PowerStor

Technical Specification

Index

PowerStor
Standby Battery Systems

In today's environment battery systems must perform in the most challenging applications. The versatile PowerStor range of sealed lead acid batteries has all the answers with a wide choice of capacity ratings in compact cases for both standard and extended design life suitable for both cyclic and float applications.

BPC is at the forefront of modern power protection technology and our expertise in the design, development and manufacture of special and custom battery systems enables us to meet the diverse needs of the leisure, industrial, commercial, emergency services, medical and defence markets.

The PowerStor range has a wide choice of technologies and capacity ratings for both standard and extended design life suitable for engine starting, cyclic and float applications. BPC extended battery range & accessories includes:

- Sealed Lead Acid AGM Batteries
- Sealed Lead Acid Gel Batteries
- Rackmount Sealed Lead Acid AGM Batteries – Front Access
- Rackmount Sealed Lead Acid Gel Batteries – Front Access
- Nickel Cadmium Vented Alkaline Batteries
- Cycling Sealed Lead Acid Batteries for Electric Vehicle Applications
- Battery Enclosures
- Battery Options & Accessories
- Battery Monitoring Systems

PowerStor PS Range

Utilising the latest advanced absorbed glass mat (AGM) and gas recombination technology, PowerStor valve regulated sealed lead acid (VRLA) batteries ensure maintenance free, reliable performance, safety and outstanding service life with up to 5 years expectation in float standby applications.

PowerStor PSL Range

For mission critical standby applications requiring longer in service life the PowerStor PSL range is available with an enhanced grid and separator design. As a result of the largely increased battery life, up to 10 years in optimum float conditions, it is possible that electrical equipment can be supported throughout its own full service life without it being necessary to change the battery.

PowerStor PSLIFR Range

For larger mission critical applications requiring longer in service life the PowerStor PSLIFR range is available with an enhanced grid and separator design. Also provided are flame retardant case and lids with inserted pole terminals. As a result of the largely increased battery life, up to 15 years in optimum float conditions, it is possible that electrical equipment can be supported throughout its own full service life without it being necessary to change the battery.

PowerStor are built in accordance with the most stringent international standards and the PSLIFR range conforms to the following requirements:-

- JIS C 8702-1995
- IEC 1056-1
- DIN 43534
- UL 44VO
- BS 6290 part 4

PowerStor PSLRACK Range

The PowerStor PSLRACK range of sealed lead acid batteries is designed for mission critical telecommunication and industrial applications requiring longer in service life up to 10 years in optimum float conditions. The batteries are designed to be compatible and able to fit in 19" telecom cabinets with ease. With a wide choice of capacity ratings in compact rackmount cases, the PSLRACK range can suit any autonomy requirements.

PowerStor Nickel Cadmium Range

PowerStor Nickel Cadmium Batteries are manufactured in basic ranges to match specific operating conditions and provide different performance characteristics. All nickel cadmium batteries use relatively expensive materials to combine maximum performance with minimum maintenance and optimum life of 20 to 25 years. Thus the nickel cadmium battery may be more expensive in the initial cost than lead acid batteries but will be considerably more cost effective over the long term.

PowerStor Gel Range

For mission critical deep cycle applications requiring longer in service life, the PowerStor Gel range is available with an enhanced grid / separator design and a gelled electrolyte introduced to the cell by means of custom built vacuum filling machine technology. As a result Gel batteries have many advantages over AGM such as full recovery from deep discharge, good tolerance to higher temperature applications, excellent performance over long discharges and improved charge acceptance due to low internal resistance so it is important to choose the right battery for your application.

PowerStor EV Range

Cyclic sealed lead acid batteries for electric vehicle applications. The versatile PowerStor EV range of sealed lead acid batteries offers higher performance against deep discharge, repeat daily cycling, higher temperature and mobile type applications. With a wide choice of capacity ratings in compact cases we can offer solutions for the most challenging applications.

PowerStor Solar Range

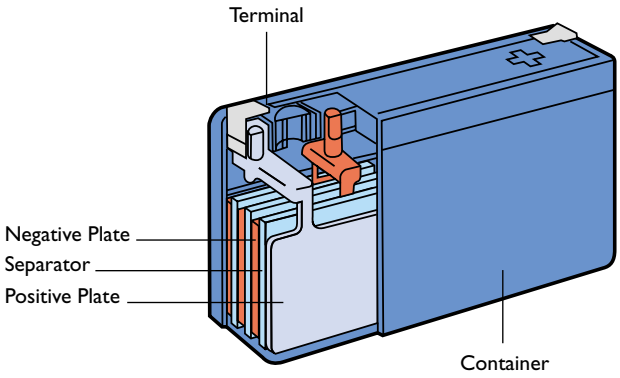
For demanding Photovoltaic applications batteries are subjected to high and low temperatures, unpredictable charging, daily cycling and probable partial state of charge discharges. The premium PowerStor Solar range has enhanced grid/separator design and gelled electrolyte technology to ensure excellent performance in such adverse operating conditions providing a maintenance free solution throughout its design life.

Typical Applications

- Fire Alarm and Security Systems
- Industrial Control Systems
- Emergency Lighting
- Model and Toy Products
- Uninterruptible Power Supplies
- Sports and Leisure Equipment
- Computer/Network Products
- Mobility Vehicles
- Telecom Equipment
- Portable Equipment

General Features and Benefits

- **Low Self Discharge** Allowing the battery to be stored for extended periods without permanent loss of capacity
- **Electrolyte Suppression System** PowerStor's unique construction and sealing technique ensures no free electrolyte can escape
- **Operation in Any Orientation** Design flexibility allows operation in any orientation with no loss of performance or concern for electrolyte leakage (exception of continuous use in the inverted position)
- **Compact PowerStor Design** Offers a high energy density providing excellent power/volume/weight ratios
- **Float or Cyclic use High Performance Design** Allows use for both cyclic and continuous float applications
- **Wide Operating Temperature Range** PowerStor batteries can be operated in temperatures of -10°C to +50°C
- **Flexible Design** PowerStor batteries are manufactured using a range of terminals to suit most standard applications but custom designs are available
- **Deep Discharge Recovery** Unique processes are used in the grid alloy and electrolyte providing easy recharge to normal levels after being deeply discharged.



Positive Plates

Positive plates are made from a Lead-Calcium system.
Negative Plates
Negative plates are made from a Lead-Calcium system.

Separators

The glass fibre separators in PowerStor batteries have high resistance to acid. The high porosity of the separators retains adequate electrolyte for the reaction of active materials in the plates.

Terminals

Excellent terminal sealing construction has been achieved by using long mechanical sealing paths and the selection of small shrinkage ratios for the sealing materials.

Principle Processes of Sealed Lead Acid Battery

Positive Plate $PbO_2+SO_4^{=} + 4H^+ +2e^- = PbSO_4 +2H_2O$
Negative Plate $Pb + SO_4^{=} = PbSO_4 + 2e^-$
Net. $PbO_2 +2SO_4^{=} + 4H^+ +Pb = 2PbSO_4 +2H_2 O$

The gassing and water loss reactions are as follows:

Positive Plate $H_2O = 2H^+ + {}^1/_2O_2 + 2e^-$
Negative Plate $2H^+ + 2e^- = H_2$
Net. $H_2O = H_2 + {}^1/_2O_2$ ……..(1)

The gassing reaction only generally occurs to any extent when the battery is almost totally charged. In the valve regulated battery it is obvious that water loss must be avoided. This is done by limiting the escape of hydrogen and oxygen from the battery. The design therefore accomplishes the recombination of the oxygen formed at the positive plate with the hydrogen formed at the negative plate. The reaction is as follows:

Negative a. $Pb + {}^1/_2O_2 + H_2SO_4 = PbSO_4 +H_2O$
Negative b. $PbSO_4 +2H^+ + 2e^- = Pb + H_2SO_4$
Net Negative. ${}^1/_2O_2 + 2H^+ + 2e^- = H_2O$ ……..(2)

The oxygen gas generated in the final stage of charging is absorbed by the negative, and so there is no increase in internal pressure, despite the sealed construction. When, however, the charging current exceeds the specified valve, or when charging is conducted at less than the specified temperature, the amount of gas generated by reaction (1) cannot all be absorbed by reaction (2). In the event, an increase in internal pressure develops.

Battery Storage

PowerStor batteries have excellent charge retention characteristics, but specific precautions must be taken against the battery over discharging itself by self-discharge when in storage or not operating. A discharged (flat) battery may be determined by the voltage of that battery. The voltage of a battery that can be described as fully discharged varies with the discharge current. The higher the discharge current for a battery, the quicker the battery reaches a fully discharged state and the lower the voltage will be for a battery to be described as fully discharged (flat). At all times a battery should be recharged immediately.

Final Acceptable Discharge Voltages

Discharge Current	Final Discharge Voltage, (vpc)
Up to 0.1 CA	1.75
0.11 – 0.17 CA	1.70
0.18 – 0.25 CA	1.67
0.26 – 0.6 CA	1.60
3 CA	1.30
Above 3 CA	Refer for advice

The slowest practical rate of discharge for a lead acid battery is self-discharge. As the current is very low the fully discharged voltage is high, i.e. the battery is flat at 2.00 – 2.03 vpc. Therefore a program of stock control must be introduced to ensure that batteries are recharged well before that voltage is reached.

Supplementary Charge Advice

Storage Temperature	Charging Interval
20°C or less	Every 9 months
20 - 30°C	Every 6 months
30 - 40°C	Every 3 months

In discharging a battery, lead sulphate is formed. If the battery is recharged as soon as discharging is completed, and then the lead sulphate is converted to active material. However on self-discharge the lead sulphate that is formed may become inactivated, so it cannot be reconverted. The lower the voltage that a battery is allowed to fall to under self discharge, the more likely that the sulphate formation will not be able to be reversed and the battery damaged beyond recovery.

Precautions Against Over Self-Discharge

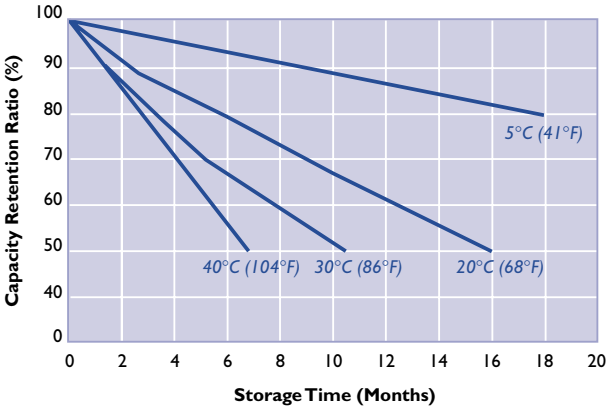
- The batteries should be stored in a cool, dry place
- The batteries should not be stored in direct sunlight
- The batteries should not be subjected to an external heat source
- The voltage of batteries in stock should be regularly checked

Precautions for Pre Installed Batteries

- Only new or freshly recharged batteries should be used
- Any load that is on the battery in the product must be fully disconnected. Any discharge on the battery other than self-discharge will quickly flatten the battery and cause the formation of lead sulphate, which if left in this state for too long, will damage the battery.
- The first operating instruction for equipment fitted and sold with a rechargeable lead acid battery must be "The battery must be fully charged before use".

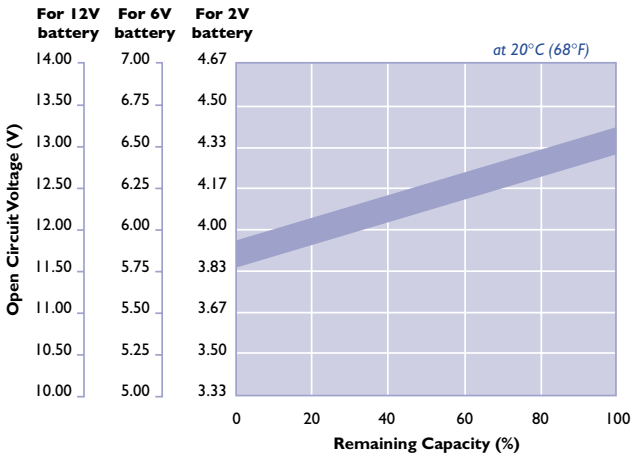
Self-Discharge Characteristics

Battery Self-Discharge Characteristics



Open Circuit Voltage and Remaining Capacity

Battery Open Circuit Voltage VS. Remaining Capacity



Recharging a Self-Discharging Battery

When a top up charge is needed, the following procedures should be observed:

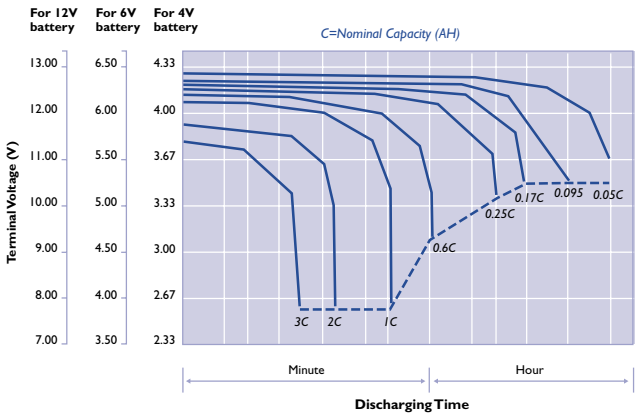
- Ensure the OCV of the battery is greater than 2 vpc. If the voltage is lower than 2 vpc please refer the problem before attempting to recharge.
- Constant voltage charging is recommended.

Storage Time	*Top Up Charging Recommendation*
Less than 6 months from manufacture or previous	Maximum of 20 hours at a constant voltage of 2.4vpc.
Up to 12 months after a manufacture or previous	Maximum of 24 hours at a constant voltage of 2.4vpc.
Note: a faster recharge may be obtained by using the constant current method of charging. This requires a closer supervision of the charging procedures.	
Less than 6 months	Maximum of 6 hours at a constant current of 0.1C Amps
Up to 12 months	Maximum of 10 hours at a constant current of 0.1C Amps

Battery Discharge Characteristics

The Discharge capacity of a lead acid battery varies and is dependant on the discharge current. PowerStor batteries use a rate at the 20 hour rate.

Characteristic Discharge Curves for PowerStor Batteries



The discharge curves in the above graph show the minimum design parameters for each fully charged PowerStor battery after installation. Full capacity is reached after some initial service.

- Float Service One month after installation and recharging.
- Cycle Service Within three to five cycles after initial charge and service entry.

Technical Terms

- Battery capacity for small batteries by accepted convention worldwide is described in "AMPERE HOUR" at the 20-hour rate C when discharged at 25°C.
- Battery load, by convention is described in terms of a multiple of C, in amps, where C is the capacity at 25°C.

Multiple of C	*Load (Amps)*	*Cut off Volts/Cell*
3C	13.5	1.30
1C	4.5	1.30
0.55C	2.475	1.55
0.1C	0.45	1.75
0.05C	0.225	1.75

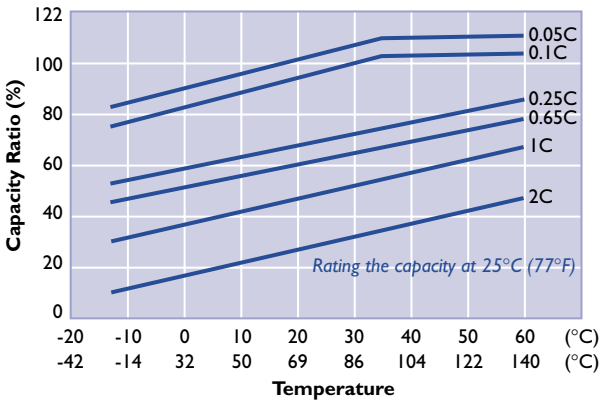
- Battery cut-off voltage is the volts per cell to which a battery may be discharged safely to maximize battery life, this data is specified according to the actual discharge load and run time. As a rule of thumb high amp loads and short run times will tolerate a lower cut off voltage (e.g. 3C at 1.3V/C), whereas a low amps long run time discharge will require as higher cut off voltage (e.g. 0.05C at 1.75V/C).

Effect of Temperature on Battery Capacity

The nominal battery capacity is based on the temperature of 25°C. Above this temperature the capacity increases marginally but it must be noted that the working battery should be kept within the temperature design limitations of the product.

Below 25°C the capacity decreases. This decrease in capacity becomes large at temperatures below 0°C and in heavy discharge rates. The graph below illustrates the situation and the decrease in capacity with the decrease in operating temperature. Temperature must be taken into capacity design calculations in applications where the operating temperature of the system is below 20°C.

Effect of Temperature on Battery Capacity



Correct battery charging ensures the maximum possible working life for the battery. There are four major methods of charging:

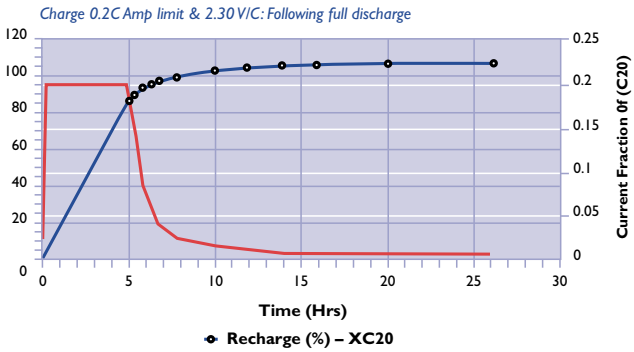
- Constant Voltage Charging
- Constant Current Charging
- Two Stage Constant Voltage Charging
- Taper Current Charging

Constant Voltage Charging

It is necessary to closely control the actual voltage to ensure that it is within the limits advised.
Float Service: 2.27 – 2.30 vpc at 25°C
Cycle Service: 2.40 – 2.45 vpc at 25°C

It is suggested that the initial current be set within 0.4 C Amps. The graph below indicates the time taken to fully recharge the battery. It should be noted that the graph illustrated is for a fully discharged battery. It is also seen that it is necessary to charge a greater amount of energy into the battery than was taken out of the battery on discharge. The actual current indicating that the battery is fully charged is approx. 5mA/Ah under charging voltage is 2.30 vpc.

Recharge 0.2C Amp Limit



It is necessary to ensure that the voltage is correctly set. A charging voltage set too high will increase the corrosion of the positive plates and shorten battery life. A charging voltage set too low will lead to sulphation of the plates causing loss of capacity and ultimately shortening the life of the battery.

Cycling Service Recharge

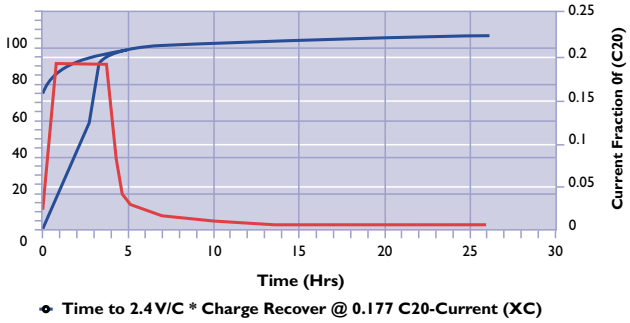
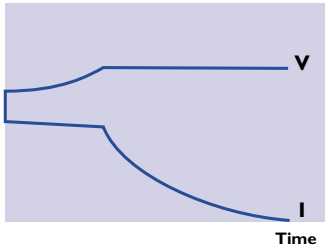


Figure 7: Constant-Voltage Charge with Current Limited



Constant Current Charging

This method of charging is generally not recommended for SLA batteries. It is necessary to understand that if the batteries are not removed from the charger as soon as possible after reaching a state of full charge, considerable damage will occur to the batteries due to overcharging.

Two Stages Constant Voltage Charging

This method should not be used where the battery and load are connected in parallel.

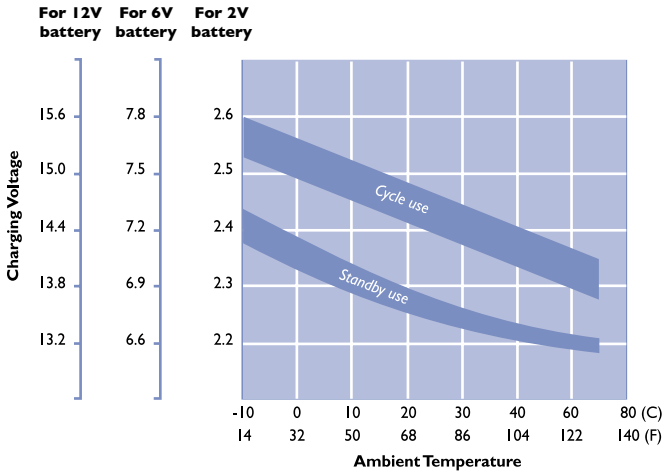
Taper Current Charging

This method is not recommended for SLA batteries.

Effect of Temperature on Charging Voltage

As temperature rises, electrochemical activity in a battery increases. Similarly, as temperature falls, electrochemical activity decreases. Therefore, conversely, as temperature rises, charging voltage should be reduced to prevent overcharge, and increased as temperature falls to avoid undercharge. In general, to assure optimum service life, use of a temperature compensated charger is recommended. The recommended compensation factor for PowerStor batteries is 3m V/ C/Cell (stand by) and 4m V/ C/Cell (cyclic use). The standard centre point for temperature compensation is 20 C. The graph below shows the relationship between temperatures and charging voltages in both cyclic and standby application.

Relationship between Charging Voltage and Temperature



Effect of Voltage on Battery Gassing

Although the batteries are of the recombination type and the amount of gassing at normal operating voltages and temperature is negligible, if the charging voltage is increased, gassing will occur despite the recombination design of the product. Gassing does not normally occur while the battery is operating under float conditions and normal constant voltage recharge of 2.27 – 2.30 vpc at 25°C. Very little gassing occurs when the battery is recharged under normal cycling recharge procedures.

Battery life depends on a number of key factors:

- Operating temperature of the battery
- Method of charging utilised
- Actual use of the product i.e. float or cycle

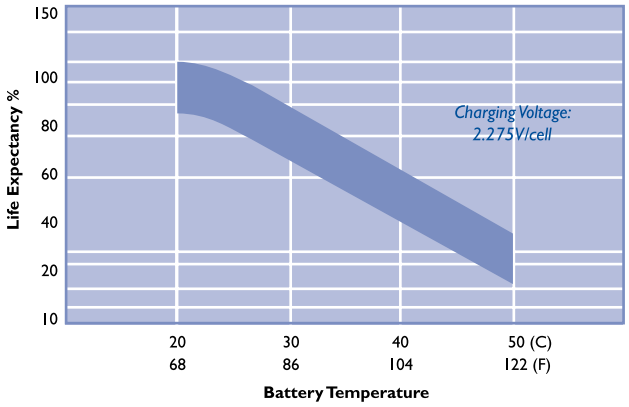
Float Service

The estimated life under float service is:

PowerStor PS – 3-5 years
PowerStor PSL – 6-10 years
PowerStor PSL RACK – 6-10 years
PowerStor GEL – 6-10 years
PowerStor PSLIFR – 9-15 years
PowerStor EV Range – Cyclic dependant
PowerStor Solar Range – Cyclic dependant

The float service is affected by the factors listed above and the number and depth of discharges the battery suffers during its lifetime. Basically the more discharges suffered and the deeper the discharges, the shorter the battery life.

Effect of Temperature on Long Term Float Life



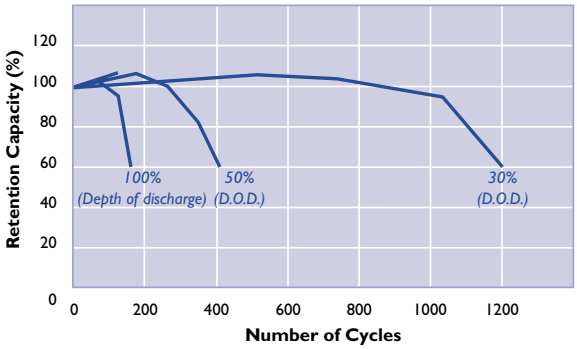
Cycle Service

Giving due consideration to the above factors, the actual life of a general purpose battery in cyclic service is dependent on the depth of discharge of each cycle and the number of cycles available from the battery.

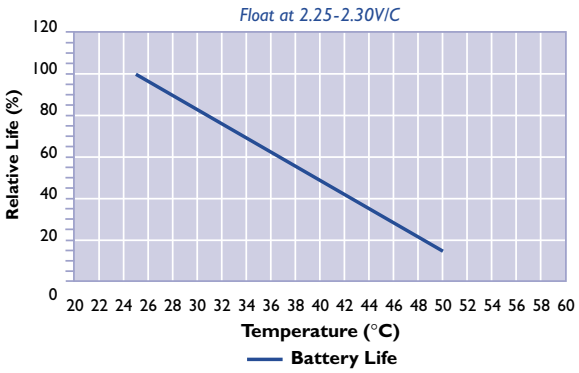
PowerStor EV & Solar range will have greater cyclic performance. (see specific data sheets)

Battery Life Characteristic of Cyclic Use

Testing Conditions:
Discharge Current: 0.25C Amp (F.V. 1.7V/cell)
Charging Current: 0.1C Amp
Charging Volume: 120% of Discharge Capacity
Ambient Temperature: 20°C (68°F)



Relative Battery Life vs. Temperature



PowerStor Battery Specifications

PS Battery Model	Volts	Rated Capacity (20hr rate) (AH)*	Approx. Dimensions			Approx. Weight (kgs)	Terminal Layout	Terminal Type
			Width (mm)	Depth (mm)	Overall Height (mm)			Standard
PS 10-6	6	10	50	151	99.5	1.8	1	B
PS 12-6	6	12	50	151	99.5	2.0	1	B
PS 2.2-12	12	2.2	34	177.5	66	1.0	1	A
PS 2.9-12	12	2.9	55	78	104	1.2	1	A
PS 3.3-12	12	3.3	67	133.5	67	1.4	2	A
PS 4.5-12	12	4.5	70	90	107	1.8	4	A
PSHR 5-12	12	5	48	140	108	1.9	1	A
PS 7-12	12	7	65	151	99	2.3	4	B
PS 7.5-12	12	7.5	65	151	99	2.5	4	B
PS 12-12	12	12	97	150	103	4.0	4	B

PSL Battery Model	Volts	Rated Capacity (20hr rate) (AH)*	Approx. Dimensions			Approx. Weight (kgs)	Terminal Layout	Terminal Type
			Width (mm)	Depth (mm)	Overall Height (mm)			Standard
PSL 9-12	12	9	65	151	99	2.6	4	B
PSL 18-12	12	18	76	181	167	5.5	2	I5
PSL 26-12	12	26	168	178	124	8.0	2	I5
PSL 35-12	12	35	130	195	160	10.4	1	I6
PSL 44-12	12	44	167	198	157	13.3	2	I6
PSL 55-12	12	55	138	229	213	17.0	1	I6
PSL 70-12	12	70	168	260	211	24.3	1	I6
PSL 70J-12	12	70	168	349	175	21.0	2	I6
PSL 80-12	12	80	168	260	211	25.8	1	I6
PSL 90-12	12	90	168	306	211	30.1	1	I6
PSL 100-12	12	100	168	306	211	28.8	1	I6
PSL 120-12	12	120	176	408	227	35.8	1	I6
PSL 135-12	12	135	173	340	283	40.6	1	I6
PSL 150-12	12	150	170	482	242	44.0	1	I6
PSL 160-12	12	160	209	530	214	55.0	3	I6
PSL 200-12	12	200	240	520	220	60.9	3	I8
PSL 230-12	12	230	269	521	203	74.0	3	I8
PSL 110-6	6	110	168	193	205	17.9	5	I6
PSL 160-6	6	160	171	298	226	26.4	5	I6
PSL 200-6	6	200	178	323	225	31.8	5	I8

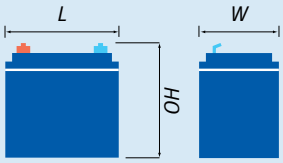
PSLIFR Battery Model	Volts	Rated Capacity (20hr rate) (AH)*	Approx. Dimensions			Approx. Weight (kgs)	Terminal Layout	Terminal Type
			Width (mm)	Depth (mm)	Overall Height (mm)			Standard
PSLIFR 50-2	2	50	50	161	166	3.2	2	I6
PSLIFR 100-2	2	100	72	171	205	6.0	2	I6
PSLIFR 150-2	2	150	102	172	205	8.1	2	I6
PSLIFR 200-2	2	200	111	173	329	13.7	2	I8
PSLIFR 300-2	2	300	151	171	330	18.1	2	I8
PSLIFR 400-2	2	400	176	211	329	27.2	4	I8
PSLIFR 450-2	2	450	187	223	351	29.5	4	I8
PSLIFR 500-2	2	500	172	241	331	30.8	4	I8
PSLIFR 600-2	2	600	175	301	331	39.0	4	I8
PSLIFR 800-2	2	800	175	410	330	52.5	8	I8
PSLIFR 1000-2	2	1000	175	475	328	63.5	8	I8
PSLIFR 1250-2	2	1250	175	475	328	76.9	8	I8
PSLIFR 1500-2	2	1500	351	401	342	102.2	8	I8
PSLIFR 2000-2	2	2000	351	491	344	133.3	8	I8
PSLIFR 3000-2	2	3000	353	762	341	200.0	8	I8
PSLIFR 3850-2	2	3850	353	762	341	260.0	8	I8

PSLRACK Battery Model	Volts	Rated Capacity (20hr rate) (AH)*	Approx. Dimensions			Approx. Weight (kgs)	Terminal Layout	Terminal Type
			Width (mm)	Depth (mm)	Overall Height (mm)			Standard
PSLRACK 55-12FA	12	55	105	277	223	18.9	FA	I6
PSLRACK 80-12FA	12	80	114	563	182	26.2	FA	I6
PSLRACK 95-12FA	12	95	109	507	227	30.8	FA	I6
PSLRACK 100-12FA	12	100	110	395	285	35.0	FA	I6
PSLRACK 100T-12FA	12	100	110	507	227	34.0	FA	I6
PSLRACK 125-12FA	12	125	172	417	240	46.3	FA	I6
PSLRACK 150-12FA	12	150	109	550	288	49.7	FA	I6
PSLRACK 180-12FA	12	180	125	560	320	60.5	FA	I8

 # Optional Terminal Types Available
 # FA – Front Access

Battery Terminal Layout & Type

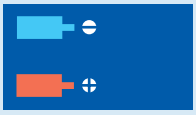
Terminal Layout



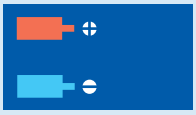
Outer dimensions

Terminal Layout 1

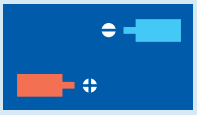
Terminal Layout 2



Terminal Layout 3

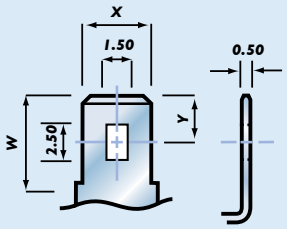


Terminal Layout 4



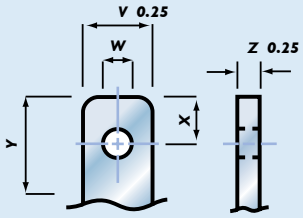
Terminal Layout 5

Terminal Type



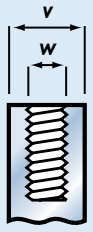
Faston tab

Terminal type	W	X	Y
A	6.35	4.70	3.15
B	7.90	6.35	4.00



Bolt Fastening Terminal

Terminal type	V	W	X	Y	Z	Bolt type
C	12.00	5.50	5.50	11.50	2.00	M5
D	15.00	5.50	7.50	15.00	5.00	M5
E	18.00	6.50	9.50	19.50	6.00	M6
F	16.00	6.50	9.50	15.00	6.00	M6
G	25.00	9.00	11.00	24.50	8.00	M8
H	26.50	9.00	12.00	28.00	8.00	M8



Inserted Terminal

Terminal type	V	W	Bolt type
I5	10.00	5.00	M5
I6	16.00	6.00	M6
I8	16.00	8.00	M8

All dimensions in millimetres

Prolonging Battery Life

Charging Instructions

- Always recharge the battery immediately after use.
- Constant voltage charging is recommended. At 25°C, 2.27 – 2.30vpc for float use and 2.40 – 2.45vpc for cycle use.
- The maximum initial charging current should be 0.4CA.
- If batteries are used in series or parallel, the correct size cabling should be used.
- Do not charge the battery in upside-down position.

The battery requires approximately 110% of the total discharging energy to fully recharge.

Discharging Instructions

- Never leave a battery in a discharging condition.
- Never allow a battery to fall below 2 vpc in storage. The full capacity may not be able to be reached and actual service life decreased.
- Maximum continuous discharge current is 5CA.
- Avoid over discharging the battery.
- Stored batteries should receive a supplementary charge at intervals suggested.

Ensure the operating temperature is below 40°C.

Supplementary Charge Advice

Storage Temp.	Charging Interval
20°C or less	Every 9 months
20 - 30°C	Every 6 months
30 - 40°C	Every 3 months

Cautions

- When cleaning the batteries, use soft cloth only. Use organic solvents such as gasoline or thinner, and application or adherence of oil to the batteries must be avoided. Do not clean the batteries using dirty or oily cloth. Contact with soft polyvinyl chloride must be avoided.
- Batteries may generate inflammable gas in some cases. Do not expose them to flame or excess heat. Do not short batteries.
- Do not attempt to disassemble the batteries. Avoid contact with sulphuric acid leaking from broken batteries. If contact is made with skin or clothes, rinse the area generously with water. If eyes come in contact, wash eyes with clean water, and consult a physician immediately.
- Batteries may explode if put into a fire. Never dispose of batteries in fire.
- Mixed usage of batteries differing in capacity, type, manufacturer or history of use (charge/discharge operation) may damage the batteries and the equipment due to the difference in characteristic resistive values. This must not be attempted anyhow.
- While our batteries are exceptionally dependable, we do not recommend use in life support medical applications unless there is an alternative redundant battery or back up power supply.
- When the batteries come to their end of life, discharge duration time becomes remarkably short. And finally, batteries lose their available capacity by internal short-circuit and/or dry out of electrolyte.