PowerSafe® SBS XC+

Operation Guide for Hybrid Applications

EnerSys®
Power/Full Solutions

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PowerSafe® SBS XC+ products should only be used in controlled hybrid off-grid applications as detailed within this document. Continuous charge will significantly reduce the battery life.

1. Introduction

The PowerSafe SBS XC+ range has been specifically designed for hybrid applications. The introduction of PowerSafe SBS XC+ provides users with an outstanding cyclic performance and the ability to operate the battery in a controlled partial state of charge (PSoC) operation for off-grid hybrid applications, as defined in table 1.

Controlled partial state of charge:
An operating mode with regular cyclic duty where the battery is deliberately operated in partial state of charge to maximise operating expenditure savings. The battery is periodically returned to full state of charge when predefined trigger points are reached. The battery can be subjected to high ambient temperatures.

Table 1

In applications where mains grid power is not available, the power requirement is typically supplied by a diesel generator and/or battery bank but it can also incorporate renewable energy sources such as wind turbine or PV array. In these off-grid hybrid applications, the battery can be subjected to warm ambient temperatures with regular cyclic duty.

The high charge acceptance and faster recharge capability of PowerSafe SBS XC+, with great cyclic performance, result in improved Total Cost of Ownership (TCO) advantages.

Table 2 provides a summary of the operating parameters to achieve optimum service life and performance.

Hybrid Operating Parameters in Controlled PSoC
✓ Discharge to maximum 50% DoD (depth of discharge)
✓ Boost voltage equivalent to 2.40Vpc @ 20°C. Return 100% of discharged Ah (97% state of charge)
✓ Charge current - minimum 0.2 C_{10}A, maximum unlimited
✓ Full recharge typically every 7 to 10 days (depending on sizing and operation)
EnerSys® will consider variations in controlled PSoC operation as necessary - please contact your local representative to discuss details.

Table 2

2. General Operating Instructions

2.1 Operating Temperature Range

The recommended operating temperature range for PowerSafe SBS XC+ is -40°C to +50°C. Optimum life and performance are attained at +20°C, however, with the correct controls in place, cyclic performance in hybrid applications is not impacted by elevated temperatures (providing that the maximum battery temperature is not allowed to exceed +50°C).

2.2 Storage

PowerSafe SBS XC+ products have a shelf life of 18 months when stored at 20°C. Higher temperatures increase the rate of self-discharge and reduce storage life. Table 3 gives the relationship between storage time, open circuit voltage (OCV) and state of charge as a function of temperature.

2.3 Refresh Charge

PowerSafe SBS XC+ must be given a refresh charge when the OCV approaches 2.10 Volts/cell or when maximum storage time is reached (whichever occurs first). The charge should be conducted using constant voltage in the range of 2.29 to 2.40 volts per cell for a period of 24 hours. The minimum charge current should be equivalent to 0.1C_{10} Amps; the maximum value is unlimited. The maximum storage times between refresh charge and recommended OCV audit frequency are given in the table below.

Temperature (°C / °F)	Storage Time (Months)	OCV Audit Interval (Months)
+10 / +50	36	6
+15 / +59	25	6
+20 / +68	18	4
+25 / +77	12	4
+30 / +86	9	3
+35 / +95	6	2
+40 / +104	4	2

Table 3

2.4 Commissioning

Prior to operation, the battery must be given a commissioning charge. This shall consist of a 24 hour charge at a voltage equivalent to 2.40Vpc at 20°C with no load connected.

2.5 Fast Charging

Fast charge is recommended for frequent discharge cyclic applications. In such applications the rectifier output voltage should be set at 2.40Vpc at 20°C. Temperature compensation for charge voltage should be applied as follows and as illustrated in figure 1:

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

Where rectifier voltage cannot be adjusted to values >2.40Vpc to compensate for temperatures below 20°C, the time for recharge will be increased.

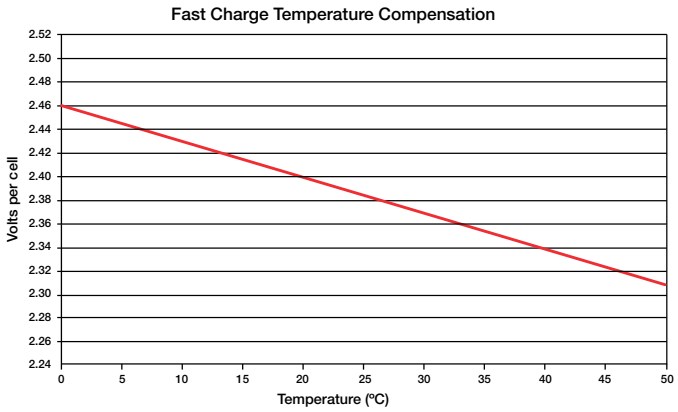

Figure 1

2.6 Charging Current Limit

Due to the very low internal resistance PowerSafe® SBS XC+ products will accept unlimited current during recharge, with minimum acceptable current equivalent to the load + $0.2C_{10}$ Amps.

3. Cyclic Operation Guidelines

3.1 Cyclic Performance

The optimal cyclic performance shown in figure 2 is based on the battery being operated in controlled PSoC between discharge cycles. It is critical to ensure that the battery is periodically returned to full state of charge to maintain battery state of health.

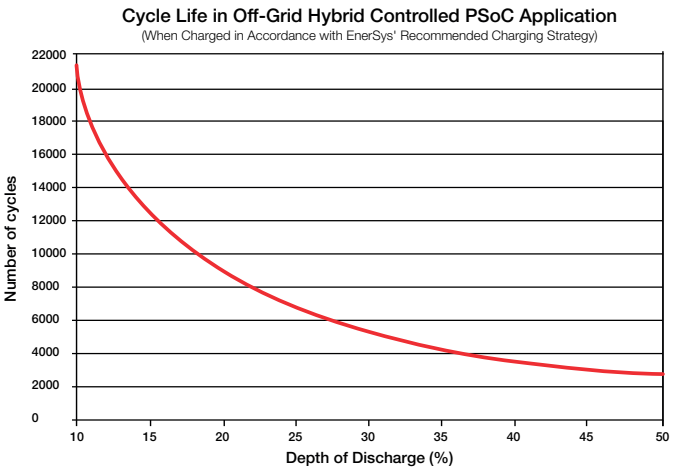

Figure 2

3.2 Discharge

In normal hybrid operation the battery should be discharged to a maximum of the C5 discharge rate. For optimum performance, battery life and TCO, it is recommended to limit the depth of discharge to a maximum of 50%.

The discharge may be stopped and recharge commenced when the on-load battery voltage falls to the level equivalent to the configured depth of discharge in the duty cycle, using the curve as shown in figure 3. As an example, a 48V system could be set up for 30% DoD in normal operation, with an end of discharge voltage trigger of 49.4V (2.06Vpc).

In abnormal situations (e.g. where a generator fails to start), a partial load disconnect at 47V (1.96Vpc - 70% DoD) and low voltage disconnect at 46.3V (1.93Vpc - 80% DoD) should be applied to protect the battery from abusive over discharge.

The discharge may also be measured by means of an Ah counting device with an accuracy of ± 1% of the expected current range.

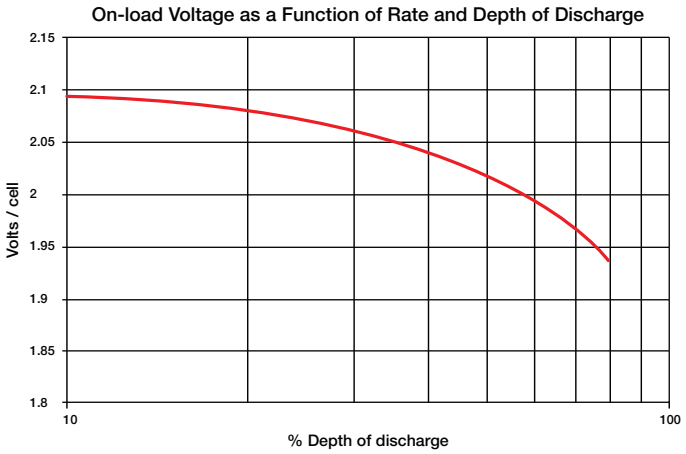

Figure 3

3.3 Recharge in Controlled PSoC Operation

There are several methods that can be utilised to control the recharge time:

1. Current absorption rate: The recharge can be stopped when the current being absorbed by the battery falls below $0.075C_{10}$ A, or after the calculated recharge time is achieved, whichever occurs first.

   The recharge time during the PSoC cycling maybe calculated based on the Ah removed and charge current:

   Recharge time (hours) = 2* ((0.8 x discharged Ah) / current limit).

2. Ah counting: A controlled recharge can be achieved by Ah counting using a device with an accuracy of ± 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 SoC, meaning that, after a periodic equalisation charge, a recalibration of the SoC is required. Where Ah counting is used to control PSoC, a recharge of 100% to 101% of the discharged Ah should be returned between discharge micro cycles.

3.4 Full Recharge & Equalisation

It is critical to ensure that the battery is periodically returned to a full state of charge to maintain the battery state of health.

Full charge and equalisation should be applied periodically, equivalent to either 4x energy throughput relative to nominal capacity or if on-load voltage falls to 1.96Vpc, whichever occurs first.

Once full state of charge is achieved, equalisation should be applied for 4 hours using 2.40Vpc at 20°C. Full state of charge is determined when the current absorbed by the battery is stable over a period of 1 hour.

Temperature compensation to the charge voltage should be applied as detailed in section 2.5.

3.5 Data Recording

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

1) Records of the commissioning charge.

2) The number of cycles performed and the depth of discharge of each cycle.

3) The duration of each discharge and charge cycle, and the Ah in and out (Wh in and 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 generator input power or other input power source, etc.).

4. 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.

Warning
In hybrid applications it is important that the maximum temperature of the battery in operation does not exceed +50°C. Continuous charge at 2.40Vpc will significantly reduce the battery life.

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