



### DC/DC CONVERTER

- EN 50155 Railway Compliant
- Conformal Coated PC-boards
- Built-in Redundancy (Decoupling Mosfet at the Output)
- Quick-connect Spring-clamp Terminals
- 77-154Vdc Wide-range Input
- Width only 65mm
- Efficiency up to 93.7%
- Excellent Partial Load Efficiency
- Safe Hiccup<sup>PLUS</sup> Overload Mode
- Minimal Inrush Current Surge
- Full Power Between -40°C and +70°C
- DC-OK Relay Contact
- Reverse Input Polarity Protected
- 3 Year Warranty

### GENERAL DESCRIPTION

The CPS20.241-60 DC/DC converter is designed specifically for railway & transportation applications. It is approved according to the EN 50155 standard, which is an international standard covering electronic equipment used on rolling stock for railway applications. The standard covers aspects such as temperature, humidity, shock, vibration, EMI and other parameters. Because of these requirements, the unit is equipped with conformal coated pc-boards.

The unit features a DC-OK signal contact for remote monitoring, a decoupling MOSFET for building redundant power supply systems and quick-connect spring-clamp terminals for a reliable connection even when mechanical vibration and shock are involved. The unit also covers an extreme wide temperature range from -40°C up to +70°C with full output current.

This DC/DC converter comes in a very compact housing and requires only 65mm space on the DIN-rail due to the high efficiency and low power losses. The high efficiency is achieved by utilizing cutting edge technology and other unique design techniques.

### ORDER NUMBERS

DC/DC converter **CPS20.241-60**

Accessory	ZM2.WALL	Wall mount bracket
	ZM13.SIDE	Side mount bracket

### SHORT-FORM DATA

Output voltage	DC 24.5V	
Adjustment range	-	not adjustable
Output current	16.3A	
Output power	400W	
Output ripple	max. 100mVpp	20Hz to 20MHz
AC Input voltage	-	-
DC Input voltage	DC 110V	- 30%/ +40%
DC Input current	3.87A	at 110Vdc
Inrush current	typ. 6A peak	at 110Vdc
Efficiency	93.7%	at 110Vdc
Losses	26.9W	at 110Vdc
Temperature range	-40°C to +70°C	operational
Derating	-	not required
Hold-up time	typ. 35ms	at 110Vdc
Dimensions	65x124x127mm	WxHxD
Weight	980g / 2.16lb	

### MARKINGS



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### TERMINOLOGY AND ABBREVIATIONS

<b>PE and <math>\oplus</math> symbol</b>	PE is the abbreviation for <b>Protective Earth</b> and has the same meaning as the symbol $\oplus$ .
<b>Earth, Ground</b>	This document uses the term "earth" which is the same as the U.S. term "ground".
<b>T.b.d.</b>	To be defined, value or description will follow later.
<b>DC 110V</b>	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually $\pm 15\%$ ) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
<b>110Vdc</b>	A figure with the unit (Vdc) at the end is a momentary figure without any additional tolerances included.
<b>may</b>	A key word indicating flexibility of choice with no implied preference.
<b>shall</b>	A key word indicating a mandatory requirement.
<b>should</b>	A key word indicating flexibility of choice with a strongly preferred implementation.

### 1. INTENDED USE

This device is designed for installation in an enclosure and is intended for the general professional use such as in rolling stock for railway applications or in industrial control, office, communication, and instrumentation equipment. Do not use this DC/DC converter in equipment, where malfunction may cause severe personal injury or threaten human life.

### 2. INSTALLATION REQUIREMENTS

This device may only be installed and put into operation by qualified personnel.

This device does not contain serviceable parts. The tripping of an internal fuse is caused by an internal defect.

If damage or malfunction should occur during installation or operation, immediately turn power off and send unit to the factory for inspection.

Mount the unit on a DIN-rail so that the terminals are located on the bottom of the unit. For other mounting orientations see de-rating requirements in this document. See chapter 23.11.

This device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid (e.g. cable conduits) by more than 15%!

Keep the following installation clearances: 40mm on top, 20mm on the bottom, 5mm on the left and right sides are recommended when the device is loaded permanently with more than 50% of the rated power. Increase this clearance to 15mm in case the adjacent device is a heat source (e.g. another power supply).

**⚠ WARNING** Risk of electrical shock, fire, personal injury or death.

- Do not use the DC/DC converter without proper grounding (Protective Earth). Use the terminal on the input block for earth connection and not one of the screws on the housing.
- Turn power off before working on the device. Protect against inadvertent re-powering.
- Make sure that the wiring is correct by following all local and national codes.
- Do not modify or repair the unit.
- Do not open the unit as high voltages are present inside.
- Use caution to prevent any foreign objects from entering the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
- Do not touch during power-on, and immediately after power-off. Hot surfaces may cause burns.

### 3. AC-INPUT

Do not operate this DC/DC converter with an AC-input voltage. Use the CPS20.241 or CPS20.241-C1 unit instead.

### 4. DC-INPUT

Use a battery or a similar DC source. A supply from the intermediate DC-bus of a frequency converter is not recommended and can cause a malfunction or damage the unit.

Input voltage	nom.	DC 110V	-30%/+40%
Input voltage range		77-154Vdc	
		66-77Vdc	short term for 100ms
Input current	typ.	3.87A	at 16.3A and 110Vdc input voltage, see Fig. 4-3
Allowed voltage between input to earth (ground)	max.	375Vdc	continuous, IEC 62103
Allowed input ripple voltage	max.	15Vpp 3Vpp	50Hz – 10kHz 10kHz – 50kHz
Turn-on voltage	typ.	77Vdc	steady-state value, at ambient temperatures between -20°C and +70°C, see Fig. 4-1
	typ.	85Vdc	steady-state value, at -40°C ambient temperature
Shut-down voltage	typ.	60Vdc	steady-state value, see Fig. 4-1
Start-up delay	typ.	900ms	see Fig. 4-2
Rise time	typ.	85ms	at 16.3A constant current load, 0mF load capacitance, see Fig. 4-2
	typ.	130ms	at 16.3A constant current load, 20mF load capacitance, see Fig. 4-2
Turn-on overshoot	max.	200mV	see Fig. 4-2
External input protection	See recommendations in chapter 23.3.		

Fig. 4-1 **Input voltage range**

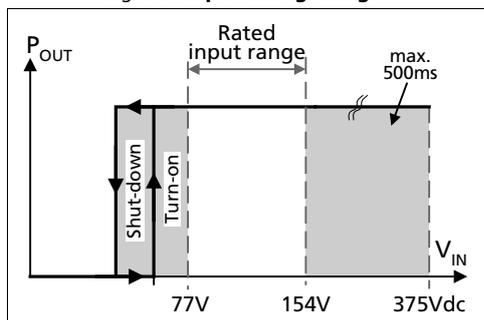


Fig. 4-2 **Turn-on behavior, definitions**

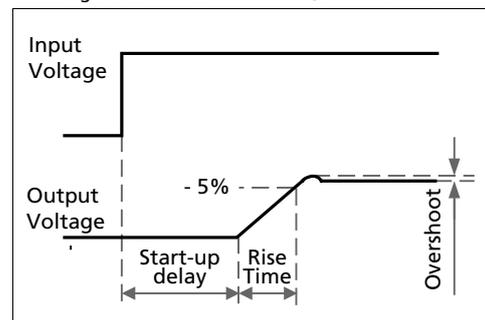
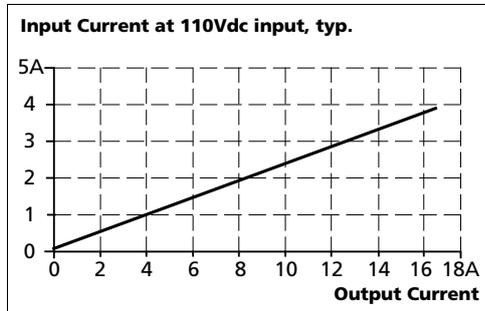


Fig. 4-3 **Input current vs. output load**

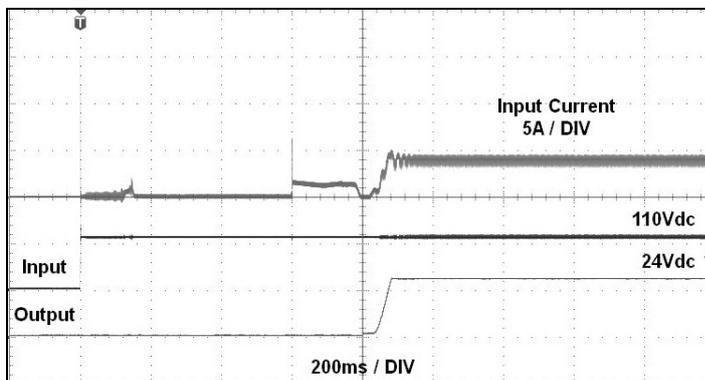


## 5. INPUT INRUSH CURRENT

An active inrush limitation circuit 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.

Inrush current	max.	13A <sub>peak</sub>	at 110Vdc, temperature independent
	typ.	6A <sub>peak</sub>	at 110Vdc, temperature independent
Inrush energy	max.	1A <sup>2</sup> s	at 110Vdc, temperature independent

Fig. 5-1 **Typical input inrush current behaviour at nominal load and 25°C ambient**



### 6. OUTPUT

Output voltage	nom.	24.5V <sup>***)</sup> 25.0V <sup>***)</sup>	±2%, at 16.3A load current ±2%, at 0A load current
Adjustment range	min.	-	fixed output voltage, no adjustments possible
Line regulation	max.	10mV	77-154Vdc
Load regulation	typ.	500mV <sup>***)</sup>	static value, 0A → 16.3A
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	16.3A	continuously available
Output power	nom.	400W	continuously available
Overload behaviour		cont. current Hiccup <sup>PLUS</sup> mode <sup>*)</sup>	output voltage > 13Vdc, see Fig. 6-1 output voltage < 13Vdc, see Fig. 6-1
Short-circuit current	min.	25A <sup>**)</sup>	load impedance < 10mOhm, see Fig. 6-2.
	max.	32A <sup>**)</sup>	load impedance < 10mOhm, see Fig. 6-2.
	max.	11A <sup>**)</sup>	average (R.M.S.) current, load impedance 50mOhm, see Fig. 6-2.
Output capacitance	typ.	7 000µF	included inside the DC/DC converter

- \*) **Hiccup<sup>PLUS</sup> Mode**  
At heavy overloads (when output voltage falls below 13V), the DC/DC converter delivers continuous output current for 2s. After this, the output is switched off for approx. 18s before a new start attempt is automatically performed. This cycle is repeated as long as the overload exists. If the overload has been cleared, the device will operate normally. See Fig. 6-2.
- \*\*\*) Discharge current of output capacitors is not included.
- \*\*) The unit is featured with a "soft output regulation characteristic" in order to achieve current share between multiple DC/DC converters, when they are connected in parallel (.g. for redundancy reasons).

Fig. 6-1 **Output voltage vs. output current, typ.**

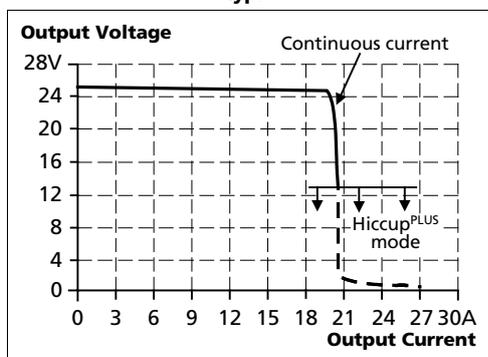
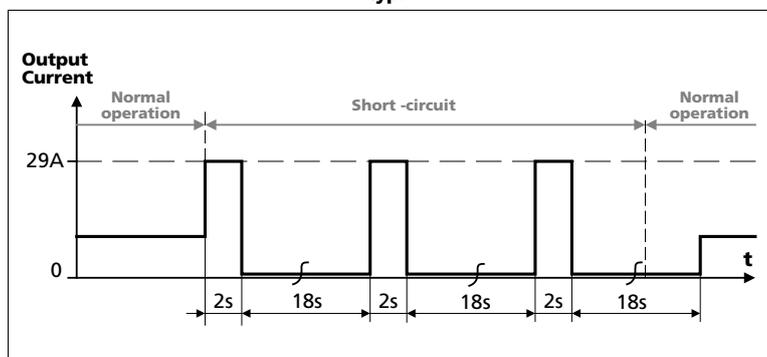


Fig. 6-2 **Short-circuit on output, Hiccup<sup>PLUS</sup> mode, typ.**



### 7. HOLD-UP TIME

The internal capacitor, which supplies the energy for the hold-up time is isolated by a diode to the input voltage. A short on the input line does not discharge the internal hold-up capacitor.

Hold-up Time	typ.	80ms	at 8.2A, see Fig. 7-1
	min.	64ms	at 8.2A, see Fig. 7-1
	typ.	35ms	at 16.3A, see Fig. 7-1
	min.	28ms	at 16.3A, see Fig. 7-1

Fig. 7-1 **Hold-up time vs. input voltage**

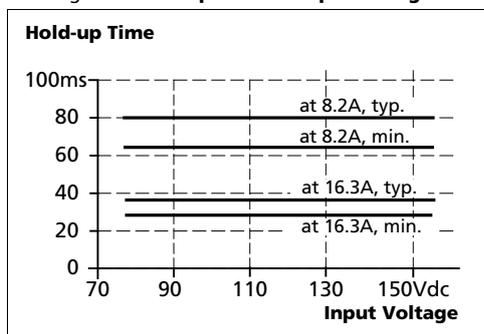
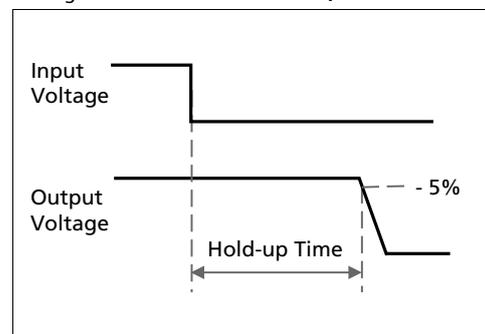


Fig. 7-2 **Shut-down behavior, definitions**

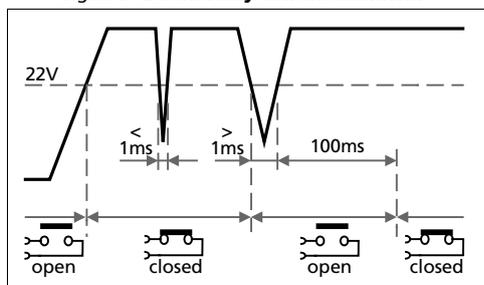


### 8. DC-OK RELAY CONTACT

This feature monitors the output voltage, which is produced by the DC/DC converter itself. It is independent of a backed voltage from a unit connected in parallel to the DC/DC converter output.

Contact closes	As soon as the output voltage reaches 22V.		
Contact opens	As soon as the output voltage falls below 22V. Short dips will be extended to a signal length of 100ms. Dips shorter than 1ms will be ignored.		
Contact ratings	max.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min.	1mA at 5Vdc	min. permissible load
Isolation voltage	See dielectric strength table in section 18.		

Fig. 8-1 **DC-ok relay contact behavior**



### 9. EFFICIENCY AND POWER LOSSES

Efficiency	typ.	93.7%	at 110Vdc input and 16.3A output current
Average efficiency <sup>*)</sup>	typ.	92.3%	25% at 4.1A, 25% at 8.2A, 25% at 12.2A, 25% at 16.3A
Power losses	typ.	4.7W	at 110Vdc input and 0A output current
	typ.	17.4W	at 110Vdc input and 8.2A output current
	typ.	26.9W	at 110Vdc input and 16.3A output current

\*) The average efficiency is an assumption for a typical application where the DC/DC converter is loaded with 25% of the nominal load for 25% of the time, 50% of the nominal load for another 25% of the time, 75% of the nominal load for another 25% of the time and with 100% of the nominal load for the rest of the time.

Fig. 9-1 Efficiency vs. output current, typ

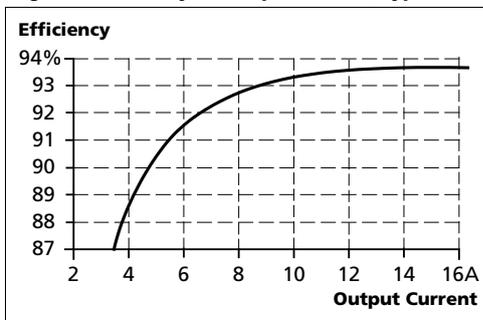
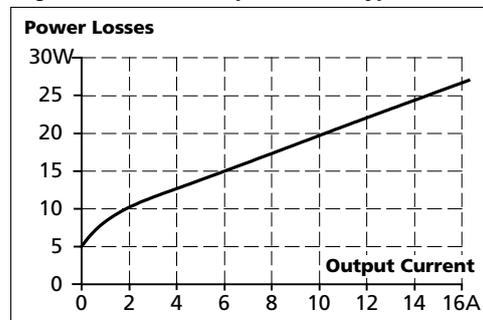


Fig. 9-2 Losses vs. output current, typ.



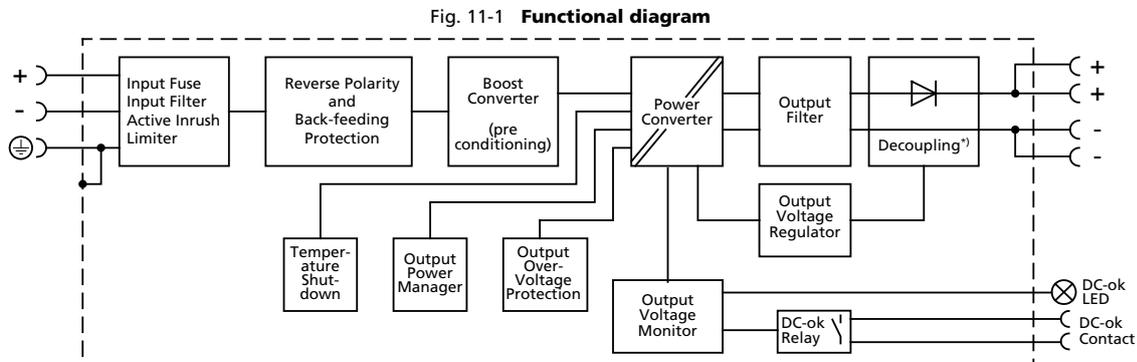
### 10. LIFETIME EXPECTANCY AND MTBF

Lifetime expectancy <sup>*)</sup>	222 000h <sup>*)</sup>	at 8.2A and 40°C
	627 000h <sup>*)</sup>	at 8.2A and 25°C
	151 000h <sup>*)</sup>	at 16.3A and 40°C
	428 000h <sup>*)</sup>	at 16.3A and 25°C
MTBF <sup>**) SN 29500, IEC 61709</sup>	571 000h	at 16.3A and 40°C
	932 000h	at 16.3A and 25°C
MTBF <sup>**) MIL HDBK 217F</sup>	238 000h	at 16.3A and 40°C, Ground Benign GB40
	322 000h	at 16.3A and 25°C, Ground Benign GB25
	51 000h	at 16.3A and 40°C, Ground Fixed GF40
	67 000h	at 16.3A and 25°C, Ground Fixed GF25

\*) The **Lifetime expectancy** shown in the table indicates the minimum operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. Lifetime expectancy is specified in operational hours and is calculated according to the capacitor's manufacturer specification. The manufacturer of the electrolytic capacitors only guarantees a maximum life of up to 15 years (131 400h). Any number exceeding this value is a calculated theoretical lifetime which can be used to compare devices.

\*\*) **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. The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 000 units are installed in the field. However, it can not be determined if the failed unit has been running for 50 000h or only for 100h.

### 11. FUNCTIONAL DIAGRAM



\*) Decoupling: This feature utilizes a Mosfet instead of a diode in order to minimize the voltage drop and power losses.

### 12. TERMINALS AND WIRING

The terminals are IP20 finger safe constructed and suitable for field- and factory wiring. Shipped in open position.

	<b>Input and output</b>	<b>DC-OK-Signal</b>
<b>Type</b>	Bi-stable, quick-connect spring-clamp terminals	push-in spring-clamp terminals
Solid wire	max. 6mm <sup>2</sup>	max. 1.5mm <sup>2</sup>
Stranded wire	max. 4mm <sup>2</sup>	max. 1.5mm <sup>2</sup>
American Wire Gauge	AWG20-10	AWG26-14
Max. wire diameter	2.8mm (including ferrules)	1.5mm (including ferrules)
Wire stripping length	10mm / 0.4inch	7mm / 0.28inch
Screwdriver	not required	3.5mm slotted (to open the spring)
Recommended tightening torque	not applicable	not applicable

**Instructions:**

- a) Use appropriate copper cables that are designed for minimum operating temperatures of:
  - 60°C for ambient up to 45°C and
  - 75°C for ambient up to 60°C minimum
  - 90°C for ambient up to 70°C minimum.
- b) Follow national installation codes and installation regulations!
- c) Ensure that all strands of a stranded wire enter the terminal connection!
- d) Do not use the unit without PE connection.
- e) Ferrules are allowed.

### Daisy chaining:

Daisy chaining (jumping from one DC/DC converter output to the next) is allowed as long as the average output current through one terminal pin does not exceed 25A. If the current is higher, use a separate distribution terminal block as shown in Fig. 12-2.

Fig. 12-1 Daisy chaining of outputs

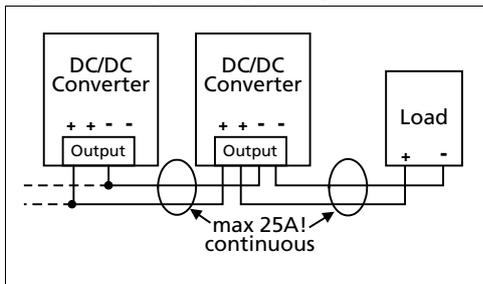
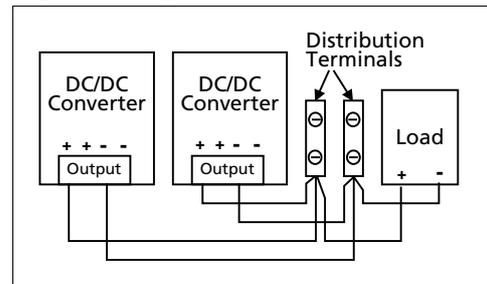
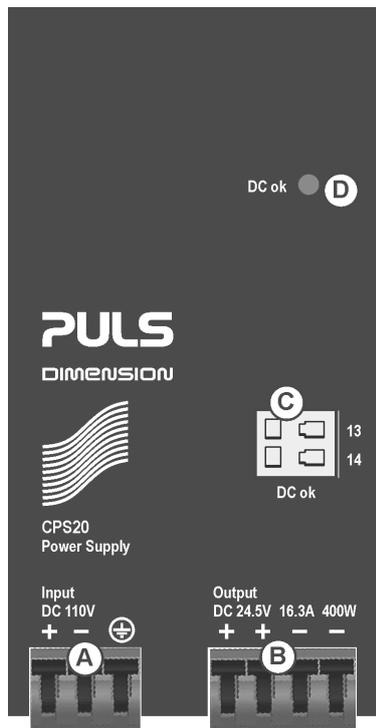


Fig. 12-2 Using distribution terminals



## 13. FRONT SIDE AND USER ELEMENTS

Fig. 13-1 Front side



### **A** Input Terminals (quick-connect spring-clamp terminals)

- + Positive input
- Negative (return) input
- ⊕ PE (Protective Earth) input

### **B** Output Terminals (quick-connect spring-clamp terminals)

- + Positive output
- Negative (return) output

### **C** DC-OK Relay Contact (push-in spring-clamp terminals)

The DC-OK relay contact is synchronized with the DC-OK LED. See chapter 8 for details.

### **D** DC-OK LED (green)

On, when the output voltage is >22V.

### 14. EMC

The DC/DC converter is suitable for rolling stock railway applications, for applications in industrial environment as well as in residential commercial and light industry environment without any restrictions.

<b>EMC Immunity</b>	According generic standards: EN 61000-6-1 and EN 61000-6-2 and according to EN 50121-3-2			
Electrostatic discharge	EN 61000-4-2	contact discharge	8kV	Criterion A
		air discharge	15kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	20V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines	4kV	Criterion A
		output lines	2kV	Criterion A
		DC-OK signal (coupling clamp)	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	+ → -	2kV	Criterion A
		+ → PE, - → PE	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	+ → -	1kV	Criterion A
		+ / - → PE	2kV	Criterion A
Surge voltage on DC-OK	EN 61000-4-5	DC-OK signal → PE	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A
Power – Frequency magnetic field	EN 61000-4-8	16.7Hz, 50Hz	100A/m	Criterion A
Power – Frequency magnetic field	EN 61000-4-8	0Hz	300A/m	Criterion A
Pulsed magnetic field	EN 61000-4-9		300A/m	Criterion A

**Criteria:**

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

<b>EMC Emission</b>	According generic standards: EN 61000-6-3 and EN 61000-6-4 and according to EN 50121-3-2		
Conducted emission input lines	CISPR 16-1-2, CISPR 16-2-1		limits for EN 50121-3-2 fulfilled, limits for DC power port according EN 61000-6-3 fulfilled
Conducted emission output lines	CISPR 16-1-2, CISPR 16-2-1		limits for EN 50121-3-2 fulfilled, limits for DC power port according EN 61000-6-3 not fulfilled *)
Radiated emission	EN 55011, EN 55022, EN 50121-3-2		Class B

This device complies with FCC Part 15 rules.

Operation is subjected to 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.

\*) for information only, not mandatory for EN 61000-6-3

<b>Switching Frequencies</b>	The DC/DC converter has two converters with two different switching frequencies included.	
Switching frequency 1	70kHz to 130kHz	PFC converter, input voltage and output power dependent
Switching frequency 2	80kHz to 140kHz	Main converter, output power dependent

### 15. ENVIRONMENT

Conformal coating	yes	all pc-boards are conformal coated
Operational temperature <sup>*)</sup>	-40°C to +70°C (-40°F to 158°F)	continuous operation, reduce output power according Fig. 15-1 for input voltages below 100Vdc
Storage temperature	+70°C to +85°C (158°F to 185°F)	for maximal 10 minutes every hour
Output de-rating	-40 to +85°C (-40°F to 185°F) 0.08A/V at +70°C or 0.16A/°C at 77Vdc	for storage and transportation required for input voltage smaller than 100Vdc in combination with ambient temperatures above +60°C (140°F). Derate linearly between 100Vdc and 77Vdc or +60°C and +70°C, see Fig. 15-1.
Humidity <sup>**)</sup>	5 to 95% r.h.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g <sup>***)</sup> 2 hours / axis	IEC 60068-2-6; DC/DC converter in operation
Vibration broadband	1.01grms for 10 minutes; 5-150Hz <sup>***)</sup>	IEC 60068-2-64, DC/DC converter in operation; Tests limits according to EN 61373
Vibration broadband	5.72grms for 300 minutes; 5-150Hz <sup>***)</sup>	IEC 60068-2-64, DC/DC converter not in operation; Tests limits according to EN 61373
Shock	30g 6ms, 20g 11ms, 50g 30ms <sup>***)</sup> 3 bumps / direction, 18 bumps in total	IEC 60068-2-27; DC/DC converter in operation
Shock	50g 30ms <sup>***)</sup> 3 bumps / direction, 18 bumps in total	IEC 60068-2-27, DC/DC converter not in operation; Tests limits according to EN 61373
Altitude	0 to 2000m (0 to 6 560ft) 2000 to 6000m (6 560 to 20 000ft)	without any restrictions reduce output power or ambient temperature, see Fig. 15-2
Altitude de-rating	24W/1000m or 5°C/1000m	IEC 62103, EN 50178, overvoltage category II > 2000m (6500ft), see Fig. 15-2
Over-voltage category	III II	IEC 62103, EN 50178, altitudes up to 2000m altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	
Audible noise	At load currents below 2A some audible noise will be emitted from the DC/DC converter	

\*) Operational temperature is the same as the ambient temperature and is defined as the air temperature 2cm below the unit.

\*\*) Do not energize while condensation is present

\*\*\*) Tested in combination with DIN-Rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm and standard orientation. Higher levels allowed when using the wall mounting bracket ZM2.WALL

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

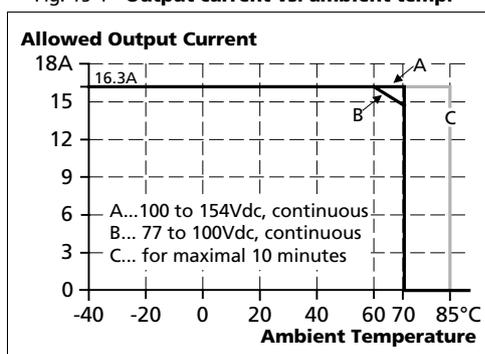
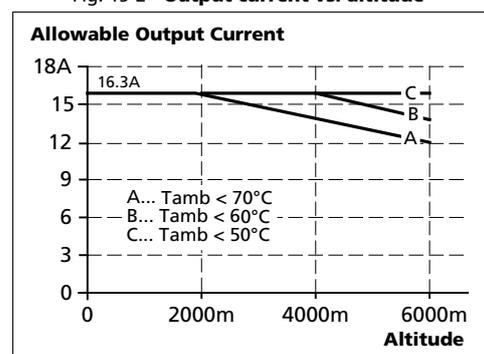


Fig. 15-2 Output current vs. altitude



### 16. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits <sup>*)</sup>	
Output over-voltage protection	typ. 30.5Vdc max. 32Vdc	In case of an internal DC/DC converter defect, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 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	DC suitable fuse included	not user replaceable
Reverse input polarity protection	yes	unit does not start, no signalling

<sup>\*)</sup> In case of a protection event, audible noise may occur.

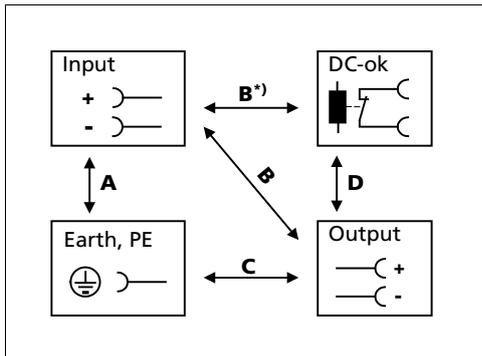
### 17. SAFETY FEATURES

Input / output separation	SELV PELV double or reinforced isolation to the input voltage	IEC/EN 60950-1 IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 5MΩ	input to output, 500Vdc
PE resistance	< 0.1Ω	
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

The output voltage is floating and has no ohmic connection to the ground. Type and factory tests are conducted by the manufacturer. Field tests may be conducted in the field using the appropriate test equipment which applies the voltage with a slow ramp (2s up and 2s down). Connect all input-terminals together as well as all output poles before conducting the test. When testing, set the cut-off current settings to the value in the table below.

Fig. 18-1 Dielectric strength



B\*) When testing input to DC-OK ensure that the max. voltage between DC-OK and the output is not exceeded (column D). We recommend connecting DC-OK pins and the output pins together when performing the test.

		<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Type test	60s	2500Vac	3000Vac	1000Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 15mA	> 15mA	> 20mA	> 1mA

To fulfil the PELV requirements according to EN60204-1 § 6.4.1, we 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 when unnoticed earth faults occur.

### 19. APPROVALS AND DECLARATIONS

EC Declaration of Conformity



The CE mark indicates conformance with the  
- EMC directive and the  
- Low-voltage directive

Railway applications - Electronic  
equipment used on rolling stock.  
EN 50155:2007



The manufacturer's declaration indicate conformance with  
the following characteristics:

- Altitude category: AX (EN 50125-1 § 4.2.1)
- Environmental category: TX (EN 50155 § 4.1.2)
- Interruption of voltage supply: S2 (EN 50155 § 5.1.1.2)
- Supply change over: C2 (EN 50155 § 5.1.3)
- Shock and vibration: Category 1, Class A and B (EN 61373)
- EMI: EN 50121-3-2
- Fire Classification: HL3 (EN 45545-2)

### 20. ROHS, REACH AND OTHER FULFILLED STANDARDS

RoHS Directive



Directive 2011/65/EU of the European Parliament and the  
Council of June 8<sup>th</sup>, 2011 on the restriction of the use of  
certain hazardous substances in electrical and electronic  
equipment.

REACH Directive



Directive 1907/2006/EU of the European Parliament and the  
Council of June 1<sup>st</sup>, 2007 regarding the Registration,  
Evaluation, Authorisation and Restriction of Chemicals  
(REACH)

### 21. PHYSICAL DIMENSIONS AND WEIGHT

Width	65mm 2.56"
Height	124mm 4.88"
Depth	127mm 5.0" The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	980g / 2.16lb
DIN-Rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: zinc-plated steel
Installation clearances	See chapter 2

Fig. 21-1 **Front view**

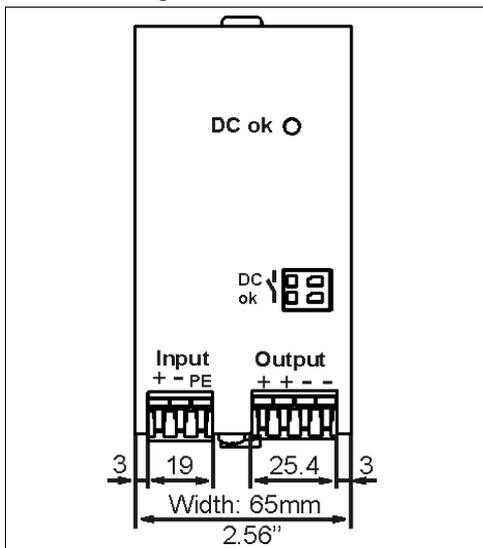
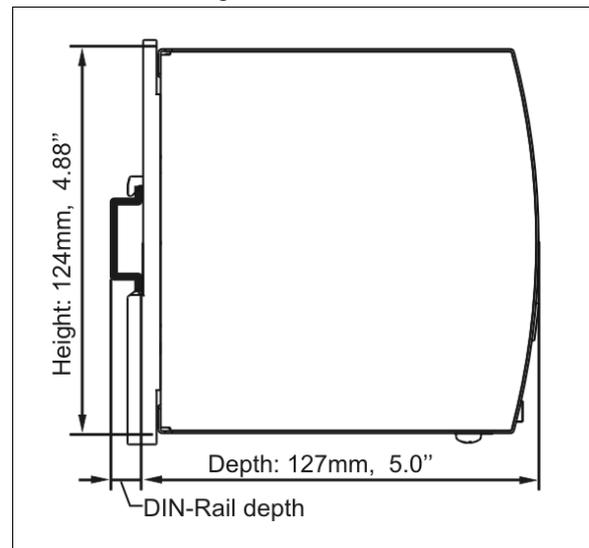


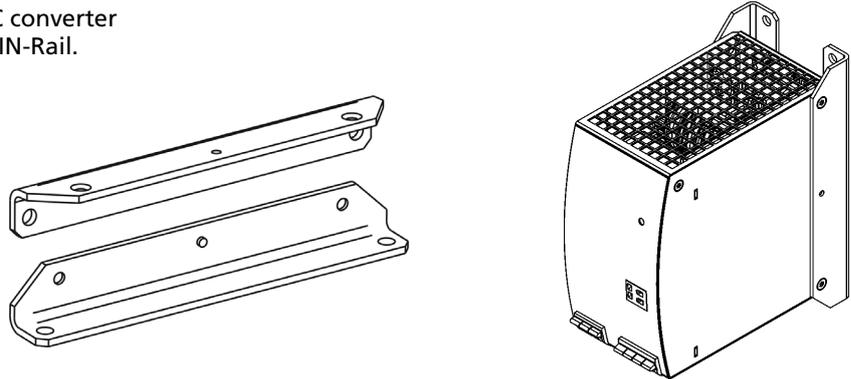
Fig. 21-2 **Side view**



## 22. ACCESSORIES

### 22.1. ZM2.WALL - WALL MOUNTING BRACKET

This bracket is used to mount the DC/DC converter onto a flat surface without utilizing a DIN-Rail.

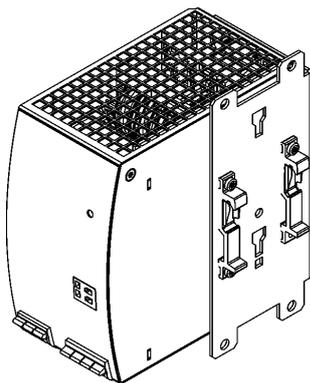


Due to the small size of the unit, it is required that the black-DIN-rail slide on the back of the unit must be removed. Instructions how to do this can be found in the manual of the ZM2.WALL.

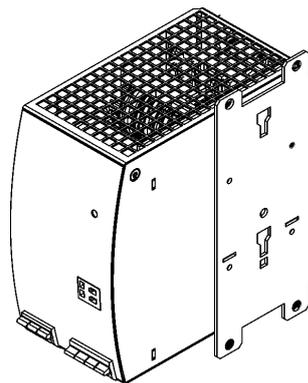
### 22.2. ZM13.SIDE - SIDE MOUNTING BRACKET

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

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



Side mounting with DIN-rail brackets



Side mounting without DIN-rail brackets

## 23. APPLICATION NOTES

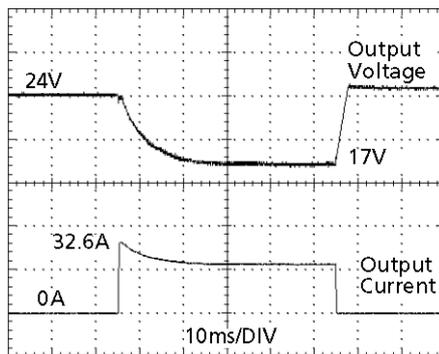
### 23.1. PEAK CURRENT CAPABILITY

The DC/DC converter can deliver peak currents (up to several milliseconds) which are higher than the specified short term currents. This helps to start current demanding loads. Solenoids, contactors and pneumatic modules often have a steady state 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. The same situation applies when starting a capacitive load.

The peak current capability also ensures the safe operation of subsequent circuit breakers of load circuits. The load branches are often individually protected with circuit breakers or fuses. In case of a short or an overload in one branch circuit, the fuse or circuit breaker need a certain amount of over-current to open in a timely manner. This avoids voltage loss in adjacent circuits.

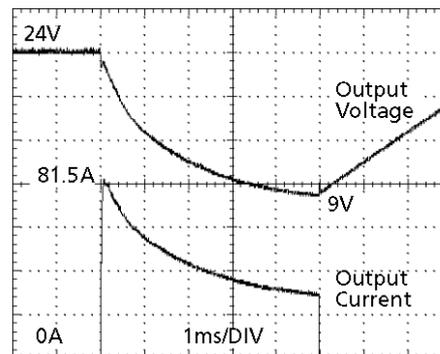
The extra current (peak current) is supplied by the built-in large sized output capacitors of the DC/DC converter. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 23-1 **Peak load with 2x the nominal current for 50ms, typ.**



32.6A Peak load (resistive) for 50ms  
Output voltage dips from 24.5V to 17V.

Fig. 23-2 **Peak load with 5x the nominal current for 5ms, typ.**



81.5A Peak load (resistive) for 5ms  
Output voltage dips from 24.5V to 9V.

Peak current voltage dips	typ.	from 24.5V to 17V	at 32.6A for 50ms, resistive load
	typ.	from 24.5V to 18V	at 81.5A for 2ms, resistive load
	typ.	from 24.5V to 9V	at 81.5A for 5ms, resistive load

### 23.2. INDUCTIVE AND CAPACITIVE LOADS

The unit is designed to supply any kind of loads, including capacitive and inductive loads. If extreme large capacitors, such as EDLCs (electric double layer capacitors or "UltraCaps") with a capacitance > 0.5F are connected to the output, the unit might charge the capacitor in the Hiccup<sup>PLUS</sup>-mode (see chapter 6).

### 23.3. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 30A (UL) and 32A (IEC). An external protection is only required if the supplying branch has an ampacity greater than this. Provided, that the negative pole is grounded. If the positive pole is grounded, an additional external fast-acting input fuse in the negative input is required.

Check also local codes and local requirements. In some countries local regulations might apply.

If an external fuse is necessary or utilized, minimum requirements need to be considered to avoid nuisance tripping of the circuit breaker. A minimum value of 10A B- or C-Characteristic breaker should be used.

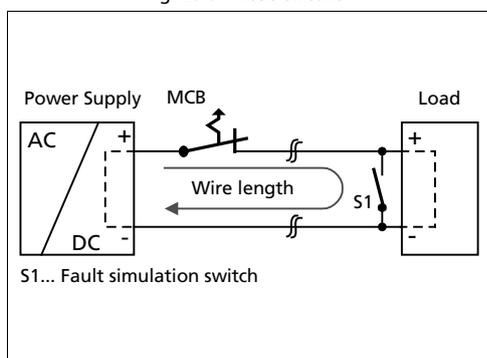
### 23.4. OUTPUT CIRCUIT BREAKERS

Standard miniature circuit breakers (MCB's or UL1077 circuit breakers) are commonly used for AC-supply systems and may also be used on 24V branches.

MCB's are designed to protect wires and circuits. If the ampere value and the characteristics of the MCB are adapted to the wire size that is used, the wiring is considered as thermally safe regardless of whether the MCB opens or not.

To avoid voltage dips and under-voltage situations in adjacent 24V branches which are supplied by the same source, a fast (magnetic) tripping of the MCB is desired. A quick shutdown within 10ms is necessary corresponding roughly to the ride-through time of PLC's. This requires DC/DC converters with high current reserves and large output capacitors. Furthermore, the impedance of the faulty branch must be sufficiently small in order for the current to actually flow. The best current reserve in the DC/DC converter does not help if Ohm's law does not permit current flow. The following table has typical test results showing which B- and C-Characteristic MCBs magnetically trip depending on the wire cross section and wire length.

Fig. 23-3 Test circuit



Maximal wire length<sup>\*)</sup> for a fast (magnetic) tripping:

	0.75mm <sup>2</sup>	1.0mm <sup>2</sup>	1.5mm <sup>2</sup>	2.5mm <sup>2</sup>
<b>C-2A</b>	30m	40m	49m	85m
<b>C-3A</b>	19m	24m	35m	52m
<b>C-4A</b>	11m	15m	22m	31m
<b>C-6A</b>	4m	6m	8m	11m
<b>C-8A</b>	1m	1m	2m	3m
<b>C-10A</b>	1m	1m	2m	3m
<b>B-6A</b>	10m	14m	22m	34m
<b>B-10A</b>	3m	5m	10m	13m
<b>B-13A</b>	2m	4m	7m	10m

\*) Don't forget to consider twice the distance to the load (or cable length) when calculating the total wire length (+ and - wire).

### 23.5. CHARGING OF BATTERIES

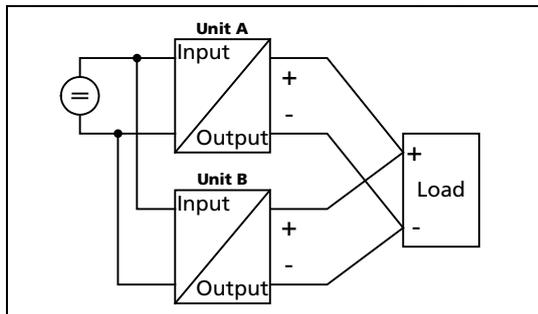
The DC/DC converter can not be used to charge batteries.

### 23.6. PARALLEL USE TO INCREASE OUTPUT POWER

CPS20.241-60 DC/DC converters can be paralleled to increase the output power as long as the ambient temperature stays below 60°C.

Energize all units at the same time to avoid the overload Hiccup<sup>PLUS</sup> mode. It also might be necessary to cycle the input power (turn-off for at least five seconds), if the output was in Hiccup<sup>PLUS</sup> mode due to overload or short circuits and the required output current is higher than the current of one unit.

Fig. 23-4 Parallel use to increase the output power



Instructions for parallel use:

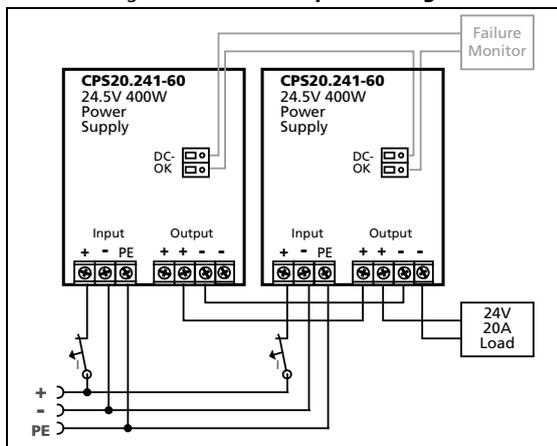
- Keep an installation clearance of 15mm (left / right) between two DC/DC converters and avoid installing the DC/DC converters on top of each other.
- Do not parallel DC/DC converters in orientations other than the standard mounting orientation (terminals on bottom of the unit) or in any other condition where a derating of the output current is required (e.g. altitude, temperature, input voltages).
- Pay attention that EMI and inrush current will increase when using multiple DC/DC converters.

### 23.7. PARALLEL USE FOR REDUNDANCY

CPS20.241-60 DC/DC converters can be paralleled for redundancy to gain 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. This is called a 1+1 redundancy. In case one DC/DC converter unit fails, the other one is automatically able to support the load current without any interruption. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five DC/DC converter, each rated for 16A are paralleled to build a 64A redundant system. For N+1 redundancy the same restrictions apply as for increasing the output power, see also section 23.6.

Since the CPS20.241-60 already has decoupling MOSFETS included, which cover failures such as an internal short circuit in the secondary side of the DC/DC converter, no additional redundancy modules are required.

Fig. 23-5 Redundant power design



Recommendations for building redundant power systems:

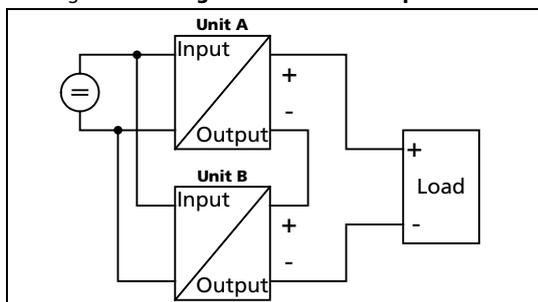
- Use separate input fuses for each DC/DC converter.
- Monitor the individual DC/DC converter units. Use the DC-OK relay contact of the CPS20.241-60.

### 23.8. SERIES OPERATION

DC/DC converters of the same type can be connected in series for higher output voltages. It is possible to connect as many units in series as needed, providing the sum of the output voltage 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.

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

Fig. 23-6 **Wiring scheme for series operation**



Instructions for series use:

- 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.
- Do not use DC/DC converters in series in mounting orientations other than the standard mounting orientation (terminals on bottom of the unit).
- Pay attention that EMI and inrush current will increase when using multiple DC/DC converters.

### 23.9. 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 35Vdc.

### 23.10. 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 outside. In such situations, the inside temperature defines the ambient temperature for the DC/DC converter.

The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

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

Enclosure:	Rittal Typ IP66 Box PK 9522 100, plastic, 254x180x165mm
Load:	24V, 13A; (=80%) load is placed outside the box
Input:	110Vdc
Temperature inside enclosure:	44.5°C (in the middle of the right side of the DC/DC converter with a distance of 2cm)
Temperature outside enclosure:	23.2°C
Temperature rise:	21.3K

### 23.11. MOUNTING ORIENTATIONS

Mounting orientations other than all terminals on the bottom require 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 in approximately half the lifetime expectancy of A1).

Fig. 23-7  
**Mounting Orientation A**  
(Standard orientation)

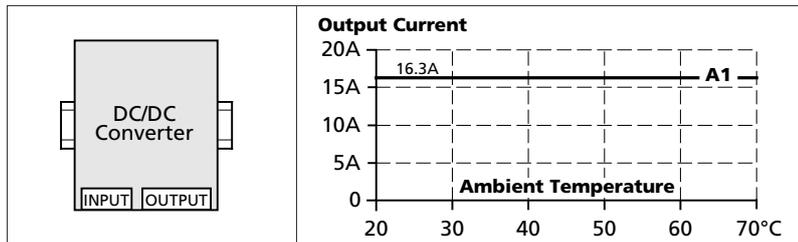


Fig. 23-8  
**Mounting Orientation B**  
(Upside down)

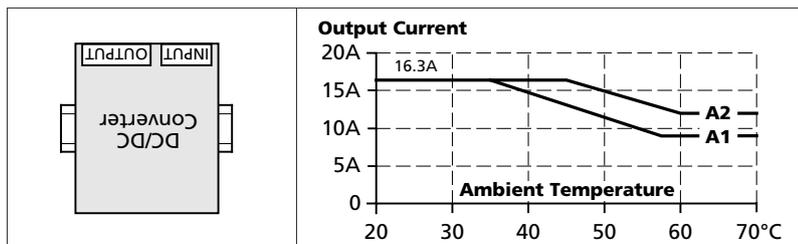


Fig. 23-9  
**Mounting Orientation C**  
(Table-top mounting)

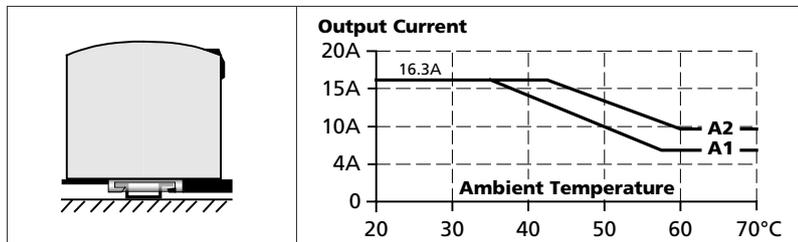


Fig. 23-10  
**Mounting Orientation D**  
(Horizontal cw)

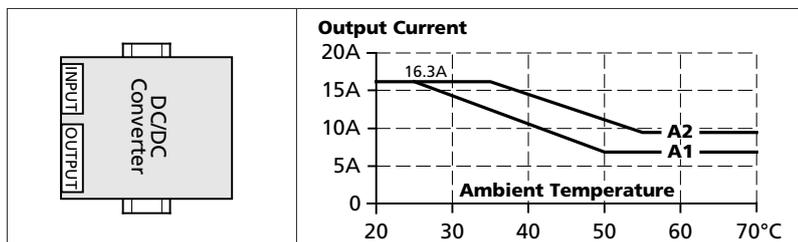


Fig. 23-11  
**Mounting Orientation E**  
(Horizontal ccw)

