

## Appendix A – LifePO4 SOC & Voltages

The state of charge (SOC) of a battery is the relative charge that is present in a battery relative to its total capacity. Like knowing the amount of fuel in your vehicle’s fuel tank. When using a voltmeter to test voltage to assess SOC, for this measurement to be trustworthy, the battery must have been “at rest” (neither charged or discharged) withing the previous 12 hours.

The best way to accurately measure battery DOC is to continuously monitor voltage, amperage, and ampere hours remaining. This is a complex calculation of the energy available, energy consumed, and the energy returned to the battery in charging. It also adds the important element of time to the equation.

And to make things a bit more exciting...there is “charging voltage” and “resting voltage” that both can mean 100% SOC. Yeah, go figure right. *Resting voltage* is the more accurate reading to use to know the true condition of the battery. And resting mean...12 hours without a charge or discharge taking place. And in most solar systems that simply doesn’t happen because the system is constantly discharging (i.e. 24-hours a day) and/or charging (i.e. 6 – 18 hours per day while the sun shines).

So the most accurate way to gauge SOC is the continuously monitor method...and that takes special instruments. But, not too special, nor too complicated.

And here is another curve ball...

- a 12v LifePO4 battery is correctly/fully charged at 13.6v and at 12v the SOC is just about 9% and the battery close to being ruined.
- a 24v LifePO4 battery is correctly/fully charged at 27.2v and at 24v the SOC is just about 9% and the battery close to being ruined.
- a 48v LifePO4 battery is correctly/fully charged at 54.4v and at 48v the SOC is just about 9% and the battery close to being ruined.

So why do they call them 12v, 24v, and 48v batteries when they don’t actually run at those voltages? I have no idea.

And another curve ball...there are “16-cell” 48v batteries and “15-cell” 48v batteries. The 15-cell version of the 48v battery is not real common and generally a good indicator of a battery manufacturer trying to hit a better price point by building a battery with one less cell and still calling it, misleading as it may be, a 48v battery.

If you are gauging a 15-cell battery you would deduct 3.4v from the fully charged, at rest, voltage of a 16-cell battery. And do so for each % rating of the 16-cell version.

To maintain a battery in healthy condition you don’t want to drop its SOC below 20%. Dropping the SOC below 20% damages the battery, meaning you are reducing it usable lifespan. Dropping the SOC

## Appendix A – LifePO4 SOC & Voltages

below 14% damages the battery, meaning you are seriously damaging the battery. Good news is...if the battery has a BMS it should turn off automatically before damage is done. Bad news is...the battery BMS may not be set right to provide adequate protection. Good news...you can also protect the battery by setting the inverter to automatically shut down at a given voltage.

Also, charging a LifePO4 battery to 100% SOC doesn't do the battery any favors. To keep a LifePO4 battery healthy and happy it is a good idea to charge to about 95% and don't discharge below 20%.

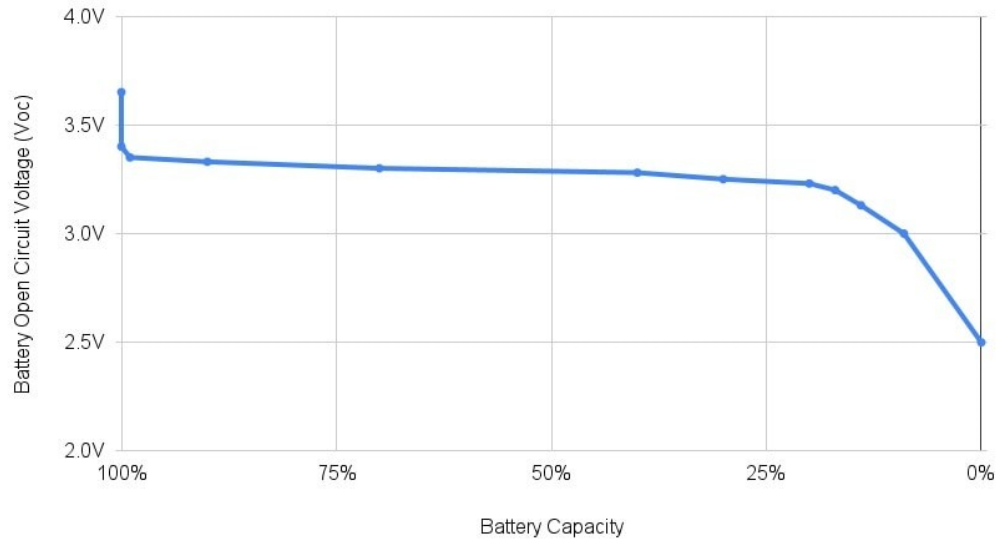
In the following charts it shows the "voltage chart" displaying the voltage "curve". Notice that the voltage curve will stay fairly flat between 100% SOC (resting) and 20% SOC, there is only .8v difference. And that is one of the huge advantages of LifePO4 battery...stable voltages throughout the discharge curve.

**IMPORTANT NOTE:** Always refer to your battery manufacturer for specific data, voltages, SOC, etc. regarding your particular battery. The information provide is only general information regarding LifePO4 batteries.

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## Per Cell -

3.2V LiFePO4 Cell Voltage Chart

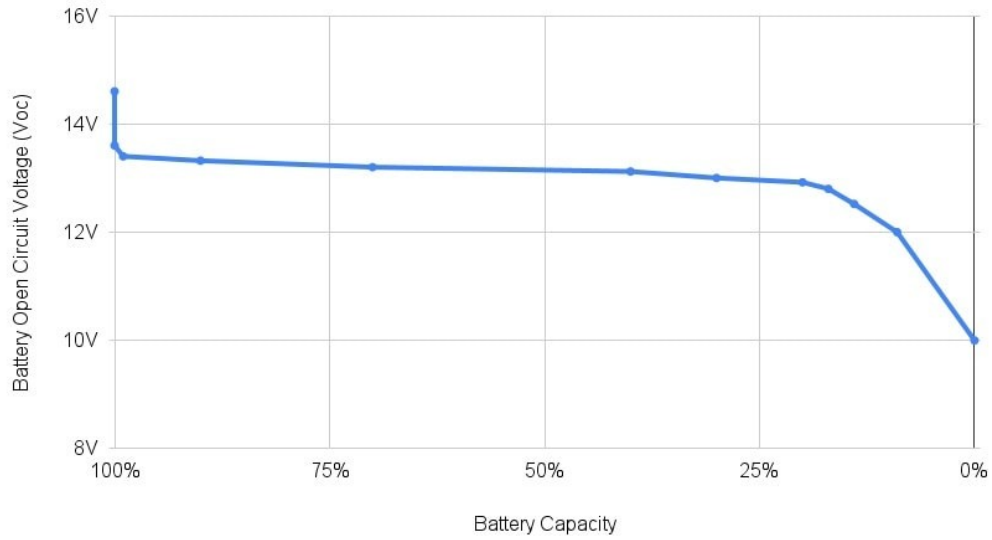


<b>3.2V LiFePO4 CELL VOLTAGE CHART</b>	
<b>VOLTAGE</b>	<b>CAPACITY</b>
<b>3.65V</b>	<b>100% (charging)</b>
<b>3.4V</b>	<b>100% (resting)</b>
<b>3.35V</b>	<b>99%</b>
<b>3.33V</b>	<b>90%</b>
<b>3.3V</b>	<b>70%</b>
<b>3.28V</b>	<b>40%</b>
<b>3.25V</b>	<b>30%</b>
<b>3.23V</b>	<b>20%</b>
<b>3.2V</b>	<b>17%</b>
<b>3.13V</b>	<b>14%</b>
<b>3.0V</b>	<b>9%</b>
<b>2.5V</b>	<b>0%</b>

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## 12v LifePO4 Battery -

12V LiFePO4 Battery Voltage Chart

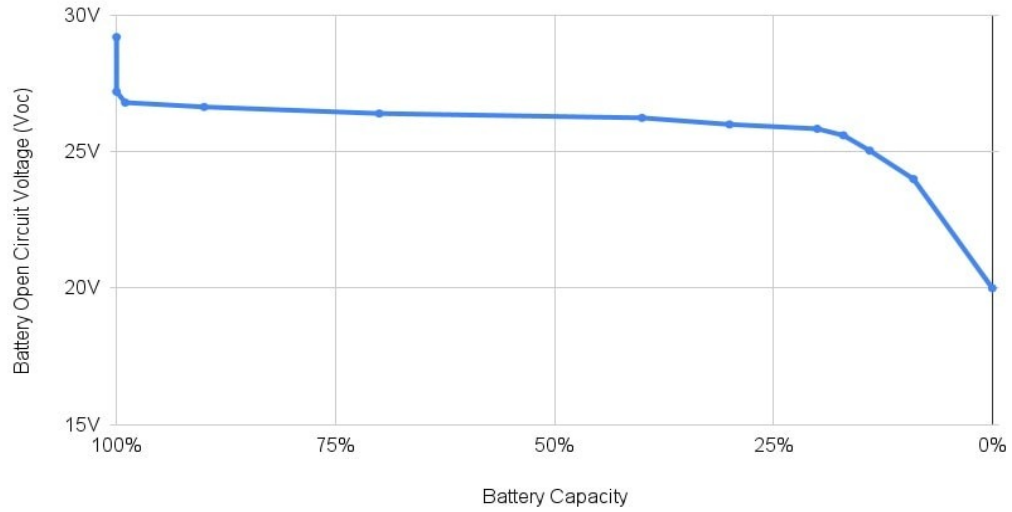


<b>12V LiFePO4 BATTERY VOLTAGE CHART</b>	
<b>VOLTAGE</b>	<b>CAPACITY</b>
<b>14.6V</b>	<b>100% (charging)</b>
<b>13.6V</b>	<b>100% (resting)</b>
<b>13.4V</b>	<b>99%</b>
<b>13.3V</b>	<b>90%</b>
<b>13.2V</b>	<b>70%</b>
<b>13.1V</b>	<b>40%</b>
<b>13.0V</b>	<b>30%</b>
<b>12.9V</b>	<b>20%</b>
<b>12.8V</b>	<b>17%</b>
<b>12.5V</b>	<b>14%</b>
<b>12.0V</b>	<b>9%</b>
<b>10.0V</b>	<b>0%</b>

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## 24v LifePO4 Battery -

24V LiFePO4 Battery Voltage Chart

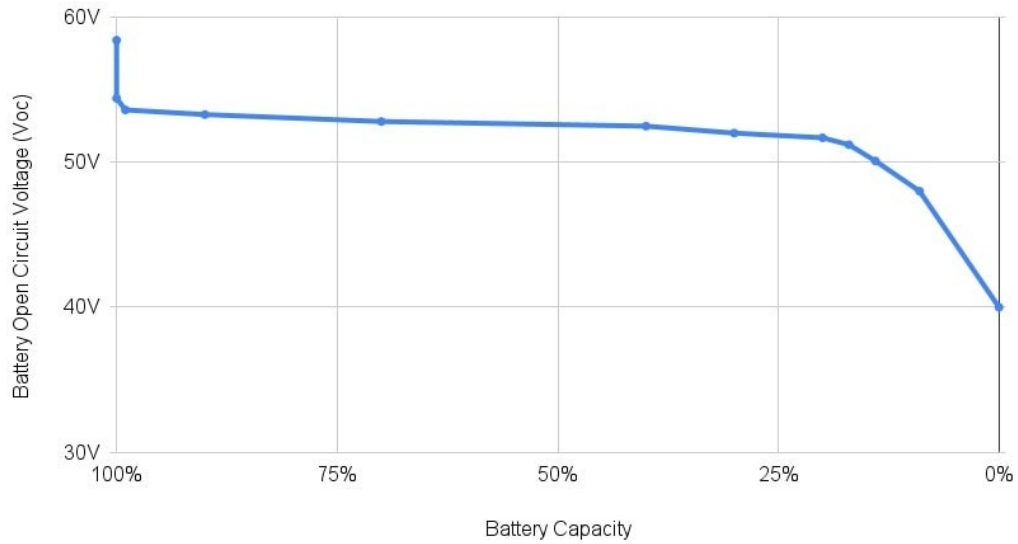


<b>24V LiFePO4 BATTERY VOLTAGE CHART</b>	
<b>VOLTAGE</b>	<b>CAPACITY</b>
<b>29.2V</b>	<b>100% (charging)</b>
<b>27.2V</b>	<b>100% (resting)</b>
<b>26.8V</b>	<b>99%</b>
<b>26.6V</b>	<b>90%</b>
<b>26.4V</b>	<b>70%</b>
<b>26.2V</b>	<b>40%</b>
<b>26.0V</b>	<b>30%</b>
<b>25.8V</b>	<b>20%</b>
<b>25.6V</b>	<b>17%</b>
<b>25.0V</b>	<b>14%</b>
<b>24.0V</b>	<b>9%</b>
<b>20.0V</b>	<b>0%</b>

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## 48v LifePO4 Battery (16-cell) -

48V LiFePO4 Battery Voltage Chart



<b>48V LiFePO4 BATTERY VOLTAGE CHART</b>	
<b>VOLTAGE</b>	<b>CAPACITY</b>
<b>58.4V</b>	<b>100% (charging)</b>
<b>54.4V</b>	<b>100% (resting)</b>
<b>53.6V</b>	<b>99%</b>
<b>53.2V</b>	<b>90%</b>
<b>52.8V</b>	<b>70%</b>
<b>52.4V</b>	<b>40%</b>
<b>52.0V</b>	<b>30%</b>
<b>51.6V</b>	<b>20%</b>
<b>51.2V</b>	<b>17%</b>
<b>50.0V</b>	<b>14%</b>
<b>48.0V</b>	<b>9%</b>
<b>40.0V</b>	<b>0%</b>