



DC/DC CONVERTER

- Wide Range DC Input (18-32.4Vdc)
- Isolated 12Vdc Output
- Efficiency up to 88.2%
- Width only 32mm
- 20% Output Power Reserves
- Full Output Power Between -25°C and +60°C
- Soft Start Function Included
- Minimal Inrush Current Surge
- Reverse Input Polarity Protection
- 3 Year Warranty

1. GENERAL DESCRIPTION

The Dimension CD5-Series offers a range of DIN-rail mountable DC/DC-converters in a very compact housing.

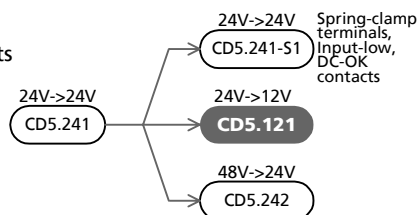
The CD5.121 converts a 24V voltage to a 12V voltage. With this DC/DC converter a 12V load can be supplied in a 24V control environment. The input source can be a battery, a solar panel or any other 24V sources.

The CD5.121 includes all the essential basic functions and has a power reserve of 20% included. This extra power can be used continuously up to +45°C.

The output is electrically isolated from the input in a safe way. The input is protected against reversed voltages and contains a soft start function.

CD-Series

Related products



2. SHORT-FORM DATA

Output voltage	DC 12V	
Adjustment range	12 – 15V	
Output current	8– 6.4A	Ambient <60°C
	9.6 – 7.7A	Ambient <45°C
Output power	96W	Ambient <60°C
	115W	Ambient <45°C
Output ripple	< 75mVpp	20Hz to 20MHz
Input voltage	DC 24V	18 to 32.4Vdc
		(14 to 18Vdc with derating)
Input current	typ. 4.6A	At 24Vdc input
Input Inrush current	typ. 1.2A peak	
Efficiency	typ. 88.2%	At 24Vdc input
Losses	typ. 12.8W	At 24Vdc input
Hold-up time	typ. 7ms	At 24Vdc input
Temperature range	-25°C to +70°C	Operational
Derating	2.5W/°C	+60 to +70°C
Dimensions	32x124x102mm	WxHxD

3. ORDER NUMBERS

DC/DC Converter	CD5.121	Standard unit
Accessories	ZM1.WALL	Wall mount bracket
	ZM11.SIDE	Side mount bracket
	YR2.DIODE	Decoupling module

4. MARKINGS



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INTENDED USE

The DC/DC converter shall only be installed and put into operation by qualified personnel.

This DC/DC converter is designed for installation in an enclosure and is intended for the general use, such as in industrial control, office, communication, and instrumentation equipment. Do not use this device in aircraft, trains and nuclear equipment, where malfunctioning of the DC/DC converter may cause severe personal injury or threaten human life.

TERMINOLOGY AND ABBREVIATIONS

PE and \oplus symbol	PE is the abbreviation for Protective Earth and has the same meaning as the symbol \oplus .
Earth, Ground	This document uses the term "earth" which is the same as the U.S. term "ground".
T.b.d.	To be defined, value or description will follow later.
DC 24V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances included. E.g.: DC 12V describes a 12V battery regardless whether it is full (13.7V) or flat (10V)
24Vac	A figure with the unit (Vdc) at the end is a momentary figure without any additional tolerances included.

DISCLAIMER

The information presented in this document is believed to be accurate and reliable and may change without notice. Some parts of this unit are patent by PULS (US patent No 091662,063, Des. 424,529, ...). No part of this document may be reproduced or utilized in any form without permission in writing from PULS GmbH.

5. INPUT VOLTAGE

Input	nom.	DC 24V	
Input voltage range	nom.	18.0-32.4Vdc	Continuous operation
		14.0-18.0Vdc	Max. 60 seconds or with de-rating, see Fig. 5-2
	max.	36.0Vdc	Absolute maximum continuous input voltage with no damage to the DC/DC converter.
Allowed voltage between input and earth (ground)	max.	60Vdc or 42.4Vac	
Allowed input ripple voltage	max.	5Vpp	47Hz-40kHz, the momentary input voltage must always be within the specified limits.
Turn-on voltage	typ.	17.5Vdc	Steady-state value, see Fig. 5-1
Shut-down voltage	typ.	14.0Vdc	Steady-state value, see Fig. 5-1
	typ.	35Vdc	Steady-state value, see Fig. 5-1
Input current	typ.	4.6A	At 24Vdc input and output 12V, 8A, see Fig. 5-4
Start-up delay	typ.	420ms	See Fig. 5-3
Rise time	typ.	210ms	0mF, 12V, 8A constant current load, see Fig. 5-3
	typ.	240ms	8mF, 12V, 8A constant current load, see Fig. 5-3
Turn-on overshoot	max.	500mV	See Fig. 5-3
Input capacitance	typ.	3000µF	

External capacitors on the input voltage bus are allowed without any limitations.

Fig. 5-1 Input voltage range

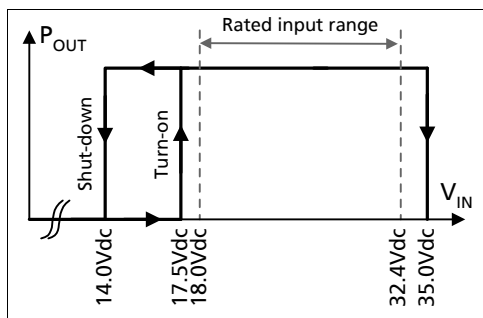


Fig. 5-2 Allowable output current below 18V input voltage

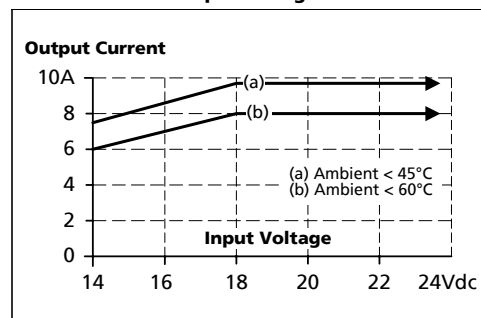


Fig. 5-3 Turn-on behavior, definitions

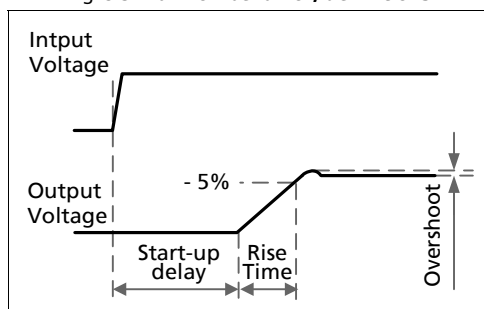
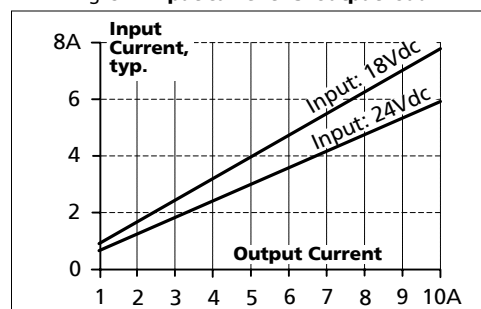


Fig. 5-4 Input current vs. output load



6. SOFT-START AND INPUT INRUSH CURRENT SURGE

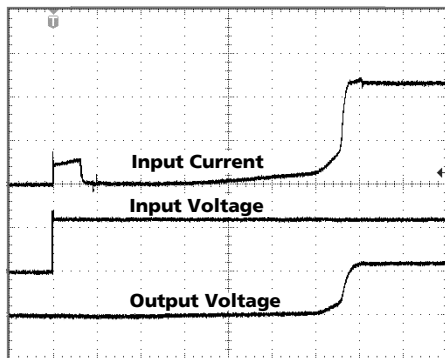
Inrush current limitation

An active inrush limitation circuit (inrush limiting resistor which is bypassed by a relay contact) limits the input inrush current after turn-on of the input voltage.

The charging current into EMI suppression capacitors is disregarded in the first microseconds after switch-on.

Input 24Vdc			
Inrush current	max.	1.6A _{peak}	-25°C to +70°C
	typ.	1.2A _{peak}	-25°C to +70°C
Inrush energy	typ.	negligible	-25°C to +70°C

Fig. 6-1 Input inrush current, typical behavior



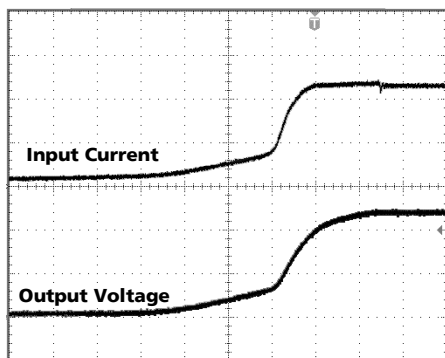
Input: 24Vdc
 Output: 12Vdc, 8A, constant current load
 Ambient: 25°C

Upper curve: Input current 2A / DIV
 Middle curve: Input voltage 20V / DIV
 Lower curve: Output voltage 10V / DIV
 Time scale: 100ms / DIV

Soft-start function:

After the DC/DC converter is turned on, the internal output current rises slowly to its nominal value. This method charges the output capacitors (internal and external capacitors) slowly and avoids high input currents during turn-on. High input currents can produce a high voltage drop on the input wiring (especially with long and thin cables) which reduces the terminal voltage on the DC/DC converter. If the terminal voltage is below the shut-down voltage, the DC/DC converter will turn-off and will make a new start-up attempt. This effect is avoided with the integrated soft-start function. Please note, that this function increases the rise time of the output voltage by a small amount.

Fig. 6-2 Soft-start behavior



Input: 24Vdc
 Output: 24Vdc, 5A, constant current load
 Ambient: 25°C
 No additional external capacitors

Upper curve: Input current 2A / DIV
 Lower curve: Output voltage 5V / DIV
 Time scale: 20ms / DIV

7. OUTPUT

Output voltage	nom.	12V	
Adjustment range	min.	12-15V	Guaranteed
	max.	16.1V	At clockwise end position of potentiometer
Factory setting		12.0V	±0.2%, at full load, cold unit
Line regulation	max.	25mV	Input variations between 18 to 32.4Vdc
Load regulation	max.	120mV	Static value, 0A → 8A → 0A
Ripple and noise voltage	max.	75mVpp	20Hz to 20MHz, 50Ohm
Output capacitance	typ.	6500µF	
Output current	nom.	9.6A	At 12V, ambient < 45°C, see Fig. 7-1
	nom.	8A	At 12V, ambient < 60°C, see Fig. 7-1
	nom.	7.7A	At 15V, ambient < 45°C, see Fig. 7-1
	nom.	6.4A	At 15V, ambient < 60°C, see Fig. 7-1
Output power	nom.	115W	Ambient < 45°C
	nom.	96W	Ambient < 60°C
Short-circuit current	min.	14A	Load impedance 150mOhm, see Fig. 7-1
	max.	18A	Load impedance 150mOhm, see Fig. 7-1

Fig. 7-1 Output voltage vs. output current, typ. (24Vdc input voltage)

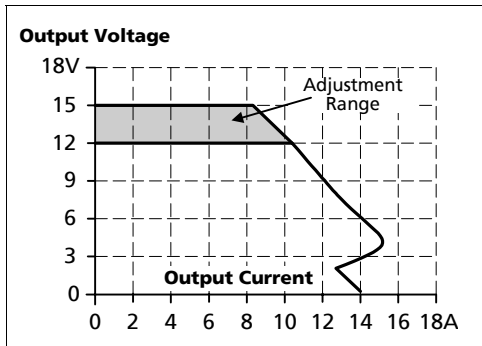
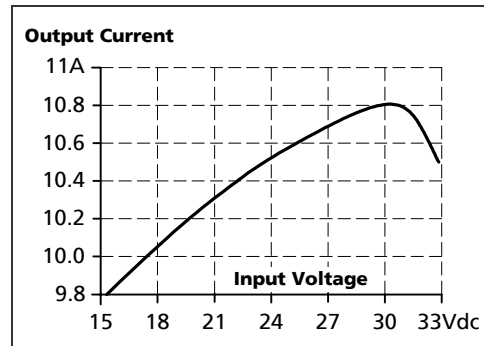


Fig. 7-2 Current limitation vs. input voltage, typ. (11.5V constant voltage load)



Peak current capability (up to several ms)

The DC/DC converter can deliver a peak current which is higher than the specified short term current. This helps to start current demanding loads or to safely operate subsequent circuit breakers.

The extra current is supplied by the output capacitors inside the DC/DC converter. During this event, the capacitors will be discharged and cause a voltage dip on the output. Detailed curves can be found in chapter 25.1.

Peak current voltage dips	typ.	from 12V to 8.3V	At 16A for 50ms, resistive load
	typ.	from 12V to 6.2V	At 40A for 2ms, resistive load
	typ.	from 12V to 4.3V	At 40A for 5ms, resistive load

8. HOLD-UP TIME

The input side of the DC/DC converter is equipped with a bulk capacitor which keeps the output voltage alive for a certain period of time when the input voltage dips or is removed. The bulk capacitor can be discharged by loading the DC/DC converter on the output side or through a load which is parallel to the input. There is no protection in the DC/DC converter which prevents current from flowing back to the input terminals. If prevention is needed, an external diode should be used.

Input 24Vdc

Hold-up Time	typ.	12.8ms	Input 24Vdc, Output: 12Vdc, 4A, see Fig. 8-1
	typ.	7ms	Input 24Vdc, Output: 12Vdc, 8A, see Fig. 8-1

Fig. 8-1 Hold-up time vs. input voltage

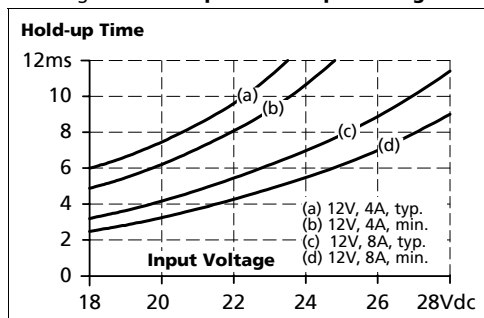


Fig. 8-2 Shut-down test setup

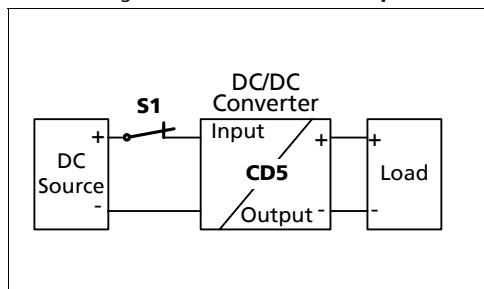
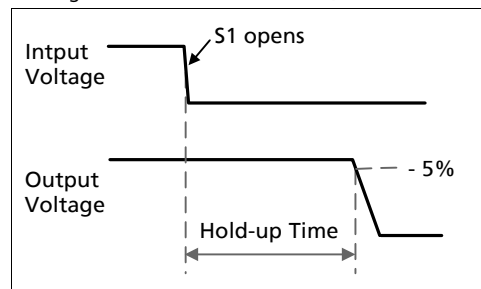


Fig. 8-3 Shut-down behavior, definitions



Note: At no load, the hold-up time can be up to several seconds. The green DC-ok lamp is also on during this time.

9. EFFICIENCY AND POWER LOSSES

Input 24Vdc			
Efficiency	typ.	88.2%	8A, 12V
Power losses	typ.	0.6W	At no output load
	typ.	6.4W	4A, 12V
	typ.	12.8W	8A, 12V
	typ.	16.8W	9.6A, 12V

Fig. 9-1 Efficiency vs. output current at 12V output voltage and 24V input voltage

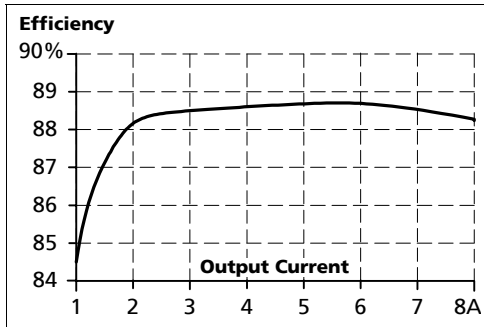


Fig. 9-2 Losses vs. output current at 12V output voltage and 24V input voltage

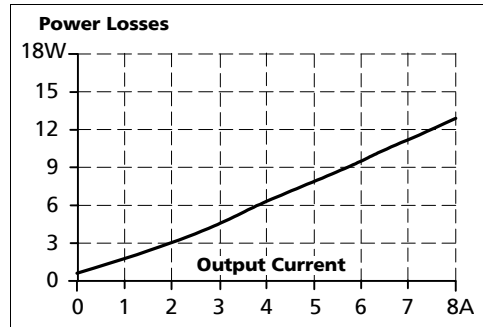


Fig. 9-3 Efficiency vs. input voltage, 12V, 8A output

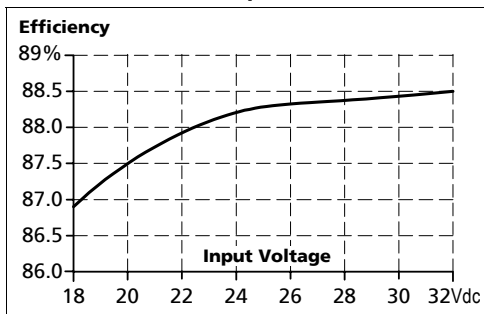
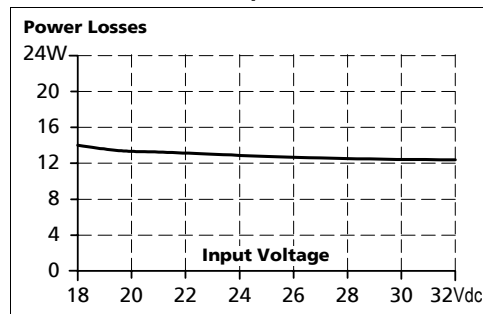
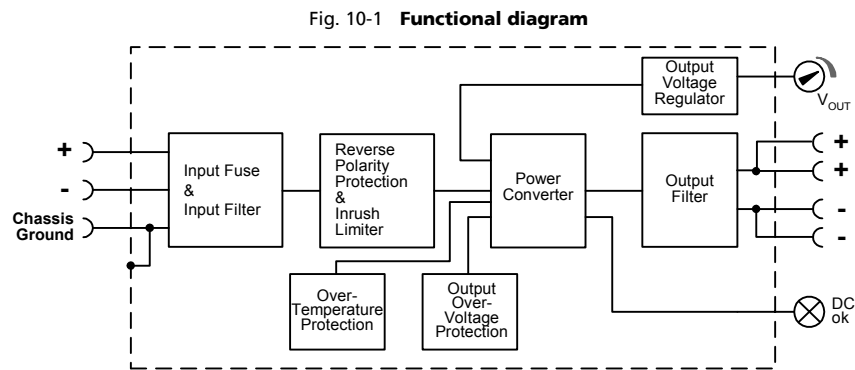


Fig. 9-4 Losses vs. input voltage, 12V, 8A output



10. FUNCTIONAL DIAGRAM



11. RELIABILITY

Input: 24Vdc

Lifetime expectancy	min.	173 000h	40°C, 12V, 4A
	min.	63 000h	40°C, 12V, 8A
	min.	35 000h	40°C, 12V, 9.6A
	min.	179 000h	25°C, 12V, 8A
MTBF SN 29500, IEC 61709		1 161 000h	40°C, 12V, 8A
		1 904 000h	25°C, 12V, 8A
MTBF MIL HDBK 217F		610 000h	40°C, 12V, 8A, Ground Benign GB40
		817 000h	25°C, 12V, 8A, Ground Benign GB25

The **Lifetime expectancy** shown in the table indicates the operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. Lifetime expectancy is specified in operational hours. Lifetime expectancy is calculated according to the capacitor's manufacturer specification. The prediction model allows a calculation of up to 15 years from date of shipment.

MTBF stands for **Mean Time Between Failure**, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

12. FRONT SIDE AND USER ELEMENTS

Fig. 12-1
Front side



A Output Terminals

- Screw terminals
- Dual terminals per pole
- + Positive output
- Negative (return) output

B Input Terminals

- Screw terminals
- + Positive input
- Negative (return) input

Chassis ground can be used to bond the housing to PE
Ground this terminal to minimize high-frequency emissions.

C Output voltage potentiometer

Open the flap to set the output voltage. Factory set: 12.0V

D DC-OK LED (green)

On when the voltage on the output terminals is > 8.5V

13. TERMINALS AND WIRING

Type	Screw terminals
Solid wire	0.5-6mm ²
Stranded wire	0.5-4mm ²
American wire gauge	20-10 AWG
Recommended tightening torque	1Nm, 9lb.in
Screwdriver	3.5mm slotted or Pozidrive No 2
Wire stripping length	7mm / 0.275inch

Instructions:

- a) Use appropriate copper cables that are designed for an operating temperature of:
60°C for ambient up to 45°C and
75°C for ambient up to 60°C minimum.
- b) Follow local and national installation codes and regulations!
- c) Ensure that all strands of a stranded wire enter the terminal connection!
- d) Up to two stranded wires with the same cross section are permitted in one connection point.
- e) Ferrules are allowed but not required
- f) In order to fulfill GL requirements, unused terminal spaces must be closed.

14. EMC

The CE mark indicates conformance with EMC directive 89/336/EEC, 93/68/EEC and 2004/108/EC and the low-voltage directive (LVD) 73/23/EC, 93/68/EC, 2006/95/EC. A detailed EMC Report is available on request.

EMC Immunity	EN 61000-6-2, EN 61000-6-1	Generic standards		
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	4kV	Criterion A
		Output lines	2kV	Criterion A
		Signal lines	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	+ → - + / - → chassis ground	1kV 2kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → chassis ground	500V 500V	Criterion A Criterion A
Conducted disturbance	EN 61000-4-6	0,15-80MHz	10V	Criterion A

Criteria:

A: DC/DC converter shows normal operation behavior within the defined limits.

C: Temporary loss of function is possible. DC/DC converter might shut-down and restarts by itself. No damage or hazards will occur to the DC/DC converter.

EMC Emission	EN 61000-6-3, EN 61000-6-4	Generic standards		
Conducted emission	CISPR 16-1-2, CISPR 16-2-1	Input / output lines (Limits for DC power ports)		
Radiated emission	EN 55011, EN 55022	Class B		

This device complies with FCC Part 15 rules.

Operation is subjected to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Switching frequency

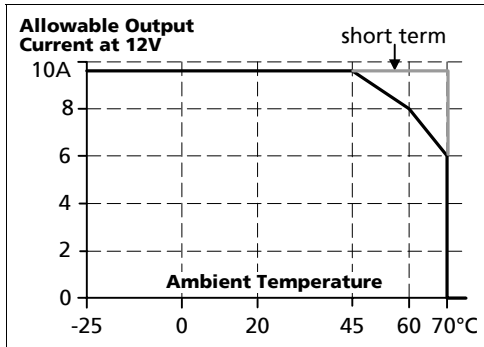
90kHz to 145kHz (Output current > 0.5A)

Input voltage and output current dependent

15. ENVIRONMENT

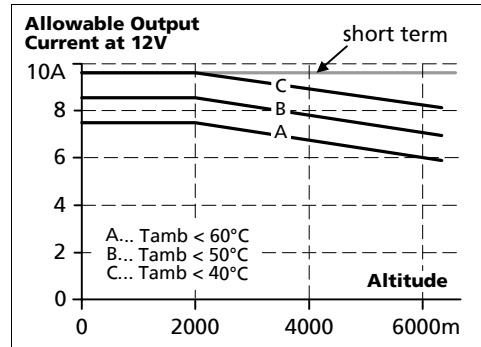
Operational temperature	-25°C to +70°C (-13°F to 158°F)	Reduce output power according to Fig. 15-1
Output de-rating	1.25W/°C 2.5W/°C	45-60°C (113°F to 140°F), see Fig. 15-1 60-70°C (140°F to 158°F), see Fig. 15-1
Storage temperature	-40 to +85°C (-40°F to 185°F)	During storage and transportation
Humidity	5 to 95% r.H.	IEC 60068-2-30 Do not energize while condensation is present
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 20000ft)	Reduce output power or ambient temperature above 2000m sea level.
Output de-rating (for altitude)	6W/1000m or 5°C/1000m	Above 2000m (6500ft), see Fig. 15-2
Over-voltage category	III II	EN 50178, altitudes up to 2000m Altitudes from 2000m to 6000m
Degree of pollution	2	EN 50178, non conductive

Fig. 15-1 Output current vs. ambient temp.



The ambient temperature is defined 2cm below the unit.

Fig. 15-2 Output current vs. altitude, 12V



16. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits	
Output over-voltage protection	typ. 16.5Vdc max. 16.8Vdc	In case of an internal DC/DC converter fault, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Reverse input polarity protection	included	Unit does not start when input voltage is reversed
Output over-current protection	electronically limited	See Fig. 7-1
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 3.5mm	E.g. screws, small parts
Over-temperature protection	yes	Output shut-down with automatic restart
Input transient protection	MOV	Metal Oxide Varistor
Internal input fuse	T10A H.B.C.	Not user replaceable

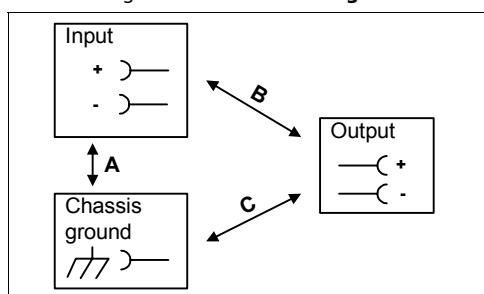
An audible noise may be heard during a no load, overload or short circuit event.

17. SAFETY

Input / output separation	SELV PELV Double or reinforced insulation, Max. allowed voltage between any input pin and ground: 60Vdc or 42.4Vac	IEC/EN 60950-1 EN 60204-1, EN 50178, IEC 60364-4-41
Class of protection	II	PE (Protective Earth) connection not required
Isolation resistance	> 5MΩ	Input to output, 500Vdc
Chassis Ground resistance	< 0.1Ω	Between housing and Chassis Ground terminal
Touch current (leakage current)	The leakage current which is produced by the DC/DC converter itself depends on the input voltage ripple and need to be investigated in the final application. For a smooth DC input voltage, the produced leakage current is less than 100µA.	

18. DIELECTRIC STRENGTH

Fig. 18-1 Dielectric strength



		A	B	C
Type test	60s	1500Vac	1500Vac	500Vac
Factory test	5s	1500Vac	1500Vac	500Vac
Field test	5s	1000Vac	1000Vac	500Vac

Type tests and factory tests:

Conducted by the manufacturer. Do not repeat test in field!







Rules for field test:

Use appropriate test equipment which applies the voltage with a slow ramp! Connect all input poles together as well as all output poles.

The output voltage is floating and has no ohmic connection to ground.

To fulfill the PELV requirements according to EN60204-1 § 6.4.1, it is recommend that either the + pole, the – pole or any other part of the output circuit shall be connected to the protective earth system. This helps to avoid situations in which a load starts unexpectedly or can not be switched off any more when an unnoticed earth faults occur.

19. APPROVALS

IEC 60950-1		CB Scheme, Information Technology Equipment
UL 508		LISTED E198865 Industrial Control Equipment
UL 60950-1		RECOGNIZED E137006 recognized for the use in U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950) Information Technology Equipment, Level 3
UL 1604 pending		RECOGNIZED E246877 recognized for use in U.S.A. (UL 1604) and Canada (C22.2 No. 213-M1987) Hazardous Location Class I Div 2 T4 Groups A,B,C,D and Class I Zone 2 Groups IIA, IIB and IIC
The unit is suitable for use in Class I Division 2 Groups A, B, C, D locations as well as for Class I Zone 2 Groups IIA, IIB and IIC locations. Substitution of components may impair suitability for Class I Division 2 environment. Do not disconnect equipment unless power has been switched off. Wiring must be in accordance with Class I, Division 2 wiring methods of the National Electrical Code, NFPA 70, and in accordance with other local or national codes.		
CSA pending		CSA approval for Canada CAN/CSA C22.2 No 107-1; CAN/ CSA 60950-1-03; UL60950-1
Marine pending		GL (Germanischer Lloyd) classified and ABS (American Bureau for Shipping) PDA for marine and offshore applications. Environmental category: C, EMC2

20. FULFILLED STANDARDS

EN 61558-2-17	Safety of Power Transformers
EN/IEC 60204-1	Safety of Electrical Equipment of Machines
EN/IEC 61131-2	Programmable Controllers
EN 50178, IEC 62103	Electronic Equipment in Power Installations

21. USED SUBSTANCES

The unit does not release any silicone and is suitable for the use in paint shops.

The unit conforms to the RoHS directive 2002/96/EC

Electrolytic capacitors included in this unit do not use electrolytes such as Quaternary Ammonium Salt Systems.

Plastic housings and other molded plastic materials are free of halogens, wires and cables are not PVC insulated.

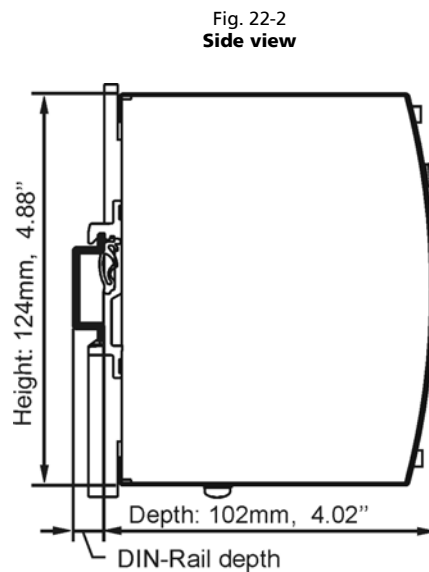
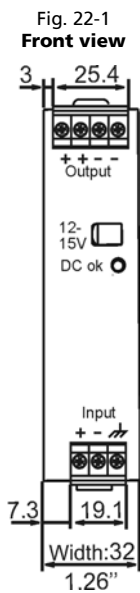
The materials used in our production process do not include the following toxic chemicals:

Polychlorinated Biphenyl (PCB), Pentachlorophenol (PCP), Polychlorinated naphthalene (PCN), Polybrominated Biphenyl (PBB), Polybrominated Biphenyl Oxide (PBO), Polybrominated Diphenyl Ether (PBDE), Polychlorinated Diphenyl Ether (PCDE), Polybrominated Diphenyl Oxide (PBDO), Cadmium, Asbestos, Mercury, Silica

22. PHYSICAL DIMENSIONS AND WEIGHT

Weight	425g / 0.94lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm. The DIN-rail height must be added to the depth (102mm) to calculate the total required installation depth.

Electronic files with mechanical data can be downloaded at www.pulspower.com



23. INSTALLATION AND OPERATION INSTRUCTIONS

Mounting:

Output terminal must be located on top and input terminal on the bottom. For other orientations see chapter 25.13. An appropriate electrical and fire end-product enclosure should be considered in the end use application.

Cooling:

Convection cooled, no forced cooling required. Do not cover ventilation grill (e.g. cable conduits) by more than 30%!

Installation clearances:

40mm on top, 20mm on the bottom, 5mm on the left and right side are recommended when loaded permanently with full power. In case the adjacent device is a heat source, 15mm clearance are recommended.

Risk of electrical shock, fire, personal injury or death!

Turn power off before working on the DC/DC converter. Protect against inadvertent re-powering.

Make sure the wiring is correct by following all local and national codes.

Do not open, modify or repair the unit.

Use caution to prevent any foreign objects from entering into the housing.

Do not use in wet locations or in areas where moisture or condensation can be expected.

Supplying source:

The inductance and resistance of the supplying network shall be below in Fig. 25-9 in chapter 25.10 to avoid resonant effects on the input terminals. Please also check chapter 25.10.

Service parts:

The unit does not contain any service parts. The tripping of an internal fuse is caused by an internal fault. If damage or malfunctioning should occur during operation, immediately turn power off and send unit to the factory for inspection!

24. ACCESSORY

ZM1.WALL Wall mounting bracket

This bracket is used to mount specific Dimension units onto a flat surface without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slide of the unit have to be removed, so that the two steel brackets can be mounted.

(Please note: Picture shows a different unit)

Fig. 24-1 **ZM1.WALL Wall Mounting Bracket**

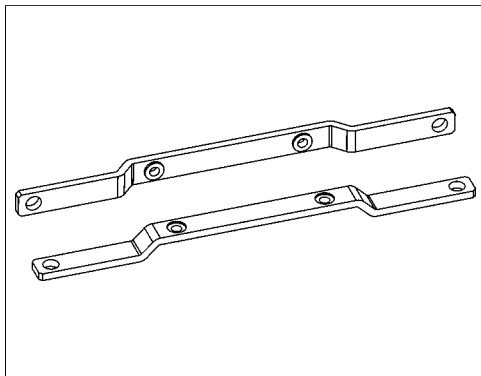
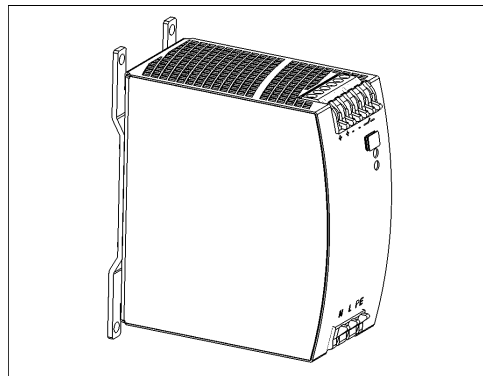


Fig. 24-2 **Assembled Wall Mounting Bracket**



ZM11.SIDE Side mounting bracket

This bracket is used to mount specific Dimension units sideways with or without utilizing a DIN-Rail. The two aluminum brackets and the black plastic slide of the unit have to be removed, so that the steel bracket can be mounted.

For sideways DIN-rail mounting, the removed aluminum brackets and the black plastic slide need to be reinstalled on the steel bracket.

(Please note: Pictures show a different unit)

Fig. 24-3 **ZM11.SIDE Side Mounting Bracket**

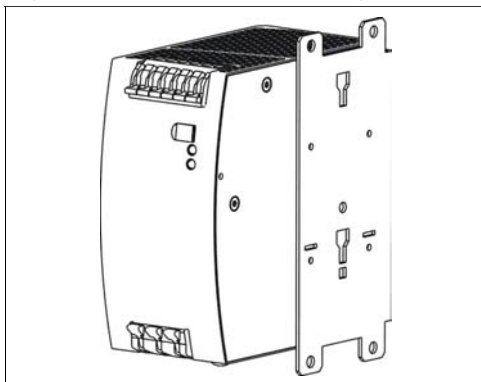
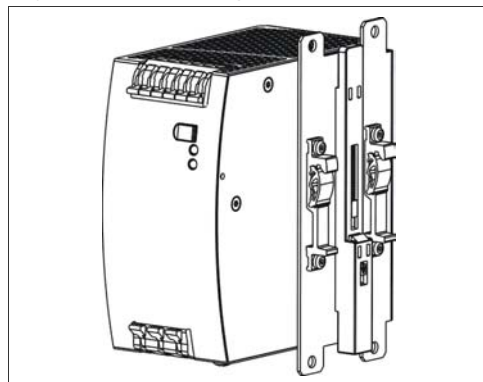


Fig. 24-4 **Side Mounting with DIN-rail brackets**



25. APPLICATION NOTES

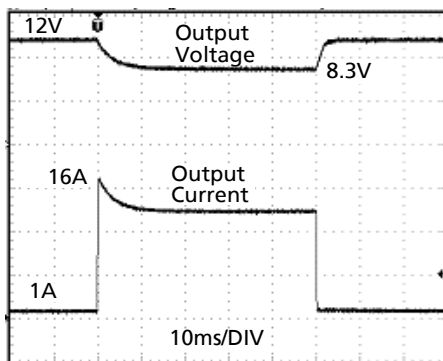
25.1. PEAK CURRENT CAPABILITY

Solenoids, contactors and pneumatic modules often have a steady state (sealed) coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady state current and usually exceeds the nominal output current (including the PowerBoost). The same situation applies, when starting a capacitive load.

Branch circuits are often protected with circuit breakers or fuses. In case of a short or an overload in the branch circuit, the fuse needs a certain amount of over-current to trip or to blow. The peak current capability ensures the safe operation of subsequent circuit breakers.

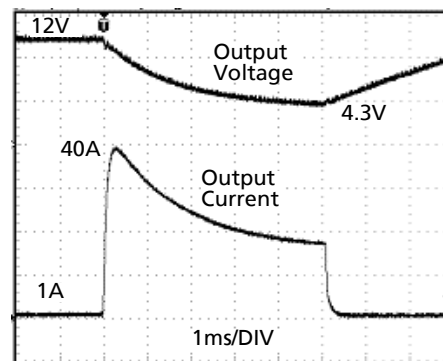
Assuming the input voltage is turned on before such an event, the built-in large sized output capacitors inside the DC/DC converter can deliver extra current. Discharging this capacitor causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 25-1 Peak load 16A for 50ms, typ.



Peak load 16A (resistive) for 50ms
Output voltage dips from 12V to 8.3V.

Fig. 25-2 Peak load 40A for 5ms, typ.



Peak load 40A (resistive) for 5ms
Output voltage dips from 12V to 4.3V.

25.2. BACK-FEEDING LOADS

Loads such as decelerating motors and inductors can feed voltage back to the DC/DC converter. This feature is also called return voltage immunity or resistance against Back- E.M.F. (Electro Magnetic Force).

This DC/DC converter is resistant and does not show malfunctioning when a load feeds back voltage to the DC/DC converter. It does not matter, whether the DC/DC converter is on or off.

The maximum allowed feed back voltage is 16Vdc. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 7.

25.3. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply any kind of load, including unlimited capacitive and inductive loads.

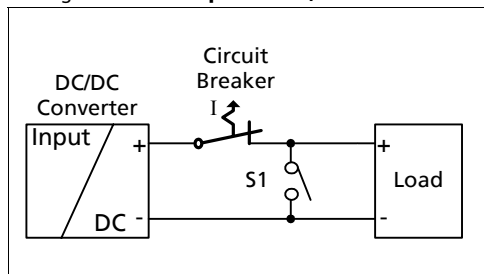
25.4. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCBs or UL1077 circuit breakers) can be used for branch circuit protection. Ensure that the MCB is also rated for DC voltage. The following tests show which circuit breakers the DC/DC converter typically trips.

Circuit breakers have huge tolerances in their tripping behavior, therefore, these typical tests can only be used as a recommendation or for comparing two different DC/DC converters. Furthermore, the loop impedance has a major influence on whether a breaker trips or not. Two tests were performed, representing typical situations:

Test 1: Short circuit with S1 on the DC/DC converter end of the cable (loop impedance approx. 20mOhm)

Fig. 25-3 Branch protectors, test circuit 1



Parameters:

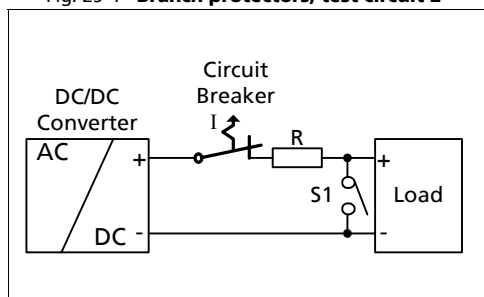
Input voltage: 24Vdc, load current: 0A

The following circuit breaker tripped during the test:

- A- or Z- Characteristic:** equal or smaller 10A *)
- B- Characteristic:** no tripping $\geq 6A$ *)
no breaker available $< 6A$
- C- Characteristic:** equal or smaller 2A *)

Test 2: Short circuit with S1 on the load end (additional impedance included; represents longer load wire length).

Fig. 25-4 Branch protectors, test circuit 2



Parameters:

Input voltage: 24Vdc, load current: 0A

The following circuit breaker tripped during the test:

- A- or Z- Characteristic:** $\leq 4A$ and $R = 220m\Omega$ *)
- B- Characteristic:** no tripping $\geq 6A$ *)
no breaker available $< 6A$
- C- Characteristic:** $\leq 2A$ and $R = 270m\Omega$ *)

What does this resistance mean in wire length?

	0.5mm ²	0.7mm ²	1.0mm ²	1.5mm ²	2.5mm ²	4.0mm ²
220mOhm	5.9m	8.2m	11.8m	17.6m	29.4m	47m
270mOhm	7.5m	10.5m	15m	23m	38m	60m

*) A list of the circuit breakers under test is available on request.

Example:

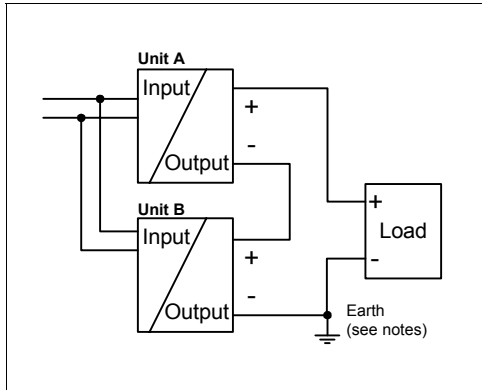
Which wire gauge must be used to trip a C-Characteristic circuit breaker with a rating of 2A? The load wire length is 21m.

Answer: A 2A C-Characteristic circuit breaker requires a loop impedance of less than 270mOhm (test results). The wire length table shows that up to 23m wire with a cross section of 1.5mm² are below 270mOhm. A wire not smaller than 1.5mm² shall be used.

25.5. SERIES OPERATION

DC/DC converters can be connected in series to increase the output voltage.

Fig. 25-5 Schematic for series operation



Instructions for use in series:

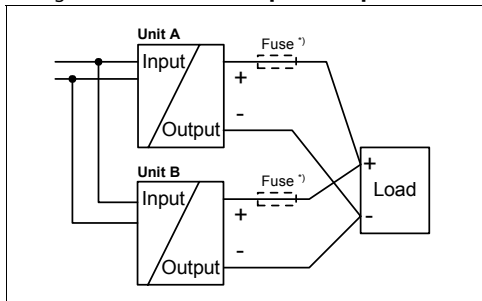
- It is possible to connect as many units in series as needed, providing the sum of the output does not exceed 150Vdc.
- Voltages with a potential above 60Vdc are not SELV any more and can be dangerous. Such voltages must be installed with a protection against touching.
- For serial operation use DC/DC converters of the same type.
- Earthing of the output is required when the sum of the output voltage is above 60Vdc.
- Keep an installation clearance of 15mm (left/right) between two DC/DC converters and avoid installing the DC/DC converters on top of each other.

Note: Avoid return voltage (e.g. from a decelerating motor or battery) which is applied to the output terminals.

25.6. PARALLEL USE TO INCREASE OUTPUT POWER

Several DC/DC converter can be paralleled to increase the output power.

Fig. 25-6 Schematic for parallel operation



Instructions for parallel use:

- Use only DC/DC converters from the same series (C-Series) or consult PULS.
- Adjust the output voltages of all power supplies to approximately the same value ($\pm 200\text{mV}$).
- A fuse (or diode) on the output is only required if more than three units are connected in parallel.
- Do not load terminals with more than 25A. Follow wiring instructions according to chapter 25.7
- Ensure that the ambient temperature of the power supply does not exceed 45°C.

25.7. DAISY CHAINING OF OUTPUTS

Daisy chaining (jumping from one power supply output to the next) is allowed as long as the maximum current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block.

Fig. 25-7 Daisy chaining of outputs

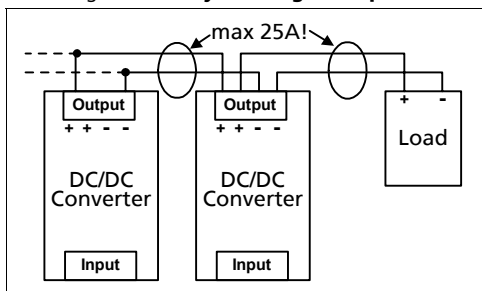
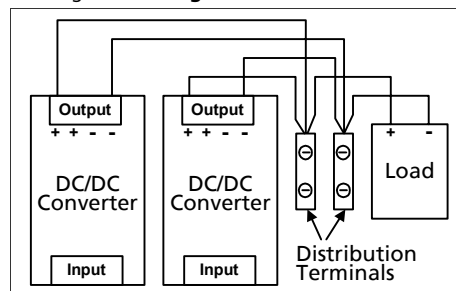


Fig. 25-8 Using distribution terminals



25.8. PARALLEL USE FOR 1+1 REDUNDANCY

DC/DC converters can be paralleled for 1+1 redundancy to gain a higher system availability. Redundant systems require a certain amount of extra power to support the load in case one DC/DC converter unit fails. The simplest way is to put two DC/DC converters in parallel. In case one converter fails, the other one is automatically able to support the load current without any interruption.

Furthermore, redundant systems can be built by using a DC/DC converter powered from a battery and a power supply with AC input.

Recommendations for building redundant power systems:

- a) Use the decoupling module YR2.DIODE in combination with two CD5.121.
- b) Use separate input fuses for each DC/DC converter.
- c) When possible, connect each DC/DC converter to different power sources.

25.9. CHARGING OF BATTERIES

The power supply can be used for float-charging of lead-acid or maintenance free 12V VRLA batteries.

Instructions for charging batteries:

- a) Ensure that the ambient temperature of the power supply does not exceed 50°C.
- b) Set the output voltage on a disconnected load, very precisely to the end-of-charge voltage according to the expected battery temperature.

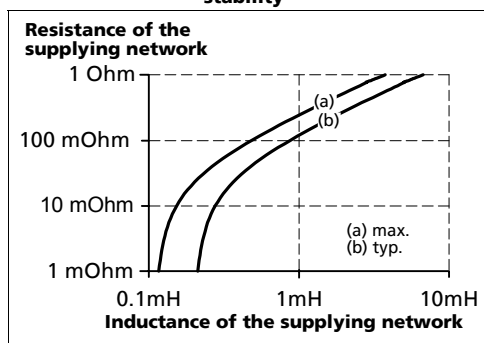
End-of-charge voltage	13.9V	13.75V	13.6V	13.4V
Battery temperature	10°C	20°C	30°C	40°C

- c) Use a 10A circuit breaker (or blocking diode) between the power supply and the battery.
- d) Ensure that the output current of the power supply is below the allowed charging current of the battery.
- e) The return current to the power supply is typ. 15mA at 12.5Vdc when the power supply is switched off (except in case a blocking diode is utilized).

25.10. REQUIREMENTS FOR THE SUPPLYING SOURCE

In certain circumstances, the input filter of the DC/DC converter can show a resonant effect which is caused by the supplying network. Especially when additional external input filters are utilized, a superimposed AC voltage can be generated on the input terminals of the DC/DC converter which might cause a malfunction of the unit. Therefore, additional input filters are not recommended. To avoid the resonant effects, the minimal resistance of the supplying network which depends on the inductance of the input network, shall be above the boundary curve in Fig. 25-9.

Fig. 25-9 Requirements for an input filter stability



25.11. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 50A. External protection is only required if the supplying branch has an ampacity greater than this. In some countries local regulations might apply so check local codes and local requirements.

If an external fuse is necessary or utilized, a minimum value is required to avoid undesired tripping of the fuse.

		B-Characteristic	C-Characteristic
Ampacity	max.	50A	50A
	min.	10A	8A

25.12. USE IN A TIGHTLY SEALED ENCLOSURE

When the DC/DC converter is installed in a tightly sealed enclosure, the temperature inside the enclosure will be higher than the outside. The inside temperature defines the ambient temperature for the DC/DC converter.

Results from such an installation:

DC/DC converter is placed in the middle of the box, no other heat producing equipment inside the box

Enclosure:	Rittal Type IP66 Box PK 9516 100, plastic, 110x180x165mm
Load:	12V, 6.4A; (=80%) load is placed outside the box
Input:	24Vdc
Temperature inside the box:	58.0°C (in the middle of the right side of the DC/DC converter with a distance of 2cm)
Temperature outside the box:	22.6°C
Temperature rise:	35.4K

25.13. MOUNTING ORIENTATIONS

Mounting orientations other than input terminals on the bottom and output on the top requires a reduction in continuous output power or a limitation in the maximum allowed ambient temperature. The amount of reduction influences the lifetime expectancy of the DC/DC converter. Therefore, two different derating curves for continuous operation can be found below:

Curve A1 Recommended output current.

Curve A2 Max allowed output current (results approx. in half the lifetime expectancy of A1).

Fig. 25-10

Mounting Orientation A
Standard Orientation

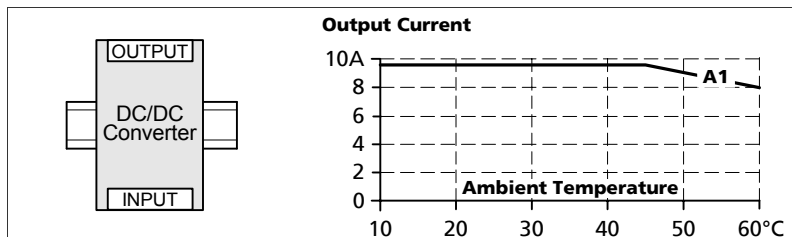


Fig. 25-11

Mounting Orientation B
(Upside down)

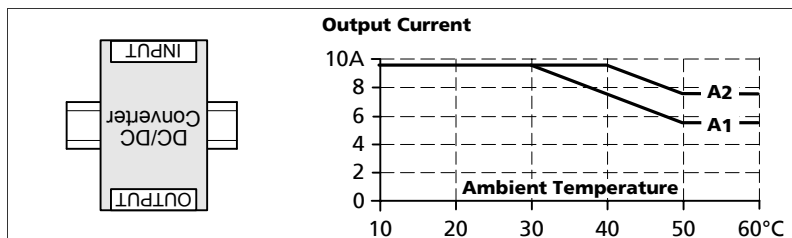


Fig. 25-12

Mounting Orientation C
(Table-top mounting)

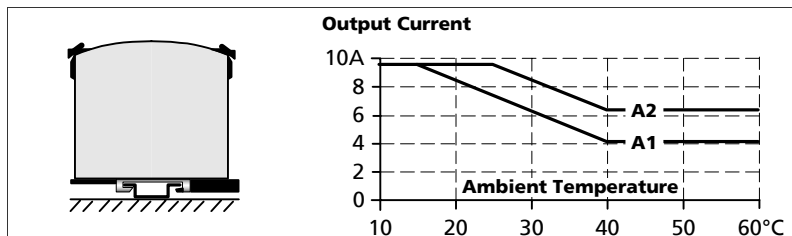


Fig. 25-13

Mounting Orientation D
(Horizontal cw)

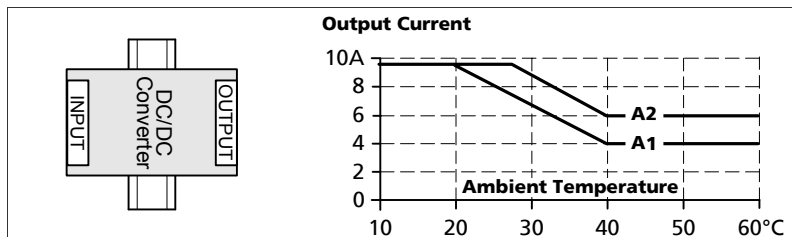


Fig. 25-14

Mounting Orientation E
(Horizontal ccw)

