

## RELiON LITHIUM IRON PHOSPHATE (LiFePO<sub>4</sub>) BATTERIES

To ensure your Lithium Iron Phosphate (LiFePO<sub>4</sub>) battery provide its maximum life, follow these Charging Instructions. When charging LiFePO<sub>4</sub> make sure that you are not using a charger meant for other lithium ion chemistries, which are typically set to a higher voltage than required by LiFePO<sub>4</sub> batteries. A lead-acid battery charger can be used if the voltage settings are within the parameters of LiFePO<sub>4</sub> batteries.

### Charger Inspection

Check that your charger cables are insulated and free of breakage. Charger terminal connectors should be clean and properly mate with the battery terminals to ensure a good connection and optimum conductivity.

### Charging Guidelines

#### When to Charge your LiFePO<sub>4</sub> Battery

If LiFePO<sub>4</sub> batteries are not fully discharged, they do not need to be charged after each use. LiFePO<sub>4</sub> batteries do not get damaged when left in a partial state of charge (PSOC). You can charge your LiFePO<sub>4</sub> batteries after each use or when they have been discharged up to 80% (20% SOC). If the Battery Management System (BMS) disconnects the battery due to low voltage, at 100% depth of discharge, remove the load to reconnect the battery circuit and charge immediately. Please note that we recommend storing batteries at 50% state of charge (SOC) to minimize irreversible capacity loss.

### Charging Temperature

LiFePO<sub>4</sub> batteries can safely charge between -20°C to 55°C (-4°F to 131°F). However, at temperatures below 0°C (32°F) the charge current must be reduced, until the temperature is >0°C (32°F), as follows:

1. 0°C to -10°C (32°F to 14°F) charge at 0.1C (10% of the battery capacity)
2. -10°C to -20°C (14°F to -4°F) charge at 0.05C (5% of the battery capacity)

LiFePO<sub>4</sub> batteries do not require temperature compensation for voltage when charging at hot or cold temperatures.

All Relion LiFePO<sub>4</sub> come with a BMS that protects the battery from over-temperature. If the BMS disconnects due to high temperature, wait until the temperature reduces and the BMS reconnects the battery circuit before using or charging the battery. Please refer to your battery data sheet for the BMS high temperature cut-off value.

### Charging with Lead-Acid Battery Chargers

Most lead-acid battery chargers can be used with LiFePO<sub>4</sub> batteries as long as they are within the appropriate voltage guidelines. AGM and Gel algorithms typically fall within the LiFePO<sub>4</sub> voltage requirements. The voltage for flooded battery charging algorithms are often higher than LiFePO<sub>4</sub> requirements, which will result in the BMS disconnecting the battery at the end of the charge cycle and possibly result in the charger displaying an error code. If this happens, it is generally a good practice to replace your charger for one with a LiFePO<sub>4</sub> charge profile. Since the BMS protects the battery, using lead-acid chargers will typically not damage the battery.



### Charging Parameters

LiFePO<sub>4</sub> can be charged with either a 1-stage profile (constant current (CC) aka Bulk Stage) or a 2-stage profile (constant current, constant voltage (CC-CV) profile aka Bulk and Absorption Stages). The 1-stage profile will charge the battery ~95% and the 2-stage profile will charge the battery 100%. The 1-stage profile is sufficient, since LiFePO<sub>4</sub> batteries do not need to be fully charged; this will not reduce life as it does with lead-acid.

#### CC Charge Profile - 1 Stage

1-STEP CHARGE DESCRIPTION	STEPS	DESCRIPTION	CHARGE PARAMETERS			
Step 1 - Charge at a constant current until the battery reaches termination voltage.	1	*Recommended Charge Current	≤0.5C			
		**Maximum Charge Current	1C or 100A (the lower of the two values)			
	SYSTEM VOLTAGE		12V	24V	36V	48V
	Stop	Termination Voltage	14.2V - 14.6V	28.4V - 29.2V	42.6V - 43.8V	56.8V - 58.4V

#### CC-CV Charge Profile - 2 Stage

2-STEP CHARGE DESCRIPTION	STEPS	DESCRIPTION	CHARGE PARAMETERS			
Step 1 - Charge at a constant current until the battery reaches absorption voltage.	1	*Recommended Charge Current	≤0.5C			
		**Maximum Charge Current	1C or 100A (the lower of the two values)			
SYSTEM VOLTAGE		12V	24V	36V	48V	
Step 2 - Hold absorption voltage until charge reduces to termination current.	2	Absorption Voltage	14.2V - 14.6V	28.4V - 29.2V	42.6V - 43.8V	56.8V - 58.4V
	Stop	Termination Current	≤0.05C			

\* Charge current must be reduced at temperatures <0°C (32°F). See details in Charge Temperature section.

\*\* For optimum life, charge at recommended rate. Some models are specially designed to allow for higher current.



### Charging Series or Parallel Systems

When connecting batteries in series or parallel, please make sure each battery is within 50mV (0.05V) of each other before putting them in service. This will minimize the chance of imbalance between batteries. If your batteries get out of balance, the voltage of any battery is >50mV (0.05V) from another battery in the set, you should charge each battery individually to rebalance. You can charge each battery individually periodically to avoid imbalance. When charging LiFePO<sub>4</sub> batteries in series, it is best to use a multi-bank charger that charges each battery individually to ensure the cells remain balanced.

If you charge batteries in series or parallel with one single bank charger (1 set of charge leads) for the entire system, please follow the instructions below.

### CC Charge Profile - 1 Stage

1-STEP CHARGE DESCRIPTION	STEPS	DESCRIPTION	CHARGE PARAMETERS			
Step 1 - Charge at a constant current until the battery reaches termination voltage.	1	*Recommended Charge Current	≤0.5C			
		**Maximum Charge Current	1C or 100A (the lower of the two values)			
	SYSTEM VOLTAGE		12V	24V	36V	48V
	Stop	Termination Voltage	14V	28V	42V	56V

\* Charge current must be reduced at temperatures <0°C (32°F). See details in Charge Temperature section.

\*\* For optimum life, charge at recommended rate. Some models are specially designed to allow for higher current.

If your charger’s voltage is lower than those listed in the tables above, it will not damage your battery, however it will be under-charged, and it will not provide the full rated capacity of the battery. If your charger’s voltages are higher than those listed in the tables above, the BMS will disconnect the battery circuit and you will have to remove the load to reconnect. We recommend you replace the charger to avoid this inconvenience.

### Fuel Gauges

If you are using a voltage-based fuel gauge that is designed for lead-acid batteries it will not accurately provide state of charge (SOC). Please replace your fuel gauge with one that measures current rather than voltage.



## Charging with an Inverter or Charge Controller Charger

### Inverter and Charge Controller Charge Parameters

Below are the typical charger inputs when using an inverter or charge controller with LiFePO<sub>4</sub> batteries. LiFePO<sub>4</sub> batteries do not require equalizing. LiFePO<sub>4</sub> batteries do not require temperature compensation for voltage when charging at hot or cold temperatures.

CHARGE PARAMETER	12V SYSTEM	24V SYSTEM	48V SYSTEM
Bulk Voltage	14V - 14.6V	28V - 29.2V	56V - 58.4V
Absorption Voltage	14V - 14.6V	28V - 29.2V	56V - 58.4V
Absorption Time	0- 15 min	0- 15 min	0- 15 min
Float Voltage	13.3V - 13.8V	26.6V - 27.6V	53.2V - 55.2V

### Inverter or Charge Controller Voltage Parameters

VOLTAGE CUTOFFS	12V SYSTEM	24V SYSTEM	48V SYSTEM
Low Voltage Cutoff	11V - 12V	22V - 24V	44V - 48V
High Voltage Cutoff	14.6V	29.2V	58.4V

## Charging with an Alternator

Depending on the quality of the alternator it may work fine with LiFePO<sub>4</sub> batteries. However, the current and voltage spikes associated with lower quality alternators or with high loading, can cause the BMS to disconnect LiFePO<sub>4</sub> batteries. If the BMS disconnects the batteries the alternator may be damaged. To protect your LiFePO<sub>4</sub> battery and alternator please be sure to use a compatible high-quality alternator or install a voltage regulator.

*If you have any technical questions, please contact RELiON Technical Support at 803-547-7288 or our toll-free number 844-385-9840.*

