Battery C Ratings - Manufacturers Lie!

by Steve Gebler

In the sometimes bewildering array of battery technology and terms, we often need to select a battery that is powerful enough and affordable to fit the requirements of the aircraft.

There are three major variables that must be considered when selecting the correct LiPo battery:

Amperage

This is basically the size of the “gas tank” in the battery. For instance, a 1000mAh battery has 1/4 the power of a 4000mAh battery. In theory an aircraft capable of flying with the 1000mAh battery could fly for four times longer with the larger battery if weight were not a consideration.

Number of Cells

You will see a designation of “S” ratings on your batteries. Each S value indicates that the battery has one cell that has a fully charged potential of 4.2 volts per cell. Hence, a 3S battery would provide 12.6 volts of power when fully charged. Why is the designation S? The S indicates that the cells in the battery are in SERIES.

C Rating

This is an indication of the maximum charge *and* discharge capability that the battery possesses. This is where the battery manufacturers lie and do so proudly! There is NO official standard for determine the C rating for batteries. So, in the pursuit of trying to outdo their competitors, the manufacturers have chosen to inflate their C ratings to appear to possess better performance.

In theory, the C designation represents the maximum current output that the battery possesses under load. For example, if you were to fly a trainer airplane that had a 2200mAh battery where you were not performing any heavy aerobatics, you would likely only require a 10C battery as the likelihood of needing a lot of “punch” from the motor is slim. However for high performance 3D planes and helicopters, you would need a lot more *sustained* power to meet the demands of the aerobatics. For those higher performance flights, you would likely choose a battery that has a 40C rating or higher to sustain the flight under heavy load.

A 40C battery can produce four times the maximum sustained power output than a 10C battery.

Simply put, it’s like the difference of trying to drain a pail of water through a drinking straw vs. a fire hose. The higher-C ratings allow for nearly instant transfer of power under load.

This drawing of power under load is also applicable to charging the batteries. In theory, you can charge a high-C rated battery faster than a low C-rating. Again, in theory, you might be able to charge a 20C battery at twice the current of a 10C battery potentially halving the time that it takes to fully charge the battery. However, there is no free lunch. Heat is the major cause of

LiPo failure over time. It is strongly recommend that you never charge a battery at an amperage rate that is higher than its Amperage designation or at a 1C level. For example, a 4000mAh battery should be charged at 4000mAh and should take approximately one hour to complete.

I have batteries that have had hundreds of charges on them that are more than five years old that still perform well as I make sure to *never* discharge them below 3.7 volts per cell and then store them at 3.85 volts. Further, I always charge them at the 1C rate.

Testing the Lies

So, how do you know the *real* C rating of your batteries?

First, you need to determine the Internal Resistance (IR) of the cells inside the battery. There are two ways to do this.

First, many of the newer battery chargers have the capability of measuring the IR.

Secondly, some battery voltage checkers have the ability to measure IR.

Finally, you can purchase a dedicated IR meter.

The cell that has the *highest* IR is the weakest link in the chain. It has the hardest time passing the voltage along through the other cells. When this occurs, the result is that the weakest cell generates heat. If the IR were high enough compared to the other cells in the pack, this heating of the weak cell has the risk of starting a fire in the pack.

Next, you need to run a little formula that will determine what the *actual* C rating of the battery pack is. I have linked a small spreadsheet that contains the formula that you need here:

https://www.palomarrcflyers.com/copy-of-free-flight-training

There is one for MS Excel and one for Apple's Numbers app. Scroll down a bit on the page to find the calculators.

I recently did a comparison of the many batteries that I own to determine the true C ratings on the batteries. I was astounded to find that *none* of my batteries possessed the advertised C ratings! I checked new batteries and older batteries. Some from big name battery manufacturers that many of us use and some from some of the lesser known brands and *all* of them failed to match the advertised C rating.

Here's an example of a *brand new* 2200mAh 50C 4S battery that I just purchased.

C Rating Calculator

Date Tested	July 8, 2022
Pack mAh	2200
Pack C Label	50
Highest Cell IR	3.1
Actual C Rating	**30.3**
C Difference	-19.7

You will note that the cell with the highest IR was 3.1 milliohms and the advertised value of the pack was 50C. After running the algorithm, the actual C rating of the pack was just above 30! And, this was on a brand new, brand name pack. As your packs age, clearly, the C ratings of the pack will decline.

Summary

Don't be fooled into believing what the manufacturers tell you about C ratings.

Test your batteries periodically to determine the IR values — the best indicator of how reliable your batteries truly are. I get in the habit of checking my IR values about every six months and mark the side of the battery with a sharpie marker indicating the date of the test, the highest IR value, and the actual C rating. In that way I can see if the pack is declining to the point of a need to replace it. Should you find your packs calculated C rating falling below 15, for example, it's probably time to replace the battery.

Good flying!

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