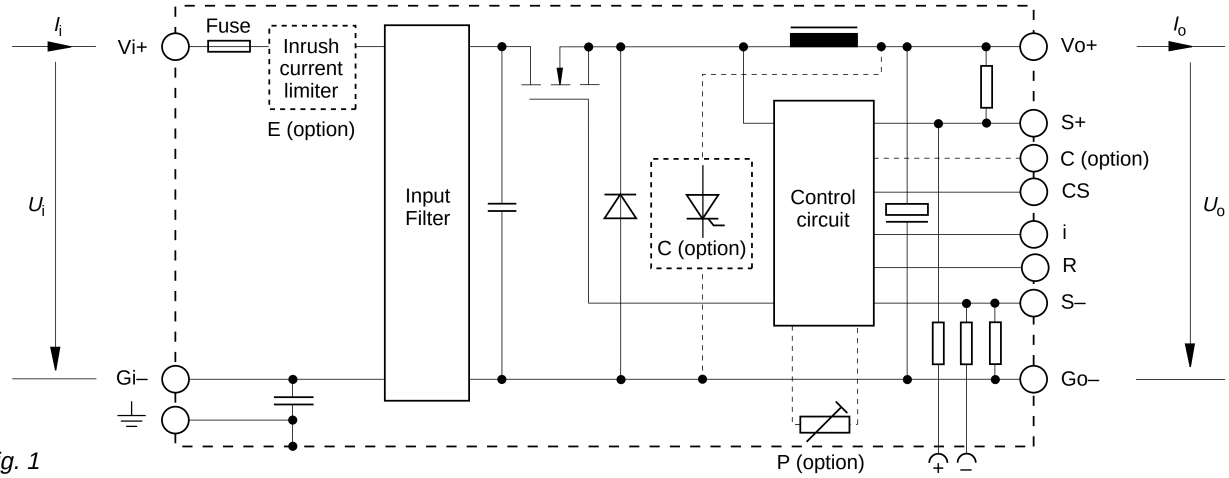


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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**	**Measures to achieve the specified safety status of the output circuit**	**Resulting safety status of the switching regulator output circuit**
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
		≤80 V	Hazardous voltage battery circuit [2]	Input fuse [1] and unearthed, non operator-accessible case [2]	SELV circuit
			Hazardous voltage battery circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [3]	SELV circuit
			ELV circuit	Input fuse [1] and earthed output circuit [3]	Earthed SELV circuit
		≤80 V	Hazardous voltage secondary circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤80 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [2]	Input fuse [1] and unearthed and non operator-accessible case [2]	SELV circuit

[1] A suitable fuse is standard built-in.
[2] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum input voltage of the switching regulator (contrary to case marking: "This apparatus must be earthed.").
[3] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012 and CAN/CSA C22.2 No. 234-M90.

Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

Table 3: H15 connector pin allocation

Electrical Determination	Type H15	
	Pin No.	**Ident.**
Output voltage (positive)	4	Vo+
Output voltage (positive)	6	Vo+
Output voltage (negative)	8	Go–
Output voltage (negative)	10	Go–
Crowbar trigger input (option C)	12	C
Inhibit input	14	i
R-input (output voltage programming) [1]	16	R
Sense line (negative)	18	S–
Sense line (positive)	20	S+
Current sharing control input	22	CS
Protective ground (protruding pin)	24	⏚
Input voltage (negative)	26	Gi–
Input voltage (negative)	28	Gi–
Input voltage (positive)	30	Vi+
Input voltage (positive)	32	Vi+

[1] Not available with option P

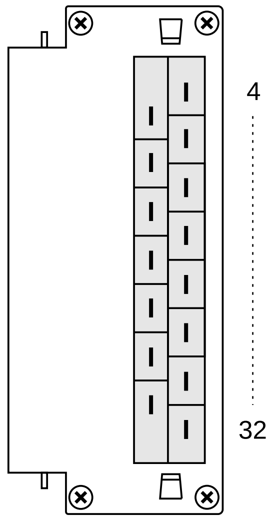


Fig. 2
View of male H15 connector

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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/s² 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/s² 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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) 5 g_n = 49 m/s² (60...2000 Hz) 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 g²/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

Table 5: Temperature specifications

Temperature			Standard -7		Option -9		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature	not operational	–40	100	–55	100	

Table 6: MTBF values and device hours

MTBF	Ground Benign	Ground Fixed		Ground Mobile	Device Hours [1]
MTBF according to MIL-HDBK-217F	T_C = 40 °C	T_C = 40 °C	T_C = 70 °C	T_C = 50°C	
	335'000 h	138'000 h	35'000 h	33'000 h	2'100'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Impulse voltage	IEC 255-4 App. E4 [5] (1976)	III	i/o, i/c, o/c +i/–i	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/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	[1]
			+i/–i	1000 V_p					
Voltage surge	IEC 571-1 (1990-07)		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	[2]
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
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]
Electric field	IEC 801-3 (1984)	3	antenna in 1m distance	10 V/m	sine wave mod-ulated w. 1 kHz		26…1000 MHz	yes	[1]
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)	III	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	[2]
			+i/–i	1000 V_p		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	3	i, o, signal wires	10 V_{rms} [6]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	[1]

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] With option C: manual reset
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

Standard Features

Note:
Additional information on input circuitry, grounding and parallel operation of units is given in section “Application Note”

Inhibit (i)

If the inhibit pin is not connected, the power supply is enabled (U_o = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

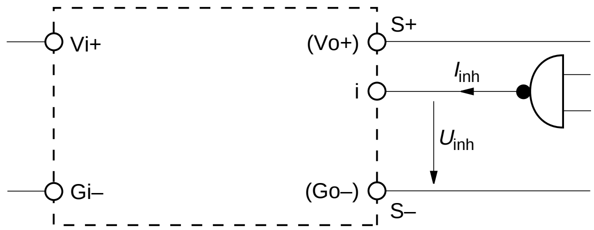


Fig. 3
Definition of inhibit voltage and current

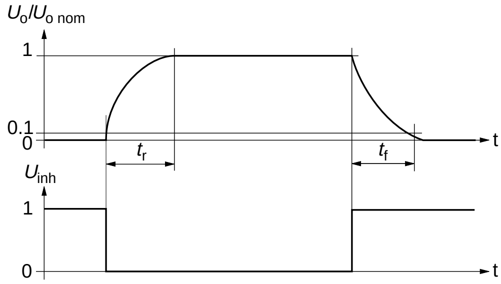


Fig. 4
Output response as a function of inhibit signal

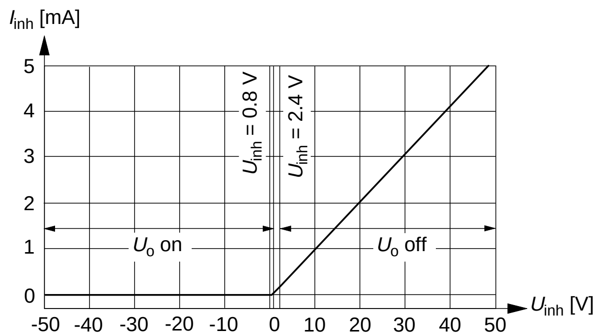


Fig. 5
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 8: Inhibit characteristics

Characteristics			Conditions	PSS 5A12			PSS 1212			PSS 2412			PSS 3612			Unit
				min	typ	max	min	typ	max	min	typ	max	min	typ	max	
U_{inh}	Inhibit input voltage to keep output voltage...	U_o = on	$U_{i\ min}...U_{i\ max}$ $T_{C\ min}...T_{C\ max}$	-50		+0.8	-50		+0.8	-50		+0.8	-50		+0.8	V DC
		U_o = off		+2.4		+50	+2.4		+50	+2.4		+50	+2.4		+50	
t_r	Switch-on time after inhibit command		$U_{i\ nom}$ $R_L = U_{o\ nom}/I_{o\ nom}$ (resistive load)		100			100			100			100		ms
t_f	Switch-off time after inhibit command				10			15			20			15		
$I_{i\ off}$	Input current with converter inhibited		$I_o = 0$ $U_{i\ nom}$		25			25			25			25		mA

Input Filter and Fuse

An input filter and a fuse are incorporated in all PSS modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$u_{i\ max}$ = 10 V_{pp} at 100 Hz, or V_{pp} = 1000 Hz/f_i • 1 V

Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage U_o internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

Current Sharing (CS)

Note: Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Sense Lines (S)

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\ max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSS connector) should not exceed the following values:

Output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
5.1 V	<0.5 V	<0.25 V
12 , 24, 36 V	<1.0 V	<0.25 V

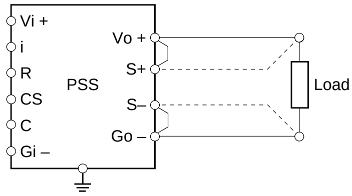


Fig. 6
Sense lines connection

External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\ nom}$. With option P, the R input must remain unconnected.

The output voltage U_o can either be adjusted with an external resistor R_1 or R_2, or with an external voltage U_{ex} referenced to S–. The adjustment range is 0...$U_{o\ max}$ (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\ min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor (R_1 resp. R_2). Option P is not recommended for parallel operation mode.

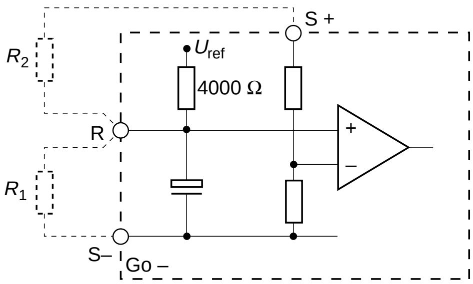


Fig. 7
Voltage adjustment with external resistor R_1 or R_2

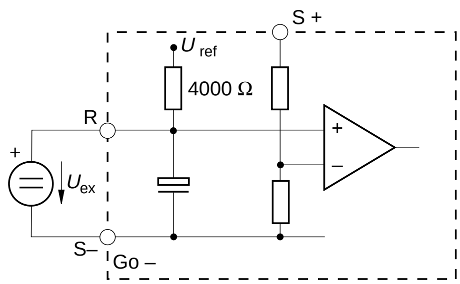


Fig. 8
Voltage adjustment with external voltage U_{ex} [V]

a) $U_o = 0...U_{o\ nom}$, using R_1 [Ω] between R and S–:

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

b) $U_o = U_{o\ nom}...U_{o\ max}$, using R_2 [Ω] between R and S+
$U_{o\ max}$ is internally limited (see data)

$$U_o \approx U_{ref} \bullet \frac{R_2}{k \bullet (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\ nom}}$$

$$R_2 \approx 4000 \bullet \frac{U_o \bullet (1-k)}{k \bullet U_o - U_{ref}} \qquad (U_{ref} = 2.48\ \text{V} \pm 1\%)$$

c) $U_o = 0...U_{o\ max}$, using U_{ex} [V] between R and S–:

$$U_o \approx U_{o\ nom} \bullet [\frac{U_{ex}}{U_{ref}} \bullet 0.98 + 0.02]$$

$(U_{ref} = 2.48\ \text{V} \pm 1\%)$

All formulae give approximate values only.

Caution: To prevent damage U_{ex} should not exceed 20 V nor be negative!

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

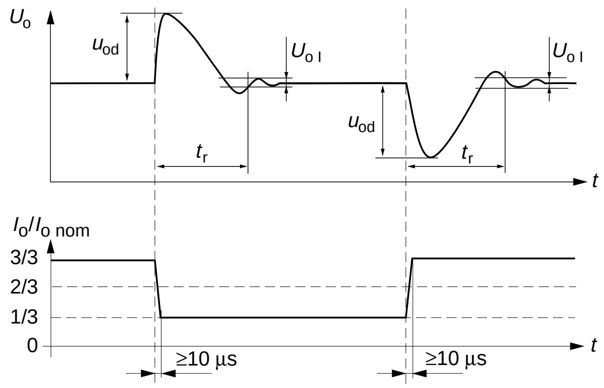


Fig. 9
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 71°C and is operated at its nominal output power, the case temperature T_C will be about 95 °C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 71°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C (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

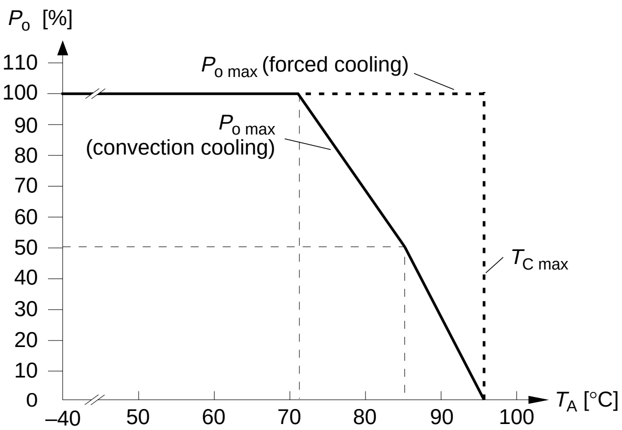


Fig. 10
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

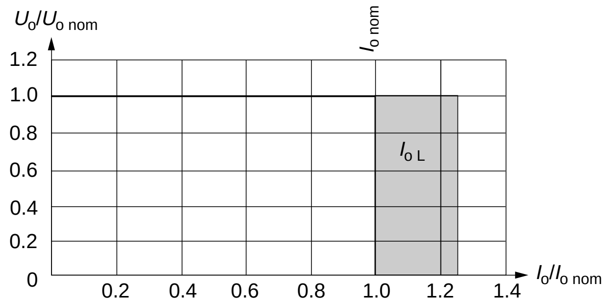


Fig. 11
Overload, short-circuit behaviour U_o versus I_o

Electrical Input and Output Data

General Conditions
- T_A = 25°C, unless T_C is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

Table 9: Input and output data

Characteristics		Conditions	PSS 5A12			PSS 1212			PSS 2412			PSS 3612			
Output			min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	5.07		5.13	11.92		12.07	23.85		24.14	35.78		36.22	V
$U_{o\,max}$	Maximum adjustable output voltage utilizing R input	$U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector			5.6			16.0			26.0			42.5	
$I_{o\,nom}$	Output current	$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$		12			12			12			12		A
$I_{o\,L}$	Output current limitation response (% of $I_{o\,nom}$)		100		125	100		125	100		125	100		125	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\,nom}$, $I_{o\,nom}$		30	70		40	80		50	110		60	110	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min} \ldots U_{i\,max}$ $I_{o\,nom}$		15	35		40	70		80	170		120	250	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0 \ldots I_{o\,nom}$		10	25		30	50		50	120		60	120	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_o \leftrightarrow {}^1/_3\, I_{o\,nom}$		70			140			180			200		
t_r	Dynamic load transient time recovery [1]			40			60			60			70		µs
α_{Uo}	Temperature coefficient $\Delta U_o / \Delta T_C$	$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$ $I_o = 0 \ldots I_{o\,nom}$		±1			±3			±5			±8		mV/K
				±0.02			±0.02			±0.02			±0.02		%/K
Input															
U_i	Input voltage range	$T_{C\,min} \ldots T_{C\,max}$ $I_o = 0 \ldots I_{o\,nom}$	8		80	15		80	29		80	42		80	V DC
$\Delta U_{io\,min}$	Minimum differential voltage U_i - U_o			3			3 [3]			5			6		
U_{io}	Undervoltage cut-out			6.5			7.3			12			19		
$I_{i\,o}$	No load input current	$I_o = 0$ $U_{i\,nom}$		36			36			36			36		mA
I_{im}	Peak value of inrush current	$U_{i\,nom}$ with option E [2]			40			60			60			80	A
u_{rfi}	RFI level at input, 0.01...30 MHz	VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$			B			B			B			B	dB (µV)
Efficiency															
η	Efficiency with option E	$U_{i\,nom}$, $I_{o\,nom}$		80			90			94			96		%
Isolation															
$U_{i\,s}$	Isolation test voltage electronic to case	All input and output terminals interconnected		750			750			750			750		V DC

[1] See "Dynamic Characteristics"
[2] See also option E
[3] For U_o > 12 V, add 1 V

5.2

5.2

Description of Options

Option -9 Extended Temperature Range

This option defines an extended operational ambient temperature range of T_A = –40...71°C.

Option E Inrush Current Limitation

Note: This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of U_i/1 Ω and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

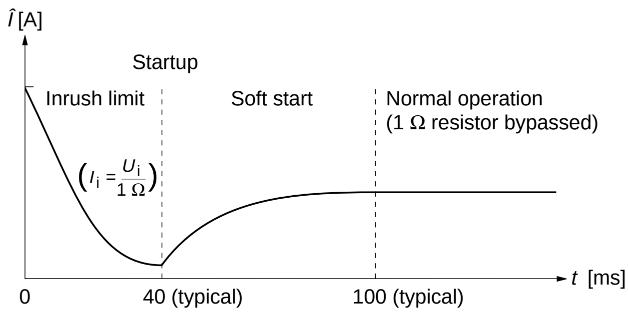


Fig. 12
Option E: Inrush current versus time

Option P Potentiometer

Note: Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\,nom}$.

The minimum differential voltage, $\Delta U_{io\,min}$ between input and output voltages should be maintained.

Option C Thyristor Crowbar

Note: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\,C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage U_o and when the trigger voltage $U_{o\,C}$ is reached, the thyristor crowbar triggers and disables the output.

An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Table 10: Crowbar trigger levels

Characteristics		Condition	PSS 5A12			PSS 1212			PSS 2412			PSS 3612			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$U_{o\,C}$	Crowbar trigger voltage	$T_{C\,min}...T_{C\,max}$ $U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$		6.3	6.7		17.8 14.3	18.9 15.2 [1]		28.89	30.6		47.0 43.0	50.0 45.5 [1]	V DC
t_s	Delay time			1.5			1.5			1.5			1.5		µs

[1] Crowbar Trigger voltage with option P

Option B, Option B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\ max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \bullet (U_o \bullet I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110 °C approximately. The output is automatically enabled again after temperature has droped below $T_{C\ max}$.

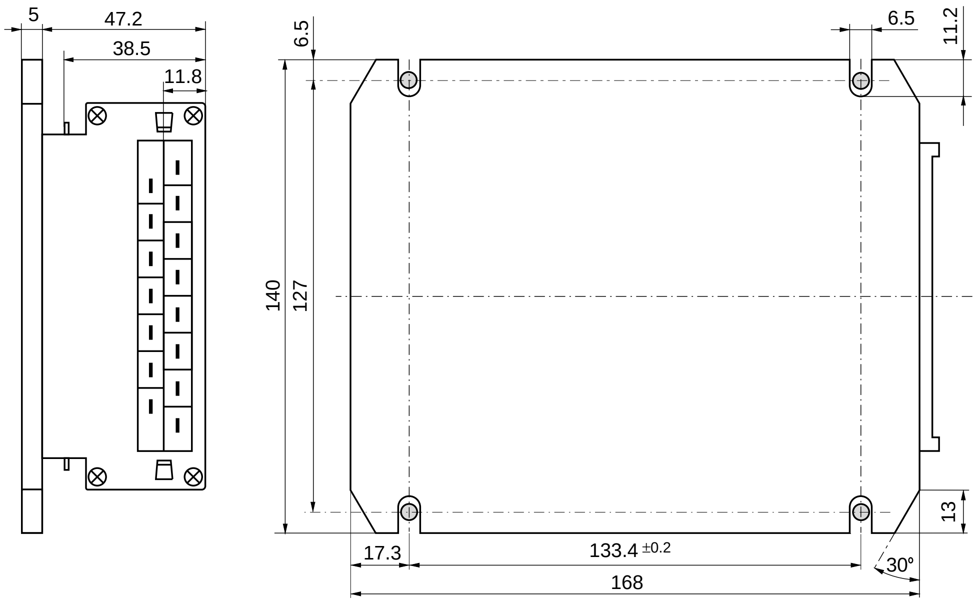


Fig. 13
Case S01 with option B (cooling plate)
Weight: 1.2 kg

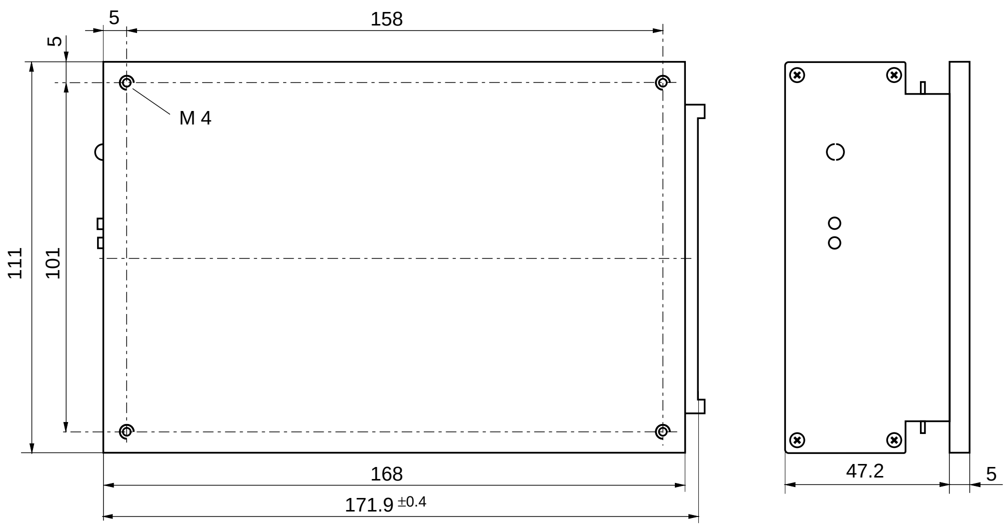


Fig. 14
Case S01 with option B1 (cooling plate)
Weight: 1.2 kg

Option U Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSS family as recognized components up to an ambient temperature of $T_{A\ max}$ – 10 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.

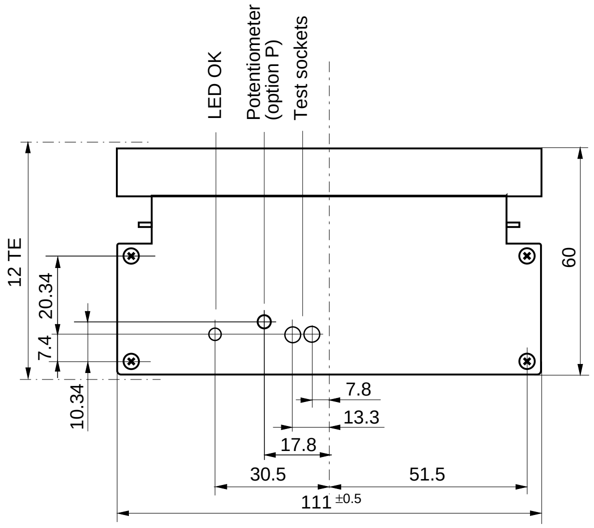
The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\ max}$ = 71 °C without any further precautions.

5.2

Mechanical Data

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

European Projection



Note:

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink

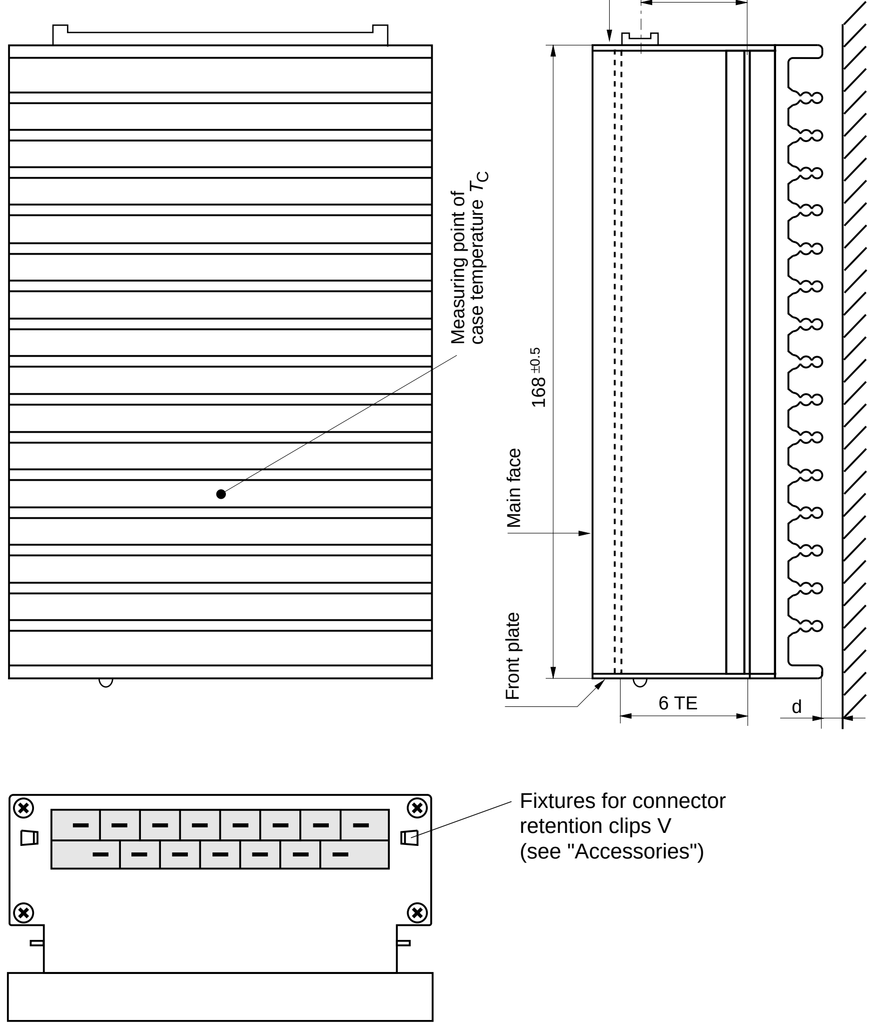


Fig. 15
Case S01 with heatsink
Weight: 1.3 kg

5.2

Type Key and Product Marking

Type Key

PSS 12 12 -7 E P C B1

Positive switching regulator in case S01 .... PSS
Blank ....
Nominal output voltage in volt (5A –> 5.1) .... 5.1...36
Nominal output current in ampere 12
Ambient temperature range
T_A = –25...71°C .... -7
T_A = –40...71°C .... -9
Inrush current limitation .... E
Potentiometer .... P
Thyristor-Crowbar C
Cooling plate .... B, B1

Example:PSS 1212-7EPCB = A positive switching regulator with a 12 V, 12 A output, ambient temperature range of –25...71°C, inrush current limitation, potentiometer, crowbar, and cooling plate B.

Product Marking

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

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

Positive Switching Regulators PSK-Family

No input to output isolation
Single output of 5.1, 12, 15, 24 or 36 V DC/80...720 W
Input voltage up to 80 V DC

- Wide input voltage range
- High efficiency up to 96%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- No derating
- Output no-load and short-circuit proof
- Output current sharing

Safety in accordance to IEC 950

Table of Contents

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i	Nominal input voltage $U_{i\,nom}$	Efficiency η^2	Type designation	Connector type	Options
5.1 V	25 A	8...40 V	20 V	85%	PSK 5A25-7	H15 S4	-9, E, P, C, B, B1
	20 A	8...80 V	40 V	80%	PSK 5A20-7		
12 V[1]		15...80 V		90%	PSK 1220-7		
24 V		29...80 V	50 V	94%	PSK 2420-7		
36 V		42...80 V	60 V	96%	PSK 3620-7		
5.1 V	16 A	8...80 V	40 V	80%	PSK 5A16-7	H15	
12 V[1]		15...80 V		90%	PSK 1216-7		
24 V		29...80 V	50 V	94%	PSK 2416-7		
36 V		42...80 V	60 V	96%	PSK 3616-7		

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment") [2] Including option E, T_A = 25 °C

Description

The switching regulators define power supply modules for industrial electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators may be completed by various options to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Two different connectors according to DIN 41 612 are provided: H15 (standard) for current values up to 16 A or H15 S4 (containing 4 high current terminals, one pair each for input and output) supplying current values from 20 A up.

Case K01: Aluminium, black finish, fully enclosed. The basic model with heat sink is self cooling.

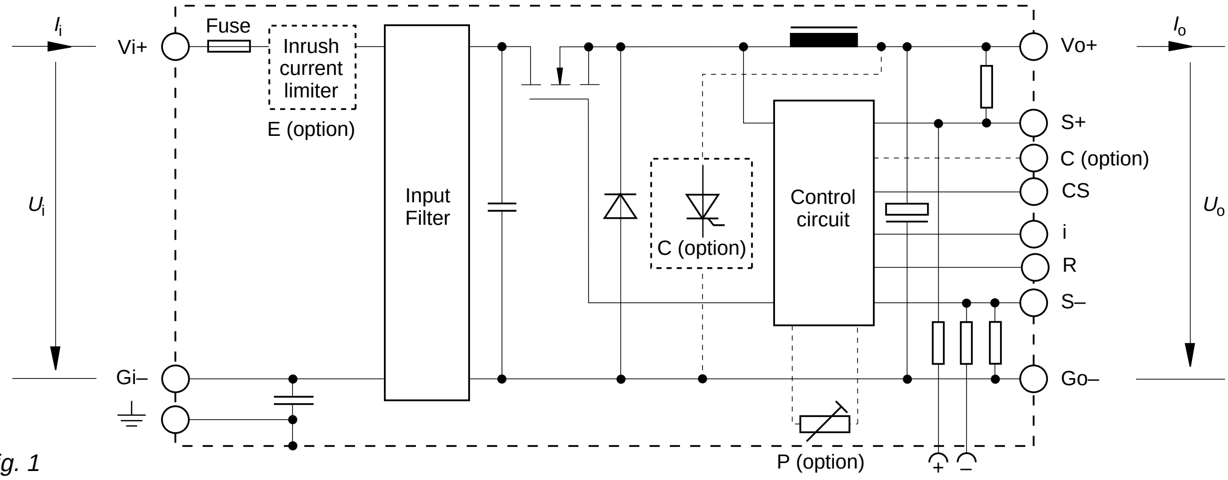


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
		≤80 V	Hazardous voltage battery circuit [2]	Input fuse [1] and unearthed, non operator-accessible case [2]	SELV circuit
			Hazardous voltage battery circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [3]	SELV circuit
			ELV circuit	Input fuse [1] and earthed output circuit [3]	Earthed SELV circuit
		≤80 V	Hazardous voltage secondary circuit	Input fuse [1] and earthed output circuit [3] and earthed [3] or non operator-accessible case	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤80 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit [2]	Input fuse [1] and unearthed and non operator-accessible case [2]	SELV circuit

[1] A suitable fuse is standard built-in.
[2] Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum input voltage of the switching regulator (contrary to case marking: "This apparatus must be earthed.").
[3] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90 and SEV approved according to SEV 1061.1981, SEV 1085.1983 and EN 55014 standards.

Protection Degree

The protection degree is defined by IP 30 (equipped with potentiometer adjustable option: IP 20). The protection degree applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 or H15 S4 (see "Accessories") to ensure requested safety!

Table 3: H15 and H15 S4 connector pin allocation

Electrical Determination	Type H15		Type H15 S4	
	Pin No.	Ident.	Pin No.	Ident.
Output voltage (positive)	4	Vo+	4/6	Vo+
Output voltage (positive)	6	Vo+		
Output voltage (negative)	8	Go–	8/10	Go–
Output voltage (negative)	10	Go–		
Crowbar trigger input (option C)	12	C	12	C
Inhibit input	14	i	14	i
R-input (output voltage programming) [1]	16	R	16	R
Sense line (negative)	18	S–	18	S–
Sense line (positive)	20	S+	20	S+
Current sharing control input	22	CS	22	CS
Protective ground (protruding pin)	24	⏚	24	⏚
Input voltage (negative)	26	Gi–	26/28	Gi–
Input voltage (negative)	28	Gi–		
Input voltage (positive)	30	Vi+	30/32	Vi+
Input voltage (positive)	32	Vi+		

[1] Not available with option P

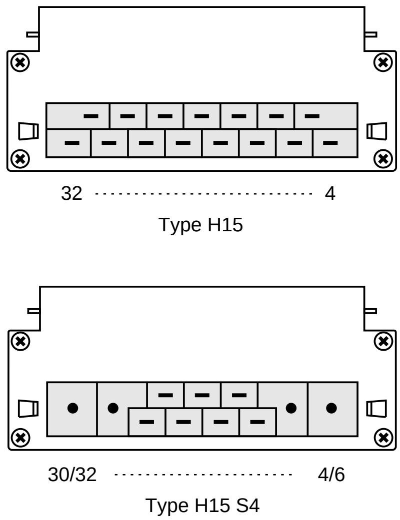


Fig. 2
View of male H15 and H15 S4 connector

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...2000 Hz 0.35 mm (10...60 Hz) 5 g_n = 49 m/s^2 (60...2000 Hz) 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

Table 5: Temperature specifications

Temperature			Standard -7		Option -9		Unit
Characteristics		Conditions	min	max	min	max	
T_A	Ambient temperature	$U_{i\ min}...U_{i\ max}$ $I_o = 0...I_{o\ nom}$	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature	not operational	–40	100	–55	100	

Table 6: MTBF values and device hours

MTBF	Ground Benign	Ground Fixed		Ground Mobile	Device Hours [1]
MTBF according to MIL-HDBK-217F	T_C = 40 °C	T_C = 40 °C	T_C = 70 °C	T_C = 50°C	
	335'000 h	138'000 h	35'000 h	33'000 h	2'100'000 h

[1] Statistical values, based on an average of 4300 working hours per year and in general field use

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Impulse voltage	IEC 255-4 App. E4 [5] (1976)	III	i/o, i/c, o/c +i/–i	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/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	1
			+i/–i	1000 V_p					
Voltage surge	IEC 571-1 (1990-07)		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	2
				1500 V_p	50 µs		1 pos. and 1 neg. voltage surge per coupling mode		
				3000 V_p	5 µs				
				4000 V_p	1 µs				
				7000 V_p	100 ns				
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
Electric field	IEC 801-3 (1984)	3	antenna in 1m distance	10 V/m	sine wave modulated w. 1 kHz		26…1000 MHz	yes	1
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)	III	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	2
			+i/–i	1000 V_p		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	3	i, o, signal wires	10 V_{rms} [6]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	1

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] With option C: manual reset
[4] i = input, o = output, c = case
[5] In correspondance with DIN 57435 part 303 and VDE 0435 part 303 (1984-09)
[6] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

Standard Features

Note:
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

Inhibit (i)

If the inhibit pin is not connected, the power supply is enabled (U_o = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

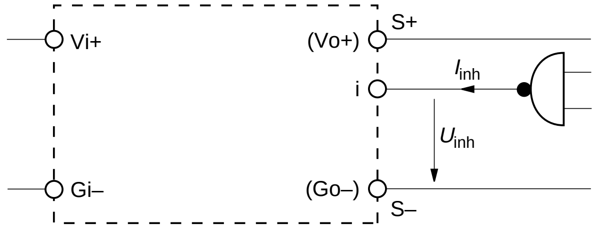


Fig. 3
Definition of inhibit voltage and current

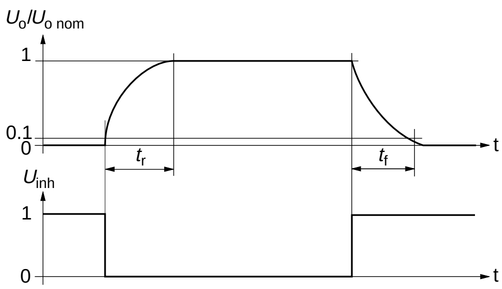


Fig. 4
Output response as a function of inhibit signal

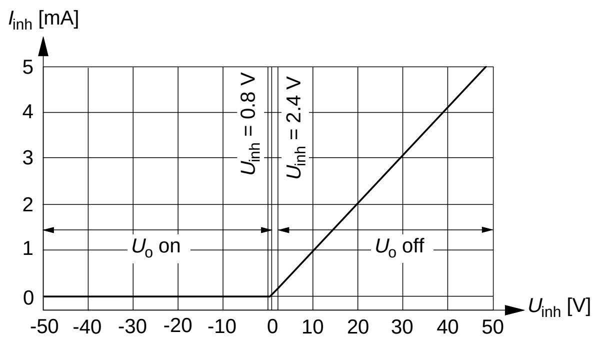


Fig. 5
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 8: Inhibit characteristics

Characteristics			Conditions	PSK 5A..			PSK 12..			PSK 24..			PSK 36..			Unit
				min	typ	max	min	typ	max	min	typ	max	min	typ	max	
U_{inh}	Inhibit input voltage to keep output voltage...	U_o = on	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	-50		+0.8	-50		+0.8	-50		+0.8	-50		+0.8	V DC
		U_o = off		+2.4		+50	+2.4		+50	+2.4		+50	+2.4		+50	
t_r	Switch-on time after inhibit command		$U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,nom}$		100			100			100			100		ms
t_f	Switch-off time after inhibit command		(resistive load)		10			15			20			15		
$I_{i\,off}$	Input current with converter inhibited		$I_o = 0$ $U_{i\,nom}$		25			25			25			25		mA

Input Filter and Fuse

An input filter and a fuse are incorporated in all PSK modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

If a reduction of the considerable high inrush current is required, refer to option E.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$u_{i\,max}$ = 10 V_{pp} at 100 Hz, or V_{pp} = 1000 Hz/f_i • 1 V

Test Sockets

Test sockets (pin Ø = 2 mm) for measuring the output voltage U_o internally at the connector terminals, are located at the front side of the module. The test sockets are protected by a series resistor.

Current Sharing (CS)

Note: Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Sense Lines (S)

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSK connector) should not exceed the following values:

Output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
5,1 V	< 0.5 V	< 0.25 V
12 , 24, 36 V	< 1.0 V	< 0.25 V

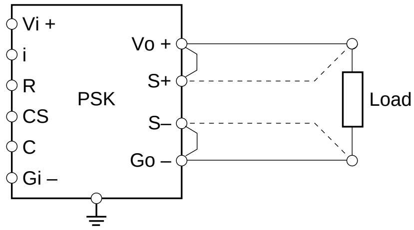


Fig. 6
Sense lines connection

External Voltage Adjustment (R)

Note: With open R input, $U_o = U_{o\,nom}$. With option P, the R input must remain unconnected.

The output voltage U_o can either be adjusted with an external resistor R_1 or R_2, or with an external voltage U_{ex} referenced to S–. The adjustment range is 0...$U_{o\,max}$ (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor (R_1 resp. R_2). Option P is not recommended for parallel operation mode.

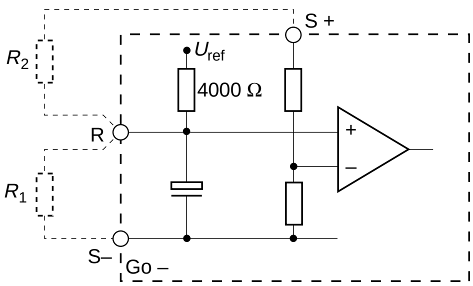


Fig. 7
Voltage adjustment with external resistor R_1 or R_2

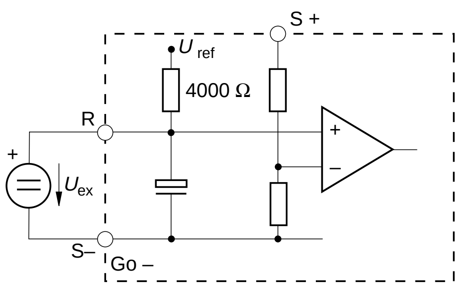


Fig. 8
Voltage adjustment with external voltage U_{ex} [V]

a) U_o = 0...$U_{o\,nom}$, using R_1 [Ω] between R and S–:

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

b) $U_o = U_{o\,nom}...U_{o\,max}$, using R_2 [Ω] between R and S+

$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \bullet \frac{R_2}{k \bullet (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \bullet \frac{U_o \bullet (1\text{-}k)}{k \bullet U_o - U_{ref}} \qquad (U_{ref} = 2.48\ \text{V} \pm 1\%)$$

c) U_o = 0...$U_{o\,max}$, using U_{ex} [V] between R and S–:

$$U_o \approx U_{o\,nom} \bullet \left[\frac{U_{ex}}{U_{ref}} \bullet 0.98 + 0.02\right]$$

$(U_{ref} = 2.48\ \text{V} \pm 1\%)$

All formulae give approximate values only.

Caution: To prevent damage U_{ex} should not exceed 20 V nor be negative!

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

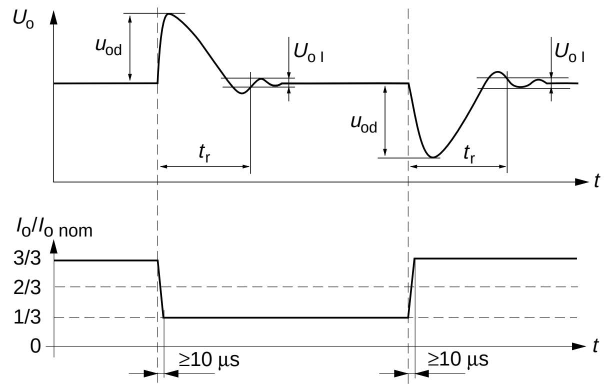


Fig. 9
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 71°C and is operated at its nominal output power, the case temperature T_C will be about 95°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 71°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 95°C (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

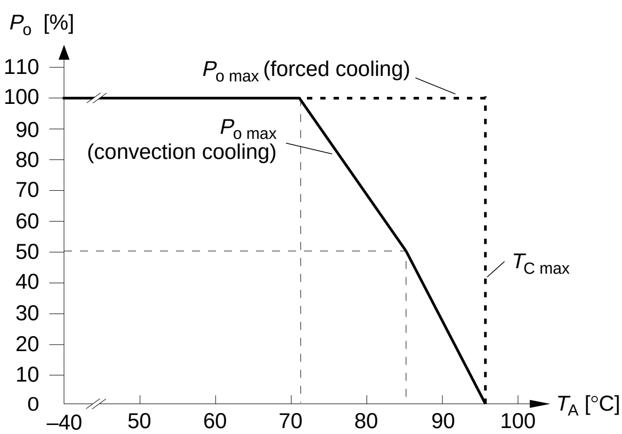


Fig. 10
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

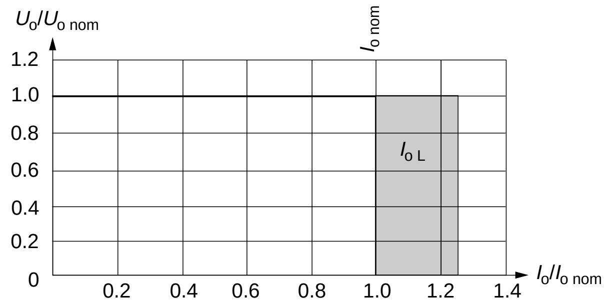


Fig. 11
Overload, short-circuit behaviour U_o versus I_o

5.2

Electrical Input and Output Data

General Conditions
- T_A = 25°C, unless T_C is specified
- With R or option P, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

Table 9: Input and output data

Characteristics		Conditions	PSK 5A16 PSK 5A20 PSK 5A25			PSK 1216 PSK 1220			PSK 2416 PSK 2420			PSK 3616 PSK 3620			
Output			min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	5.07		5.13	11.92		12.07	23.85		24.14	35.78		36.22	V
$U_{o\,max}$	Maximum adjustable output voltage utilizing R input	$U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector			5.6			16.0			26.0			42.5	
$I_{o\,nom}$	Output current: PSK ...16 PSK ...20 PSK 5A25	$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$		16 20 25			16 20 –			16 20 –			16 20 –		A
$I_{o\,L}$	Output current limitation response (% of $I_{o\,nom}$)		100		125	100		125	100		125	100		125	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\,nom}$, $I_{o\,nom}$		30	70		40	80		50	110		60	110	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min} \ldots U_{i\,max}$ $I_{o\,nom}$		15	35		40	70		80	170		120	250	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0 \ldots I_{o\,nom}$		10	25		30	50		50	120		60	120	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_o \leftrightarrow {}^{1}/_{3}\, I_{o\,nom}$		70			140			180			200		
t_r	Dynamic load transient time recovery [1]			40			60			60			70		µs
α_{Uo}	Temperature coefficient $\Delta U_o / \Delta T_C$	$U_{i\,min} \ldots U_{i\,max}$ $T_{C\,min} \ldots T_{C\,max}$ $I_o = 0 \ldots I_{o\,nom}$		±1			±3			±5			±8		mV/K
				±0.02			±0.02			±0.02			±0.02		%/K
Input															
U_i	Input voltage range	$T_{C\,min} \ldots T_{C\,max}$ $I_o = 0 \ldots I_{o\,nom}$	8		80 [2]	15		80	29		80	42		80	V DC
$\Delta U_{io\,min}$	Minimum differential voltage U_i - U_o			3			3 [3]			5			6		
U_{io}	Undervoltage cut-out			6.5			7.3			12			19		
$I_{i\,o}$	No load input current	$I_o = 0$ $U_{i\,nom}$		36			36			36			36		mA
I_{im}	Peak value of inrush current	$U_{i\,nom}$ with option E [4]			40			60			60			80	A
u_{rfi}	RFI level at input, 0.01...30 MHz	VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$			B			B			B			B	dB (µV)
Efficiency															
h	Efficiency with option E	$U_{i\,nom}$, $I_{o\,nom}$		80 [5]			90			94			96		%
Isolation															
$U_{i\,s}$	Isolation test voltage electronic to case	All input and output terminals interconnected		750			750			750			750		V DC

[1] See "Dynamic Characteristics"
[2] PSK 5A25: U_i = 8...40 V
[3] For U_o > 12 V, add 1 V
[4] See also option E
[5] PSK 5A25: η = 85%

Description of Options

Option -9 Extended Temperature Range

This option defines an extended operational ambient temperature range of T_A = –40...71°C.

Option E Inrush Current Limitation

Note: This option requires increased minimum input voltage of up to 1 V, dependend on input range. In battery driven applications the use of option E is essential due to very low battery impedances.

Inrush current can reach several thousand amperes depending on the source and input line conditions. Immediately after the initial application of the input supply, the inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. The power supply input presents a very low impedance to such currents and when driven from a low impedance source, for example a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. Option E dramatically reduces this peak current to a level of U_i/1 Ω and is recommended for any application to protect series elements such as switches or circuit brakers and rectifiers. After startup, the resistor is bypassed for normal operation.

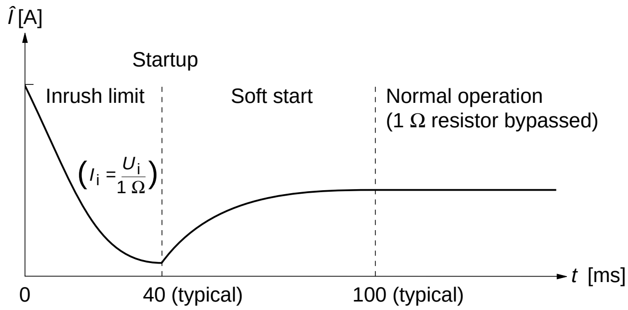


Fig. 12
Option E: Inrush current versus time

Option P Potentiometer

Note: Option P is not recommended if several modules are operated in parallel connection.

The potentiometer can be controlled with a screwdriver from the front side. The output voltage adjustment range is 90...110% of the nominal output voltage $U_{o\ nom}$.

The minimum differential voltage, $\Delta U_{io\ min}$ between input and output voltages should be maintained.

Option C Thyristor Crowbar

Note: The thyristor can be deactivated by removal of the input voltage only. The inhibit signal cannot deactivate the thyristor.

Option C protects the load against power supply malfunction. It is not designed to sink external currents.

As a central overvoltage protection device, the crowbar is usually connected to the external load via distributed inductance of the lines. For this reason, the overvoltage at the load can temporarily exceed the trigger voltage $U_{o\ C}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage U_o and when the trigger voltage $U_{o\ C}$ is reached, the thyristor crowbar triggers and disables the output. An external connection C (crowbar trigger control) is provided. When crowbar option is used with two or more power supplies in parallel connection, all crowbar trigger terminals (C) should be interconnected. This ensures all crowbar circuits triggering simultaneously in order to disable all outputs at once. The crowbar trigger voltage is maintained between Vo+ and Go– and to prevent false triggering, the user should ensure that $U_{o\ max}$ (between Vo+ and Go–) is not exceeded.

Table 10: Crowbar trigger levels

Characteristics		Condition	PSK 5A..			PSK 12..			PSK 24..			PSK 36..			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$U_{o\ C}$	Crowbar trigger voltage	$T_{C\ min}...T_{C\ max}$ $U_{i\ min}...U_{i\ max}$ $I_o = 0...I_{o\ nom}$		6.3	6.7		17.8 14.3	18.9 15.2 [1]		28.89	30.6		47.0 43.0	50.0 45.5 [1]	V DC
t_s	Delay time			1.5			1.5			1.5			1.5		µs

[1] Crowbar Trigger voltage with option P

Option B, Option B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\,max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \cdot (U_o \cdot I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output at 110 °C approximately. The output is automatically enabled again after temperature has droped below $T_{C\,max}$.

5.2

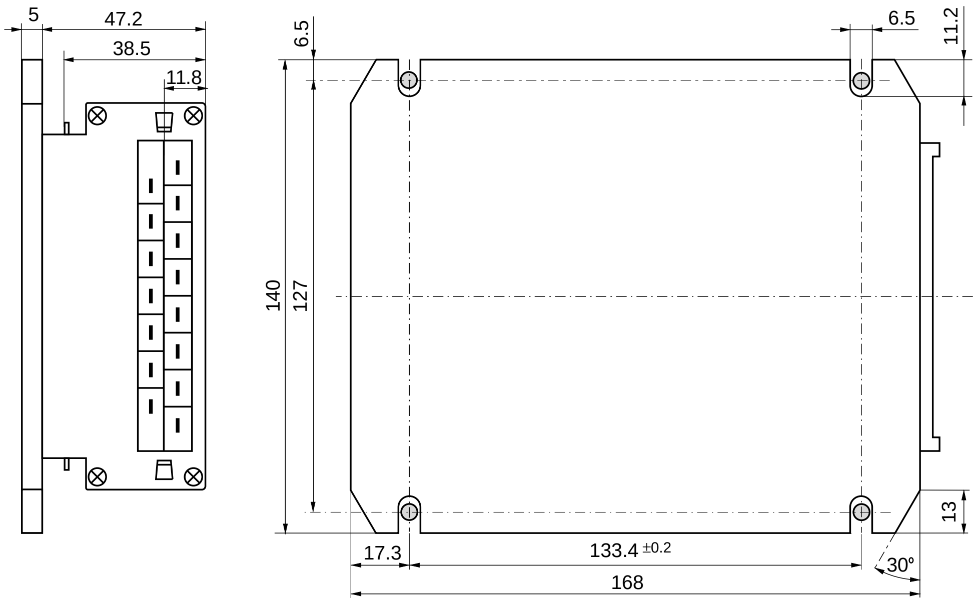


Fig. 13
Case K01 with option B (cooling plate)
Weight: 1.2 kg

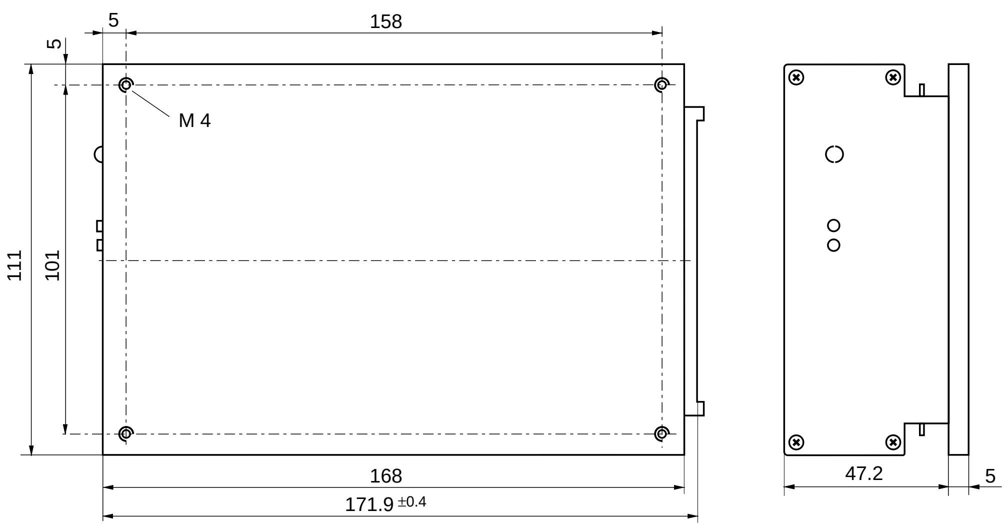


Fig. 14
Case K01 with option B1 (cooling plate)
Weight: 1.2 kg

Option U Ambient Temp. Range acc. UL Recognition

Underwriters Laboratories (UL) have approved the PSK family as recognized components up to an ambient temperature of $T_{A\,max}$ – 10 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.

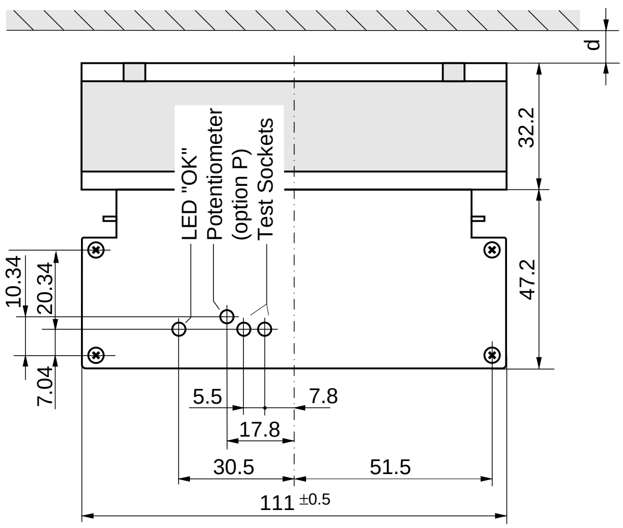
The European approval boards have in contrast to UL accepted the standard PCB material to be operated up to $T_{A\,max}$ = 71 °C without any further precautions.

Mechanical Data

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

European Projection

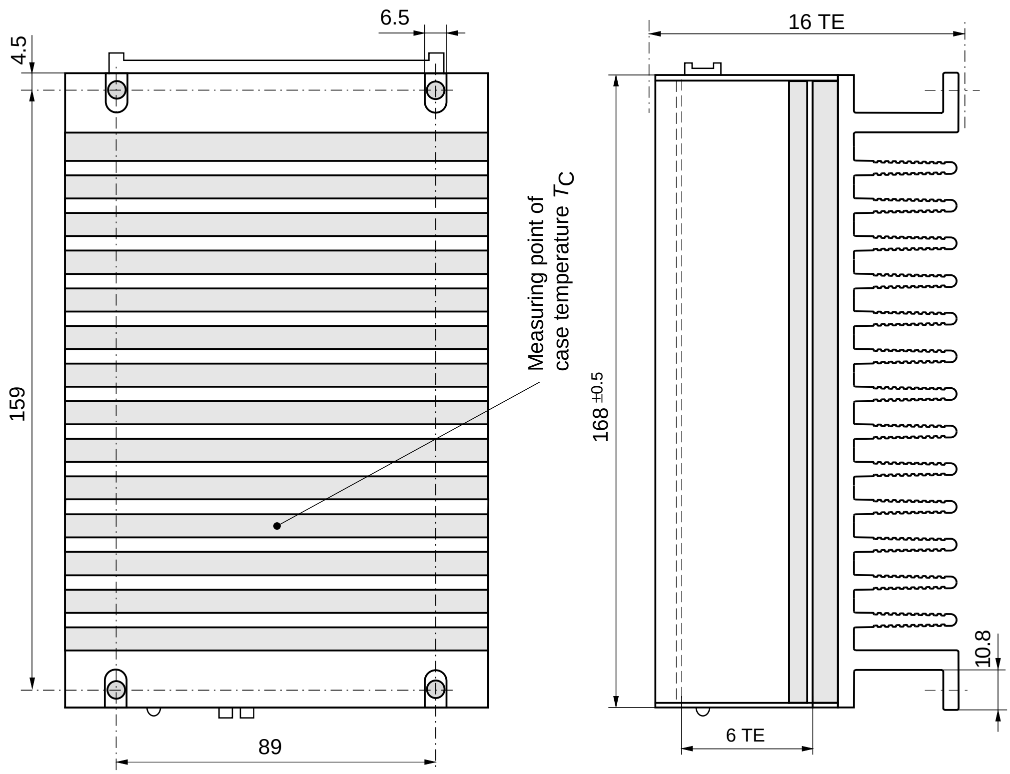
5.2



Note:

– d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power

– free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow throught heat sink



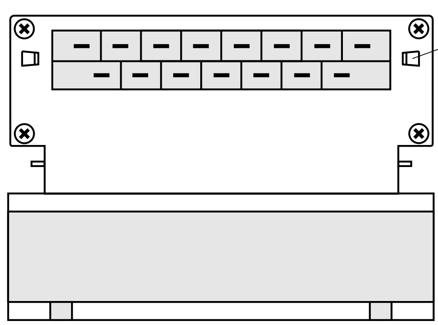


Fig. 15
Case K01 with heatsink
Weight: 1.6 kg

Type Key and Product Marking

Type Key

PSK 12 16 -7 E P C B1

Positive switching regulator in case K01 .... PSK
Blank ....
Nominal output voltage in volt (5A –> 5.1) .... 5.1...36
Nominal output current in ampere .... 16...25
Ambient temperature range
T_A = –25...71°C .... -7
T_A = –40...71°C .... -9
Inrush current limitation .... E
Potentiometer .... P
Thyristor-Crowbar C
Cooling plate .... B, B1

Example:PSK 1216-7EPCB = A positive switching regulator with a 12 V, 16 A output, ambient temperature range of –25...71°C, inrush current limitation, potentiometer, thyristor-crowbar, and cooling plate B.

Product Marking

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

Front plate: Identification of LED, test sockets and potentiometer.

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of option and auxiliary functions and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

PSR: Positive Switching Regulators

PSL-Family

No input to output isolation
Single output of 5.1 to 24 V DC/55...216 W
Input voltage up to 60 V DC

- High efficiency up to 94%
- Wide input voltage range
- Low input-to-ouptut differential voltage
- Very good dynamic properties
- Input undervoltage cut-out
- Parallel configurations possible
- Continuous no-load and short-circuit proof
- No derating
- Safety according to IEC 950

Safety according to IEC 950

Table of Contents

Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i	Nominal input voltage $U_{i\,nom}$	Efficiency η	Type designation
5.1 V	11 A	8...40 V	20 V	79%	PSL 5A11-2R
12 V	9 A	15...40 V	20 V	90%	PSL 129-2R
15 V		19...40 V	30 V	91%	PSL 159-2R
24 V		29...60 V	40 V	94%	PSL 249-2R

Description

The PSL family of positive swiching regulators is designed as power supply modules for electronic systems. Their major advantages include a high level of efficiency that remains virtually constant over the entire input range, high reliability, low ripple and excellent dynamic response. Modules with input up to 60 V are specially designed for secondary switched and battery driven applications.
Case L04: Aluminium and self cooling.

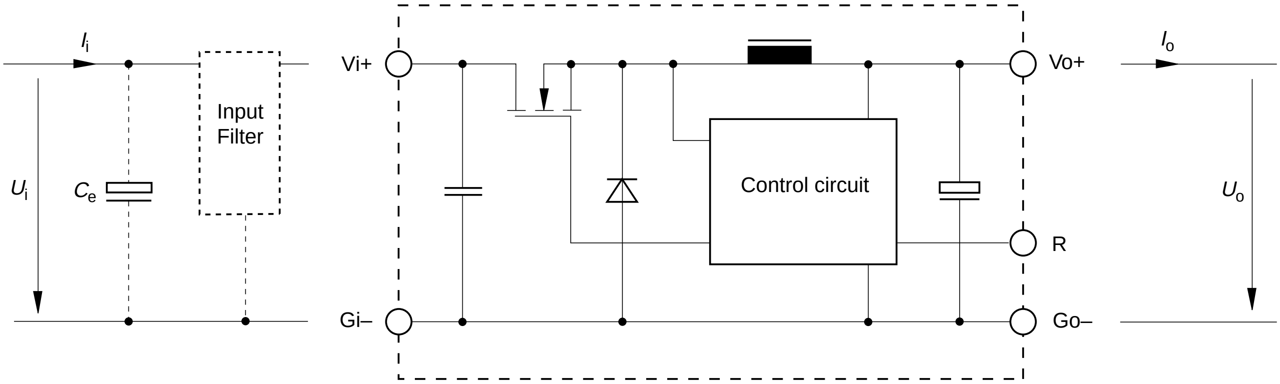


Fig. 1
Block Diagram

External input circuitry

An external input filter (see "Accessories") or an external capacitor (see "Application Notes") is required in rectifier mode and in DC operation mode only, if the sum of the lengths of the two input lines between source and input is greater than approx. 5 m.

5.3

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [1]	SELV circuit
			ELV circuit	Input fuse [2] and earthed output circuit [1]	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit

[1] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.
[2] The installer shall provide an approved fuse (slow blow type with lowest rating suitable for the application, max. 12.5 A) in the positive or negative input conductor directly at the input of the switching regulator. For UL's purpose, the fuse needs to be UL-listed.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90.

Protection Degree

The protection degree is defined by IP 20. It applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 32 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H11 (according to DIN 41612) to ensure requested safety!

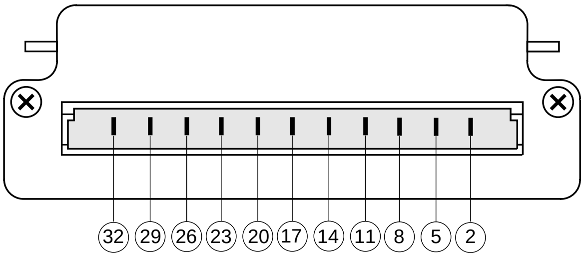


Fig. 2
View of male H11 connector

Table 3: H11 connector pin allocation and designation

Electrical Determination	Type H11 Pin No.	Type H11 Design.
R-input	2	R
Not connected	5	-
Output voltage (negative)	8	Go–
Output voltage (negative)	11	Go–
Output voltage(positive)	14	Vo+
Output voltage (positive)	17	Vo+
Input voltage (negative)	20	Gi–
Input voltage (negative)	23	Gi–
Input voltage (positive)	26	Vi+
Input voltage (positive)	29	Vi+
Protective ground (protruding pin)	32	⏚

5.3

Standard Features

R External Output Voltage Adjustment

Note: With an open R-pin, $U_o = U_{o\ nom}$!

The output voltage U_o can be adjusted either with an external resistance R_{ex} or an external reference voltage U_{ex}. The adjustment range is 0…1.00 of $U_{o\ nom}$. The minimum differential voltage $\Delta U_{io\ min}$ between input and output voltages as specified in relevant tables must be maintained.

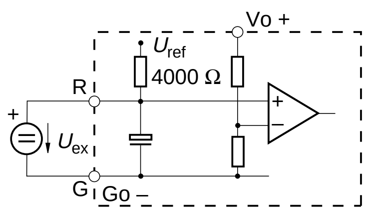


Fig. 3
Voltage adjustment with U_{ex}

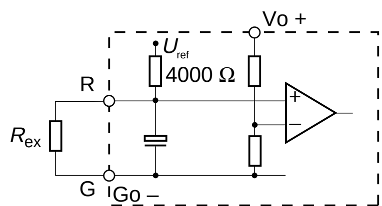


Fig. 4
Voltage adjustment with R_{ex}

Voltage adjustment with U_{ex} (U_{ref} = 2.5 V ±4%)

$$U_o \approx U_{ex} \cdot \frac{U_{o\ nom}}{U_{ref}} \quad [V]$$

Caution: To prevent damage U_{ex} should not exceed U_{ref}, nor be negative.

Voltage adjustment with R_{ex}

$$U_o \approx U_{o\ nom} \cdot \frac{R_{ex}}{R_{ex} + 4000} \quad [V]$$

$$R_{ex} \approx 4000 \cdot \frac{U_o}{U_{o\ nom} - U_o} \quad [\Omega]$$

All formulae give approximate values only.

Immunity to Environmental Conditions

Table 4: Mechanical stress

Test Method		Standard	Test Conditions		Status
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:	15 g_n = 147 m/s^2 11 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:	10 g_n = 98 m/s^2 16 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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...150 Hz 0.15 mm (10...60 Hz) 2 g_n = 20 m/s^2 60...150 Hz) 3.75 h (1.25 h each axis)	Unit operating

Table 5: Temperature specifications

Temperature			Standard -2		
Characteristics		Conditions	min	max	Unit
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–10	50	°C
T_C	Case temperature		–10	80	
T_S	Storage temperature	(Not operational)	–25	100	

Table 6: MTBF

MTBF	Ground Benign
MTBF acc. to MIL-HDBK-217F	T_C = 40°C
	484'000 h

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed

Table 7: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Electrostatic discharge	IEC 801-2 (1991-04)	2	contact discharge to case	4000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	[1, 4]
Electric field	IEC 801-3 (1984)	2	antenna in 1m distance	3 V/m	sine wave modulated w. 1 kHz		26…1000 MHz	yes	[1]
Fast transient/ burst	IEC 801-4 (1988)	2	i/c, +i/–i	1000 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]
		3		2000 V_p					[2, 4]
Transient	IEC 801-5 (Draft 1993-01)	II	i/c	1000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	[1, 4]
			+i/–i	500 V_p		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	2	i, o, signal wires	3 V_{rms} [3]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	[1]

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] Open circuit
[4] External input filter necessary (see "Accessories").

Emission

For emission levels refer to "Electrical Input and Output Data".

Electrical Input and Output Data

General Conditions
- T_A = 25°C, unless T_C is specified
- With R or option P, output voltage $U_o = U_{o\ nom}$ at $I_{o\ nom}$

Table 8: Input and output data

Characteristics		Conditions	PSL 5A11			PSL 129			PSL 159			PSL 249			
Output			min	typ	max	min	typ	max	min	typ	max	min	typ	max	Unit
$U_{o\ nom}$	Output voltage	$U_{i\ nom}$, $I_{o\ nom}$	5.05		5.15	11.60		12.40	14.50		15.50	23.30		24.70	V
$I_{o\ nom}$	Output current	$U_{i\ min}...U_{i\ max}$ $T_{C\ min}...T_{C\ max}$		11.0			9.0			9.0			9.0		A
$I_{o\ L}$	Output current limitation response		11.0		14.3	9.0		11.7	9.0		11.7	9.0		11.7	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\ nom}$, $I_{o\ nom}$			100			240			300			480	mV_{pp}
$\Delta U_{o\ U}$	Static control deviation versus input voltage U_i	$U_{i\ min}...U_{i\ max}$ $I_{o\ nom}$			100			240			300			480	mV
$\Delta U_{o\ I}$	Static control deviation versus output current I_o	$U_{i\ nom}$ $I_o = 0...I_{o\ nom}$			100			120			150			240	
$u_{o\ d}$	Dynamic control deviation [1]	$U_{i\ nom}$ $I_o \leftrightarrow {}^1/_3\ I_{o\ nom}$		150			360			450			700		
t_r	Dynamic load transient time recovery [1]			50			60			60			80		µs
α_{Uo}	Temperature coefficient $\Delta U_o / \Delta T_C$	$U_{i\ min}...U_{i\ max}$ $T_{C\ min}...T_{C\ max}$ $I_o = 0...I_{o\ nom}$			±1			±2			±3			±5	mV/K
					±0.02			±0.02			±0.02			±0.02	%/K
Input															
U_i	Input voltage range	$T_{C\ min}...T_{C\ max}$ $I_o = 0...I_{o\ nom}$	8		40	15		40	19		40	29		60	V DC
$\Delta U_{io\ min}$	Minimum differential voltage U_i - U_o			3			3			4			5		
U_{io}	Undervoltage cut-out			7.3			7.3			7.3			12.0		
$I_{i\ o}$	No load input current	$I_o = 0$ $U_{i\ nom}$		40			35			35			35		mA
I_{im}	Peak value of inrush current [2]	$U_{i\ nom}$		250			250			250			250		A
$t_{i\ s}$	Rise time [2]			5			5			5			5		µs
$t_{i\ r}$	Tail half value time [2]			40			40			40			40		
$u_{i\ rfi}$	RFI level at input [3] 0.01...30 MHz	VDE0871 (6.78) $U_{i\ nom}$, $I_{o\ nom}$			A			A			A			A	dB (µV)
Efficiency															
η	Efficiency	$U_{i\ nom}$, $I_{o\ nom}$		79			90			91			94		%
Isolation															
$U_{i\ s}$	Isolation test voltage electronic to case	Input/outputs interconnected		500			500			500			500		V DC

[1] See "Dynamic Characteristics"
[2] Definitions according to VDE 0433, part 3.
[3] Additional external input filter or capacitor necessary.

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

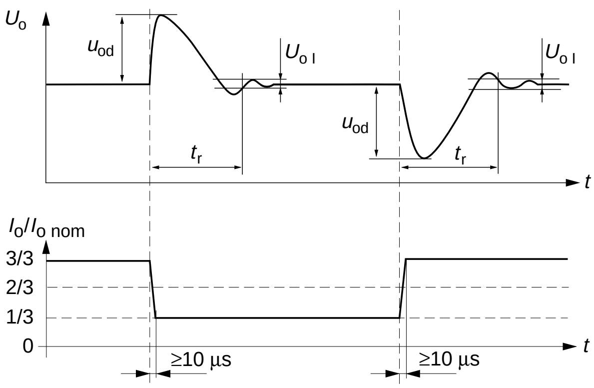


Fig. 5
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 50°C and is operated at its nominal output power, the case temperature T_C will be about 80°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 50°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 80°C (heat sink, fan, etc.).

Example: Sufficient forced cooling allows $T_{A\,max}$ = 65°C. A simple check of the case temperature T_C ($T_C \leq$ 80°C) at full load ensures correct operation of the system

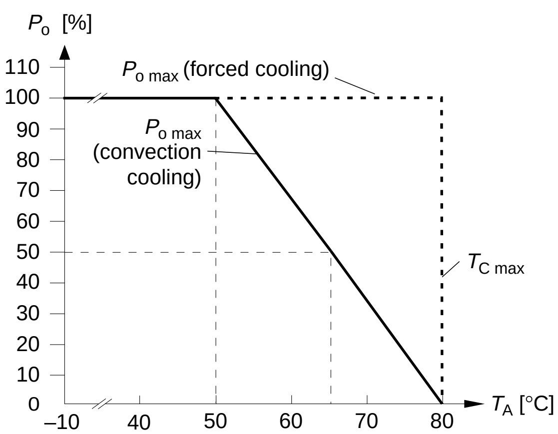


Fig. 6
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

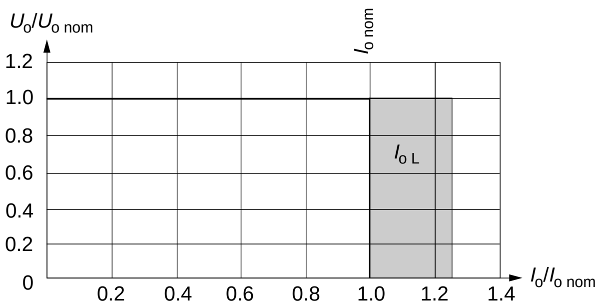
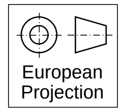


Fig. 7
Overload, short-circuit behaviour U_o versus I_o

Mechanical Data

Dimensions are in mm. Tolerances are ±0.3 mm unless otherwise specified.



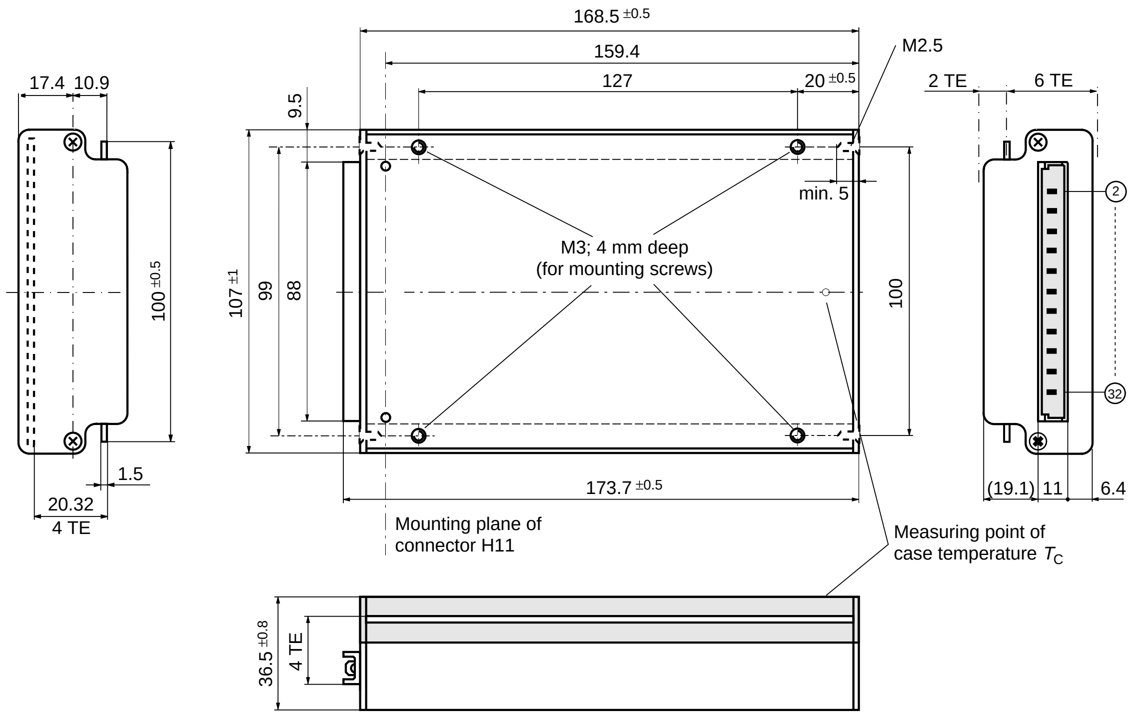


Fig. 8
Case L04 (weight 550 g)

Type Key and Product Marking

Type Key

PSL 12 9 -2 R

Positive switching regulator in case L04 .... PSL
Blank ....
Nominal output voltage in volt (5A → 5.1) .... 5.1...24
Nominal output current in ampere .... 9...11
Ambient temperature range
T_A = –10...50°C .... -2
External output voltage adjustment .... R

Example: PSL 129-2R = A positive switching regulator with a 12 V, 9 A output, ambient temperature range of –10...50°C and external output voltage adjustment.

Produkt Marking

Main face: Family designation, applicable safety approval and recognition marks, warnings, pin allocation, Melcher patent nos. and company logo.

Back plate: Specific type designation, input voltage range, nominal output voltage and current, pin allocation of auxiliary function and degree of protection.

Rear side: Label with batch no., serial no. and data code comprising production site, modification status of the main PCB and production date.

Positive Switching Regulators PSS-Family

No input to output isolation
Single output of 5.1, 12, 15 or 24 V DC/70...336 W
Input voltage up to 60 V DC

- Wide input voltage range
- High efficiency up to 94%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no-load and short-circuit proof
- Output current sharing
- No derating

Safety according to IEC 950

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i	Nominal input voltage $U_{i\,nom}$	Efficiency η	Type designation	Option
5.1 V	14 A	8...40 V	20 V	80%	PSS 5A14-2	B, B1
12 V [1]		16...40 V	30 V	90%	PSS 1214-2	
24 V		29...60 V	40 V	94%	PSS 2414-2	

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")

Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators incorporates various standard features to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case S01: Aluminium, fully enclosed. The basic model with heat sink is self cooling.

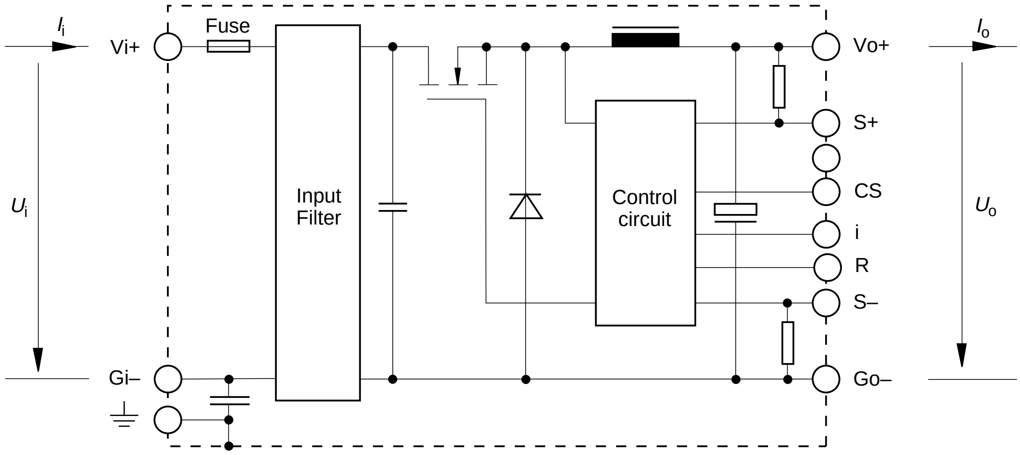


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [1]	SELV circuit
			ELV circuit	Input fuse [2] and earthed output circuit [1]	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit

[1] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.
[2] A suitable fuse is standard built-in.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90.

Protection Degree

The protection degree is defined by IP 30. It applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

Table 3: H15 connector pin allocation

Electrical Determination	Type H15	
	Pin No.	Ident.
Output voltage (positive)	4	Vo+
Output voltage (positive)	6	Vo+
Output voltage (negative)	8	Go–
Output voltage (negative)	10	Go–
Not connected	12	n.c.
Inhibit input	14	i
R-input (output voltage programming)	16	R
Sense line (negative)	18	S–
Sense line (positive)	20	S+
Current sharing control input	22	CS
Protective ground (protruding pin)	24	⏚
Input voltage (negative)	26	Gi–
Input voltage (negative)	28	Gi–
Input voltage (positive)	30	Vi+
Input voltage (positive)	32	Vi+

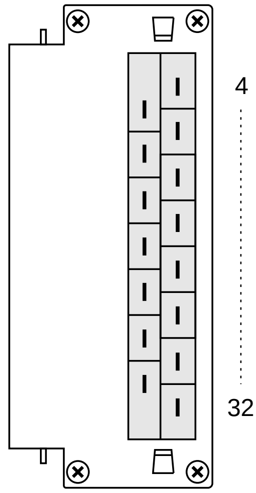


Fig. 2
View of male H15 connector

Standard Features

Note:
Additional information on input circuitry, grounding and parallel operation of units is given in section “Application Note”

Inhibit (i)

If the inhibit pin is not connected, the power supply is enabled (U_o = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

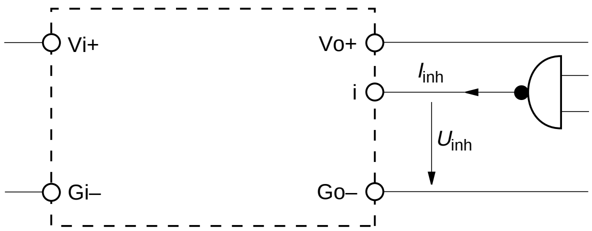


Fig. 3
Definition of inhibit voltage and current

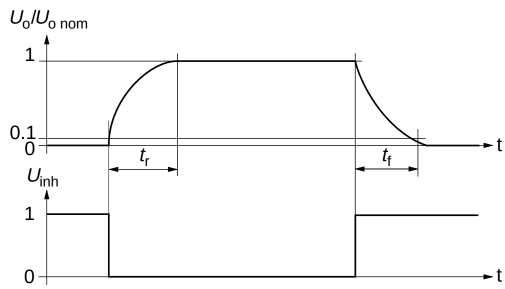


Fig. 4
Output response as a function of inhibit signal

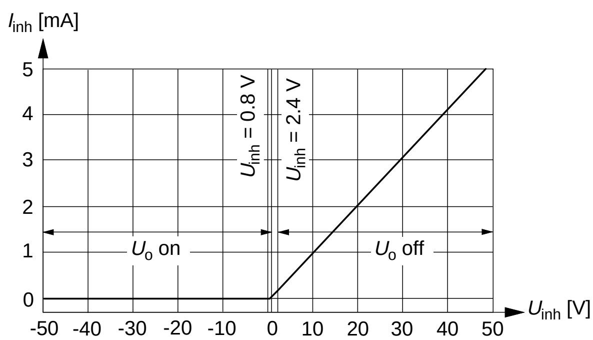


Fig. 5
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 4: Inhibit charakteristics

Characteristic			Conditions	PSS 5A14			PSS 1214			PSS 2414			Unit
				min	typ	max	min	typ	max	min	typ	max	
U_{inh}	Inhibit input voltage to keep output voltage...	U_o = on	$U_{i\,min}$...$U_{i\,max}$ $T_{C\,min}$...$T_{C\,max}$	-50		+0.8	-50		+0.8	-50		+0.8	V DC
		U_o = off		+2.4		+50	+2.4		+50	+2.4		+50	
t_r	Switch-on time after inhibit command		$U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,max}$ (resistive load)		100			100			100		ms
t_f	Switch-off time after inhibit command				10			15			20		
$I_{i\,off}$	Input current with converter inhibited		$I_o = 0$ $U_{i\,nom}$		25			25			25		mA

5.3

Input Filter and Fuse

An input filter and a fuse are incorporated in all PSS modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$u_{i\,max} = 10\ V_{pp}$ at 100 Hz, or $V_{pp} = 1000\ Hz/f_i \cdot 1\ V$

Note: Inrush current can reach very high values depending on the source and input line conditions. The inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. This input presents a very low impedance to such currents and when driven from a low impedance source, e.g. a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. To protect series elements such as switches or circuit brakers and rectifiers the use of additional external current limitation device is recommended.

Current Sharing (CS)

Note: Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Sense Lines (S)

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSS connector) should not exceed the following values:

Output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
5.1 V	<0.5 V	<0.25 V
12 , 24 V	<1.0 V	<0.25 V

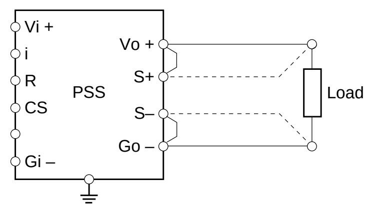


Fig. 6
Sense lines connection

External Voltage Adjustment (R)

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

The output voltage U_o can either be adjusted with an external resistor R_1 or R_2, or with an external voltage U_{ex} referenced to S–. The adjustment range is 0...$U_{o\,max}$ (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor (R_1 resp. R_2).

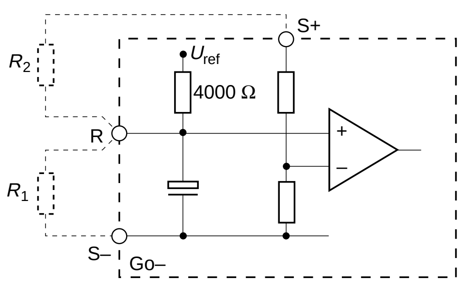


Fig. 7
Voltage adjustment with external resistor R_1 or R_2

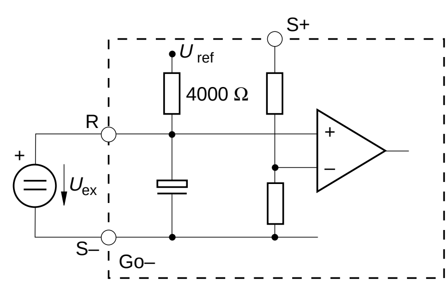


Fig. 8
Voltage adjustment with external voltage U_{ex} [V]

a) $U_o = 0...U_{o\,nom}$, using R_1 [Ω] between R and S–:

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

b) $U_o = U_{o\,nom}...U_{o\,max}$, using R_2 [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1-k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) $U_o = 0...U_{o\,max}$, using U_{ex} [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \left[\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02\right]$$

$(U_{ref} = 2.48\ V \pm 1\%)$

All formulae give approximate values only.

Caution: To prevent damage U_{ex} should not exceed 20 V nor be negative!

Immunity to Environmental Conditions

Table 5: Mechanical stress

Test Method		Standard	Test Conditions		Status
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:	15 g_n = 147 m/s^2 11 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:	10 g_n = 98 m/s^2 16 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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...150 Hz 0.15 mm (10...60 Hz) 2 g_n = 20 m/s^2 (60...150 Hz) 3.75 h (1.25 h each axis)	Unit operating

Table 6: Temperature specifications

Temperature			Standard -2		
Characteristics		Conditions	min	max	Unit
T_A	Ambient temperature	$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$	–10	50	°C
T_C	Case temperature		–10	80	
T_S	Storage temperature	Not operational	–25	100	

Table 7: MTBF values

MTBF	Ground Benign
MTBF acc. to MIL-HDBK-217F	T_C = 40°C
	335'000 h

5.3

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 8: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Electrostatic discharge	IEC 801-2 (1991-04)	3	contact discharge to case	6000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	1
Electric field	IEC 801-3 (1984)	2	antenna in 1m distance	3 V/m	sine wave modulated w. 1 kHz		26…1000 MHz	yes	1
Fast transient/ burst	IEC 801-4 (1988)	2	i/c, +i/–i	1000 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
		3		2000 V_p					2
Transient	IEC 801-5 (Draft 1993-01)	II	i/c	1000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	1
			+i/–i	500 V_P		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	2	i, o, signal wires	3 V_{rms} [3]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	1

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

Electrical Input and Output Data

General Conditions

- T_A = 25°C, unless T_C is specified
- With R, output voltage $U_o = U_{o\,nom}$ at $I_{o\,nom}$

Table 9: Input and output data

Characteristics		Conditions	PSS 5A14			PSS 1214			PSS 2414			Unit
Output			min	typ	max	min	typ	max	min	typ	max	
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	5.05		5.15	11.60		12.40	23.30		24.70	V
$U_{o\,max}$	Maximum adjustable output voltage utilizing R input	$U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector			5.6			16.0			26.0	
$I_{o\,nom}$	Output current	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$		14			14			14		A
$I_{o\,L}$	Output current limitation response (% of $I_{o\,nom}$)		100		125	100		125	100		125	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\,nom}$, $I_{o\,nom}$			100			240			480	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$			100			240			480	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0...I_{o\,nom}$			100			120			240	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_o \leftrightarrow {}^1/_3\, I_{o\,nom}$		150			360			700		
t_r	Dynamic load transient time recovery [1]			40			60			60		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$		±1			±3			±5		mV/K
				±0.02			±0.02			±0.02		%/K
Input												
U_i	Input voltage range	$T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$	8		40	16		40	29		60	V DC
$\Delta U_{io\,min}$	Minimum differential voltage $U_i - U_o$			3			4			5		
U_{io}	Undervoltage cut-out			6.5			7.3			12		
$I_{i\,o}$	No load input current	$I_o = 0$ $U_{i\,nom}$		36			36			36		mA
u_{rfi}	RFI level at input, 0.01...30 MHz	VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$			A			A			A	dB (µV)
Efficiency												
η	Efficiency	$U_{i\,nom}$, $I_{o\,nom}$		80			90			94		%
Isolation												
$U_{i\,s}$	Isolation test voltage electronic to case	All input and output terminals interconnected		500			500			500		V DC

[1] See "Dynamic Characteristics"

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

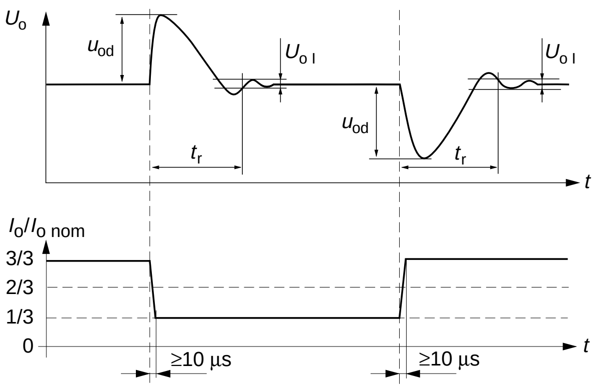


Fig. 9
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 50°C and is operated at its nominal output power, the case temperature T_C will be about 80°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 50°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 80°C (heat sink, fan, etc.).

Example: Sufficient forced cooling allows $T_{A\,max}$ = 65°C. A simple check of the case temperature T_C ($T_C \leq$ 80°C) at full load ensures correct operation of the system

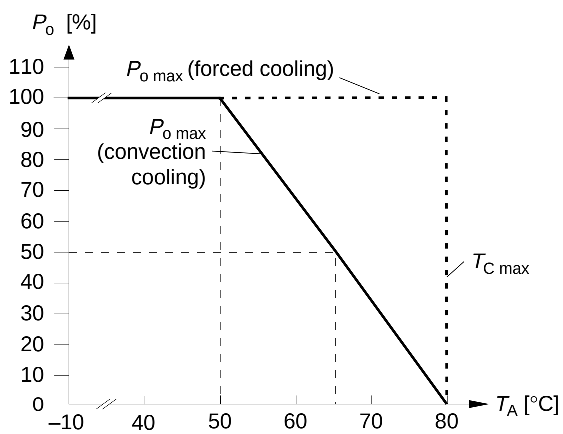


Fig. 10
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

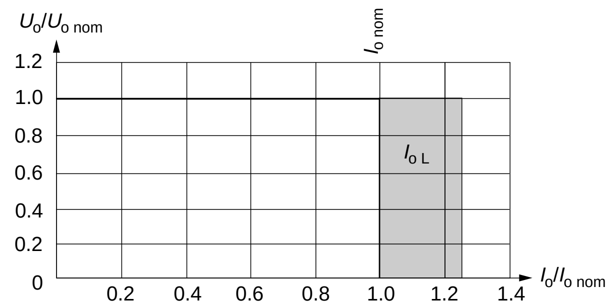


Fig. 11
Overload, short-circuit behaviour U_o versus I_o

Description of Options

Option B, Option B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\ max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \bullet (U_o \bullet I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output above $T_{C\ max}$. The output is automatically enabled again after temperature has droped below $T_{C\ max}$.

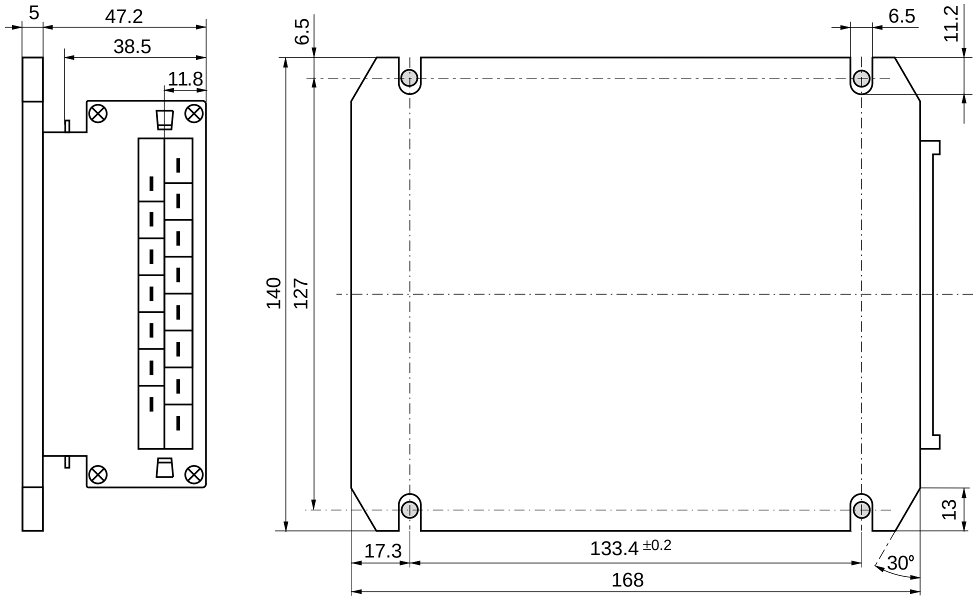


Fig. 12
Case S01 with option B (cooling plate)
Weight: 1.2 kg

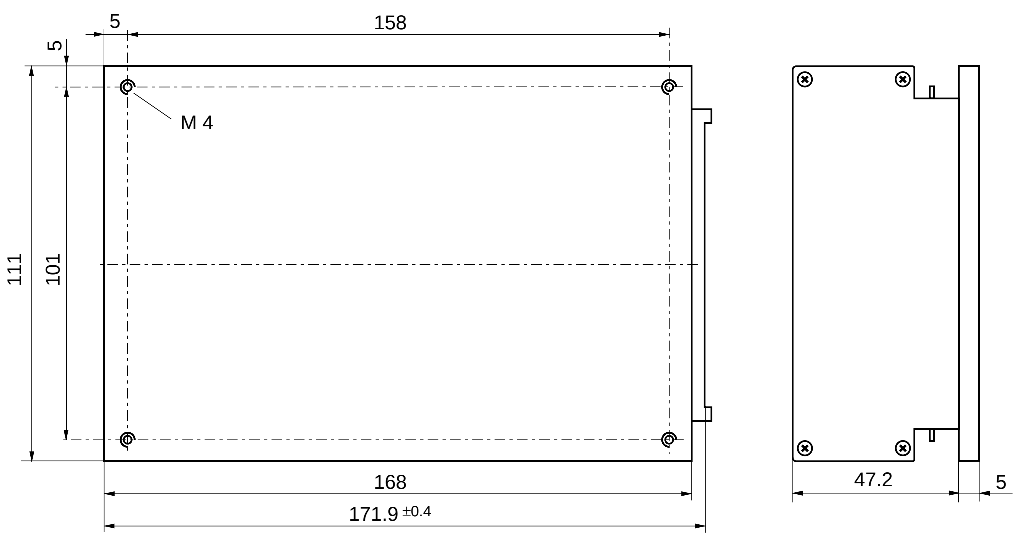
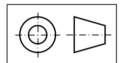


Fig. 13
Case S01 with option B1 (cooling plate)
Weight: 1.2 kg

Mechanical Data



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

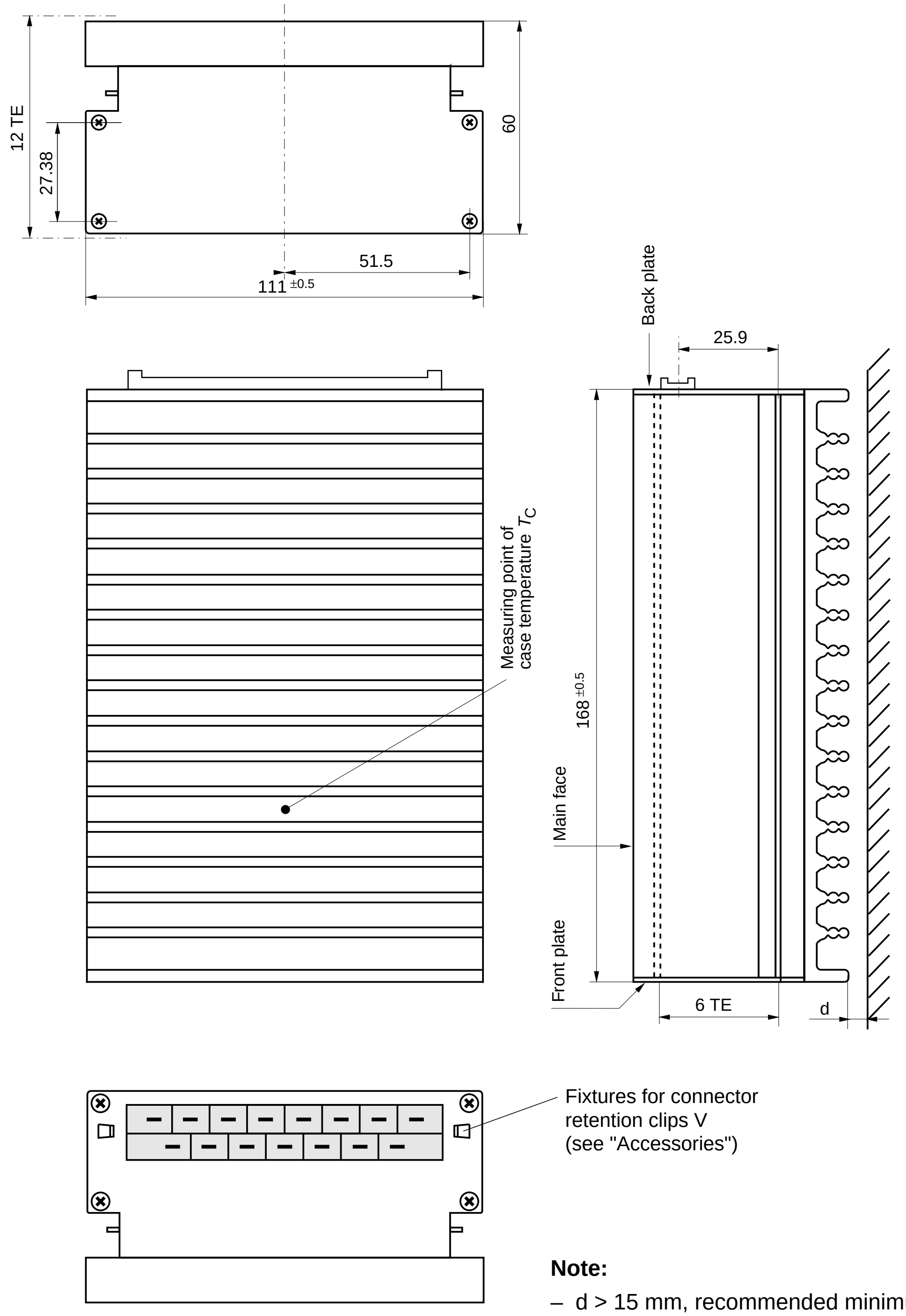


Fig. 14
Case S01 with heatsink
Weight: 1.3 kg

Note:

– d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power

– free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink

5.3

Type Key and Product Marking

Type Key

PSS 12 14 -2 B

Positive switching regulator in case S01 .... PSS
Blank ....
Nominal output voltage in volt (5A → 5.1) .... 5.1...24
Nominal output current in ampere 14
Ambient temperature range
T_A = –10...50°C .... -2
Cooling plate .... B, B1

Example: PSS 1214-2B = A positive switching regulator with a 12 V, 14 A output, ambient temperature range of –10...50°C and cooling plate B.

Product Marking

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

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of auxiliary functions and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.

MELCHER
The Power Partners.

Positive Switching Regulators PSK-Family

No input to output isolation
Single output of 5.1, 12, 15 or 24 V DC/90...432 W
Input voltage up to 60 V DC

- Wide input voltage range
- High efficiency up to 94%
- Input undervoltage cut-out
- Output voltage adjustment and inhibit
- Output voltage sense lines
- Fast dynamic response
- Output no-load and short-circuit proof
- Output current sharing
- No derating

Safety according to IEC 950

Table of Contents

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Type Survey

Table 1: Type survey

Nominal output voltage $U_{o\,nom}$	Nominal output current $I_{o\,nom}$	Input voltage range U_i	Nominal input voltage $U_{i\,nom}$	Efficiency η	Type designation	Option
5.1 V	18 A	8...40 V	20 V	80%	PSK 5A18-2	B, B1
12 V [1]		16...40 V	30 V	90%	PSK 1218-2	
24 V		29...60 V	40 V	94%	PSK 2418-2	

[1] 15 V output adjustable at R-input (see Standard Features: "External Voltage Adjustment")

Description

The switching regulators define power supply modules for electronic systems. Their major advantages include very high efficiency which remains virtually constant over the entire input voltage range, high reliability, low output ripple and excellent dynamic response. This allows operation in the majority of battery driven or secondary switched applications. The basic type of regulators incorporates various standard features to adapt almost to any individual application. The modules can depending on application and cooling requirements either be delivered in the design of a 19" cassette with a heatsink for rack-mounting including chassis fixation, or the heat sink being replaced by a cooling plate (option B, B1) suitable for chassis-mount on a metal surface, acting as the heat sink.

Connector type: H15 according to DIN 41612.

Case K01: Aluminium, fully enclosed. The basic model with heat sink is self cooling.

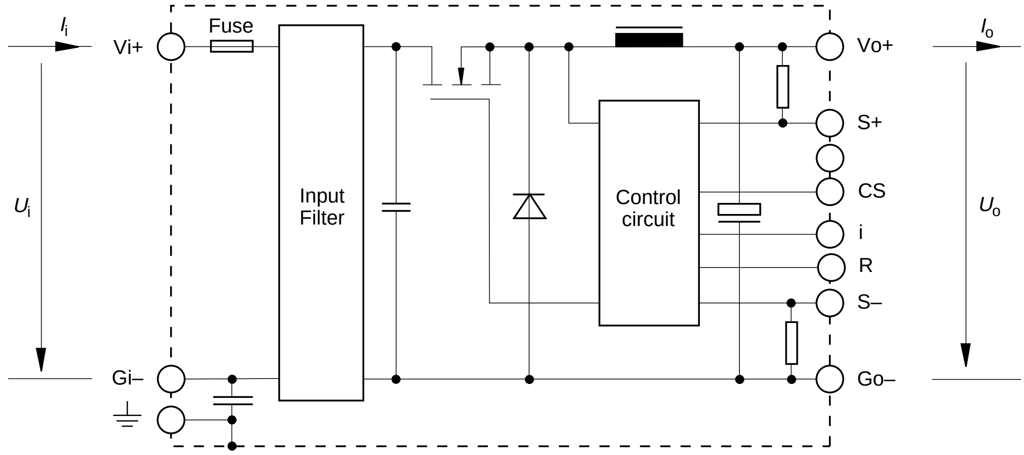


Fig. 1
Block diagram

Safety and Installation Instructions

Safety

If the output circuit of a switching regulator 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.

If the following table is observed, the output of any switching regulator is considered to be an SELV circuit up to a nominal output voltage of 36 V.

Note: Check for hazardous voltages before altering any connections. Do not open the module. The input and the output circuitry are not separated, i.e. the negative path is internally interconnected!

Table 2: Insulation concept for SELV circuits

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	Measures to achieve the specified safety status of the output circuit	Resulting safety status of the switching regulator output circuit
None	Battery supply completely separated from mains	≤60 V	SELV battery circuit	None	SELV circuit
≤250 V	Basic	≤60 V	Earthed SELV circuit	Earthed input circuit [1]	SELV circuit
			ELV circuit	Input fuse [2] and earthed output circuit [1]	Earthed SELV circuit
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit

[1] The earth connection has to be provided by the installer according to the relevant safety standards, e.g. IEC 950.
[2] A suitable fuse is standard built-in.

Standards and Approvals

All Melcher power supplies are subject to manufacturing surveillance in accordance with ISO 9001 standards.

All units are UL recognized as per UL 1950, UL 1012, CAN/CSA C22.2 No. 234-M90.

Protection Degree

The protection degree is defined by IP 30. It applies only if the module is plugged-in or the female connector is properly attached to the module.

Installation Instructions

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin no. 24 is the protective ground pin and is protruding, i.e. attaching the female connector, this pin provides electrical contact first. The modules should only be wired via the female connector H15 (see "Accessories") to ensure requested safety!

Table 3: H15 connector pin allocation

Electrical Determination	Type H15	
	Pin No.	**Ident.**
Output voltage (positive)	4	Vo+
Output voltage (positive)	6	Vo+
Output voltage (negative)	8	Go–
Output voltage (negative)	10	Go–
Not connected	12	n.c.
Inhibit input	14	i
R-input (output voltage programming)	16	R
Sense line (negative)	18	S–
Sense line (positive)	20	S+
Current sharing control input	22	CS
Protective ground (protruding pin)	24	⏚
Input voltage (negative)	26	Gi–
Input voltage (negative)	28	Gi–
Input voltage (positive)	30	Vi+
Input voltage (positive)	32	Vi+

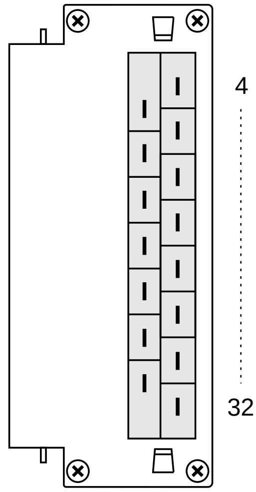


Fig. 2
View of male H15 connector

Standard Features

Note:
Additional information on input circuitry, grounding and parallel operation of units is given in section "Application Note"

Inhibit (i)

If the inhibit pin is not connected, the power supply is enabled (U_o = on). Unused inhibit inputs do not need to be tied to ground or negative sense line respectively.

The switching regulator can be switched on or off with a control signal via the inhibit input i. In systems consisting of several switching regulator modules, this feature can be used for example to control the activation sequence of the regulator modules by means of a logic signal (TTL, C-MOS, etc.).

An output voltage overshoot will not occur when the modules are switched on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

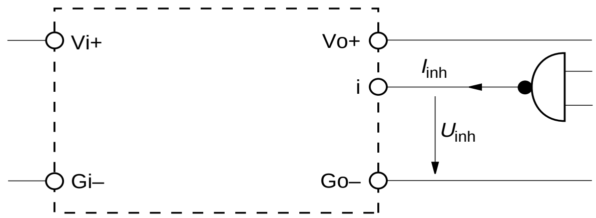


Fig. 3
Definition of inhibit voltage and current

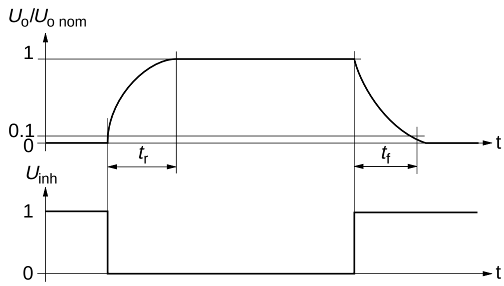


Fig. 4
Output response as a function of inhibit signal

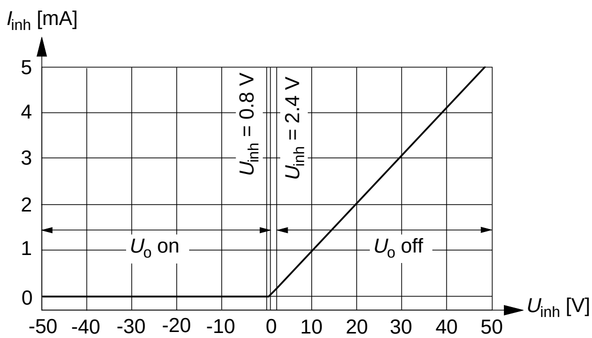


Fig. 5
Inhibit current I_{inh} versus inhibit voltage U_{inh}

Table 4: Inhibit characteristics

Characteristic			Conditions	PSK 5A18			PSK 1218			PSK 2418			Unit
				min	typ	max	min	typ	max	min	typ	max	
U_{inh}	Inhibit input voltage to keep output voltage...	U_o = on	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	-50		+0.8	-50		+0.8	-50		+0.8	V DC
		U_o = off		+2.4		+50	+2.4		+50	+2.4		+50	
t_r	Switch-on time after inhibit command		$U_{i\,nom}$ $R_L = U_{o\,nom}/I_{o\,max}$ (resistive load)		100			100			100		ms
t_f	Switch-off time after inhibit command				10			15			20		
$I_{i\,off}$	Input current with converter inhibited		$I_o = 0$ $U_{i\,nom}$		25			25			25		mA

Input Filter and Fuse

An input filter and a fuse are incorporated in all PSK modules as standard. The filter reduces emitted electrical noise and prevents oscillations caused by the negative input impedance characteristic of a switched mode regulator. The input fuse protects against severe defects.

The maximum permissible additionally superimposed ripple u_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

$$u_{i\,max} = 10\ V_{pp} \text{ at } 100\ Hz, \text{ or } V_{pp} = 1000\ Hz/f_i \cdot 1\ V$$

Note: Inrush current can reach very high values depending on the source and input line conditions. The inrush current into a switching regulator is limited by parasitic components of the voltage source and power supply input only. This input presents a very low impedance to such currents and when driven from a low impedance source, e.g. a battery, the inrush current can peak at several orders of magnitude above the continuous DC input current. To protect series elements such as switches or circuit brakers and rectifiers the use of additional external current limitation device is recommended.

Current Sharing (CS)

Note: Never disconnect any operating modules using CS!

For parallel operation of several modules, interconnecting all CS pins ensures that the output currents are evenly distributed. This feature improves transient load performance and increases system reliability. All paralleled units should be supplied by equal input voltage (U_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Sense Lines (S)

Note: Sense lines should always be connected! It is recommended to connect the sense lines directly at the female connector.

This feature enables compensation of voltage drop across the connector contacts and the load lines. In case the sense lines are connected at the load rather than directly at the connector, the user must ensure that $U_{o\,max}$ (between Vo+ and Go–) is not exceeded.

Applying generously dimensioned cross-section load leads avoids troublesome voltage drop. To minimize noise pick-up wire sense lines in parallel or twisted.

To ensure correct operation, both sense lines must be connected to their respective power output potential. The voltage difference between any sense line and its respective power output pin (as measured on the PSK connector) should not exceed the following values:

Output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
5.1 V	<0.5 V	<0.25 V
12 , 24 V	<1.0 V	<0.25 V

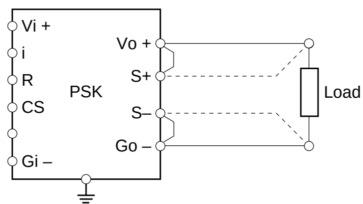


Fig. 6
Sense lines connection

External Voltage Adjustment (R)

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

The output voltage U_o can either be adjusted with an external resistor R_1 or R_2, or with an external voltage U_{ex} referenced to S–. The adjustment range is 0...$U_{o\,max}$ (see "Electrical Data"). The minimal differential voltage $\Delta U_{io\,min}$ between input and output voltages must be maintained.

Paralleled units must be connected to the same resistor (R_1 resp. R_2).

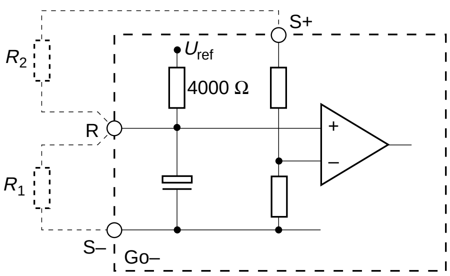


Fig. 7
Voltage adjustment with external resistor R_1 or R_2

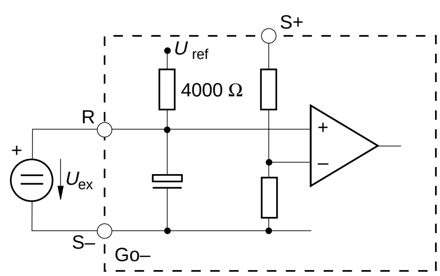


Fig. 8
Voltage adjustment with external voltage U_{ex} [V]

a) U_o = 0...$U_{o\,nom}$, using R_1 [Ω] between R and S–:

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

b) $U_o = U_{o\,nom}...U_{o\,max}$, using R_2 [Ω] between R and S+
$U_{o\,max}$ is internally limited (see data)

$$U_o \approx U_{ref} \cdot \frac{R_2}{k \cdot (R_2 + 4000) - 4000} \qquad k = \frac{U_{ref}}{U_{o\,nom}}$$

$$R_2 \approx 4000 \cdot \frac{U_o \cdot (1\text{-}k)}{k \cdot U_o - U_{ref}} \qquad (U_{ref} = 2.48\ V \pm 1\%)$$

c) U_o = 0...$U_{o\,max}$, using U_{ex} [V] between R and S–:

$$U_o \approx U_{o\,nom} \cdot \left[\frac{U_{ex}}{U_{ref}} \cdot 0.98 + 0.02\right]$$

$(U_{ref} = 2.48\ V \pm 1\%)$

All formulae give approximate values only.

Caution: To prevent damage U_{ex} should not exceed 20 V nor be negative!

Immunity to Environmental Conditions

Table 5: Mechanical stress

Test Method		Standard	Test Conditions		Status
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:	15 g_n = 147 m/s^2 11 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:	10 g_n = 98 m/s^2 16 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): Max. vibration amplitude: Acceleration amplitude: Test duration:	10...150 Hz 0.15 mm (10...60 Hz) 2 g_n = 20 m/s^2 (60...150 Hz) 3.75 h (1.25 h each axis)	Unit operating

Table 6: Temperture specifications

Temperature			Standard -2		
Characteristics		Conditions	min	max	Unit
T_A	Ambient temperature	$U_{i\ min}...U_{i\ max}$ I_o = 0...$I_{o\ nom}$	–10	50	°C
T_C	Case temperature		–10	80	
T_S	Storage temperature	Not operational	–25	100	

Table 7: MTBF values

MTBF	Ground Benign
MTBF acc. to MIL-HDBK-217F	T_C = 40°C
	335'000 h

5.3

Electromagnetic Compatibility EMC

Immunity

General condition: Case earthed.

Table 8: Immunity type tests

Phenomenon	Standard	Class Level	Coupling mode [4]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form.
Electrostatic discharge	IEC 801-2 (1991-04)	3	contact discharge to case	6000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	[1]
Electric field	IEC 801-3 (1984)	2	antenna in 1m distance	3 V/m	sine wave modulated w. 1 kHz		26…1000 MHz	yes	[1]
Fast transient/ burst	IEC 801-4 (1988)	2	i/c, +i/–i	1000 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]
		3		2000 V_p					[2]
Transient	IEC 801-5 (Draft 1993-01)	II	i/c	1000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. impulses per coupling mode	yes	[1]
			+i/–i	500 V_P		2 Ω			
Immunity to conducted disturbancies	IEC 801-6	2	i, o, signal wires	3 V_{rms} [3]	80% amplitude modulated with 1 kHz	50 Ω	AM 0.15...80 MHz	yes	[1]

[1] Normal operation, no deviation from specifications
[2] Normal operation, temporary deviation from specs possible
[3] Open circuit

Emission

For emission levels refer to "Electrical Input and Output Data".

5.3

Characteristics and Definitions

Output Protection

A voltage suppressor diode protects the output against an internally generated overvoltage, which could occur due to a failure of the control circuit, which in worst case conditions fails into a short circuit. The suppressor diode is not designed to withstand externally applied overvoltages. The user should ensure that systems with Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

Dynamic Characteristics

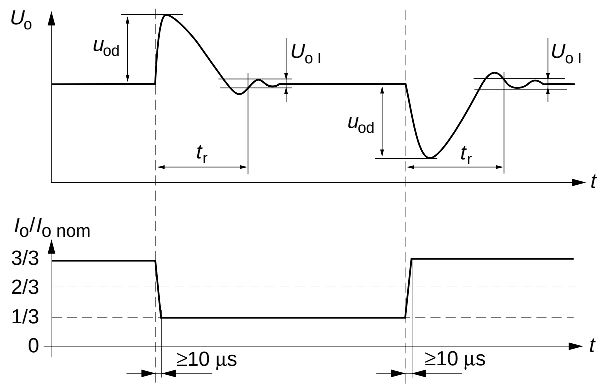


Fig. 9
Behaviour and characteristics under varying load conditions.

Temperature

When a converter is located in free, quasi-stationary air at a temperature T_A = 50°C and is operated at its nominal output power, the case temperature T_C will be about 80°C after the warm-up phase measured at the measuring point of case temperature T_C (see "Mechanical Data").

Under practical operating conditions, the ambient temperature T_A may exceed 50°C, provided additional measures are taken to ensure that the case temperature T_C does not exceed its maximum value of 80°C (heat sink, fan, etc.).

Example: Sufficient forced cooling allows $T_{A\,max}$ = 65°C. A simple check of the case temperature T_C ($T_C \leq$ 80°C) at full load ensures correct operation of the system

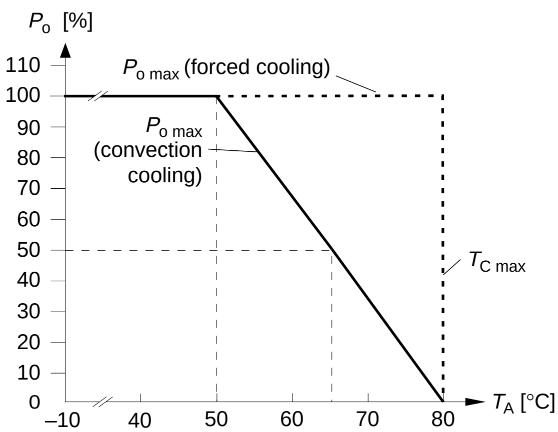


Fig. 10
Output power derating versus ambient temperature

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. However, the use of a single unit with higher output power, because of its power dissipation, is always a better solution.

In parallel-connected operation, one or several outputs may operate continuously at their current limit knee-point which will cause an increase of the case temperature. Consequently, the max. ambient temperature value should be reduced by 10 K.

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Galvanically separated source voltages are needed for each module!

Short circuit behaviour

A constant current limitation circuit holds the output current almost constant whenever an overload or a short circuit is applied to the regulator's output. It acts self-protecting and recovers - in contrary to the fold back method - automatically after removal of the overload or short circuit condition.

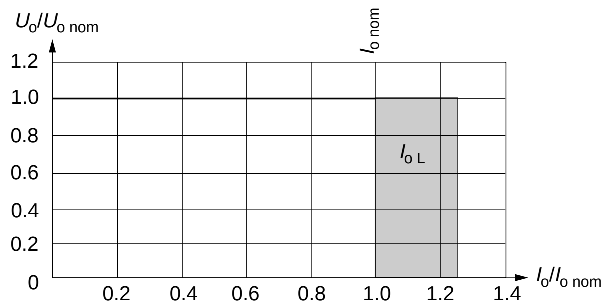


Fig. 11
Overload, short-circuit behaviour U_o versus I_o

Electrical Input and Output Data

General Conditions

- T_A = 25°C, unless T_C is specified
- With R, output voltage U_o = $U_{o\,nom}$ at $I_{o\,nom}$

Table 9: Input and output data

Characteristics		Conditions	PSK 5A18			PSK 1218			PSK 2418			
Output			min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage	$U_{i\,nom}$, $I_{o\,nom}$	5.05		5.15	11.60		12.40	23.30		24.70	V
$U_{o\,max}$	Maximum adjustable output voltage utilizing R input	$U_{i\,nom}$, $I_{o\,nom}$ sense lines linked at the connector			5.6			16.0			26.0	
$I_{o\,nom}$	Output current	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$		18			18			18		A
$I_{o\,L}$	Output current limitation response (% of $I_{o\,nom}$)		100		125	100		125	100		125	%
u_o	Ripple at Output (BW = 20 MHz)	$U_{i\,nom}$, $I_{o\,nom}$			100			240			480	mV_{pp}
$\Delta U_{o\,U}$	Static control deviation versus input voltage U_i	$U_{i\,min}...U_{i\,max}$ $I_{o\,nom}$			100			240			480	mV
$\Delta U_{o\,I}$	Static control deviation versus output current I_o	$U_{i\,nom}$ $I_o = 0...I_{o\,nom}$			100			120			240	
$u_{o\,d}$	Dynamic control deviation [1]	$U_{i\,nom}$ $I_o \leftrightarrow {}^1/_3\ I_{o\,nom}$		150			360			700		
t_r	Dynamic load transient time recovery [1]			40			60			60		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$	$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$		±1			±3			±5		mV/K
				±0.02			±0.02			±0.02		%/K
Input												
U_i	Input voltage range	$T_{C\,min}...T_{C\,max}$ $I_o = 0...I_{o\,nom}$	8		40	16		40	29		60	V DC
$\Delta U_{io\,min}$	Minimum differential voltage $U_i - U_o$			3			4			5		
U_{io}	Undervoltage cut-out			6.5			7.3			12		
$I_{i\,o}$	No load input current	$I_o = 0$ $U_{i\,nom}$		36			36			36		mA
u_{rfi}	RFI level at input, 0.01...30 MHz	VDE0871, part 11 EN 55011/55022 $U_{i\,nom}$, $I_{o\,nom}$			A			A			A	dB (µV)
Efficiency												
η	Efficiency	$U_{i\,nom}$, $I_{o\,nom}$		80			90			94		%
Isolation												
$U_{i\,s}$	Isolation test voltage electronic to case	All input and output terminals interconnected		500			500			500		V DC

[1] See "Dynamic Characteristics"

5.3

Description of Options

Option B, Option B1 Cooling Plate

Where a cooling surface is available, a cooling plate (option B, or option B1) can be used instead of the standard heatsink. The mounting system must ensure sufficient cooling capacity to guarantee that the maximum case temperature $T_{C\ max}$ is not exceeded. The required cooling capacity can be calculated by the following formula:

$$P_{Loss} = \frac{100\% - \eta}{\eta} \bullet (U_o \bullet I_o)$$

The unit is self-protecting by an internal temperature monitor, which inhibits the output above $T_{C\ max}$. The output is automatically enabled again after temperature has droped below $T_{C\ max}$.

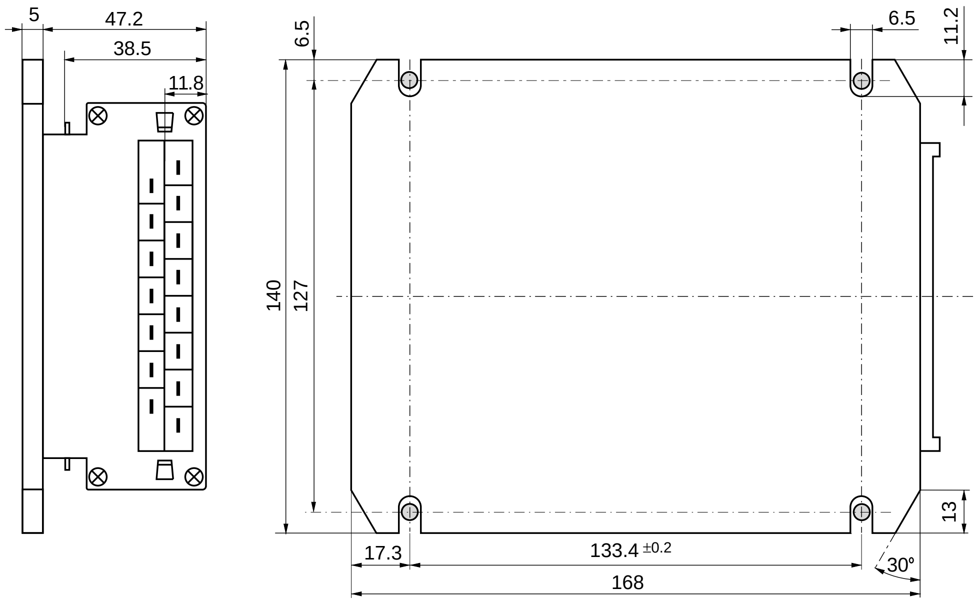


Fig. 12
Case K01 with option B (cooling plate)
Weight: 1.2 kg

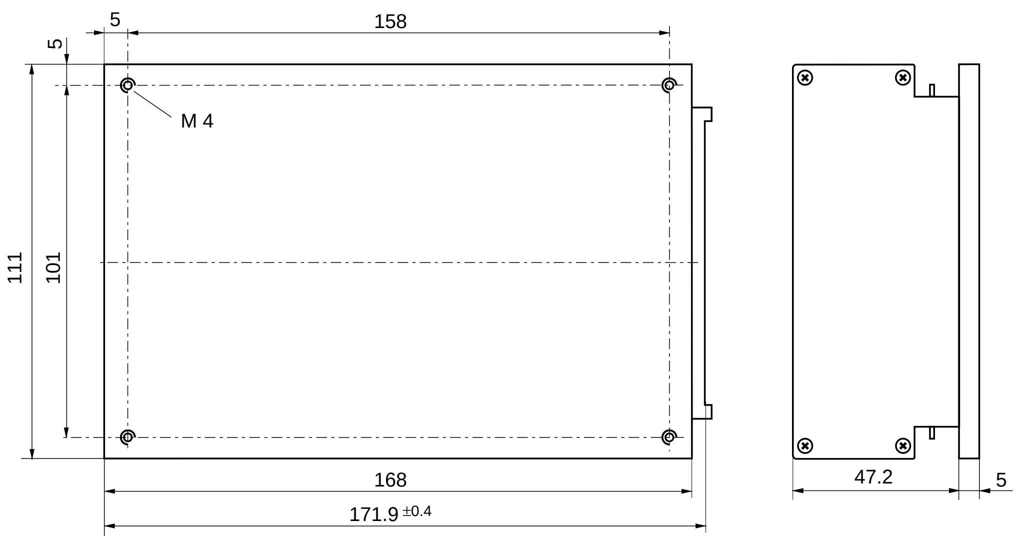
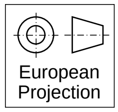
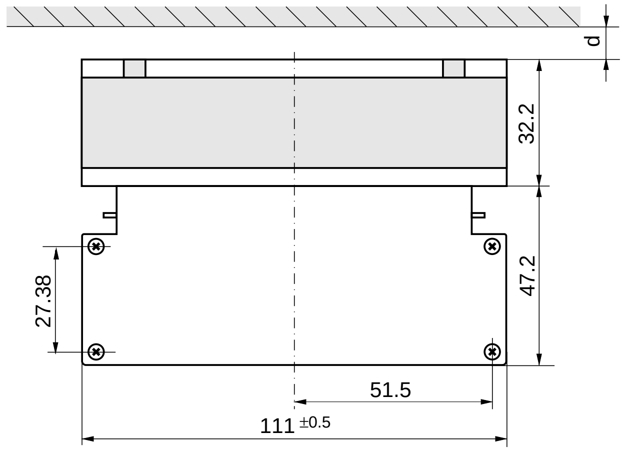


Fig. 13
Case K01 with option B1 (cooling plate)
Weight: 1.2 kg

Mechanical Data

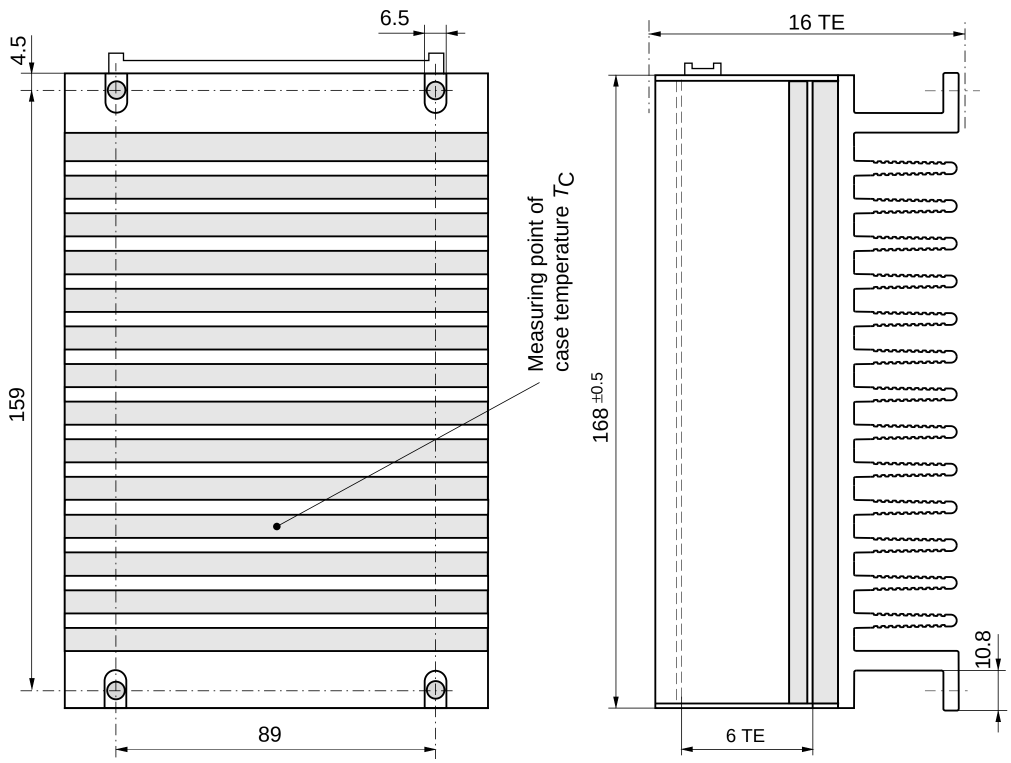
Dimensions in mm. Tolerances ±0.3 mm unless otherwise indicated.





Note:

- d > 15 mm, recommended minimum distance to next part to ensure proper air circulation at full output power
- free air locations: the modules should be mounted with fins in vertical position to achieve a maximum air flow through heat sink



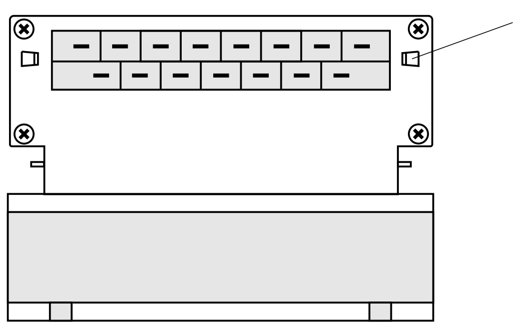


Fig. 14
Case K01 with heatsink
Weight: 1.6 kg

Type Key and Product Marking

Type Key

PSK 12 18 -2 B

Positive switching regulator in case K01 .... PSK
Blank ....
Nominal output voltage in volt (5A → 5.1) .... 5.1...24
Nominal output current in ampere 18
Ambient temperature range
T_A = –10...50°C .... -2
Cooling plate .... B, B1

Example: PSK 1218-2B = A positive switching regulator with a 12 V, 18 A output, ambient temperature range of –10...50 °C and cooling plate B.

Product Marking

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

Back plate: Specific type designation, input voltage range, nominal output voltage and output current, pin allocation of auxiliary functions and degree of protection.

Label: Batch No., serial No. and data code including production site, modification status of main pcb and date of production.