



### DC/DC CONVERTER

- DC 600V Input
- Optimized for Intermediate DC-bus of Drive Systems
- Two Input Fuses for DC 600V included
- 95% Full Load and Excellent Partial Load Efficiencies
- Width only 65mm, Weight only 890g
- 25% BonusPower®, 600W for up to 4s
- Active Filtering of Input Transients
- Full Power Between -25°C and +60°C
- Extremely Low Input Inrush Current Surge
- Reverse Input Polarity Protection
- DC-OK Relay Contact
- Quick-connect Spring-clamp Terminals
- 3 Year Warranty

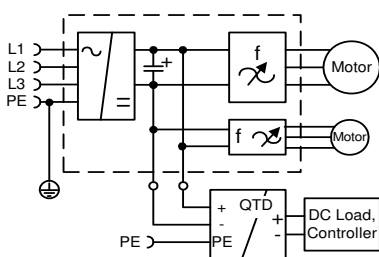
### GENERAL DESCRIPTION

Modern machines typically use maintenance-free AC-motors which are controlled by frequency converters or servo amplifiers. Such devices have an intermediate DC-bus where all individual drives are connected.

The QTD20 DC/DC converter can be connected directly to the intermediate DC-bus. In case of a mains failure, the QTD20 utilizes the power from the DC-bus capacitors which are charged from the kinetic energy of the motor until the motor has come to a complete stop.

The intermediate DC-bus is usually unfiltered and have high EMI noise so the QTD20 has a very robust input stage and an appropriate input filter included.

Additionally, the QTD20 is UL 508 approved and is equipped with input fuses which are rated and tested for 600Vdc applications.



### SHORT-FORM DATA

Output voltage	DC 24V	nominal
Adjustment range	24 - 28V	
Output current	20 – 17.5A	continuous
	25 – 21.4A	short term (4s)
Output power	480W	continuous
	600W	short term (4s)
Output ripple	< 100mVpp	20Hz to 20MHz
Input voltage	DC 600V	-20%/+40%
Input current	0.85A	at 600Vdc
Inrush current	typ. 1.5A peak	
Efficiency	95.0%	at 600Vdc
Losses	25.5W	at 600Vdc
Temperature range	-25°C to +70°C	operational
Derating	12W/°C	+60 to +70°C
Hold-up time	typ. 22ms	at 600Vdc
Dimensions	65x124x127mm	WxHxD
Weight	890g / 1.96lb	

### ORDER NUMBERS

DC/DC converter	<b>QTD20.241</b>	
Accessory	ZM1.WALL	Wall mount bracket
	ZM14.SIDE	Side mount bracket
	UF20.241	Buffer unit
	YR40.241	Redundancy module

### MARKINGS



## INDEX

	Page		Page
1. Intended Use .....	3	20. Accessories .....	18
2. Installation Requirements.....	3	20.1. ZM1.WALL – Wall/Panel mounting.....	18
3. Input .....	4	20.2. ZM14.SIDE - Side Mounting Bracket.....	19
4. Input Inrush Current .....	5	20.3. UF20.241 - Buffer module .....	20
5. Output .....	6	20.4. YR40.241 - Redundancy Module.....	20
6. Hold-up Time.....	8	21. Application Notes.....	21
7. DC-OK Relay Contact .....	8	21.1. Repetitive Pulse Loading.....	21
8. Efficiency and Power Losses.....	9	21.2. Peak Current Capability .....	22
9. Lifetime Expectancy and MTBF.....	10	21.3. External Input Protection.....	22
10. Functional Diagram.....	10	21.4. Charging of Batteries .....	23
11. Terminals and Wiring.....	11	21.5. Output Circuit Breakers.....	24
12. Front Side and User Elements.....	12	21.6. Series Operation .....	24
13. EMC.....	13	21.7. Parallel Use to Increase Output Power....	25
14. Environment .....	14	21.8. Parallel Use for Redundancy .....	25
15. Protection Features .....	15	21.9. Inductive and Capacitive Loads.....	25
16. Safety Features .....	15	21.10. Back-feeding Loads .....	26
17. Dielectric Strength .....	16	21.11. Use in a Tightly Sealed Enclosure .....	26
18. Approvals.....	16	21.12. Mounting Orientations .....	27
19. Physical Dimensions and Weight.....	17		

The information given in this document is correct to the best of our knowledge and experience at the time of publication. If not expressly agreed otherwise, this information does not represent a warranty in the legal sense of the word. As the state of our knowledge and experience is constantly changing, the information in this data sheet is subject to revision. We therefore kindly ask you to always use the latest issue of this document (available under [www.pulspower.com](http://www.pulspower.com)). No part of this document may be reproduced or utilized in any form without our prior permission in writing.

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 600V</b>	A figure displayed with the AC or DC before the value represents a nominal voltage with standard tolerances included. E.g.: DC 12V describes a 12V battery disregarding whether it is full (13.7V) or flat (10V)
<b>600Vdc</b>	A figure with the unit (Vac or 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 in industrial 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 device 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 21.12.

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 DC/DC converter).

Caution: For use in a controlled environment according to CSA 22.2 No 107.1-01.

 **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. INPUT

Input	nom.	DC 600V <sup>-20%/+40%</sup>	
Input range	min.	480-840Vdc	Continuous operation
	min.	360-480Vdc	Maximal 60s or with reduced output current, see Fig. 5-2
	min.	840V-900Vdc	Maximal 60s or with reduced output current, see Fig. 5-2
	max.	1000Vdc	Absolute maximum input voltage with no damage to the DC/DC converter. Above 900Vdc, the output will switch off and will turn-on again, when the input voltage falls below 850Vdc.
Allowed voltage input to Earth	max.	600V R.M.S.	Continuous, IEC 60664-1
	max.	±900Vpk	Peak value, allowed for transients
Slew rate for voltages between input and Earth (ground)	max.	1000V/μs	
Allowed input ripple voltage	max.	50Vpp	50Hz-40kHz
Turn-on voltage	typ.	450Vdc	Steady-state value, load independent, see Fig. 3-1
Shut-down voltage	typ.	325Vdc	Steady-state value, load independent, see Fig. 3-1
Input current	typ.	0.79A	At 24V, 20A, see Fig. 3-3
Start-up delay	typ.	350ms	See Fig. 3-2
Rise time	typ.	70ms	At 24V, 20A, only resistive load see Fig. 3-2
	typ.	110ms	At 24V, 20A, resistive load with an additional 20mF capacitor
Turn-on overshoot	max.	500mV	See Fig. 3-2
External capacitors on input	Allowed without any limitations		

Fig. 3-1 Input voltage range

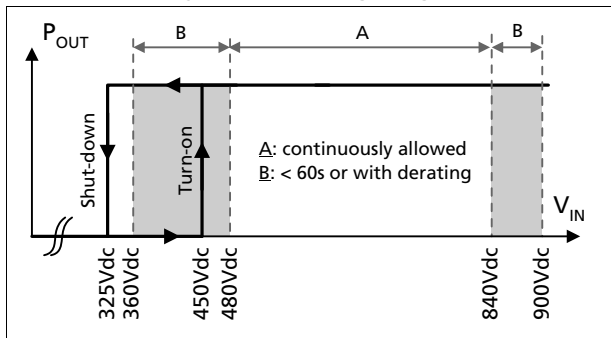


Fig. 3-2 Turn-on behavior, definitions

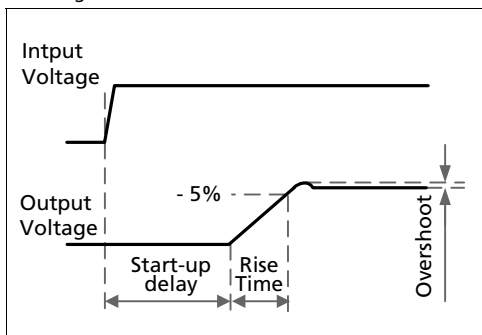
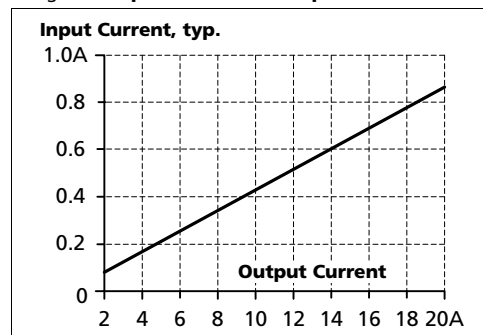


Fig. 3-3 Input current vs. output load at 24V



### 4. INPUT INRUSH CURRENT

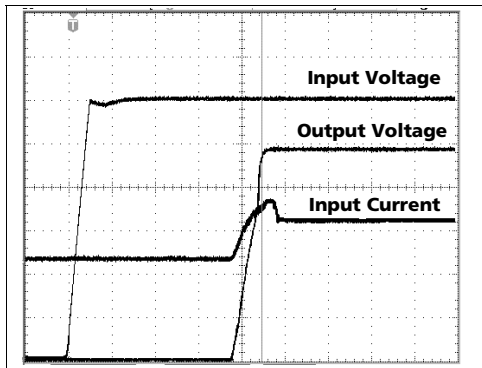
The DC/DC converter is equipped with an active inrush current limitation circuit, which limits the input inrush current after turn-on and after short input voltage interruptions to a very low value.

**DC 600V**

Inrush current <sup>*)</sup>	max.	3A <sub>peak</sub>	Over entire temperature range
	typ.	1.6A <sub>peak</sub>	Over entire temperature range
Inrush energy	max.	1A <sup>2</sup> s	Over entire temperature range
Inrush delay	typ.	350ms	

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

Fig. 4-1 Typical turn-on behavior at nominal load and 25°C ambient temperature



Input: 600Vdc  
 Output: 24V, 20A  
 Ambient: 25°C

Upper curve: Input voltage 100V/Div  
 Medium curve: Output voltage 5V/DIV  
 Lower curve: Input current 1A/DIV  
 Time base: 100ms/DIV

### 5. OUTPUT

Output voltage	nom.	24V	
Adjustment range	min.	24-28V	Guaranteed
	max.	30V <sup>3)</sup>	At clockwise end position of potentiometer
Factory setting	typ.	24.1V	±0.2%, at full load, cold unit
Line regulation	max.	10mV	At 480-840Vdc voltage change
Load regulation	max.	100mV	Static value, 0A→20A
Ripple and noise voltage	max.	100mVpp	20Hz to 20MHz, 50Ohm
Output current – continuous	nom.	20A <sup>4)</sup>	At 24V, input: 480-840Vdc, see Fig. 5-1
	nom.	17.5A <sup>4)</sup>	At 28V, input: 480-840Vdc, see Fig. 5-1
Output current – up to 4s <sup>1)</sup>	nom.	25A	At 24V, input: 480-840Vdc, see Fig. 5-1 and Fig. 5-3
	nom.	21.4A	At 28V, input: 480-840Vdc, see Fig. 5-1 and Fig. 5-3
Output power – continuous	nom.	480W	At 24-28V
Output power – up to 4s <sup>1)</sup>	nom.	600W	At 24-28V
BonusPower® time	typ.	4s	Duration until the output voltage dips, see Fig. 5-3
BonusPower® recovery time	typ.	7s	Overload free time to reset power manager, see Fig. 5-4
Overload behavior		cont. current	See Fig. 5-1
Short-circuit current <sup>2)</sup>	min.	20A	Continuous, load impedance 50mOhm, see Fig. 5-1
	max.	23A	Continuous, load impedance 50mOhm, see Fig. 5-1
	min.	25A	Short-term (4s), load impedance 50mOhm, see Fig. 5-1
	max.	28A	Short-term (4s), load impedance 50mOhm, see Fig. 5-1
Output capacitance	typ.	950µF	Included in the DC/DC converter

- 1) **BonusPower®, short term power capability (up to typ. 4s)**  
The DC/DC converter is designed to support loads with a higher short-term power requirement without damage or shutdown. The short-term duration is hardware controlled by an output power manager. This BonusPower® is repeatedly available. Detailed information can be found in chapter 21.1. If the DC/DC converter is loaded longer with the BonusPower® than shown in the bonus-time diagram (see Fig. 5-3), the max. output power is automatically reduced to 480W.
- 2) Discharge current of output capacitors is not included.
- 3) This is the maximum output voltage which can occur at the clockwise end position of the potentiometer due to tolerances. It is not guaranteed value which can be achieved. The typical value is about 28.5V.
- 4) Reduce output current according to Fig. 5-2 for the extended input voltage ranges from 360-480Vdc and 840-900Vdc.

Fig. 5-1 Output voltage vs. output current, typ.

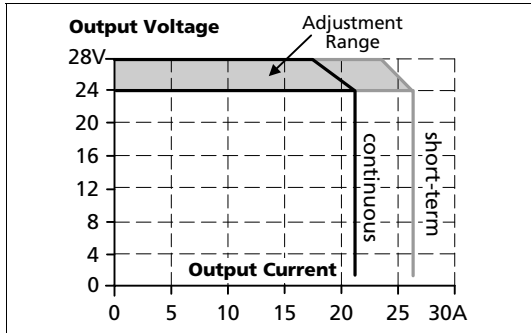


Fig. 5-2 Output current vs. input voltage

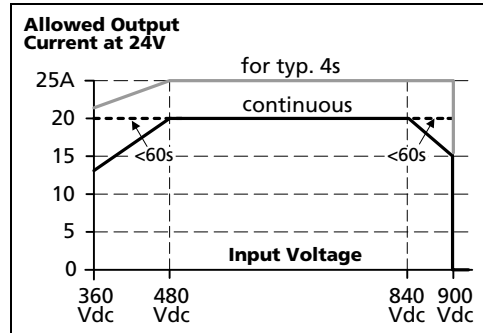


Fig. 5-3 Bonus time vs. output power

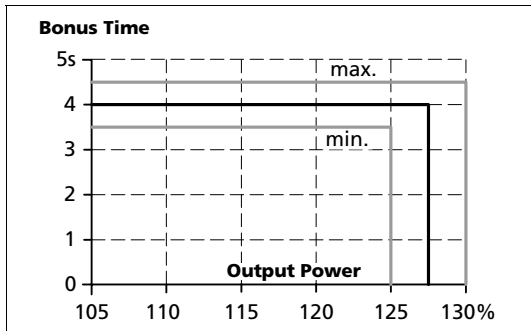
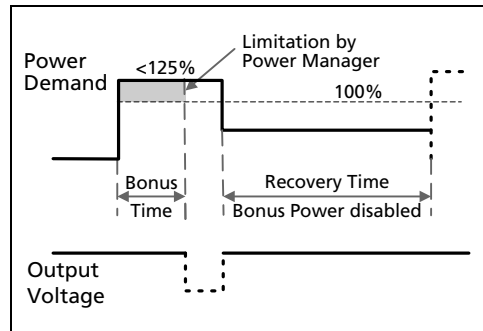


Fig. 5-4 BonusPower® recovery time



The BonusPower® is available as soon as power comes on and after the end of an output short circuit or output overload.

Fig. 5-5 BonusPower® after input turn-on

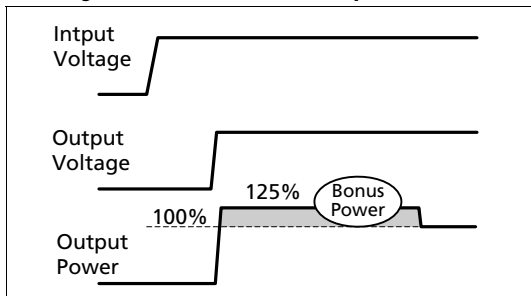
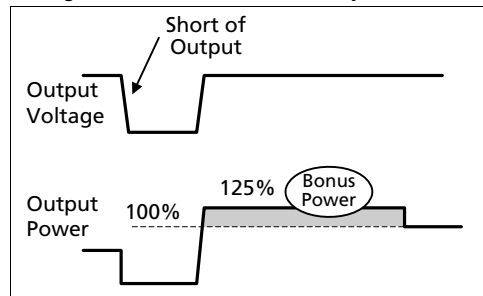


Fig. 5-6 BonusPower® after output short



### 6. HOLD-UP TIME

#### DC 600V

Hold-up Time	typ.	44ms	At 24V, 10A, see Fig. 6-1
	min.	36ms	At 24V, 10A, see Fig. 6-1
	typ.	22ms	At 24V, 20A, see Fig. 6-1
	min.	18ms	At 24V, 20A, see Fig. 6-1

Fig. 6-1 Hold-up time vs. input voltage

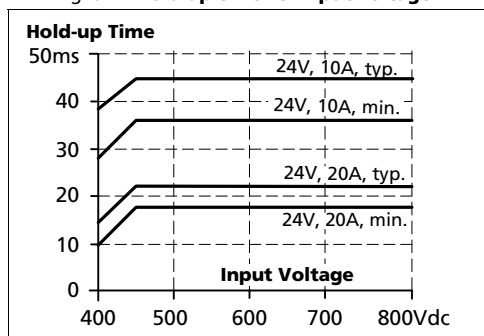
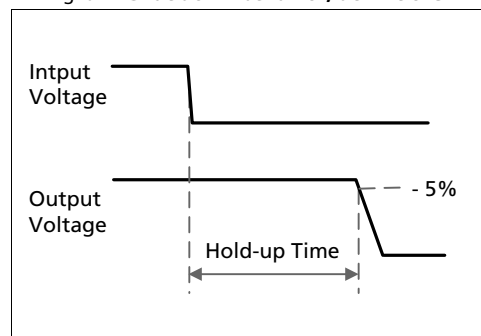


Fig. 6-2 Shut-down behavior, definitions

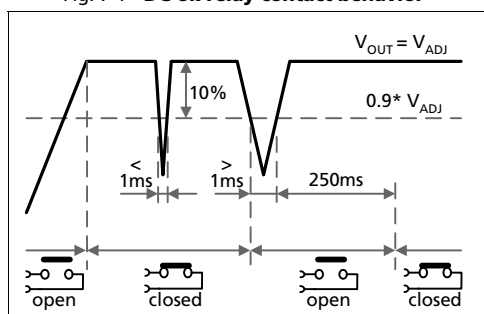


### 7. DC-OK RELAY CONTACT

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

Contact closes	As soon as the output voltage reaches the adjusted output voltage.		
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 250ms. Dips shorter than 1ms will be ignored.		
Contact re-closes	As soon as the output voltage exceeds 90% of the adjusted voltage.		
Contact ratings	max.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	Resistive load
	min.	1mA at 5Vdc	Min. permissible load
Isolation voltage	See dielectric strength table in section 17.		

Fig. 7-1 DC-ok relay contact behavior





### 8. EFFICIENCY AND POWER LOSSES

**DC 600V**

Efficiency	typ.	95.0%	At 24V, 20A
Average efficiency*)	typ.	94.4%	25% at 5A, 25% at 10A, 25% at 15A and 25% at 20A
Power losses	typ.	7.7W	At 24V, 0A (no load)
	typ.	12.8W	At 24V, 10A (half load)
	typ.	25.5W	At 24V, 20A (full load)

\*) 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. 8-1 Efficiency vs. output current at 24V, typ.

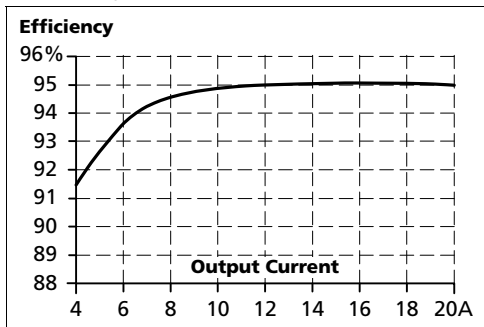


Fig. 8-2 Losses vs. output current at 24V, typ.

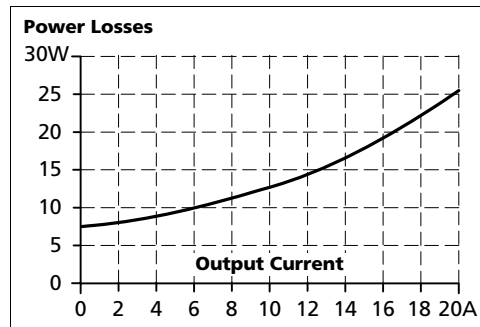


Fig. 8-3 Efficiency vs. input voltage at 24V, 20A, typ.

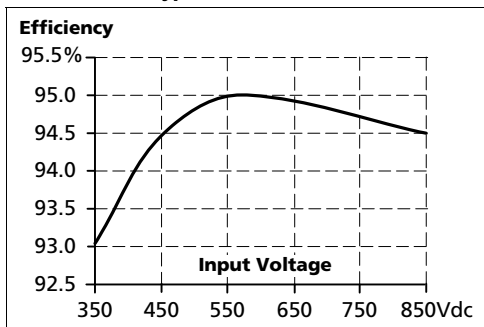
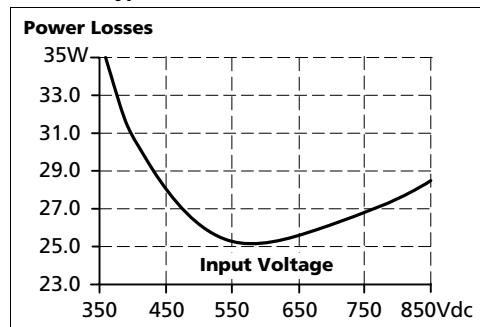


Fig. 8-4 Losses vs. input voltage at 24V, 20A, typ.

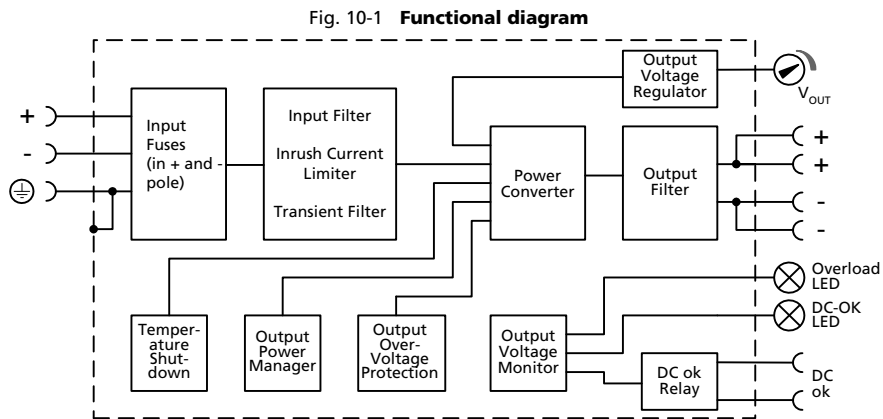


### 9. LIFETIME EXPECTANCY AND MTBF

DC 600V		
Calculated lifetime expectancy*)	220 000h <sup>*)</sup>	At 24V, 10A and 25°C
	78 000h	At 24V, 10A and 40°C
	119 000h	At 24V, 20A and 25°C
	42 000h	At 24V, 20A and 40°C
MTBF**) SN 29500, IEC 61709	801 000h	At 24V, 20A and 25°C
	446 000h	At 24V, 20A and 40°C
MTBF**) MIL HDBK 217F	267 000h	At 24V, 20A and 25°C; Ground Benign GB25
	204 000h	At 24V, 20A and 40°C; Ground Benign GB40

- \*) The **calculated lifetime expectancy** shown in the table indicates the minimum operating hours (service life) and is determined by the lifetime expectancy of the built-in electrolytic capacitors. Lifetime expectancy is specified in operational hours and is calculated according to the capacitor's manufacturer specification. The manufacturer of the electrolytic capacitors only guarantees a maximum life of up to 15 years (131 400h). Any number exceeding this value is a calculated theoretical lifetime which can be used to compare devices.
- \*\*) **MTBF** stands for **Mean Time Between Failure**, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product. The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 000 units are installed in the field. However, it can not be determined if the failed unit has been running for 50 000h or only for 100h.

### 10. FUNCTIONAL DIAGRAM



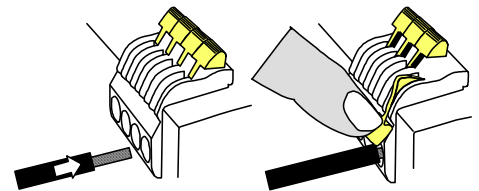
### 11. TERMINALS AND WIRING

The terminals are IP20 Finger safe constructed and suitable for field and factory wiring.

<b>Type</b>	Quick-connect spring-clamp terminals
Solid wire	Max. 6mm <sup>2</sup>
Stranded wire	Max. 4mm <sup>2</sup>
American Wire Gauge	Max. AWG10
Wire diameter	Max. 2.8mm (including ferrules)
Wire stripping length	Typ. 10mm / 0.4inch
Screwdriver	Not applicable
Recommended tightening torque	Not applicable

**Instructions:**

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

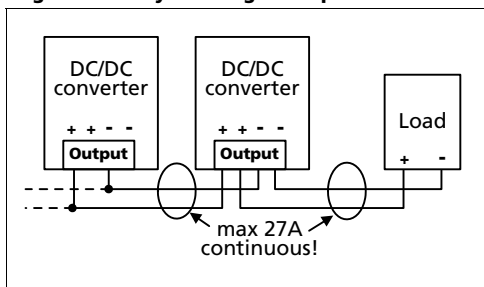


**1. Insert the wire    2. Snap the lever**  
 To disconnect wire: same procedure vice versa

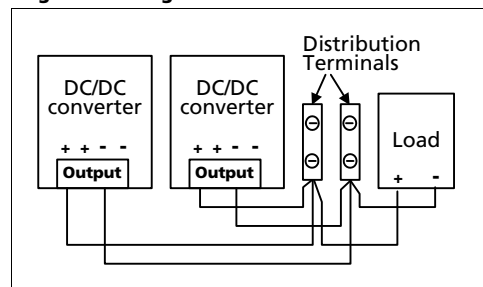
**Daisy chaining:**

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 27A. If the current is higher, use a separate distribution terminal block as shown in Fig. 11-2.

**Fig. 11-1 Daisy chaining of outputs**

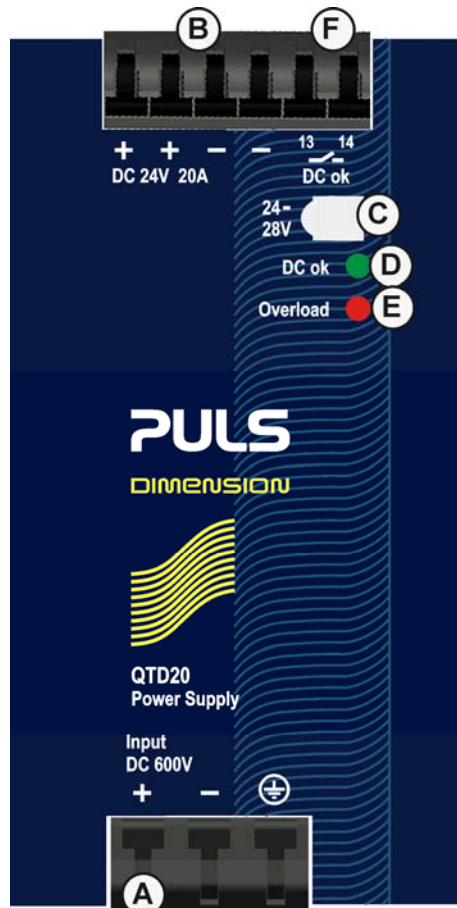


**Fig. 11-2 Using distribution terminals**



### 12. FRONT SIDE AND USER ELEMENTS

Fig. 12-1 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 pins per pole)

- + Positive output
- Negative (return) output

#### C Output Voltage Potentiometer

Multi turn potentiometer;  
Open the flap to set the output voltage.  
Factory set: 24.1V at full output current

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

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

#### E Overload LED (red)

- On, when the voltage on the output terminals is <90% of the adjusted output voltage, or in case of a short circuit in the output.
- On, when the unit has switched off due to over-temperature.
- Input voltage is always required

#### F DC-OK Relay Contact (Quick-connect spring-clamp terminals)

The DC-OK relay contact is synchronized with the DC-OK LED.  
See chapter 7 for details.

Indicators, LEDs:	Overload LED	DC-OK LED	DC-OK Contact
Normal mode	OFF	ON	Closed
During BonusPower®	OFF	ON	Closed
Overload (Vout < 90%)	ON	OFF	Open
Output short circuit	ON	OFF	Open
Temperature Shut-down	ON	OFF	Open
No input power	OFF	OFF	Open

### 13. EMC

The DC/DC converter is suitable for applications in industrial environment.

<b>EMC Immunity</b>		According to generic standards: EN 61000-6-2 and EN 61800-3		
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	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	(+) → (-)	1kV	Criterion A
		(+) / (-) → PE	4kV	Criterion A
Surge voltage on output	EN 61000-4-5	(+) → (-)	500V	Criterion A
		(+) / (-) → PE	1kV	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

**Criteria:**

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

<b>EMC Emission</b>		According to generic standards: EN 61000-6-4 and EN 61800-3	
Conducted emission input lines	EN 55011, EN 55022, FCC Part 15, CISPR 11, CISPR 22	15dB higher than average limits for DC power port according to EN 61000-6-4 <sup>*)</sup>	
Conducted emission output lines	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	5dB higher than average limits for DC power port according to EN 61000-6-4 <sup>*)</sup>	
Radiated emission	EN 55011, EN 55022	Class A	

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.

\*) There are no mandatory requirements in the generic standards EN 61000-6-4 and EN 61800-3 for conducted emissions on DC-Lines. For assessment of the conducted emissions, the input filter of the frequency converter or servo amplifier need to be taken into account.

<b>Switching Frequencies</b>		The DC/DC converter has three converters with three different switching frequencies included. One is nearly constant. The others are input voltage and load dependent.	
Switching frequency 1	100kHz	Resonant converter, nearly constant	
Switching frequency 2	30kHz to 90kHz	Boost converter, load dependent	
Switching frequency 3	17kHz to 120kHz	Buck converter, input voltage and load dependent	

### 14. ENVIRONMENT

Operational temperature <sup>*)</sup>	-25°C to +70°C (-13°F to 158°F)	Reduce output power according Fig. 14-1
Storage temperature	-40 to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	12W/°C	60-70°C (140°F to 158°F)
Humidity <sup>**)</sup>	5 to 95% r.H.	IEC 60068-2-30
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	IEC 60068-2-6
Vibration random	0.5m <sup>2</sup> (s <sup>3</sup> ) 2 hours / axis	IEC 60068-2-64
Shock	30g 6ms, 20g 11ms 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
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. 14-2 IEC 62103, EN 50178, overvoltage category II
Altitude de-rating	30W/1000m or 5°C/1000m	> 2000m (6500ft), see Fig. 14-2
Over-voltage category	III II	IEC 62103, EN 62477-1, altitudes up to 2000m For altitudes from 2000m to 6000m
Degree of pollution	2	IEC 62103, EN 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 or surrounding temperature and is defined as the air temperature 2cm below the unit.

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

Fig. 14-1 **Output current vs. ambient temp.**

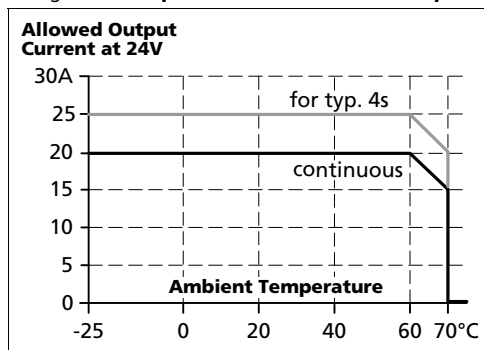
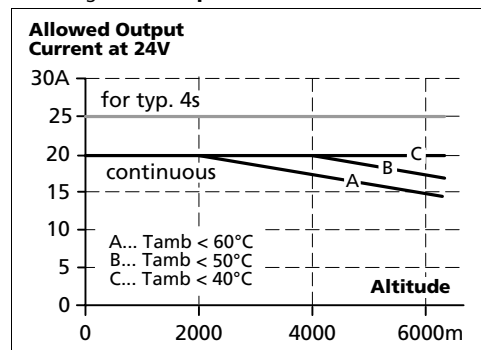


Fig. 14-2 **Output current vs. altitude**



### 15. PROTECTION FEATURES

Output protection	Electronically protected against overload, no-load and short-circuits*)	
Output over-voltage protection	typ. 32Vdc max. 35Vdc	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.
Reverse input polarity protection	included	Unit does not start when input voltage is reversed.
Degree of protection	IP 20	EN/IEC 60529
Penetration protection	> 3.5mm	E.g. screws, small parts
Over-temperature protection	yes	Output shut-down with automatic restart
Input transient protection	MOV (Metal Oxide Varistor)	
Internal input fuse	included	The unit is equipped with two internal input fuses (+ line and - line) which protect the unit against internal short circuits and ground faults. The fuses are not user accessible. A tripping of an internal fuse is caused by an internal fault.

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

### 16. SAFETY FEATURES

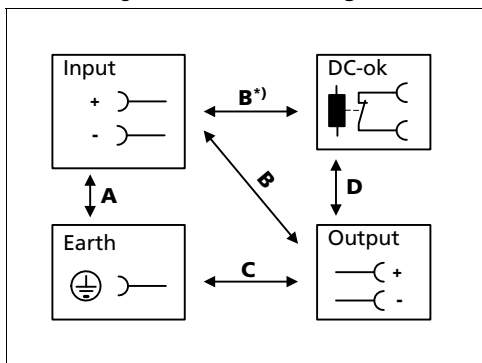
Input / output separation*)	SELV	EN 62477-1
	PELV	IEC/EN 60204-1, EN 62477-1, IEC 62103, IEC 60364-4-41
Class of protection	I	PE (Protective Earth) connection required
Isolation resistance	> 500MΩ	Input to output, 500Vdc
PE resistance	< 0.1Ω	
Touch current (leakage current)	The leakage current, which is produced by the DC/DC converter itself, depends on the input voltage ripple and need to be investigated in the final application. For a smooth DC input voltage, the produced leakage current is less than 100µA.	

\*) double or reinforced insulation

### 17. 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 poles 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
Factory test	5s	2500Vac	2500Vac	500Vac	500Vac
Field test	5s	2000Vac	2000Vac	500Vac	500Vac
Cut-off current setting		> 10mA	> 10mA	> 30mA	> 1mA

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 max. voltage between DC-OK and the output is not exceeded (column D). We recommend connecting DC-OK pins and the output pins together when performing the test.

### 18. APPROVALS

EC Declaration of Conformity



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

UL 508



Listed for use as Industrial Control Equipment;  
 U.S.A. (UL 508) and Canada (C22.2 No. 107-1-01);  
 E-File: E198865

EAC TR Registration



Registration for the Eurasian Customs Union market  
 (Russia, Kazakhstan, Belarus)



### 19. PHYSICAL DIMENSIONS AND WEIGHT

Width	65mm 2.56"
Height	124mm 4.88"
Depth	127mm 5.0"
	The DIN-rail height must be added to the unit depth to calculate the total required installation depth.
Weight	890g / 1.96lb
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. 19-1 Front view

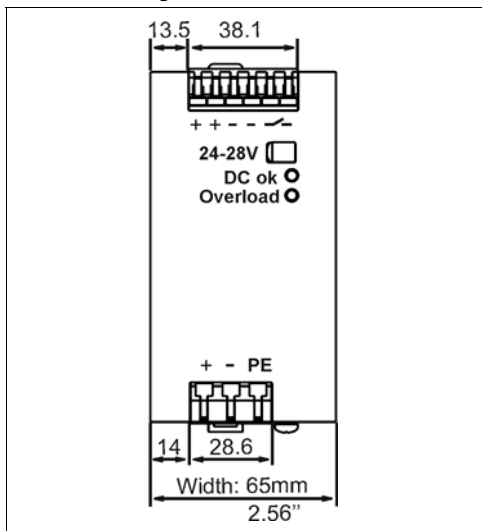
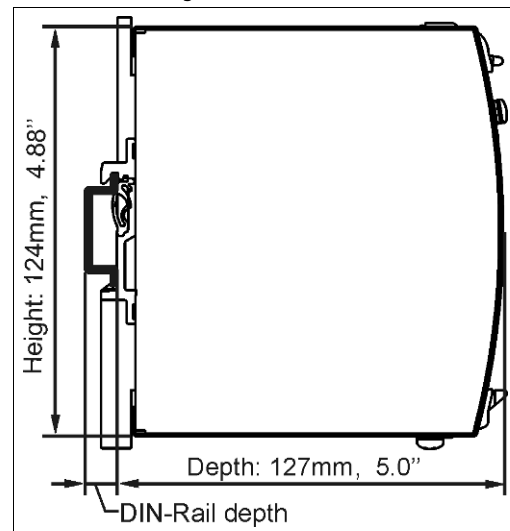


Fig. 19-2 Side view



### 20. ACCESSORIES

#### 20.1. ZM1.WALL – WALL/PANEL MOUNTING



This bracket is used to mount the QTD20 DC/DC converter on a wall/panel 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.

Fig. 20-1 Wall/panel mounting

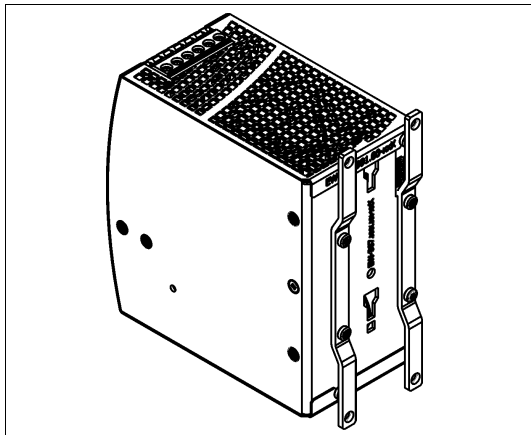
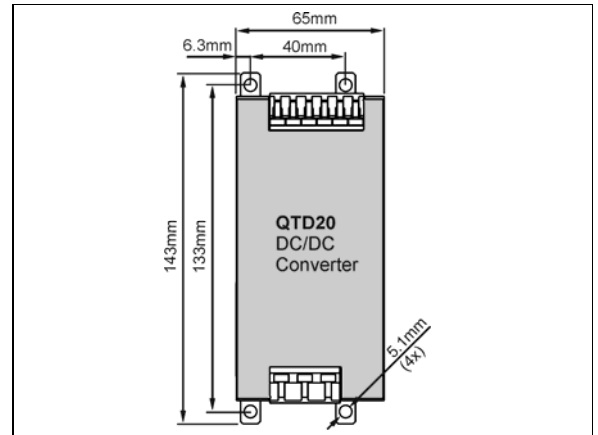


Fig. 20-2 Mounting Dimensions - Wall mounting bracket



### 20.2. ZM14.SIDE - SIDE MOUNTING BRACKET



This bracket is used to mount the QTD20 DC/DC converter 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. 20-3  
Side mounting without DIN-rail brackets

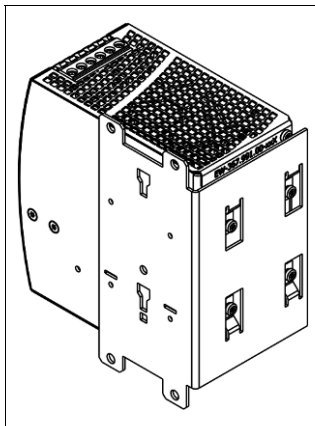


Fig. 20-4  
Side mounting with DIN-rail brackets

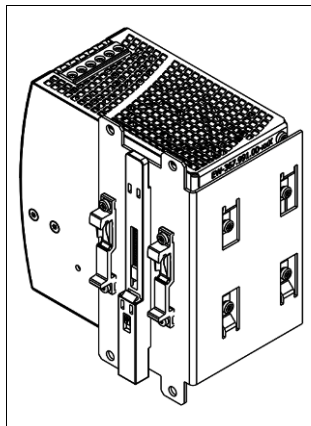
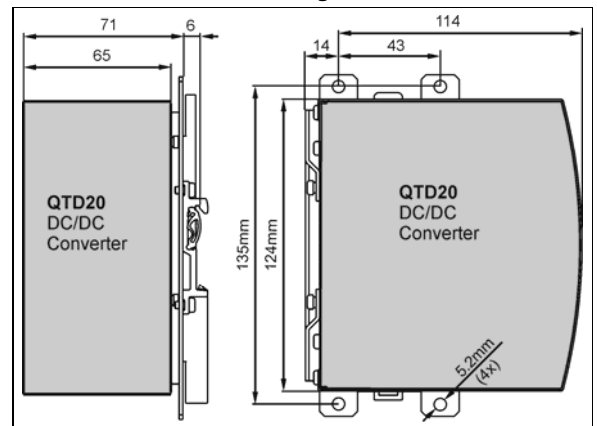
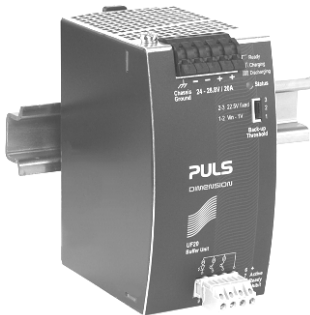


Fig. 20-5  
Mounting Dimensions  
Side mounting bracket

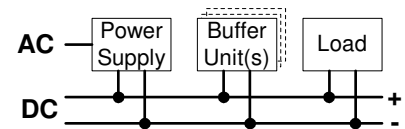


### 20.3. UF20.241 - BUFFER MODULE



This buffer unit is a supplementary device for DC 24V power supplies and DC/DC converter. It delivers power to bridge typical mains failures or extends the hold-up time after turn-off of the AC or DC power. In times when the DC/DC converter provides sufficient voltages, the buffer unit stores energy in the integrated electrolytic capacitors. In case of mains voltage fault, this energy is released again in a regulated process.

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.



### 20.4. YR40.241 - REDUNDANCY MODULE



The YR40.241 redundancy module is equipped with two input channels (20A each), which are individually decoupled by utilizing MOSFET technology. The output current can go as high as 40A.

Using MOSFET instead of diodes reduces the heat generation and the voltage drop between input and output. The YR40.241 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 36mm width on the DIN-rail.

Fig. 20-6 Typical 1+1 Redundant configuration for 20A with one dual redundancy module und two DC/DC converters

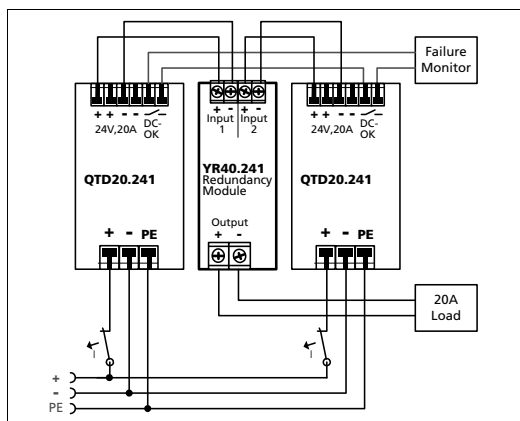
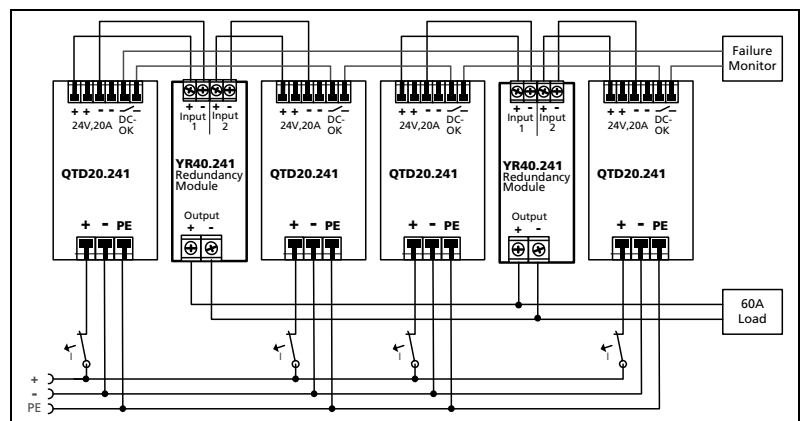


Fig. 20-7 Typical N+1 Redundant configuration for 60A with two dual redundancy modules and four DC/DC converters



## 21. APPLICATION NOTES

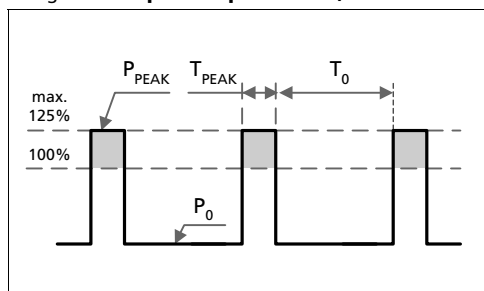
### 21.1. REPETITIVE PULSE LOADING

Typically, a load current is not constant and varies over time. This DC/DC converter is designed to support loads with a higher short-term power demand (=BonusPower®). The short-term duration is hardware controlled by an output power manager and is available on a repeated basis. If the BonusPower® load lasts longer than the hardware controller allows it, the output voltage will dip and the next BonusPower® is available after the BonusPower® recovery time (see chapter 5) has elapsed.

To avoid this, the following rules must be met:

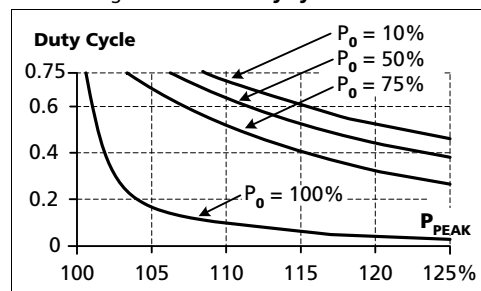
- The power demand of the pulse must be below 125% of the nominal output power.
- The duration of the pulse power must be shorter than the allowed BonusPower® time. (see output section)
- The average (R.M.S.) output current must be below the specified continuous output current. If the R.M.S. current is higher, the unit will respond with a thermal shut-down after a period of time. Use the maximum duty cycle curve (Fig. 21-2) to check if the average output current is below the nominal current.
- The duty cycle must be below 0.75.

Fig. 21-1 Repetitive pulse loads, definitions



- P<sub>0</sub> Base load (W)
- P<sub>PEAK</sub> Pulse load (above 100%)
- T<sub>0</sub> Duration between pulses (s)
- T<sub>PEAK</sub> Pulse duration (s)

Fig. 21-2 Max. duty cycle curve



$$\text{DutyCycle} = \frac{T_{\text{peak}}}{T_{\text{peak}} + T_0}$$

$$T_0 = \frac{T_{\text{peak}} - (\text{DutyCycle} \times T_{\text{peak}})}{\text{DutyCycle}}$$

**Example:** A load is powered continuously with 240W (= 50% of the rated output load). From time to time a peak power of 600W (= 125% of the rated output load) is needed for 1 second.

The question is: How often can this pulse be supplied without overloading the DC/DC converter?

- Make a vertical line at P<sub>PEAK</sub> = 125% and a horizontal line where the vertical line crosses the P<sub>0</sub> = 50% curve. Read the max. duty cycle from the duty cycle-axis (= 0.37)
- Calculate the required pause (base load) length T<sub>0</sub>:
- Result: The required pause length = 1.7s
- Max. repetition rate = pulse +pause length = **2.7s**

$$T_0 = \frac{T_{\text{peak}} - (\text{DutyCycle} \times T_{\text{peak}})}{\text{DutyCycle}} = \frac{1\text{s} - (0.37 \times 1\text{s})}{0.37} = \mathbf{1.7\text{s}}$$

#### More examples for pulse load compatibility:

P <sub>PEAK</sub>	P <sub>0</sub>	T <sub>PEAK</sub>	T <sub>0</sub>	P <sub>PEAK</sub>	P <sub>0</sub>	T <sub>PEAK</sub>	T <sub>0</sub>
600W	480W	1s	>25s	600W	240W	0.1s	>0.16s
600W	0W	1s	>1.3s	600W	240W	1s	>1.6s
540W	240W	1s	> 0.75s	600W	240W	3s	>4.9s

### 21.2. PEAK CURRENT CAPABILITY

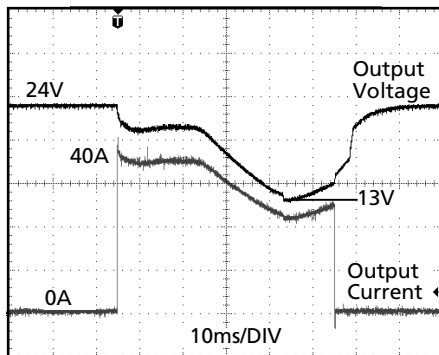
The DC/DC converter can deliver peak currents (up to several milliseconds) which are higher than the specified short term currents.

This helps to start current demanding loads. Solenoids, contactors and pneumatic modules often have a steady state coil and a pick-up coil. The inrush current demand of the pick-up coil is several times higher than the steady-state current and usually exceeds the nominal output current (including the BonusPower®). 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.

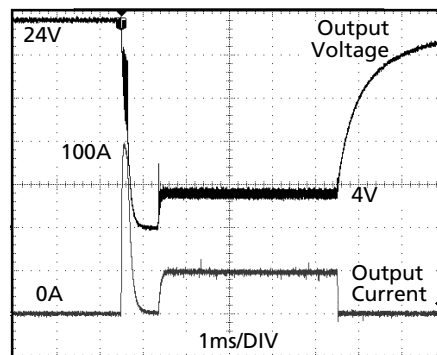
The extra current (peak current) is supplied by the power converter and the built-in large sized output capacitors of the DC/DC converter. The capacitors get discharged during such an event, which causes a voltage dip on the output. The following two examples show typical voltage dips:

Fig. 21-3 Peak load with 2x the nominal current for 50ms, typ.



40A Peak load (resistive) for 50ms  
Output voltage dips from 24V to 13V.

Fig. 21-4 Peak load with 5x the nominal current for 5ms, typ.



100A Peak load (resistive) for 5ms  
Output voltage dips from 24V to 4V.

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

Peak current voltage dips	typ.	from 24V to 13V	At 40A for 50ms, resistive load
	typ.	from 24V to 4V	At 80A for 2ms, resistive load
	typ.	from 24V to 4V	At 80A for 5ms, resistive load

### 21.3. EXTERNAL INPUT PROTECTION

The unit is tested and approved for branch circuits up to 15A (U.S.A.) and 16A (IEC). 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 3A C-Characteristic breaker should be chosen.

### 21.4. 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 25A 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 DC/DC converter (battery discharge current) is typ. 16mA when the DC/DC converter is switched off (except in case a blocking diode is utilized).

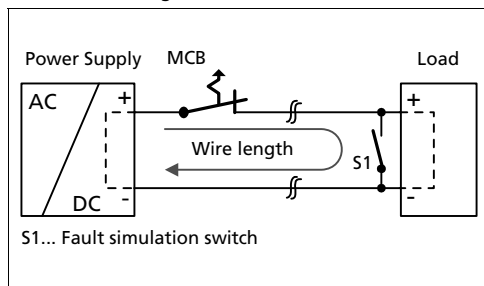
### 21.5. OUTPUT CIRCUIT BREAKERS

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

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

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

Fig. 21-5 Test circuit



Maximal wire length\*) for a fast (magnetic) tripping:

	0.75mm <sup>2</sup>	1.0mm <sup>2</sup>	1.5mm <sup>2</sup>	2.5mm <sup>2</sup>
<b>C-2A</b>	31m	39m	59m	86m
<b>C-3A</b>	24m	31m	43m	68m
<b>C-4A</b>	15m	15m	32m	41m
<b>C-6A</b>	-	-	-	-
<b>B-6A</b>	16m	25m	34m	58m
<b>B-10A</b>	-	-	-	-

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

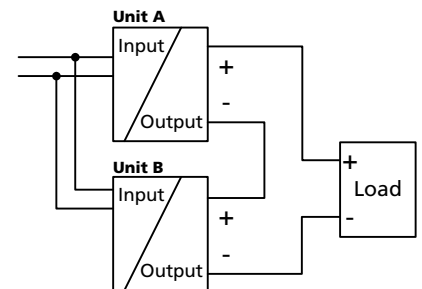
### 21.6. SERIES OPERATION

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.

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 the bottom of the unit).

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





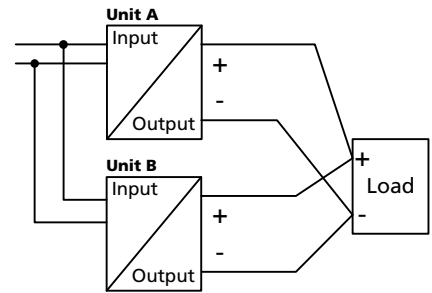
### 21.7. PARALLEL USE TO INCREASE OUTPUT POWER

DC/DC converters and power supplies from the same series (Q-Series) can be paralleled to increase the output power. The output voltage shall be adjusted to the same value ( $\pm 100\text{mV}$ ) or the units can be left with the factory settings.

If more than three units are connected in parallel, a fuse or circuit breaker with a rating of 25A is required on each output. Alternatively, a diode or redundancy module can also be utilized.

Keep an installation clearance of 15mm (left / right) between two power supplies and avoid installing the DC/DC converters or power supplies on top of each other. Do not use DC/DC converters or power supplies in parallel in mounting orientations other than the standard mounting orientation (input terminals on the 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, harmonics will increase when using multiple DC/DC converters.



### 21.8. 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 connect two DC/DC converters in parallel. This is called a 1+1 redundancy. In case one DC/DC converter unit fails, the other one is automatically able to support the load current without any interruption. Redundant systems for a higher power demand are usually built in a N+1 method. E.g. five DC/DC converters, each rated for 20A are paralleled to build a 80A redundant system. For N+1 redundancy the same restrictions apply as for increasing the output power, see also chapter 21.7.

**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 utilizing redundancy modules, which have decoupling devices (diodes or MOSFETs) included. Further information and wiring configurations can be found in chapter 20.4.

Recommendations for building redundant power systems:

- Use separate input fuses for each DC/DC converter. A separate source for each supply when possible increases the reliability of the redundant system.
- Monitor the individual DC/DC converter units. Therefore, use the DC-OK relay contact of the QTD20.241.
- 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.

### 21.9. INDUCTIVE AND CAPACITIVE LOADS

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

## 21.10. 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 34Vdc. The absorbing energy can be calculated according to the built-in output capacitor which is specified in chapter 5.

## 21.11. USE IN A TIGHTLY SEALED ENCLOSURE

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

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

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

Enclosure:	Rittal Typ IP66 Box PK 9519 100, plastic, 180x180x165mm
Load:	24V, 16A; (=80%) load is placed outside the box
Input:	600Vdc
Temperature inside enclosure:	54.9°C (in the middle of the right side of the DC/DC converter with a distance of 2cm)
Temperature outside enclosure:	22.6°C
Temperature rise:	32.6K

### 21.12. 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. 21-6  
**Mounting Orientation A**  
(Standard orientation)

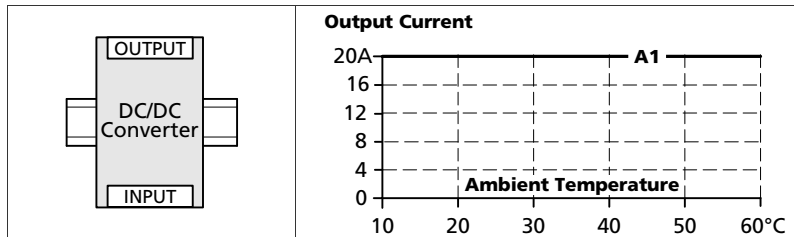


Fig. 21-7  
**Mounting Orientation B**  
(Upside down)

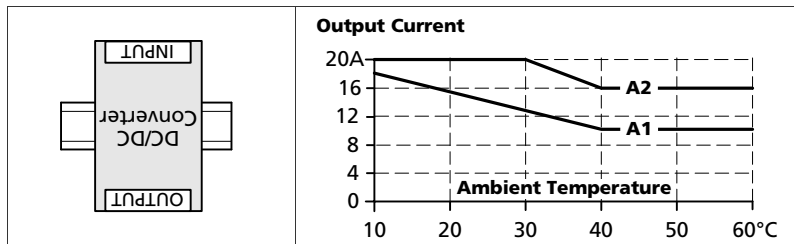


Fig. 21-8  
**Mounting Orientation C**  
(Table-top mounting)

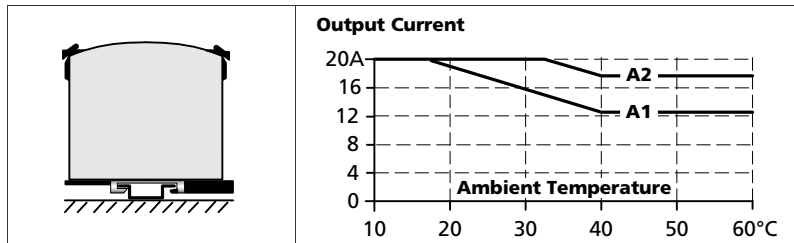


Fig. 21-9  
**Mounting Orientation D**  
(Horizontal cw)

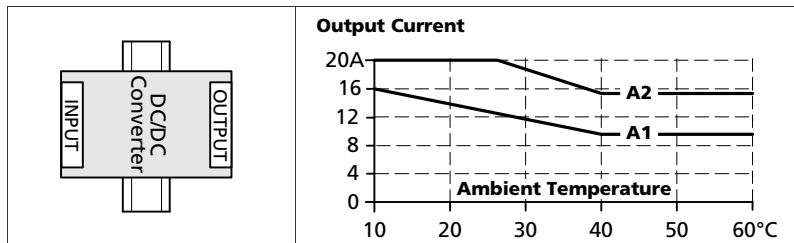


Fig. 21-10  
**Mounting Orientation E**  
(Horizontal ccw)

