PowerSafe® SBS XC+

Operation Guide

for Renewable Energy Applications

EnerSys®

Power/Full Solutions

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PowerSafe® SBS XC+

1. Introduction

The EnerSys® PowerSafe® SBS® XC+ range of valve regulated lead acid cells and monoblocs is designed to meet today's challenging demands of renewable energy applications, such as solar and wind.

This range of 2V cells and 12V blocs are optimised for repeated cycling, high reliability and very low maintenance. This combination makes PowerSafe SBS XC+ the ideal solution for many of the most demanding applications and particularly for remote locations where the highest level of reliability is essential. It has the added benefit of resilience against deep discharge.

The high cyclability of PowerSafe SBS XC+ and its ability to operate in uncontrolled PSoC conditions, where ambient temperature can often be high, provides the operator significant benefits in terms of total cost of ownership (TCO).

For operation in unreliable grid applications, refer to the **PowerSafe SBS XC+ Operation Guide for Unreliable Grid Applications.**

For operation in controlled Partial State of Charge applications, refer to the **PowerSafe SBS XC+ Operation Guide for Hybrid Applications.**

2. Application

PowerSafe SBS XC+ is designed for renewable energy applications where the battery must undergo repeated cycling with daily depths of discharge of up to 35% of capacity C_{120}, such as rural settlements, communications systems and lighting systems.

The battery is normally used with a daily cycle - charge during the day and discharge during night. Typically, the daily discharge usage is between 2 and 20% DoD.

The attributes of this type of battery are as follows:

- High cycling (one 'cycle' consists of a discharge; of any depth, followed by a recharge)
- High recharge roundtrip efficiency (%Wh)
- Deep discharge recovery
- No addition of water required during service life

3. Storage

Monoblocs and cells lose capacity when standing on open-circuit because of parasitic chemical reactions. The high purity of the materials used in the construction of PowerSafe SBS XC+ batteries results in a very low rate of self-discharge, delivering up to 2-years shelf life (at 20°C) before a refresh charge is required, subject to OCV auditing.
The self-discharge rate of PowerSafe SBS XC+ monoblocs and cells is a function of the temperature. See below for the rate of self-discharge at various temperatures:

Temperature	20°C	25°C	30°C	40°C
Monthly self-discharge rate	1.25%	1.76%	2.5%	5%

Batteries should be stored in a cool, dry area. Note that high temperature increases the rate of self-discharge and reduces storage life. The following table gives the maximum storage time before a refresh charge is required and the recommended OCV audit intervals, at the given average storage ambient temperature:

Temperature (°C / °F)	Storage Time (Months)	OCV Audit Interval (Months)
+10 / +50	48	12
+15 / +59	34	12
+20 / +68	24	12
+25 / +77	17	6
+30 / +96	12	6
+35 / +95	8.5	3
+40 / +104	6	3

4. Initial Charging

4.1 Refreshing Charge

Cells and monoblocs must be given a refreshing charge when, either:

- the OCV approaches 2.10Vpc, or
- the maximum storage time is reached, whichever occurs first.

Refer to the **PowerSafe SBS XC+ Installation, Operation & Maintenance (IOM) Manual** for further details.

4.2 Commissioning Charge

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

In the case of renewable energy applications; with no external source available for recharging, connect the battery to the solar panel regulator and leave at rest for one to two weeks. For this charge, set the regulator to the values as described in Section 5.3 hereafter.

5. Operation

The high charge acceptance of PowerSafe SBS XC+ cells and monoblocs enables the use of fast charge techniques. Once the battery is brought to full state of charge, the voltage should be reverted to float, with appropriate temperature compensation, to prevent prolonged periods of overcharge.

5.1. Operating Temperature

The recommended operating temperature range for optimum life and performance is between 20°C to 25°C. However, PowerSafe SBS XC+ cells and monoblocs can be operated in the temperature range -40°C to +50°C. To maintain mechanical integrity of the plastic components, the battery temperature in operation should not exceed 50°C. Note, operation of batteries at temperatures higher than recommended will reduce life expectancy.

5.2. Float Charging

The recommended float voltage setting is 2.29Vpc at 20°C (+68°F). Therefore, the total system voltage setting equals the number of cells in series multiplied by 2.29V.

The recommended float voltage temperature compensation is:

- 2.29Vpc +3mV per cell per °C below 20°C
- 2.29Vpc -3mV per cell per °C above 20°C

Also see **Figure 1** below.

Temperature compensation is capped at 46°C (115°F). At this temperature the compensated charge voltage approaches the natural open circuit voltage of the battery, and there is insufficient overvoltage to keep the battery in a fully charged condition.

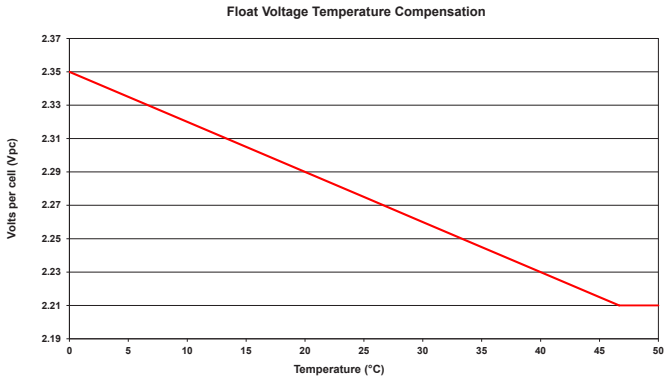

Figure 1

5.3. Fast Charging

The high charge acceptance of the TPPL technology used in PowerSafe SBS XC+ is suited for applications which require a fast time to repeat duty. In such applications the voltage regulator should be set at between 2.35Vpc to 2.40Vpc at 25°C. Once fully charged, the voltage can be reverted to float voltage, with appropriate temperature compensation.

There are several methods that can be utilised to control the recharge and determine, when using fast charge, that full state of charge is obtained, such as 'Current Absorption' and 'Ah Counting'.

Based on Current Absorption, the recharge can be stopped when the current being absorbed by the battery reduces to 0.01C_{10} Amps. At this point a timer can be set/activated to deliver an additional 1 hour of charge.

Ah Counting, i.e. returning 103% of the discharged Ah (115% in terms of Wh), can be used to control the recharge with a device with the accuracy ±1% of the expected current range.

However, inaccuracies associated with equipment calibration and/or controller algorithm accuracy can lead to drift in determining the true state of charge (SoC), meaning that periodic equalisation charge and recalibration of SoC is required.

Whether Current Absorption or Ah Counting is used to control the recharge, the battery voltage can be maintained at a constant of 2.35Vpc to 2.40Vpc provided that the battery temperature is controlled at or below 50°C (122°F).

A third method of recharging available is known as 'Time Base'. It is possible to estimate time to full state of charge when using a recharge voltage of 2.40Vpc at 20°C by using the calculation:

Recharge Time (Hrs) = (2 x ((0.8 x discharged Ah) / Available Current)) + 1

When time is being used as a trigger for the end of fast recharge, temperature compensation for charge voltage is required. See **Figure 2** below.

5.4. Fast Charge Temperature Compensation

Using 2.40Vpc as the nominal voltage, apply the same temperature compensation values to fast charge voltage as float, above. Note, if the voltage cannot be adjusted to values >2.40Vpc to compensate for temperatures below 20°C, the time to full state of charge will increase.

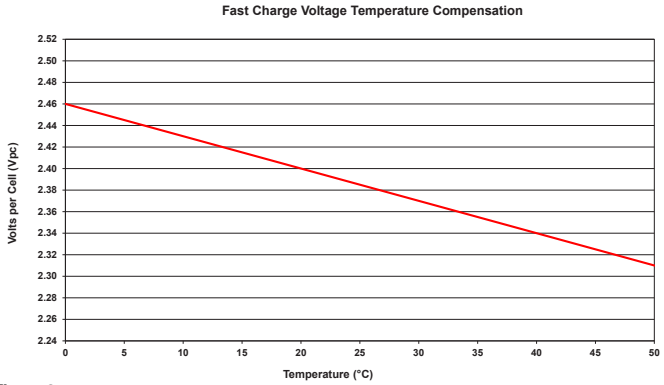

Figure 2

5.5. Fast Charge Current Limit

In addition to the influence of charge voltage, the available charge current will impact on the time to repeat duty. **Figure 3** illustrates the typical time to full SoC as a function of available charge current from varying depths of discharge based on recharge at 2.40Vpc at 20°C.

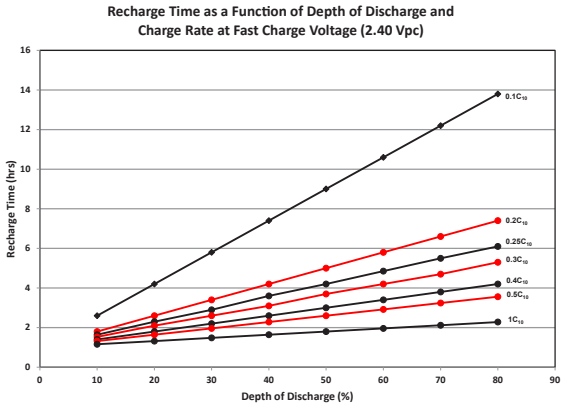

Figure 3

PowerSafe® SBS XC+

5.6. State of Charge

The table hereafter gives the relationship of the State of Charge (SoC) of cells and blocs and the Open Circuit Voltage (OCV).

State of Charge (%)	Voltage (Vpc)
100	2.17
90	2.15
80	2.12
70	2.10

For additional information and guidance on this subject, please contact your EnerSys® representative.

5.7. Discharging

Do not over-discharge the battery or leave the battery in a discharged condition after supplying the load. Return the battery to recharge mode immediately. An abusive deep discharge can severely impact battery performance.

This can be avoided by applying a Low Voltage Disconnect (LVD) 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 (Hours)		
	100	120	240
Low Voltage Alarm	1.96Vpc	1.96Vpc	1.99Vpc
Disconnect Voltage (LVD)	1.93Vpc	1.93Vpc	1.96Vpc

5.8. Effect of Temperature on Capacity

If the ambient temperature deviates from 25°C, a correction factor must be applied to the published rating to optimise the service life. See **Figure 4** below for 20-hour discharges as a typical example. please contact your EnerSys® representative for alternative discharge rates.

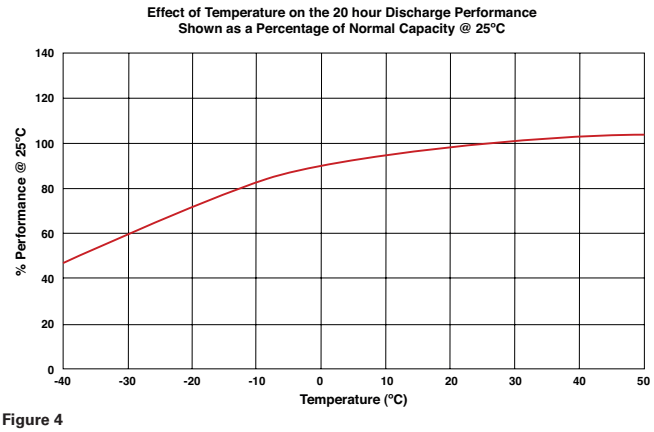

Figure 4

5.9. Cyclic Performance

The performance characteristics of the PowerSafe SBS XC+ range has been optimised with the added capability to deliver high performance in renewable energy applications. This is particularly the case where, due to the frequency of power outages, there is a risk of uncontrolled partial state of charge operation.

Figure 5 below shows cycling capability of PowerSafe SBS XC+ products in typical renewable energy applications. Note, actual life obtained is dependent on site-specific conditions.

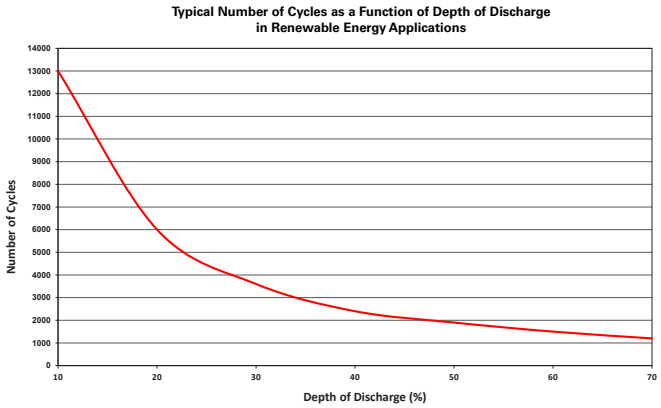

Figure 5

5.10. Service Life

Under normal operating conditions, the battery lifetime largely depends on the temperature and depth of discharge. The service life in cycling applications is based on the number of years with a daily depth of discharge and can never exceed the design life of the product.

See Typical Number of Cycles as a Function of DoD graph, **Figure 5**, and an example of a PowerSafe® SBS XC+ battery at 25°C:

Daily Depth of Discharge (% DoD)	Number of Cycles at 25°C	Estimated Life Expectancy (Years)
30	3,600	9.8

6. Maintenance

PowerSafe SBS XC+ cells and monoblocs are classed as VRLA batteries and do not have to be topped up with water.

- Do not open or remove 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 done with a damped cotton cloth without additives and without man-made fibres or the addition of cleaning agents. Never use abrasives or solvents.
- Do NOT use any type of oil, solvent, detergent, petroleum-based solvents or ammonia solution to clean the battery containers or lids.
- Discharge any possible static electricity from clothes by touching an earth connected part.

7. Data Recording

It is recommended that, as a minimum, the following information is recorded by means of regular data logging, which the user must make available to EnerSys® to validate any warranty claim.

1) Records of the commission charge.
2) The number of cycles performed and the depth of discharge (DoD) of each cycle.
3) The duration of each charge and discharge cycle, and the Ah in and Ah out, or Wh in and Wh out.
4) Full details of the recharge voltage/current profile for the last 50 cycles.
5) A full history of the ambient and battery surface temperatures, recorded at regular intervals throughout battery operation and life.
6) The time and date of each event. An event is defined as the start/stop of the battery discharge, the start/stop of the battery recharge, the start/stop of any input power source.

8. Disposal

PowerSafe SBS XC+ products 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.

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