

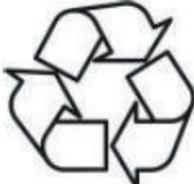
Operating Instructions

Stationary solar valve regulated lead-acid batteries (VLA)

WARNINGS

	Observe operating instructions and position them within sight of the battery! Work only on batteries under instruction of skilled personnel!
	When working on batteries wear safety glasses and protective clothing! Comply with accident prevention rules as well as with DIN VDE 0510 and DIN EN 50110-1 (VDE 0105-1)!
	No smoking! Do not expose the battery to an open flame, a glowing fire or sparks as explosion and fire hazards exist.
	Acid splashes in the eyes or on the skin must be washed out or off with plenty of water. Then see a doctor immediately. Clothing exposed to acid should be washed out with water without delay.
	Dangerous voltage!
	The electrolyte (diluted sulphuric acid) is extremely corrosive.
	Block batteries or cells are heavy! Ensure secure installation! Only use suitable lifting and transport equipment!
	Explosion and fire hazard due to explosive gases escaping from the battery. Caution! Metal parts of the battery are always live, therefore do not place items or tools on the battery! Avoid short circuits!

Usage of the battery which does not comply with the OPERATING INSTRUCTIONS, repairs carried out non-approved with spare parts, use of additives in the electrolyte or unauthorised interference with the battery will invalidate any claim for warranty.

	Used batteries with this symbol are reusable goods and must be returned to the recycling process or must be disposed in accordance with the rules of the country concerned.	
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1. Commissioning of filled and charged batteries

Install the racks or cabinets provided for the installation in the correct location. Inspect all cells for mechanical damage. Before commissioning all cells/blocks must be inspected for mechanical damage. Having battery strings connected in parallel, take care that the same thermal environment and the same electric connection resistance are applied. Don't connect more than 4 partial batteries in parallel. Assemble the cells/blocks in accordance with their polarity. The distance between cells/blocks should be 10 mm.

If necessary the surfaces of the poles and connectors have to be cleaned. For multipole cells all poles have to be connected by connectors with same diameter and length. The connectors have to be firmly seated by tightening the terminal screws M10 with a torque of 22 ± 1 Nm for OPzS. Cable connectors have to be secured during mounting by a fixing tool for connector installation. Observe the Installation Instruction. The temperature difference within a battery string should be smaller than 3 K to avoid differences in voltages and in the general behaviour of separate cells/blocks.

Check the electrolyte level in all cells. If necessary top up with purified water as specified under DIN 43530-4 all cells having lower level of electrolyte. Be aware that the electrolyte level will increase during charging. Connect the battery to the DC power supply, with switched off charger, removed battery fuses and disconnected load, ensure that the correct polarity: Positive terminal of the battery to the positive terminal of the charger.

Switch on the charger and charge as per point 3.3a. The first charge must be monitored to ensure that limits are not exceeded and that no unacceptable temperatures occur. When charging is finished switch off the charger or switch over to operating voltage, as per point 2.1.

2. Operation

At installation and operation of stationary batteries for solar applications the standard EN 50272-2 has to be observed.

Solar batteries should be operated with charge controllers which prevent a deep discharge of the battery. Avoid direct sunlight.

2.1 Operation modes standby and buffer

In this case the load, the DC power supply and the battery must be connected permanently in parallel. Thereby the charging voltage is the operational voltage of the battery and also the system voltage.

a) During standby operation (float) the DC power supply

must be always able to provide the maximum load current and the battery charging current. The battery only supplies current, if the DC power supply fails. The charge voltage at 20 °C must be set for PVS at $(2.23 \text{ V} \pm 1 \%) \times \text{number of cells}$ measured at the batteries terminals.

b) During buffer operation the DC power supply is not always able to provide the maximum load current. The load current temporarily exceeds the rated current of the DC power supply. During this time the battery supplies current. The battery is not always fully charged. Depending on the load, the charge voltage should be set at $(2.25 \text{ to } 2.30 \text{ V}) \times \text{number of cells}$.

2.2 General terms of discharging

a) Discharge: A battery discharges when it supplies an electrical current by switching off the charger and connecting the load with the battery poles. During the discharge the active materials Pb and PbO₂ react with the sulphuric acid and become lead sulphate and water.

b) Self discharge: If the battery voltage is permanently below float voltage (see 3.2c) - e.g. without charge or with low voltage - the battery discharges by itself. It leads in capacity loss and possible sulphation of the electrodes.

c) Voltage drop: When discharged with currents higher than I100, a fully charged battery shows a voltage drop in the beginning (about 5 %) of the discharge, followed by a voltage maximum at about 10 % of discharge time. The presence and the depth of this drop can be a fine indicator for the state of charge (SOC) before discharging.

d) Discharge regimes: Discharge capacities and voltages are specified in point 9. Discharges subjected to operation are limited to 80 % DOD. The final cell voltage for all discharges of 10 hours or longer is 1.8 V/cell. Don't discharge more than specified capacities. Charge immediately after discharge as well as after partial discharge. Deep discharges of more than 80 % C10 have to be avoided as the life time of the batteries will be reduced. **Batteries have to be recharged immediately after a partial or complete discharge but at least within a period of 1 week up to 4 weeks to 100 %.**

3. Charging

3.1 Charging with alternative power supply

When using an alternative power supply, the battery charger is not always able to supply the maximum load current. The load current can exceed the nominal current of the battery charger. The battery supplies power during this period and the battery will be discharged.

In photovoltaic installations normally IU-characteristic is used (see chapter 3.2a). The initial constant current phase („I“) will be named "bulk phase". The final voltage criteria to stop that phase should be adjusted according the following table:

Depth of Discharge (DOD)	Charging voltage
< 0.2 C ₁₀	2.30 – 2.35 V/cell
≥ 0.2 C ₁₀	2.35 – 2.40 V/cell*

* In accordance with item 3.2d the charging time at those increased voltages shall be limited to maximum 72 h. If no discharge follows then switch to standby operation.

Observe the values of point 3.2d to adjust the equalising charge at the charge controller. The charge controller and the battery must be sized properly. Manufacturer instructions for the charger are to be considered. For daily discharges of more than 30 % DOD the hazard of acid stratification occurs if at least a gassing charge once a week has do be done.

After deep discharge or after inadequate recharging an equalising charging as per item 3.2d is necessary. At stand-by operation without cycling the batteries should be operated at float charge with $(2.23 \text{ V/cell} \pm 1 \%) \times \text{number of cells}$.

3.2 Charging with external charger

Charging must only be carried out with direct current. Chargers with IU-, IUI- or W-characteristics according to DIN 41773, DIN 41776 and DIN 41774 may be used.

a) IU- (or IUI-) characteristics: Starting with a given initially constant charging current („I“) the cell or battery voltage reaches the given final value which depends on the charging requirement by the application. The charger automatically switches then to constant operating voltage („U“). As long as the gassing voltage is not reached 2.4 V/cell, the charging current is limited by the charger only. Typical values for constant currents are 0.5 to 2.0 times I10. Typical constant voltages are 2.23, 2.25, 2.30, 2.40 V/cell. The different voltages are given in section "3.3 Special cases". The IUI-characteristic provides a switching point after a higher first constant voltage to operating voltage.

b) IUI-characteristics: This characteristic is a very effective method in order to recharge batteries in short time and to crack sulphations. At first, an IU- characteristic is applied to the battery. After a given time held out at constant voltage, the charging method is then extended by using a reduced constant current („I“). This current is limited to 5 A/100 Ah C10. The cell or battery voltage reaches values between 2.60 and 2.75 V/cell. Check if loads have to be disconnected before, in order to prevent damage. On exceeding the maximum temperature of 55 °C (131 °F), the charging has to be either stopped or proceed with reduced current or be switched to float charge as in order to allow the temperature to drop. The fully charged state is reached, when the cell voltages and the electrolyte specific gravities have not risen for a period of 2 h during a charge with constant current.

c) Float charge (float voltage): A battery is float charged, when the electrodes are sufficiently polarised in that quantity that the floating current compensates the self discharge rate of the battery (see 2.2b). A fully charged battery remains at 100 % SOC while being floated.

Floating voltage	Battery type
2.23 V/cell ± 1 %	PVS, PVSM

d) Equalising or boost charge: Charging method with increased gassing activity at higher cell voltages (>2.33 V/cell), done with either increased constant voltage (e.g. 2.33 to 2.40 V/cell) or constant current. Equalization charges are to be done at least once at year. The application of this method shall be time (max. 72 h) and temperature (max. 55 °C (131 °F)) limited. Please take the values from following table:

Charging characteristics	Maximum current in A/100 Ah C ₁₀	Voltage per cell
I	5.0	2.60 - 2.75
W	7.0	2.40
	3.5	2.65

On exceeding the temperature maximum, the charging must either be stopped or proceeded with reduced current or be switched to float charge to allow the temperature to drop. The equalising charge is completed, when the cell voltages and the electrolyte specific gravities have not risen for a period of 2 h during a charge with constant current.

e) Ripple currents: During recharging up to 2.40 V/cell the RMS value of the AC ripple current may reach temporarily max. 20 % of the RMS value of the charging current. After recharging

and at standby (float) or buffer operation the RMS value of the ripple current must not exceed 5 % of the RMS value of the charging current.

3.3 Special cases

a) Charging a new battery

The charging can be done by using IU- or IUI-characteristics (3.2a and 3.2b) with increased voltage of 2.33 to 2.40 V/cell.

Charging times:

IU	IUI
Min. 1 day	Approx. 8 to 12 hours

b) Recharging: After a discharge the battery can be recharged at float/operating voltage (see 3.2c). This can take weeks until months for a complete recharge. To reduce the charging time the recharging can be carried out by using IUU-characteristics (3.2a) with increased voltage (2.33 to 2.40 V/cell) x number of cells with automatic reduction (switching point) to the operating voltage under 2.1a. Recharging times are dependent on the charging current available; as a rule they run from 12 to 24 hours at initial currents between 2 x I10 to 0.5 x I10. Using IUI-characteristics is recommended.

c) Deep discharges/inadequate charged batteries: After deep discharges recharging with IUI-characteristic (3.2b) at 100 % SOC is necessary immediately. After inadequate recharging an equalising charge (3.2d) is to be done.

3.4 Battery temperature and related charging voltage

All technical data refer to the nominal temperature of 20 °C (68 °F). The ideal operating temperature range is 20 °C ± 5 K (59 °F to 77 °F). The recommended operating temperature range is 10 °C (50 °F) to 30 °C (86 °F). Higher temperatures reduce the working life. Lower temperatures reduce the available capacity. Exceeding the temperature limit of 45 °C (113 °F) up to 55 °C (131 °F) is acceptable only for short periods. Exceeding the temperature limit of 55 °C (131 °F) is not permissible. A temperature-related adjustment of the charging voltage within monthly averaged battery temperature of 10 °C (50 °F) to 30 °C (86 °F) is not necessary. Below 10 °C (50 °F) in the monthly average the charging voltage should be increased (0.003 V/cell per K) for a faster recharging. Above 30 °C (86 °F) in the monthly average voltage may be reduced (-0.003 V/cell per K) to reduce water decomposition and corrosion.

4. Electrolyte

The electrolyte is diluted sulphuric acid. The rated specific gravity of the electrolyte in the fully charged state is based on 20 °C (68 °F) and the "MAX" electrolyte level with a maximum deviation ± 0.01 kg/l. The rated specific gravity is printed on every type label. Higher temperatures reduce the specific gravity of the electrolyte, lower temperatures increase it. The temperature correction factor is -0.0007 kg/l per K.

Examples:

Electrolyte specific gravity 1.23 kg/l at +35 °C (95 °F) corresponds to 1.24 kg/l at 20 °C (68 °F).

Electrolyte specific gravity 1.247 kg/l at +10 °C (50 °F) corresponds to 1.24 kg/l at 20 °C (68 °F).

5. Maintenance

To avoid leakage currents and the associated risk of fire keep the battery dry and clean. Cleaning with clear water, no solvents and no detergents. Avoid electrostatic charges. If the electrolyte level has dropped to the „MIN" mark, purified water as specified under DIN 43530-4 (maximum conductivity 30 µS/

cm) must be used to top up the electrolyte level to the „MAX" mark.

To be measured and listed every 6 months:

- battery voltage
- the voltage of some cells/block batteries (pilot cells)
- the temperature of the electrolyte in some cells/block batteries (pilot cells).

Every 12 months:

- The voltages and densities of the electrolyte/temperatures in all cells/blocks have to be measured and listed.
- Connectors, racks and ventilation have to be visually checked and restored if necessary.

Should the float charge voltage in single cells deviate more than +0.10 V or -0.05 V from the average value (see 3.2c), the customer service should be called.

6. Testing

Tests must be conducted according to DIN 43539 Part 1 and 4 and IEC 60896-11. Special test instructions, e. g. to prove operational safety in accordance with DIN VDE 0107 and DIN VDE 0108 must be observed.

7. Storage and taking out of operation

If filled lead-acid accumulators are to be taken out of operation for a longer period of time, they must be placed fully charged in a dry, frost-free room. To avoid damage periodical equalising charges (every 6 weeks) or permanent float charging have to be made. If the average room temperatures are above 25 °C (77 °F), shorter intervals are necessary.

8. Transport

The cells/batteries are protected against short-circuit. They are not subject to the German Regulations on Dangerous Goods carried on road and railway (GGVSEB) of the ADR, if they show no damage, are protected against sliding, falling over and damaging and are piled up on pallets appropriately (ADR, Chapter 3.3, Special Provision 598).

These cells/batteries are dangerous goods on sea transport. Declaration and packaging must comply with the requirements of IMDG-Codes.

9. Technical data

Sun Station OPzS Phaesun	GUG	weight	TV	weight L x W x H		R _i	I _k	capacity							Terminal
	Art. no.	kg	Art. no.	kg	mm	mΩ	kA	Ah (C1)	Ah (C10)	Ah (C20)	Ah (72)	Ah (C100)	Ah (C120)	Ah (C240)	
2 OPzS 140	340335	14,5	340363	9,1	105x208x420	1,49	1,39	63	111	127	141	143	144	148	M10
3 OPzS 210	340336	16,4	340364	11,2	105x208x420	1,04	1,99	95	167	191	211	215	217	222	M10
4 OPzS 280	340337	18	340365	12,8	105x208x420	0,837	2,49	127	223	254	282	287	289	295	M10
5 OPzS 350	340338	21,7	340366	15,3	126x208x420	0,690	3,02	159	279	318	352	359	361	369	M10
6 OPzS 420	340339	25,7	340367	18,1	147x208x420	0,590	3,53	191	334	382	424	431	434	444	M10
5 OPzS 550	340340	28,8	340368	20,0	126x208x535	0,572	3,65	223	389	432	486	496	500	513	M10
6 OPzS 660	340341	34	340369	23,5	147x208x535	0,492	4,24	267	467	518	583	595	601	616	M10
7 OPzS 770	340342	39,1	340370	26,8	168x208x535	0,435	4,79	311	544	604	681	694	700	720	M10
6 OPzS 900	340343	47,4	340371	33,0	147x208x710	0,468	4,45	352	665	748	856	877	888	916	M10
7 OPzS 1050	340344	61,5	340372	42,1	215x193x710	0,366	5,70	415	777	872	993	1020	1033	1065	M10
8 OPzS 1200	340345	65,4	340373	46,6	215x193x710	0,325	6,41	474	886	996	1137	1160	1178	1216	M10
9 OPzS 1350	340346	75,4	340374	51,4	215x235x710	0,283	7,36	534	991	1116	1281	1300	1320	1365	M10
10 OPzS 1500	340347	79,4	340375	56,0	215x235x710	0,250	8,32	594	1100	1240	1418	1450	1464	1516	M10
11 OPzS 1650	340348	89,6	340376	61,0	215x277x710	0,243	8,59	649	1210	1362	1562	1590	1608	1665	M10
12 OPzS 1800	340349	93,4	340377	65,4	215x277x710	0,220	9,49	709	1320	1486	1699	1740	1752	1816	M10
11 OPzS 2090	340350	105,9	340378	72,7	215x277x855	0,233	8,94	793	1470	1636	1951	1870	2016	2090	M10
12 OPzS 2280	340351	110,4	340379	77,4	215x277x855	0,219	9,52	861	1600	1784	2124	2040	2196	2277	M10
13 OPzS 2470	340352	137,8	340380	90,8	215x400x815	0,175	11,91	956	1740	1938	2304	2210	2376	2448	M10
14 OPzS 2660	340353	142,4	340381	95,3	215x400x815	0,166	12,57	1026	1880	2080	2476	2380	2556	2640	M10
15 OPzS 2850	340354	146,9	340382	100,2	215x400x815	0,158	13,18	1096	2010	2220	2649	2550	2736	2832	M10
16 OPzS 3040	340355	151,6	340383	105,4	215x400x815	0,150	13,85	1166	2140	2380	2822	2710	2916	3024	M10
17 OPzS 3230	340356	175,1	340384	117,7	215x490x815	0,135	15,47	1251	2290	2540	3031	2910	3132	3240	M10
18 OPzS 3420	340357	179,1	340385	121,9	215x490x815	0,126	16,53	1326	2420	2680	3204	3080	3312	3432	M10
19 OPzS 3610	340358	183,6	340386	126,8	215x490x815	0,124	16,77	1391	2560	2840	3376	3250	3492	3600	M10
20 OPzS 3800	340359	188,3	340387	132,0	215x490x815	0,114	18,28	1472	2690	2980	3556	3420	3672	3792	M10
22 OPzS 4180	340360	213,9	340388	145,4	215x580x815	0,107	19,44	1610	2950	3280	3902	3750	4044	4176	M10
24 OPzS 4560	340361	223	340389	155,2	215x580x815	0,101	20,58	1748	3220	3560	4255	4090	4404	4536	M10
26 OPzS 4940	340362	232	340390	165,0	215x580x815	0,096	21,68	1884	3480	3860	4600	4420	4.64	4920	M10