



### DC-UPS CONTROL UNIT

- No Change in Output Voltage in Battery Mode
- Selectable Output Voltages in Battery Mode
- 1-Battery-Concept  
Each 12V Battery is Charged and Monitored Separately for Longest Battery Life
- Precise Battery Charging by Using a Temperature Sensor
- Battery Size Selector for Small or Large Batteries
- 50% BonusPower®, 30A for up to 4s
- High Breaking Capacity for Branch Protectors
- Smart Battery Diagnostics and Monitoring Functions
- 3 Year Warranty

### GENERAL DESCRIPTION

The UB20.241 uninterruptible power supply controller (DC-UPS) is used in addition with a 24V power supply and batteries to bridge power failures or voltage fluctuations. This configuration can prevent expensive downtimes, long restart cycles and loss of data.

A unique feature of the UB20 series is the constant voltage in battery mode, which will not change as the batteries discharge. The buffer voltage in battery mode can be set to four different output values. Another feature is the utilization of two independent battery chargers for the two 12V-batteries in series. This feature makes matching batteries unnecessary and allows for precise battery charging, testing and optimized usage of the battery capacity to achieve the longest battery service life.

The UB20.241 includes many battery diagnostic functions that ensure a reliable operation of the entire system. Furthermore, a temperature controlled charging extends the life of the batteries. It also includes a selectable buffer time limiter as well as ready, buffering and replace battery contacts. For safety and maintenance, an inhibit input signal is included which prevents a battery backup.

### SHORT-FORM DATA

Input voltage	DC 24V $\pm 25\%$	18-30Vdc
Output voltage	same as input voltage 22.5V, 24V, 25V, 26V (selectable)	in power supply mode in battery mode
Output current	25A continuous 30A for 4s 20A continuous 30A for 4s	in power supply mode in battery mode at 22.5V
Allowed battery sizes	3.9 – 150Ah	2 batteries in series, each 12V
Buffer time	6min 45s 16min 47s 2h 49min 6h 20min	at 20A, 7Ah at 20A, 12Ah at 20A, 65Ah at 20A, 140Ah
Temperature range	-40°C to +70°C	operational
Derating	0.5A/°C	+60°C to +70°C
Dimensions	46x 124x 127mm	W x H x D
Weight	700g / 1.54lb	

### ORDER NUMBERS

DC-UPS	<b>UB20.241</b>	Standard DC-UPS unit
Accessory	UZK24.071	Battery module 24V, 7Ah
	UZO24.071	UZK24.071 without batteries
	UZK24.121	Battery module 24V, 12Ah
	UZO24.121	UZK24.121 without batteries
	UZS24.100	Sensor & center tap board
	ZM2.WALL	Panel/ wall-mount bracket
	ZM12.SIDE	Side-mount bracket

### MARKINGS



### INDEX

	Page		Page
1. Terminology and Abbreviations.....	3	20. Approvals.....	22
2. Intended Use .....	4	21. Physical Dimensions and Weight.....	23
3. Installation Notes .....	4	22. Accessories .....	24
4. Input / Output .....	6	22.1. ZM2.WALL – Wall-Mounting Bracket.....	24
5. Batteries and Battery Charging .....	10	22.2. ZM12.SIDE – Wall-Mounting Bracket .....	24
6. Buffer Time.....	12	22.3. UZS24.100 – Sensor Board for DC-UPS.....	24
7. Ready and Buffering Relay Contact .....	14	22.4. UZK24.071 – 24V, 7AH Battery Module...	25
8. Replace Battery Relay Contact.....	14	22.5. UZK24.121 – 24V, 12AH Battery Module.	25
9. Inhibit Input.....	14	23. Application Notes.....	26
10. Efficiency and Power Losses.....	15	23.1. Battery Replacement Intervals.....	26
11. Lifetime Expectancy and MTBF.....	15	23.2. External Input Protection.....	28
12. Functional Diagram.....	16	23.3. Output Circuit Breakers.....	28
13. Terminals and Wiring.....	16	23.4. Back-feeding Loads .....	28
14. Front Side and User Elements.....	17	23.5. Parallel Use to Increase Output Current..	29
15. EMC.....	19	23.6. Parallel Use for Redundancy .....	29
16. Environment .....	20	23.7. Series Use for 48V Applications .....	30
17. Protection Features .....	21	23.8. Using the Inhibit-Input.....	30
18. Safety Features .....	21	23.9. Troubleshooting .....	31
19. Dielectric Strength .....	22		

The information presented in this document is believed to be accurate and reliable and may change without notice. No part of this document may be reproduced or utilized in any form without permission in writing from the publisher.

## 1. TERMINOLOGY AND ABBREVIATIONS

<b>DC-UPS</b>	Abbreviation for <b>U</b> ninterruptible <b>P</b> ower <b>S</b> upply system with a <b>DC</b> input and a DC output. A DC-UPS utilizes batteries as back-up energy source.
<b>Power supply mode</b>	Describes a condition where the input voltage is in the rated input voltage range and the supplying power supply can deliver a sufficient amount of current for the DC-UPS and the load. Additionally it is assumed that the output is loaded within the allowed limits and the battery is charged, if necessary. The mode can also be called "Normal mode".
<b>Battery mode</b>	Describes a condition where the input voltage is below the transfer threshold level, the unit is running on batteries (buffering) and the output is loaded within the allowed limits. The mode can also be called "Buffer mode".
<b>Normal mode</b>	see "Power supply mode"
<b>Buffer mode</b>	see "Battery mode"
<b>Inhibit mode</b>	Describes a condition where buffering is disabled on purpose (e.g. for service actions).
<b>T.b.d.</b>	To be defined, value or description will follow later.
<b>DC 24V</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>24Vdc</b>	A figure with the unit (Vdc) at the end is a momentary figure without any additional tolerances included.
<b>may</b>	A key word indicating flexibility of choice with no implied preference.
<b>shall</b>	A key word indicating a mandatory requirement.
<b>should</b>	A key word indicating flexibility of choice with a strongly preferred implementation.

## 2. INTENDED USE

This device is designed for installation in an enclosure. Use an appropriate enclosure which protects against mechanical, electrical and fire hazards.

This device is intended for professional use in areas such as in industrial control, office, communication, and instrumentation equipment.

Do not use this device in equipment or systems where malfunction may cause severe personal injury or threaten human life.

## 3. INSTALLATION NOTES

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

The input must be powered from a SELV or PELV power source.

Use DIN-rails according to EN 60715 with a height of 7.5 or 15mm.

Mounting orientation must be output and input terminals on top.

Do not obstruct air flow as the unit is convection cooled. Ventilation grid must be kept free of any obstructions.

Use an appropriately sized 24V power supply, which can deliver the additional required internal current consumption (including the charging current) specified as input current in the table of chapter 4.

Install the batteries outside the cabinet or in a place, where the batteries will not be heated by adjacent equipment and ensure sufficient ventilation for the batteries as required in the EN 50272-2 standard.

Use wires not smaller than 4mm<sup>2</sup> (or AWG 12) and not longer than 2x1.5m (equal 1.5m cord length) between the batteries and the DC-UPS. Longer or thinner wires can change performance of the DC-UPS system.

Use a 35A fuse (ATOF® 287 035 from Littelfuse or an UL listed fuse with the same characteristics) in the battery path. The battery fuse protects the wires between the battery and the DC-UPS and shall be located close to the battery. If PULS battery modules are used, this fuse is already included.

Use a 4A fuse (ATOF® 287 004 from Littelfuse or an UL listed fuse with same characteristics) between the connection point of the two 12V batteries and the "Center TAP" connection point of the DC-UPS. An equivalent protection is included on the PULS battery modules or the PULS UZS24 sensor board. Please note: The center tap connection is not mandatory but enables an individual charging and monitoring of the two batteries.

Optionally, a PT1000 temperature sensor can be connected to terminals point 11 and 12 to measure the battery temperature. This adjusts the charging voltage according to the battery temperature which extends the battery life. This sensor is already installed in the PULS battery modules (UZK24) and the PULS UZS24.100 sensor board.

The following installation clearances must be maintained when the device is loaded permanently with more than 50% of the rated power:

- Left / right: 5mm (15mm in case the adjacent device is a heat source)
- On top of the unit: 40mm
- On bottom of the unit: 20mm

Agency approvals apply only for altitudes up to 2000m.

Maximum surrounding air temperature: 70°C / 158°F.

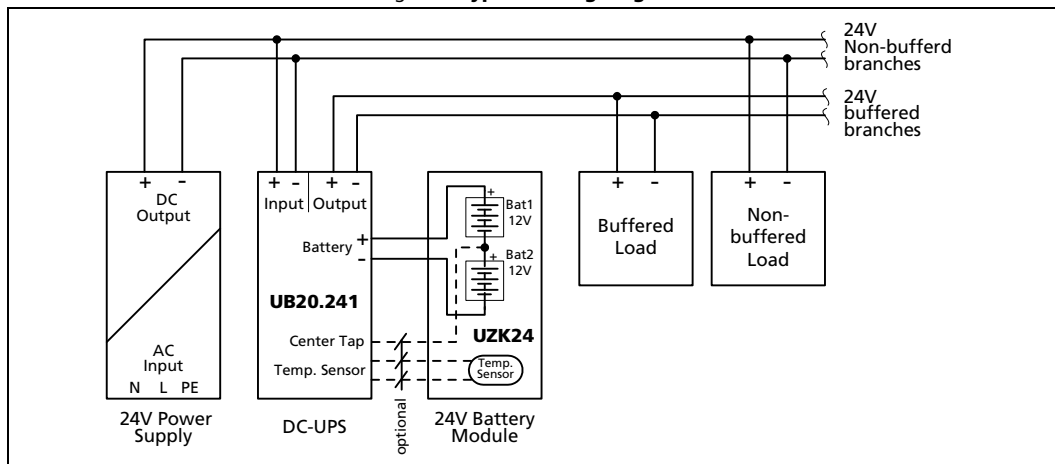
A disconnecting means shall be provided for the output and battery input when used in applications according to CSA C22.2 No 107.1-01.

**⚠ WARNING**

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

- Turn power off and disconnect the battery fuse 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 dangerous voltages may be 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.
- Always dispose the batteries through a recycling organization. Batteries must be completely discharged before recycling.

Fig. 3-1 **Typical wiring diagram**



### 4. INPUT / OUTPUT

The output is connected to the input through a back-fed protection (MOSFET). In power supply mode, the output voltage follows the input voltage decreased by a small voltage loss. In battery mode, the output voltage is a constant voltage, which can be preselected in one of four voltages.

**Input Voltage Range:**

At voltages within the input voltage range, control functions such as LEDs, monitoring features, relay contacts, etc. are functioning normally. Within the input voltage range the unit can either be in power supply mode or in battery mode.

**Normal Operating Voltage Ranges (four ranges):**

The normal operating voltage range describes the input voltage, which supports the full functionality of the DC-UPS (including charging) but without entering the battery mode. It requires a minimum of 1V higher than the buffer voltage settings and a maximum voltage of not more than 30Vdc.

**Buffering and Buffer Voltage:**

Buffering will start immediately without interruption after the input voltage falls below the lower end of the normal operating voltage range. Buffering is possible even if the batteries are not fully charged.

Buffering can not be started without having previously entered the normal operating voltage range.

The buffer voltage is the output voltage determined by "the buffer voltage setting" and will not change as the batteries discharge. The buffer voltage is pre-selectable in one of four voltages.

Fig. 4-1 Definition of "power supply mode" and "battery mode"

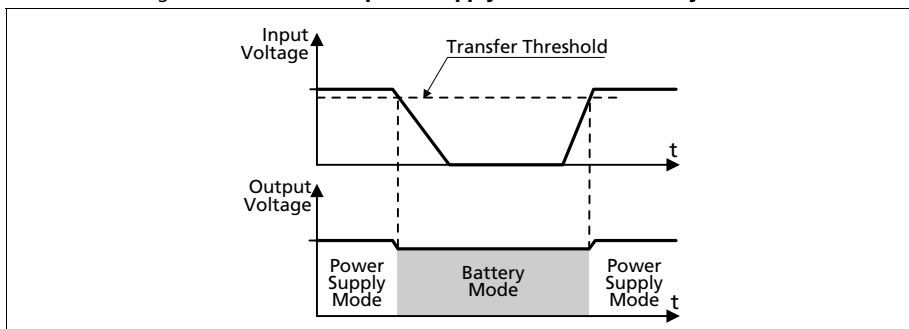


Fig. 4-2 Input Voltage Ranges

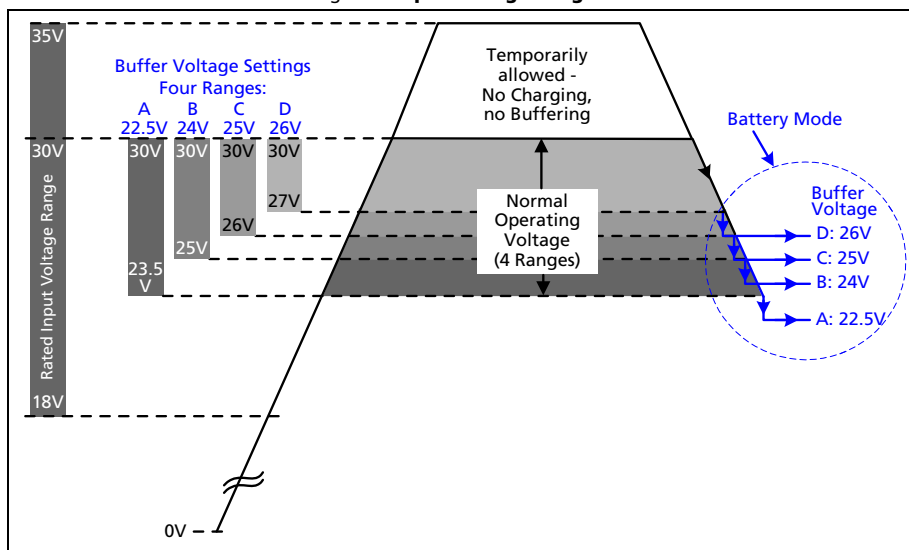
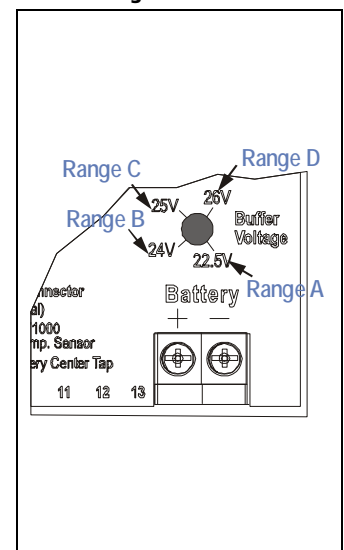


Fig. 4-3 Buffer voltage Settings on the front



Input voltage	nom.	DC 24V $\pm 25\%$		
Input voltage range	nom.	18-30Vdc	Control functions such as LEDs, monitoring features, relay contacts, etc. are working. The unit can either be in power supply mode or in battery mode. See Fig. 4-2. Temporarily allowed, no damage to the DC-UPS. The red error LED will report "Input Voltage", charging and buffering are not possible. See Fig. 4-2. Absolute max. voltage with no damage to the unit.	
	max.	30-35Vdc		
	max.	35Vdc		
Normal operating input voltage ranges	typ.	23.5 – 30Vdc	Ranges, where the unit does not switch to battery mode. See Fig. 4-2. Range A for a 22.5V buffer voltage setting Range B for a 24V buffer voltage setting Range C for a 25V buffer voltage setting Range D for a 26V buffer voltage setting Please note: The lower end must be at least 1V higher than buffer voltages settings.	
	typ.	25 – 30Vdc		
	typ.	26 – 30Vdc		
	typ.	27 – 30Vdc		
Transfer voltage for switching into battery mode	typ.	23.5Vdc	Range A, 22.5V buffer voltage Range B, 24V buffer voltage Range C, 25V buffer voltage Range D, 26V buffer voltage	
	typ.	25Vdc		
	typ.	26Vdc		
	typ.	27Vdc		
Output voltage in power supply mode	typ.	0.12V less than input voltage at 20A	The output voltage is always slightly lower than the input voltage, independent of the value of the input voltage. See Fig. 4-4 and Fig. 4-5.  The buffer voltage is the output voltage in battery mode, selectable in four steps via rotary switch on the front of the unit and will not change as the batteries discharge. See Fig. 4-2.	
	in battery mode	nom.		22.5Vdc $\pm 3\%$
		nom.		24.0Vdc $\pm 3\%$
		nom.		25.0Vdc $\pm 3\%$
Ripple and noise voltage in power supply mode		not applicable	better as the supplying power supply (filter included) 20Hz to 20MHz, 50Ohm	
	in battery mode	max.		120mVpp
Requirements for the power supply on the input			<ul style="list-style-type: none"> <li>- Use an appropriately sized 24V power supply, which can deliver the additional required internal current consumption of the DC-UPS and the required current for charging the batteries. See also Fig. 4-6.</li> <li>- Use power supplies that do not deliver more than 28A continuous output current <sup>1)</sup>.</li> </ul>	
Input current internal consumption	typ.	80mA	When batteries are fully charged For <10Ah / >10Ah settings; during battery charging, no temperature sensor installed For <10Ah / >10Ah settings; during battery charging, temperature sensor is installed	
	max.	2.1A / 4.0A		
	max.	2.3A / 4.3A		
total input current	max.	Sum of the output (load) current and the internal current consumption		

Footnotes can be found on the next page.

<b>Output current</b>			
in power supply mode	nom.	25A	Continuously allowed
	nom.	30A	For max. 5s
in battery mode	nom.	20A at 22.5V, 18A at 26V	Continuously allowed see Fig. 4-7 (interpolate linearly between 22.5V and 26V)
	nom.	30A at 22.5V, 26A at 26V	For typ. 4s (BonusPower® 4) see Fig. 4-7 (interpolate linearly between 22.5V and 26V)
	typ.	80A	For typ. 25ms, output voltage stays above 20V, (dynamic peak current), see Fig. 4-9.
<b>Overload behavior</b>			
in power supply mode		not limited	Description see footnotes 1) and 2)
in battery mode		Hiccup <sup>PLUS</sup> Mode	Description see footnote 3)
<b>Output short circuit current</b>			
in power supply mode		not limited	Description see footnotes 1) and 2)
in battery mode	typ.	31A for 2 sec	50mOhm impedance, repetitive pulses, see Fig. 4-8.
Return current	typ.	-200µA	Leakage current to the input of the DC-UPS in battery mode
Allowed voltage between input and earth (chassis)	max.	60Vdc or 42.4Vac	continuous, IEC 62103
Capacitive and inductive loads		No limitation	

- 1) Use a 25A melting fuse with a melting  $I^2t$  of 400A<sup>2</sup>s – 1500A<sup>2</sup>s or a 25A circuit breaker with tripping characteristic B, C, D or K on the input of the DC-UPS if the current of the power supply is higher than 28A.
- 2) The DC-UPS has no current limiting feature included in power supply mode. The current is limited by the supplying power supply or the fuse/ circuit breaker, which must be installed when the power supply has a continuous output current capability of more than 28A.
- 3) **Hiccup<sup>PLUS</sup> Mode:**  
In battery mode, the DC-UPS can deliver 50% more output current for a period of up to 4s before it reduces the output current automatically to the nominal output current. If the current requirement is continuously higher than the nominal current, the current regulation of the DC-UPS reduces the output voltage. As soon as the output voltage falls below 18V, the output switches off and makes a restart attempt every 17s. This cycle is repeated as long as the overload exists.
- 4) **BonusPower®:**  
The DC-UPS is designed to support loads with a higher short-term power requirement without damage or shutdown. In battery mode, the short-term duration is hardware controlled by an output power manager. At 150% output current, it is typically 4s and longer for lower currents. Once the BonusPower® time is exceeded, the maximum output current is automatically reduced to the nominal output current or the DC-UPS goes into the Hiccup<sup>PLUS</sup> mode.

Fig. 4-4 Input to output voltage loss

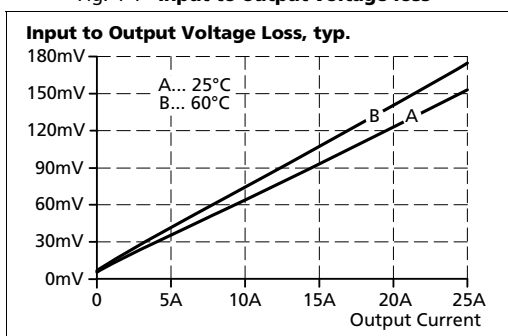


Fig. 4-5 Input to output voltage loss measurement setup

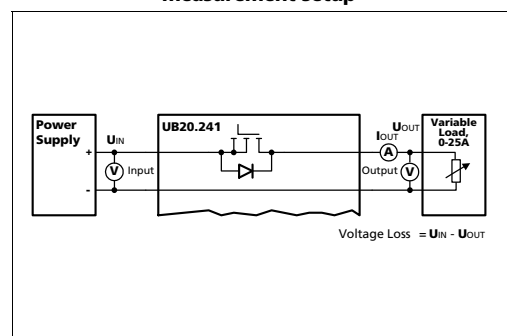




Fig. 4-6 Select an appropriate power supply, which can deliver the additional current for charging and internal consumption the DC-UPS

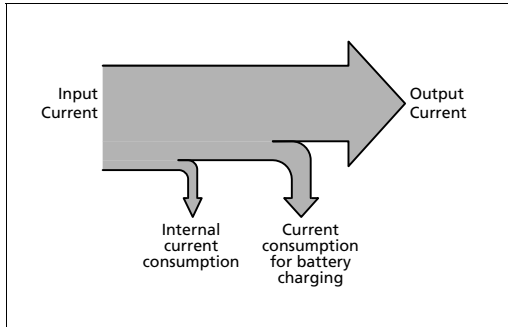


Fig. 4-7 Battery mode: Output voltage vs. output current, typ.

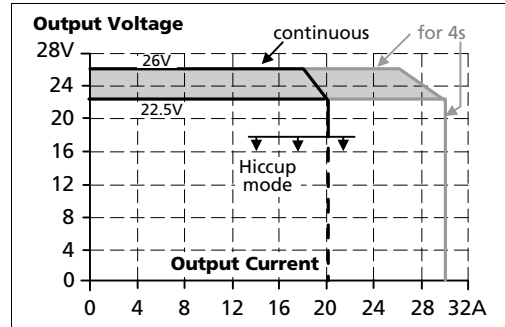


Fig. 4-8 Battery mode: Hiccup<sup>PLUS</sup> behavior during a short-circuit on output, typ.

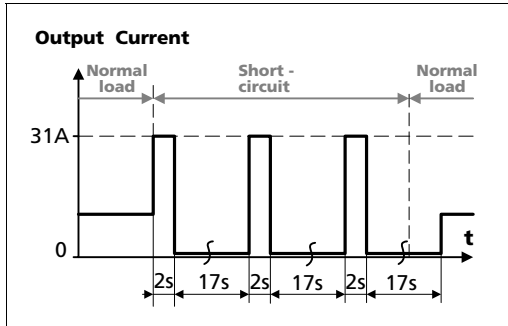
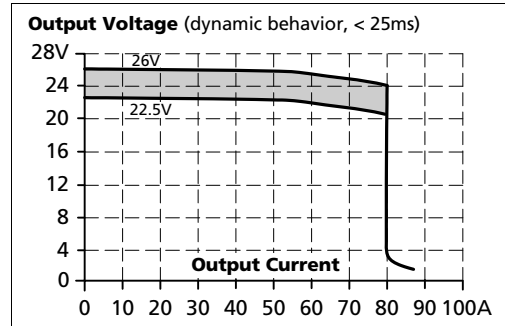


Fig. 4-9 Battery mode: Dynamic peak current behavior, typ.



## 5. BATTERIES AND BATTERY CHARGING

The battery is not included in the DC-UPS. Use one of the PULS 24V battery modules (see chapter 22.4 and 22.5). In addition to the PULS battery modules, the UB20.241 is also designed to be compatible with a large variety of different VRLA (Valve Regulated Lead Acid) or SLA (Sealed Lead Acid) batteries from various suppliers.

The battery is one of the most important parts of a DC-UPS system, which needs to be carefully selected while also paying close attention to storage, charging and environmental conditions. Select the proper size (capacity) according to the required buffer time (see chapter 6) and the lifetime requirements (see chapter 23.1).

Batteries are service parts and need to be replaced periodically or when the internal battery tests of the DC-UPS reports a random failure. Information regarding the DC-UPS battery tests and the replacement requirements can be found in chapter 23.1.

The wiring from the battery to the DC-UPS must follow the instructions in chapter 3. Be aware that the current from the battery to the DC-UPS can be higher than the load current due to the buffer voltage transformation, which restores the battery voltage to a constant buffer voltage.

The UB20.241 has a battery size selector included, which allows an optimal use of small and large battery sizes.

It is not recommended to connect multiple batteries or battery modules in parallel. Choose larger sized battery instead.

### Charging:

The UB20 comprises a constant current / constant voltage (CC-CV) charging method.

When the center-tap connection is installed, both 12V batteries are charged individually with their own charger. The center-tap connection is optional and if not installed, both batteries will be charged with one common charging voltage. The UB20 automatically recognizes if the center-tap connection is present or not.

When charging is approximately 85% completed, the individual green "Ready" LED for the specific battery stops flashing and is on solid.

During charging, the DC-UPS consumes additional current from the input. The supplying power supply must be able to deliver the additional required internal current consumption (including the charging current) specified as input current in the table of chapter 4.

When the temperature sensor is installed, the end-of-charge-voltage is temperature compensated. The UB20 automatically recognizes if a temperature sensor is connected or not. In case no temperature sensor is installed, the end-of-charge-voltage is fixed to a value which corresponds to a battery temperature of 40°C.

Use a PT1000 temperature sensor or the PULS UZK24 battery modules, which have this sensor already included. A list of suitable PT1000 temperature sensors from different vendors can be provided.

Setting of battery size selector		<b>small battery &lt; 10Ah</b>	<b>large battery &gt; 10Ah</b>	
Allowed battery sizes	nom.	3.9Ah – 10Ah <sup>5)</sup>	10Ah – 150Ah	
Battery voltage	nom.	24V	24V	2x 12V batteries in series
Battery charging current	typ.	1.5A	3A	In constant current mode
End-of-charge-voltage	typ.	2 x13.25V	2 x13.25V	center-tap connected, no temperature sensor connected
	typ.	26.5V	26.5V	center-tap not connected, no temperature sensor connected
	typ.	2x 13.1 to 14.2V <sup>1)</sup>	2x 13.1 to 14.2V <sup>1)</sup>	center-tap connected, temperature sensor connected
	typ.	26.2V to 28.4V <sup>1)</sup>	26.2V to 28.4V <sup>1)</sup>	center-tap not connected, temperature sensor connected
Temperature range for which the charging process is enabled	nom.	-10°C to +50°C <sup>2)</sup>	-40°C to +50°C <sup>2)</sup>	

Footnotes can be found on the next page.

Setting of battery size selector - ctd.		<b>small battery &lt; 10Ah</b>	<b>large battery &gt; 10Ah</b>	
Deep-discharge protection	typ.	10.5V / 9.0V	10.5V / 9.0V	At 0A / 20A buffer current, center-tap connected, Buffering stops as soon as one battery falls below this value.
	typ.	21V / 18V	21V / 18V	At 0A / 20A buffer current, center-tap not connected
Required min. battery voltage to allow charging <sup>3)</sup>	min.	2 x 7V	2 x 7V	center-tap connected
	min.	14V	14V	center-tap not connected
Battery charging time	max.	4h 40mins <sup>4)</sup>	-	for a 7Ah battery
	max.	8h <sup>4)</sup>	4h <sup>4)</sup>	for a 12Ah battery
	max.	44h <sup>4)</sup>	22h <sup>4)</sup>	for a 65Ah battery
	max.	94h <sup>4)</sup>	47h <sup>4)</sup>	for a 140Ah battery
Battery discharge current	typ.	170mA	170mA	in battery mode at no output current

- 1) The end-of-charge voltage depends on the battery temperature. At 20°C the end-of-charge voltage is set to 13.6V (rsp. 27.2V) and changes with -18mV/°C for 12V batteries and -36mV/°C for 24V batteries but not higher than 14.2V rsp. 28.4V.
- 2) Corresponds to the temperature readings of the external temperature sensor of the battery and is not the surrounding air temperature of the DC-UPS. Frequent charging below +5°C (41°F) reduced the lifetime of the battery and should be avoided. Low temperatures increase the battery impedance and also change the battery characteristics. This could result in a false "replace battery" signal or an unexpected interruption of a buffer event, especially with small batteries. To avoid this, the temperature range for charging is limited at low temperatures depending on the battery size. If the end application requires temperatures below +5°C, it is recommended to use batteries >10Ah.
- 3) Below this voltage level, charging does not start and the DC-UPS reports "check wiring".
- 4) The listed charging time applies for a complete discharged battery until the DC-UPS indicated "Ready" with the green status LED. In practice, the charging time can be much shorter, since the battery is usually not completely discharged. A very long charging time is most likely caused by a defective or old battery.
- 5) Batteries smaller than 6Ah are only recommended when the load current is below 10A.

### 6. BUFFER TIME

The buffer time (sometimes also called autonomy time) is the maximum period of time for which the battery can maintain the required output current. The buffer time mainly depends on the capacity and quality of the battery and the output current in battery mode.

The following times are typical values for a new product and the aging effect during operation is not included.

Pay attention:

- The following buffer times apply for a battery temperature between 20°C and 30°C and a buffer voltage setting of 22.5V. At higher voltages, the buffer time is correspondingly shorter. Furthermore, with a wire length of 2x1m (equal 1m cord length) and a cross section of 4mm<sup>2</sup> (or AWG 12) between the battery module and the DC-UPS.
- Due to long-term aging effects of batteries consider a buffer time reduction of 30-50% over time.
- The shown buffer times only apply for PULS battery modules or from PULS recommended batteries.
- The buffer time is defined for a fully charged battery. The buffer time can be 10-20% shorter for buffer events, which start immediately after the "Ready" signal becomes active.

Battery size		7Ah (UZK24.071)	12Ah (UZK24.121)	26Ah	
Buffer time	typ.	1d : 17h : 40m : 0s	2d : 22h : 50m : 0s	6d : 19h : 53m : 20s	At 22.5V, <b>0A</b>
	typ.	17h : 13m : 20s	1d : 6h : 41m : 40s	2d : 20h : 03m : 20s	At 22.5V, <b>0.2A</b>
	typ.	5h : 16m : 40s	9h : 51m : 40s	21h : 43m : 20s	At 22.5V, <b>1A</b>
	typ.	2h : 32m : 0s	5h : 17m : 59s	11h : 27m : 30s	At 22.5V, <b>2A</b>
	typ.	46m : 30s	2h : 2m : 55s	4h : 26m : 40s	At 22.5V, <b>5A</b>
	typ.	19m : 11s	46m : 2s	2h : 10m : 0s	At 22.5V, <b>10A</b>
	typ.	10m : 35s	27m : 34s	1h : 17m : 40s	At 22.5V, <b>15A</b>
	typ.	06m : 45s	16m : 47s	55m : 00s	At 22.5V, <b>20A</b>
	typ.	4s	4s	4s	At 22.5V, <b>30A</b>

Battery size		65Ah	100Ah	140Ah	
Buffer time	typ.	16d : 10h : 26m : 40s	24d : 7h : 20m : 0s	34d : 17h : 20m : 0s	At 22.5V, <b>0A</b>
	typ.	7d : 0h : 3m : 20s	10d : 17h : 05m : 0s	14d : 11h : 13m : 20s	At 22.5V, <b>0.2A</b>
	typ.	2d : 4h : 21m : 40s	3d : 11h : 20m : 0s	4d : 21h : 21m : 40s	At 22.5V, <b>1A</b>
	typ.	1d : 6h : 8m : 20s	1d : 22h : 30m : 0s	2d : 17h : 6m : 40s	At 22.5V, <b>2A</b>
	typ.	11h : 56m : 40s	18h : 30m : 40s	1d : 1h : 55m : 0s	At 22.5V, <b>5A</b>
	typ.	5h : 50m : 15s	9h : 11m : 40s	12h : 52m : 36s	At 22.5V, <b>10A</b>
	typ.	3h : 49m : 17s	6h : 3m : 0s	8h : 27m : 44s	At 22.5V, <b>15A</b>
	typ.	2h : 49m : 29s	4h : 31m : 0s	6h : 19m : 29s	At 22.5V, <b>20A</b>
	typ.	4s	4s	4s	At 22.5V, <b>30A</b>

Fig. 6-1 Buffer time definition

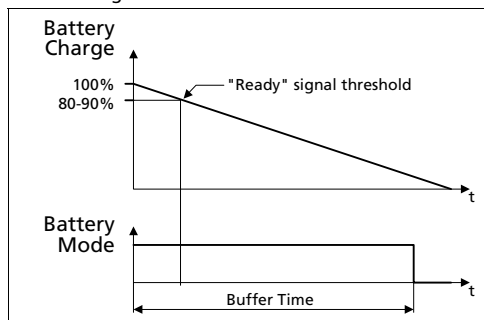


Fig. 6-2 **Buffer time curves for battery modules UZK24.071 and UZK24.121, typ.**

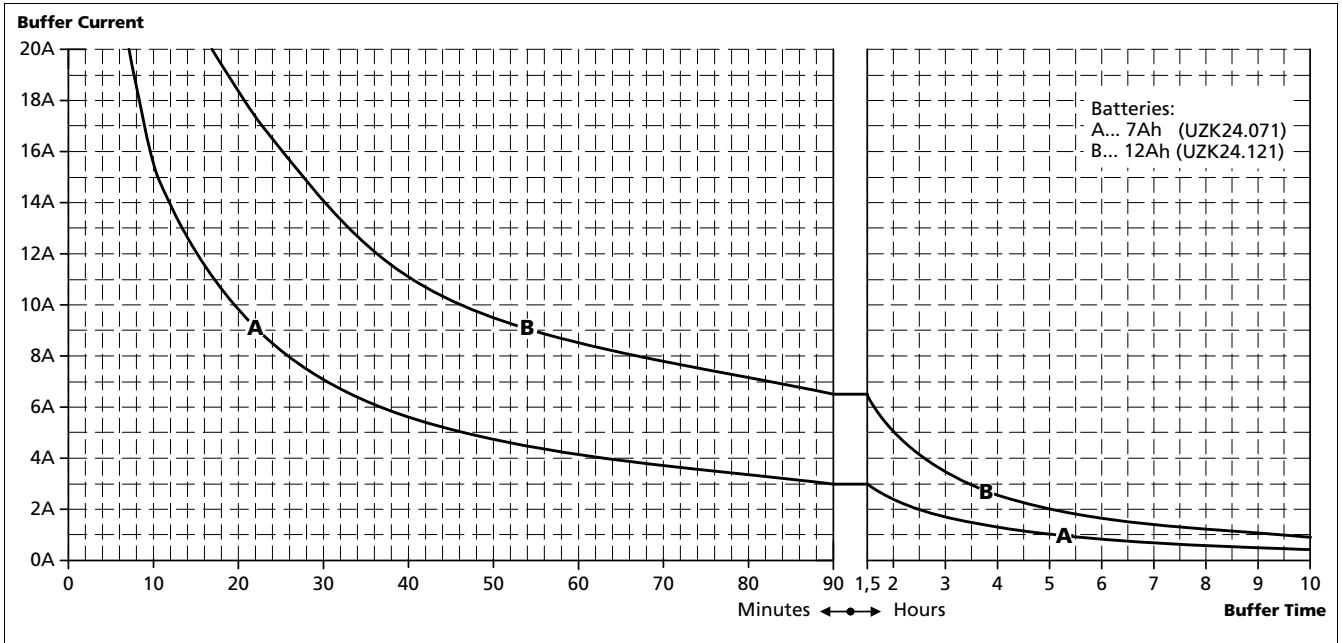
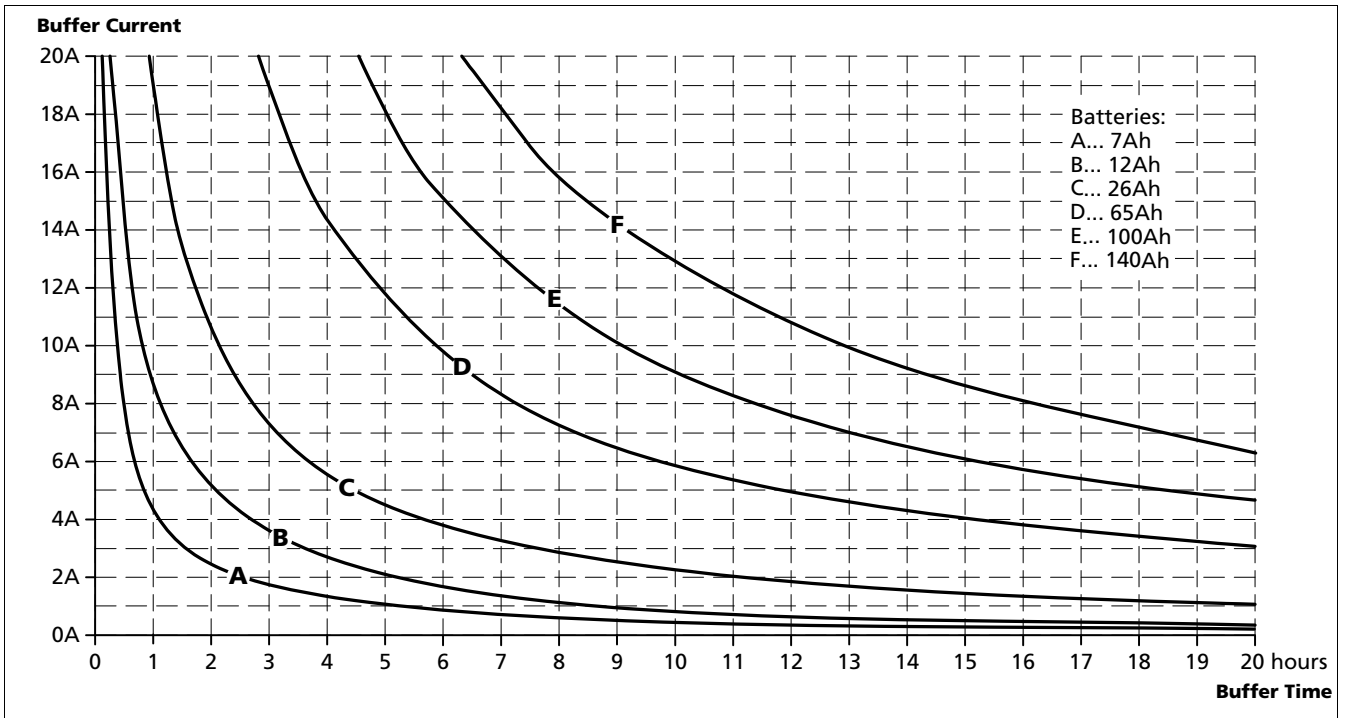


Fig. 6-3 **Buffer time curves for various battery sizes, typ.**



### 7. READY AND BUFFERING RELAY CONTACT

The DC-UPS is equipped with two independent relay contacts for remote monitoring and controlling of the unit.

#### Ready contact

Contact is closed when both batteries are charged more than typical 85%, no wiring failure is detected, input voltage is sufficient and inhibit signal is not active.

Contact ratings	max.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min.	1mA at 5Vdc	min. permissible load
Isolation voltage	see chapter 19.		

#### Buffering contact

Contact is closed when unit is in battery mode.

Contact ratings	max.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min.	1mA at 5Vdc	min. permissible load
Isolation voltage	see chapter 19.		

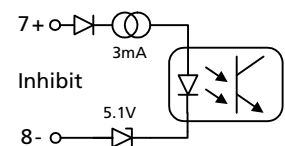
### 8. REPLACE BATTERY RELAY CONTACT

The contact is closed when one of the battery quality tests of at least one battery reports a negative result. To reset the "replace battery" signal, cycle the input power. The battery that has failed is indicated by the green LED which is off. The battery should be replaced as soon as possible.

Contact ratings	max.	60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A	resistive load
	min.	1mA at 5Vdc	min. permissible load
Isolation voltage	see chapter 19.		

### 9. INHIBIT INPUT

The inhibit input disables buffering. In power supply mode, a static signal is required. In battery mode, a pulse with a minimum length of 250ms is required to stop buffering. See chapter 23.8 for details.



Signal voltage	max.	35Vdc
Signal current	max.	6mA, current limited
Inhibit threshold	min.	6Vdc, buffering is disabled above this threshold level
	max.	10Vdc
Isolation voltage	see chapter 19.	

### 10. EFFICIENCY AND POWER LOSSES

Efficiency	typ.	99%	Power supply mode, 20A output current, batteries fully charged
Power losses	typ.	1.9W	Power supply mode, 0A output current, batteries fully charged
	typ.	4.8W	Power supply mode, 0A output current, during charging batteries < 10Ah
	typ.	6.8W	Power supply mode, 0A output current, during charging batteries > 10Ah
	typ.	4.6W	Power supply mode, 20A output current, batteries fully charged
	typ.	4.2W	Battery mode, 0A output current
	typ.	7.6W	Battery mode, 10A output current
	typ.	21.3W	Battery mode, 20A output current

### 11. LIFETIME EXPECTANCY AND MTBF

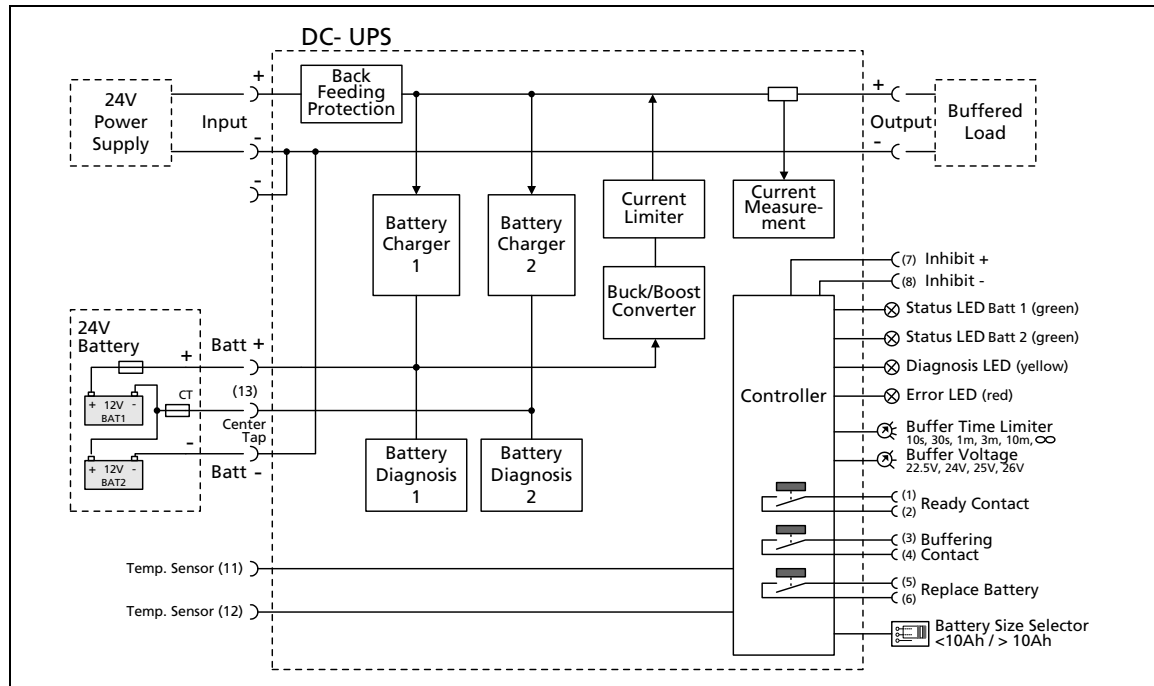
Calculated lifetime expectancy <sup>*)</sup>	440 000h <sup>*)</sup>	Power supply mode, 10A and 40°C
	1 244 000h <sup>*)</sup>	Power supply mode, 10A and 25°C
	122 000h <sup>*)</sup>	Power supply mode, 20A and 40°C
	345 000h	Power supply mode, 20A and 25°C
MTBF <sup>**) SN 29500, IEC 61709</sup>	649 000h	Power supply mode, 20A and 40°C
	1 097 000h	Power supply mode, 20A and 25°C
MTBF <sup>**) MIL HDBK 217F (Ground benign)</sup>	372 000h	Power supply mode, 20A and 40°C; Ground Benign GB40
	498 000h	Power supply mode, 20A and 25°C; Ground Benign GB25
MTBF <sup>**) MIL HDBK 217F (Ground fixed)</sup>	107 000h	Power supply mode, 20A and 40°C; Ground Fixed GF40
	137 000h	Power supply mode, 20A and 25°C; Ground Fixed GF25

\*) 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 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.

## 12. FUNCTIONAL DIAGRAM

Fig. 12-1 **Functional diagram**



## 13. TERMINALS AND WIRING

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

	<b>Input and output</b>	<b>Signals</b>
<b>Type</b>	screw terminals	pluggable screw terminals
Solid wire	0.5-6mm <sup>2</sup>	0.2-1.5mm <sup>2</sup>
Stranded wire	0.5-4mm <sup>2</sup>	0.2-1.5mm <sup>2</sup>
American Wire Gauge	AWG 20-10	AWG 22-14
Max. wire diameter	2.8mm (including ferrules)	1.5mm (including ferrules)
Wire stripping length	7mm / 0.28inch	6mm / 0.25inch
Tightening torque	1Nm / 9lb.inch	0.4Nm / 3.5lb.inch
Screwdriver	3.5mm slotted or cross-head No 2	3mm slotted

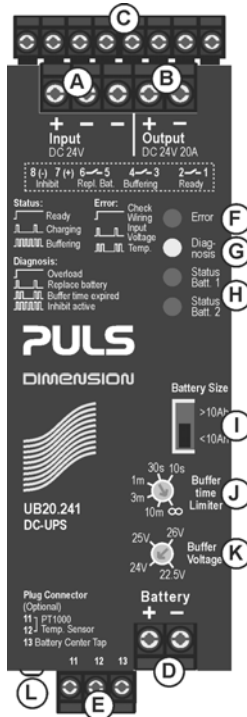
### Instructions:

- 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 and  
90°C for ambient up to 70°C minimum.
- Follow national installation codes and installation regulations!
- Ensure that all strands of a stranded wire enter the terminal connection!
- Unused terminal compartments should be securely tightened or closed.
- Ferrules are allowed.



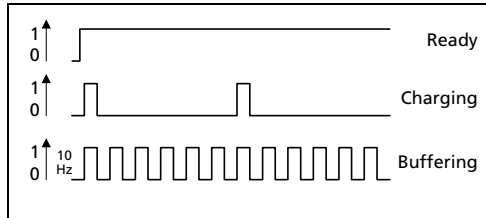
### 14. FRONT SIDE AND USER ELEMENTS

Fig. 14-1 **Front side**



- A Input Terminal** (screw terminal)
- B Output Terminal** (screw terminal) One extra (-) pole for easy grounding. The minus-pole is internally hard-wired with the minus-pole of the input and battery terminals.
- C Signal Connector** (8-pole plug connector) comprises the following connections:
  - Ready relay contact, see chapter 7.
  - Buffering relay contact, see chapter 7.
  - Inhibit input signal, see chapter 9 and chapter 23.8.
  - Replace battery, see chapter 5 and 8.
- D Battery Terminal** (screw terminal)
- E Battery Monitoring Connector** (3-pole plug connector)
  - Connection for temperature sensor for battery temperature. See chapter 5 (optional).
  - "Center-Tap" connection - middle point of the two batteries See chapter 3 (optional).
- F Red Error LED** – This LED indicates that charging or buffering is not possible. The flashing pattern reports the following reasons:
  - Check wiring
  - Insufficient input voltage
  - Too high temperatures
 For details see Fig. 14-4.
- G Yellow Diagnosis LED** – This LED helps troubleshooting and the flashing pattern indicates the following:
  - Output overloaded (current)
  - Battery replacement required
  - Expired buffer time due to buffer time selector or discharged battery
  - Activated inhibit input
 For details see Fig. 14-3.
- H Green Status LED** – Each battery has its own status LED. Battery 1 represents the battery, which is electrically closer to the (+) pole and battery 2, which is closer to the (-) pole. The flashing pattern of this LED reports the following information:
  - Ready
  - Charging
  - Buffering
 For details see Fig. 14-2.
- I Battery Size Selector** (pluggable jumper) - For details see chapter 5. Two positions to select battery sizes > and <10Ah. Influences the charging current, the allowed battery temperature range and the battery quality tests. Factory set: <10Ah. A missing jumper equals a <10Ah setting.
- J Buffer Time Limiter** (rotary switch with 6 dents) - For details see chapter 6. Limits the maximum buffer time in a buffer event to save battery energy. Selectable between 10s 30s, 60s, 3 minutes and 10 minutes. If no limitation is selected (infinite period of time), the buffering will be ended by the deep discharge protection. Factory set: infinite.
- K Buffer Voltage Selector** (rotary switch with 4 dents) - For details see chapter 4. Allows setting the output voltage in battery mode to 22.5V, 24V, 25V or 26V. Factory set: 22.5V
- L Chassis Ground** (screw)
  - Use a M4 ring-type terminal to connect the housing to ground, when required.

Fig. 14-2  
Flashing pattern for green "Status LED"



Each battery has its own status LED. The signals are the same for both batteries.

Ready:

The LEDs are on solid when the battery is charged (> 85%), no wiring failure is recognized, input voltage is sufficient. After the unit is turned-on with charged batteries, it can take 20s or longer that the signal switches from charging to ready.

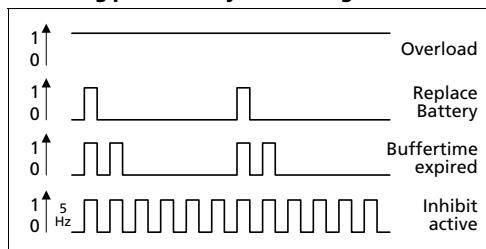
Charging:

The LEDs are flashing with a low frequency when the batteries are charging and the state-of-charge is below 85%.

Buffering:

The LEDs are flashing with a high frequency when the unit is in battery mode.

Fig. 14-3  
Flashing pattern for yellow "Diagnoses LED"



This LED helps troubleshooting.

Overload:

The LED is on solid when the output current is permanently above 20A in battery mode or 25A in power supply mode.

Replace Battery:

The LED is flashing with a low frequency when one battery has failed the periodically performed battery quality test. In case the center-tap connection is present, the battery that has failed is indicated by the green LED which is off. Otherwise, both LEDs are off. The battery should be replaced as soon as possible.

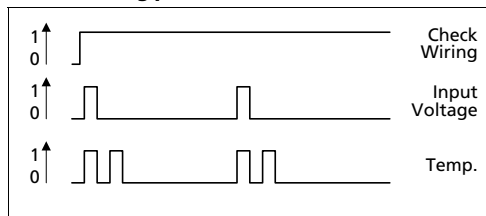
Buffertime expired:

The LED is double flashing when the output has switched off due to the setting of the buffer-time limiter or discharged battery. This signal will be displayed for 15 minutes after the output has switched off.

Inhibit active:

The LED is flashing with a high frequency when buffering is disabled due to an active inhibit signal.

Fig. 14-4  
Flashing pattern for red "Error LED"



This LED indicates that charging or buffering is not possible.

Check Wiring:

The LED is on solid when a failure in the wiring, battery or battery fuse is identified.

Input Voltage:

A single flash indicates that the input voltage is >30V or the input voltage is too low for the adjusted buffer voltage. The input voltage must be at least 1V higher than the selected buffer voltage.

Temperature:

A double flash indicates that the temperature of the DC-UPS is too high (> 70°C) or that the temperature of the battery is too high (> 50°C) or too low (< -10°C in setting <10Ah). Battery temperatures indications require a connected battery temperature sensor.

### 15. EMC

The DC-UPS is suitable for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions.

All tests are performed in power supply and battery mode.

<b>EMC Immunity</b>	According generic standards: EN 61000-6-1 and EN 61000-6-2			
Electrostatic discharge	EN 61000-4-2	contact discharge *)	8kV	Criterion A
		air discharge *)	15kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz-2.7GHz	10V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	input lines	2kV	Criterion A
		output lines	2kV	Criterion A
		signals **)	2kV	Criterion A
Surge voltage on input	EN 61000-4-5	+ → -	1kV	Criterion A
		+ / - → chassis ground	2kV	Criterion A
Surge voltage on output	EN 61000-4-5	+ → -	1kV	Criterion A
		+ / - → chassis ground	2kV	Criterion A
Surge voltage on battery and center-tap	EN 61000-4-5	+ → -	- ***)	Criterion A
		+ / - → chassis ground	1kV	Criterion A
Surge voltage on inhibit input, ready-, buffering and replace battery contacts	EN 61000-4-5	signals → chassis ground	1kV	Criterion A
Surge voltage on temperature sensor	EN 61000-4-5	signals → chassis ground	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A

\*) Chassis ground connection earthed (grounded)

\*\*) Tested with coupling clamp

\*\*\*) Not relevant due to short wire length

**Criteria:**

**A:** DC-UPS shows normal operation behavior within the defined limits.

<b>EMC Emission</b>	According generic standards: EN 61000-6-3 and EN 61000-6-4		
Conducted emission	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	input lines	limits for DC power ports acc. EN 61000-6-3 fulfilled
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	output lines	limits for DC power ports acc. EN 61000-6-3 fulfilled
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1	battery lines	- ***)
Radiated emission	EN 55011, EN 55022		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.

\*\*\*) Not relevant due to short wire length

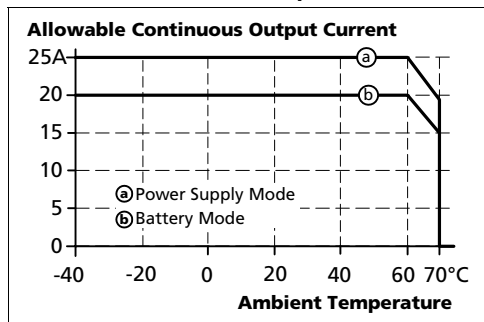
<b>Switching Frequency</b>	The DC-UPS has four converters included, three operate with the same switching frequency.	
100kHz	Buck-boost converter and battery charger	
45 to 80kHz	Auxiliary converter, switching frequency is input voltage dependent	

### 16. ENVIRONMENT

Operational temperature *)	-40°C to +70°C (-40°F to 158°F)	Reduce continuous output current according Fig. 16-1. The operational temperature range can be reduced by the battery specification. The DC-UPS includes some safety features which reduce the temperature range for charging. See chapter 5 for details.
Derating	2.5%/°C	+60°C to +70°C (140°F to 158°F)
Storage temperature	-40 to +70°C (-40°F to 158°F)	For storage and transportation
Humidity **)	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
Shock	30g 6ms, 20g 11ms ***) 3 bumps / direction, 18 bumps in total	IEC 60068-2-27
Altitude	0 to 6000m (0 to 20 000ft)	Approvals apply only up to 2000m
Over-voltage category	II	IEC 62103, EN 50178, EN 60950, UL 840
Degree of pollution	2	IEC 62103, EN 50178, not conductive
LABS compatibility	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.	

\*) 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  
 \*\*\*) Higher levels are allowed when using the wall mounting bracket ZM2.WALL

Fig. 16-1 **Continuous output current vs. ambient temp.**



### 17. PROTECTION FEATURES

Output protection	<p>In power supply mode: The DC-UPS is protected by the current limitation of the supplying power supply or a circuit protector on the input in case the power supply has an ampacity greater than 28A.</p> <p>In battery mode: The DC-UPS is electronically protected against overload, no-load and short-circuits</p>	
Output over-voltage protection	typ. 32Vdc max. 35Vdc	In case of an internal DC-UPS defect, a redundant circuit limits the maximum output voltage in battery mode. The output shuts down and automatically attempts to restart.
Degree of protection	IP 20	EN/IEC 60529 For use in a controlled environment according to CSA 22.2 No 107.1-01.
Penetration protection	> 3.5mm	E.g. screws, small parts
Over-temperature protection	included for battery mode	Output shuts down with automatic restart. Additional temperature protection for charging of batteries can be found in chapter 5.
Input over-voltage protection	max. 35Vdc	No harm or defect of the unit
Internal input fuse	no	
Reverse input polarity protection	included	Max. -40V
Reverse battery polarity protection	included	Max. -35Vdc
Protection against wrong battery voltage	included	Max. +35Vdc
Battery deep discharge protection	included	Buffering will stop when deep discharge protection is active. Battery will be disconnected from the DC-UPS.

### 18. SAFETY FEATURES

Input / output separation	not provided	The minus-pole is internally hard-wired with the minus-pole of the input and battery terminals.
Output voltage	SELV	IEC/EN 60950-1, The input must be powered from a SELV power source.
	PELV	IEC/EN 60204-1, EN 50178, IEC 62103, IEC 60364-4-41, The input must be powered from a PELV power source.
Class of protection	III	PE (Protective Earth) connection not required
Isolation resistance *)	> 10MΩ > 10MΩ > 10MΩ	Power port to signal port Power port to housing Signal port to housing
Touch current (leakage current)	The leakage current which is produced by the DC-UPS 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.	

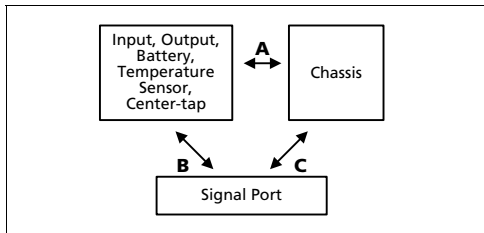
\*) Center-tap terminal is categorized in the group of "power port".

### 19. DIELECTRIC STRENGTH

The signal port (relay contacts and inhibit input) are floating and separated from the power port (input voltage, output voltage, center-tap terminal and temperature sensor).

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 poles of the power port terminals together as well as all poles of the signal port before conducting the test. When testing, set the cut-off current settings to the value in the table below. The following isolation tests were performed:

Fig. 19-1 Dielectric strength



		<b>A</b>	<b>B</b>	<b>C</b>
Type test	60s	1060Vac	1060Vac	1060Vac
Factory test	5s	650Vac	650Vac	650Vac
Field test	5s	500Vac	500Vac	500Vac
Cut-off current setting		> 90mA	> 1mA	> 1mA

### 20. APPROVALS

EC Declaration of Conformity



The CE mark indicates conformance with the  
 - EMC directive 2004/108/EC,  
 - Low-voltage directive (LVD) 2006/95/EC and the  
 - RoHS directive 2011/65/EU.

IEC 60950-1  
2<sup>nd</sup> Edition



CB Scheme,  
Information Technology Equipment  
Applicable for altitudes up to 2000m.

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

UL 60950-1  
2<sup>nd</sup> Edition



Recognized for use as Information Technology Equipment,  
Level 5; U.S.A. (UL 60950-1) and Canada (C22.2 No. 60950-1);  
E-File: E137006  
Applicable for altitudes up to 2000m.

ANSI / ISA 12.12.01-2013  
Class I Div 2



Recognized for use in Hazardous Location Class I Div 2 T4  
Groups A,B,C,D systems; U.S.A. (ANSI / ISA 12.12.01-2013) and  
Canada (C22.2 No. 213-M1987)

EN 60079-0, EN 60079-15  
ATEX



Approval for use in hazardous locations Zone 2 Category 3G.  
Number of ATEX certificate: EPS 15 ATEX 1 025 X  
The DC-UPS must be built-in in an IP54 enclosure.

IEC 60079-0, IEC 60079-15



Suitable for use in Class 1 Zone 2 Groups IIa, IIb and IIc  
locations. Number of IECEx certificate: IECEx EPS 15.0049X

Marine



Germanischer Lloyd classified  
Environmental category: C, EMC2  
Marine and offshore applications

### 21. PHYSICAL DIMENSIONS AND WEIGHT

Width	46mm	1.81"
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	700g / 1.54lb	
DIN-rail	Use 35mm DIN-rails according to EN 60715 or EN 50022 with a height of 7.5 or 15mm.	
Housing material	Body: Aluminium alloy Cover: zinc-plated steel	
Installation clearances	See chapter 2	

Fig. 21-1 Front view

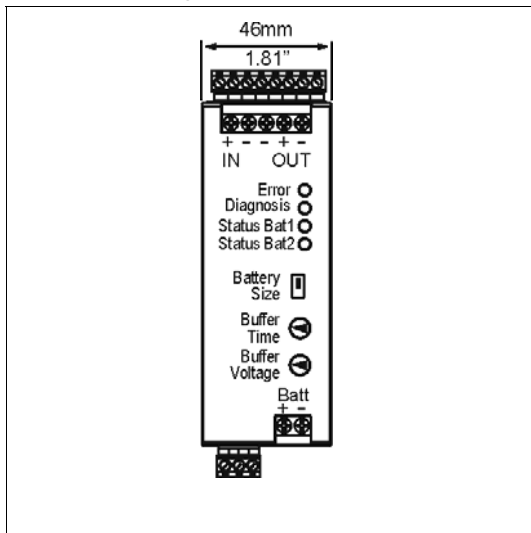
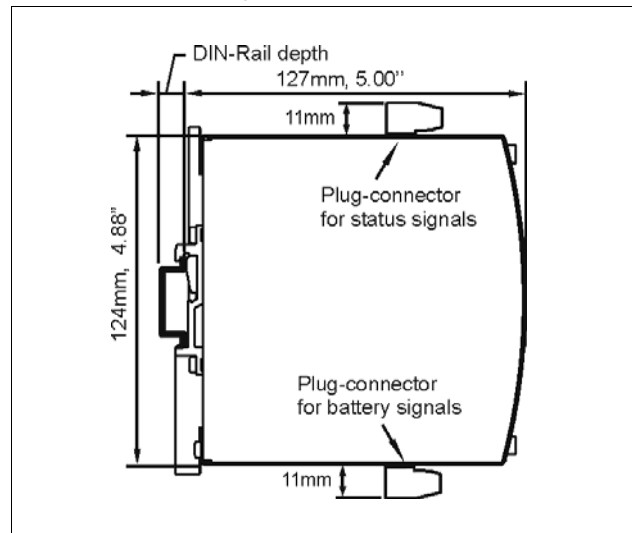


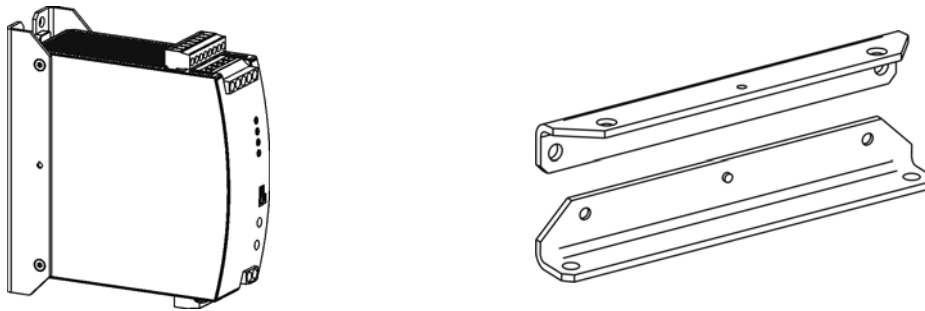
Fig. 21-2 Side view



## 22. ACCESSORIES

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

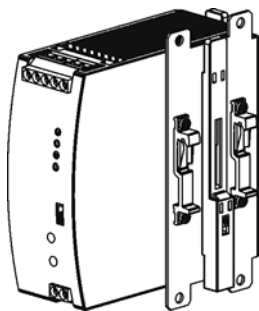
This bracket is used to mount the DC-UPS onto a flat surface without utilizing a DIN-rail.



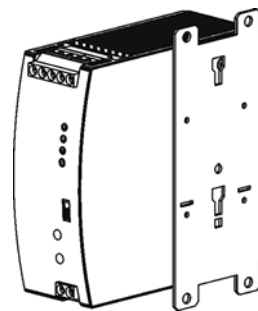
### 22.2. ZM12.SIDE – WALL-MOUNTING BRACKET

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

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



Side mounting with DIN-rail brackets



Side mounting without DIN-rail brackets

### 22.3. UZS24.100 – SENSOR BOARD FOR DC-UPS

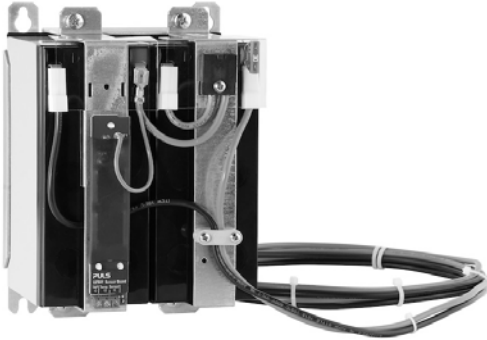


The UZS24.100 enables all the benefits of the PULS 1-Battery-Concept when using individual batteries and not one of the UZK24 battery modules. This sensor board makes the use of matched batteries unnecessary and allows a precise battery charging and testing resulting in the longest possible battery life. The sensor board contains a PT1000 temperature sensor

and an auto-resettable fuse which is suitable for charging currents up to 3.5A. The fuse protects the center-tap wire between the battery module and the DC-UPS control unit.



### 22.4. UZK24.071 – 24V, 7AH BATTERY MODULE



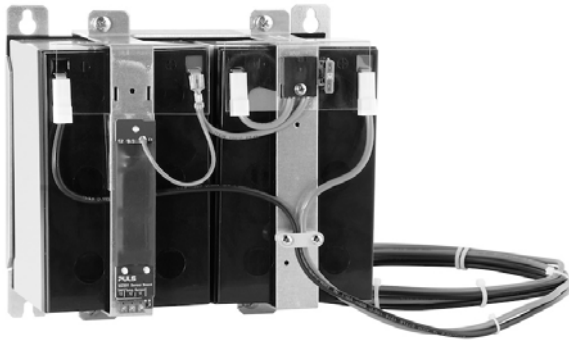
The UZK24.071 passive battery module utilizes two non-spillable 7Ah maintenance-free lead-acid batteries (connected in series), that are assembled in one package with all the required wiring included.

The battery module includes the monitoring and protection board UZS24.100. This board contains a temperature sensor and a center-tap connection with an auto-resettable fuse to protect the center-tap wire between the battery module and the DC-UPS control unit. Connecting the center-tap wire to the DC-UPS control unit enables all the benefits of the PULS 1-Battery-Concept. This makes the use of matched replacement batteries unnecessary and allows a precise battery charging and testing which results in the longest possible battery life.

The UZK24 battery module is available in two different options. It can be ordered with assembled batteries (UZK24.071) or as a battery bracket without batteries (UZO24.071), allowing for different battery options. The mounting bracket option also allows the batteries to be assembled just in time, avoiding outdated batteries due to limited shelf life.

Battery voltage	DC 24V
Battery capacity	7Ah
Temperature sensor	PT1000
Dimensions WxHxD	137x186x143mm
Weight UZK24.071 / UZO24.071	6000g / 800g

### 22.5. UZK24.121 – 24V, 12AH BATTERY MODULE



The UZK24.121 passive battery module utilizes two non-spillable 12Ah maintenance-free VRLA lead-acid batteries (connected in series), that are assembled in one package with all the required wiring included.

The battery module includes the monitoring and protection board UZS24.100. This board contains a temperature sensor and a center-tap connection with an auto-resettable fuse to protect the center-tap wire between the battery module and the DC-UPS control unit. Connecting the center-tap wire to the DC-UPS control unit enables all the benefits of the PULS 1-Battery-Concept. This makes the use of matched replacement batteries unnecessary and allows a precise battery charging and testing which results in the longest possible battery life.

The UZK24 battery module is available in two different options. It can be ordered with assembled batteries (UZK24.121) or as a battery bracket without batteries (UZO24.121), allowing for different battery options. The mounting bracket option also allows the batteries to be assembled just in time, avoiding outdated batteries due to limited shelf life.

Battery voltage	DC 24V
Battery capacity	12Ah
Temperature sensor	PT1000
Dimensions WxHxD	203x186x143mm
Weight UZK24.121 / UZO24.121	9000g / 900g

## 23. APPLICATION NOTES

### 23.1. BATTERY REPLACEMENT INTERVALS

There are two main causes for battery failures and the need for replacing them:

**- Random failures:**

Within the defined service life of a battery, random battery failures can happen. E.g. short circuit in one cell, broken cell connection, acid pollution, mechanical defects, ... . Such failures occur randomly and cannot be predicted. The UB20 has various battery test features included, which periodically test both batteries individually and report such failures. These battery tests include:

- Battery presence test, performed every 10s
- Battery dynamic impedance test, performed every 4hours
- Charging time period (max. 40h in <10Ah settings and max. 170h in >10Ah settings)

Battery tests start as soon as the batteries are fully charged (the green status LED must be on solid). Battery dynamic impedance tests need to fail several times in a row before "replace battery" is reported. This can take up to 14 additional hours after the batteries are fully charged.

**- Wear-out failures:**

The electrical characteristics of batteries degrade slowly over time. Main causes are chemical effects, which can be calculated. Therefore, battery manufacturers specify the design life of batteries to be able to calculate the expected service time. The degradation of a battery cannot be easily tested on a running system. Therefore in addition to the results from the battery tests of the UB20.241 (random failures), a periodical replacement is strictly recommended.

**Service and design life of a battery:**

Batteries have a limited service life and need to be replaced periodically. The service life depends on the grade of the battery, which is expressed in the design life. The design life figures can be found in the individual datasheets of the batteries and is usually specified according to the Eurobat guideline.

The design life is the estimated life, based on laboratory condition, and is quoted at 20°C using the manufacturer's recommended float voltage condition. According to the Eurobat guideline, design lives have been structured into the following different groups:

- 3 - 5 years: This group of batteries is very popular in standby applications and in small emergency equipment. This represents a 4 years design life with a production tolerance of  $\pm 1$  year.
- 6 - 9 years: This group of batteries is usually used when an improved life is required. This represents a 7.5 years design life with a production tolerance of  $\pm 1.5$  years.
- 10 - 12 years: This group of batteries is used when in applications where longest life and highest safety level are required. This represents a 11 years design life with a production tolerance of  $\pm 1$  year.

If the operational parameters differ from those which are specified for the design life, an earlier replacement of the battery might be necessary. The "real life" is called service life and is defined as the point at which the cell's actual capacity has reached 80% of its nominal capacity. At the end of the service life the capacity degrades much faster, so that a further use of the battery is not recommended.

The degradation of a battery begins with the production date and not with the time when usage starts.

**Effects, which shortens the service life of the battery and requires an earlier battery replacement:**

- Temperature:
 

The temperature has the biggest impact in the service life. The higher the temperature, the earlier the wear-out phase of the battery begins. The wear-out results in a degradation of battery capacity. See Fig. 23-1 for details.
- Number of discharging cycles:
 

The number as well as the depth of discharging cycles is limited. A replacement of the battery might be necessary earlier than the calculated service life if the battery exceeds the numbers and values of Fig. 23-2.
- Overcharging and deep discharging:
 

Overcharging and deep discharging shortens the service life and should be avoided. Due to the two individual

battery chargers and the temperature tracking feature of the UB20.241, the end-of-charge-voltage can be set very precisely to the required value and thereby avoiding unnecessary aging effects.

- Discharged batteries:  
Charge retention is important to get the longest battery life. Stored batteries which are not fully charged age faster than charged batteries. Batteries which are not in use should be recharged at least once a year.
- High ripple voltage:  
Excessive float charge ripple across the battery has an effect of reducing life and performance. The UB20.241 does not produce such a ripple voltage. This effect can be ignored when the battery is charged with the UB20.241.

**Recommendations for achieving a long battery service life:**

- Place the batteries in a cool location: E.g. near the bottom of the control cabinet.
- Do not place the batteries near heat generating devices.
- Do not store discharged batteries.
- Do not discharge the batteries more than necessary. Set buffer time limiter to the required buffer time.
- When choosing the batteries capacity, always try to get the next higher capacity than required. The depth of discharge reduces the service life of the batteries and limits the number of cycles. See Fig. 23-2.

Fig. 23-1 Service life versus ambient temperatures, typ \*)

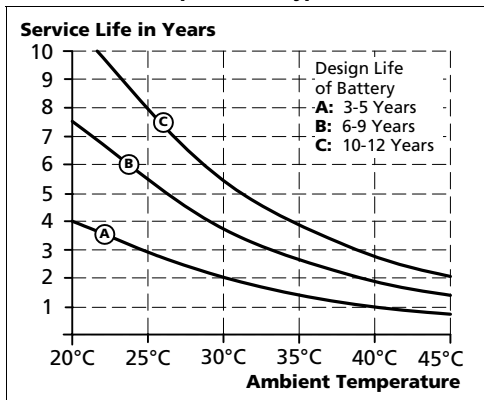
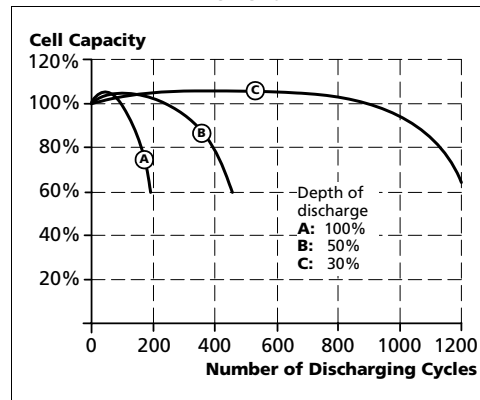


Fig. 23-2 Battery capacity degradation vs. discharging cycles \*)



\*) Datasheet figures provided by the battery manufacturer

**How to determine the replacement intervals:**

Example:

- Two 26Ah batteries with a design life of 10-12 years are used
- The average ambient temperature is 30°C
- One buffer event consumes approx. 25% of the achievable buffer time.
- One buffer event every two days (=182 cycles / year)

Calculation:

A) Ambient temperature influence:

According to Fig. 23-1 curve C, a 5 years service life can be expected for an ambient temperature of 30°C.

B) Number of discharging cycles: 5 years \* 182 cycles = 910cycles in 5 years.

According to Fig. 23-2, curve C has to be used (only 25% of battery capacity is required). 910 cycles have only a negligible influence in a battery degradation and can be ignored.

Result:

The battery shall be replaced after 5 years.

Please note that the battery degrading begins from the production date (check date code on the battery) which may shorten the replacement intervals.

### 23.2. EXTERNAL INPUT PROTECTION

The DC-UPS is tested and approved for branch circuits up to 28A. An external protection is only required, if the supplying branch has an ampacity greater than this. 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 25A B- or C-Characteristic breaker should be used.

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

### 23.3. OUTPUT CIRCUIT BREAKERS

Some applications require branch circuit or branch circuit conductor protection on the 24V supply voltage. Therefore standard miniature circuit breakers (MCB's or UL 1077 circuit breakers) are commonly used on 24V branches.

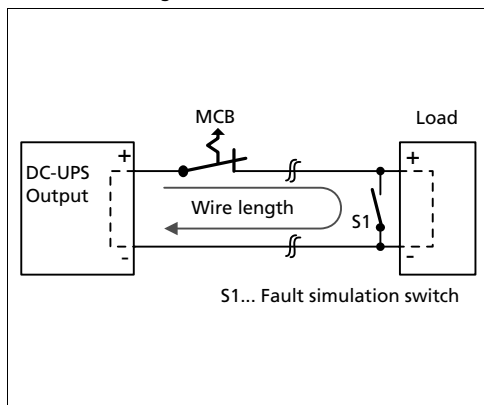
MCB's are designed to protect wires and circuits. If the ampere value and the characteristics of the MCB are adapted to the wire size that is used, the wiring is considered as thermally safe regardless of whether the MCB opens or not.

To avoid voltage dips and under-voltage situations in adjacent 24V branches which are supplied by the same source, a fast (magnetic) tripping of the MCB is desired. A quick shutdown within 10ms is necessary corresponding roughly to the ride-through time of PLC's. This requires high peak currents to open the circuit breaker in the required time. Furthermore, the impedance of the faulty branch must be sufficiently small in order for the current to actually flow.

For this discipline, two cases must be differentiated:

- A) DC-UPS is operating in power supply mode:  
In this case, the supplying source is responsible for the peak current to trip circuit breakers. These values can be found in the datasheet of the power supply.
- B) DC-UPS is operating in battery mode:  
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 (setting for buffer voltage: 22.5V).

Fig. 23-3 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>	25m	34m	48m	72m
<b>C-3A</b>	24m	32m	47m	68m
<b>C-4A</b>	18m	24m	33m	48m
<b>C-6A</b>	10m	12m	18m	28m
<b>C-10A</b>	5m	6m	9m	13m
<b>C-13A</b>	1m	2m	2m	3m
<b>B-6A</b>	23m	26m	32m	46m
<b>B-10A</b>	10m	14m	20m	31m
<b>B-13A</b>	9m	10m	18m	27m
<b>B-16A</b>	3m	4m	9m	13m

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

### 23.4. BACK-FEEDING LOADS

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

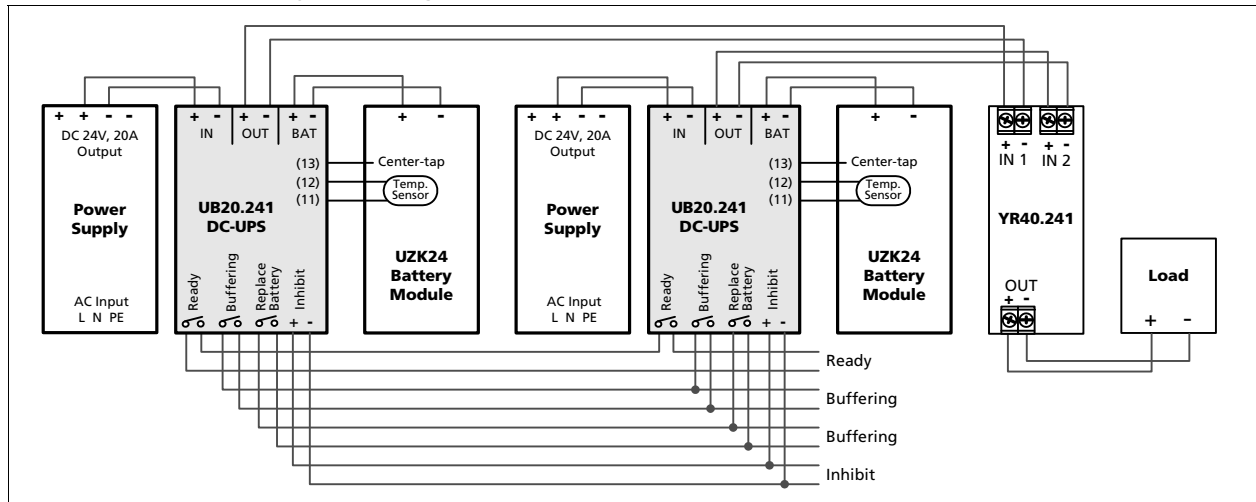
This DC-UPS is resistant and does not show malfunctioning when a load feeds back voltage to the power supply. It does not matter whether the DC-UPS is on or off.

The maximum allowed fed-back-voltage is 35Vdc.

### 23.5. PARALLEL USE TO INCREASE OUTPUT CURRENT

Two DC-UPSs with two individual power supplies, two battery modules and one decoupling module can be used to build a system with higher output current.

Fig. 23-4 **Wiring example for parallel use to increase the output current**



### 23.6. PARALLEL USE FOR REDUNDANCY

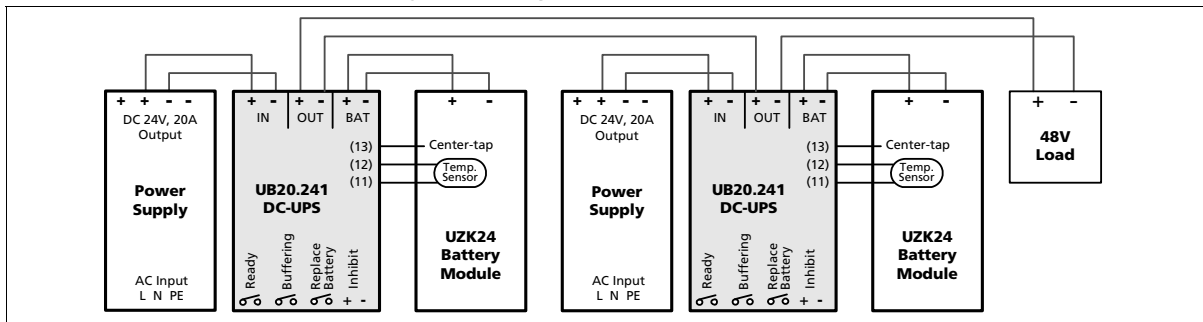
Use the same schematic as for parallel use for higher output current Fig. 23-4 and follow additional the following recommendations:

- Use separate input fuses for each power supply.
- Set the power supply into "Parallel use" mode if available.
- Use a redundancy module to decouple the two power sources.
- Monitor the individual sources. Therefore, use the alarm contacts of the power supplies.
- It is desirable to set the output voltages of all power supplies to the same value ( $\pm 100\text{mV}$ ) or leave it at the factory setting.

### 23.7. SERIES USE FOR 48V APPLICATIONS

A series connection for 48V applications is allowed when utilizing two individual power supplies, two DC-UPSs and two battery modules.

Fig. 23-5 **Wiring example for 48V serial use**



### 23.8. USING THE INHIBIT-INPUT

The inhibit input is a feature to disable the battery mode on purpose. This can be the case when buffering should actively be stopped in order to save battery capacity (e.g. when machines are not in use for a long period of time) and to have shorter recharging times or in case of a service event, where the application must be turned off.

Buffering can be inhibited or stopped:

- When a static voltage is applied to the inhibit input terminals, there will be no buffering after the input voltage is switched off.
- When, during the battery mode, a short voltage pulse with a minimum length of 250ms is applied to the inhibit input terminals, the output will switch off and stay off until the input voltage recovers.

Batteries will be charged when the inhibit mode is activated or a voltage is applied to the inhibit input terminals.

Electrical details of the inhibit input are specified in the chapters 9 and 19.

Fig. 23-6 **Wiring example for inhibit input**

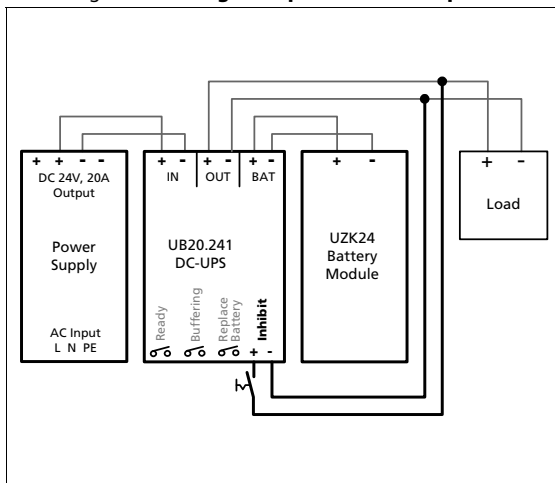
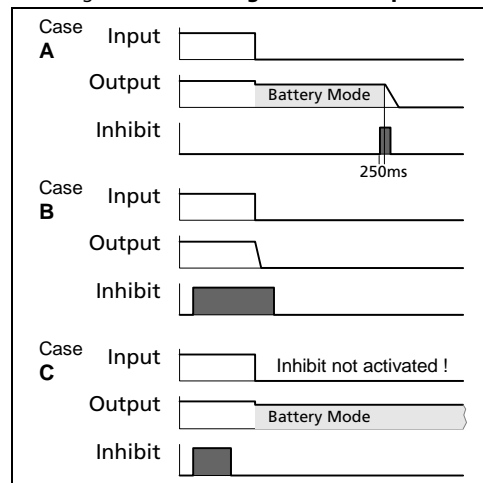


Fig. 23-7 **Activating the inhibit input**



### 23.9. TROUBLESHOOTING

The following guidelines provide instructions for fixing the most common failures and problems. Always start with the most likely and easiest to check condition. Some of the suggestions may require special safety precautions. See notes in section 3 first.

Symptom:	Explanation / Action:
Single flash on the "Error" LED	<ul style="list-style-type: none"> <li>- Check input voltage. The input voltage must be at least 1V higher than the selected buffer voltage and smaller than 30V.</li> </ul>
"Error" LED is solid on	<ul style="list-style-type: none"> <li>- Check correct wiring between the battery and the DC-UPS</li> <li>- Check battery fuse. Is the battery fuse inserted or blown?</li> <li>- Check battery voltage (must be between 14.8V and 30V)</li> <li>- Check battery polarity</li> </ul>
DC-UPS did not buffer	<ul style="list-style-type: none"> <li>- Inhibit input was set.</li> <li>- Battery did not have enough time to get charged and the battery voltage is still below the deep-discharge protection level.</li> </ul>
DC-UPS stopped buffering	<ul style="list-style-type: none"> <li>- Deep discharge protection stopped buffering. Use a larger battery, or allow sufficient time for charging the battery.</li> <li>- End of service life of the battery</li> <li>- Battery did not have enough time to be charged.</li> <li>- Inhibit input was activated</li> <li>- Buffer time limiter stopped buffering. Change the settings of the buffer time limiter on the front of the unit.</li> <li>- At too high temperatures</li> </ul>
DC-UPS stopped buffering for 1s	<ul style="list-style-type: none"> <li>- Center-tap connection opens in buffer mode</li> <li>- Center-tap connection problems</li> </ul>
DC-UPS constantly switches between power supply mode and battery mode	<ul style="list-style-type: none"> <li>- The supplying source on the input is too small and can not deliver sufficient current. Use a larger power supply or reduce the output load.</li> <li>- The output voltage of the power supply dips to a too low value. The input voltage must always be at least 1V higher than the selected buffer voltage and smaller than 30V. Increase the output voltage of the power supply</li> <li>- Too high voltage drops on wires. Increase the output voltage of the power supply or increase the wires cross section from the power supply to the DC-UPS.</li> </ul>