

# PowerSafe®










Sustainable solutions



## PowerSafe® OPzV Operation Guide for Solar Applications

**Safety precautions**  
 Batteries give off explosive gasses. They are filled with dilute sulphuric acid, which is very corrosive. When working with sulphuric acid, always wear protective clothing and glasses. Exposed metal parts of the battery always carry a voltage and are electrically live (risk of short circuits). Avoid electrostatic charge. The protective measures according to EN 50272-2 and IEC 62485:2010 must be observed.

Care for your safety

	No smoking no naked flames, no sparks		Shield eyes		Note operating instructions
	Electrical hazard		Danger		Recycle scrap batteries. Contains lead. Pb
	Electrolyte is corrosive, in case of broken containers/lids		Clean all acid splash in eyes or on skin with lot of clear water. Then visit a doctor. Acid on clothing is to be washed with water.		Warning: Risk of fire, ... explosion, or burns. Do not disassemble, heat above 60°C, or incinerate. Avoid any short circuit. Metallic parts under voltage on the battery, do not place tools or items on top of the battery.

**Handling**  
 OPzV batteries are supplied in a fully charged state and must be unpacked carefully to avoid short-circuit between terminals of opposite polarity. The cells are heavy and must be lifted with appropriate equipment.

**Keep Flames Away**  
 In the case of an accidental overcharge, a flammable gas may be emitted from the safety valve. Discharge any possible static electricity from clothes by touching an earth-connected part.

**Tools**  
 Use tools with insulated handles. Do not place or drop metal objects onto the battery. Remove rings, wristwatch and metal articles of clothing that might come into contact with the battery terminals.

**Warranty**  
 Any of the following actions will invalidate the warranty - Non-adherence to the Installation, Operating and Maintenance instructions. Repairs carried out with non-approved spare parts. Application of additives to the electrolyte. Unauthorised interference with the battery.

**Specific Abilities**

The specific abilities of this type of battery for renewable energy applications are as follows.

- **Cycling** (one “cycle” consists of a discharge, of any depth, followed by a recharge)
- **Overcharge ability**
- **Cycling in state of discharge**
- **Low rate of self-discharge**
- **No addition of water required during service life**

PowerSafe® OPzV are designed for applications where the battery must undergo repeated cycling with daily depths of discharge of up to 35% of capacity C<sub>120</sub> (such as rural settlements, communications systems and lighting systems etc.).

**Cell Design**

The PowerSafe® OPzV cells consist of:

- **Tubular positive plates** with Lead-Calcium-Tin alloy, diecast to offer longer service life thanks to an extremely cohesive Lead-Calcium alloy grid
- Electrolyte immobilised as a gel
- **Pressure Relief Valve - One way valve with integral flame arrestor**

**Features & Benefits**

- **Excellent deep discharge recovery and cyclability**
- **Up to 1600 Cycles to 60% depth of discharge and 1200 cycles to 80% DOD**
- **Vertical or horizontal installation (see § 1.4 Commissioning (Installation & ventilation)).**
- **No topping up required**

**Capacity**

**Capacity is the number of Ah a battery can supply for a well-defined current and an end of discharge voltage.**

Capacity varies with the discharge time, discharge rate and temperature.

Example: Capacities vs discharge time for PowerSafe 6 OPzV 600 cell are as follows:

Discharge time	50 h	100h	120h
End voltage	1.85Vpc	1.85Vpc	1.85Vpc
Capacity at 25°C	823Ah	880Ah	894Ah

The nominal capacity of PowerSafe® OPzV cells for renewable energy applications is given as follows:

Capacity Ah	Current A	Discharge period h	End voltage V/cell
C <sub>120</sub>	I <sub>120</sub>	120	1.85V

**Discharge Rate:** Is the ratio of discharge current divided by battery capacity

**Depth of Discharge (DOD):** Capacity removed from the battery compared to total capacity. It is expressed as a percentage.

The battery will be sized for solar applications with a DOD < 80% for the autonomy required.

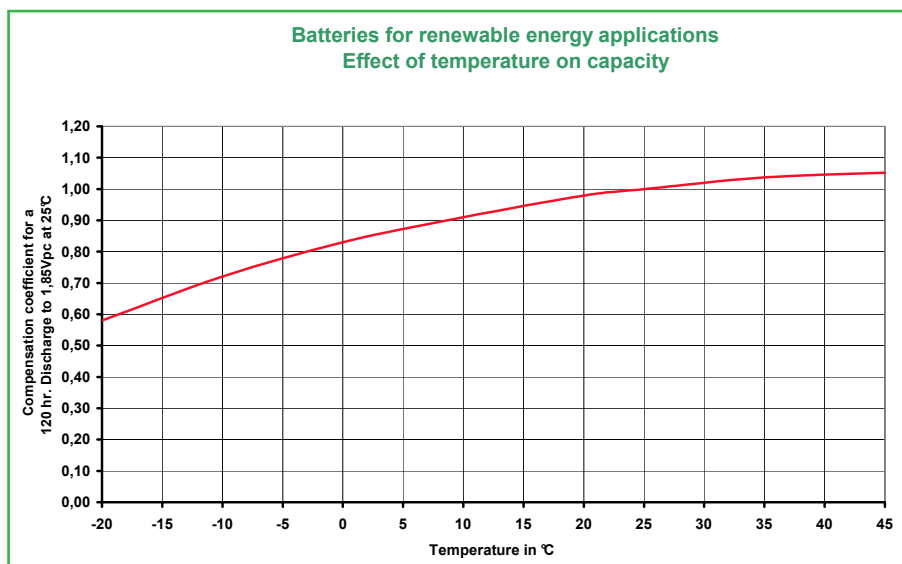
**Daily cycle:** The battery is normally used with a daily cycle as follows: Charge during the day hours and discharge during night hours.

Typically daily use is between 2 to 20% DOD.

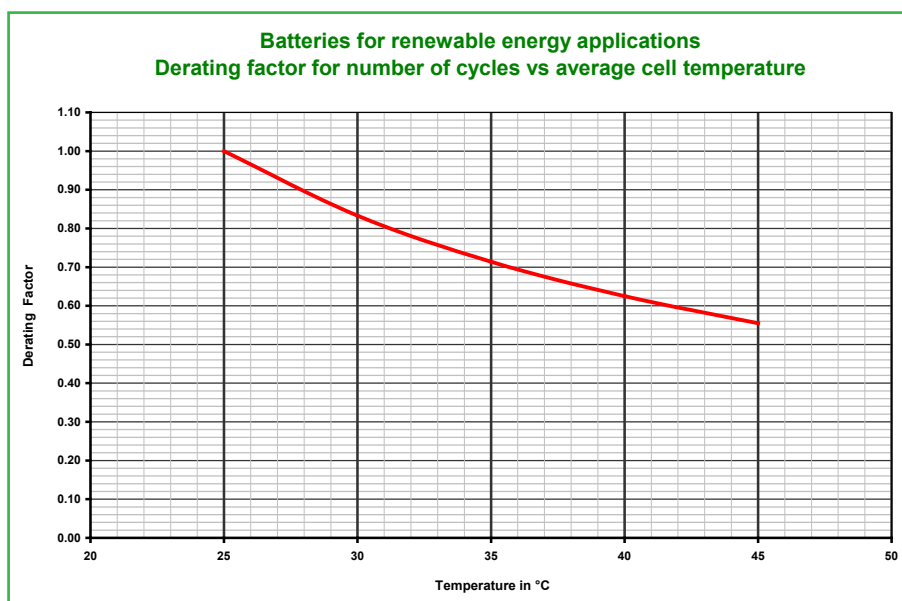
### Effect of Temperature

**On capacity:** Correction factors of the capacity, according to the temperature are shown in the curve below.

If the temperature is other than 25°C, the correction factors must be applied to the installation rating in order to secure an optimum service life.



**On the number of cycles:** A rise in temperature brings about a decrease in the number of cycles (see below).



### Charge Efficiency

The charge efficiency is the ratio between the quantity of Ah delivered during the discharge and the quantity of Ah necessary to restore the initial state of charge.

State of Charge (SOC)	Ah Efficiency
90	> 85
75	> 90
<50	> 95

## 1 GENERAL OPERATING INSTRUCTIONS

### 1.1 Operating Temperature Range

The recommended operating temperature range for PowerSafe® OPzV technology is -15°C to 40°C (Humidity <90%). Optimum life and performance is attained at +25°C.

All technical data relates to the rated temperature of +25°C.

### 1.2 Storage

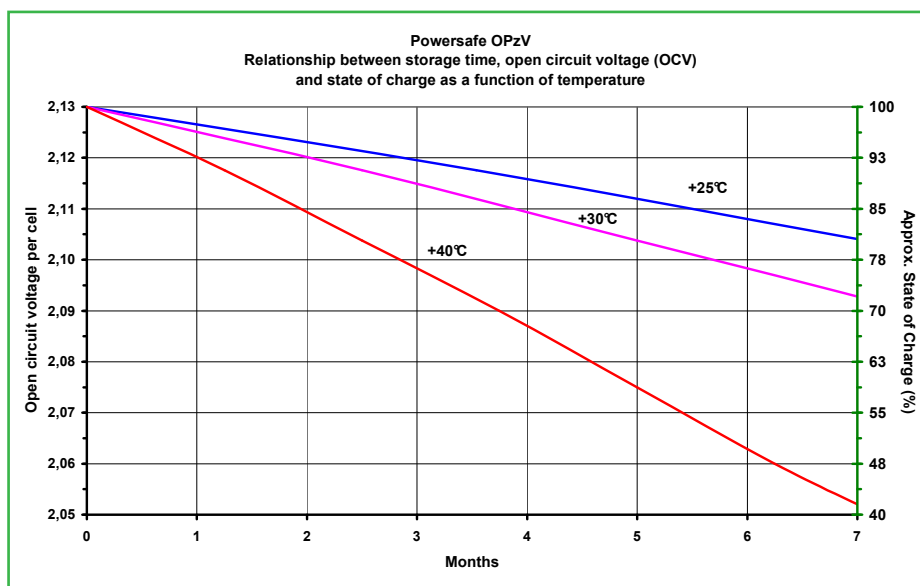
Store the battery at a dry, clean and preferably cold and frost-free location. Do not expose the cells to direct sunlight, otherwise defects on container and cover may occur.

Limit values for storage conditions: Temperature range of -20°C to +45°C, Humidity <90%

The self-discharge rate of OPzV batteries is a function of the temperature.

Temperature	25°C	30°C	40°C
Monthly self-discharge rate	3%	4%	8%

PowerSafe® OPzV technology has a shelf life of 5 months when stored at 25°C. Higher temperatures increase the rate of self discharge and therefore reduce storage life. The following figure gives the relationship between storage time, open circuit voltage (OCV) and state of charge as a function of temperature.



This table gives the **maximum** storage period before refresh, at the given average storage ambient temperature:

Average storage ambient temperature	Maximum storage time
20°C	6 months
25°C	5 months
30°C	4 months
40°C	2 months

The table hereafter gives an indication of the state of charge of the cells from a reading of the open circuit voltage. Batteries must typically be recharged when they fall to ~75% state of charge.

State of charge	Voltage
100%	2.13 Vpc
70%	2.09 Vpc
50%	2.06 Vpc
20%	2.02 Vpc

### 1.3 Freshening Charge

PowerSafe OPzV batteries must be given a refreshing charge :

- when maximum storage time is reached or
- when the OCV approaches 2.10Volts/cell whichever occurs first.

The maximum storage times between refresh charge and recommended OCV audit frequency is given in the table below:

Temperature (°C/°F)	Storage Time (Months)	OCV Audit Interval (Months)
+20/+68	6	3
+25/+77	5	2.5
+30/+86	4	2
+40/+104	2	1

The refreshing charge should be conducted using constant voltage (adjusted to the temperature) eg. 2.25Vpc at 20-25°C with 0.1 C10Amps current limit for a minimum period of 96h.

Alternatively, a refresh charge can be conducted using and applied constant voltage of 2.40Vpc for 24-48h maximum.

### 1.4 Commissioning

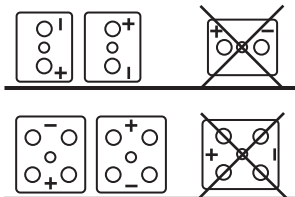
#### Installation & ventilation

The electrical protective measures and the accommodation and ventilation of the battery installation must be in accordance with the applicable "local" national standards, rules and regulations.

Low ventilation requirement according to EN 50272-2 and IEC 62485-2:2010.

The battery should be installed in a clean, dry area.

For the installation of cells in the horizontal position, always ensure that the arrow on the lid of each unit is pointing in vertical orientation.



- Do not use terminal posts to lift or handle cells.
- Ensure that the stand runners are located under the container rather than the lid and/or lid/container seal.
- Do not invert cells (vents upside down) or allow the front of the cells to be positioned lower than the base of the cell as it might block the safety valve and damage pillars.

Avoid placing the battery in a hot place or in front of a window (no direct sunlight). Battery racks are recommended for proper installation. Place the cells on the rack and arrange the positive and the negative terminals for connection according the wiring diagram.

Check that all contact surfaces are clean. Tighten terminal screws, taking care to use the correct torque loading (Tab.1). Fit the covers supplied for protection against direct contact.

Terminal screw	Torque
M10	23 - 25 Nm

Follow the polarity to avoid short circuiting of cell groups. A loose connector can cause trouble in adjusting the system, erratic battery performance, and possible damage to the battery and/or personal injury.

**Commissioning**

The initial charge is extremely important as it will condition the battery service life. So the battery must be fully recharged to ensure that it is in an optimum state of charge.

**Case 1:** Using a constant voltage charger. Cells here will need to be recharged at a constant voltage of between 2.35 and 2.40 Vpc (maximum) at 25°C for a minimum of 48h and a maximum of 72h with a current limited to 0.10C<sub>10</sub>. Temperature compensation for charge voltage should be applied at the rates shown below:

Temperature °C	Charge Voltage (Vpc)
+10	2.45
+20	2.42
+25	2.4
+30	2.38
+40	2.35

**Case 2:** With no external source available for recharging. Connect the battery to the solar panel regulator and leave at rest for 1 to 2 weeks. For this charge, set the regulator to the values given in the § 2.3 Setting charging voltages.

	Temperature °C	Voltage
Low charge-restart voltage	0 to 20°C	2.30V
	20 to 40°C	2.30V
High charge-disconnect voltage	0 to 20°C	2.50V
	20 to 40°C	2.45V

**End-of-charge reading**

The battery is charged once open-circuit voltage (OCV) readings after 24h of rest are in conformity with the values shown on the above table.

The table hereafter gives an indication of the state of charge of cells from a reading of open circuit voltage.

State of charge	Voltage (Vpc)
100%	2.13
90%	2.12
80%	2.105
70%	2.09
50%	2.06

**1.5 Disposal**

Lead acid PowerSafe® OPzV batteries are recyclable. End of life batteries must be packaged and transported according to prevailing transportation rules and regulations. End of life batteries must be disposed of in compliance with local and national laws by a licensed battery recycler.

### 1.6 Products Covered by this Guide

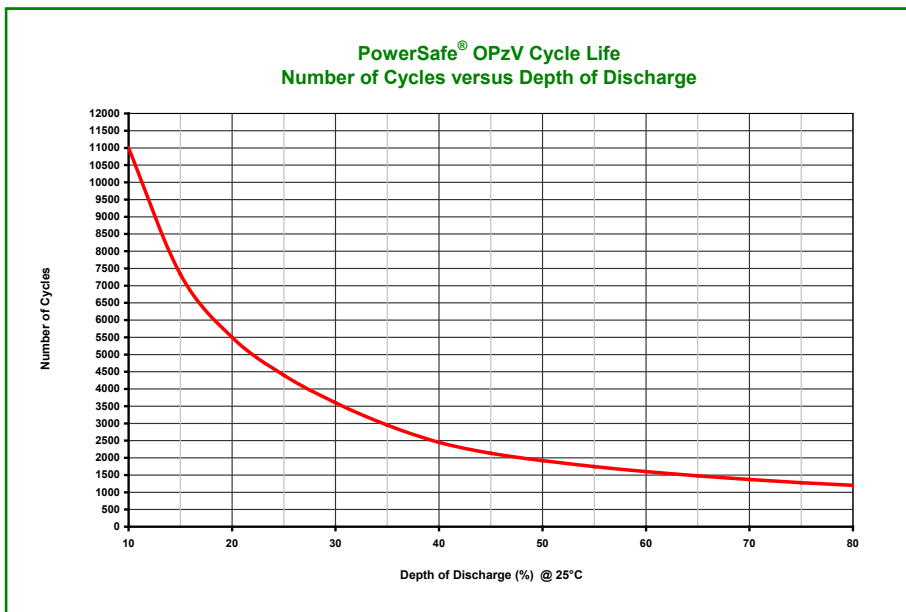
General Specifications			Nominal Capacity (Ah)		Nominal Dimensions						Typical Weight		Short Circuit Current	Internal Resistance
Type	Nominal Voltage (V)	Number of Terminals	10 hr rate to 1.80Vpc	120 hr rate to 1.85Vpc	Length		Width		Height		kg	lbs	(A)	(mΩ)
			@20°C	@25°C	mm	in	mm	in	mm	in				
4 OPzV 200	2	2	215	273	103	4.06	206	8.12	403	15.88	19.5	43	2195	0.95
5 OPzV 250	2	2	265	343	124	4.89	206	8.12	403	15.88	23.5	51.9	2737	0.76
6 OPzV 300	2	2	320	413	145	5.71	206	8.12	403	15.88	28.0	61.8	3175	0.66
5 OPzV 350	2	2	385	484	124	4.89	206	8.12	520	20.49	31.0	68.4	3410	0.61
6 OPzV 420	2	2	465	574	145	5.71	206	8.12	520	20.49	36.5	80.5	4043	0.51
7 OPzV 490	2	2	540	678	166	6.54	206	8.12	520	20.49	42.0	92.6	4607	0.45
6 OPzV 600	2	2	705	895	145	5.71	206	8.12	695	27.38	50.0	110.3	3796	0.55
8 OPzV 800	2	4	940	1187	210	8.27	191	7.53	695	27.38	68.0	150	5200	0.40
10 OPzV 1000	2	4	1170	1491	210	8.27	233	9.18	695	27.38	82.0	180.8	6460	0.32
12 OPzV 1200	2	4	1410	1796	210	8.27	275	10.84	695	27.38	97.0	213.9	7675	0.27
12 OPzV 1500	2	4	1600	1967	210	8.27	275	10.84	845	33.29	120.0	264.6	7510	0.28
16 OPzV 2000	2	6	2110	2629	212	8.35	397	15.64	820	32.31	165.0	363.8	10048	0.21
20 OPzV 2500	2	8	2640	3272	212	8.35	487	19.19	820	32.31	200.0	441	12606	0.17
24 OPzV 3000	2	8	3170	3932	212	8.35	576	22.69	820	32.31	240.0	529.2	14964	0.14

Notes: The electrical values shown in the table relate to performance from a fully charged condition at ambient temperature of +25°C. Height shown is overall height, including connectors and shrouds.

## 2 CYCLIC OPERATION

### 2.1 Cyclic Performance

The graph below shows cycling capability of PowerSafe® OPzV products:



## 2.2 Discharging

Do not over-discharge the battery. This can be avoided by including a Low Voltage Disconnect (LVD) switch in the circuit or by disconnecting the battery from the load when the end discharge voltage is reached.

As a rule, installations will be equipped with a regulator whose voltage threshold values will protect against deep discharge:

	Discharge time		
	10h	120h	240h
Low voltage alarm per cell	1.92V	1.92V	1.95V
Disconnect voltage per cell (LVD)	1.80V	1.85V	1.90V

## 2.3 Setting Charging Voltages

In order to ensure optimum “pulsing” recharge process, the following setting charge disconnect and restart voltages (Solar charge off on and solar charge voltages) can be applied:

	Temperature			
	-20 to 0°C	0 to 20°C	20 to 35°C	> 35°C
Low recharge-restart voltage (Vpc)	2.35V	2.30V	2.30V	2.25V
High recharge-disconnect voltage (Vpc)	2.55V	2.45V	2.40V	2.35V

The voltage/temperature compensation is + 3mV/°C/Cell for a temperature lower than 25°C(77°F) (the reference temperature being 25°C) and - 3mV/°C/Cell for a temperature higher than 25°C.

## 3 SERVICE LIFE

Under normal operating conditions, the battery lifetime largely depends on the temperature and depths of discharge. Influence of temperature (see curve page 3).

Example of an PowerSafe® OPzV battery cycling with 20% daily:

Average temperature of cells	Number of cycles at 25°C	Compensation coefficient	Estimated average number of cycles at average temperature
25°C	5500	1	5500
30°C	5500	0.83	4565
35°C	5500	0.71	3905

Influence of depth of discharge

See curve (item 2.1), relative to number of cycles according to DOD at 25°C.

Example of an PowerSafe® OPzV battery at 25°C:

Daily depth of discharge	Number of cycles at 25°C	Estimated life expectancy
20	5500	15 years

## 4 MAINTENANCE CHECKS DATA RECORDING

PowerSafe® OPzV cells are VRLA batteries and do not have to be topped up.

- Do not open the valve. Opening could cause lasting damage to the battery and is prohibited.
- The containers and lids should be kept dry and free from dust. Cleaning must be undertaken with a dampened cotton cloth without additives and without manmade fibres or addition of cleaning agents, never use abrasives or solvents.
- Do NOT use any type of oil, solvent, detergent, petroleum-based solvent or ammonia solution to clean the battery containers or lids.
- Avoid electrostatic charging.
- Every 6 months, check total voltage at battery terminals (if necessary adjust the charging voltages to the correct values given in the §2.3), cell voltages of pilot cells, the cells surface temperature and battery room temperature.
- Once a year, take readings of individual cell voltages too (the cells should be within 4.5% of the average) .
- Keep a logbook in which the measured values can be noted (all readings should be recorded in a format where deviations and trends are easily identifiable) as well as time and date of each event like discharge tests etc.



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easy to do business with, while supplying  
the highest quality products and services  
on time and in the most cost-effective manner.”**



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