Operating instructions

Stationary solar valve regulated lead-acid batteries **OPzV.solar & OPzV.block.solar**

Assembly and CE-marking by.....
.....
Commissioning by .....

date.....
date.....

Number of cells/blocks:
.....
Type: .....

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 EN 50272-2!

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.

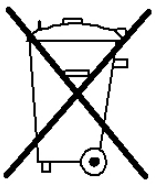
Explosion and fire hazard due to explosive gases escaping from the battery. Caution! Metal parts of the battery are always live, therefore do not place items or tools on the battery! Avoid short circuits!

The electrolyte (diluted sulphuric acid) is highly corrosive. Under normal operating conditions contact with electrolyte is prevented. In case of damage of the container contact with the gelled sulphuric acid has to be avoided. It is highly corrosive as well.

Block batteries or cells are heavy! Ensure secure installation! Only use suitable transport equipment!

Dangerous voltage!

Usage of the battery which does not comply with the OPERATING INSTRUCTIONS, repairs carried out with spare parts not approved by manufacturer, 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.

General

Valve regulated lead-acid batteries must not be topped up with water through their entire life. The valves must not be opened, because access of oxygen discharges the cells. During charging the cells will release hydrogen through the valve. Observe the ventilation instruction EN 50272-2. Protect batteries from direct sunlight. For the assembly and operation of stationary battery installations EN 50272-2 applies. The battery must be installed and operated in such a way that the ambient temperature differences between the cells/blocks of one battery are < 3 K.

1. Installing the battery

Install the racks or cabinets provided for the installation in the correct location. Inspect all cells/blocks for mechanical damage. Cells/blocks may be operating in upright or – if ordered and designated correspondingly – in horizontal position. Use our Installation instruction and for horizontal installation pay attention to our Supplement to the Installation instruction. Having battery strings connected in parallel, care must be taken that the same thermal environment and the same electric connection resistance are applied. Therefore normally not more than 4 partial batteries are connected in parallel. Set up the cells/blocks with the correct polarity. The distance between cells/blocks should be 10 mm. If necessary the surfaces of the poles and connectors have to be cleaned. Multipole cells have to be connected using all poles with same diameter and length of connectors. The connectors have to be firmly seated by tightening the terminal screws with a torque of 22 ± 1 Nm. Cable connectors have to be secured during mounting by cable holders (see Installation Instruction).

2. Commissioning

Connect the battery to the DC power supply, with the charger switched off, battery fuses removed and the load disconnected, ensuring that the polarity is correct: Positive terminal of the battery to the positive terminal of the charger. If the cells/blocks have been stored for more than 4 weeks, check the open-circuit voltage (OCV) before start of charging to ascertain the optimum commissioning charge:

- Charging according to 3.3c, if the cells have OCV's > 2.08 V.
- If the cells have OCV's < 2.08 V charging according to 3.3b or 3.3d. In case of 3.3d charge one day per month storage time to equalise the state of charge of the

cells/blocks.

- If cells have an OCV < 0.02 V below average, contact the battery manufacturer.

The first charge should 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 float charging as per 3.3c.

3. Operation

3.1 Operation modes: stand-by and buffer

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

a) During **stand-by 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 charging voltage at 20 °C (68 °F) must be set to (2.25 V ± 1 %) x number of OPzV.solar cells. The number of cells per block is given by the nominal block voltage divided by 2 V.

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. Depending on the load and after having consulted the battery manufacturer, the charging voltage should be set at (2.25 - 2.30 V) x number of cells for OPzV.solar.

3.2 General terms for discharging

a) Discharge

A battery is discharged when it supplies an electrical current by switching of the charger and connecting the load with the battery poles. During discharge, the active materials are converted to lead sulphate and water.

Batteries have to be recharged immediately after a partial or complete discharge but at least within a period of one week up to 4 weeks to 100 %.

b) Self discharge

If the battery voltage is permanently less than floating voltage (see 3.3.c) - e.g. without charge or voltage too small - the battery discharges by itself. It results in a loss of capacity and possible sulphation of the electrodes.

c) Voltage drop

When discharged with currents higher then 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, currents and voltages are specified in the last page. For other discharge data (times, currents, capacities, end voltages, temperatures), please contact battery manufacturer. Never discharge the battery below the specified final voltages. The end cell voltage for all discharges of 10 hours or longer is 1.8 V/cell. No more than specified capacities are to be discharged. Charge immediately after discharge as well as after partial discharge.

3.3 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 not be fully charged. The charge voltage has, therefore, to be set at floating voltage up to 2.35 V/cell ±1 % x number of cells.

At regular discharges of less than 0.4 x C_{10} a charging voltage of 2.30 to 2.35 V/cell has to be used.

At regular discharges from 0.4 to 0.6 x C_{10} the charging voltage should be 2.35 to 2.40 V/cell.

In accordance with item 3.3.d the charging time at those increased voltages shall be limited to maximum 72 h. If no discharge follows then switch to stand-by operation.

At stand-by operation without cycling the batteries should be operated at float charge with 2.25 V/cell ± 1 % for OPzV.solar.

After deep discharge or after inadequate recharging an equalizing charging as per Item 3.3d is necessary.

3.4 Charging with external charger

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

a) IU (or IUU) 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", 3.1a). As long as the final voltage is not reached yet, the charging current is limited only by the charger. Typical values for constant currents are 0.5 to 2.0 times I10. Typical constant voltages are 2.25, 2.27, 2.35, 2.40 V/cell. The different voltages are given by the application. Please see exact values in section "3.4. Special cases". The IUU characteristic provides a switching point after a higher first constant voltage to operating voltage.

b) IUI characteristics

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 1.5 A/100 Ah C_{10}. The cell or battery voltage reaches values between 2.60 and 2.75 V/cell. Check if loads have to be disconnected before. If temperatures higher than 45 °C (113 °F) occur, the charging has to be interrupted. The fully charged state is reached, when the cell voltages have not risen for a period of 2 h.

c) Float charge (float voltage)

A battery is float charged, when the electrodes are sufficiently polarized in that quantity that the floating current compensates the self discharge rate (see 3.2b) of the battery. A fully charged battery remains at 100 % SOC while being floated. The float voltage depends on acid density. Please take the values from following table:

Floating voltage	Battery type
2.25 V/cell ± 1 %	OPzV.solar

d) Equalizing 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. The application of this method shall be time (max. 72 h) and temperature limited to max. 45 °C (113 °F). When using constant currents, they are to be limited to 1.5 A/100 Ah C_{10}. 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 equalizing charge, when executed with constant current, is completed, when the individual cell voltages no longer increase within 2 hours.

e) Ripple currents

During recharging up to 2.40 V/cell the RMS value of the AC ripple current may reach temporarily max. 20 A/100 Ah C_{10}. After recharging and at stand-by (float) or buffer operation the RMS value of the ripple current must not exceed 5 A/100 Ah C_{10}.

3.5 Special cases

a) Charging a new battery

Can be done by using IU- or IUI-characteristics (3.3a and 3.3b) 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 operating voltage (see 3.1a). 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 (3.3a) with increased voltage (2.33 to 2.40 V/cell) x number of cells with automatic reduction (switching point) to the operating voltage under 3.1a. Recharging times are dependant on the charging current available; as a rule they run to 12 to 24 hours at initial currents between 2xI10 to 0.5xI10. Using IUI-characteristics is also recommended.

c) Equalizing charge

After deep discharge or after inadequate recharging equalizing charging is necessary. See 3.4d.

3.5 Battery temperature and related charging voltage

All technical data refer to the nominal temperature of 20 °C (68 °F).

The recommended temperature range is 10 °C (50 °F) to 30 °C (86 °F). Higher temperatures reduce the operational 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. A temperature-related adjustment of the charging voltage within monthly averaged battery temperature of 10 °C (50 °F) to 45 °C (113 °F) must not be made. A decrease of the charging voltage at temperatures above 20 °C (68 °F) endangers the fully charged state of the battery. Below 10 °C (50 °F) in the monthly average the charging voltage should be increased (-0.003 V/cell/K) for a faster recharging.

4. Maintenance

To avoid leakage currents and the associated risk of fire keep the battery dry and clean. Cleaning with clean water, no detergents, no solvents. Avoid electrostatic charges. During whole life time, the battery needs not to be refilled with water. The electrolyte is diluted sulphuric acid and fixed as GEL made with micro porous SiO_2.

To be measured and listed every 6 months:

- battery voltage
- voltages of some cells/blocks (pilot cells)
- surface temperatures of pilot cells and the room temperature

Every 12 months:

- Voltages of all cells/blocks and surface temperatures of pilot 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 of single cells deviate more than +0.2 V or -0.1 V from the average value (see 3.3) and should the surface temperatures of different cells/blocks deviate more than 3 K, the customer service should be called. A service contract with battery manufacturer or its local agent is recommended.

5. Tests

Tests must be conducted according to IEC 60896-21.

6. Storage and taking out of operation

Should batteries be stored or taken out of operation for extended periods, they must be stored fully charged in a dry frost-free room. To avoid damage one of the two charging methods has to be selected:

a) Equalising charging every 3 months. If the room temperatures are higher than 30 °C (86 °F), shorter intervals are necessary.
b) Float charging as under 3.3c.

7. Transport

Cells/batteries are protected against short-circuit. They are no dangerous goods in accordance with the road and railway transportation regulations (ADR; RID) if they show no damage and are protected against sliding, falling over and damaging. They also have to be piled up on pallets in accordance with the ADR special rule 598 (Chap. 3.3). During sea and air transport of cells/batteries the rules of IMDG-Code or IATA-DGR must be followed.

8. Technical data

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Type Ue V/cell	$C_{1\,h}$ Ah 1.65	$C_{10\,h}$ Ah 1.80	$C_{20\,h}$ Ah 1.80	$C_{72\,h}$ Ah 1.80	$C_{100\,h}$ Ah 1.80	$C_{120\,h}$ Ah 1.80	$C_{240\,h}$ Ah 1.80	R_i 1) mΩ	I_k 2) kA	Length mm	Width mm	Height mm	Weight kg
4 OPzV.solar 330	136	239	262	315	329	334	348	1.200	1.70	105	208	420	20.0
5 OPzV.solar 390	165	286	314	378	394	400	415	0.960	2.15	126	208	420	23.0
6 OPzV.solar 470	198	344	378	453	473	481	499	0.800	2.57	147	208	420	28.8
5 OPzV.solar 590	252	444	496	573	587	594	609	0.710	2.88	126	208	535	32.0
6 OPzV.solar 710	303	532	596	688	705	712	732	0.600	3.46	147	208	535	36.7
7 OPzV.solar 790	341	597	666	763	785	793	813	0.510	4.04	168	208	535	41.0
6 OPzV.solar 930	391	700	794	907	932	942	979	0.450	4.58	147	208	710	52.0
8 OPzV.solar 1190	506	903	1,022	1,166	1,190	1,200	1,255	0.340	6.10	215	193	710	68.9
10 OPzV.solar 1530	647	1,150	1,312	1,504	1,530	1,548	1,620	0.270	7.63	215	235	710	84.6
12 OPzV.solar 1800	762	1,360	1,540	1,764	1,800	1,812	1,896	0.230	9.15	215	277	710	99.6
12 OPzV.solar 2200	954	1,640	1,854	2,160	2,200	2,220	2,294	0.240	8.58	215	277	855	115.0
16 OPzV.solar 3010	1,291	2,240	2,520	2,944	3,010	3,036	3,120	0.180	11.40	215	400	815	156.2
20 OPzV.solar 3780	1,618	2,820	3,160	3,700	3,780	3,816	3,936	0.144	14.30	215	490	815	195.0
22 OPzV.solar 4040	1,749	3,020	3,400	3,960	4,040	4,080	4,200	0.131	15.67	215	580	815	216.0
24 OPzV.solar 4610	1,960	3,430	3,860	4,521	4,610	4,656	4,800	0.120	17.10	215	580	815	236.0
26 OPzV.solar 4770	2,067	3,570	4,000	4,680	4,770	4,824	4,968	0.111	18.52	215	580	815	250.0

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Type U_e [V/cell]	$C_{1\,h}$ Ah 1.65	$C_{10\,h}$ Ah 1.80	$C_{20\,h}$ Ah 1.80	$C_{72\,h}$ Ah 1.80	$C_{100\,h}$ Ah 1.80	$C_{120\,h}$ Ah 1.80	$C_{240\,h}$ Ah 1.80	R_i 1) mΩ	I_k 2) kA	Length mm	Width mm	Height mm	Weight kg
12V 1 OPzV.block.solar 70	37.1	57.3	61.6	69.9	71.8	72.6	74.8	21.60	0.58	272	205	385	43
12V 2 OPzV.block.solar 140	71.5	109	118	133	137	138	144	10.80	1.15	272	205	385	52
12V 3 OPzV.block.solar 210	107	165	178	201	206	208	216	7.2 0	1.73	380	205	385	74.2
6V 4 OPzV.block.solar 290	148	229	246	280	287	290	300	2.70	2.30	272	205	385	51
6V 5 OPzV.block.solar 360	185	286	308	349	359	362	374	2.16	2.88	380	205	385	65
6V 6 OPzV.block.solar 430	222	344	370	419	431	435	448	1.80	3.45	380	205	385	73.8
2V 12 OPzV.block.solar 860	445	688	740	835	862	872	900	0.30	6.90	272	205	385	51
2V 15 OPzV.block.solar 1070	557	860	926	1,044	1,070	1,089	1,123	0.24	8.63	380	205	385	65
2V 18 OPzV.block.solar 1290	668	1,030	1,110	1,260	1,290	1,308	1,348	0.20	10.35	380	205	385	73.8

Reference temperature for all data is 20 °C (68 °F). The manufacturer reserves the right to alter technical specifications. 1,2) internal resistance and short circuit current according to IEC 60896-21

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02/2011