Operating instructions

GB

BAE Energy from Batteries

Stationary solar valve regulated lead-acid batteries (VRLA) **PVV and PVVM**

Assembly and CE-marking by: Number of cells/blocks:

..... Date: ....

Commissioning by: ..... Date: ..... 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 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.

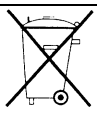
Dangerous voltage!

The electrolyte (diluted sulphuric acid) is 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 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 with spare parts not approved by BAE, 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.

1. Installing the battery

Install the racks or cabinets provided for the installation in the correct location. Inspect all cells/blocks for mechanical damage. The lateral transport plates for PVVM cells to prevent the bulging must not be removed until directly before installation. It is necessary to install the PVVM cells in trays or racks which prevent excessive bulging.

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. For all horizontal installations only flexible connectors are to be used.

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. 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 with a torque of 22 ± 1 Nm for PVV, 29 ± 1 Nm for PVVM. Cable connectors have to be secured during mounting by a fixing tool for connector installation. Observe the BAE 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.

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 4.2c, if the cells have OCV's ≥2.08 V.
  If the cells have OCV's <2.08 V charging according to 4.2b or 4.2d. In case of 4.2d charge one day per month storage time to equalise the state of charge of the cells/blocks.

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

The first charge should be monitored to ensure that limits of voltages, currents and temperatures are not exceeded and that no unacceptable values occur. When charging is finished switch off the charger or switch over to float charging as per 4.2c.

3. Operation

For the assembly and operation of stationary battery installations EN 50272-2 applies. Solar batteries should be operated with charge controllers which prevent a deep discharge of the battery. Avoid direct sunlight.

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 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 to 2.30 V) x number of cells.

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 Pb and PbO_2 with the sulphuric acid 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 1 week up to 4 weeks to 100 %.

b) Self discharge

If the battery voltage is permanently less than floating voltage (see 4.2c) - 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 than I_{100}, 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 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.

4. Charging

4.1 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 4.2a). 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
< 0.4 C_{10}	2.30 – 2.35 V/cell
≥ 0.4 C_{10}	2.35 – 2.40 V/cell*

* In accordance with item 4.2d 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 4.2d 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.

Especially off-grid systems should be dimensioned in such a way, that the batteries will be fully charged daily; it is advisable to avoid discharges to more than 30 % DOD.

After deep discharge or after inadequate recharging an equalising charging as per item 4.2d is necessary.

At stand-by operation without cycling the batteries should be operated at float charge with (2.25 V/cell ± 1 %) x number of cells.

4.2 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 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 gassing voltage is not reached 2.4 V/cell, the charging current is limited only by the charger. Typical values for constant currents are 0.5 to 2.0 times I_{10}. 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 "4.3 Special cases". The IUU-characteristic provides a switching point after a higher first constant voltage to operating voltage.

b) IUI-characteristics

IUI charging is an effective method to recharge batteries in short times and for cracking sulphation. 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 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 (see 3.2b) of the battery. A fully charged battery remains at 100 % SOC while being floated.

Floating voltage	Battery type
2.25 V/cell ± 1 %	PVV and PVVM

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. Equalisation charges are to be done at least once at year. 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 equalising charge is completed, when the cell voltages 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 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}.

4.3 Special cases

a) Charging a new battery

Can be done by using IU- or IUI-characteristics (4.2a and 4.2b) 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 operating voltage (see 4.2c). 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 (4.2a) with increased voltage (2.33 to 2.40 V/cell) x number of cells with automatic reduction (switching point) to the operating voltage under 3.1a. Recharging times are dependent on the charging current available; as a rule they run to 12 to 24 hours at initial currents between 2 x I_{10} to 0.5 x I_{10}. Using IUI-characteristics is also recommended.

c) Deep discharges/inadequate charged batteries

After deep discharges recharging with IUI-characteristic (4.2b) at 100 % SOC is necessary immediately. After inadequate recharging an equalising charge (4.2d) is to be done.

4.4 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 per K) for a faster recharging.

5. 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 microporous SiO_2.
To be measured and listed every 6 months:

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

Every 12 months:

- Voltages and surface temperatures of 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 of single cells deviate more than +0.2 V or -0.1 V from the average value (see 4.2c) and should the surface temperatures of different cells/blocks deviate more than 3 K, the customer service should be called. A service contract with BAE or its local agent is recommended.

6. Tests

Tests must be conducted according to IEC 60896-21.

7. 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 6 months. If the average room temperatures are higher than 25 °C (77 °F), shorter intervals are necessary.
b) Float charging as under 4.2c.

8. Transport

BAE *SECURA* 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 Provisions 598 and 238).
There must not be dangerous traces of acid visible on the outside of the packages.

During sea transport of cells/batteries the rules of IMDG-Code (GGVSEE, Chapter 3.2, Special Provisions 29 and 238) must be followed.

9. Technical data

BAE *SECURA PVV BLOCK solar*

Type	$C_{1\,h}$ Ah	$C_{10\,h}$ Ah	$C_{20\,h}$ Ah	$C_{72\,h}$ Ah	$C_{100\,h}$ Ah	$C_{120\,h}$ Ah	$C_{240\,h}$ Ah	R_i 1) mΩ	I_k 2) kA	Length (L) mm	Width (W) mm	Height (H) mm	Weight kg
U_e (V/Cell)	1.67	1.80	1.80	1.80	1.80	1.80	1.80						
12 V 1 PVV 70	35	60	67	76	78	79	82	17.47	0.73	272	205	385	43.0
12 V 2 PVV 140	68	110	120	133	137	138	142	9.55	1.34	272	205	385	52.0
12 V 3 PVV 210	103	167	182	203	208	210	216	6.74	1.91	380	205	385	74.2
6 V 4 PVV 280	137	224	244	273	279	282	290	2.66	2.42	272	205	385	51.0
6 V 5 PVV 350	172	281	306	343	350	354	364	2.24	2.87	380	205	385	65.0
6 V 6 PVV 420	207	337	368	412	421	424	439	1.94	3.31	380	205	385	73.8
2 V 12 PVV 840	413	674	734	820	838	846	873	0.29	7.33	272	205	385	51.0
2 V 15 PVV 1050	517	844	920	1,029	1,050	1,062	1,094	0.24	8.81	380	205	385	65.0
2 V 18 PVV 1260	622	1,010	1,108	1,238	1,260	1,272	1,317	0.21	10.18	380	205	385	73.8

BAE *SECURA PVV solar*

Type	$C_{1\,h}$ Ah	$C_{10\,h}$ Ah	$C_{20\,h}$ Ah	$C_{72\,h}$ Ah	$C_{100\,h}$ Ah	$C_{120\,h}$ Ah	$C_{240\,h}$ Ah	R_i 1) mΩ	I_k 2) kA	Length (L) mm	Width (W) mm	Height (H) mm	Weight kg
U_e (V/Cell)	1.67	1.80	1.80	1.80	1.80	1.80	1.80						
2 PVV 140	71	121	134	153	157	158	165	1.65	1.30	105	208	420	12.4
3 PVV 210	107	182	202	229	236	238	247	1.15	1.86	105	208	420	17.1
4 PVV 280	143	243	268	306	314	318	331	0.89	2.40	105	208	420	19.4
5 PVV 350	179	304	336	383	393	397	412	0.73	2.91	126	208	420	23.3
6 PVV 420	215	364	404	460	472	477	496	0.63	3.39	147	208	420	27.4
5 PVV 550	254	447	506	570	583	589	609	0.68	3.14	126	208	535	31.4
6 PVV 660	302	529	598	671	686	693	715	0.58	3.64	147	208	535	36.9
7 PVV 770	350	610	688	770	788	795	820	0.52	4.12	168	208	535	42.4
6 PVV 900	417	729	834	943	968	978	1,012	0.46	4.63	147	208	710	51.0
7 PVV 1050	492	858	980	1,116	1,140	1,154	1,195	0.36	5.81	215	193	710	61.9
8 PVV 1200	559	970	1,106	1,252	1,280	1,296	1,344	0.32	6.54	215	193	710	68.8
9 PVV 1350	616	1,090	1,252	1,418	1,450	1,464	1,524	0.34	6.29	215	235	710	77.0
10 PVV 1500	691	1,200	1,382	1,562	1,600	1,620	1,675	0.28	7.50	215	235	710	83.9
11 PVV 1650	748	1,320	1,512	1,713	1,750	1,764	1,836	0.28	7.56	215	277	710	92.2
12 PVV 1800	822	1,440	1,644	1,857	1,900	1,920	1,989	0.24	8.63	215	277	710	99.2
11 PVV 2090	839	1,570	1,772	2,023	2,070	2,088	2,169	0.27	7.86	215	277	855	108.2
12 PVV 2280	927	1,710	1,918	2,181	2,230	2,256	2,337	0.23	9.18	215	277	855	116.5
13 PVV 2470	1,040	1,890	2,120	2,426	2,490	2,508	2,592	0.18	11.91	215	400	815	131.4
14 PVV 2660	1,125	2,070	2,320	2,678	2,740	2,772	2,880	0.17	12.63	215	400	815	141.2
15 PVV 2850	1,191	2,170	2,420	2,772	2,840	2,868	2,976	0.16	13.25	215	400	815	147.9
16 PVV 3040	1,265	2,300	2,580	2,937	3,000	3,036	3,144	0.15	13.94	215	400	815	156.2
17 PVV 3230	1,358	2,480	2,780	3,182	3,260	3,300	3,408	0.14	15.32	215	490	815	173.6
18 PVV 3420	1,433	2,610	2,920	3,348	3,420	3,468	3,576	0.13	16.03	215	490	815	181.4
19 PVV 3610	1,507	2,740	3,080	3,506	3,590	3,624	3,744	0.12	16.70	215	490	815	189.6
20 PVV 3800	1,581	2,870	3,220	3,664	3,750	3,792	3,912	0.12	17.37	215	490	815	197.8
22 PVV 4180	1,740	3,210	3,600	4,118	4,220	4,272	4,416	0.11	18.43	215	580	815	205.7
24 PVV 4560	1,887	3,470	3,900	4,442	4,550	4,596	4,752	0.10	19.76	215	580	815	222.0
26 PVV 4940	2,014	3,650	4,060	4,608	4,710	4,764	4,920	0.10	21.02	215	580	815	235.1

BAE SECURA PVVM solar

Type	$C_{1\,h}$ Ah	$C_{10\,h}$ Ah	$C_{20\,h}$ Ah	$C_{72\,h}$ Ah	$C_{100\,h}$ Ah	$C_{120\,h}$ Ah	$C_{240\,h}$ Ah	R_i 1) mΩ	I_k 2) kA	Length (L) mm	Width (W) mm	Height (H) mm	Weight kg
Ue (V/Cell)	1.67	1.78	1.80	1.80	1.80	1.80	1.80						
2 PVVM 140	70	112	121	134	137	138	143	1.57	1.37	47	198	370	8.8
3 PVVM 210	106	170	184	205	209	211	217	1.10	1.96	65	198	370	12.5
4 PVVM 280	142	227	246	275	280	283	290	0.86	2.52	83	198	370	16.2
5 PVVM 350	178	285	310	344	352	355	364	0.71	3.05	101	198	370	19.9
6 PVVM 420	214	342	372	415	423	427	439	0.61	3.54	119	198	370	23.6
7 PVVM 490	250	400	436	485	495	499	513	0.54	4.00	137	198	370	27.3
8 PVVM 560	285	458	498	555	566	571	588	0.47	4.53	155	198	370	31.2
9 PVVM 630	321	515	560	624	638	643	662	0.43	4.96	173	198	370	34.9
10 PVVM 700	357	573	624	695	709	716	736	0.40	5.36	191	198	370	38.6

Reference temperature for all data is 20 °C (68 °F).
All values given in the table correspond to 100 % DOD without voltage drop of connectors.
1, 2) Internal resistance R_i and short circuit current I_k according to IEC 60896-21
Height (H) is the maximum height between container bottom and top of the bolts in assembled condition.

12/2012 4805061 Technical details may be subject to alterations.

BAE Batterien GmbH
Wilhelminenhofstraße 69/70
12459 Berlin
Germany

Tel.: +49 (0)30 53001-661
Fax: +49 (0)30 53001-667
E-Mail: info@bae-berlin.de
www.bae-berlin.de

Energy from Batteries