



Application Guide: Programming Sol-Ark for Flooded and Deep Cycle Batteries for Grid-Tie or Off-Grid Applications

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Introduction

Flooded and deep cycle batteries are one of the first battery chemistries used in off-grid solar systems, providing reliable energy storage when the sun isn't shining. These batteries have no BMS or computerized charging systems, making them ideal for use with EMP hardened Sol-Ark inverters.

However, to get the most out of your investment in diverse types of batteries, it's essential to understand how to program the Sol-Ark, and account for specific factors when using them in off-grid solar applications.

Flooded batteries may require more hands-on maintenance. It's vital to program the battery for manufacturer-recommended charge voltages, and adjust for charge conditions, to avoid under/overcharge, capacity loss, and eventual battery failure.

1. Battery Maintenance for Flooded and Deep Cycle Batteries

Proper maintenance is critical for flooded and deep cycle batteries, especially in off-grid solar setups where battery reliability is essential.

See your battery manufacturer's documentation for specifications on maintaining the battery in your system. Maintenance may include checking the fluid level of the battery and assessing the tightness of the wiring/busbars.

In many cases, it's essential that at least one full Bulk & Absorption charge be completed at a set interval. However, it may be recommended to size the system to fully charge the batteries daily. The requirements for full state-of-charge depend on the battery's make and model, cycle frequency, and depth of discharge.

2. Programming the Sol-Ark

Programming the charge controller correctly will maintain battery health and maximize its lifespan, particularly in solar off-grid systems where charging depends on variable sunlight.

2.1 Nominal Battery Bank Voltage

Lead-acid batteries are made up of individual 2-volt cells. The manufacturer-recommended charge voltage is often provided in a "voltage per cell" table.

Examples

- A 12V battery contains (x6) 2-volt cells such as with the Sol-Ark PCC 230. A 48V system that the Sol-Ark operates would therefore have (x4) 12V batteries in a series (24 x 2-volt cells).
- If a battery manufacturer with a charge voltage noted at 2.5VPC, a 12-volt battery with 6 cells would then require 6 x 2.5VPC or 15V. **48V = 24 x 2.5VPC = 60V**

Sol-Ark Voltage Settings

- **Bulk/Absorption Voltage:** Set the bulk charge voltage from manufacturer specifications to ensure the battery charges fully but does not overcharge.
- **End Amps Timer:** A rigid value for when the inverter transitions from Absorption to Float. Lasts until the current decreases and voltage is held steady. Using this value varies depending on the battery manufacturer, temperature, and depth of discharge.
- **Float Voltage:** Maintains the battery's charge after reaching full capacity without overcharging. Set the float voltage from manufacturer specifications.

2.2 Equalization Charging

This is a controlled overcharge to balance the cells in AGM and flooded batteries. It helps restore full capacity.

- **When to Equalize:** Supplied by the battery manufacturer or when there is a noticeable drop in battery performance (such as uneven voltages across cells).
- **How to Perform:** If the Sol-Ark lacks sufficient PV (solar) power, use a battery charger with equalization mode. Make sure it's set to the proper voltage for your specific battery type.

Note: Equalization is available only with Grid power or PV; a generator can't complete it.

- **Equalization Voltage:** Ensure equalization charging (if needed) is set to the correct voltage. The frequency and timer is set by manufacturer depending on the health of the battery.

2.3 Temperature Compensation

Why It's Important

Consult the battery manufacturer for adjustments for temperature, because cold temperatures may require a higher charge voltage, and warm temperatures may require a lower charge voltage.

Temperature Sensors

External temperature sensors automatically adjust charging voltage based on ambient temperature.

2.4 Temperature Sensor

What it does

The temperature sensor adjusts the voltage in programmed increments based on the temperature of a test battery cell.

Where to install the Temperature Sensor

For an accurate reading, the sensor must be installed on the side of the battery case, approximately halfway down the side, below the electrolyte level.

Manufacturer-provided charge settings typically assume that the batteries are installed in a cool, dry location and that the provided temperature sensor is properly installed. Charge voltage requirements will increase or decrease based on the temperature of the battery bank. Some battery manufacturers may recommend a preferred location in the middle of the banks.

Note: The temperature sensor should not be mounted to the terminal posts or the top of the battery, as the actual cell temperature is typically 10-20C higher than these areas. If the battery temperature sensor (BTS) is installed incorrectly, it could cause an under/overcharge, causing the battery bank to fail prematurely.

2.5 Voltage Settings

Proper voltage settings ensure that the battery charges and discharges are within safe limits. The battery manufacturer must provide these details for you to program the Sol-Ark inverter to efficiently use the batteries.

Example 1

- A 48V system, with a charge voltage of 57.2V, a temperature compensation value of -5mV/°C/cell, and a battery temperature of 40°C.
- From the system voltage, there are 24 battery cells (48V / 2V per cell).
- $-0.005\text{V}/^\circ\text{C}/\text{cell} \times \text{cells} = -0.12\text{V}/^\circ\text{C}$. The temperature compensation value is from 25°C, so $40^\circ\text{C} - 25^\circ\text{C} = 15^\circ\text{C} \times -0.12\text{V}/^\circ\text{C} = -1.8\text{V} + 57.2\text{V} = 55.4\text{V}$. Therefore, the battery charge voltage at 40°C would be **55.4V**.

Note: The Sol-Ark does this calculation automatically. This is a technical reference for how battery manufacturers may expect the Sol-Ark to behave across different ambient temperatures.

Example 2

- A 12V system, with a charge voltage of 14.1V, a temperature compensation value of -3mV/°C/cell, and a battery temperature of 5°C.
- From the system voltage, there are 6 battery cells (12V / 2V per cell).
- $-0.003\text{V}/^\circ\text{C}/\text{cell} \times 6 \text{ cells} = -0.018\text{V}/^\circ\text{C}$. The temperature compensation value is from 25°C, so $5^\circ\text{C} - 25^\circ\text{C} = -20^\circ\text{C} \times -0.018\text{V}/^\circ\text{C} = 0.36\text{V} + 14.1\text{V} = 14.46\text{V}$. Then battery charge voltage at 5°C would be **~14.4V**.

2.6 Current Settings

- **Batt Capacity:** Enter the battery bank's size connected to the system. The manufacturer will guide or suggest various amp/hour ratings based on usage.
- **Max A Charge:** Set the max charge rate for the batteries (refer to manufacturer documentation).
- **Max A discharge:** Set the max discharge for the battery bank. (In off-grid mode, the battery bank will discharge 120% of this value for 10 seconds before the inverter shuts down to prevent battery damage).

2.7 Other Battery Settings

- **Shutdown V:** Battery voltage at which the inverter will shut down (battery symbol on the home screen will turn red). It's recommended to set a buffer in SoC or voltage to prevent impact on the batteries or premature shutdown.
- **Low Batt V:** Low battery voltage (battery symbol on the home screen will turn yellow).
- **Restart V:** Battery voltage at which AC output will automatically resume after the inverter reaches shutdown voltage.
- **Batt Resistance:** Resistance of the total bank. This can be calculated from manufacturer values.
- **Batt Charge Efficiency:** How efficient the battery is at accepting charge from the Sol-Ark that does not end up lost as heat.
- **Batt Empty V:** Tells the Sol-Ark what a heavily depleted battery is. This should be the lowest voltage cutoff value for the batteries.

3. Key Considerations for Solar Off-Grid Applications

3.1 Battery Capacity (Ah and kWh)

Sizing the Battery Bank

Calculate the battery capacity (measured in amp-hours or kilowatt-hours) needed for power during periods of low solar input or at night. In general, it's recommended to use the 20hr rate for solar backup; however, consult the battery manufacturer's documentation for details.

- Determine your daily energy consumption in kWh.
- Multiply this by the number of days of autonomy (how many days you want the system to run without sun).
- Factor in battery depth of discharge (DOD) limits. Consider the number of cycles available at various DOD and consider increasing the battery bank or reducing available power loads.

3.2 Depth of Discharge (DOD)

Why It Matters

Repeated deep discharges can shorten battery life, leading to cycle counts. Ambient temperature can also negatively affect cycle count.

- **Flooded Batteries:** Refer to the manufacturer's discharge/charge graphs for DOD versus life cycle counts.
- **AGM Batteries:** Refer to the manufacturer's discharge/charge graphs for DOD versus life cycle counts.
- **Battery Monitoring:** Use Voltage mode for direct control of the unit over % mode of the Sol-Ark.

3.3 Charging Source and Solar Array Sizing

Solar Panel Sizing

Make sure that the solar array is sized to provide enough energy to fully recharge the batteries during the day, accounting for cloudy days and system losses.

- Factor in panel output (W), hours of sunlight, and some buffer for system losses.
- Balance battery bank capacity and solar panel output for optimal performance.

Generator Sizing

A generator should be sized for redundancy, to provide power when solar power is unavailable and the batteries are nearly depleted. This means sizing the generator to cover the programmed current charge of the battery while also powering the loads. It is recommended to reduce the number of running appliances in this situation, to focus the generator power to charge the battery.

The generator must be able to handle the power for charging the battery and expected loads in a low battery/limited PV environment. When enabled, a generator will charge up to 95% SOC. This limits fuel consumption while maximizing the generator for bulk charging the battery. An external AC/DC charger may be needed for extended charge cycles without available solar.

Sol-Ark Generator Controls

These are the available controls for a generator on the Sol-Ark:

- **GEN Charge:** If a Generator is connected to the **GEN** input, this specifies the maximum DC current the inverter will draw for the battery.
This value must be **<= the Maximum A Charge** value in the battery setup.
- **GRID Charge:** If a Generator is connected to the **GRID** input, this specifies the maximum DC current the inverter will draw for the battery.
This value must be **<= the Maximum A Charge** value in the battery setup.
- **GEN Start%/V:** Sets the trigger for the 2-wire auto-start of the Sol-Ark for a generator connected to the Sol-Ark's **GEN** input.
Suggested programming: **>= the Battery Low %/V**
- **GRID Start%/V:** Sets the trigger for the Sol-Ark's 2-wire auto start for a generator connected to the Sol-Ark's **GRID** input.
Suggested programming: **>= the Battery Low %/V**
- **TOU GEN STOP %/V:** TOU can be used in off-grid applications to set an automatic shutoff trigger **<95% default**. This can be used to provide finer control for shorter generator operating times.

3.4 Battery Temperature Management

Avoid Extreme Temperatures: Heat can accelerate water loss in flooded batteries, and freezing temperatures can damage discharged batteries.

- Keep batteries in a well-ventilated, temperature-controlled space.
- Use insulated battery boxes or heaters in cold climates to maintain battery health.

3.5 Planning for Battery Replacement

Monitor battery health and plan for replacements as batteries age, as performance may degrade over time.

Conclusion

Flooded and deep cycle batteries are a key component of off-grid solar systems, but their performance depends on regular maintenance, proper charging, and careful monitoring. By programming the Sol-Ark with appropriate settings, and considering key factors like battery capacity and DOD, you can maximize the life of your battery bank in your off-grid system.

Document Revision History

Rev.	Date	Author	Description of Changes
001	03/12/2025	Devin Mangru	Document Created

Disclaimers

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