5. INPUT

Input voltage	nom.	DC 24V	
Input voltage ranges	nom.	22.5 to 30Vdc	Continuous operation, see Fig. 5-1
		30 to 35Vdc	Temporarily allowed, no damage to the DC-UPS *)
		35Vdc	Absolute maximum input voltage with no damage to the DC-UPS
		0 to 22.5Vdc	The DC-UPS switches into buffer mode and delivers output voltage from the battery if the input was above the turn-on level before and all other buffer conditions are fulfilled.
Allowed input voltage ripple	max.	1.5Vpp	Bandwidth <400Hz
		1Vpp	Bandwidth 400Hz to 1kHz
Allowed voltage between input and earth (ground)	max.	60Vdc or 42.4Vac	
Turn-on voltage	typ. max.	22.8Vdc 23Vdc	The output does not switch on if the input voltage does not exceed this level.
Input current **)	typ.	140mA	Internal current consumption
	typ.	1.1A	Current consumption for battery charging in constant current mode at 24V input See Fig. 8-2 ***)
External capacitors on the input		No limitation	

*) The DC-UPS shows "Check Wiring" with the red LED and buffering is not possible

**) The total input current is the sum of the output current, the current which is required to charge the battery during the charging process and the current which is needed to supply the DC-UPS itself. See also Fig. 5-2. This calculation does not apply in overload situations where the DC-UPS limits the output current, therefore see Fig. 5-3.

***) Please note: This is the input current and not the current which flows into the battery during charging. The battery current can be found in chapter 8.

Fig. 5-1 **Input voltage range**

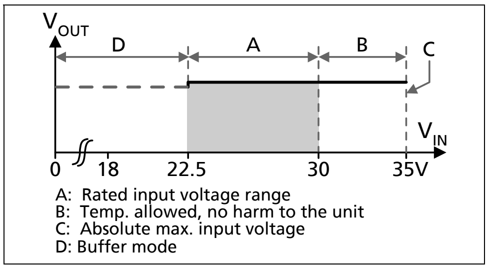
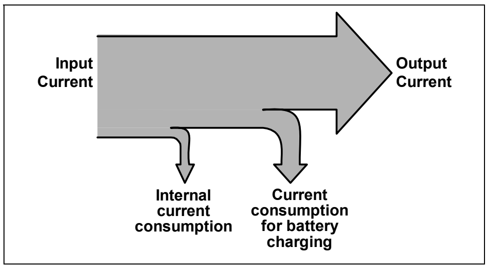


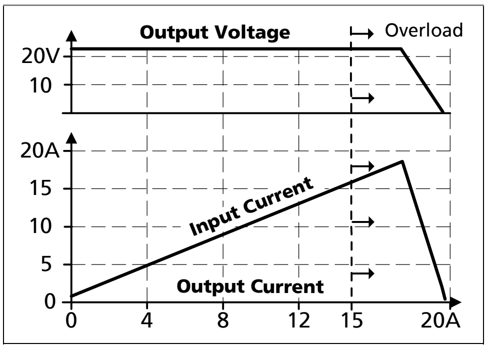
Fig. 5-2 **Input current, definitions**



Electronic output current limitation

The DC-UPS is equipped with an electronic output current limitation. This current limitation works in a switching mode which reduces the power losses and heat generation to a minimum. As a result, the output voltage drops since there is not enough current to support the load. A positive effect of the current limitation in switching mode is that the input current goes down despite an increase in the output current resulting in less stress for the supplying source. Fig. 5-3 shows the behavior when the 12V is not loaded. Power which is taken out from the 12V reduces the power on the 24V side.

Fig. 5-3 **Input current vs. 24V output current, typ. (battery fully charged)**



6. OUTPUT IN NORMAL MODE

The total output power of 360W can be shifted dynamically between the two outputs.

24V Output:

Output voltage	nom.	DC 24V	The output voltage follows the input voltage reduced by the input to output voltage drop.
Voltage drop between input and output	max.	0.3V	At 10A output current, see Fig. 6-1 for typical values
	max.	0.45V	At 15A output current, see Fig. 6-1 for typical values
Ripple and noise voltage	max.	20mVpp	20Hz to 20MHz, 50Ohm *)
Output current	nom.	0 – 15A	Continuously allowed, lower if the 12V output is loaded.
	min.	12.3A	Output if 12V output is loaded with 5A.
Short-circuit current	min.	17.9A	Load impedance 100mOhm, see Fig. 6-2 for typical values. The 12V output is off during an overload or short on the 24V.
	max.	21A	
Capacitive and inductive loads		No limitation	

12V Output:

Output voltage	nom.	DC 12V	
Output voltage tolerance		±2%	
Ripple and noise voltage	typ.	30mVpp	20Hz to 20MHz, 50Ohm *)
Output current	nom.	0 - 5A	Continuously allowed, may be lower if the 24V output is loaded more than 12.3A
Short-circuit current	min.	4A	Load impedance 100mOhm, see Fig. 7-5. for typical values. The 24V output is on during an overload or short on the 12V.
	max.	5.5A	
Capacitive and inductive loads		No limitation	

*) This figure shows the ripple and noise voltage which is generated by the DC-UPS. The ripple and noise voltage might be higher if the supplying source has a higher ripple and noise voltage.

Fig. 6-1 **Input to output voltage drop, typ.**

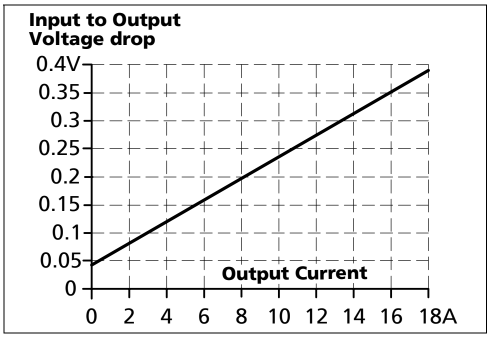
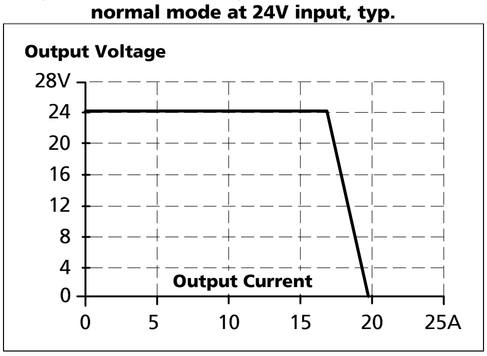


Fig. 6-2 **Output voltage vs. output current in normal mode at 24V input, typ.**



7. OUTPUT IN BUFFER MODE

If the input voltage falls below the transfer threshold level, the DC-UPS starts buffering without any interruption or voltage dips. The transfer threshold level is typically 80mV higher than the 24V output voltage in buffer mode. Buffering is possible even if the battery is not fully charged.

24V Output

Output voltage	nom.	DC 24V	Output is stabilized and independent from battery voltage
		22.45V	±1%, at no load,
		22.25V	±1%, at 10A output current
Ripple and noise voltage	max.	20mVpp	20Hz to 20MHz, 50Ohm
Output current	nom.	0 - 10A	Continuously allowed, 12V output not loaded.
		10 - 15A	*) 12V output not loaded.
	min.	7.0A	If 12V output is loaded with 5A.
Short-circuit current	min.	17.9A	Load impedance 100mOhm **); The 12V output is off during an overload or short on the 24V.
	max.	21A	

12V Output

Output voltage	nom.	DC 12V	Output is stabilized and independent from battery voltage
Output voltage tolerance		±2%	
Ripple and noise voltage	typ.	30mVpp	20Hz to 20MHz, 50Ohm ;
Output current	nom.	0 - 5A	Continuously allowed, may be lower if the 24V output is loaded more than 7.0A
Short-circuit current	min.	4A	Load impedance 100mOhm, see Fig. 7-5 for typical values. Continuous constant; The 24V output is on during an overload or short on the 12V as long as the battery delivers current.
	max.	5.5A	

*) If the output current is in the range between 10A and 15A (Bonus Power) for longer than 5s, a hardware controlled reduction of the maximal output current to 10A occurs. If the 10A are not sufficient to maintain the 24V, buffering stops at both outputs after another 5s. The buffering is possible again as soon as the input voltage recovers.

**) If the nominal output voltage cannot be maintained in buffer mode, the DC-UPS switches off after 5s to save battery capacity.

Fig. 7-1 **Buffering transition, definitions**

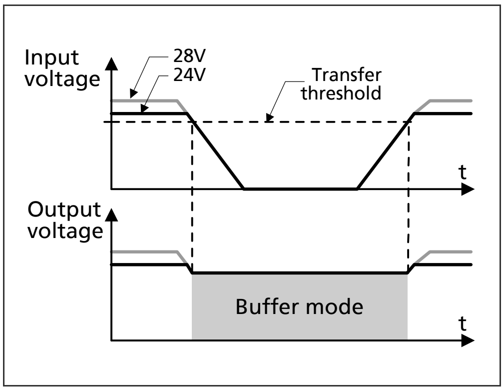


Fig. 7-2 **Transfer behavior, typ.**

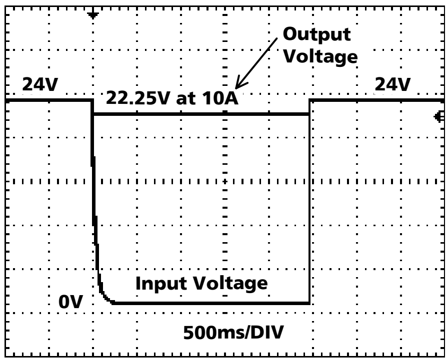


Fig. 7-3 **Available output current in buffer mode**

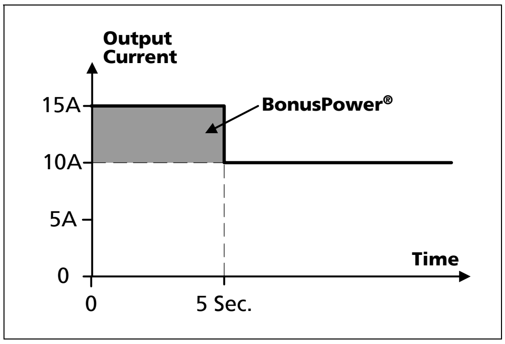


Fig. 7-4 **24V Output voltage vs. output current in buffer mode, typ.**

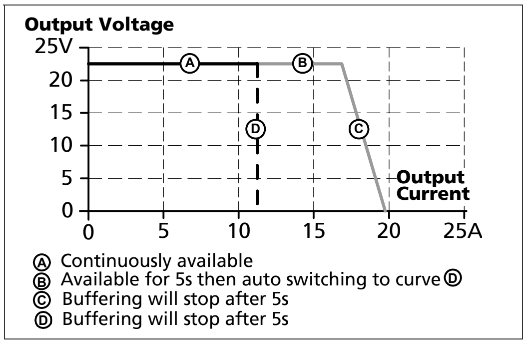
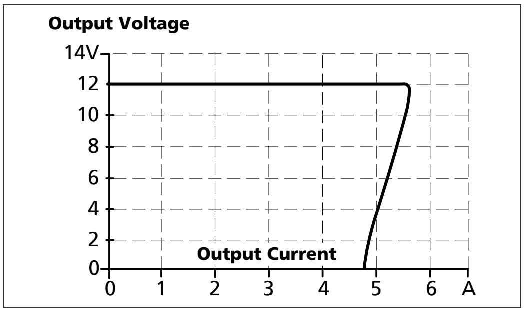


Fig. 7-5 **12V Output voltage vs. output current in normal or buffer mode, typ.**



8. BATTERY INPUT

The DC-UPS requires one 12V VRLA battery to buffer the 24V and 12V output.

Battery voltage	nom.	DC 12V	Use one maintenance-free 12V VRLA lead acid battery or one battery module which is listed in the chapter accessories.
Battery voltage range		9.0 – 15.0V	Continuously allowed, except deep discharge protection
	max.	35Vdc	Absolute maximum voltage with no damage to the unit
	typ.	7.4V	Above this voltage level battery charging is possible
Allowed battery sizes	min.	3.9Ah	
	max.	27Ah	
Internal battery resistance	max.	100mOhm	See individual battery datasheets for this value
Battery charging method		CC-CV	Constant current, constant voltage mode
Battery charging current (CC-mode)	nom.	1.5A	Independent from battery size,
	max.	1.7A	Corresponding 24V input current see Fig. 8-2
End-of-charge-voltage (CV-mode)		13.4-13.9V	Adjustable, see chapter 14
Battery charging time	typ.	5h *)	For a 7Ah battery
	typ.	17h *)	For a 26Ah battery
Battery discharging current **)	typ.	21A	Buffer mode, 240W output, 11.5V on the battery terminal of the DC-UPS, see Fig. 8-1 for other parameters
	typ.	0.3A	Buffer mode, 0A output current
	max.	50µA	At no input, buffering had switched off, all LEDs are off
	typ.	310mA	At no input, buffering had switched off, yellow LED shows "buffer time expired" (max. 15 minutes)
Deep discharge protection ***)	typ.	10.5V	At 0% output load
	typ.	9.0V	At 100% output load

*) The charging time depends on the duration and load current of the last buffer event. The numbers in the table represent a fully discharged battery. A typical figure for a buffer current of 10A at 24V output is 3h 20Min. for a 7Ah battery.

**) The current between the battery and the DC-UPS is more than twice the 24V output current. This is caused by boosting the 12V battery voltage to a 24V level. This high current requires large wire gauges and short cable length for the longest possible buffer time. The higher the resistance of the connection between the battery and the DC-UPS, the lower the voltage on the battery terminals which increases the discharging current. See also chapter 25 for more installation instructions.

***) To ensure longest battery lifetime, the DC-UPS has a battery deep discharge protection feature included. The DC-UPS stops buffering when the voltage on the battery terminals of the DC-UPS falls below a certain value.

Fig. 8-1 **Battery discharging current vs. 24V output current, typ. (12V not loaded)**

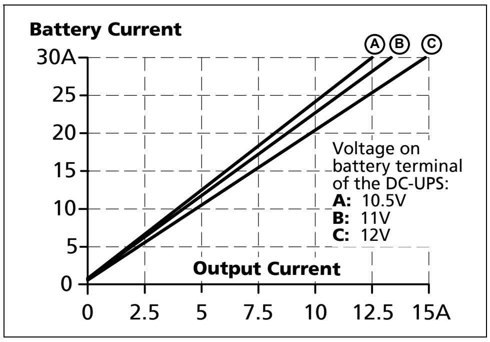
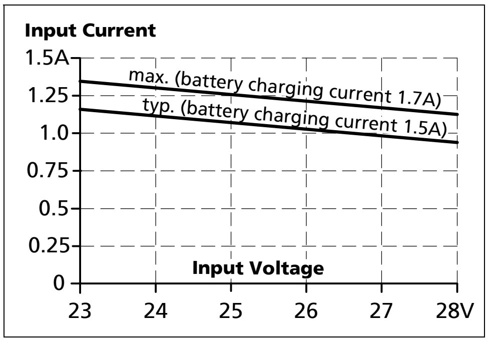


Fig. 8-2 **Required input current vs. input voltage for battery charging (12V not loaded)**



9. BUFFER TIME

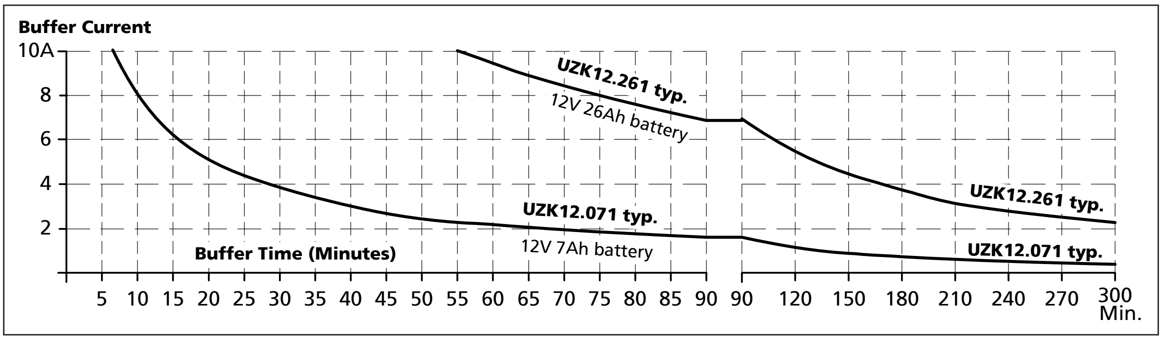
The buffer time depends on the capacity and performance of the battery as well as the load current. The diagram below shows the typical buffer times of the 24V output with the standard battery modules at 20°C.

Buffer time with battery module UZK12.071	min.	18'30''	At 5A output current *)
	min.	5'30''	At 10A output current *)
	typ.	20'50''	At 5A output current, see Fig. 9-1 **)
	typ.	6'30''	At 10A output current, see Fig. 9-1 **)
Buffer time with battery module UZK12.261	min.	96'30''	At 5A output current *)
	min.	37'50"	At 10A output current *)
	typ.	126'	At 5A output current, see Fig. 9-1 **)
	typ.	53'20"	At 10A output current, see Fig. 9-1 **)

*) Minimum value includes 20% aging of the battery and a cable length of 1.5m with a cross section of 2.5mm² between the battery and the DC-UPS and requires a fully charged (min. 24h) battery.

**) Typical value includes 10% aging of the battery and a cable length of 0.3m with a cross section of 2.5mm² between the battery and the DC-UPS and requires a fully charged (min. 24h) battery.

Fig. 9-1 **Buffer time vs. 24V output current with the battery modules UZK12.071 and UZK12.261**



The buffer time is reduced if the 12V output is loaded. This can be calculated according to the following example:

Example: 24V, 5A and 12V, 4A load

Step1: Convert the 12V current to a virtual 22.3V level:

Ratio: 12V/22.3V= 0.54 12V, 4A output converted to 22.3V level: 0.54*4A=2.15A

Step 2: Add the computed current to the actual 24V current:

2.15A+ 5A = 7.15A

Step 3: Determine the buffer time by using the standard buffer time curve (Fig. 9-1)**:**

7.15A load with UZK12.071: Approx. 12 minutes buffer time.

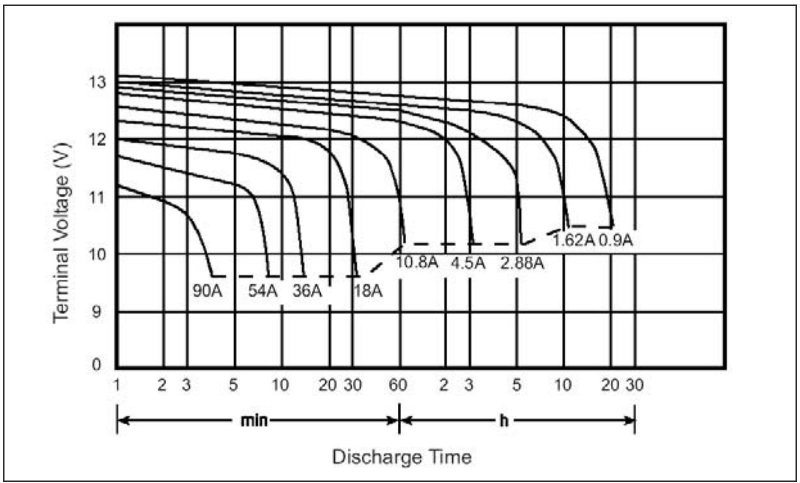
The battery capacity is usually specified in amp-hours (Ah) for a 20h discharging event. The battery discharge is non-linear (due to the battery chemistry). The higher the discharging current, the lower the appropriable battery capacity. The magnitude of the reduction depends on the discharging current as well as on the type of battery. High current battery types can have up to 50% longer buffer times compared to regular batteries when batteries will be discharged in less than 1 hour. High discharging currents do not necessarily mean high power losses as the appropriable battery capacity is reduced with such currents. When the battery begins to recharge after a discharging event, the process is completed much faster since only the energy which was taken out of the battery needs to be "refilled". For this reason, the buffer time cannot be calculated using the Ah capacity value.

The equation "I x t" = capacity in Ah generally leads to incorrect results when the discharging current is higher than C20 (discharging current for 20h). The battery datasheet needs to be studied and a determination of the expected buffer time can be made according to the following example:

Example how to determine the expected buffer time for other battery types and battery sizes:

Step 1 Check the datasheet of the battery which is planned to be used and look for the discharging curve. Sometimes, the individual discharging curves are marked with relative C-factors instead of current values. This can easily be converted. The C-factor needs to be multiplied with the nominal battery capacity to get the current value. E.g.: 0.6C on a 17Ah battery means 10.2A.

Fig. 9-2 **Typical discharging curve of a typical 17Ah battery, curve taken from a manufacturer's datasheet**



Step 2 Determine the required battery current. Use Fig. 8-1 "Battery discharging current vs. output current" to get the battery current. Fig. 8-1 requires the average voltage on the battery terminals. Since there is a voltage drop between the battery terminals and the battery input of the DC-UPS, it is recommended to use the curve A or B for output currents > 3A or when long battery cables are used. For all other situations, use curve C.

Step 3 Use the determined current from Step 2 to find the appropriate curve in Fig. 9-2. The buffer time (Discharging Time) can be found where this curve meets the dotted line. This is the point where the DC-UPS stops buffering due to the under-voltage lockout.

Step 4 Depending on Fig. 9-2, the buffer time needs to be reduced to take aging effects or guaranteed values into account.

Example:

The buffer current is 24V 7.5A and a battery according Fig. 9-2 is used. The cable between the battery and the DC-UPS is 1m and has a cross section of 2.5mm^2. How much is the maximum achievable buffer time.

Answer:

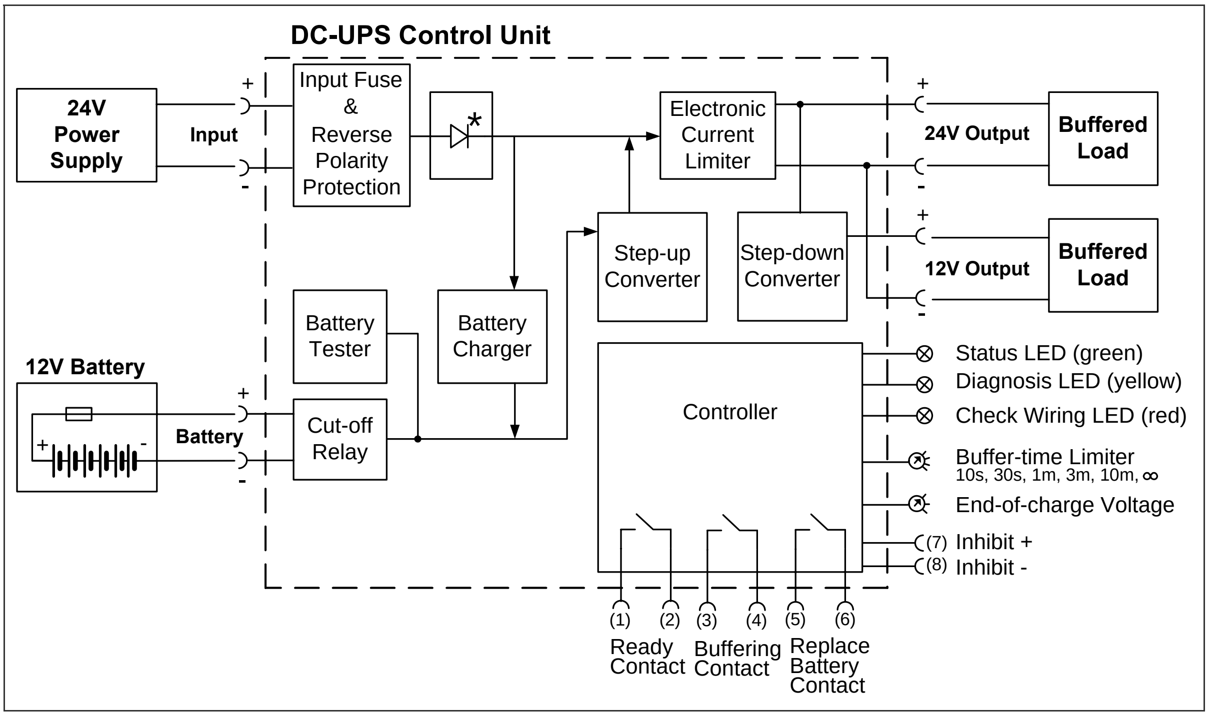
- According to Fig. 8-1, the battery current is 18A. Curve A is used since the battery current is > 3A and the length of the cable is one meter.
- According to Fig. 9-2, a buffer time (Discharging Time) of 30 Minutes can be determined. It is recommended to reduce this figure to approximately 24 minutes for a guaranteed value and to cover aging effects.

10. EFFICIENCY AND POWER LOSSES

Efficiency	typ.	97.5%	Normal mode, 24V 10A, 12V 0A, battery fully charged
	typ.	96%	Normal mode, 24V 7.0A, 12V 5A, battery fully charged
Power losses	typ.	3.4W	Normal mode, no load, battery fully charged
	typ.	6W	Normal mode, 24V 10A, 12V 0A, battery fully charged
	typ.	10W	Normal mode, 24V 12.3A, 12V 5A, battery fully charged
	typ.	5.5W	During battery charging, no load.
	typ.	19W	Buffer mode, 24V 10A, 12V 0A
	typ.	23W	Buffer mode, 24V 7.0A, 12V 5A

11. FUNCTIONAL DIAGRAM

Fig. 11-1 **Functional diagram**



*) Return current protection; This feature utilizes a Mosfet instead of a diode in order to minimize the voltage drop and power losses.