



PSL-SC-12350-GU1 12.8V 35.0AH

Rechargeable Lithium Battery
PSL SC – Serial Connection Capable Series

BATTERY FEATURES

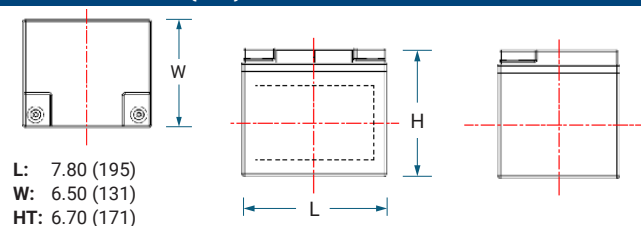
- Super safe lithium iron phosphate (LiFePO₄) chemistry reducing the risk of explosion or combustion due to high impact, over-charging or short circuit situation
- Battery Management System (BMS) controls the parameters of the battery to provide optimum safety by protecting against over-charging and over-discharging
- BMS enhanced design balances the battery cells, optimizing battery performance
- Higher capacity or voltage capability through parallel or serial connections
- Delivers twice the power of lead acid batteries, even at high discharge rates, while maintaining constant power
- Faster charging and lower self-discharge
- Up to 10 times more cycles than lead acid batteries
- Compact and only 40% of the weight of comparable lead acid batteries
- Rugged impact resistant ABS case

APPROVALS

- UL 1642 cell certificate
- IEC 62133 cell certificate
- UN 38.3 certified
- ISO9001:2015 - Quality management systems



DIMENSIONS: inch (mm)



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INTELLIGENT BATTERY MANAGEMENT SYSTEM

The PSL-SC Series comes with an intelligent battery management system which monitors current and voltages during charge and discharge. This protects the battery from over-charge and over-discharge.

The BMS embeds smart balancing algorithms that control all cell voltages in the battery, making sure they are constantly at the same voltage level, optimizing battery capacity.

SERIAL CONNECTION CAPABLE

The SC series allows for up to 4 batteries connected in series or 4 in parallel, but not concurrently. The batteries must all be matched at voltage levels, capacity, state of charge, date of manufacturing, and chemistry.

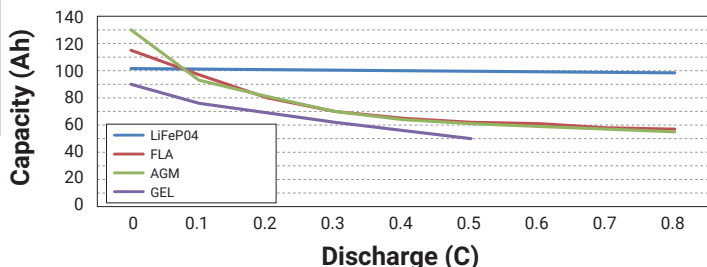
APPLICATIONS

- Medical
- Solar
- Wind
- Mobility
- Data Center
- Transport
- Sports & Recreation
- Utility

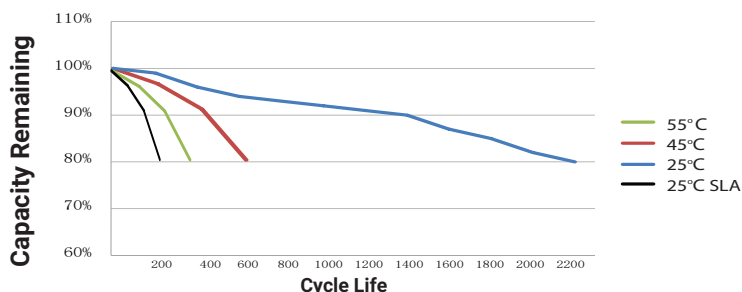
PERFORMANCE SPECIFICATIONS

Nominal Voltage	12.8 V
Rated Capacity	35 AH at a Constant Current of 0.2C to 10V
Stored Energy	448 Wh
Cycle Life (@DOD100%)	2000 Cycles
Approximate Weight	9.7 lbs (4.4 kg)
Internal Resistance	≤60.0 mΩ
Max Charge Current	35 A
Max Discharge Current	35 A
Charging Voltage	14.6 V
Recommended Discharge Cut-Off Voltage	11 V
Series & Parallel Connection	4 in series or 4 in parallel
Operating Temperature Range	Charge: 32°F (0°C) to 113°F (45°C) Discharge: -4°F (-20°C) to 140°F (60°C) Recommended: 59°F (15°C) to 95°F (35°C)
Self-Discharge Rate	≤3%/month
Long Term Storage	Charge every 6 months or as soon as OCV is 12.8V
Power Sonic Chargers	Contact us for information on a suitable charge
Life Expectancy (years)	5 years at one cycle per day
Short Circuit Protection	Automatically recover after removal of short
Dimensional Tolerances	+/- 0.04 in. (+/- 1mm) for length and width +/- 0.08 in. (+/- 2mm) for height dimensions
Terminal Type	T11

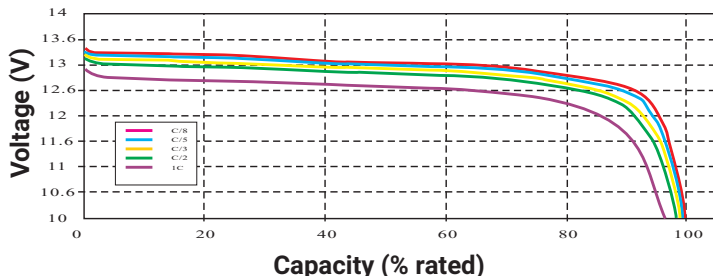
CAPACITY OF LiFeP04 vs. LEAD ACID AT VARIOUS CURRENTS OF DISCHARGE



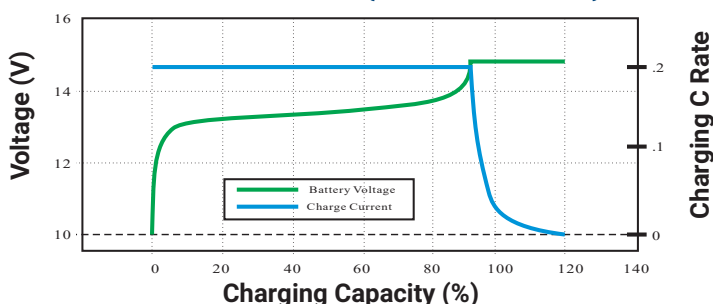
CYCLE LIFE vs. VARIOUS TEMPERATURE 0.2C CHARGE/0.5C DISCHARGE @ 100% DOD



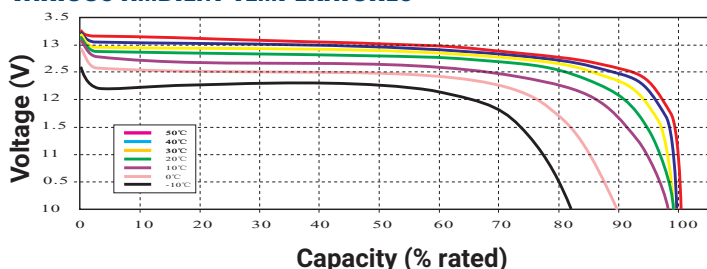
DISCHARGE VOLTAGE PROFILES AT VARIOUS RATES 25°C AMBIENT TEMPERATURE



CHARGING CHARACTERISTICS (0.2C AMP @ 25°C)



DISCHARGE VOLTAGE PROFILES AT 0.5C DISCHARGE RATE VARIOUS AMBIENT TEMPERATURES



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Rechargeable Lithium Battery PSL SC – Serial Connection Capable Series BENEFITS OF LITHIUM

Lithium offers several performance benefits versus its sealed lead acid (SLA) equivalent. A lithium battery's capacity is independent from the discharge rate and provides constant power throughout its discharge. The degradation of a lithium battery at a high temperature is significantly reduced in comparison to SLA.

Lithium has ten times the cycle life as SLA at room temperature. Even at an elevated temperature, lithium still has increased cycle life over SLA at room temperature.

Lastly, Lithium charging follows a similar charging profile as SLA, Constant Current Constant Voltage (CC/CV). However, lithium can be charged faster, without the need for a maintenance float charge.

BMS TECHNICAL SPECIFICATIONS

Over Charge

Over-charge protection for each cell	3.90 V
Over-charge release for each cell	3.60 V
Over-charge release method	Protection releases when all cell voltages drop below the over-charge release voltage

Over Discharge

Over-discharge protection for each cell	2.00 V
Over-discharge release for each cell	2.50 V
Over-discharge release method	Protection releases when all cell voltages rise above the over-discharge release voltage

Over current

Discharge over-current protection	100-110 A
Protection delay time	31 ms
Over-current release method	Remove load for the over-current protection to release

Battery Temperature

Over-temperature protection	65° C
Release temperature	55° C

Short circuit protection

Function condition	External short circuit
Short circuit delay time	250-500 ms
Release condition	Remove load for the short circuit protection to release

FURTHER INFORMATION

Please refer to our website www.power-sonic.com or email us at technical-support@power-sonic.com for a complete range of useful downloads, such as product catalogs, material safety data sheets (MSDS), ISO certification, etc.

HOW TO CHARGE LITHIUM IRON PHOSPHATE (LIFEPO4) BATTERIES

If you've recently purchased or are researching lithium iron phosphate batteries (referred to lithium or LiFePO₄ in this white paper), you know they provide more cycles, an even distribution of power delivery, and weigh less than a comparable sealed lead acid (SLA) battery. Did you know they can also charge four times faster than SLA? But exactly how do you charge a lithium battery, anyway?

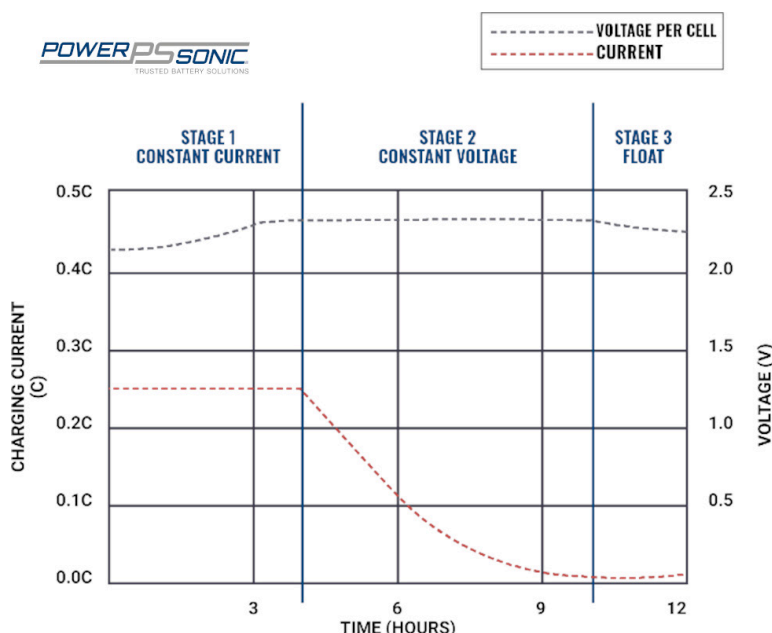
Power Sonic recommends you select a charger designed for the chemistry of your battery. This means we recommend using a lithium charger when charging lithium batteries.

CAN A LEAD ACID CHARGER CHARGE A LITHIUM BATTERY?

As you will learn in this white paper, there are many similarities in the charging profiles of SLA and lithium. However, extra caution should be exercised when using SLA chargers to charge lithium batteries as they can damage, under charge, or reduce the capacity of the lithium battery over time. There are many differences when comparing lithium and SLA batteries.

SEALED LEAD ACID (SLA) BATTERY CHARGING PROFILE

Let's go back to the basics of how to charge a sealed lead acid battery. The most common charging method is a three-stage approach: the initial charge (constant current), the saturation topping charge (constant voltage), and the float charge.



Stage 1, as shown above, the current is limited to avoid damage to the battery. The rate of change in voltage continually changes during Stage 1 eventually beginning to plateau when the full charge voltage limit is approached. The constant current/Stage 1 portion of the charge is crucial before moving onto the next stage. Stage 1 charging is typically done at 10%-30% (0.1C to 0.3C) current of the capacity rating of the battery or less.

Stage 2, constant voltage, begins when the voltage reaches the voltage limit (14.7V for fast charging SLA batteries). During this stage, the current draw gradually decreases as the topping charge of the battery continues. This stage terminates when the current falls below 5% of the battery's rated capacity. The last stage, the float charge, is necessary to keep the battery from self-discharging and losing capacity.

If the battery is being used in a standby application, the float charge is necessary to ensure the battery is at full capacity when the battery is called upon to discharge. In an application where the battery is in storage, float charging keeps the SLA battery at 100% State of Charge (SOC), which is necessary to prevent sulfating of the battery that therefore prevents damage to the plates of the battery.

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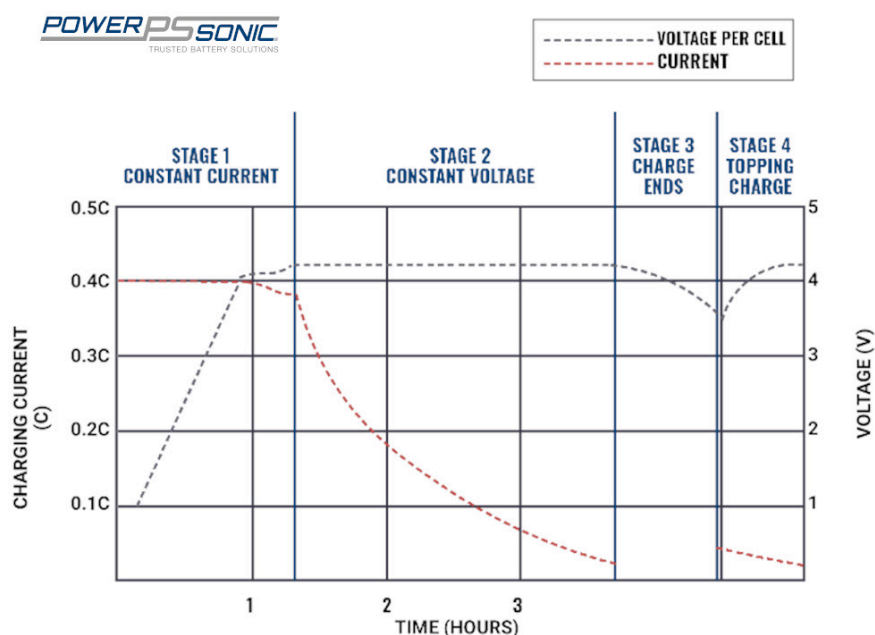
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LIFEPO4 BATTERY CHARGING PROFILE

A LiFePO4 battery uses the same constant current and constant voltage stages as the SLA battery. Even though these two stages are similar and perform the same function, the advantage of the LiFePO4 battery is that the rate of charge can be much higher, making the charge time much faster.



Stage 1 battery charging is typically done at 30%-100% (0.3C to 1.0C) current of the capacity rating of the battery. Stage 1 of the SLA chart above takes four hours to complete. The Stage 1 of a lithium battery can take as little as one hour to complete, making a lithium battery available for use four times faster than SLA.

Stage 2 is necessary in both chemistries to bring the battery to 100% SOC. The SLA battery takes 7 hours to complete Stage 2, whereas the lithium battery can take as little as 15 minutes. Overall, the lithium battery charges in four hours, and the SLA battery typically takes 10. In cyclic applications, the charge time is very critical. A lithium battery can be charged and discharged several times a day, whereas a lead acid battery can only be fully cycled once a day.

Where they become different in charging profiles is Stage 3. A lithium battery does not need a float charge like lead acid. In long-term storage applications, a lithium battery should not be stored at 100% SOC, and therefore can be maintained with a full cycle (charged and discharged) once every 6 - 12 months to 30% - 70% SOC.

In standby applications, since the self-discharge rate of lithium is so low, the lithium battery will deliver close to full capacity even if it has not been charged for 6 - 12 months. For longer periods of time, a charge system that provides a topping charge based on voltage is recommended.

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HOW TO CHARGE LITHIUM IRON PHOSPHATE (LIFEPO4) BATTERIES

LITHIUM BATTERY CHARGING CHARACTERISTICS

Voltage and current settings during charging

The full charge voltage of a 12V SLA battery is nominally around 13.1 and the full charge voltage of a 12.8V lithium battery is around 13.4. A battery will only sustain damage if the charging voltage applied is significantly higher than the full charge voltage of the battery.

This means an SLA battery should be kept below 14.7V for Stage 2 charging and below 15.2V for lithium. Float charging is only required for an SLA battery, recommended around 13.8V. Based on this, a charge voltage range between 13.8V and 14.7V is sufficient to charge any battery without causing damage. When selecting a charger for either chemistry, it is important to choose one that will stay between the limits listed above.

Chargers are selected to match the capacity of the battery to be charged, since the current used during charging is based on the capacity rating of the battery. A lithium battery can be charged as fast as 1C, whereas a lead acid battery should be kept below 0.3C. This means a 10AH lithium battery can typically be charged at 10A while a 10AH lead acid battery can be charged at 3A.

The charge cut-off current is 5% of the capacity, so the cutoff for both batteries would be 0.5A. Typically, the terminal current setting is determined by the charger.

Universal chargers will typically have a function to select the chemistry. This function chooses the optimal voltage charging range, and determines when the battery is fully charged. If it is charging a lithium battery, the charger should shut off automatically. If it is charging an SLA battery, it should switch to a float charge.

Lithium batteries replacing sealed lead acid in float applications

It is very common for lithium batteries to be placed in an application where an SLA battery used to be maintained on a float charge, such as a UPS system. There has been some concern, whether this is safe for lithium batteries. It is generally acceptable to use a standard constant voltage SLA charger with our lithium batteries, as long as it adheres to certain standards.

If using a constant voltage SLA charger, the charger must meet the following conditions:

- Charger must not contain a de-sulfating setting
- Fast charge voltage of 14.7V
- Recommended float charge voltage of 13.8V

As a side note, some smart or multi-stage SLA chargers have a feature that detects open circuit voltage (OCV). An over-discharged lithium battery that is in protection mode will have an OCV of 0. This type of charger would assume this battery is dead and would not try to charge it. A charger with a lithium setting will try to recover or "wake up" an over-discharged lithium battery.

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Long term storage

If you need to keep your batteries in storage for an extended period, there are a few things to consider as the storage requirements are different for SLA and lithium batteries. There are two main reasons that storing an SLA versus a Lithium battery is different.

The first reason is that the chemistry of the battery determines the optimal SOC for storage. For an SLA battery, you want to store it as close to possible as 100% to avoid sulfating, which causes a buildup of sulfate crystals on the plates. The buildup of sulfate crystals will diminish the capacity of the battery.

For a lithium battery the structure of the positive terminal becomes unstable when depleted of electrons for long periods of time. The instability of the positive terminal can lead to permanent capacity loss. For this reason, a lithium battery should be stored near 50% SOC, which equally distributes the electrons on the positive and negative terminals.

The second influence on storage is the self-discharge rate. The high self-discharge rate of the SLA battery means that you should put it on a float charge or a trickle charge to maintain it as close as possible to 100% SOC to avoid permanent capacity loss. For a lithium battery, which has a much lower discharge rate and doesn't need to be at 100% SOC, you may be able to get away with minimal maintenance charging.



Recommended battery chargers

It is always important to match your charger to deliver the correct current and voltage for the battery you are charging. For example, you wouldn't use a 24V charger to charge a 12V battery. It is also recommended that you use a charger matched to your battery chemistry, barring the notes from above on how to use an SLA charger with a lithium battery.

If you have any questions about an existing charger's capability with one of our products, please give us a call or send us an email. We would be happy to assist you with your charging needs.

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