PSS, PSK Extended Data Sheet
Positive Switching Regulator (Rugged)

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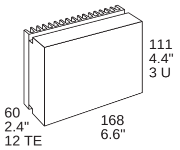
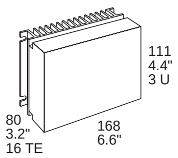


Input voltage up to 144 VDC
Single output of 12 to 48 VDC
No input to output isolation

- High efficiency up to 97%
- Extremely wide input voltage range
- Low input to output differential voltage
- Very good dynamic properties
- Input undervoltage lock-out
- Active current sharing for parallel operation
- Output voltage adjustment, inhibit and sense lines
- Fast dynamic response
- Continuous no-load and short-circuit proof
- No derating

Safety according to IEC/EN 60950, UL 1950

c UL us CE



Summary

The PSS/PSK series of positive switching 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 voltages up to 144 V are specially designed for secondary switched and battery-driven mobile applications. The standard case design with heat sink allows operation at nominal load up to 71°C without additional cooling, suitable for 19" rack or chassis mounting.

Replacing the heat sink by an optional cooling plate B or B1, allows chassis or wall mounting on top of a metal surface, acting as heat sink.

Connector type: H15 (according to DIN 41612).

Table of Contents

Model Selection and Key Data

Table 1: Type survey

Output voltage $V_{o\,nom}$ [V]	Output current $I_{o\,nom}$ [A]	Input voltage range V_i [V] [1]	Input voltage $V_{i\,nom}$ [V]	Efficiency [2]		Type designation	Options
				η_{min} [%]	η_{typ} [%]		
12	9	18 - 144	60	90	91	PSS 129-7	B, B1
12	12	18 - 144	60	90	91	PSK 1212-7	-9
15 [3]	9	22 - 144	60	90	92	PSS 129-7	E
15 [3]	12	22 - 144	60	90	92	PSK 1212-7	P
24	9	31 - 144	60	93	94	PSS 249-7	C
24	12	31 - 144	60	93	94	PSK 2412-7	
36	9	44 - 144	80	95	96	PSS 369-7	
36	12	44 - 144	80	95	96	PSK 3612-7	
48	9	58 - 144	80	96	97	PSS 489-7	
48	12	58 - 144	80	96	97	PSK 4812-7	

[1] Surges up to 156 V for 2 s. See also: *Electrical Input Data:* $\Delta V_{io\,min}$.
[2] Efficiency at $V_{i\,nom}$ and $I_{o\,nom}$.
[3] Output set to 15 V at R control input

Non standard input/output configurations or special custom adaptions are available on request.

Part Number Description and Product Marking

Type Key

PSK 12 12 -7 E P C B

Positive switching regulator in case S01, K01 .. PSS, PSK
Nominal output voltage in volt .... 12, ...48
Nominal output current in ampere 9, 12
Operational ambient temperature range T_A
–25 to 71°C .... -7
–40 to 71°C (option) .... -9
Options: Inrush current limitation .... E
Potentiometer [1] .... P
Thyristor crowbar C
Cooling plate large/small .... B, B1

[1] Option P excludes R-features and vice versa.

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

Note: All units feature the following auxiliary functions which are not shown in the type designation: Input filter, inhibit, R control, sense lines, current sharing and test jacks.

Produkt Marking

Basic type designation, applicable safety approvals and recognition marks, warnings, pin allocation, Power-One patents and company logo, identification of LED, test sockets and optional potentiometer.

Specific type designation, input voltage range, nominal output voltage and current, protection degree, batch no., serial no. and data code including production site, modification status and date of production.

Functional Description

The switching regulators are designed using the buck converter topology. The input is not electrically isolated from the output. During the on period of the switching transistor, current is transferred to the output and energy is stored in the output choke. During the off period, this energy forces the current to continue flowing through the output chocke to the load and back through the freewheeling diode. Regulation is accomplished by varying on/off duty cycle.

These regulators are ideal for a wide range of applications, where input to output isolation is not necessary, or where already provided by an external front end (e.g. a transformer with rectifier). To optimise customer's needs, additional options and accessories are available.

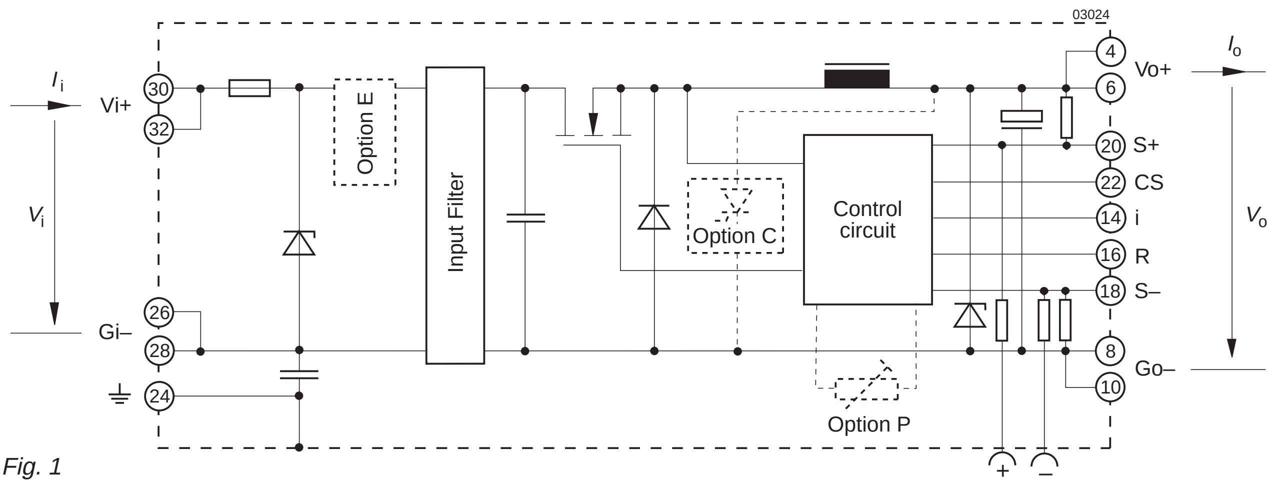


Fig. 1
Block diagram

Electrical Input Data

General Conditions: T_A = 25 °C, unless T_C is specified

Table 2a: Input data

Input			**PSS 129 PSK 1212**			**PSS 129 [2] PSK 1212 [2]**			**PSS 249 PSK 2412**			
Characteristics		**Conditions**	**min**	**typ**	**max**	**min**	**typ**	**max**	**min**	**typ**	**max**	**Unit**
V_i	Operating input voltage [1]	I_o = 0 - $I_{o\ nom}$ $T_{C\ min}$ - $T_{C\ max}$	18		144	22		144	31		144	VDC
$\Delta V_{io\ min}$	Min. diff. voltage $V_i – V_o$				6			7			7	
$V_{i\ o}$	Undervoltage lock-out			12			12			24		
$I_{i\ 0}$	No load input current	I_o = 0, $V_{i\ min}$ - $V_{i\ max}$			50			50			50	mA
$I_{inr\ p}$	Peak value of inrush current	$V_{i\ nom}$, with option E			4.5			4.5			4.5	A
$V_{i\ RFI}$	Input RFI level, EN 55011/22 0.15 - 30 MHz	$V_{i\ nom}$, $I_{o\ nom}$			B			B			B	

[1] Surges up to 156 V for 2 s.
[2] Output set to 15 V at R control input, see *Auxiliary Functions*.

Table 2b: Input data

Input			**PSS 369 PSK 3612**			**PSS 489 PSK 4812**			
Characteristics		**Conditions**	**min**	**typ**	**max**	**min**	**typ**	**max**	**Unit**
V_i	Operating input voltage	$I_o = 0$ - $I_{o\,nom}$ $T_{C\,min}$ - $T_{C\,max}$	44		144	58		144	V
$\Delta V_{io\,min}$	Min. diff. voltage $V_i - V_o$				8			10	
$V_{i\,o}$	Undervoltage lock-out			36			48		
$I_{i\,0}$	No load input current	$I_o = 0$, $V_{i\,min}$ - $V_{i\,max}$			50			50	mA
$I_{inr\,p}$	Peak value of inrush current	$V_{i\,nom}$, with option E			6			6	A
$V_{i\,RFI}$	Input RFI level, EN 55011/22 0.15 - 30 MHz	$V_{i\,nom}$, $I_{o\,nom}$			B			B	

[1] Surges up to 156 V for 2 s (complying to LES-DB standard for $U_N = 110$ V).
[2] Output set to 15 V at R control input, see *Auxiliary Functions*.

Input Filter and Fuse

An input filter and a fuse are incorporated in all 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 v_i of the input voltage (rectifier mode) at a specified input frequency f_i has the following values:

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

Inrush Current

Depending on the input source and the input impedance, the inrush current into the regulator may peak several thousand amperes during the switch-on sequence. It also determine the rating of input devices such as switches, relays, fuses etc. To protect these input devices by limiting the peak of the inrush current we recommend the use of the active inrush current limitation circuit, option E.

Electrical Output Data

General Conditions:
– $T_A = 25$°C, unless T_C is specified
– With R control output voltage $V_o = V_{o\,nom}$ at $I_{o\,nom}$
– Sense lines connected at female connector

Table 3a: Output data

Output				**PSS 129**			**PSS 129** [3]			**PSS 249**			
Characteristics			**Conditions**	**min**	**typ**	**max**	**min**	**typ**	**max**	**min**	**typ**	**max**	**Unit**
V_o	Output voltage		$V_{i\,nom}$, $I_{o\,nom}$	11.93		12.07	14.91		15.09	23.86		24.14	V
I_o	Output current [1]		$V_{i\,min}$ - $V_{i\,max}$ $T_{C\,min}$ - $T_{C\,max}$	0		9.0	0		9.0	0		9.0	A
I_{oL}	Output current limitation response			9.0		11.25	9.0		11.25	9.0		11.25	
v_o	Output voltage noise	Switching freq.	$V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		25	50		30	60		35	60	mV_{pp}
		Total			29	54		34	64		39	65	
$\Delta V_{o\,U}$	Static line regulation		$V_{i\,min}$ - $V_{i\,max}$, $I_{o\,nom}$		40	70		50	80		80	170	mV
$\Delta V_{o\,I}$	Static load regulation		$V_{i\,nom}$, $I_o = 0$ - $I_{o\,nom}$		30	50		40	60		50	120	
$v_{o\,d}$	Dynamic load regulation	Voltage deviat.	$V_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		140			140			180		
t_d		Recovery time			60			60			60		µs
α_{Uo}	Temperature coefficient $\Delta V_o / \Delta T_C$ ($T_{C\,min}$ - $T_{C\,max}$)		$V_{i\,min}$ - $V_{i\,max}$ $I_o = 0$ - $I_{o\,nom}$			±3			±4			±5	mV/K
						±0.02			±0.02			±0.02	%/K

[1] See also: *Thermal Consideration.*
[2] See: *Technical Information: Measuring and Testing.*
[3] Output set to 15 V at R control input, see: *Auxiliary Functions.*

Table 3b: Output data

Output				PSS 369			PSS 489			
Characteristics			**Conditions**	**min**	**typ**	**max**	**min**	**typ**	**max**	**Unit**
V_o	Output voltage		$V_{i\,nom}$, $I_{o\,nom}$	35.78		35.22	47.71		48.29	V
I_o	Output current [1]		$V_{i\,min}$ - $V_{i\,max}$ $T_{C\,min}$ - $T_{C\,max}$	0		9.0	0		9.0	A
I_{oL}	Output current limitation response			9.0		11.25	9.0		11.25	
v_o	Output voltage noise	Switching freq.	$V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		35	60		35	60	mV_{pp}
		Total			39	64		39	64	
$\Delta V_{o\,U}$	Static line regulation		$V_{i\,min}$ - $V_{i\,max}$, $I_{o\,nom}$		120	250		150	350	mV
$\Delta V_{o\,I}$	Static load regulation		$V_{i\,nom}$, $I_o = 0$ - $I_{o\,nom}$		60	120		70	150	
$v_{o\,d}$	Dynamic load regulation	Voltage deviat.	$V_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		200			200		
t_d		Recovery time			70			70		µs
α_{Uo}	Temperature coefficient $\Delta V_o/\Delta T_C$ ($T_{C\,min}$ - $T_{C\,max}$)		$V_{i\,min}$ - $V_{i\,max}$ $I_o = 0$ - $I_{o\,nom}$			±8			±10	mV/K
						±0.02			±0.02	%/K

Table 3c: Output data

Output				PSK 1212			PSK 1212 [3]			PSK 2412			
Characteristics			**Conditions**	**min**	**typ**	**max**	**min**	**typ**	**max**	**min**	**typ**	**max**	**Unit**
V_o	Output voltage		$V_{i\,nom}$, $I_{o\,nom}$	11.93		12.07	14.91		15.09	23.86		24.14	V
I_o	Output current [1]		$V_{i\,min}$ - $V_{i\,max}$ $T_{C\,min}$ - $T_{C\,max}$	0		12.0	0		12.0	0		12.0	A
I_{oL}	Output current limitation response			12.0		15.0	12.0		15.0	12.0		15.0	
v_o	Output voltage noise	Switching freq.	$V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		25	50		30	60		35	60	mV_{pp}
		Total			29	54		34	64		39	65	
$\Delta V_{o\,U}$	Static line regulation		$V_{i\,min}$ - $V_{i\,max}$, $I_{o\,nom}$		40	70		50	80		80	170	mV
$\Delta V_{o\,I}$	Static load regulation		$V_{i\,nom}$, $I_o = 0$ - $I_{o\,nom}$		30	50		40	60		50	120	
$v_{o\,d}$	Dynamic load regulation	Voltage deviat.	$V_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		140			140			180		
t_d		Recovery time			60			60			60		µs
α_{Uo}	Temperature coefficient $\Delta V_o/\Delta T_C$ ($T_{C\,min}$ - $T_{C\,max}$)		$V_{i\,min}$ - $V_{i\,max}$ $I_o = 0$ - $I_{o\,nom}$			±3			±4			±5	mV/K
						±0.02			±0.02			±0.02	%/K

[1] See also: *Thermal Consideration.*
[2] See: *Technical Information: Measuring and Testing.*
[3] Output set to 15 V at R control input, see: *Auxiliary Functions.*

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Table 3d: OVtpVt data

Output				PSK 3612			PSK 4812			
Characteristics			**Conditions**	**min**	**typ**	**max**	**min**	**typ**	**max**	**Unit**
V_o	Output voltage		$V_{i\,nom}$, $I_{o\,nom}$	35.78		36.22	47.71		48.29	V
I_o	Output current [1]		$V_{i\,min}$ - $V_{i\,max}$ $T_{C\,min}$ - $T_{C\,max}$	0		12.0	0		12.0	A
I_{oL}	Output current limitation response			12.0		15.0	12.0		15.0	
v_o	Output voltage noise	Switching freq.	$V_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		35	60		35	60	mV_{pp}
		Total			39	64		39	64	
$\Delta V_{o\,U}$	Static line regulation		$V_{i\,min}$ - $V_{i\,max}$, $I_{o\,nom}$		120	250		150	350	mV
$\Delta V_{o\,l}$	Static load regulation		$V_{i\,nom}$, $I_o = 0$ - $I_{o\,nom}$		60	120		70	150	
$v_{o\,d}$	Dynamic load regulation	Voltage deviat.	$V_{i\,nom}$ $I_{o\,nom} \leftrightarrow 1/3\, I_{o\,nom}$ IEC/EN 61204 [2]		200			200		
t_d		Recovery time			70			70		µs
α_{Uo}	Temperature coefficient $\Delta V_o/\Delta T_C$ ($T_{C\,min}$ - $T_{C\,max}$)		$V_{i\,min}$ - $V_{i\,max}$ $I_o = 0$ - $I_{o\,nom}$			±8			±10	mV/K
						±0.02			±0.02	%/K

[1] See also: *Thermal Consideration.*
[2] See: *Technical Information: MeasVring and Testing.*
[3] Output set to 15 V at R control input, see: *Auxiliary Functions.*

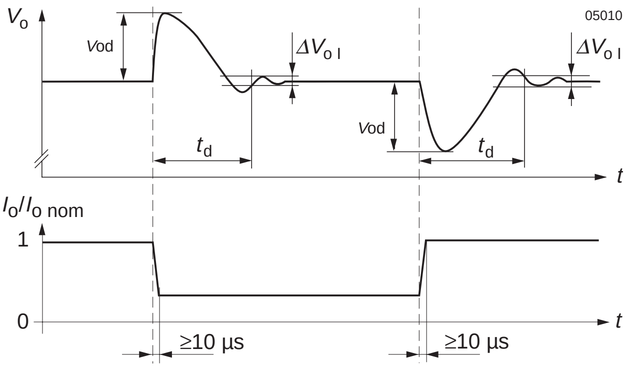


Fig. 2
Dynamic load regulation.

Overtemperature Protection

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 dropped below $T_{C\,max}$.

Output Protection

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

Thermal Considerations

When a switching regulator is located in free, quasi-stationary air (convection cooling) at a temperature $T_A = 71°C$ and is operated at its nominal output current $I_{o\,nom}$, the case temperature T_C will be about 95°C after the warm-up phase, measured at the: *MeasVring point of case temperatVre* T_C (see: *Mechanical Data*).

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

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.

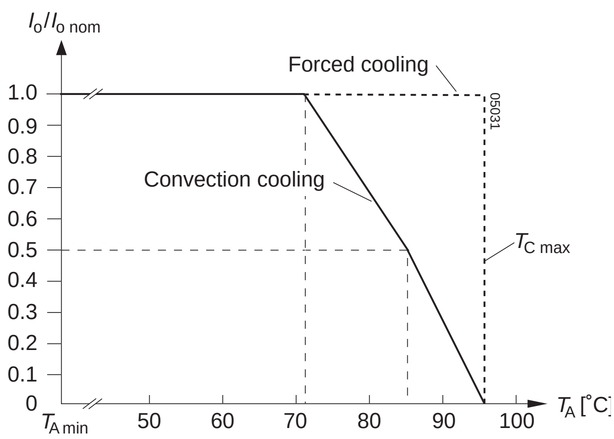


Fig. 3
Output current derating versus temperature.

Auxiliary Functions

S Sense Lines

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

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 $V_{o\,max}$ (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 connector) should not exceed the values given in the following table.

i Inhibit (Remote On / Off)

Note: With open i input, output is enabled (V_o = on)

The inhibit input allows the switching regulator output 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 switching on or off. The inhibit characteristics are referenced to the S– remote sense terminal.

Parallel and Series Connection

Outputs of equal nominal voltages can be parallel-connected. Use the current sharing feature (CS) for even distribution of the output current. See also: *Auxiliary Functions.*

Outputs can be series-connected with any other module. In series-connection the maximum output current is limited by the lowest current limitation. Electrically 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.

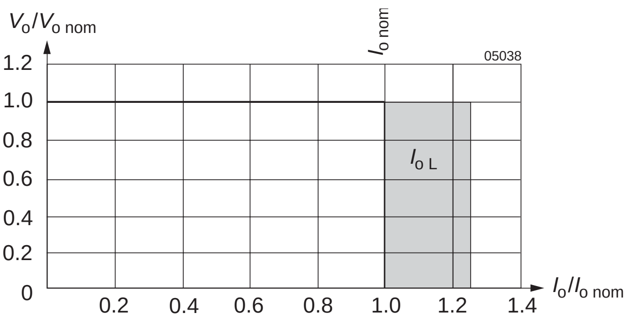


Fig. 4
Overload, short-circuit behaviour V_o versus I_o.

Table 4: MaximVm allowed voltage compensation

Nominal output voltage	Total voltage difference between both sense lines and their respective output	Voltage difference between Go– and S–
12 - 48 V	<1.0 V	<0.25 V

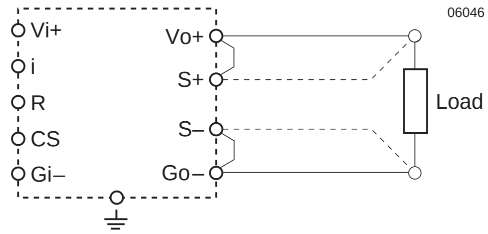


Fig. 5
Sense lines connection

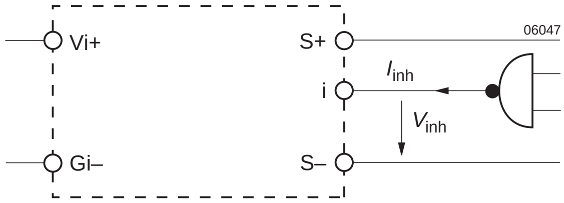


Fig. 6
Definition of I_{inh} and V_{inh}

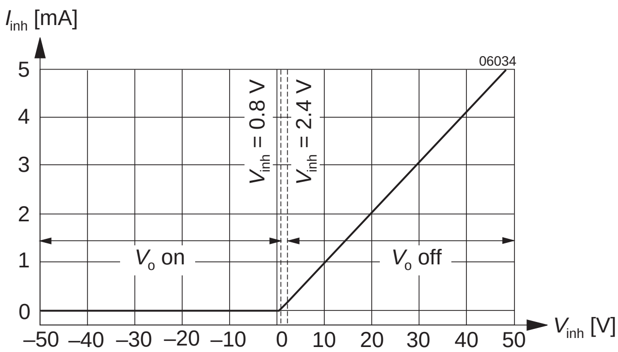


Fig. 7
Typical inhibit current I_{inh} versus inhibit voltage V_{inh}

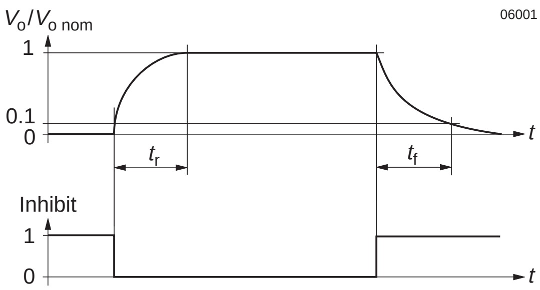


Fig. 8
Output response as a function of inhibit signal

Table 5: Inhibit characteristics

Characteristics			Conditions	min	typ	max	Unit
V_{inh}	Inhibit input voltage to keep regulator output voltage -	V_o = on	$V_{i\,min}$ - $V_{i\,max}$ $T_{C\,min}$ - $T_{C\,max}$	–50		+0.8	VDC
		V_o = off		+2.4		+50	
t_r	Switch-on time after inhibit command		$V_i = V_{i\,nom}$ $R_L = V_{o\,nom} / I_{o\,nom}$		150		ms
t_f	Switch-off time after inhibit command				30		
$I_{i\,inh}$	Input current when inhibited		$V_i = V_{i\,nom}$		25		mA

R Control for Output Voltage Adjustment

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

The output voltage V_o can either be adjusted with an external reference voltage (V_{ext}) or with an external resistor (R_1 or R_2). The adjustment range is 0 - $V_{o\,max}$. The minimum differential voltage $\Delta V_{io\,min}$ between input and output (see: *Electrical Input Data*) should be maintained. Undervoltage lock-out = minimum input voltage.

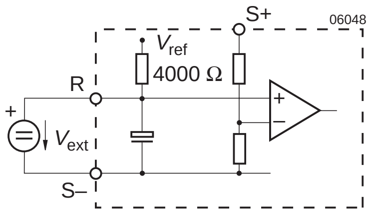


Fig. 9
Voltage adjustment with V_{ext} between R and S–

a) V_o = 0 - $V_{o\,max}$, using V_{ext} between R and S–:

$$V_{ext} \approx 2.5\,\text{V} \cdot \frac{V_o}{V_{o\,nom}} \qquad V_o \approx V_{o\,nom} \cdot \frac{V_{ext}}{2.5\,\text{V}}$$

Caution: To prevent damage V_{ext} should not exceed 20 V, nor be negative, and R_2 should never be less than 47 kΩ.

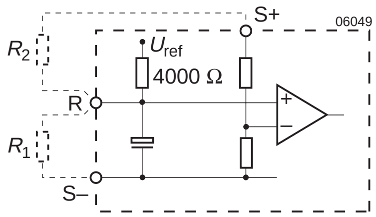


Fig. 10
Voltage adjustment with external resistor R_1 or R_2

b) V_o = 0 - 100% $V_{o\,nom}$, using R_1 between R and S–:

$$R_1 \approx \frac{4000\,\Omega \cdot V_o}{V_{o\,nom} - V_o} \qquad V_o \approx \frac{V_{o\,nom} \cdot R_1}{R_1 + 4000\,\Omega}$$

c) $V_o = V_{o\,nom}$ - $V_{o\,max}$, using R_2 between R and S+:

$$R_2 \approx \frac{4000\,\Omega \cdot V_o \cdot (V_{o\,nom} - 2.5\,\text{V})}{2.5\,\text{V} \cdot (V_o - V_{o\,nom})}$$

$$V_o \approx \frac{V_{o\,nom} \cdot 2.5\,\text{V} \cdot R_2}{2.5\,\text{V} \cdot (R_2 + 4000\,\Omega) - V_{o\,nom} \cdot 4000\,\Omega}$$

Table 6: Maximum adjustable output voltage

Characteristics		Conditions	PSS 129 PSK 1212	PSS 249 PSK 2412	PSS 369 PSK 3612	PSS 489 PSK 4812	
			min typ max	min typ max	min typ max	min typ max	Unit
$V_{o\,max}$	Maximum adjustable output at R control input	$V_{i\,nom}$, $I_{o\,nom}$	16.0	26.0	42.5	52.8	V

CS Current Sharing

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 (V_i) and interconnecting leads should have equal length and cross section to ensure equal voltage drop.

Test Sockets

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

LED Output Voltage Indicator

A green output indicator LED shines when the output voltage is present.

Electromagnetic Compatibility (EMC)

Electromagnetic Immunity

General condition: Case not earthed.

Table 7: Immunity type tests

Phenomenon	Standard [1]	Class Level	Coupling mode [2]	Value applied	Waveform	Source Imped.	Test procedure	In oper.	Per-form. [3]
1 MHz burst disturbance	IEC 60255-22-1	III	i/o, i/c, o/c	2500 V_p	400 damped 1 MHz waves/s	200 Ω	2 s per coupling mode	yes	A
			+i/–i, +o/–o	1000 V_p					
Voltage surge	IEC 60571-1		i/c, +i/–i	800 V_p	100 µs	100 Ω		yes	B
				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/EN 61000-4-2	4	contact discharge to case	8000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	A
Electromagnetic field	IEC/EN 61000-4-3	3	antenna	10 V/m	AM 80% 1 kHz		80 - 1000 MHz	yes	A
Electrical fast transient/burst	IEC/EN 61000-4-4	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	60 s positive 60 s negative bursts per coupling mode	yes	A
		4		4000 V_p					B [4]
Surge	IEC/EN 61000-4-5	3	i/c	2000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. surges per coupling mode	yes	A
			+i/–i	1000 V_p		2 Ω			
Conducted disturbances	IEC/EN 61000-4-6	3	i, o, signal wires	10 VAC (140 dBµV)	AM 80% 1 kHz	150 Ω	0.15 - 80 MHz	yes	A

[1] For related and previous standards see: *Technical Information: EMC*. [2] i = input, o = output, c = case.
[3] A = Normal operation, no deviation from specifications, B = Normal operation, temporary deviation from specs possible.
[4] With option C, manual reset might be necessary.

Electromagnetic Emission

For emission levels refer to: *Electrical Input Data*.

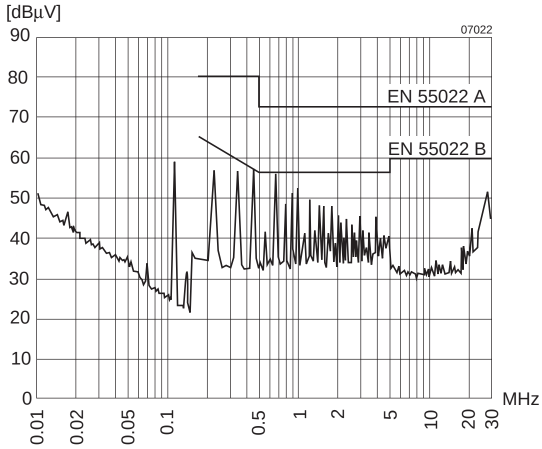


Fig. 11
Typical disturbance voltage (quasi-peak) at the input according to EN 55011/22 measured at $V_{i\,nom}$ and $I_{o\,nom}$.

Immunity to Environmental Conditions

Table 8: Mechanical stress

Test Method		Standard	Test Conditions		Status
Ca	Damp heat steady state	IEC/DIN IEC 60068-2-3 MIL-STD-810D section 507.2	Temperature: Relative humidity: Duration:	$40^{\pm 2}$ °C $93^{+2/-3}$ % 56 days	Unit not operating
Ea	Shock (half-sinusoidal)	IEC/EN/DIN EN 60068-2-27 MIL-STD-810D section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	100 g_n = 981 m/s^2 6 ms 18 (3 each direction)	Unit operating
Eb	Bump (half-sinusoidal)	IEC/EN/DIN EN 60068-2-29 MIL-STD-810D section 516.3	Acceleration amplitude: Bump duration: Number of bumps:	40 g_n = 392 m/s^2 6 ms 6000 (1000 each direction)	Unit operating
Fc	Vibration (sinusoidal)	IEC/EN/DIN EN 60068-2-6 MIL-STD-810D section 514.3	Acceleration amplitude: Frequency (1 Oct/min): Test duration:	0.35 mm (10 - 60 Hz) 5 g_n = 49 m/s^2 (60 - 2000 Hz) 10 - 2000 Hz 7.5 h (2.5 h each axis)	Unit operating
Fda	Random vibration wide band Reproducibility high	IEC 60068-2-35 DIN 40046 part 23	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 operating
Kb	Salt mist, cyclic (sodium chloride NaCl solution)	IEC/EN/DIN IEC 60068-2-52	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 9: Temperature specifications, valid for an air pressure of 800 - 1200 hPa (800 - 1200 mbar)

Temperature			Standard -7		Option -9		
Characteristics		Conditions	min	max	min	max	Unit
T_A	Ambient temperature [1]	Operational [2]	–25	71	–40	71	°C
T_C	Case temperature		–25	95	–40	95	
T_S	Storage temperature [1]	Non operational	–40	100	–55	100	

[1] MIL-STD-810D section 501.2 and 502.2.
[2] See: *Thermal Considerations* and *Overtemperature Protection.*

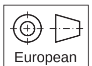
Table 10: MTBF and device hoVrs

MTBF	Ground Benign	Ground Fixed		Ground Mobile	Device Hours [1]
MTBF acc. 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

Mechanical Data

The converters are designed to be inserted into a rack according to IEC 60297-3.



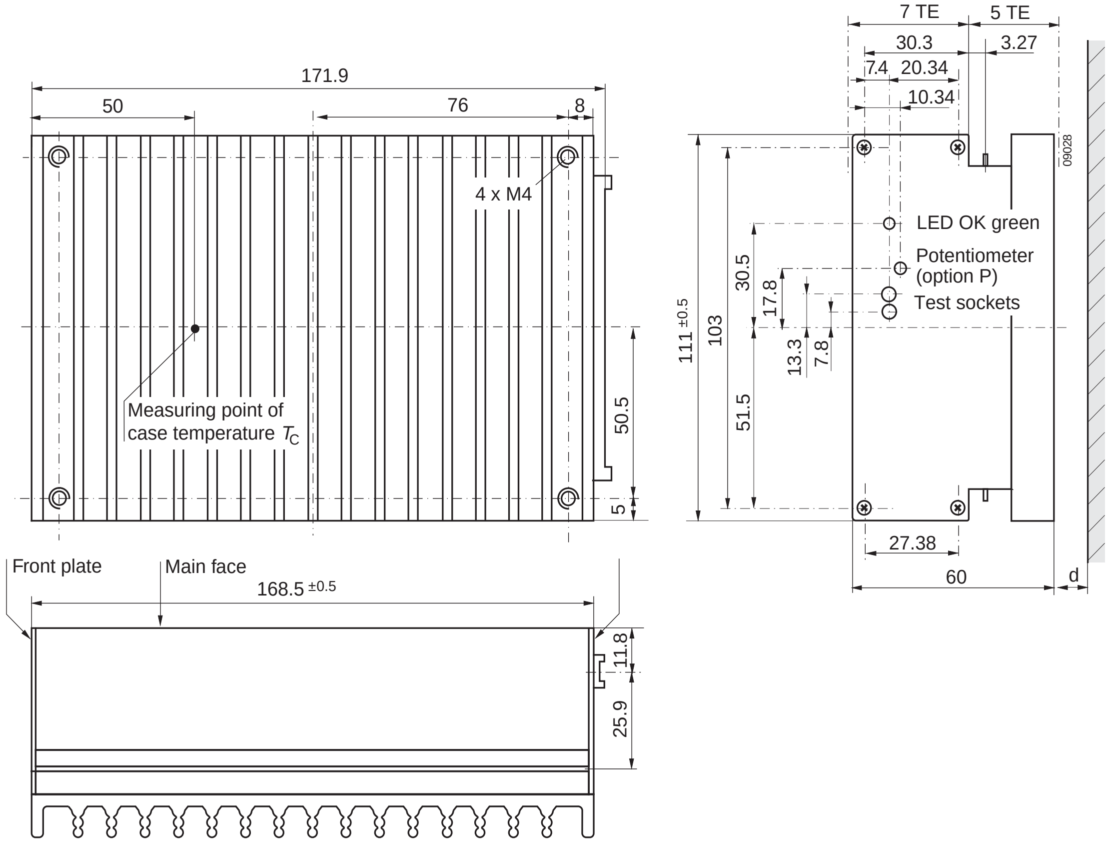


Fig. 12
Case S01, weight 1.3 kg
Aluminium, fully enclosed,black finish and self cooling.

Note:

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

Mechanical Data

The converters are designed to be inserted into a rack according to IEC 60297-3.

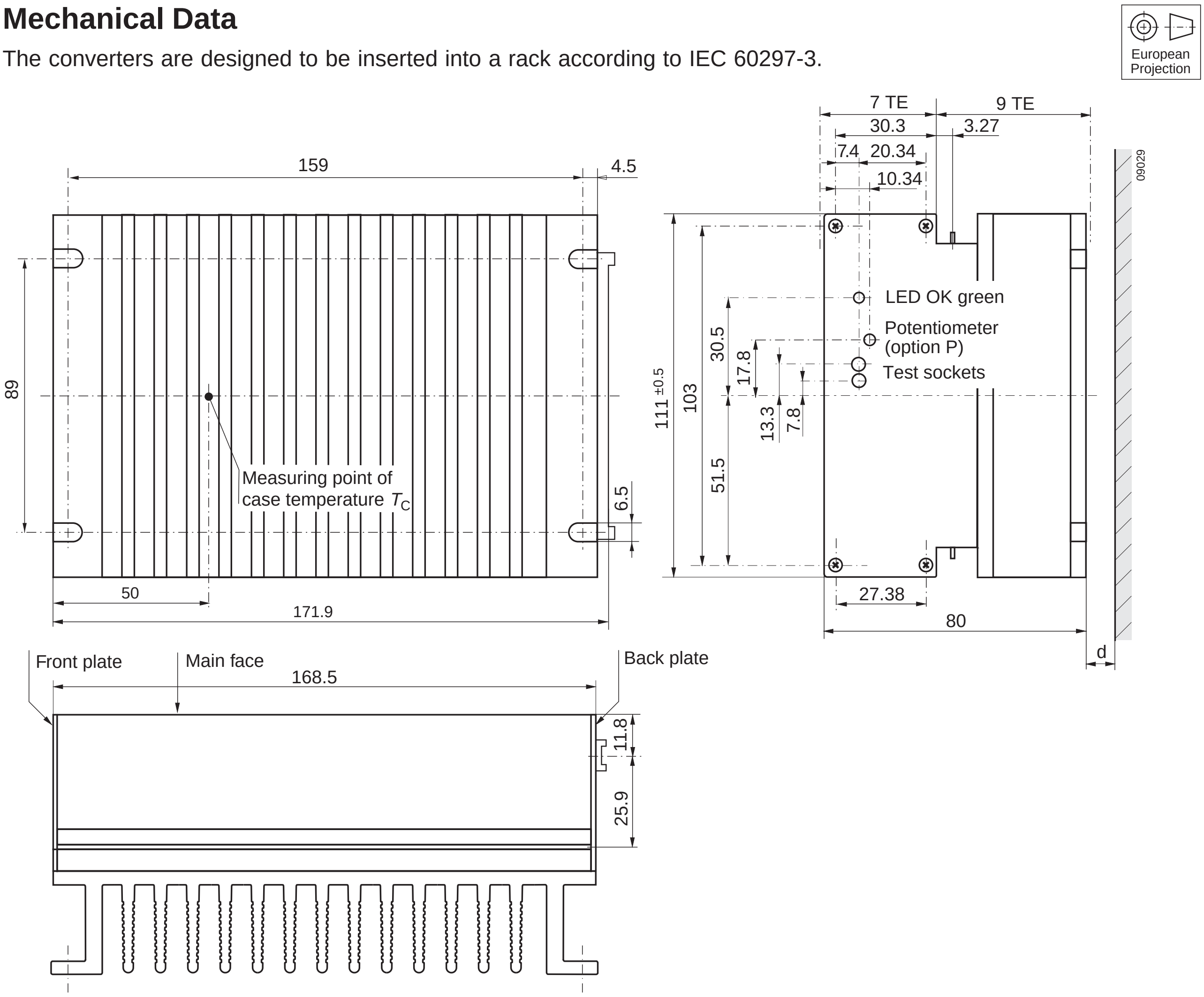


Fig. 13
Case K01, weight 1.6 kg
Aluminium, fully enclosed, black finish and self cooling.

Note:

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

Safety and Installation Instructions

Connector Pin Allocation

The connector pin allocation table defines the electrical potentials and the physical pin position on the connector. Pin 24 (protective earth) is a leading pin, which provides electrical contact first. The modules should only be wired via the female connector H15 (according to DIN 41612) to ensure requested safety!

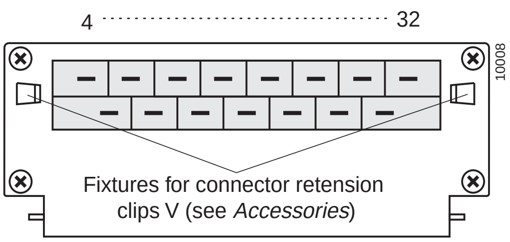


Fig. 14
View of male H15 connector

Table 11: 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	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 (leading pin)	24	⏚
Input voltage (negative)	26	Gi–
Input voltage (negative)	28	Gi–
Input voltage (positive)	30	Vi+
Input voltage (positive)	32	Vi+

Installation Instruction

Installation of the switching regulators must strictly follow the national safety regulations in compliance with the enclosure, mounting, creepage, clearance, casualty, markings and segregation requirements of the end-use application.

Check for hazardous voltages before altering any connections.

The input and the output circuit are not separated. i.e. the negative path is internally interconnected!

The units should be connected to a secondary circuit. Do not open any module. Ensure that a unit failure (e.g. by an internal short-circuit) does not result in a hazardous condition. See also *:Safety of operator accessible output circuit.*

Note: Additional information on input circuitry, grounding and parallel operation of units is given in: *Technical Information: Application Notes.*

Protection Degree

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

Isolation

Electric strength test voltage between input interconnected with output and case: 1500 VDC, 1 s. This test is performed in the factory as routine test in accordance with IEC/EN 60950 and UL 60950 and should not be repeated in the field. Power-One will not honour any guarantee claims resulting from electric strength field tests.

Standards and Approvals

All switching regulators are UL recognized according to UL 60950, CAN/CSA C22.2 No. 234-M90 and IEC/EN 60950.

The units have been evaluated for:

- Building in
- Operational insulation from input to output and input/output to case
- The use in a pollution degree 2 environment
- Connecting the input to a secondary circuit which is subject to a maximum transient rating of 1500 V

The switching regulators are subject to manufacturing surveillance in accordance with the above mentioned UL, CSA and ISO 9001 standards.

Safety of Operator Accessible Output Circuit

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

The following table shows some possible installation configurations, compliance with which causes the output circuit of the switching regulator to be an SELV circuit according to IEC/EN 60950 up to a configured nominal output voltage of 30 V, or 48 V if option C is fitted.

However, it is the sole responsibility of the installer or user to assure the compliance with the relevant and applicable safety regulations.

Table 12: Insulation concept leading to an SELV output circuit

Conditions	**Front end**			**Switching regulator**	**Result**
Supply voltage	Minimum required grade of isolation, to be provided by the AC-DC front end, including mains supplied battery charger	Maximum DC output voltage from the front end[1]	Minimum required safety status of the front end output circuit	Measures to achieve the specified safety status of the output circuit	Safety status of the switching regulator output circuit
Battery supply, considered as secondary circuit	Double or Reinforced	≤60 V	SELV circuit	None	SELV circuit
		≤60 V	Earthed hazardous voltage secondary circuit[2]	Input fuse[3] and earthed[4] or non accessible case[5]	Earthed SELV circuit
			Unearthed hazardous voltage secondary circuit[5]	Input fuse[3] and unearthed, non accessible case[5]	Unearthed SELV circuit
			Hazardous voltage secondary circuit	Input fuse[3] and earthed output circuit[4] and earthed[4] or non accessible case[5]	Earthed SELV circuit
Mains ≤250 VAC	Basic	≤60 V	Earthed SELV circuit[4]	None	
			ELV circuit	Input fuse[3] and earthed output circuit[4] and earthed[4] or non user accessible case[5]	
		>60 V	Hazardous voltage secondary circuit		
	Double or reinforced	≤60 V	SELV circuit	None	SELV circuit
		>60 V	Double or reinforced insulated unearthed hazardous voltage secondary circuit[5]	Input fuse[3] and unearthed and non accessible case[5]	Unearthed SELV circuit

1 The front end output voltage should match the specified input voltage range of the switching regulator.
2 The Gi– terminal of the switching regulator has to be connected to earth by the installer according to the relevant safety standard, e.g. IEC/EN 60950.
3 The installer shall provide an approved fuse (slow blow type with the lowest current rating suitable for the application, max. 12.5 A) in a non-earthed input conductor directly at the input of the switching regulator. If Vo+ is earthed, insert the fuse in the Gi- line. For UL's purpose, the fuse needs to be UL-listed.
4 The earth connection has to be provided by the installer according to the relevant safety standard, e.g. IEC/EN 60950.
5 Has to be insulated from earth by double or reinforced insulation according to the relevant safety standard, based on the maximum output voltage from the front end.

Description of Options

-9 Extended Temperature Range

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

P Potentiometer

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

Option P excludes R function. The output voltage V_o can be adjusted with a screwdriver in the range 90 - 110% $V_{o\,nom}$.

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

E Inrush Current Limitation

Note: This option requires increased minimum input voltage of up to 1 V, dependent upon 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 application of the input supply, the inrush current 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 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.

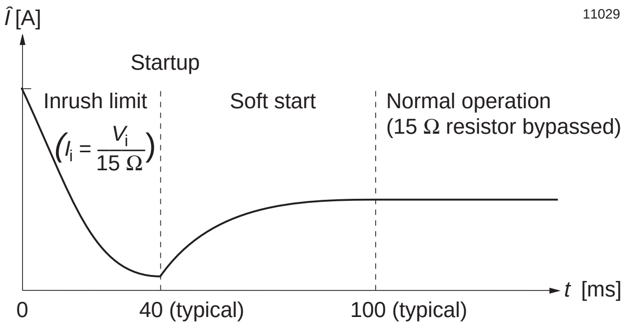


Fig. 15
Option E: Inrush current versus time

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 $V_{o\,c}$. Depending on the application, further decentralized overvoltage protection elements may have to be used additionally.

A fixed-value monitoring circuit checks the output voltage V_o and when the trigger voltage $V_{o\,c}$ 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–. To prevent false triggering, the user should ensure that V_o (between Vo+ and Go–) deos not exceed $V_{o\,c}$.

Table 13: Crowbar trigger levels

Characteristics		Condition	PSS 129 PSK 1212			PSS 249 PSK 2412			PSS 369 PSK 3612			PSS 489 PSK 4812			Unit
			min	typ	max	min	typ	max	min	typ	max	min	typ	max	
$V_{o\,c}$	Trigger voltage	$T_{C\,min}$ - $T_{C\,max}$ $V_{i\,min}$ - $V_{i\,max}$ 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]		63.0	67.0	VDC
t_s	Delay time			1.5			1.5			1.5			1.5		µs

[1] Crowbar trigger voltage with option P

B, 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:

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

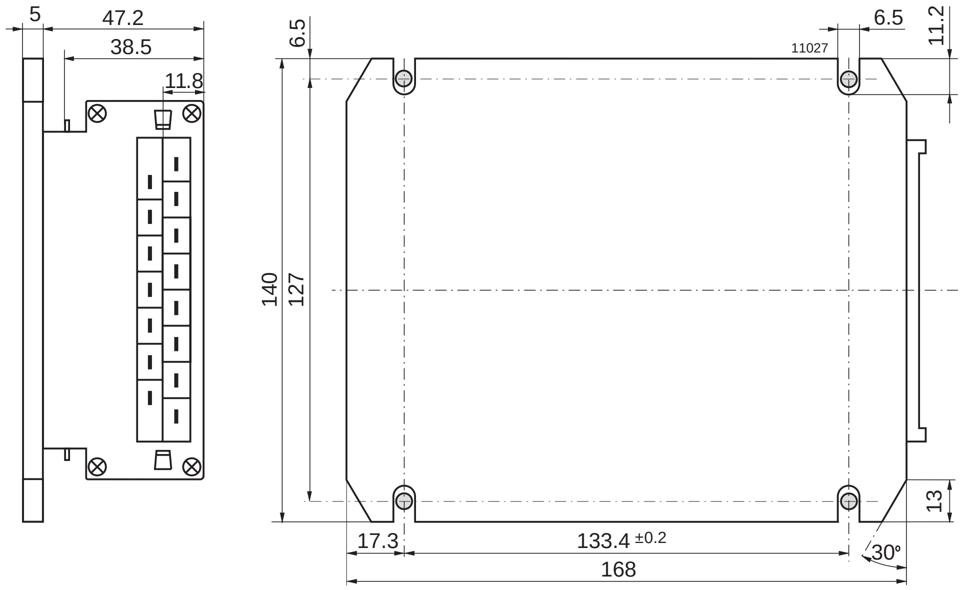


Fig. 16
Option B, large cooling plate
Weight: 1.2 kg

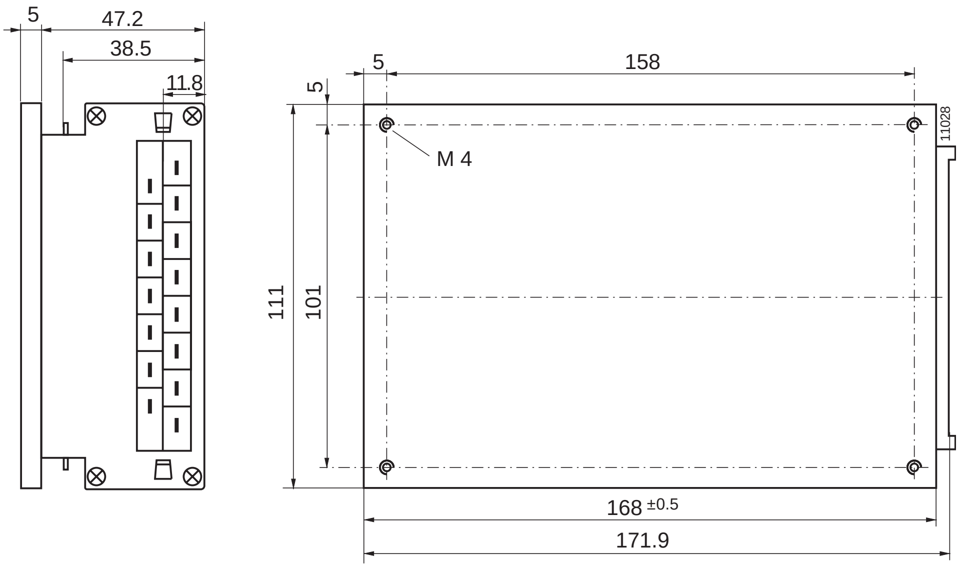


Fig. 17
Option B1, small cooling plate
Weight: 1.2 kg

Accessories

A variety of electrical and mechanical accessories are available including:

– Front panels for 19" rack mounting, Schroff and Intermas systems, 12 and 16 TE.
– Mating H15 and H15 S4 connectors with screw, solder fast-on or press-fit terminals.
– Connector retention facilities (V-clips).
– DIN-rail mounting adaptor.

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

power-one™ Changing the Shape of Power

EC Declaration of Conformity

We

Power-One AG
Ackerstrasse 56 CH-8610 Uster

declare under our sole responsibility that all PSx Series switching regulators carrying the CE-mark are in conformity with the provisions of the Low Voltage Directive (LVD) 73/23/EEC of the European Communities.

Conformity with the directive is presumed by conformity wih the following harmonized standards:

- EN 61204: 1995 (= IEC 61204: 1993, modified)
  Low-voltage power supply devices, d.c. output - Perfomance characteristics and safety requirements
- EN 60950: 1992 + A1: 1993 + A2 (= IEC 950 second edition 1991 + A1: 1992 + A2: 1993)
  Safety of information technology equipment

The installation instructions given in the corresponding data sheet describe correct installation leading to the presumption of conformity of the end product with the LVD. All PSx Series Switching Regulators are components, intended exclusively for inclusion within other equipment by an industrial assembly operation or by professional installers. They must not be operated as stand alone products.

Hence conformity with the Electromagnetic Compatibility Directive 89/336/EEC (EMC Directive) needs not to be declared. Nevertheless, guidance is provided in most product application notes on how conformity of the end product with the indicated EMC standards under the responsibility of the installer can be achieved, from which conformity with the EMC directive can be presumed.

Uster, 1 Sep. 2003

Power-One AG

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