

### Safety

Li-Gen batteries use LFP (LiFePO<sub>4</sub>, lithium iron phosphate) cells. These cells are among the safest Li-ion cell chemistries. However, all Li-ion cells, including LFP cells, are capable of releasing intense levels of energy in a short period, which the battery may survive but the loads attached to the battery may not.

Therefore, treat all Li-ion batteries with more care than lead-acid batteries. In particular, design and build the system such that it is practically impossible for a short circuit to occur during normal operation (e.g., vibration loosening cables), in case of an accident (e.g., vehicle flipped upside-down), or natural disasters (do not rely on gravity alone; even a stationary is affected by earthquakes).

### Battery operation

The Li-Gen battery includes a protector battery management system. It protects the cells in the battery against the following:

- Cell overcharge and overdischarge
- Charging overcurrent, discharging overcurrent, and, to a limited extent, short-circuit
- Charging and discharging over-temperature, charging under-temperature

It does so by disabling charging, discharging, or both, as appropriate. It re-enables charging automatically when the conditions return to normal. It re-enables discharging automatically when the conditions return to normal and then a charger is connected to the battery.

For best results, follow the guidelines in this manual and the requirements listed in the specification sheet for your particular battery model.

### Battery installation

Secure the battery upright so it remains in place under all conditions. Do not place in areas susceptible to flooding. Avoid installations that experience freezing temperatures or heat extremes. Tighten the bolts in the terminals to the torque specified in the specifications. Additionally, secure the cable so that they cannot rotate away from their initial orientation.

### Maximizing the life of your battery

Item	Solution
State of charge	Do not float charge the battery for a long time Do not leave empty for a long time 50 % State of Charge is ideal
Temperature	Do not let the battery get too hot or too cold 30 °C is ideal during use 10 °C is ideal during storage
Current	Do not operate at high current Avoid high current pulses (e.g., motor starting inrush) 0.1 C charge and discharge is ideal (10 A over 10 hours for a 100 Ah battery)

**Guidelines for a single battery**

	<b>Do</b>	<b>Don't</b>	<b>Why not</b>
Install	Treat the Li-gen battery like the powerful battery it is	Do not connect backward	May damage the load, the charger, and even the electronics in the battery
		Do not short across the terminals	Even though the battery includes protection, damage may occur in the system
Charging	Charge with a CCCV charger	Do not charge with a power supply	The current is not limited, which may damage the power supply and will degrade the battery cells
		Do not charge directly from a Vehicle alternator	The current is not limited, which will overheat the alternator and will degrade the battery cells If the battery suddenly disables charging, the alternator will produce a high voltage pulse, which will damage electronic products
	Charge with a CC setting of up to 0.5 C (e.g., 50 A for a 100 Ah battery)	Do not charge above 0.5 C	It degrades the battery cells
	Charge with a CV setting of 13.6 V (± 0.1 V) If using a lead-acid charger, set the same voltage for the “bulk” and “absorption” settings	Do not charge with a lower CV setting	The battery will not be fully charged
		Do not leave on a charger with a slightly higher CV setting	The battery cells will slowly degrade
		Do not charge with a much higher CV setting (such as a 16.8 V one for LCO Li-ion batteries)	The battery will not be fully charged because it shuts off charging before being “topped-up”
	Stop charging when the current drops below 0.05 C (e.g., 5 A for a 100 Ah battery)	Do not float charge the battery	The battery cells will slowly degrade
	Charge between 0 °C and 40 °C	Do not charge below freezing	The battery cells will quickly degrade
		Do not charge above 40 °C	The battery cells will slowly degrade
	Charge fully on a regular basis	Do not charge partially every time	The battery will go slowly out of balance, reducing its capacity (charge fully for a long time to reverse)
Discharging	Discharge between -20 °C and 60 °C. Limit the current to 1 C (e.g., 100 A for a 100 Ah battery)	Do not discharge below -20 °C	The battery voltage sags too much
		Do not discharge above 60 °C	The battery cells will slowly degrade
	Use a “Coulomb counting” fuel gauge	Do not use a voltmeter fuel gauge	A voltmeter fuel gauge may be fine for a lead-acid battery, but it won't report the correct State of Charge for a Li-ion battery
	When connected to a solar charge controller or an inverter (charger/inverter) always keep above 10 % State of Charge	Do not let the battery discharge to the point it shuts down	Most solar charge controllers and inverter are powered by the battery and won't restart when the sun or grid returns
Storage	Store in a cool place (25 °C max)	Do not store above 25 °C	The battery cells will slowly discharge, the battery will go out of balance, reducing the its capacity (charge fully for a long time to reverse)

Store at about 50 % State of Charge	Do not store fully discharged	Over time, battery cells will over-discharge
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**Additional guidelines for multiple batteries in series**

	<b>Do</b>	<b>Don't</b>	<b>Why not</b>	
Installation	You may connect two, three, or four 12 V batteries in series; you may connect two 24 V batteries in series	Do not connect batteries in series to achieve more than 48 V	When a battery opens under load, its electronics will be damaged	
	Before connecting in series, charge each battery fully, individually, with a 12 V charger.	Do not connect Li-ion batteries in series at different State of Charge	It reduces total string capacity: one battery limits charging, another one limits discharging	
	Respect battery polarities	Connect a battery backward	It will charge during discharge	
	Connect identical Li-Gen batteries in series of the same age		Do not use batteries of different nominal capacity (e.g., 100 Ah and 200 Ah)	The lowest-capacity battery limits the string capacity, so the extra capacity in the other batteries is never used
			Do not use batteries of different actual capacity (e.g., new 100 Ah and old 90 Ah)	The lowest-capacity battery will operate at low voltage more often than the others and will degrade faster
			Do not mix Li-Gen batteries and other chemistries (e.g., lead-acid)	The lead-acid battery may discharge to 0 V, then reverse voltage and catch on fire
	Charging	Charge with a CV setting of 13.6 V ( $\pm 0.1$ V) for each 12 V battery in series: - 27.2 V for two 12 V batteries - 40.8 V for three 12 V batteries - 54.4 for four 12 V batteries or two 24 V batteries	Do not charge with a lower CV setting	The batteries will not be fully charged; worse, the string will slowly get out of balance, reducing the total string capacity: one battery limits charging, another one limits discharging
Do not leave on a charger with a slightly higher CV setting			The battery cells will slowly degrade	
Do not charge with a much higher CV setting			The batteries will not be fully charged because the most charged battery shuts off charging, preventing the other batteries from charging	
On a regular schedule, charge each battery fully, individually, with a 12 V charger		Do not wait too long before charging each battery fully	The string will slowly get out of balance, reducing the total string capacity	

**Multiple batteries in parallel are not allowed**

<b>Do</b>	<b>Don't</b>	<b>Why not</b>
Buy a battery of the required capacity	Do not connect Li-Gen batteries in parallel	May result in an inrush current between batteries that will degrade the battery cells
	Do not mix Li-Gen batteries and other chemistries (e.g., lead-acid)	Direct connection may result in high current between the batteries when the temperature changes

## Troubleshooting

<b>Issue</b>	<b>Cause</b>	<b>Solution</b>
No voltage on terminals	Battery is empty	Charge the battery
	Battery is hot	Allow battery to cool down
	Battery is damaged	Contact tech support
Large voltage sag under load	Loose connections	Tighten the terminals to specified torque
	Battery is damaged	Contact tech support
No charging	Charger doesn't see battery, so it doesn't start	Use a charger that doesn't require to see a battery voltage Use the same charger, but temporarily apply a voltage from some other source to "prime" the charger
	Battery is hot	Allow battery to cool down
	Battery is cold	Bring the battery temperature to above freezing
	Battery is damaged	Contact tech support