



### DC/DC CONVERTER

- EN 50155 Railway Compliant
- Conformal Coated PC-boards
- Quick-connect Spring-clamp Terminals
- 67-154Vdc Wide-range Input
- Width only 39mm
- Efficiency up to 94.5%
- Excellent Partial Load Efficiency
- 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 DC/DC converter CP10.241-60 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, 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 39mm 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.

### SHORT-FORM DATA

Output voltage	DC 24V	
Adjustment range	24 - 28V	
Output current	8.3 - 7.1A	Continuous, < +70°C
	8.3 - 7.1A	For 10 minutes, < +85°C
Input voltage DC	DC 96 - 110V	- 30% / +40%
Input voltage range	67.2 - 154V	
Input current DC	2.25 / 1.95A	At 96 / 110Vdc
Input inrush current	2.5A pk	
Efficiency	94.3 / 94.5%	At 96 / 110Vdc
Losses	12.1 / 11.6W	At 96 / 110Vdc
Hold-up time	34ms	
Temperature range	-40 to +70°C	
Size (wxhxd)	39x124x117mm Without DIN-rail	
Weight	620g / 1.37lb	

### ORDER NUMBERS

DC/DC converter **CP10.241-60**

Accessory	ZM4.WALL	Wall/Panel mount bracket
	ZM12.SIDE	Side mount bracket
	YR20.242	Redundancy module
	YR20.246	Redundancy module
	UF20.241	Buffer module

### MARKINGS



May 2017 / Rev. 0.1 DS-QS10.241-60-EN preliminary  
 All parameters are typical values specified at 24V, 8.3A output, 110Vdc input, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

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Some parts of this unit are patent by PULS (US patent No 091662,063, Des. 424,529, ...).

**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 input terminals are located on the bottom of the unit. For other mounting orientations see de-rating requirements in this document. See chapter 24.10.

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. 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 96-110V	-30%/+40%
Input voltage range		67-154Vdc	
		57-67Vdc	Short term for 2s, no start at 57Vdc
Input current	Typ.	2.25A	At 8.3A and 96Vdc input voltage, see Fig. 3-3
	Typ.	1.95A	At 8.3A and 110Vdc input voltage, see Fig. 3-3
Allowed voltage between input to earth (ground)	Max.	300Vdc	Continuous, IEC 62477-1
Allowed input ripple voltage	Max.	15Vpp 3Vpp	50Hz – 10kHz 10kHz – 50kHz
Turn-on voltage	Typ.	64.5Vdc	Steady-state value, temperature independent, see Fig. 3-1
Shut-down voltage	Typ.	62.5Vdc	Steady-state value, temperature independent, see Fig. 3-1
Start-up delay	Typ.	700ms	At 96Vdc input, see Fig. 3-2
	Typ.	600ms	At 110Vdc input, see Fig. 3-2
Rise time	Typ.	45ms	At 8.3A constant current load, 0mF load capacitance
	Typ.	90ms	At 8.3A constant current load, 8mF load capacitance, see Fig. 3-2
Turn-on overshoot	Max.	200mV	See Fig. 3-2
External input protection	See recommendations in chapter 24.3.		

Fig. 3-1 Input voltage range

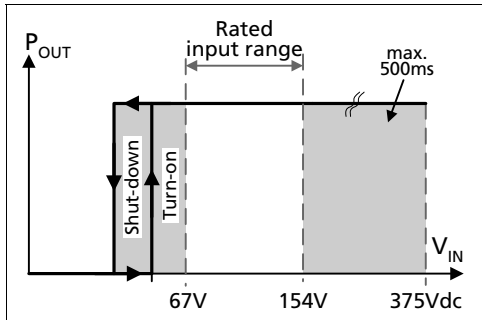


Fig. 3-2 Turn-on behavior, definitions

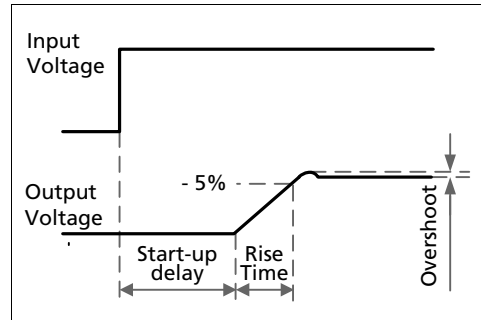
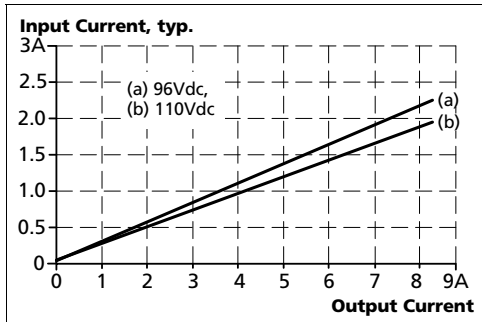


Fig. 3-3 Input current vs. output load at 24V



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## 4. AC-INPUT

Do not operate this DC/DC converter with an AC-input voltage. Use the CP10.241 or CP10.241-C1 (when conformal coating is needed) unit instead.

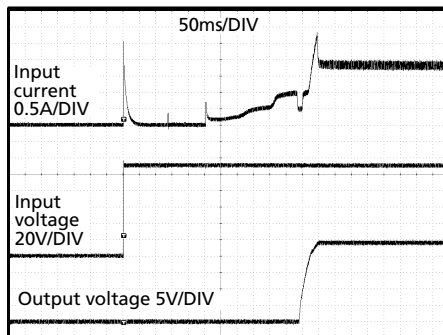
## 5. INPUT INRUSH CURRENT

An active inrush limitation circuit (inrush limiting fixed resistor which is bypassed by a relay) 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.

		DC 96V	DC 110V	
Inrush current	Max.	8A <sub>peak</sub>	8A <sub>peak</sub>	At 110Vdc, temperature independent
	Typ.	2.5A <sub>peak</sub>	2.5A <sub>peak</sub>	At 110Vdc, temperature independent
Inrush energy		Negligible low		At 110Vdc, temperature independent

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



**6. OUTPUT**

Output voltage	Nom.	24V	
Adjustment range	Min.	24-28V	Guaranteed
	Max.	30V *)	At clockwise end position of potentiometer
Factory setting	Typ.	24.1V	±0.2%, at full load, cold unit
Line regulation	Max.	10mV	67-154Vdc
Load regulation	Max.	100mV	Static value, 0A → 8.3A
Ripple and noise voltage	Max.	50mVpp	20Hz to 20MHz, 50Ohm
Output current	Nom.	8.3A	At 24V, ambient temperature <70°C, see Fig. 6-1
	Nom.	7.1A	At 28V, ambient temperature <70°C, see Fig. 6-1
	Typ.	30A	Up to 12ms, output voltage stays above 20V, see Fig. 6-2 and Fig. 24-3, This peak current is available once every five seconds (firmware controlled).
Output power	Nom.	200W	Continuously available
Overload behaviour	Cont. current		Output voltage > 13Vdc, see Fig. 6-1
	Hiccup <sup>PLUS</sup> mode**)		Output voltage < 13Vdc, see Fig. 6-1
Short-circuit current	Min.	9.5A***)	Load impedance 50mOhm, see Fig. 6-1
	Max.	13.5A***)	Load impedance 50mOhm, see Fig. 6-1
	Max.	4.3A	Average (R.M.S.) current, load impedance 50mOhm, see Fig. 6-3
	Min.	28A	Up to 12ms, load impedance 50mOhm, see Fig. 6-2
	Typ.	30.5A	Up to 15ms, load impedance 50mOhm, see Fig. 6-2
	Typ.	4 400µF	Included inside the power supply

\*) This is the maximum output voltage which can occur at the clockwise end position of the potentiometer due to tolerances. It is not a guaranteed value, which can be achieved. The typical value is 28.6V.  
 \*\*) Hiccup<sup>PLUS</sup> Mode  
 At heavy overloads (when output voltage falls below 13V), the power supply 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. 6-3  
 \*\*\*) Discharge current of output capacitors is not included.

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

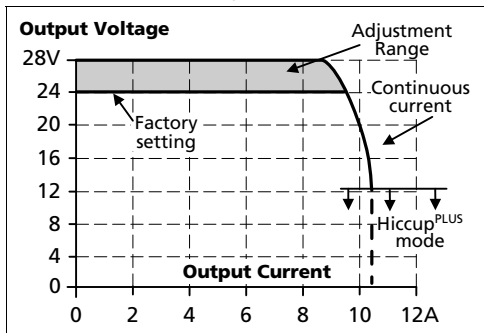


Fig. 6-2 Dynamic output current capability, typ.

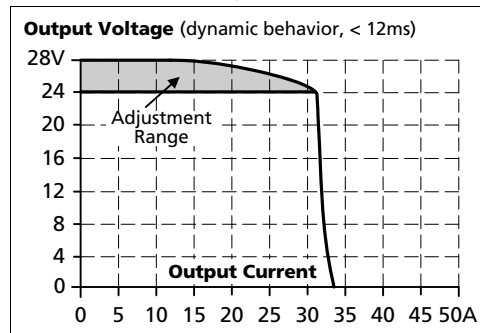
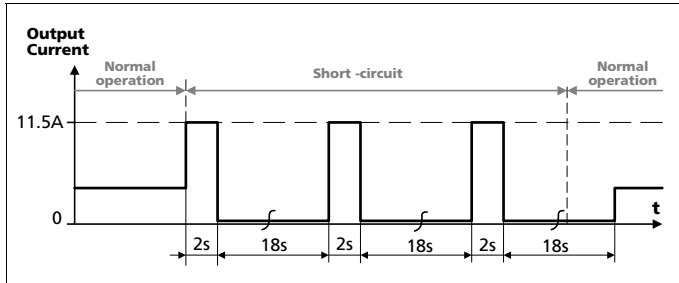


Fig. 6-3 Short-circuit on output, Hiccup<sup>PLUS</sup> mode, typ.



## 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.

		DC 96V		DC 110V	
		Hold-up Time	Typ.	89ms	89ms
	Min.	67ms	67ms	At 4.15A, see Fig. 7-1	
	Typ.	45ms	45ms	At 8.3A, see Fig. 7-1	
	Min.	37ms	37ms	At 8.3A, see Fig. 7-1	

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

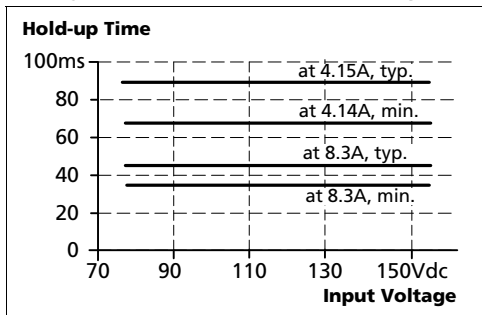
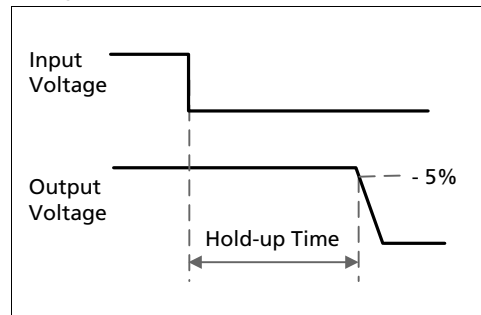


Fig. 7-2 Shut-down behavior, definitions



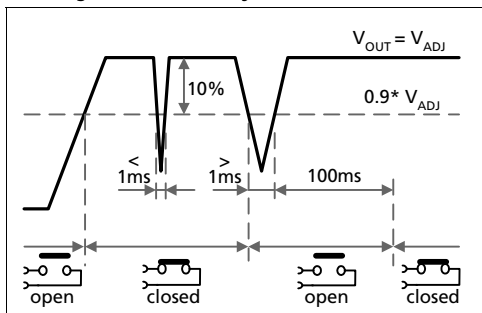
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 All parameters are typical values specified at 24V, 8.3A output, 110Vdc input, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

## 8. DC-OK RELAY CONTACT

This feature monitors the output voltage on the output terminals of a running power supply.

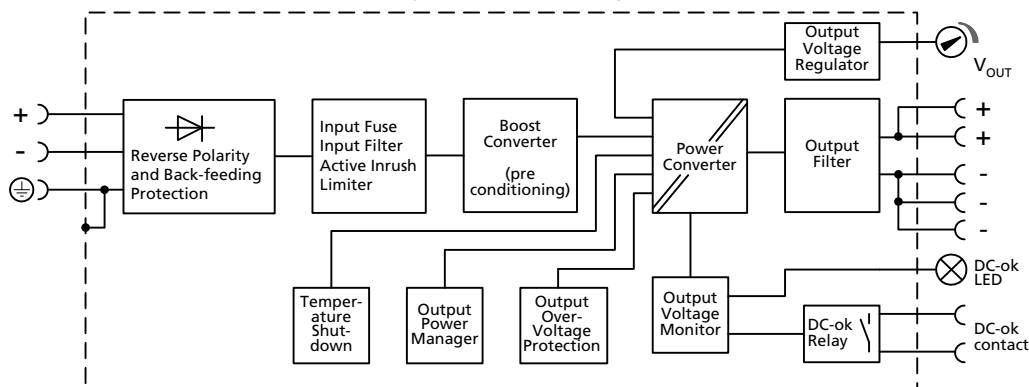
Contact closes	As soon as the output voltage reaches typ. 90% of the adjusted output voltage level.
Contact opens	As soon as the output voltage dips more than 10% below the adjusted output voltage. Short dips will be extended to a signal length of 100ms. Dips shorter than 1ms will be ignored.
Contact ratings	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
Isolation voltage	See dielectric strength table in section 18.

Fig. 8-1 DC-ok relay contact behavior



## 9. FUNCTIONAL DIAGRAM

Fig. 9-1 Functional diagram





## 10. EFFICIENCY AND POWER LOSSES

		DC 96V	DC 110V	
Efficiency	Typ.	94.3%	94.5%	At 24V, 8.3A
Average efficiency*)	Typ.	93.1%	93.5%	25% at 2.1A, 25% at 4.2A, 25% at 6.2A. 25% at 8.3A
Power losses	Typ.	2.8W	2.6W	At 24V, 0A
	Typ.	7.2W	6.8W	At 24V, 4.2A (= 50% load)
	Typ.	12.1W	11.6W	At 24V, 8.3A

\*) 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. 10-1 Efficiency vs. output current, at 24V, typ.

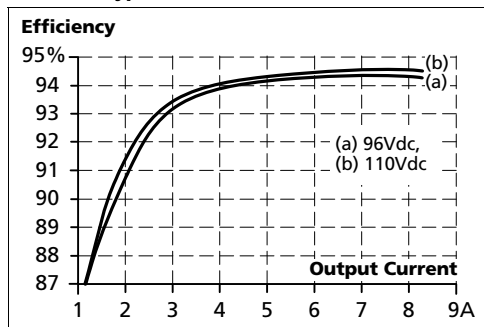
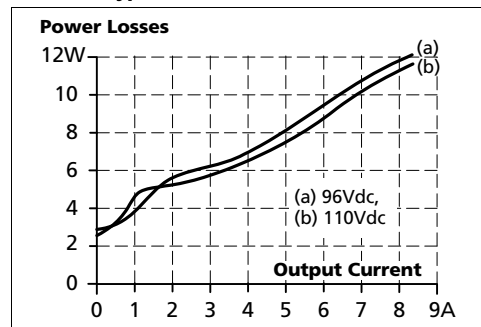


Fig. 10-2 Losses vs. output current, at 24V, typ.



## 11. LIFETIME EXPECTANCY

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.

	DC 96V	DC 110V	
Lifetime expectancy	171 000h	194 000h	At 24V, 4.2A and 40°C
	485 000h	549 000h	At 24V, 4.2A and 25°C
	112 000h	119 000h	At 24V, 8.3A and 40°C
	316 000h	336 000h	At 24V, 8.3A and 25°C

## 12. MTBF

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 hours if 10 000 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.

For these types of units the MTTF (**Mean Time To Failure**) value is the same value as the MTBF value.

	DC 96V	DC 110V	
MTBF SN 29500, IEC 61709	T.B.D.	T.B.D.	At 24V, 8.3A and 40°C
	T.B.D.	T.B.D.	At 24V, 8.3A and 25°C
MTBF MIL HDBK 217F	T.B.D.	T.B.D.	At 24V, 8.3A and 40°C, Ground Benign GB40
	T.B.D.	T.B.D.	At 24V, 8.3A and 25°C, Ground Benign GB25
	T.B.D.	T.B.D.	At 24V, 8.3A and 40°C, Ground Fixed GF40
	T.B.D.	T.B.D.	At 24V, 8.3A and 25°C, Ground Fixed GF25

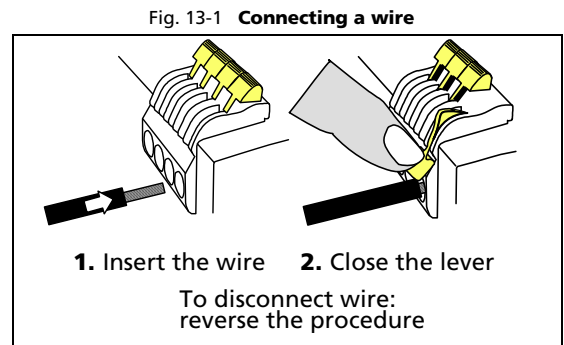
### 13. TERMINALS AND WIRING

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

Type	Input and output	DC-OK-Signal
	Bi-stable, quick-connect spring-clamp terminals	Push-in 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	AWG 20-10	Max. AWG 28-16
Max. wire diameter	2.8mm (including ferrules)	Max. 1.6mm (including ferrules)
Wire stripping length	10mm / 0.4inch	7mm / 0.28inch
Screwdriver	Not required	Not required
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) 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. 13-3.

Fig. 13-2 **Daisy chaining of outputs**

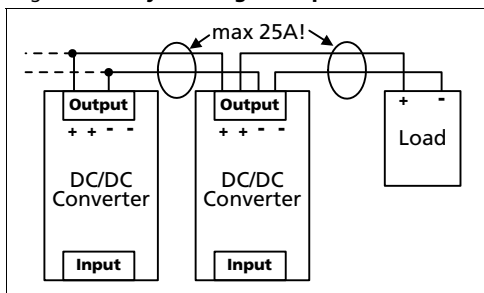
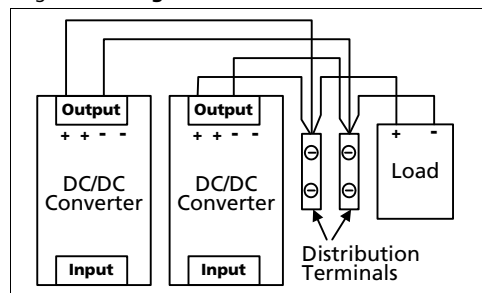


Fig. 13-3 **Using distribution terminals**



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## 14. FRONT SIDE AND USER ELEMENTS

Fig. 14-1 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, two positive pins and three negative pins)

- + Positive output
- Negative (return) output

### **C** Output voltage potentiometer

Open the flap to adjust the output voltage. Factory set: 24.1V

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

On, when the output voltage is >90% of the adjusted output voltage

### **E** DC-OK Relay Contact

(Push-in terminals)

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

## 15. 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
		5.1-6GHz	10V/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
		0Hz	300A/m	Criterion A
Pulsed magnetic field	EN 61000-4-9		300A/m	Criterion B

**Criteria:**

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

**B:** During the test the output voltage can slightly drift below or above the specified 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 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.

<b>Switching Frequencies</b>	The power supply has three converters with three different switching frequencies included. Two are nearly constant. The other one is input voltage and load dependent.	
Switching frequency 1	100kHz	Boost converter
Switching frequency 2	110kHz to 140kHz	Main converter, input voltage and output power dependent
Switching frequency 3	60kHz	Auxiliary converter

### 16. ENVIRONMENT

Conformal coating	yes	All pc-boards are conformal coated
Operational temperature <sup>*)</sup>	-40°C to +70°C (-40°F to 158°F) +70°C to +85°C (185°F to 185°F)	Continuous operation, see Fig. 16-1 For maximal 10 minutes every hour
Storage temperature	-40 to +85°C (-40°F to 185°F)	For storage and transportation
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 IEC 62477-1, overvoltage category II
Altitude de-rating	12W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 15-2
Over-voltage category	III II	IEC 62477-1, altitudes up to 2000m For altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62477-1, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

\*) 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.

Fig. 16-1 Output current vs. ambient temp. at 24V output voltage

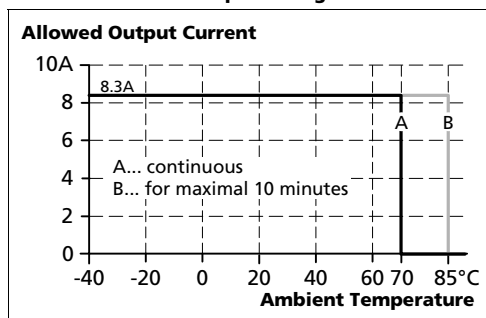
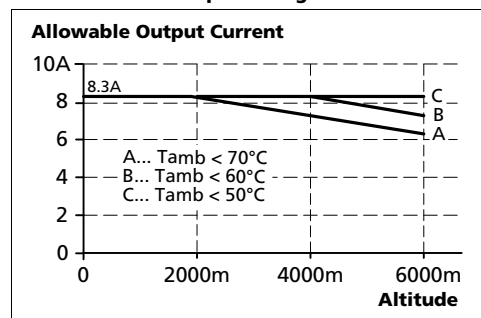


Fig. 16-2 Output current vs. altitude at 24V output voltage



## 17. 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	> 4mm	E.g. screws, small parts
Over-temperature protection <sup>**)</sup>	Yes	Output shut-down with automatic restart, no signalling
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

\*) In case of a protection event, audible noise may occur.

\*\*\*) The temperature sensor is installed close to critical components inside the unit and turns the unit off in safety critical situations (e.g. customer does not care about de-rating requirements, ambient temperature too high, obstructs the airflow or install the unit in unsuitable mounting orientation)  
There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.

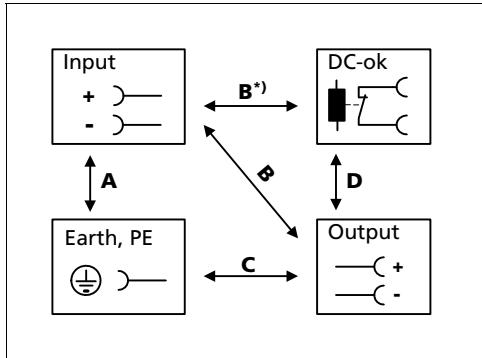
## 18. SAFETY FEATURES

Classification of output voltage	SELV PELV Double or reinforced isolation to the input voltage	IEC/EN 60950-1 IEC/EN 60204-1
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 500MΩ	At delivered condition between input and output, measured with 500Vdc
	> 500MΩ	At delivered condition between input and PE, measured with 500Vdc
	> 500MΩ	At delivered condition between output and PE, measured with 500Vdc
	> 500MΩ	At delivered condition between output and DC-OK contacts, measured with 500Vdc
PE resistance	< 0.1Ω	Resistance between PE terminal and the housing in the area of the DIN-rail mounting bracket.
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.	

## 19. 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. 19-1 Dielectric strength




		A	B	C	D
Type test	60s	2500Vac	3000Vac	500Vac	500Vac
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 15mA	> 15mA	> 50mA	> 5mA

To fulfil the PELV requirements according to EN 60204-1 § 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.



B\*) When testing input to DC-OK ensure that the maximum 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.



**20. APPROVALS AND DECLARATIONS**

EC Declaration of Conformity planned		The CE mark indicates conformance with the - EMC directive and the - Low-voltage directive
IEC 60950-1 2 <sup>nd</sup> Edition planned		CB Scheme, Information Technology Equipment
UL 508 planned		Listed for use as Industrial Control Equipment; U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01); E-File: E198865
UL 60950-1 2 <sup>nd</sup> Edition planned		Recognized for use as Information Technology Equipment, Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1); E-File: E137006 Applicable for altitudes up to 2000m.
Railway applications - Electronic equipment used on rolling stock. EN 50155:2007 planned		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)
EAC TR Registration		Registration for the Eurasian Customs Union market (Russia, Kazakhstan, Belarus)

**21. 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)

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All parameters are typical values specified at 24V, 8.3A output, 110Vdc input, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

## 22. PHYSICAL DIMENSIONS AND WEIGHT

Width	39mm 1.54"
Height	124mm 4.88"
Depth	117mm 4.61" The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	620g / 1.37lb
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. 22-1 Front view

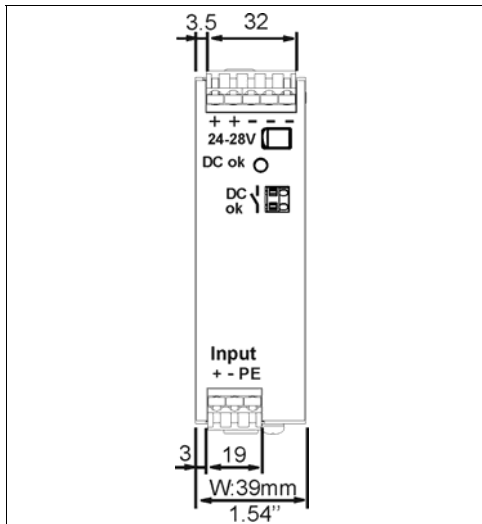
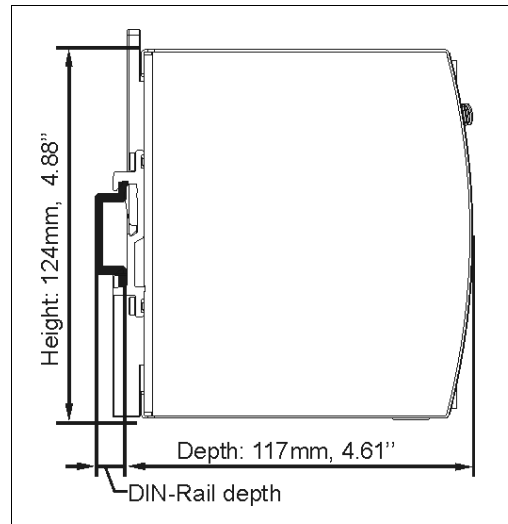


Fig. 22-2 Side view



### 23. ACCESSORIES

#### 23.1. ZM12.SIDE - SIDE MOUNTING BRACKET



This bracket is used to mount the power supply 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.

Fig. 23-1  
Side mounting without DIN-rail brackets

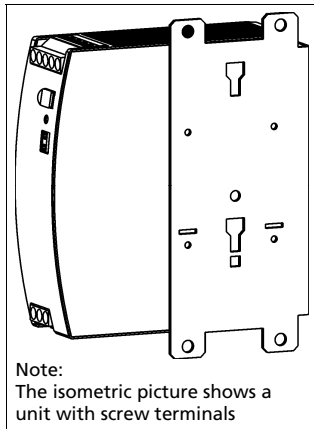


Fig. 23-2  
Side mounting with DIN-rail brackets

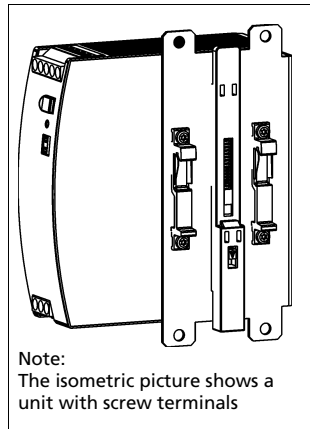
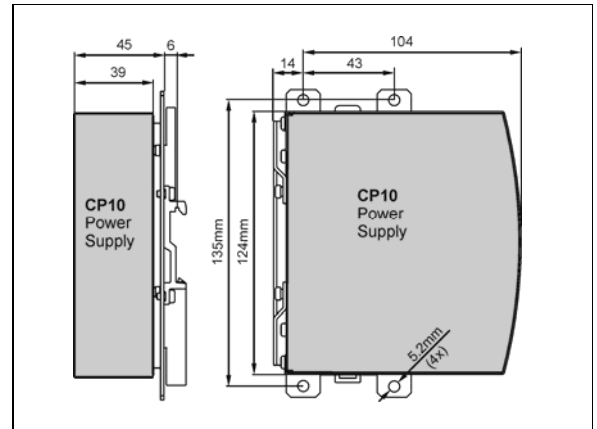
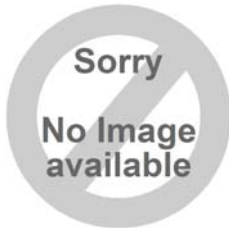


Fig. 23-3  
Mounting Dimensions  
Side mounting bracket



23.2. ZM4.WALL – WALL/PANEL MOUNT BRACKET



This bracket is used to mount the devices on a wall/panel without utilizing a DIN-Rail. The bracket can be mounted without detaching the DIN-rail brackets.

Fig. 23-4 Isometric view

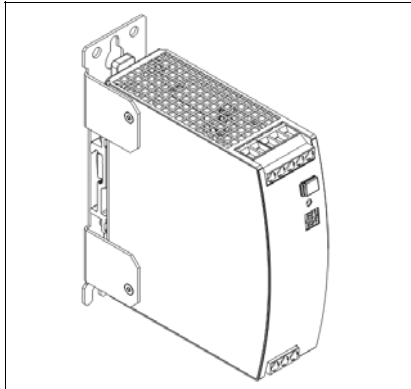


Fig. 23-5 Isometric view

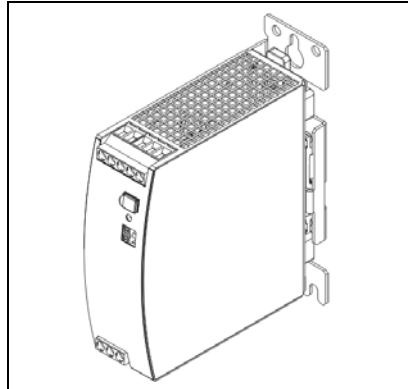


Fig. 23-6 Isometric view

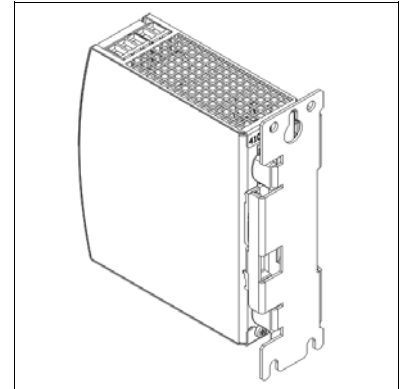


Fig. 23-7 Wall/panel mounting, front view

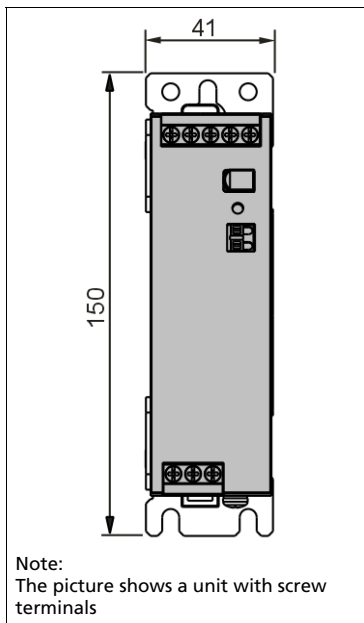


Fig. 23-8 Hole pattern for wall mounting

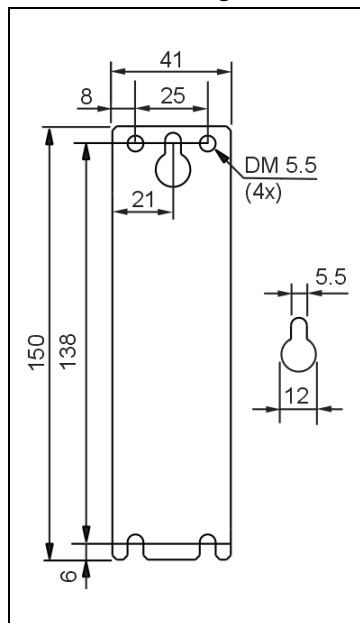
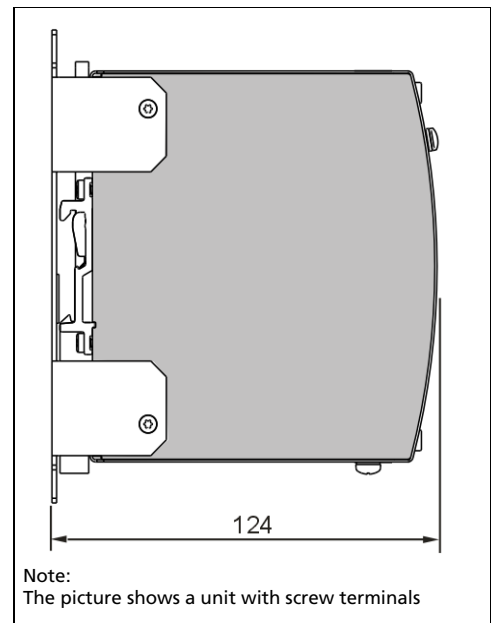
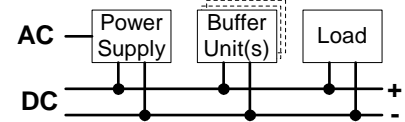


Fig. 23-9 Wall/panel mounting, side view



### 23.3. UF20.241 BUFFER MODULE

This buffer unit is a supplementary device for DC 24V power supplies. It delivers power to bridge typical mains failures or extends the hold-up time after turn-off of the input power. In times when the power supply provides sufficient voltages, the buffer unit stores energy in integrated electrolytic capacitors. In case of input voltage fault, this energy is released again in a regulated process. One buffer module can deliver 20A additional current.



The buffer unit does not require any control wiring. It can be added in parallel to the load circuit at any given point. Buffer units can be added in parallel to increase the output ampacity or the hold-up time.

### 23.4. YR20.242 - REDUNDANCY MODULE



The YR20.242 is equipped with two input channels, which are individually decoupled by utilizing MOSFET technology. Using MOSFETs instead of diodes reduces the heat generation and the voltage drop between input and output. The YR20.242 does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

Due to the low power losses, the unit is very slender and only requires 32mm width on the DIN-rail.

The YR20.242 can be used for n+1 and 1+1 redundancy systems.

Further information and wiring configurations can be found in chapter 24.7.

### 23.5. YR20.246 - REDUNDANCY MODULE WITH AUTOMATED LOAD SHARING



The YR20.246 is equipped with two input channels, which are individually decoupled by utilizing MOSFET technology. Using MOSFETs instead of diodes reduces the heat generation and the voltage drop between input and output. The YR20.246 does not require an additional auxiliary voltage and is self-powered even in case of a short circuit across the output.

Due to the low power losses, the unit is very slender and only requires 32mm width on the DIN-rail.

The YR20.246 is optimized for 1+1 redundancy systems.

Compared to the YR20.242, the YR20.246 is featured with an automated load sharing between the connected power supplies. The YR20.246 monitors the function of the redundancy circuitry and provides a signal in case of too high of output current, which could prevent redundancy, if one

power supply fails.

Further information and wiring configurations can be found in chapter 24.7.

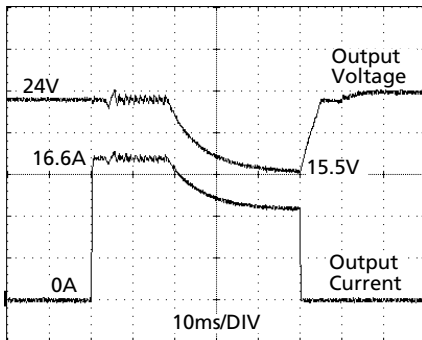
## 24. APPLICATION NOTES

### 24.1. PEAK CURRENT CAPABILITY

The unit 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.

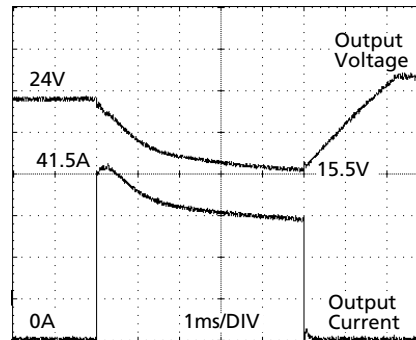
The extra current (peak current) is supplied by the power converter and the built-in large sized output capacitors of the power supply. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following examples show typical voltage dips:

Fig. 24-1 **Peak load with 2x the nominal current for 50ms, typ.**



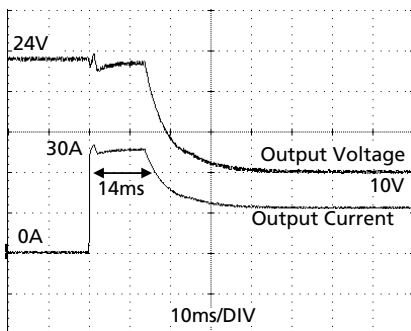
16.6A Peak load (resistive) for 50ms  
Output voltage dips from 24V to 15.5V.

Fig. 24-2 **Peak load with 5x the nominal current for 5ms, typ.**



41.5A Peak load (resistive) for 5ms  
Output voltage dips from 24V to 15.5V.

Fig. 24-3 **25A Peak load, typ.**



High Overload Current (typ. 25A for 12ms) enables easy fuse tripping

Please note: The DC-OK relay triggers when the voltage dips more than 10% for longer than 1ms.

Peak current voltage dips	Typically from 24V to 15.5V	at 16.6A for 50ms, resistive load
	Typically from 24V to 17V	at 41.5A for 2ms, resistive load
	Typically from 24V to 15.5V	at 41.5A for 5ms, resistive load

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All parameters are typical values specified at 24V, 8.3A output, 110Vdc input, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.

### 24.2. 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 larger than 1.25F are connected to the output, the unit might charge the capacitor in the Hiccup<sup>PLUS</sup> mode (see chapter 6).

### 24.3. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 20A. An external protection is only required if the supplying branch has an ampacity greater than this. 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 6A B- or 4A C-Characteristic breaker should be used.

### 24.4. CHARGING OF BATTERIES

The DC/DC converter can be used to charge lead-acid or maintenance free batteries. (Two 12V batteries in series)

**Instructions for charging batteries:**

- a) Set output voltage (measured at no load and at the battery end of the cable) very precisely to the end-of-charge voltage.

End-of-charge voltage	27.8V	27.5V	27.15V	26.8V
Battery temperature	10°C	20°C	30°C	40°C

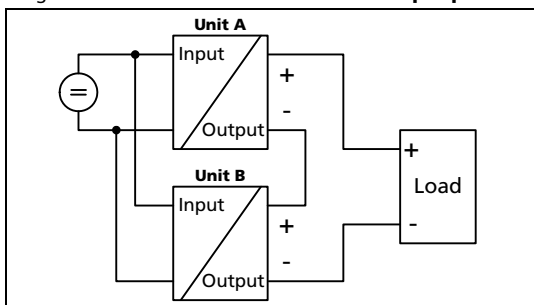
- b) Use a 15A or 16A circuit breaker (or blocking diode) between the DC/DC converter and the battery.
- c) Ensure that the output current of the DC/DC converter is below the allowed charging current of the battery.
- d) Use only matched batteries when putting 12V types in series.
- e) The return current to the power supply (battery discharge current) is typ. 3mA when the power supply is switched off (except in case a blocking diode is utilized).

### 24.5. 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. 24-4 Parallel use to increase the output power



Instructions for series use:

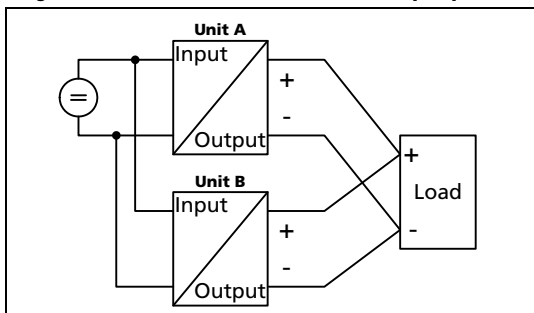
- Keep an installation clearance of 15mm (left / right) between two DC/DC converters and avoid installing the DC/DC converters on top of each other.
- Do not use DC/DC converters in series in mounting orientations other than the standard mounting orientation (input terminals on bottom of the unit).
- Pay attention that EMI and inrush current will increase when using multiple DC/DC converters.

### 24.6. PARALLEL USE TO INCREASE OUTPUT POWER

DC/DC converters can be paralleled to increase the output power. The output voltage shall be adjusted to the same value ( $\pm 100\text{mV}$ ) with the same load conditions on all units, or the units can be left with the factory settings. The ambient temperature is not allowed to exceed  $+60^\circ\text{C}$ .

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 15A or 16A is required on each output. Alternatively, a diode or redundancy module can also be utilized.

Fig. 24-5 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 (input 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.



### 24.7. PARALLEL USE FOR REDUNDANCY

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 power supplies, each rated for 8.3A are paralleled to build a 33.2A redundant system.

For N+1 redundancy the same restrictions apply as for increasing the output power, see also section 0.

**Please note:** This simple way to build a redundant system does not cover failures such as an internal short circuit in the secondary side of the DC/DC converter. In such a case, the defective unit becomes a load for the other power supplies and the output voltage can not be maintained any more. This can be avoided by using redundancy modules.

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 CP10 DC/DC converter.
- It is desirable to set the output voltages of all units to the same value ( $\pm 100\text{mV}$ ) or leave it at the factory setting.

Fig. 24-6 Redundant power design utilizing the YR20.242 redundancy module

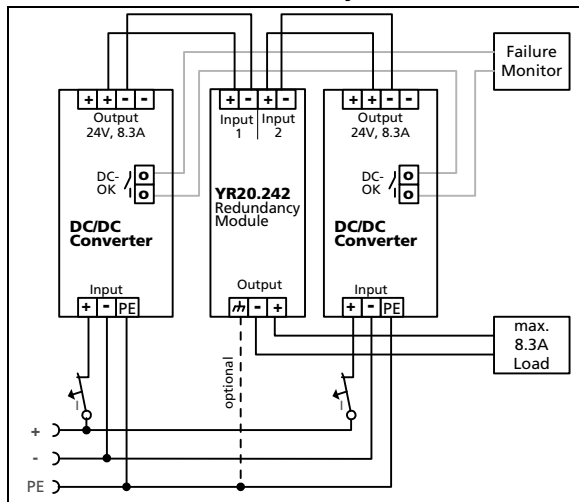
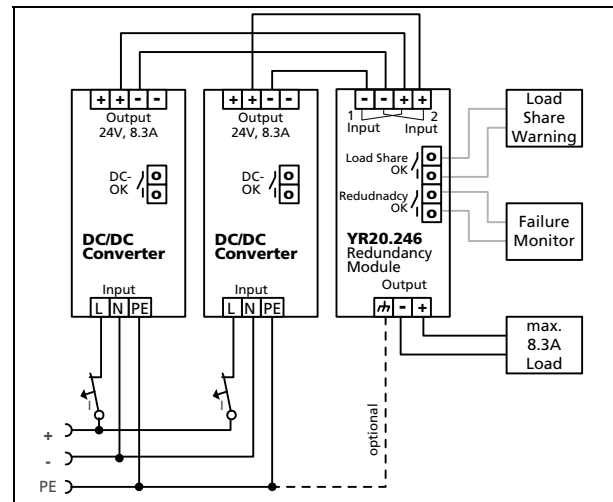


Fig. 24-7 Redundant power design utilizing the YR20.246 redundancy module with automated load sharing



## 24.8. 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. The maximum allowed feed-back-current is 40A. Higher currents can temporarily shut-down the output voltage. The absorbing energy can be calculated according to the built-in large sized output capacitor which is specified in chapter 6.

## 24.9. 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

### Test 1: 80% load

Enclosure:	Rittal Typ IP66 Box PK 9519 100, plastic, 180x180x165mm
Load:	24V, 6.6A; (=80%) load is placed outside the box
Input:	110Vdc
Temperature inside enclosure:	46.3°C (in the middle of the right side of the DC/DC converter with a distance of 2cm)
Temperature outside enclosure:	27.8°C
Temperature rise:	18.5K

### Test 2: 100% load

Enclosure:	Rittal Typ IP66 Box PK 9519 100, plastic, 180x180x165mm
Load:	24V, 8.3A; (=100%) load is placed outside the box
Input:	110Vdc
Temperature inside enclosure:	49.7°C (in the middle of the right side of the DC/DC converter with a distance of 2cm)
Temperature outside enclosure:	28.1°C
Temperature rise:	21.6K

### 24.10. 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. 24-8  
Mounting  
Orientation A  
(Standard  
orientation)

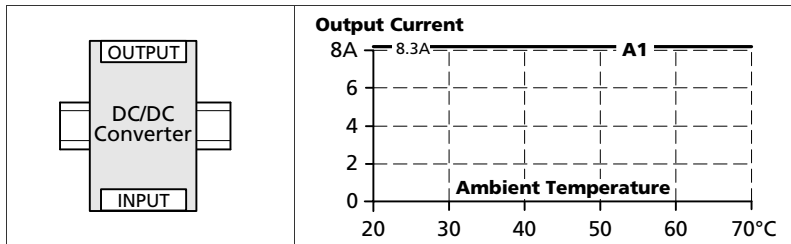


Fig. 24-9  
Mounting  
Orientation B  
(Upside down)

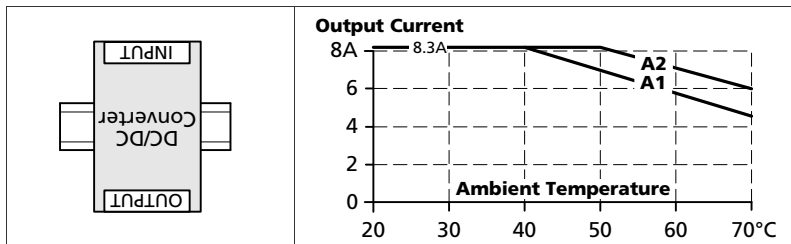


Fig. 24-10  
Mounting  
Orientation C  
(Table-top  
mounting)

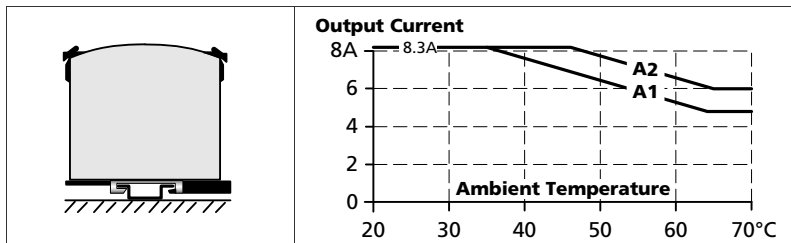


Fig. 24-11  
Mounting  
Orientation D  
(Horizontal cw)

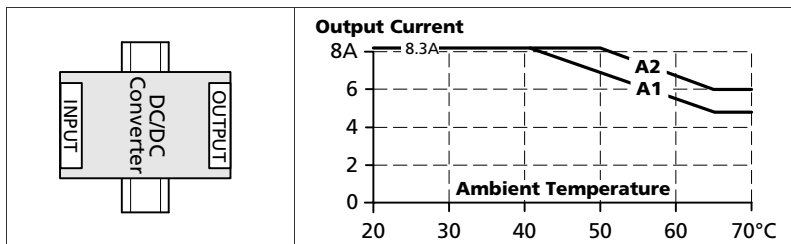
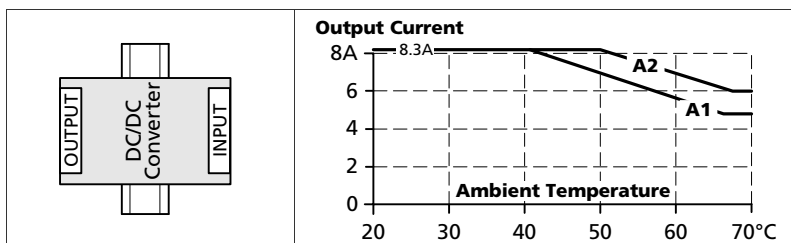


Fig. 24-12  
Mounting  
Orientation E  
(Horizontal ccw)



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All parameters are typical values specified at 24V, 8.3A output, 110Vdc input, 25°C ambient and after a 5 minutes run-in time unless otherwise noted.