CP10.241-60

24V, 200W, DC/DC CONVERTER

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

PRODUCT 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	Nominal
Adjustment range	24 - 28V	Factory setting 24.1V
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 (W x H x D)	39x124x117mm	Without DIN rail
Weight	620g	

ORDER NUMBERS

DC/DC converter

CP10.241-60

Accessory	ZM10.WALL	Wall/panel mount bracket
	ZM12.SIDE	Side mount bracket

MAIN APPROVALS

For details and the complete approval list, see chapter 19.

Railroad

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TERMINOLOGY AND ABBREVIATIONS

PE and ⏚ symbol	PE is the abbreviation for **P**rotective **E**arth and has the same meaning as the symbol ⏚.
Earth, Ground	This document uses the term “earth” which is the same as the U.S. term “ground”.
t.b.d.	To be defined, value or description will follow later.
DC 110V	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances (usually ±15%) included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
110Vdc	A figure with the unit (Vdc) at the end is a momentary figure without any additional tolerances included.
may	A key word indicating flexibility of choice with no implied preference.
shall	A key word indicating a mandatory requirement.
should	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 use in rolling stock equipment for railway applications according to EN 50155 or for use in industrial control, process control, monitoring and measurement equipment or the like.

Do not use this device in equipment, where malfunctioning may cause severe personal injury or threaten human life without additional appropriate safety devices, that are suited for the application.

If this device is used in a manner outside of its specification, the protection provided by the device may be impaired.

2. INSTALLATION INSTRUCTIONS

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

- Turn power off before working on the device and protect against inadvertent re-powering.
- Do not open, modify or repair the device.
- Use caution to prevent any foreign objects from entering into the housing.
- Do not use in wet locations or in areas where moisture or condensation can be expected.
- Do not touch during power-on, and immediately after power-off. Hot surface may cause burns.

Obey the following installation instructions:

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.

Install device in an enclosure providing protection against electrical, mechanical and fire hazards.

Install the device onto a DIN rail according to EN 60715 with the input terminals on the bottom of the device. Other mounting orientations require a reduction in output current.

Make sure that the wiring is correct by following all local and national codes. Use appropriate copper cables that are designed for a minimum operating temperature of 60°C for ambient temperatures up to +45°C, 75°C for ambient temperatures up to +60°C and 90°C for ambient temperatures up to +70°C. Ensure that all strands of a stranded wire enter the terminal connection.

The device is designed for pollution degree 2 areas in controlled environments. No condensation or frost allowed.

The enclosure of the device provides a degree of protection of IP20.

The device is designed as “Class of Protection I” equipment according to IEC 61140.

Do not use without a proper PE (Protective Earth) connection.

The device can be powered from a regulated power supply or a similar DC source. The voltage between the supply voltage terminals and ground must not exceed 150Vdc continuously.

A disconnecting means shall be provided for the input of the device.

The device is designed for convection cooling and does not require an external fan. Do not obstruct airflow and do not cover ventilation grid!

The device is designed for altitudes up to 5000m. See additional requirements in the product datasheet for use above 2000m.

Keep the following minimum installation clearances: 40mm on top, 20mm on the bottom, 5mm left and right side. Increase the 5mm to 15mm in case the adjacent device is a heat source. When the device is permanently loaded with less than 50%, the 5mm can be reduced to zero.

The device is designed, tested and approved for branch circuits up to 20A without additional protection device. If an external fuse is utilized, do not use circuit breakers smaller than 6A B- or 4A C-Characteristic to avoid a nuisance tripping of the circuit breaker.

The maximum surrounding air temperature is +85°C. The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.

The device is designed to operate in areas between 5% and 95% relative humidity.

Check for correct input polarity. The device will not operate when the voltage is reversed.

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
Reverse input polarity protection		Included	The device will not operate when the voltage is reversed.
Turn-on overshoot	Max.	200mV	See Fig. 3-2
External input protection	See recommendations in chapter 2.		

Fig. 3-1 **Input voltage range**

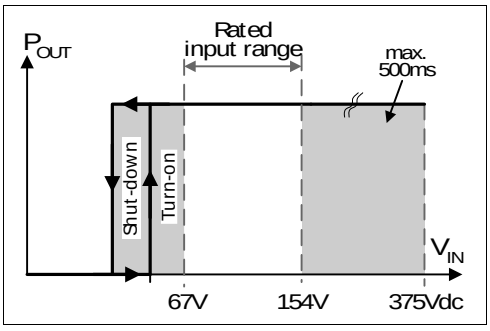


Fig. 3-2 **Turn-on behavior, definitions**

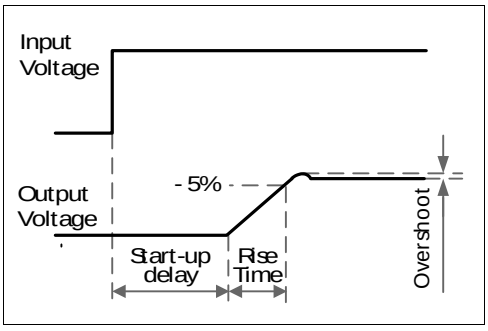
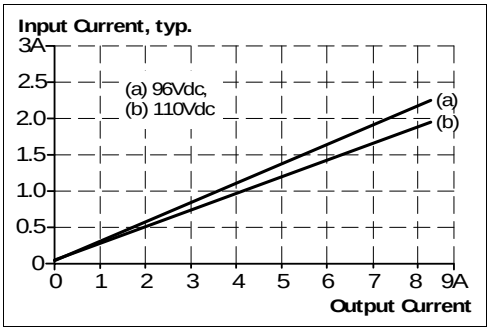


Fig. 3-3 **Input current vs. output load at 24V**



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.

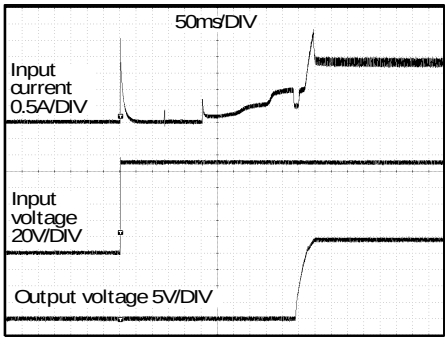
5. INPUT INRUSH CURRENT

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.	$8A_{peak}$	$8A_{peak}$	Temperature independent
	Typ.	$2.5A_{peak}$	$2.5A_{peak}$	Temperature independent
Inrush energy	Max.	$0.1A^2s$	$0.1A^2s$	Temperature independent

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



6. OUTPUT

The output provides a SELV/PELV/ES1 rated voltage, which is galvanically isolated from the input voltage.

The device 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 >1.5F are connected, the unit might charge the capacitor in an intermittent mode.

Output voltage	Nom.	24V	
Adjustment range		24-28V	Guaranteed
	Max.	30V	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.
Factory setting	Typ.	24.1V ±0.2%	At full load, cold unit
Line regulation	Max.	10mV	Between 67 and 154Vdc
Load regulation	Max.	100mV	Between 0A and 8.3A, static value
Ripple and noise voltage	Max.	50mVpp	Bandwidth 20Hz to 20MHz, 50Ohm
Output current	Nom.	8.3A	At 24V and an ambient temperature below 70°C or at +85°C for maximum 10 minutes.
	Nom.	7.1A	At 28V and an ambient temperature below 70°C or at +85°C for maximum 10 minutes.
Fuse breaking current[1)]	Typ.	30A	Up to 12ms once every five seconds, see Fig. 6-2.
Overload protection		Included	Electronically protected against overload, no-load and short-circuits. In case of a protection event, audible noise may occur.
Overload behaviour		Continuous current	Output voltage above 13Vdc, see Fig. 6-1
		Intermitted current[2)]	Output voltage below 13Vdc, see Fig. 6-1
Overload/ short-circuit current	Max.	10.6A	Continuous current, see Fig. 6-1
	Typ.	11.5A	Intermitted current peak value for typ. 2s Load impedance 50mOhm, see Fig. 6-3 Discharge current of output capacitors is not included.
	Max.	4.3A	Intermitted current average value (R.M.S.) Load impedance 50mOhm, see Fig. 6-3
Output capacitance	Typ.	4 400µF	Included inside the power supply
Back-feeding loads	Max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the power supply. It does not matter whether the power supply is on or off. The absorbing energy can be calculated according to the built-in large sized output capacitor.

1) The fuse braking current is an enhanced transient current which helps to start heavy loads or to trip fuses on faulty output branches. The output voltage stays above 20V. See chapter 25.1 for additional measurements.

2) 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. 6-2.

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

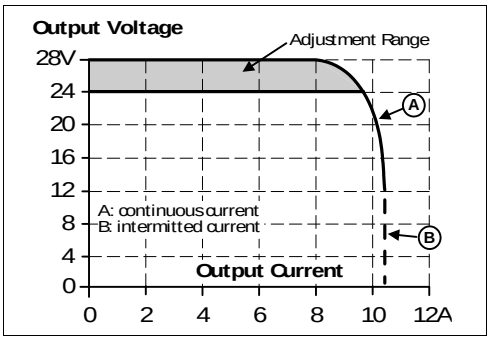


Fig. 6-2 **Dynamic output current capability, typ.**

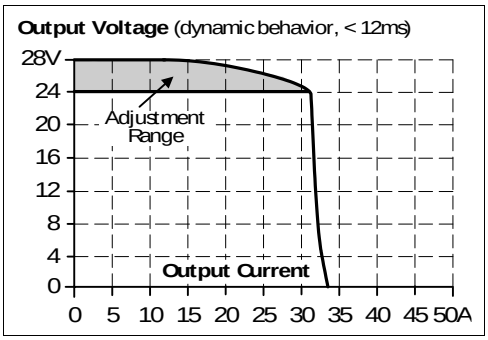
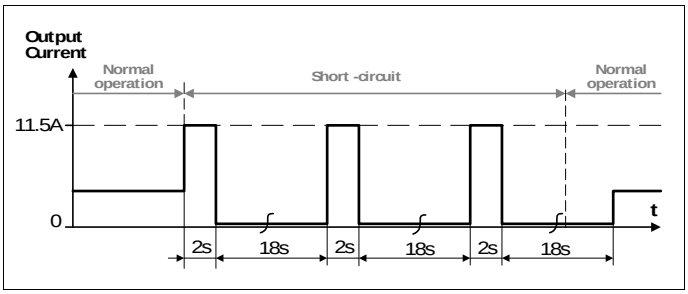


Fig. 6-3 **Short-circuit on output, Hiccup^{PLUS} mode, typ.**



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.	72ms	72ms	At 4.15A, see Fig. 7-1
	Min.	54ms	54ms	At 4.15A, see Fig. 7-1
	Typ.	34ms	34ms	At 8.3A, see Fig. 7-1
	Min.	26ms	26ms	At 8.3A, see Fig. 7-1

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

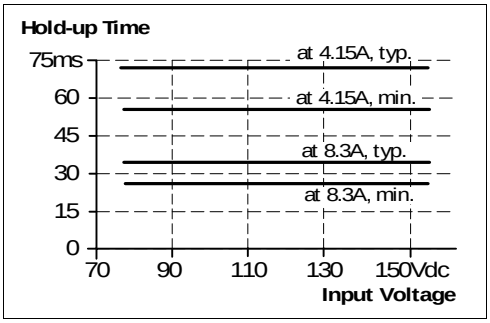
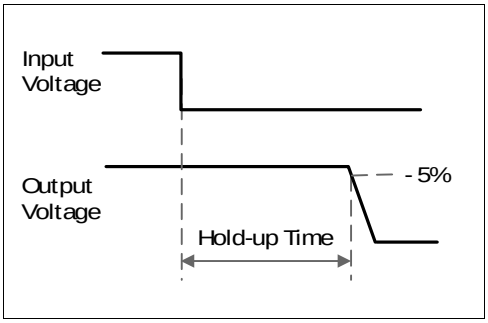


Fig. 7-2 **Shut-down behavior, definitions**

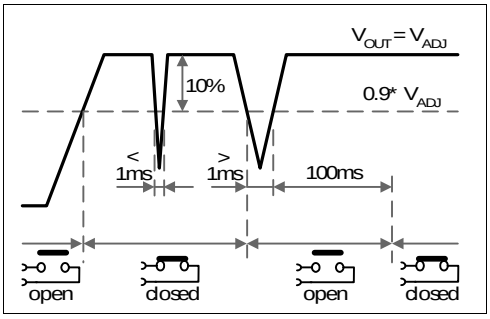


8. DC-OK RELAY CONTACT

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

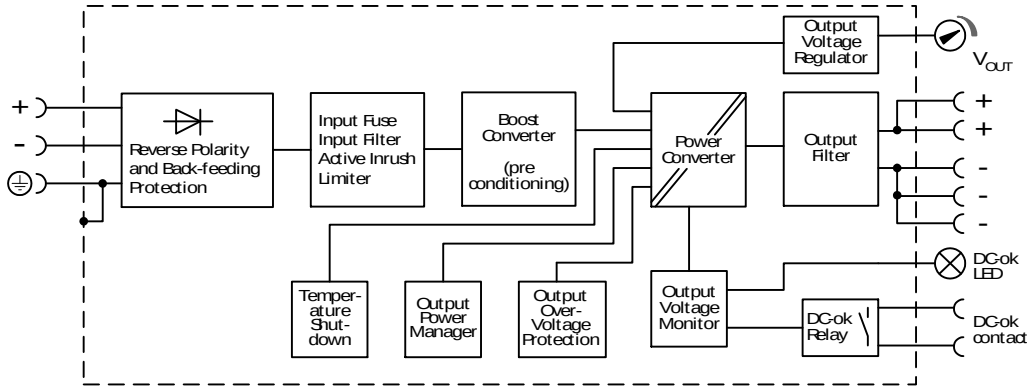
Contact closes	As soon as the output voltage reaches typ. 90% of the adjusted output voltage level.
Contact opens	As soon as the output voltage dips more than 10% below the adjusted output voltage. Short dips will be extended to a signal length of 100ms. Dips shorter than 1ms will be ignored.
Switching hysteresis	1V
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 chapter 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 4.15A, 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.**

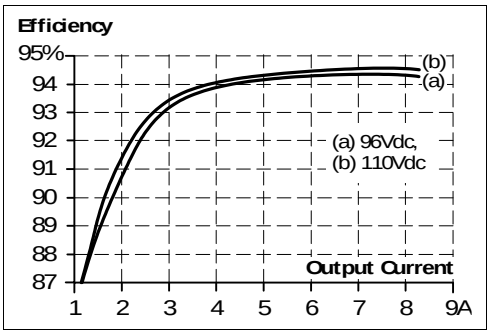
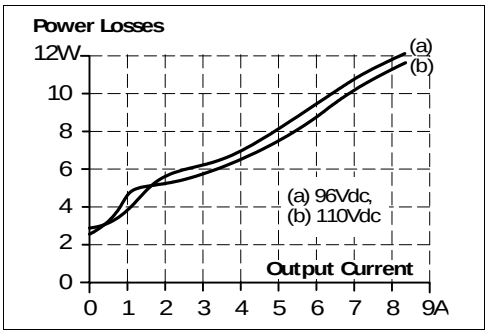


Fig. 10-2 **Losses vs. output current, at 24V, typ.**



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 **M**ean **T**ime **B**etween **F**ailure, 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 (**M**ean **T**ime **T**o **F**ailure) value is the same value as the MTBF value.

	DC 96V	DC 110V	
MTBF SN 29500, IEC 61709	758 000h	775 000h	At 24V, 8.3A and 40°C
	1 337 000h	1 362 000h	At 24V, 8.3A and 25°C
MTBF MIL HDBK 217F	291 000h	292 000h	At 24V, 8.3A and 40°C, Ground Benign GB40
	404 000h	406 000h	At 24V, 8.3A and 25°C, Ground Benign GB25
	72 000h	72 000h	At 24V, 8.3A and 40°C, Ground Fixed GF40
	93 000h	94 000h	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.

	Input and output	**DC-OK-Signal**
Type	Quick-connect spring-clamp terminals	Push-in terminals
Solid wire	Max. 6mm²	Max. 1.5mm²
Stranded wire	Max. 4mm²	Max. 1.5mm²
American Wire Gauge	AWG 20-10	Max. AWG 28-16
Max. wire diameter	2.8mm (including ferrules)	1.6mm (including ferrules)
Wire stripping length	10mm	7mm
Screwdriver	Not required	3mm slotted to open the spring
Recommended tightening torque	Not applicable	Not applicable

Instructions for wiring:

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!

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. 13-2.

Fig. 13-1 **Daisy chaining of outputs**

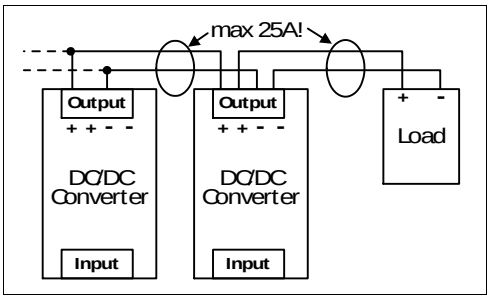
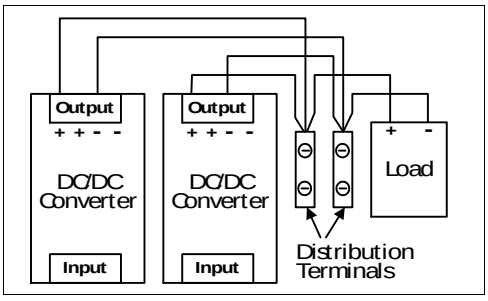
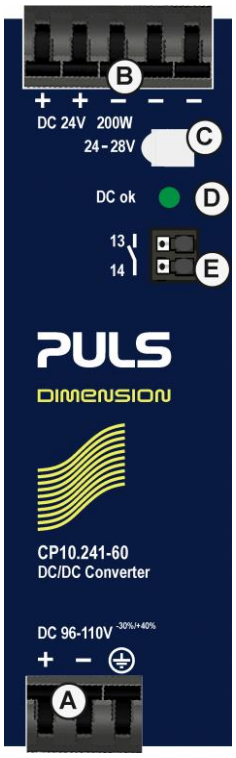


Fig. 13-2 **Using distribution terminals**



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 EMC behavior of the DC/DC converter is designed for rolling stock railway applications and for applications in industrial environments.

EMC Immunity	According to generic standards EN 61000-6-1 and EN 61000-6-2 and according to the railway standard EN 50121-3-2.			
Electrostatic discharge	EN 61000-4-2	Contact discharge Air discharge	8kV 15kV	Criterion A Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz 5.1-6GHz	20V/m 10V/m	Criterion A Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines Output lines DC-OK signal (coupling clamp)	4kV 2kV 2kV	Criterion A Criterion A Criterion A
Surge voltage on input	EN 61000-4-5	+ → - + → PE, - → PE	2kV 4kV	Criterion A Criterion A
Surge voltage on output	EN 61000-4-5	+ → - + / - → PE	1kV 2kV	Criterion A 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 0Hz	100A/m 300A/m	Criterion A Criterion A
Pulsed magnetic field	EN 61000-4-9		300A/m	Criterion B

Criterions:
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.

EMC Emission	According to the generic standard EN 61000-6-4 and according to railway standard 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 61000-6-4 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 61000-6-4 fulfilled
Radiated emission	EN 55011, EN 55032, 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.

Switching Frequencies

Boost converter	100kHz	Fixed frequency
Main converter	110kHz to 140kHz	Input voltage and output load dependent
Auxiliary converter	60kHz	Fixed frequency

16. ENVIRONMENT

Operational temperature	-40°C to +70°C	The operational temperature is the ambient or surrounding temperature and is defined as the air temperature 2cm below the device.
	+70°C to +85°C	For maximal 10 minutes every hour
Storage temperature	-40°C to +85°C	For storage and transportation
Output derating	12W/1000m or 5°C/1000m	For altitudes >2000m, see Fig. 16-2
	7.5W/-5kPa or 3°C/-5kPa	For atmospheric pressures <80kPa, see Fig. 16-2
	The derating is not hardware controlled. The customer has to take care by himself to stay below the derated current limits in order not to overload the unit.	
Humidity	5 to 95% r.h.	According to IEC 60068-2-30 Do not energize while condensation is present.
Atmospheric pressure	110-47kPa	See Fig. 16-2 for details
Altitude	Up to 5000m	See Fig. 16-2 for details
Over-voltage category	III	According to IEC 60664-1 for altitudes up to 2000m and atmospheric pressures from 110 to 80kPa
	II	According to IEC 60664-1 for altitudes from 2000 to 5000m and atmospheric pressures from 80 to 47kPa
Degree of pollution	2	According to IEC 62477-1, not conductive
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g[***)] 2 hours / axis	According to IEC 60068-2-6; DC/DC converter in operation
Vibration broadband	1.01grms for 10 minutes; 5-150Hz[***)]	According to IEC 60068-2-64, DC/DC converter in operation, Tests limits according to EN 61373
	5.72grms for 300 minutes; 5-150Hz[***)]	According to IEC 60068-2-64, DC/DC converter not in operation; Tests limits according to EN 61373
Shock	30g 6ms, 20g 11ms, 50g 30ms[***)] 3 bumps / direction, 18 bumps in total	According to IEC 60068-2-27; DC/DC converter in operation
	50g 30ms[***)] 3 bumps / direction, 18 bumps in total	According to IEC 60068-2-27, DC/DC converter not in operation; Tests limits according to EN 61373
	Shock and vibration is tested in combination with DIN rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm and standard orientation.	
Audible noise	Some audible noise may be emitted from the power supply during no load, overload or short circuit.	

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

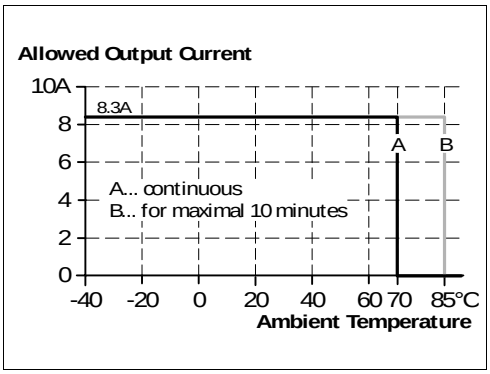
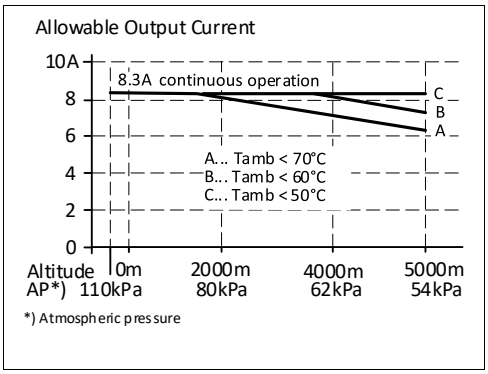


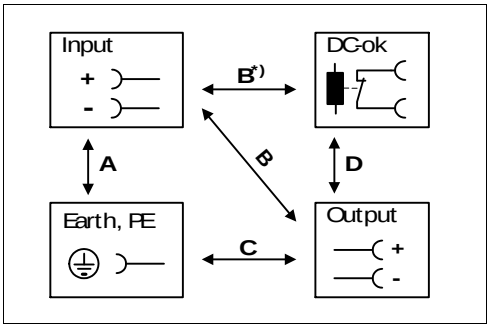
Fig. 16-2 **Output current vs. altitude at 24V output voltage**



17. DIELECTRIC STRENGTH

The output voltage is floating and has no ohmic connection to the ground. Type and routine 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. 17-1 **Dielectric strength**



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

It is recommend that either the + pole, the – pole or any other part of the output circuit shall be connected to the earth/ground 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.

18. SAFETY AND PROTECTION FEATURES

Isolation resistance	Min.	500MOhm	At delivered condition between input and output, measured with 500Vdc
	Min.	500MOhm	At delivered condition between input and PE, measured with 500Vdc
	Min.	500MOhm	At delivered condition between output and PE, measured with 500Vdc
	Min.	500MOhm	At delivered condition between output and DC-OK contacts, measured with 500Vdc
PE resistance	Max.	0.1Ohm	Resistance between PE terminal and the housing in the area of the DIN rail mounting bracket.
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.	
Class of protection		I	According to IEC 61140 A PE (Protective Earth) connection is required
Degree of protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	Output shut-down with automatic restart. Temperature sensors are installed on critical components inside the unit and turn the unit off in safety critical situations, which can happen e.g. when ambient temperature is too high, ventilation is obstructed or the derating requirements are not followed. There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.
Input transient protection		MOV (Metal Oxide Varistor)	For protection values see chapter 15 (EMC).
Internal input fuse		DC suitable fuse included	Not user replaceable slow-blow high-braking capacity fuse
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. APPROVED, FULFILLED OR TESTED STANDARDS

Railroad (Rolling Stock)		Manufacturer's Declaration EN 50155 - Electronic Equipment Used on Rolling Stock Altitude category: AX Environmental category: TX Interruption of voltage supply: S2 Supply change over: C2 Shock and vibration: Category 1, Class A and B EMI: EN 50121-3-2 Fire Classification: HL3
IEC 61010-2-201	Safety✓	Manufacturer's Declaration Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment
IEC 60068-2-60	Corrosion IEC 60068-2-60 Method 4 ✓	Manufacturer's Declaration (Online Document) Environmental Tests, Flowing Mixed Gas Corrosion Test IEC 60068-2-60 Method 4 Test Ke - Method 4 H2S: 10ppb NO2: 200ppb Cl2: 10ppb SO2: 200ppb Test Duration: 3 weeks, this simulates a service life of 10 years.
ISA-71.04 G3	Corrosion G3-ISA-71.04 ✓	Manufacturer's Declaration (Online Document) Airborne Contaminants Corrosion Test ISA-71.04 G3 Severity Level: G3 Harsh H2S: 100ppb NOx: 1250ppb Cl2: 20ppb SO2: 300ppb Test Duration: 3 weeks, this simulates a service life of 10 years.
Labs	LABS VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

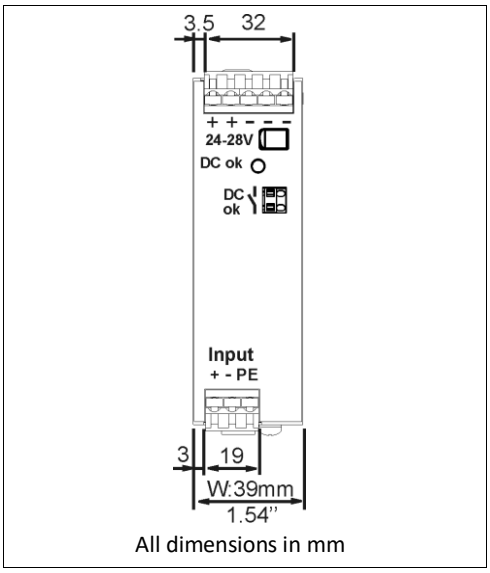
20. REGULATORY PRODUCT COMPLIANCE

EU Declaration of Conformity	CE	The CE mark indicates conformance with the - EMC directive - Low-voltage directive - RoHS directive
REACH Regulation (EU)	REACH ✓	Manufacturer's Declaration EU regulation regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) fulfilled. EU Regulation (EC) 1907/2006.
WEEE Regulation		Manufacturer's Declaration EU Regulation on Waste Electrical and Electronic Equipment Registered as business to business (B2B) products. EU Regulation 2012/19/EU
UKCA	UK CA	UKCA Declaration of Conformity Trade conformity assessment for England, Scotland and Wales The UKCA mark indicates conformity with the UK Statutory Instruments 2016 No.1101, 2016 No.1091, 2012 No.3032

21. PHYSICAL DIMENSIONS AND WEIGHT

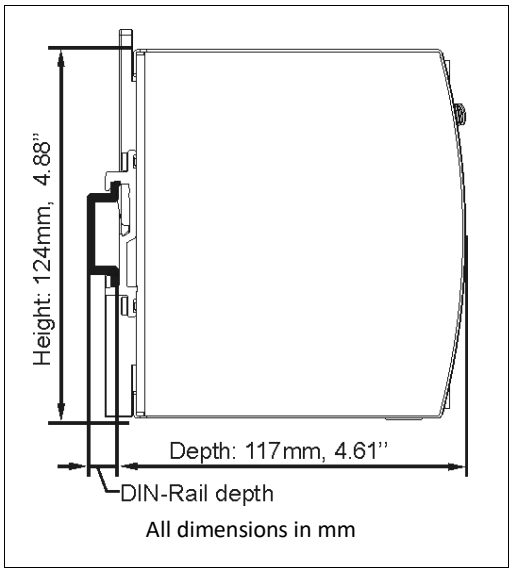
Width	39mm
Height	124mm
Depth	117mm The DIN rail depth must be added to the unit depth to calculate the total required installation depth.
Weight	620g
DIN rail	Use 35mm DIN rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.
Housing material	Body: Aluminium alloy Cover: Zinc-plated steel
Installation clearances	See chapter 2
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4mm

Fig. 21-1 **Front view**



All dimensions in mm

Fig. 21-2 **Side view**



All dimensions in mm

22. ACCESSORIES

22.1. ZM10.WALL - WALL/PANEL MOUNT BRACKET

This bracket is used to mount the devices on a wall/panel without utilizing the DIN rail. The bracket can be mounted without detaching the DIN rail brackets from the power supply. PSU for illustration purpose only.

Fig. 22-1 **Isometric view**

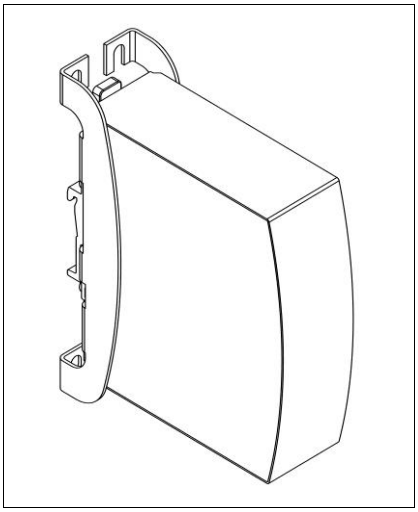


Fig. 22-2 **Isometric view**

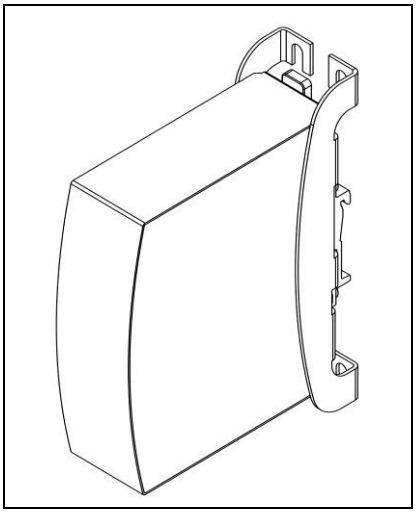
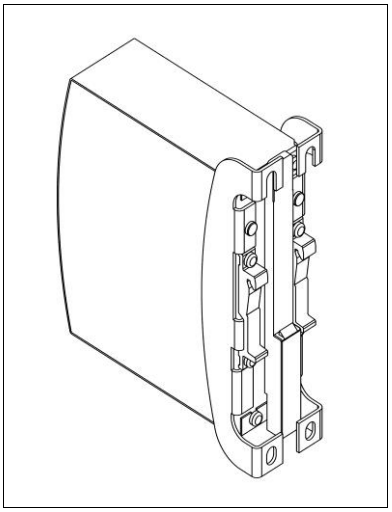


Fig. 22-3 **Isometric view**



23.

24.

Fig. 22-4 **Wall/panel mounting, front view**

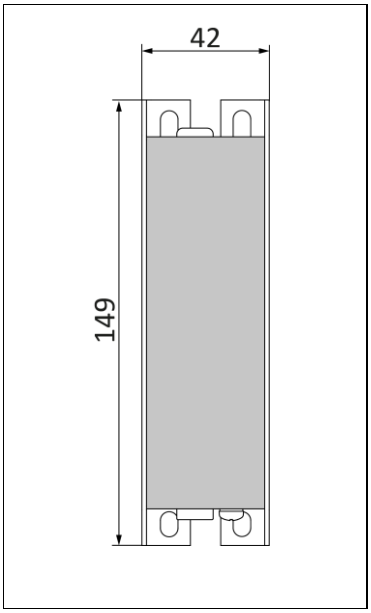


Fig. 22-5 **Hole pattern for wall mounting**

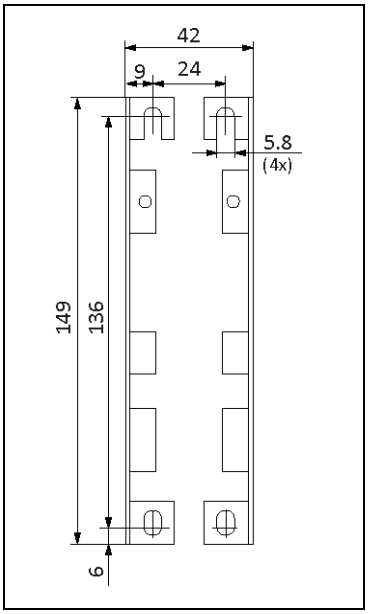
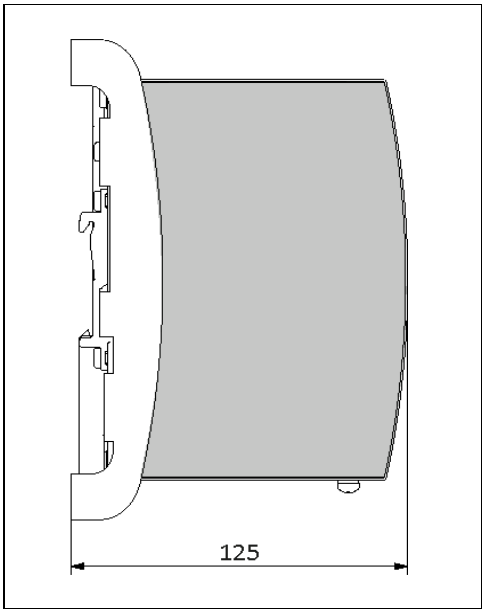


Fig. 22-6 **Wall/panel mounting, side view**



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

Fig. 22-4
Side mounting without DIN rail brackets

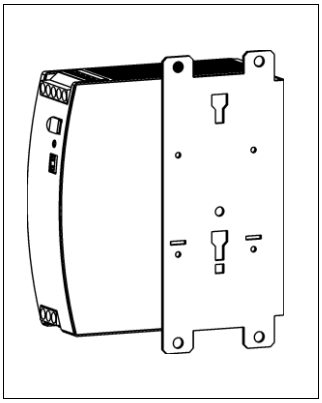


Fig. 22-5
Side mounting with DIN rail brackets

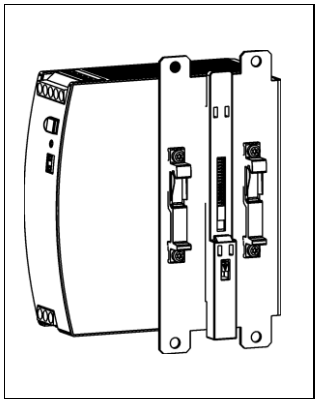
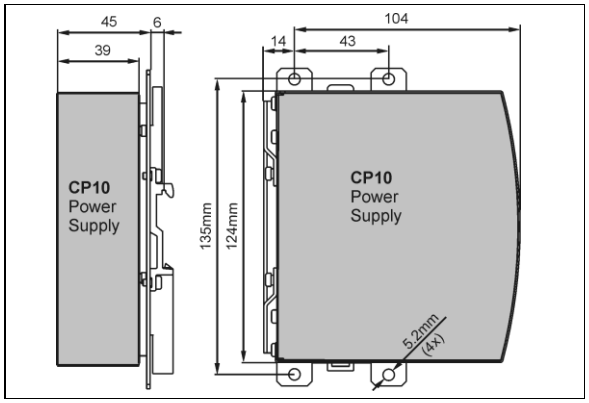
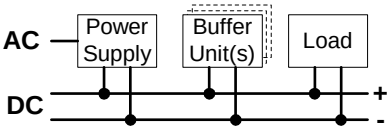


Fig. 22-6
Mounting Dimensions
Side mounting bracket



24.2. 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.

24.3. YR20.242 - REDUNDANCY MODULE

The YR20.242 is equipped with two input channels, which are individually decoupled by utilizing MOSFET technology. Using MOSFETSs 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 25.5.

24.4. 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 MOSFETSs 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 25.5.

25. APPLICATION NOTES

25.1. 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 for resistive loads:

Fig. 25-1 **16.6A peak current for 50ms, typ. (2x the nominal current)**

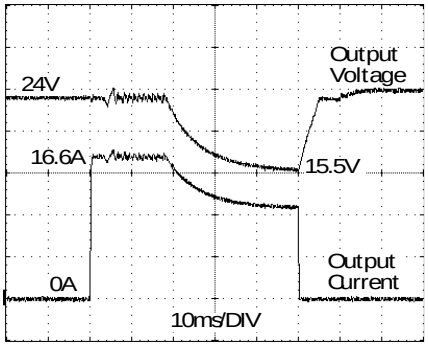


Fig. 25-2 **41.5A peak current for 5ms, typ. (5x the nominal current).**

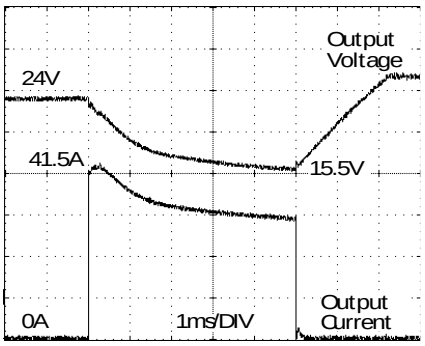
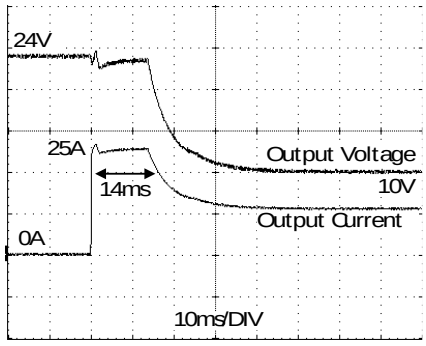


Fig. 25-3 **25A peak current for 12ms, typ. (3x the nominal current)**



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

25.2. 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

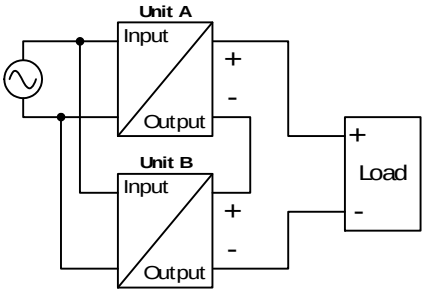
b) Use a 15A or 16A circuit breaker (or blocking diode) between the DC/DC converter and the battery.

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).

25.3. SERIES OPERATION



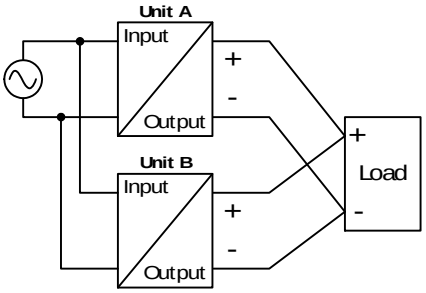
DC/DC converters of the same type can be connected in series for higher output voltages. It is possible to connect as many units in series as needed, providing the sum of the output voltage does not exceed 150Vdc. Voltages with a potential above 60Vdc must be installed with a protection against touching.

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

Keep an installation clearance of 15mm (left / right) between two power supplies and avoid installing the power supplies on top of each other. Do not use power supplies in series in mounting orientations other than the standard mounting orientation (input terminals on bottom of the unit).

Pay attention that leakage current, EMI, inrush current will increase when using multiple power supplies.

25.4. 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 (±100mV) 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°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.

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

Keep an installation clearance of 15mm (left / right) between two power supplies and avoid installing the power supplies on top of each other. Do not use power supplies in parallel in mounting 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, above 60°C, …).

Pay attention that leakage current, EMI, inrush current will increase when using multiple power supplies.

25.5. PARALLEL USE FOR REDUNDANCY

1+1 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 unit fails, the other one is automatically able to support the load current without any interruption. It is essential to use a redundancy module to decouple power supplies from each other. This prevents that the defective unit becomes a load for the other power supplies and the output voltage cannot be maintained any more.

Recommendations for building redundant power systems:

- Use separate input fuses for each power supply.
- Monitor the individual DC/DC converter units. Therefore, use the DC-OK relay contact of the DC/DC converter.
- It is desirable to set the output voltages of all units to the same value (± 100mV) or leave it at the factory setting.

Pay attention that leakage current, EMI, inrush current will increase when using multiple DC/DC converters.

Wiring examples for 1+1 redundancy:

Fig. 25-4 **Redundant power design utilizing the YR20.242 redundancy module**

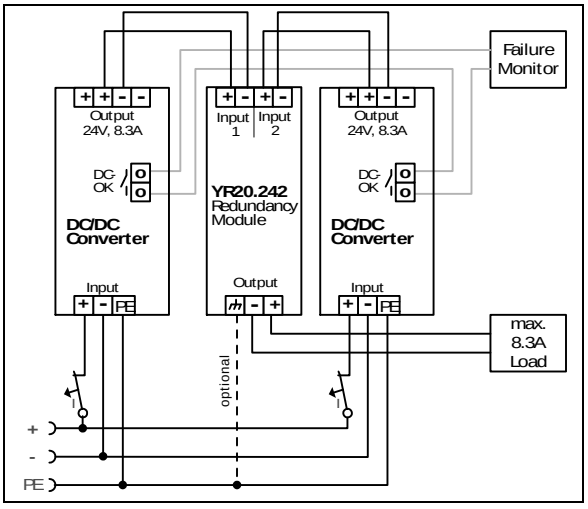
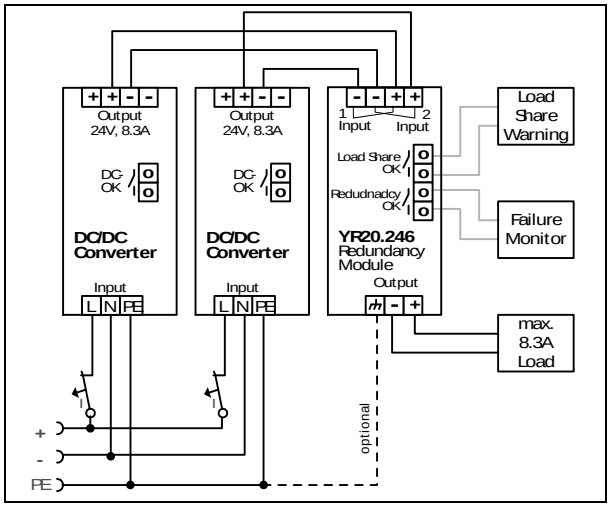


Fig. 25-5 **Redundant power design utilizing the YR20.246 redundancy module with automated load sharing**



N+1 Redundancy:
Redundant systems for a higher power demand are usually built in a N+1 method. E.g. four DC/DC converters, each rated for 8.3A are paralleled to build a 24.9A redundant system.

Ensure that the ambient temperature of the DC/DC converters below 60°C for n+1 redundancy applications.

Keep an installation clearance of 15mm (left / right) between two DC/DC converters and avoid installing the units on top of each other.

Do not use DC/DC converters in parallel in mounting orientations other than the standard mounting orientation or in any other condition, where a derating of the output current is required.

Pay attention that leakage current, EMI, inrush current will increase when using multiple DC/DC converters.

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

The temperature sensor inside the box is placed in the middle of the right side of the power supply with a distance of 1cm.
The following measurement results can be used as a reference to estimate the temperature rise inside the enclosure.

	Case A	**Case B**
Enclosure size	180x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic	180x180x165mm Rittal Typ IP66 Box PK 9519 100, plastic
Input voltage	110Vdc	110Vdc
Load	24V, 6.6A; (=**80%**)	24V, 8.3A; (=**100%**)
Temperature inside the box	46.3°C	49.7°C
Temperature outside the box	27.8°C	28.1°C
Temperature rise	18.5K	21.6K

25.7. 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. 25-6
Mounting Orientation A
(Standard orientation)

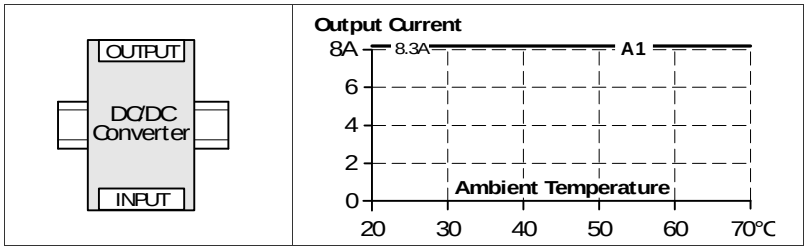


Fig. 25-7
Mounting Orientation B
(Upside down)

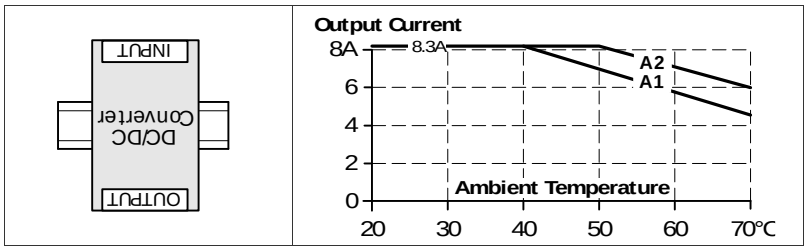


Fig. 25-8
Mounting Orientation C
(Table-top mounting)

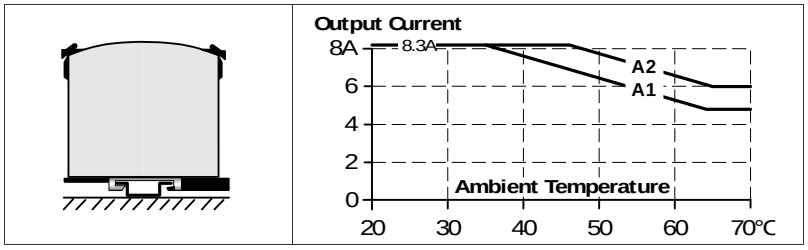


Fig. 25-9
Mounting Orientation D
(Horizontal cw)

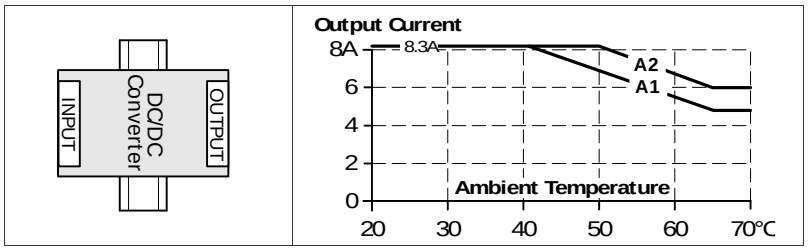


Fig. 25-10
Mounting Orientation E
(Horizontal ccw)