



### DC-UPS CONTROL UNIT

- 1-Battery-Concept - Each 12V battery is charged and monitored separately for longest battery life, matching of batteries not necessary
- Output is decoupled from the input to separate load circuits into buffered and non-buffered sections
- Allows VRLA battery sizes between 12Ah and 200Ah; "Battery Size" selector for various battery sizes
- 50% Extra output power for up to 5s
- Superior battery management for longest battery life
- Comprehensive diagnostic and monitoring functions
- "Replace Battery" signal included
- "Battery-Low Prewarning" signal included
- Selectable buffer time limiter
- Temperature controlled battery charging
- 3 Years warranty

### PRODUCT DESCRIPTION

The UB40.241 is an uninterruptible power supply controller (DC-UPS controller), which is used in combination with a 24V power supply and an external 24V-battery pack to bridge power failures. When the power supply provides sufficient voltages, the DC-UPS controller charges the battery. When the power supply voltage fails, the energy stored in the battery is released to the DC bus in a regulated process.

A unique feature is the battery charger, which can balance two unmatched batteries and which includes two independent battery testers for the two 12V batteries connected 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 device includes various battery diagnostic functions including a battery-low pre-warning signal that ensure a reliable operation of the entire system. Furthermore, 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 to enable phases without enforced buffering.

### ORDER NUMBERS

DC-UPS	<b>UB40.241</b>	Standard DC-UPS unit
Batteries	UZX24.122	Battery module 24V, 12Ah
	UZO24.122	UZX24.122 w/o batteries
	UZX24.262	Battery module 24V, 26Ah
	UZO24.262	UZX24.262 w/o batteries
	UZX24.262-E1	Battery extension 24V, 26Ah
	UZO24.262-E1	UZX24.262-E1 w/o batteries
	UZW24.100	Connection and wiring kit
	UZW24.101	Connection and wiring kit
	USZ24.100	Sensor and center-tap board

### SHORT-FORM DATA

Input voltage	DC 24V	±25%
Min. input voltage to start charging and to enable battery mode	23V	
Transfer voltage to switch to battery mode	22.2V	
Internal current consumption	3.2A / 6.2A	<65Ah / ≥65Ah, incl. charging current
Voltage loss	55mV / 110mV	Input to output, at 20A / 40A
	110mV / 220mV	Battery input to output, at 20A / 40A
Output current	50A	Below +50°C
	40A	At +60°C
	30A	At +70°C
	60A	Short term, up to 5s
	Derate linearly between +50 and +70°C	
Power losses	6.0W	At 40A in power supply mode, full batteries
	9.9W	At 40A in battery mode
Temperature range	-25°C to +70°C	
Size (wxhxd)	46x124x127mm	Without DIN-rail
Weight	530g / 1.17lb	

### MAIN APPROVALS

For details or a complete approval list see chapter 19.



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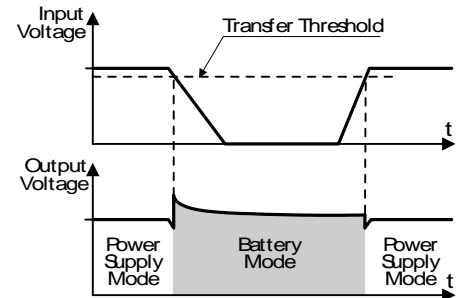
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Packaging and packaging aids can and should always be recycled. The product itself may not be disposed of as domestic refuse.

## 1. TERMINOLOGY AND ABBREVIATIONS

<b>DC-UPS</b>	Abbreviation for <u>U</u> ninterruptible <u>P</u> ower <u>S</u> upply system with a <b>DC</b> input and a DC output. A DC-UPS utilizes batteries as back-up energy source.
<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 indicate flexibility of choice with no implied preference.
<b>shall</b>	A key word indicate a mandatory requirement.
<b>should</b>	A key word indicate flexibility of choice with a strongly preferred implementation.
<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>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".



## 2. INTENDED USE

This device is designed for installation in an enclosure and is intended for commercial use, such as in industrial control, process control, monitoring and measurement equipment or the like.

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

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

## 3. INSTALLATION INSTRUCTIONS



### WARNING

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

- Turn power off before working on the device. Protect against inadvertent re-powering.
- 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.

### Obey the following installation instructions:

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

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

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

Turn power off and disconnect the battery fuse before working on the device.

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

Install the device onto a DIN-rail according to EN 60715 with the battery terminals on the bottom of the unit.

The input can be powered from a regulated power supply or a similar DC source. Use an appropriately sized power supply, which can deliver the additionally required internal current consumption of the DC-UPS and the required current for charging the batteries. If a power supply with a continuous output current greater than 50A is used, a fuse with 63A B- or C-Characteristic must be connected between the power supply and the DC-UPS. The continuous voltage between the input and ground must not exceed 60Vdc. The input must be powered from a PELV or SELV source or an "Isolated Secondary Circuit" in order to maintain a SELV or PELV output. Check for correct input and battery polarity. The device will not operate when the voltage is reversed.

Use only VRLA lead acid batteries with a capacity between 12Ah and 200Ah.

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

Do not use wires smaller than 6mm<sup>2</sup> (AWG 10) and not longer than 2x1m between the power supply and the DC-UPS controller. Longer or smaller gauge wires can cause malfunctioning of the system.

Do not use wires smaller than 6mm<sup>2</sup> (AWG 10) and not longer than 2x1.5m between the battery and the DC-UPS controller. Longer or smaller gauge wires can change performance of the system.

Use two fuses each 35A or 40A in parallel (ATOF® 287 035 or ATOF® 287 040 from Little fuse or an UL listed fuse with the same characteristics) in the battery circuit. The battery fuse protects the wires between the battery and the DC-UPS and shall be located close to the battery.

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

The device is designed as "Class of Protection III" equipment according to IEC 61140.

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

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

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

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

The device is designed for altitudes up to 5000m (16400ft). Above 2000m (6560ft) a reduction in output current is required.

The maximum surrounding air temperature is +70°C (+158°F). The operational temperature is the same as the ambient or surrounding air temperature and is defined 2cm below the device.

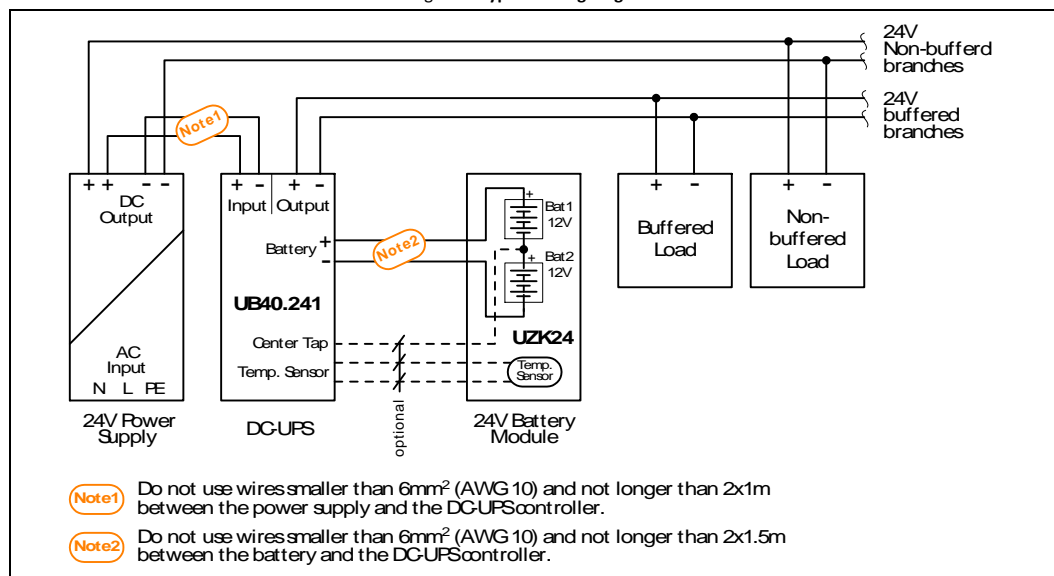
The device is designed to operate in areas between 5% and 95% relative humidity.

Use a 4A fuse (ATOF® 287 004 from Little fuse 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 original battery modules. 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 original battery modules.

## 4. TYPICAL WIRING SCHEME

Fig. 4-1 Typical wiring diagram

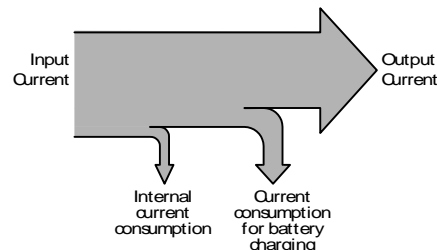


## 5. INPUT AND OUTPUT CHARACTERISTICS

The input can be powered from a regulated power supply or a similar DC source. Use an appropriately sized power supply, which can deliver the additionally required internal current consumption of the DC-UPS and the required current for charging the batteries. If a power supply with a continuous output current greater than 50A is used, a fuse or circuit breaker with 63A (B- or C-Characteristic) must be connected between the power supply and the DC-UPS. The continuous voltage between the input and ground must not exceed 60Vdc. The input must be powered from a PELV or SELV source or an "Isolated Secondary Circuit" in order to maintain a SELV or PELV output. Check for correct input and battery polarity. The device will not operate when the voltage is reversed.

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 follows the battery voltage decreased by a small voltage loss.

The output can supply any kind of loads, including inductive loads and capacitive loads. If capacitors with a capacitance larger than 40mF are connected to the output, the unit might switch off in order to protect itself. If the load inductance is larger than 0.5mH, the unit can be damaged.



Input voltage	Nom.	DC 24V	±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.
	Max.	30-35Vdc	Temporarily allowed, no damage to the DC-UPS. The red error LED will report "Input Voltage", charging and buffering are not possible.
Normal operating input voltage ranges	Nom.	23-30Vdc	This range describes the input voltage, which supports the full functionality of the DC-UPS (including charging) but without entering the battery mode.
Transfer voltage for switching into battery mode	Typ.	22.2Vdc	
Input current		The input current can be calculated by adding the output current and the internal current consumption. The current for charging the batteries is included in the internal current consumption.	
Internal current consumption	Typ.	60mA	When batteries are fully charged
	Typ.	3.2A	Includes charging current for battery size settings of 12Ah, 26Ah and 38Ah
	Max.	4.0A	
	Typ.	6.2A	Includes charging current for battery size settings of 65Ah, 100Ah and 150Ah
	Max.	7A	
	Typ.	2A	Above 40A input current due to reduced charging current
Output voltage	Nom.	DC 24V	
Input to output voltage loss in power supply mode	Typ.	55mV	At 20A load current
	Typ.	110mV	At 40A load current
Battery input to output voltage loss in battery mode	Typ.	110mV	At 20A load current
	Typ.	220mV	At 40A load current
Output current	Nom.	50A	Continuous, below +50°C
	Nom.	40A	Continuous, at +60°C
	Nom.	30A	Continuous, at +70°C
	Nom.	60A	Short term for max. 5s, below +70°C
			Derate linearly between +50°C and +70°C
Overload behavior in power supply mode		Typically, the current limitation of the supplying power source limits the current in an overload condition. There is no overload control included in the	

Jun. 2020 / Rev.0.1 DS-UB40.241-EN All values are typical figures specified at 24Vdc input voltage, 40A output current in power supply mode at 25°C ambient, no charging and after a 5 minutes run-in time unless otherwise noted.

		DC-UPS. The user has to take care by himself to stay below the allowed output currents in order not to overload the unit.	
Output short circuit current in power supply mode		Corresponds to the short-circuit current of the power supply or the current limitation of an input fuse, if installed.	
Overload behavior in battery mode		Time-delayed switch-off	
Tripping delay in battery mode	Typ.	5s	At 60A
	Typ.	2.3s	At 70A
	Typ.	0.73s	At 100A
	Typ.	0.05ms	At shorted output
Return current	Typ.	-250µA	Leakage current to the input of the DC-UPS in battery mode
Back-feeding loads	Max.	35V	The unit is resistant and does not show malfunctioning when a load feeds back voltage to the DC-UPS. It does not matter whether the DC-UPS is on or off.

Fig. 5-1 Input to output voltage loss, typ.

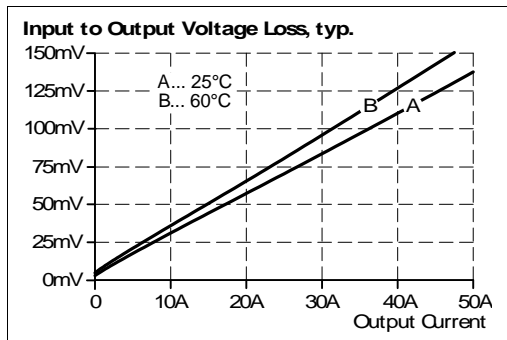


Fig. 5-2 Battery input to output voltage loss, typ.

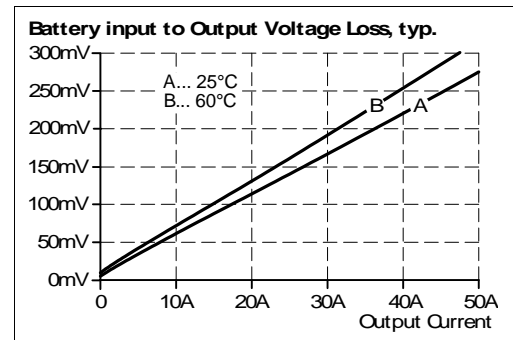


Fig. 5-3 Voltage loss measurement setup

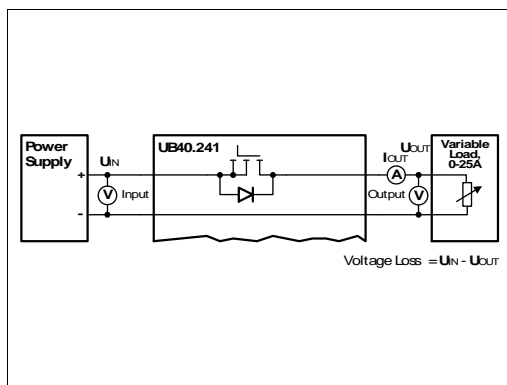
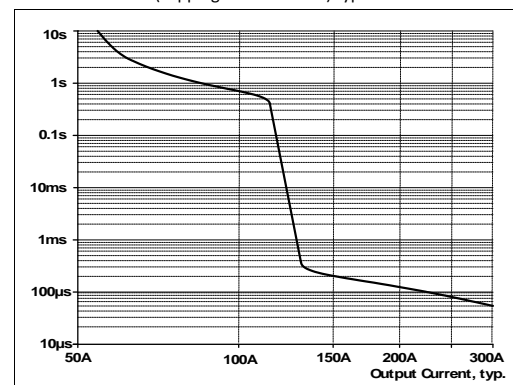


Fig. 5-4 Overload current in battery mode, (tripping characteristic) typ.



## 6. BATTERIES AND BATTERY CHARGING

The battery is not included in the DC-UPS. 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 battery capacity according to the required buffer time and select the right battery quality to achieve the requirements for changing intervals.

Batteries are service parts and need to be replaced periodically and also need to be replaced when the internal battery tests of the DC-UPS report an unexpected failure.

The device has a battery size selector included, which allows an optimal use of different battery sizes.

Batteries smaller than 12Ah are only recommended when the load current is below 20A.

### Charging:

During charging, the DC-UPS consumes additional current from the input. The supplying power source must be able to deliver the additional internal current consumption (including the charging current) specified as input current in the table in the chapter "Input and Output Characteristic".

A special feature of this device is the automatic reduction of the charging current to 2A when the input current reaches 40A. This should help to prevent an overload of a 40A power supply.

The device charges the batteries in a constant current / constant voltage (CC-CV) mode.

When the battery center-tap connection is installed, the two 12V batteries are charged with a balancing function. This adaptive charging mode enables up to 1A more in charging current for the battery which require a higher current to get fully charged, while the other battery gets up to 1A less. This results in a faster and more efficient battery charging and makes matched (paired) batteries unnecessary.

The center-tap connection is optional and if not installed, both batteries will be charged with one common charging voltage. The device 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.

When the temperature sensor (PT1000) is installed, the end-of-charge-voltage is temperature compensated. The device automatically recognizes if a temperature sensor is connected or not. A list of suitable PT1000 temperature sensors from different vendors can be provided.

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.

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. For this reason, the charging current is reduced at low temperatures depending on the battery size.



Setting of battery size selector	12Ah	26Ah	38Ah	65Ah	100Ah	150Ah	
Battery voltage	24V	24V	24V	24V	24V	24V	2x 12V batteries in series
Recommended battery sizes	12Ah - 17Ah	18Ah - 34Ah	35Ah - 50Ah	51Ah - 80Ah	81Ah - 130Ah	131Ah - 200Ah	
Required min. battery voltage for charging	2 x 7V 14V			2 x 7V 14V			Center-tap connected Center-tap not connected Below this voltage level, charging does not start and the DC-UPS reports “check wiring”
Charging current	3A			6A			In constant current mode
Reduced charging current	2A			2A			To avoid overloading of the power supply, charging current is automatically reduced when the input current is larger than 40A
	2A			2A			At battery temperatures above +50°C or below -15°C
	2A			2A			At battery voltages below 20V
	2A			2A			At input voltages below 22.8V
End-of-charge-voltage	2 x13.25V						Center-tap connected, no temperature sensor connected
	26.5V						Center-tap not connected, no temperature sensor connected
	2x 13.1 to 14.2V (below +50°C), 2x 12.9 at 60°C (13.6V applies for +20°C and changes with -18mV/°C)						Center-tap connected, temperature sensor connected
	26.2V to 28.4V (below +50°C), 25.8V (at +60°C) (27.2V applies for +20°C and changes with -36mV/°C)						Center-tap not connected, temperature sensor connected
Temperature range for which the charging process is enabled	-25°C to +60°C						Corresponds to the temperature readings of the external temperature sensor
Deep-discharge protection	10.6V 9.3V 21.2V 18.6V	10.6V 9.3V 21.2V 18.6V	10.6V 9.5V 21.2V 19.0V	10.7V 10.0V 21.4V 20.0V	10.8V 10.1V 21.6V 20.2V	10.9V 10.2V 21.8V 20.4V	At 0A, center-tap connected At 40A, center-tap connected At 0A, center-tap not connected At 40A, center-tap not connected
Battery discharge current	60mA			60mA			In battery mode at no output current

### Charging times:

The below 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.

Battery charging time	Max.	4h	For a 12Ah battery in 12Ah setting
	Max.	9h	For a 26Ah battery in 26Ah setting
	Max.	11h	For a 65Ah battery in 65Ah setting
	Max.	25h	For a 150Ah battery in 150Ah setting

An extensive longer charging time is most likely caused by a defective or outdated battery.

### 7. BUFFER TIME

Buffering will start immediately without interruption after the input voltage falls below typically 22.2V. Buffering is possible even if the batteries are not fully charged.

Buffering can not be started without having previously reached typically 23.0V.

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.

Too many buffering events in too short of a time can lead to a 5 second lock for further buffering requests. For example, if there are multiple 0.2s buffer requests over a duration of 3.3s or multiple 0.3s buffer requests over a duration of 9.2s or multiple 0.4s buffer requests over a duration of 14s, further buffering requests can be blocked for 5 seconds. Multiple buffer events longer than 0.5s do not lead to such a 5s lock for further buffering events.

The following times are typical values for a new product in combination with PULS battery modules or with batteries recommended from PULS. Due to long-term aging effects of batteries consider a buffer time reduction of 30-50% over time. The values apply for a battery temperature between 20°C and 30°C.

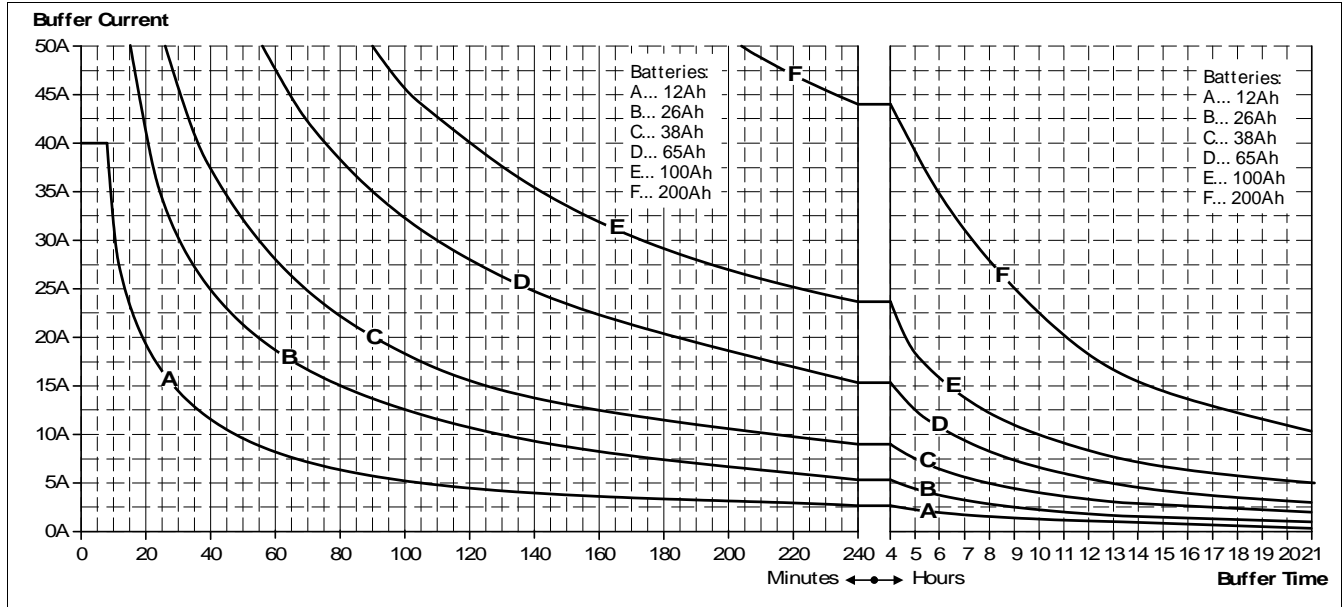
The buffer times are defined for fully charged batteries and can be 10-20% shorter for buffer events, which start immediately after the "Ready" signal becomes active.

The buffer times apply for a wiring with a wire length of 2x0.5m (equal 0.5m cord length) and a cross section of 6mm<sup>2</sup> (or AWG 10) between the battery module and the DC-UPS.

Battery size		12Ah (UZK24.122)	26Ah (UZK24.262)	38Ah	
Buffer time	Typ.	13 days	30 days	43 days	At 0A load
	Typ.	1d : 0h : 4m : 27s	2d : 5h : 14m : 27s	3d : 9h : 1m : 7s	At 0.5A load
	Typ.	11h : 20m : 33s	1d : 1h : 27m : 47s	1d : 11h : 18m : 3s	At 1A load
	Typ.	5h : 29m : 52s	12h : 9m : 10s	19h : 5m : 50s	At 2A load
	Typ.	2h : 0m : 35s	4h : 44m : 43s	7h : 24m : 27s	At 5A load
	Typ.	47m : 35s	2h : 17m : 27s	3h : 28m : 20s	At 10A load
	Typ.	27m : 29s	1h : 21m : 7s	2h : 8m : 8s	At 15A load
	Typ.	18m : 17s	55m : 46s	1h : 31m : 33s	At 20A load
	Typ.	13m : 40s	40m : 52s	1h : 8m : 27s	At 25A load
	Typ.	10m : 47s	31m : 34s	53m : 58s	At 30A load
	Typ.	8m : 49s	25m : 17s	44m : 9s	At 35A load
	Typ.	7m : 25s	21m : 1s	36m : 21s	At 40A load
	Typ.	-	15m : 12s	26m : 53s	At 50A load

Battery size		65Ah	100Ah	200Ah	
Buffer time	Typ.	77 days	115 days	240 days	At 0A load
	Typ.	6d : 1h : 50m : 0s	9d : 3h : 54m : 27s	19d : 16h : 13m : 20s	At 0.5A load
	Typ.	2d : 23h : 45m : 33s	4d : 12h : 13m : 3s	9d : 18h : 22m : 30s	At 1A load
	Typ.	1d : 9h : 13m : 35s	2d : 5h : 14m : 27s	4d : 20h : 19m : 10s	At 2A load
	Typ.	13h : 53m : 20s	20h : 50m : 0s	1d : 21h : 50m : 0s	At 5A load
	Typ.	6h : 49m : 43s	10h : 7m : 38s	22h : 27m : 13s	At 10A load
	Typ.	4h : 23m : 53s	6h : 33m : 31s	14h : 44m : 16s	At 15A load
	Typ.	3h : 4m : 30s	4h : 48m : 12s	10h : 52m : 47s	At 20A load
	Typ.	2h : 17m : 58s	3h : 40m : 26s	8h : 33m : 53s	At 25A load
	Typ.	1h : 48m : 47s	2h : 53m : 49s	7h : 1m : 18s	At 30A load
	Typ.	1h : 28m : 59s	2h : 22m : 11s	5h : 51m : 22s	At 35A load
	Typ.	1h : 14m : 45s	1h : 59m : 28s	4h : 55m : 15s	At 40A load
	Typ.	55m : 53s	1h : 29m : 18s	3h : 24m : 3s	At 50A load

Fig. 7-1 Buffer time curves, typ.



## 8. INHIBIT-INPUT

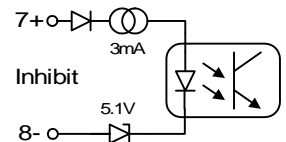
The inhibit-input is a feature to disable the battery mode on purpose. This can be the case when buffering should actively be stopped in order to save battery capacity and to have shorter recharging time.

The inhibit-input can also be used 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 still be charged when the inhibit mode is activated or a voltage is applied to the inhibit-input terminals.



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 "Dielectric Strength"	

Fig. 8-1 Wiring example for inhibit-input

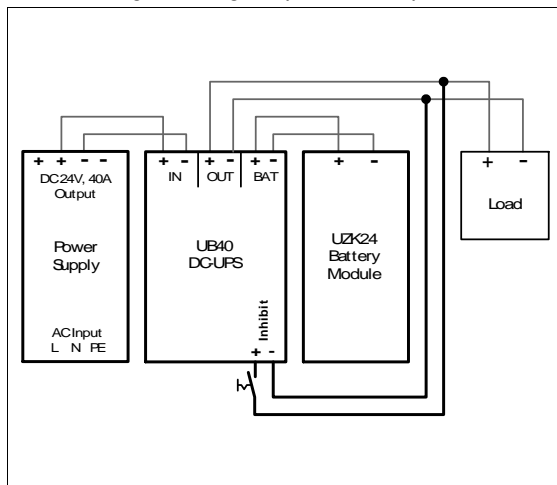
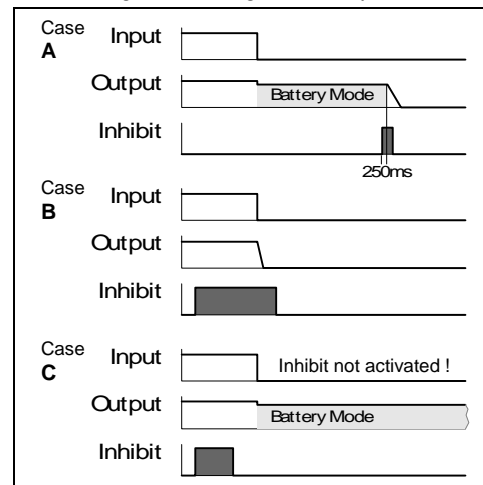


Fig. 8-2 Activating the inhibit-input



## 9. SIGNAL OUTPUTS

Please note:

If the buffering is terminated due to the deep discharge protection or due to the buffer time limiter, the last signal state is stored and displayed for another 15 minutes.

### Ready contact

The ready 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.

The device can switch to battery mode regardless of whether the ready status is reached or not.

The contact opens at a too high battery or DC-UPS temperatures.

After the unit has been switched on with fully charged batteries, it may take 20s or more before the contact switches from charging to ready.

Please note: After a short buffer event, the opening of the contact is suppressed for 5 minutes. This is to avoid a wrong signaling after it can be assumed that the short buffer event has taken only little energy from the battery. If the battery has really been deeply discharged after a short buffer event, a signal is only given after 5 minutes.

Contact ratings	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
-----------------	---

Isolation voltage	See chapter "Dielectric Strength"
-------------------	-----------------------------------

### Buffering contact

The buffering contact is closed when unit is in battery mode.

Contact ratings	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
-----------------	---

Isolation voltage	See chapter "Dielectric Strength"
-------------------	-----------------------------------

### Battery-low pre-warning contact

The battery-low pre-warning contact closes shortly before the battery is discharged.

Contact ratings	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
-----------------	---

Isolation voltage	See chapter "Dielectric Strength"
-------------------	-----------------------------------

### Replace Battery Relay Contact

The contact is closed when one of the battery qualities 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	Maximal 60Vdc 0.3A, 30Vdc 1A, 30Vac 0.5A, resistive load Minimal permissible load: 1mA at 5Vdc
-----------------	---

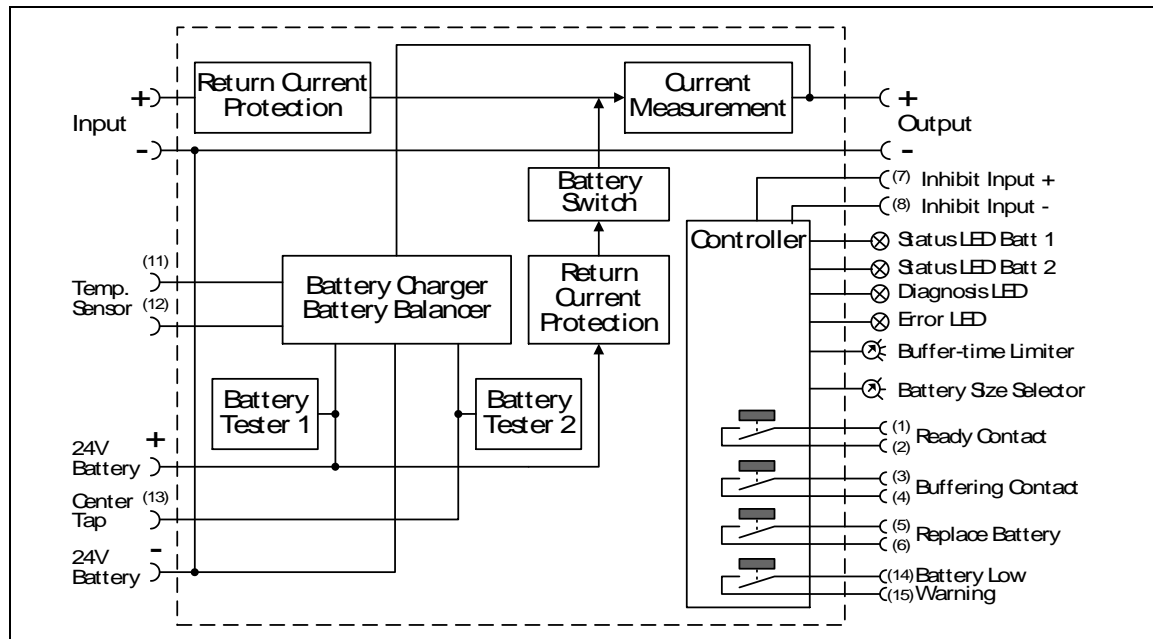
Isolation voltage	See chapter "Dielectric Strength"
-------------------	-----------------------------------

## 10. EFFICIENCY AND POWER LOSSES

Efficiency	Typ.	99.3%	Power supply mode, 40A output current, batteries fully charged
Power losses	Typ.	1.7W	Power supply mode, 0A output current, batteries fully charged
	Typ.	2.7W	Power supply mode, 0A output current, batteries fully charged, center tap connected
	Typ.	3.5W	Power supply mode, 0A output current, 3A charging current
	Typ.	5.5W	Power supply mode, 0A output current, 3A charging current, center tap connected
	Typ.	6.0W	Power supply mode, 0A output current, 6A charging current
	Typ.	8.7W	Power supply mode, 0A output current, 6A charging current, center tap connected
	Typ.	6.0W	Power supply mode, 40A output current, batteries fully charged
	Typ.	7.1W	Power supply mode, 40A output current, batteries fully charged, center tap connected
	Typ.	1.5W	Battery mode, 0A output current
	Typ.	3.6W	Battery mode, 20A output current
	Typ.	9.9W	Battery mode, 40A output current

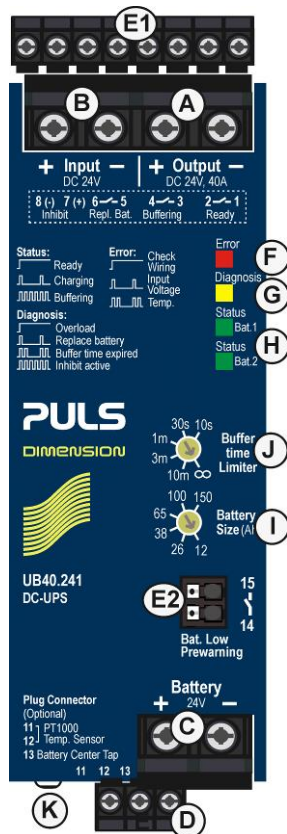
## 11. FUNCTIONAL DIAGRAM

Fig. 11-1 Functional diagram



## 12. FRONT SIDE AND USER ELEMENTS

Fig. 12-1 Front side



### A Output Terminal

- + → Positive output
- → Negative output

### B Input Terminal

- + → Positive input
- → Negative input

### C Battery Terminal

- + → Terminal for positive battery connection
- → Terminal for positive battery connection

### D Battery Monitoring Connector

Connection for temperature sensor for battery temperature and "Center-Tap" connection (middle point of the two batteries).

### E Signal Connector

For details see chapter "Signal Outputs" and "Inhibit-input"

The 8-pole plug connector and the 2-pole push-in terminal comprise the replace battery, ready, buffering and battery low pre-warning relay contacts..

The 8-pole plug connector also comprises the inhibit signal input.

### F Red Error LED

For details see figure "Flashing pattern for red Error LED"

This LED indicates that charging or buffering is not possible. The flashing pattern reports check wiring, battery fuses, too high/low voltage or too high/low temperatures.

### G Yellow Diagnosis LED

For details see figure "Flashing pattern for yellow diagnoses LED"

This LED helps troubleshooting and the flashing pattern indicates output overloaded (current), battery replacement required, expired buffer time due to buffer time selector or discharged battery or activated inhibit-input.

### H Green Status LED

For details see figure "Flashing pattern for 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 ready, charging or buffering.

### I Battery Size Selector

For details see chapter "Batteries and Battery Charging"

Six positions to select battery sizes to optimize the charging process, the battery quality tests and protection features. Factory setting is 12Ah.

### J Buffer Time Limiter

Six positions to limits the maximum buffer time in a buffer event to save battery energy.

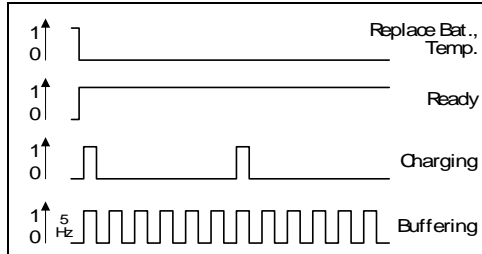
Selectable between 10s 30s, 60s, 3 minutes and 10 minutes. If no limitation is selected (infinite period of time), the buffering will be ended by the deep discharge protection. Factory set: infinite.

### K Chassis Ground

Use a M4 ring-type terminal to connect the housing to ground, when required.

Fig. 12-2

Flashing pattern for green "Status LED"



Each battery has its own status LED. The signals are the same for both batteries. (Listed in order of priorities)

Replace Battery, Battery or DC-UPS temperature too hot:

The LEDs are off when replace battery signal is active or the temperature of the DC-UPS or battery is too hot.

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:

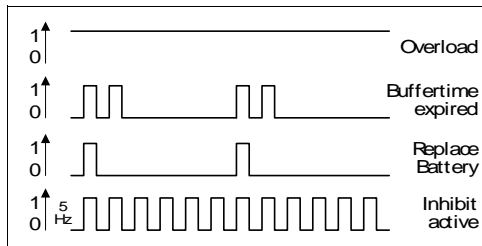
The LEDs are flashing with a low frequency when the batteries are charging, and the state-of-charge is below 85%.

Buffering:

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

Fig. 12-3

Flashing pattern for yellow "Diagnoses LED"



This LED helps troubleshooting. (Listed in order of priorities)

Overload:

The LED is on solid when the input or battery current is permanently above 40A in battery or power supply mode.

Buffer time 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.

Replace Battery:

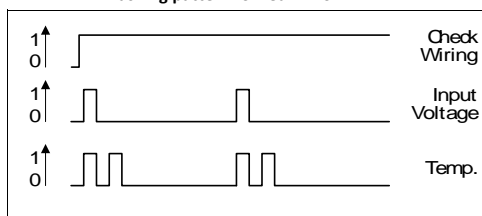
The LED is flashing with a low frequency when one battery has failed the periodically performed battery quality test. In case the centre-tap connection is present, the battery that has failed is indicated by the green LED which is off. Otherwise, both LEDs are off. The battery should be replaced as soon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

Inhibit active:

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

Fig. 12-4

Flashing pattern for red "Error LED"



This LED indicates that charging or buffering is not possible. (Listed in order of priorities)

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 above 30V or the battery voltage was below 23V before a buffer request.

Temperature:

A double flash indicates that the temperature of the DC-UPS is too high (above 70°C) or that the temperature of the battery is too high (above 50°C) or too low (below -15°C). Battery temperatures indications require a connected battery temperature sensor.



## 13. CONNECTION TERMINALS

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

	<b>Input, output and battery terminals</b>	<b>Signal terminals (except battery-low pre-warning)</b>	<b>Battery-low pre-warning terminals</b>
<b>Type</b>	Screw terminals	Pluggable screw terminals	Push-in termination
Solid wire	Max. 16mm <sup>2</sup>	Max. 1.5mm <sup>2</sup>	Max. 1.5mm <sup>2</sup>
Stranded wire	Max. 10mm <sup>2</sup>	Max. 1.5mm <sup>2</sup>	Max. 1.5mm <sup>2</sup>
American Wire Gauge	AWG 22-8	AWG 22-14	AWG 24-16
Max. wire diameter (including ferrules)	5.2mm	1.5mm	1.6mm
Wire stripping length	12mm / 0.5inch	6mm / 0.25inch	7mm / 0.28inch
Tightening torque	2.3Nm / 20lb.inch	0.4Nm / 3.5lb.inch	-
Screwdriver	Slotted 6.5mm, Philips No 2	Slotted 3mm	Slotted 3mm to open the spring

## 14. LIFETIME EXPECTANCY

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

Lifetime expectancy	457 000h	Power supply mode, 20A and 40°C, fully charged
	1 370 000h	Power supply mode, 20A and 25°C, fully charged
	322 000h	Power supply mode, 40A and 40°C, fully charged
	842 000h	Power supply mode, 40A and 25°C, fully charged

## 15. MTBF

MTBF stands for **Mean Time Between Failure**, which is calculated according to statistical device failures, and indicates reliability of a device. It is the statistical representation of the likelihood of a unit to fail and does not necessarily represent the life of a product.

The MTBF figure is a statistical representation of the likelihood of a device to fail. A MTBF figure of e.g. 1 000 000h means that statistically one unit will fail every 100 hours if 10 000 units are installed in the field. However, it can not be determined if the failed unit has been running for 50 000h or only for 100h.

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

MTBF SN 29500, IEC 61709	T.B.D.	Power supply mode, 40A and 40°C
	T.B.D.	Power supply mode, 40A and 25°C
MTBF MIL HDBK 217F	T.B.D.	Power supply mode, 40A and 40°C; Ground Benign GB40
	T.B.D.	Power supply mode, 40A and 25°C; Ground Benign GB25
	T.B.D.	Power supply mode, 40A and 40°C; Ground Fixed GF40
	T.B.D.	Power supply mode, 40A and 25°C; Ground Fixed GF25

## 16. EMC

The EMC behavior of the device is designed for applications in industrial environment as well as in residential, commercial and light industry environment without any restrictions.

The device complies with EN 61000-6-1, EN 61000-6-2, EN 61000-6-3, EN 61000-6-4, EN 61000-3-2 and EN 61000-3-3.

The 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.

All tests are performed in power supply and battery mode.

The chassis of the device is earthed through the DIN-rail mounting connection to a grounded metal plate.

EMC Immunity	Power lines and housing			
Electrostatic discharge	EN 61000-4-2	Contact discharge	8kV	Criterion A
		Air discharge	15kV	Criterion A
Electromagnetic RF field	EN 61000-4-3	80MHz – 2.7GHz	20V/m	Criterion A
Fast transients (Burst)	EN 61000-4-4	Input lines	2kV	Criterion A
		Output lines	2kV	Criterion A
Surge voltage on input lines	EN 61000-4-5	+ → -	1kV with 40 Ohms or 0.5kV, 2 Ohms	Criterion A
		+ / - → Chassis ground	1kV	Criterion A
Surge voltage on output lines	EN 61000-4-5	+ → -	1kV with 40 Ohms	Criterion A
		+ / - → Chassis ground	1kV	Criterion A
Surge voltage on battery and center-tap (CT)	EN 61000-4-5	+ → -	N/A (wire length)	-
		+ / - / CT → chassis ground	1kV	Criterion A
Conducted disturbance	EN 61000-4-6	0.15-80MHz	10V	Criterion A

EMC Immunity	Signals			
Fast transients (Burst)	EN 61000-4-4	With coupling clamp	2kV	Criterion A
Surge voltage	EN 61000-4-5	Signal → chassis ground	1kV	Criterion A

### Criteria:

**A:** The device shows normal operation behavior within the defined limits.

### EMC Emission

Conducted emission	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1		Input lines	Limits for local DC power networks fulfilled.
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1		Output lines	Limits for local DC power networks fulfilled.
	IEC/CISPR 16-1-2, IEC/CISPR 16-2-1		Battery lines	N/A (wire length)
Radiated emission	EN 55011, EN 55032, CISPR 11, CISPR 32			Class B

### Switching Frequencies

Battery charger	110kHz and 220kHz	Two fixed frequencies, can occur at the same time
Battery balancer	100kHz	Fixed frequency
Auxiliary converter	40 to 80kHz	Input voltage dependent
Microcontroller	24 MHz	Fixed frequency

## 17. ENVIRONMENT

Operational temperature	-25°C to +70°C (-13°F to 158°F)	Operational temperature is the same as the ambient or surrounding temperature and is defined as the air temperature 2cm below the unit.
Storage temperature	-40°C to +85°C (-40°F to 185°F)	For storage and transportation
Output de-rating	1A/°C 2.5A/1000m or 5°C/1000m The de-rating is not hardware controlled. The user has to take this into consideration to stay below the de-rated current limits in order not to overload the unit.	Between +50°C and +70°C (122 - 158°F), see Fig. 17-1 For altitudes above 2000m (6560ft), see Fig. 17-2
Humidity	5 to 95% r.h.	According to IEC 60068-2-30
Atmospheric pressure	110-54kPa	See Fig. 17-2 for details
Altitude	Up to 5000m (16 400ft)	See Fig. 17-2 for details
Overvoltage category	N/A	
Impulse withstand voltages	1.5kV	Between input and chassis (according to IEC 60664-1 over-voltage category II)
Degree of pollution	2	According to IEC 60664-1, not conductive
Vibration sinusoidal	2-17.8Hz: ±1.6mm; 17.8-500Hz: 2g 2 hours / axis	According to IEC 60068-2-6
Shock	30g 6ms, 20g 11ms 3 bumps per direction, 18 bumps in total Shock and vibration are tested in combination with DIN-Rails according to EN 60715 with a height of 15mm and a thickness of 1.3mm.	According to IEC 60068-2-27

Fig. 17-1 Output current vs. ambient temp.

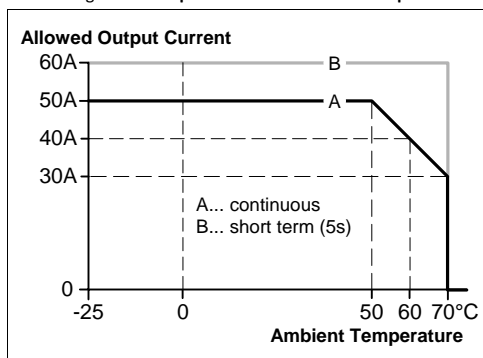
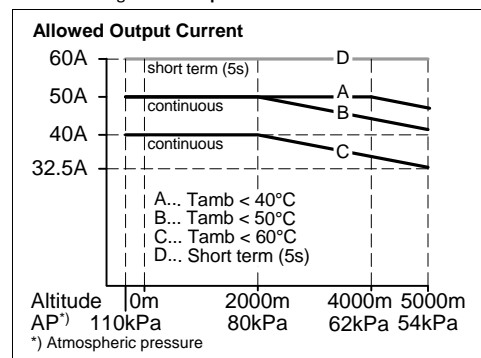





Fig. 17-2 Output current vs. altitude







## 18. SAFETY AND PROTECTION FEATURES

Isolation resistance	Min.	10MΩ	At delivered condition between power port and signals, measured with 500Vdc
	Min.	10MΩ	At delivered condition between power port and housing, measured with 500Vdc
	Min.	10MΩ	At delivered condition between signals and housing, measured with 500Vdc
Dielectric strength	Max.	500Vac	Power port to signal port
	Max.	500Vac	Power port / signal port to housing
Class of protection		III	A PE (Protective Earth) connection is not required
Ingress protection		IP 20	According to EN/IEC 60529
Over-temperature protection		Included	In case of a too high temperature in battery mode, the output shuts down. To attempt a restart, turn the input power off and wait until the device has cooled off before turning in again.  There is no correlation between the operating temperature and turn-off temperature since this is dependent on input voltage, load and installation methods.
Output over-voltage protection	Max.	32V	In case of an internal defect, a redundant circuit limits the maximum output voltage. The output shuts down and automatically attempts to restart.
Internal input fuse		Not included	
Input over-voltage protection	Max.	35Vdc	No harm or defect of the unit
Reverse input polarity protection	Max.	-35Vdc	No harm or defect of the unit
Reverse battery polarity protection	Max.	-35Vdc	No harm or defect of the unit
Protection against wrong battery voltage	Max.	+35Vdc	No harm or defect of the unit
Battery deep discharge protection		Included	Buffering will stop when deep discharge protection is active, and batteries will be disconnected from the DC-UPS.
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.	

## 19. APPROVALS AND FULFILLED OR TESTED STANDARDS

IEC 61010 planned	<b>IECEE</b> CB SCHEME	CB Scheme Certificate IEC 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular Requirements for control equipment
IEC 60950-1 planned	<b>IECEE</b> CB SCHEME	CB Scheme Certificate IEC 60950-1 General safety requirements for Information Technology Equipment (ITE)
UL 61010-2-201 (former UL 508) planned	 Ind. Cont. Eq.	UL Certificate Listed equipment for category NMTR - UL 61010-2-201 Electrical Equipment for Measurement, Control and Laboratory Use - Particular requirements for control equipment Applicable for US and Canada E-File: E198865
IEC 60068-2-60	<b>Corrosion</b> IEC 60068-2-60 Method 4 	Flowing Mixed Gas Corrosion Test - Test KE, Method 4 H <sub>2</sub> S: 10ppb, NO <sub>2</sub> : 200ppb, Cl <sub>2</sub> : 10ppb, SO <sub>2</sub> : 200ppb Test Duration: 3 weeks, simulates a service life of 10 years.
ISA-71.04-1985	<b>Corrosion</b> G3-ISA-71.04 	Airborne Contaminants Corrosion Test - Severity Level G3 H <sub>2</sub> S: 100ppb, NO <sub>x</sub> : 1250ppb, Cl <sub>2</sub> : 20ppb, SO <sub>2</sub> : 300ppb Test Duration: 3 weeks, simulates a service life of 10 years.
VDMA 24364	<b>LABS</b> VDMA 24364-C1-L/W	Paint Wetting Impairment Substances Test (or LABS-Test) Tested for Zone 2 and test class C1 according to VDMA 24364-C1-L/W for solvents and water-based paints

## 20. REGULATORY COMPLIANCE

CE		EU Declaration of Conformity Trade conformity assessment for Europe The CE mark indicates conformance with the European - RoHS directive and the - EMC directive
REACH Directive	<b>REACH</b> 	Manufacturer's Statement EU-Regulation regarding the Registration, Evaluation, Authorisation and Restriction of Chemicals
WEEE Directive		Manufacturer's Statement EU-Directive on Waste Electrical and Electronic Equipment
RoHS (China RoHS 2)		Manufacturer's Statement Administrative Measures for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products 25 years

## 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	530g / 1.17lb	
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 "Installation Instructions"	
Penetration protection	Small parts like screws, nuts, etc. with a diameter larger than 4mm	

Fig. 21-1 Front view

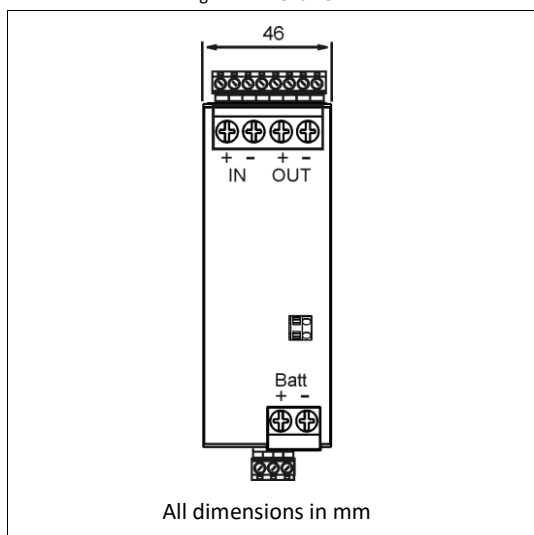
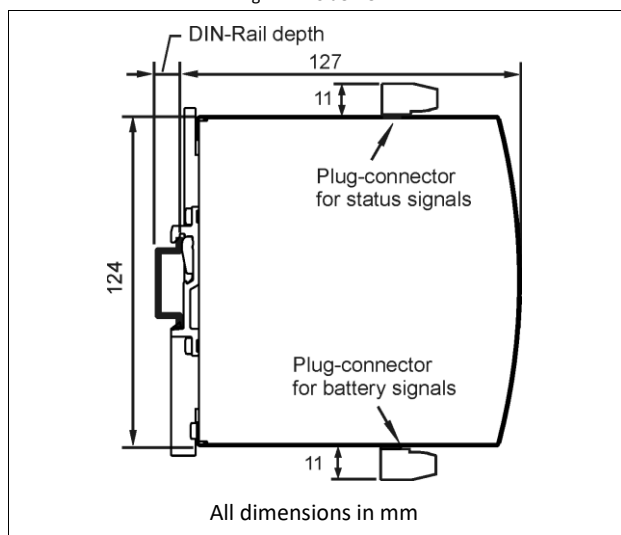


Fig. 21-2 Side view



## 22. ACCESSORIES

### 22.1. ZM10.WALL – WALL/PANEL MOUNT BRACKET

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

Fig. 22-1 Isometric view

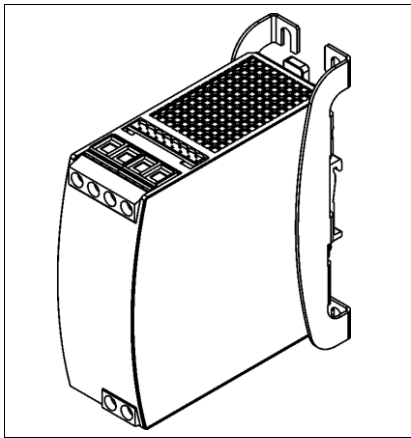


Fig. 22-2 Isometric view

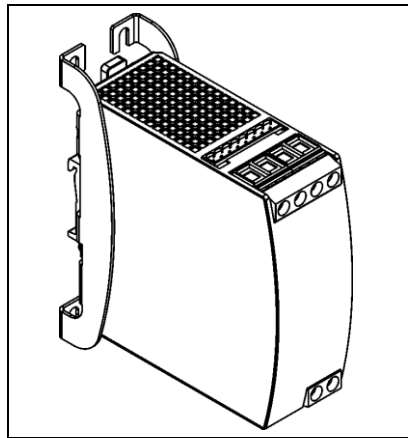


Fig. 22-3 Isometric view

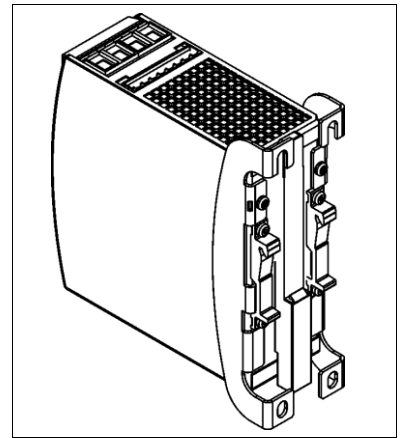


Fig. 22-4 Wall/panel mounting, front view

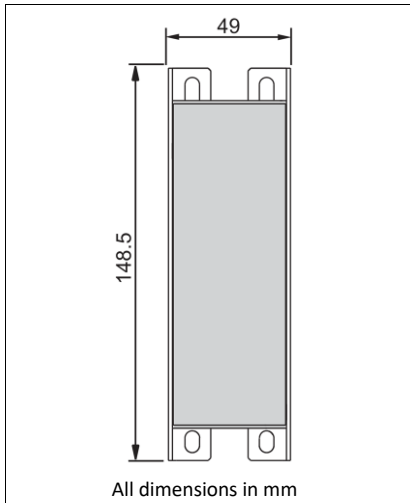


Fig. 22-5 Hole pattern for wall mounting

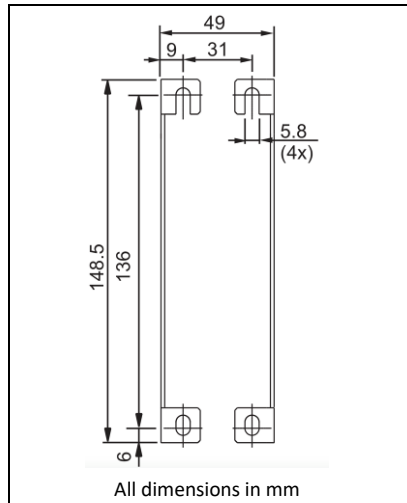
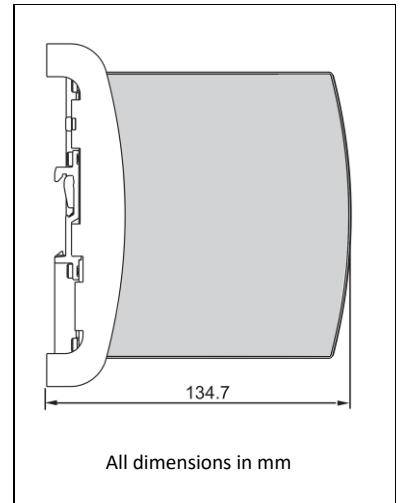


Fig. 22-6 Wall/panel mounting, side view





## 22.2. ZM12.SIDE - SIDE MOUNTING BRACKET



This bracket is used to mount the power supply sideways with or without utilizing a DIN-Rail.

The two aluminum brackets and the black plastic slider of the unit have to be detached, so that the steel brackets can be mounted.

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

Fig. 22-7  
Side mounting without DIN-rail  
brackets

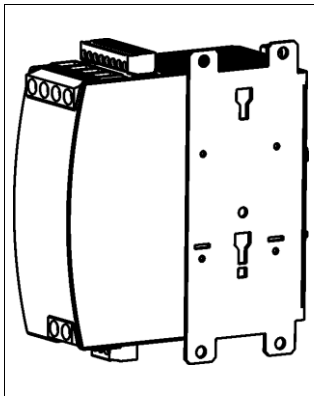


Fig. 22-8  
Side mounting with DIN-rail  
brackets

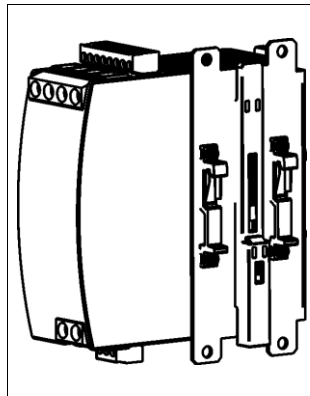
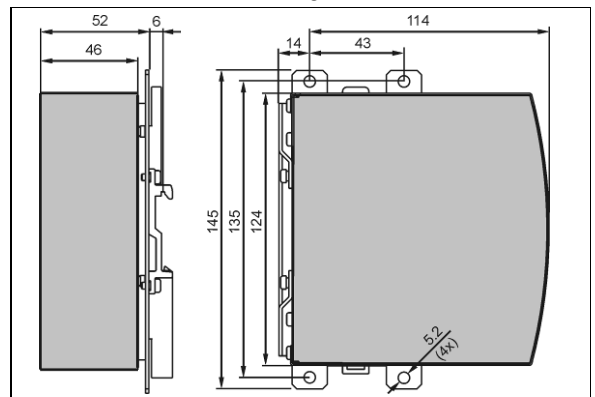


Fig. 22-9  
Mounting Dimensions  
Side mounting bracket



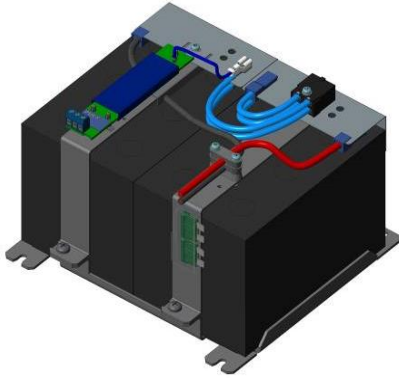
## 22.3. UZS24.100 – SENSOR BOARD FOR DC-UPS



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.

The fuse protects the center-tap wire between the battery module and the DC-UPS control unit.

## 22.4. UZK24.122 – 24V, 12AH BATTERY MODULE

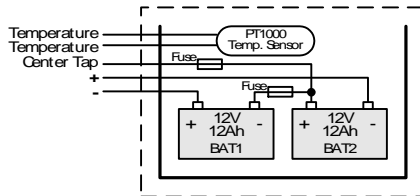


The UZK24.122 battery module, recommended for load currents up to 40A, which utilizes two non-spillable maintenance-free VRLA lead-acid batteries with absorbent glass mat (AGM) technology connected in series. It is assembled with 1.5m wire leads and fusing included.

The battery module is available in two different options. It can be ordered as UZK-module with batteries included or as UZO-module without batteries, which can be installed at a later date. This option helps to avoid outdated batteries.

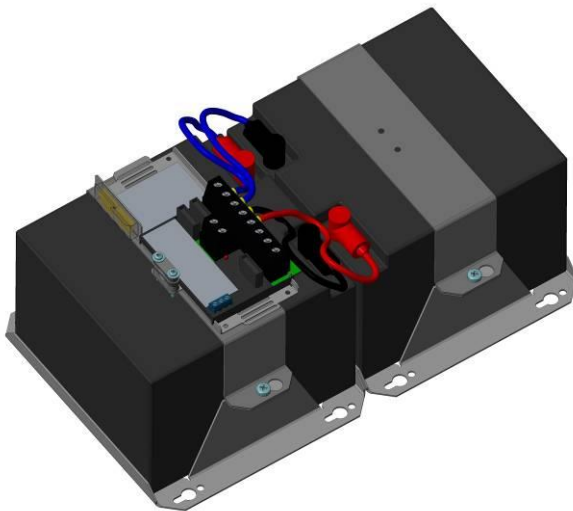
The battery module also includes a sensor board, which contains a temperature sensor and a center-tap connection terminal. The use of the sensor board enables to monitor and charge the two batteries individually and precisely. This extends the service life of the batteries and makes the use of matched replacement batteries unnecessary.

The use of the sensor board is optional and the DC-UPS will function without the sensor board installed.



UZK24.122 Wiring scheme

## 22.5. UZK24.262 – 24V, 26AH BATTERY MODULE



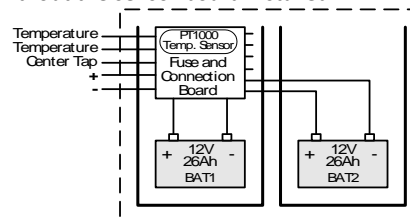
The UZK24.262 battery module utilizes two non-spillable maintenance-free VRLA lead-acid batteries with absorbent glass mat (AGM) technology connected in series. It is assembled with all wiring and fusing included.

For easier mounting and because of the high weight the battery holder is made in two parts.

The battery module is available in two different options. It can be ordered as UZK-module with batteries included or as UZO-module without batteries, which can be installed at a later date. This option helps to avoid outdated batteries.

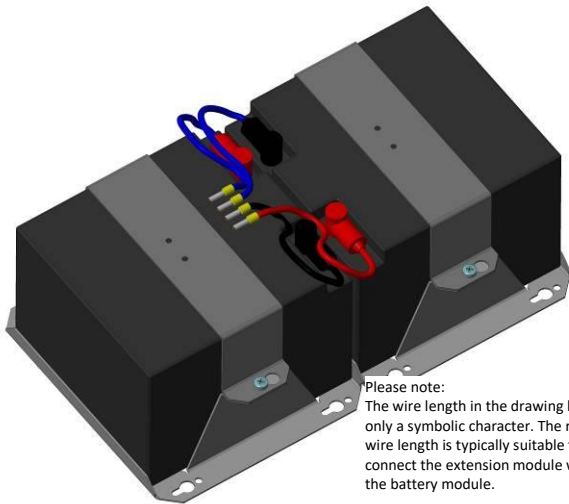
The battery module also includes a sensor board, which contains a temperature sensor and a center-tap connection terminal. The use of the sensor board enables to monitor and charge the two batteries individually and precisely. This extends the service life of the batteries and makes the use of matched replacement batteries unnecessary.

The use of the sensor board is optional and the DC-UPS will function without the sensor board installed.



UZK24.262 Wiring scheme

## 22.6. UZK24.262-E1 – 24V, 26AH BATTERY MODULE EXTENSION

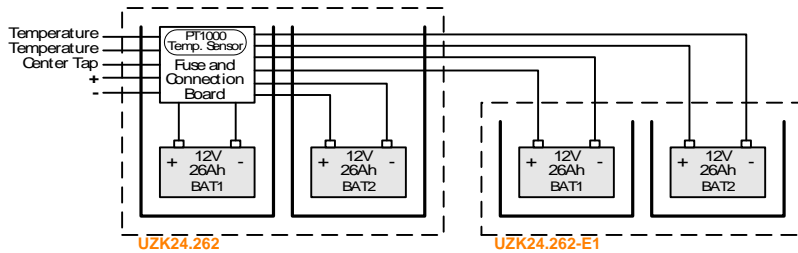


The UZK24.262-E1 battery module extension utilizes two non-spillable maintenance-free VRLA lead-acid batteries with absorbent glass mat (AGM) technology connected in series. It is assembled with all wiring included.

The battery module extension can be connected to the UZK24.262, which doubles the autonomy time by paralleling of batteries.

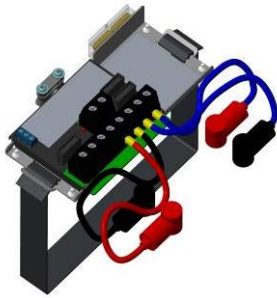
For easier mounting and because of the high weight the battery holder is made in two parts.

The battery module is available in two different options. It can be ordered as UZK-module with batteries included or as UZO-module without batteries, which can be installed at a later date. This option helps to avoid outdated batteries.



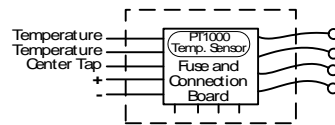
UZK24.262 + UZK24.262-E1 Wiring scheme

## 22.7. UZW24.100 – CONNECTION AND WIRING KIT



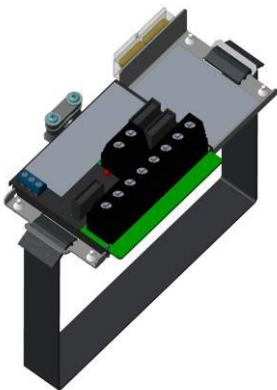
The UZW24.100 is a wiring kit for batteries which are not supplied by PULS or larger sized batteries. It includes the necessary cabling and a 60cm fastening strap for fixing to the battery. The battery wiring is optimized for 26Ah batteries.

The wiring kit also includes a sensor board, which contains a temperature sensor and a center-tap connection terminal. The use of the sensor board enables to monitor and charge the two batteries individually and precisely. This extends the service life of the batteries and makes the use of matched batteries unnecessary. The use of the sensor board is optional, and the DC-UPS will function without the sensor board installed.

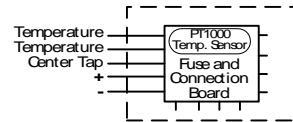


UZW24.100 Wiring scheme

## 22.8. UZW24.101 – CONNECTION AND WIRING KIT



The UZW24.101 is the same as the UZW24.100 but with a 1m fastening strap and without the cabling for battery connection.



UZW24.101 Wiring scheme

## 23. APPLICATION NOTES

### 23.1. 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:

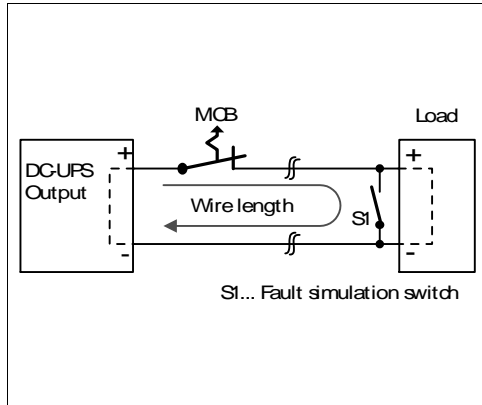
A) DC-UPS is operating in power supply mode:

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 and must be slightly reduced due to losses in the DC-UPS.

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.

Fig. 23-1 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>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>C-3A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>C-4A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>C-6A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>C-10A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>C-13A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>B-6A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>B-10A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>B-13A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.
<b>B-16A</b>	T.B.D.	T.B.D.	T.B.D.	T.B.D.

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

## 23.2. 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, etc. Such failures occur randomly and cannot be predicted. The device 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 minute
- Battery dynamic impedance test, performed every 4 hours. Please note that the first test starts earliest 1 minute after applying the input voltage.
- Extensive longer charging time test when charging time exceeds 19h in 12Ah setting, 27h in 26Ah, 42h in 36Ah, 32h in 65Ah, 72h in 100Ah and 120h in >150Ah setting

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 device (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. 23-2 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. 23-3.
- **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 device, 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 device does not produce such a ripple voltage. This effect can be ignored when the battery is charged with the device.

**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. 23-3.

Fig. 23-2 Service life versus ambient temperatures, typ \*)

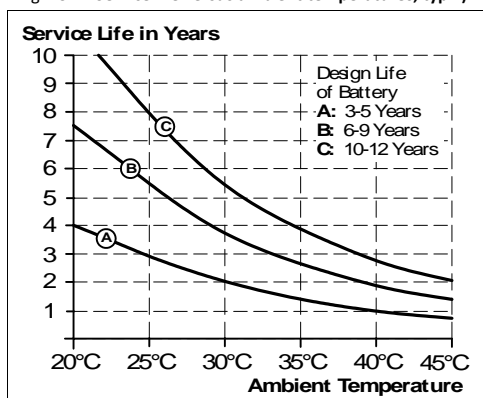
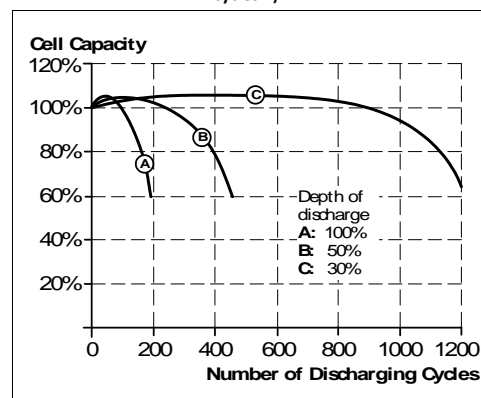


Fig. 23-3 Battery capacity degradation vs. discharging cycles \*)



\*) 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. 23-2 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. 23-3, 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:**

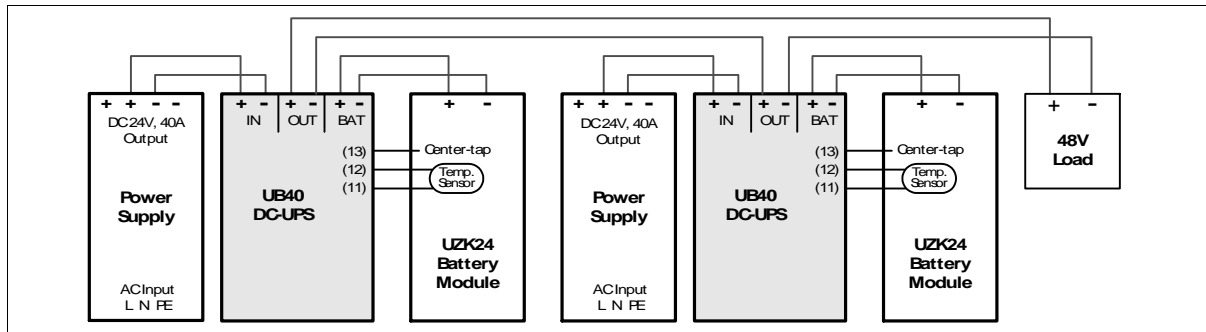
The battery shall be replaced after 5 years.

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

## 23.3. SERIES OPERATION

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

Fig. 23-4 Wiring example for 48V serial use



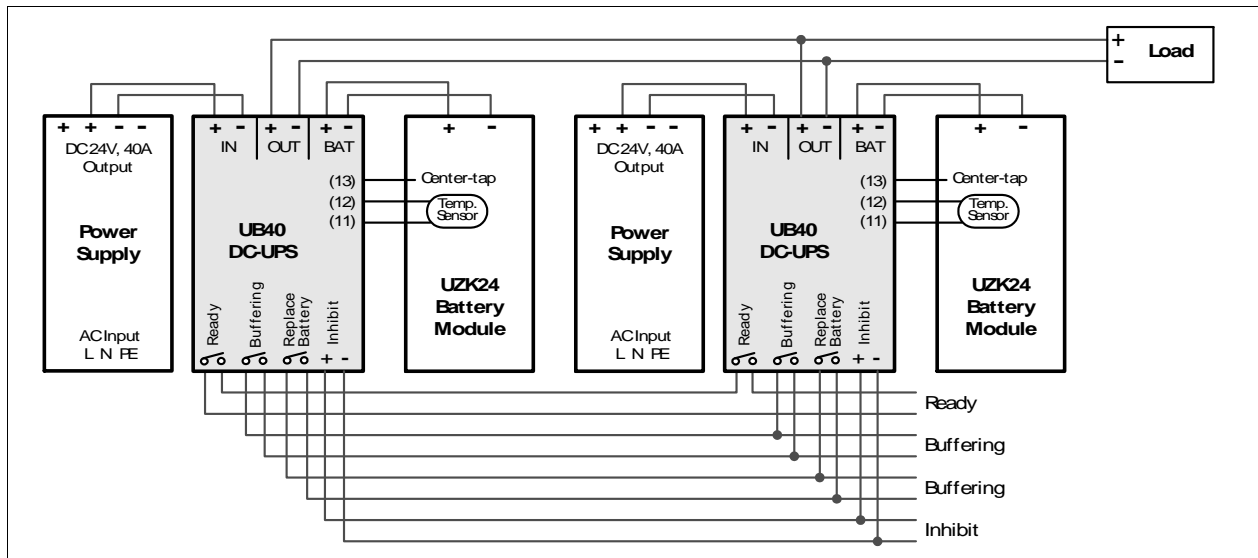
## 23.4. PARALLELING OF MODULES

### Parallel use to increase the output current

Use two DC-UPSs with two individual power supplies and two battery modules to build a system with higher output current.

Please note that the maximal allowed capacitive or inductive load do not double or multiply, when modules are connected in parallel.

Fig. 23-5 Wiring example for parallel use to increase the output current





### Parallel use for redundancy

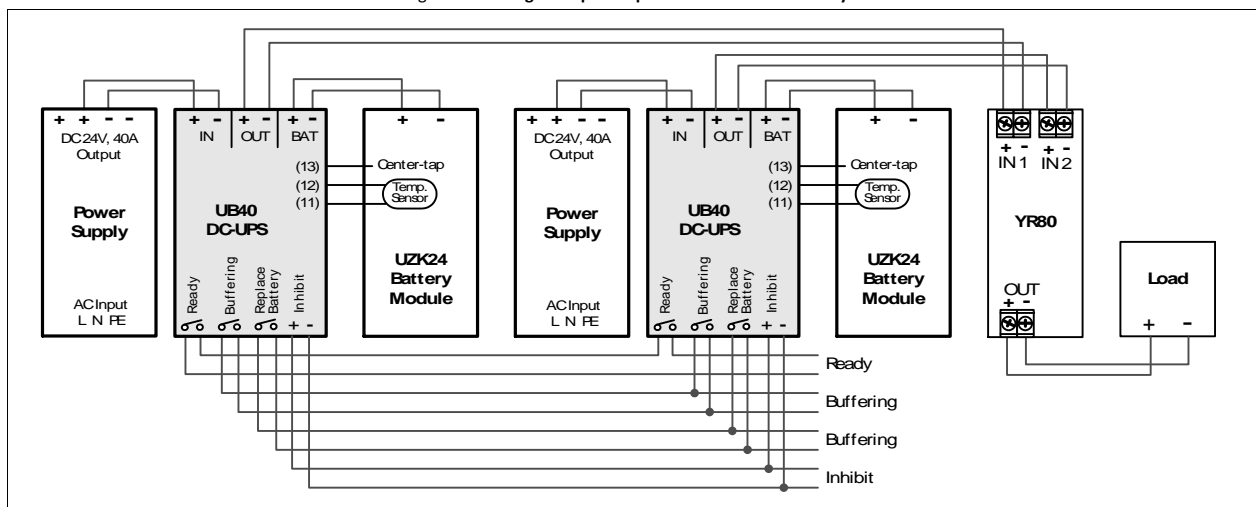
Use two DC-UPSs with two individual power supplies, two battery modules and one decoupling module to build a redundant system.

Recommendations for building redundant systems:

- 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.

Please note that the maximal allowed capacitive or inductive load do not double or multiply, when modules are connected in parallel.

Fig. 23-6 Wiring example for parallel use for redundancy



### 23.5. 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 chapter "Installation Instructions" 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 higher than 23V 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 14V 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>- Input voltage of the DC-UPS did not reach the minimum voltage of 23V.</li> <li>- Battery voltage is below 23V.</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 of the battery or DC-UPS</li> <li>- Too large output capacitors. The resulting peak current can trigger the current limiter, which switches off the output of the DC-UPS. See also chapter 5.</li> <li>- Critical low input voltage. Due to excessive voltage drops between the power supply and the DC UPS, the input voltage can exceed the 23V threshold several times during load changes, which is recognized by the DC UPS as a restart.</li> <li>- Center-tap connection opens (or other center-tap connection problems) during battery mode</li> </ul>
The DC UPS stops buffering and prevents re-buffering for 5 seconds	<p>Too many buffering events in too short of a time can lead to a 5 second lock for further buffering requests.</p> <p>For example, if there are multiple 0.2s buffer requests over a duration of 3.3s or multiple 0.3s buffer requests over a duration of 9.2s or multiple 0.4s buffer requests over a duration of 14s, further buffering requests can be blocked for 5 seconds.</p> <p>Multiple buffer events longer than 0.5s do not lead to such a 5s lock for further buffering events.</p>
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 lower than 22.2V or higher than 23V. Each transition through 22.2V and 23V switches between power supply mode and battery mode. 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>