PSR: Positive Switching Regulators

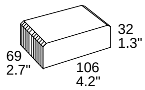
PSB-Family

4

No input to output isolation
Single output of 5.1, 12, 15, 24 or 36 V DC/30...180 W
Input voltage up to 80 V DC

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

Safety according to IEC/EN 60950



Summary

The PSB family 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 80 V are specially designed for secondary switched and battery driven applications. The case design allows operation at nominal load up to 71°C without additional cooling.

Type Survey and Key Data

Table 1: Type survey

Output voltage $U_{o\,nom}$ [V]	Output current $I_{o\,nom}$ [A]	Input voltage range U_i [V] [1]	Input voltage $U_{i\,nom}$ [V]	Efficiency [2] η_{min} [%]	η_{typ} [%]	Type designation	Options	Superseded old type (phased-out)
5.1	7	7...40	20	83	84	PSB 5A7-7iR	-9, L, P, C	PSR 57-7
	6	8...80	40	79	81	PSB 5A6-7iR		PSR 55-7
12	5	15...80		89	90	PSB 125-7iR		PSR 124-7
15		19...80		90	92	PSB 155-7iR		PSR 154-7
24		29...80	50	93	95	PSB 245-7iR		PSR 244-7
36		42...80	60	95	96	PSB 365-7iR		PSR 364-7

[1] See *Electrical Input Data:* $\Delta U_{io\,min}$ (min. differential voltage $U_i - U_o$).
[3] Efficiency at $U_{i\,nom}$ and $I_{o\,nom}$.

Non standard input/output configurations or special custom adaptions are available on request.
See also *Commercial Information: Inquiry Form for Customized Power Supply.*

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Type Key and Product Marking

Type Key

PSB 12 5 -7 L i R P C

Positive switching regulator in case B02	PSB
Nominal output voltage in volt (5A for 5.1 V)	5A...36
Nominal output current in ampere	5...7
Operational ambient temperature range T_A	
–25...71°C	-7
–40...71°C (option)	-9
Input filter (option)	L
Inhibit input	i
Control input for output voltage adjustment [1]	R
Potentiometer [1] (option)	P
Thyristor crowbar (option)	C

[1] Feature R excludes option P and vice versa.

Example: PSB 125-7LiPC = A positive switching regulator with a 12 V, 5 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, Melcher patent nos. and company logo.

Cover: Specific type designation, input voltage range, nominal output voltage and current, pin allocation, identification of LED, potentiometer and protection degree.

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

Functional Description

The switching regulators are designed using the buck converter topology. See also *Technical Information: Topologies*. 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 in the form of flux. During the off period, this energy forces the current to continue flowing through the output, to the load and back through the freewheeling diode. Regulation is accomplished by varying the on to off duty ratio of the power switch.

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.

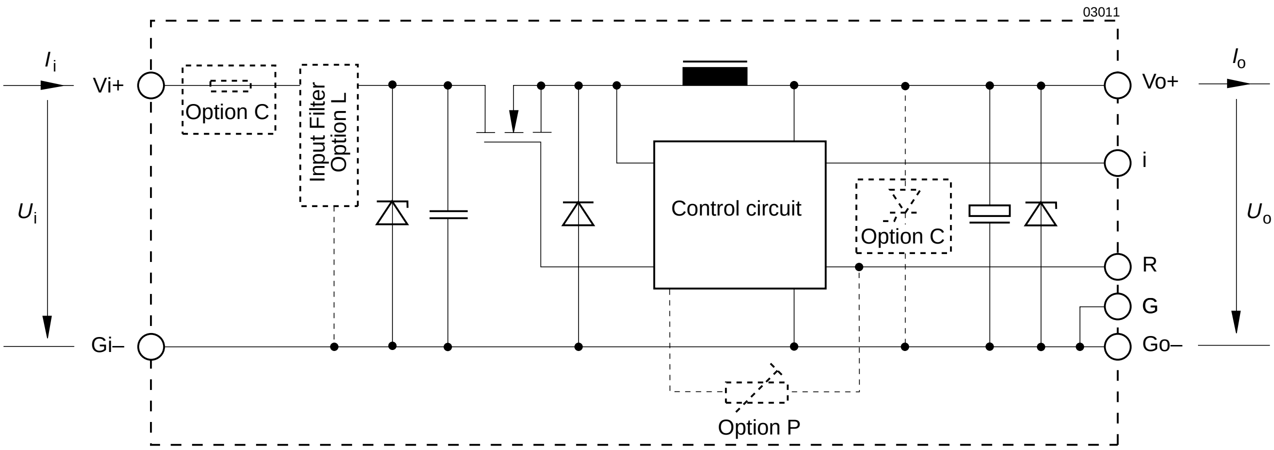

Fig. 1
Block diagram

Electrical Input Data

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

Table 2a: Input data

Input			PSB 5A7			PSB 5A6			PSB 125			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Operating input voltage	I_o = 0...$I_{o\ nom}$ $T_{C\ min}$...$T_{C\ max}$	7		40	8		80	15		80	V DC
$\Delta U_{io\ min}$	Min. diff. voltage $U_i - U_o$				1.9			2.9			3	
$U_{i\ o}$	Undervoltage lock-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
$I_{inr\ p}$	Peak value of inrush current	$U_{i\ nom}$ without option L		75			150			150		A
$t_{inr\ r}$	Rise time			5			5			5		µs
$t_{inr\ h}$	Time to half-value			40			40			40		
$I_{inr\ p}$	Peak value of inrush current	$U_{i\ nom}$ with option L		100			180			180		A
$t_{inr\ r}$	Rise time			15			15			15		µs
$t_{inr\ h}$	Time to half-value			100			100			100		
$u_{i\ RFI}$	Input RFI level, EN 55011/22 0.01...30 MHz	$U_{i\ nom}$, $I_{o\ nom}$ with option L			B			B			B	

Table 2b: Input data

Input			PSB 155			PSB 245			PSB 365			
Characteristics		Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_i	Operating input voltage	I_o = 0...$I_{o\ nom}$ $T_{C\ min}$...$T_{C\ max}$	19		80	29		80	42		80	V DC
$\Delta U_{io\ min}$	Min. diff. voltage $U_i - U_o$				4			5			6 [1]	
$U_{i\ o}$	Undervoltage lock-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
$I_{inr\ p}$	Peak value of inrush current	$U_{i\ nom}$ without option L		150			150			150		A
$t_{inr\ r}$	Rise time			5			5			5		µs
$t_{inr\ h}$	Time to half-value			40			40			40		
$I_{inr\ p}$	Peak value of inrush current	$U_{i\ nom}$ with option L		180			180			180		A
$t_{inr\ r}$	Rise time			15			15			15		µs
$t_{inr\ h}$	Time to half-value			100			100			100		
$u_{i\ RFI}$	Input RFI level, EN 55011/22 0.01...30 MHz	$U_{i\ nom}$, $I_{o\ nom}$ with option L			B			B			B	

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

External Input Circuitry

The sum of the lengths of the supply lines to the source or to the nearest capacitor ≥100 µF (a + b) should not exceed 5 m unless option L is fitted. This option is recommended in order to prevent power line oscillations and reduce superimposed interference voltages. See also *Technical Information: Application Notes.*

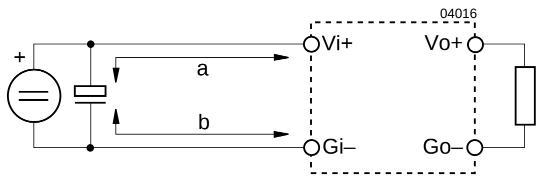

Fig. 2
Switching regulator with long supply lines.

Electrical 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 3a: Output data

Output				**PSB 5A7**			**PSB 5A6**			**PSB 125**			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$	5.07		5.13	5.07		5.13	11.93		12.07	V
I_o	Output current [1]		$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	0		7.0	0		6.0	0		5.0	A
I_{oL}	Output current limitation response [1]			7.0		9.1	6.0		7.8	5.0		6.5	
u_o	Output voltage noise	Switching freq.	$U_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		15	25		15	35		25	45	mV_{pp}
		Total			19	29		19	39		29	49	
$\Delta U_{o\,U}$	Static line regulation		$U_{i\,min}...U_{i\,max}$, $I_{o\,nom}$		25	45		25	45		25	50	mV
$\Delta U_{o\,I}$	Static load regulation		$U_{i\,nom}$, $I_o = 0...I_{o\,nom}$		10	25		10	25		20	35	
$u_{o\,d}$	Dynamic load regulation	Voltage deviat.	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		120			100			100		
t_d		Recovery time			40			50			60		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$ ($T_{C\,min}...T_{C\,max}$)		$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$			±1			±1			±2	mV/K
						±0.02			±0.02			±0.02	%/K

Table 3b: Output data

Output				**PSB 155**			**PSB 245**			**PSB 365**			
Characteristics			Conditions	min	typ	max	min	typ	max	min	typ	max	Unit
U_o	Output voltage		$U_{i\,nom}$, $I_{o\,nom}$	14.91		15.09	23.86		24.14	35.78		36.22	V
I_o	Output current [1]		$U_{i\,min}...U_{i\,max}$ $T_{C\,min}...T_{C\,max}$	0		5.0	0		5.0	0		5.0	A
I_{oL}	Output current limitation response [1]			5.0		6.5	5.0		6.5	5.0		6.5	
u_o	Output voltage noise	Switching freq.	$U_{i\,nom}$, $I_{o\,nom}$ IEC/EN 61204 [2] BW = 20 MHz		40	70		45	120		70	180	mV_{pp}
		Total			44	74		50	125		75	185	
$\Delta U_{o\,U}$	Static line regulation		$U_{i\,min}...U_{i\,max}$, $I_{o\,nom}$		40	75		70	150		100	200	mV
$\Delta U_{o\,I}$	Static load regulation		$U_{i\,nom}$, $I_o = 0...I_{o\,nom}$		30	65		70	120		120	160	
$u_{o\,d}$	Dynamic load regulation	Voltage deviat.	$U_{i\,nom}$ $I_{o\,nom} \leftrightarrow {}^1/_3\, I_{o\,nom}$ IEC/EN 61204 [2]		100			120			180		
t_d		Recovery time			60			80			100		µs
α_{Uo}	Temperature coefficient $\Delta U_o/\Delta T_C$ ($T_{C\,min}...T_{C\,max}$)		$U_{i\,min}...U_{i\,max}$ $I_o = 0...I_{o\,nom}$			±3			±5			±8	mV/K
						±0.02			±0.02			±0.02	%/K

[1] See also *Thermal Considerations.*
[2] See *Technical Information: Measuring and Testing.*

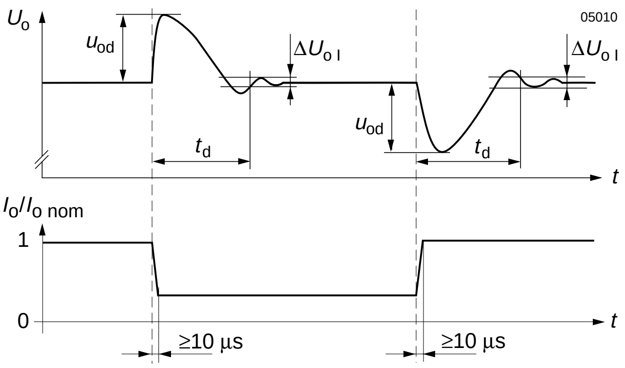

Fig. 3
Dynamic load regulation.

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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 *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 (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.

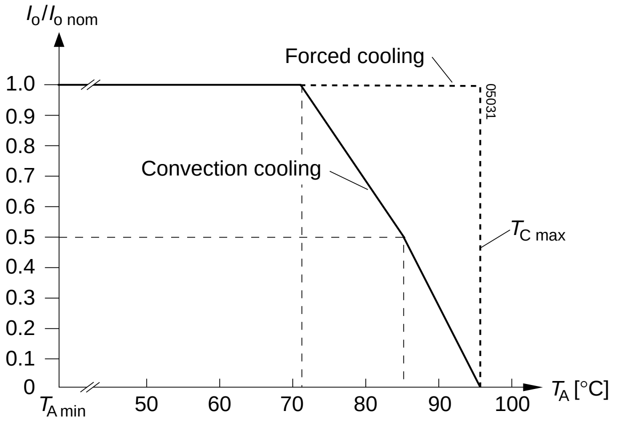


Fig. 4
Output current derating versus temperature

Output Protection

A voltage suppressor diode which in worst case conditions fails into a short circuit, (or a thyristor crowbar, option C) 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 Melcher power supplies, in the event of a failure, do not result in an unsafe condition (fail-safe).

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 heat generation. 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. 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.

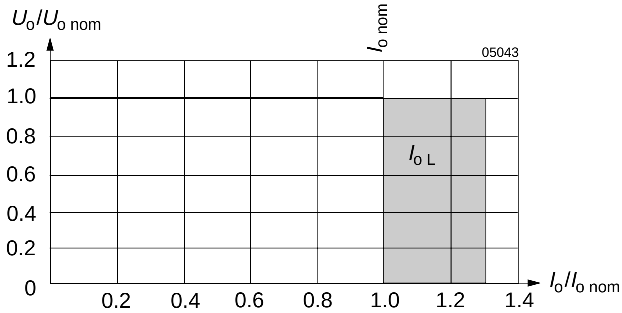


Fig. 5
Overload, short-circuit behaviour U_o versus I_o

Auxiliary Functions

i Inhibit for Remote On and Off

Note: With open i-input, output is enabled (U_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.

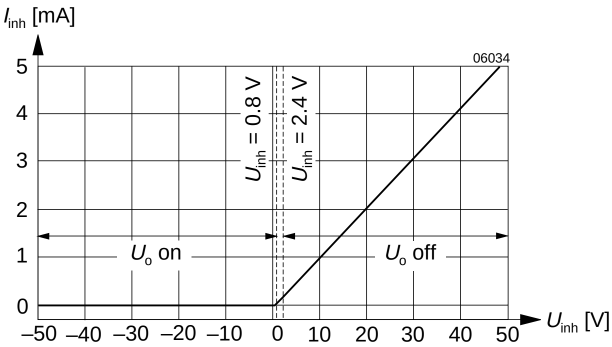


Fig. 6
Typical inhibit current I_{inh} versus inhibit voltage U_{inh}

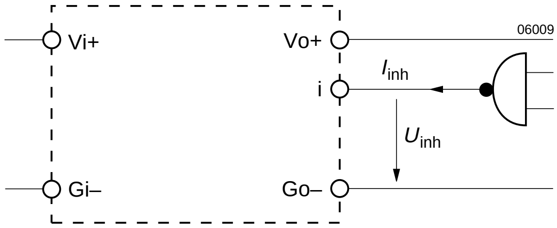


Fig. 7
Definition of I_{inh} and U_{inh}

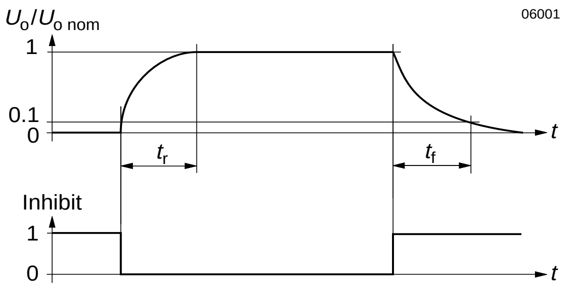


Fig. 8
Output response as a function of inhibit signal

Table 4: 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		
$I_{i\,inh}$	Input current when inhibited		$U_i = U_{i\,nom}$		10		mA

R Control for Output Voltage Adjustment

Note: With open R input, $U_o \approx U_{o\,nom}$. R excludes option P. (For superseded PSR types $U_o \approx 1.08 \cdot U_{o\,nom}$)

The output voltage U_o can either be adjusted with an external voltage (U_{ext}) or with an external resistor (R_1 or R_2). The adjustment range is 0...108% of $U_{o\,nom}$. The minimum differential voltage $\Delta U_{io\,min}$ between input and output (see *Electrical Input Data*) should be maintained. Undervoltage lock-out = Minimum input voltage.

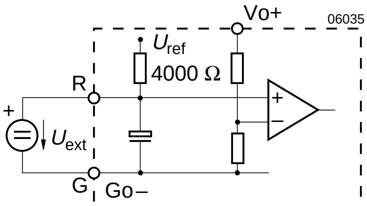


Fig. 9
Voltage adjustment with U_{ext} between R and G (Go–)

a) U_o = 0...108% $U_{o\,nom}$, using U_{ext} between R and G (Go–)

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

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

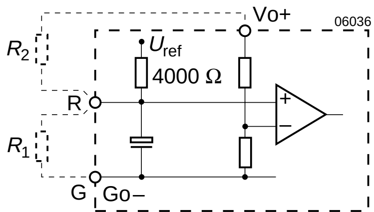


Fig. 10
Voltage adjustment with external resistor R_1 or R_2

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

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

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

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

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

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

LED Output Voltage Indicator

A yellow output indicator LED shines when the output voltage is higher than approx. 3 V.

4

Electromagnetic Compatibility (EMC)

Electromagnetic Immunity

General condition: Case not earthed.

Table 5: 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 [5]
			+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	3	contact discharge to case	6000 V_p	1/50 ns	330 Ω	10 positive and 10 negative discharges	yes	B [4 5]
Electromagnetic field	IEC/EN 61000-4-3	2	antenna	3 V/m	AM 80% 1 kHz		26…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	1 min positive 1 min negative bursts per coupling mode	yes	A [4]
		4		4000 V_p					B [4 5]
Surge	IEC/EN 61000-4-5	2	i/c	1000 V_p	1.2/50 µs	12 Ω	5 pos. and 5 neg. surges per coupling mode	yes	A [4]
			+i/–i	500 V_p		2 Ω			
Conducted disturbancies	IEC/EN 61000-4-6	3	i, o, signal wires	140 dBµV (10 V_{rms})	AM 80% 1 kHz	150 Ω	0.15...80 MHz	yes	A

[1] For related and previous standards see *Technical Information: Safety & 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] Option L neccessary. [5] With option C, manual reset might be necessary.

Electromagnetic Emission

For emission levels refer to *Electrical Input Data*.

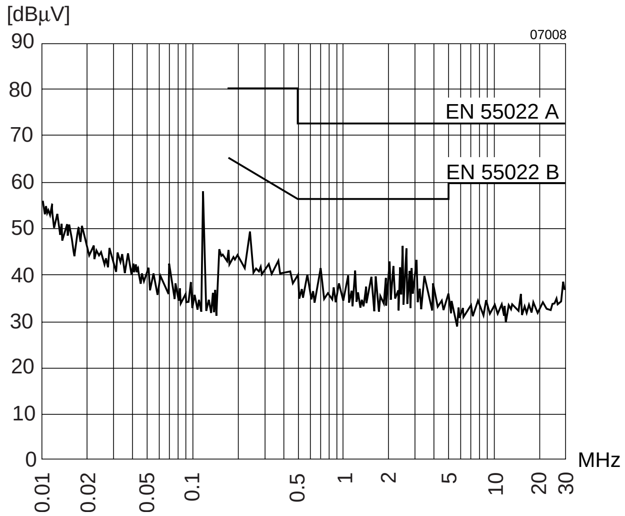


Fig. 11
Typical disturbance voltage (quasi-peak) at the input according to EN 55011/22 measured at $U_{i\,nom}$ and $I_{o\,nom}$.

Immunity to Environmental Conditions

Table 6: 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 7: Temperature specifications, valid for 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*

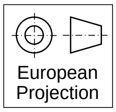
Table 8: MTBF and device hours

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	
	624'000	207'000 h	96'000 h	46'000 h	13'000'000 h

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

Mechanical Data

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



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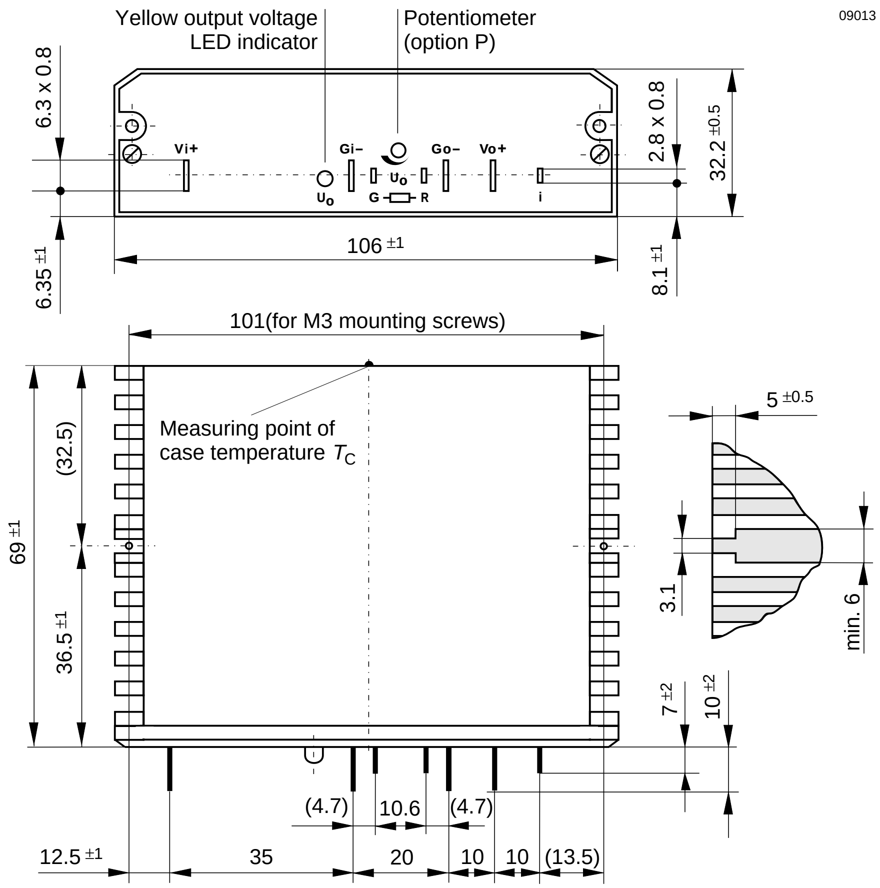

Fig. 12
Case B02, weight 230 g
Aluminium,
black finish and self cooling

Safety and Installation Instructions

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. Connections can be made using fast-on or soldering technique.

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 the 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.*

Cleaning Agents

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

Protection Degree

The protection degree is IP 20.

Standards and Approvals

All switching regulators are UL recognized according to UL 1950, UL 1012 and EN 60950, UL recognized for Canada to CAN/CSA C22.2 No. 234-M90 and SEV approved to IEC/EN 60950 and EN 55014 standards.

The units have been evaluated for:

- Building in,
- Operational insulation from input to output and input/output to case,
- The use in an overvoltage category II environment,
- The use in a pollution degree 2 environment.

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

Isolation

Electric strength test voltage between input interconnected with output and case: 750 V DC, 1 s.

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

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 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.

More information is given in *Technical Information: Safety & EMC*.

Table 9: 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 V AC	Basic	≤60 V	Earthed SELV circuit [4]	None	
			ELV circuit	Input fuse [3] and earthed output circuit [4] and earthed [4] or non 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 conductor to 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. If option C is fitted, a suitable fuse is already built-in in the Vi+ line.

[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

The operational ambient temperature range is extended to T_A = –40...71°C. (T_C = –40...95°C, T_S = –55...100°C.)

P Potentiometer

Option P excludes R-function. 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 Data* should be maintained.

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 60 mV_{rms}. A reduction can be achieved by insertion of a capacitor across the input (e.g. plastic foil between Vi+ and Gi–).

The input impedance of the switching regulator at 120 kHz is about 17 Ω. The harmonics are small in comparison with the fundamental wave. See also *Electrical Input 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:

Units with max input voltage 40 V:

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

Units with max input voltage 80 V:

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

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 $U_{o\,c}$ 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. For further information see *Technical Information: Application Notes.*

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

Accessories

A variety of electrical and mechanical accessories are available including:

– PCB-tags and isolation pads for easy and safe PCB-mounting.

– Ring core chockes for ripple and interference reduction.

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