Battery Flight Times for the SYMA X5C-1 Quadcopter

by Wayne A. Diercks - 4/15/2015

Intro

Early on, nearly all pilots of the X5C quadcopter experience the desire for spare batteries. The short flight time of the included 500 mah LiPo (Lithium Polymer) battery leaves one begging for more in a hurry. The nearly ninety-minute recharge time leaves no alternative but to have at least four or five available spares while waiting.

Although flight times were often mentioned, they lacked specifics and consistency. I wanted scientifically obtained, quantitative figures for comparison and for measuring future modifications I intend to pursue. Since there were none, I designed a scientifically and reproducible testing procedure and am sharing my findings for all to view. If you are not particularly interested in the details just jump to the *Test Results* and *Conclusions* sections at the end of this lengthy and informative article.

By far the most popular after-market battery for this quad is the 600 mah LiPo with an extra blue foil label touting the name "GOO". This is the same brand as the 720 mah batteries in my tests. However, Turnigy is the brand of the 750 mah batteries.

I purchased the package of four 600 mah batteries with a regulated, 4-port charger labeled "WSX" for only about $16 including shipping from a reputable Chinese dealer. I found this to be the best money I ever spent on my quadcopter short of the actual SYMA X5C-1 full quadcopter kit for about $55 including shipping from the same dealer. Be forewarned that the actual shipping time (after prompt processing when in stock) from China can be one entire month or more. If you are impatient, you can now purchase these from U.S. sources at a slight premium.

First, it may be advantageous to learn about the safety precautions and peculiarities of LiPo batteries. Among the best articles available and well worth the read is one at the following website: http://www.rchelicopterfun.com/rc-lipo-batteries.html. In summary: always use a

regulated charger port for each cell, do not overcharge beyond 4.20 volts per cell for safety and battery longevity, wait several minutes after a flight for the battery to cool before charging, do not charge a damaged battery, store batteries out of the sun and avoid excessive heat, follow safety procedures during charging and for long-term storage drain to around 3.80 volts and possibly refrigerate. My batteries arrived shipped at 3.83 volts.

Battery Charging

Single-cell LiPo batteries (known as "1S" configuration) are designed to produce current at a nominal 3.7 volts. Everything on the X5C quad is designed to operate at about 3.7 volts as opposed to more powerful quadcopters that operate at 7.4 volts (2S) or 11.1 volts (3S) using two or three cells in series. The milliamp hour (mah) rating is a capacity or total amperage output until drained. The "25C" specification is a discharge rating of maximum sustained current (multiplied by the mah capacity) which is somewhat comparable to the cold cranking amps rating in a car battery.

For maximum effectiveness and long life no LiPo cell should ever be charged fast nor above 4.20 volts and never drained below 3.10 volts. The X5C quad automatically warns with flashing lights at about 3.20 volts. It is the function of the regulated battery charger to slowly and consistently charge the battery (no matter the mah capacity) up to exactly 4.20 volts and never more for maximum battery longevity and safety.

I found that the stock, single-port charger that comes with the SYMA X5C-1 is inconsistent in its final voltage cut-off. Occasionally, the battery would be charged to as low as 4.10 volts and often as high as 4.40 volts! This may not sound like much but most measurements deal in hundredths of a volt and overcharging a cell by as much as 20 hundredths of a volt is significant as we shall later see.

On the other hand, the inexpensive, WSX, 4-port charger consistently charged LiPo cells of any capacity to exactly 4.20 volts (plus or minus 2/100 volt) on all ports independently. I use a simple, $6 digital VOM meter from Harbor Freight for my measurements. Once I discovered the differences in these chargers, I decided on the WSX 4-port charger for all my tests and everyday quadcopter use.

String Hover Test Parameters

In order to quantify flight times achieved with various batteries, I decided to conduct an indoor "stringed hover test" as my standard. I wanted a scientific means to reproduce my findings as accurately and conveniently as possible. It consisted of attaching waxed kite string to the bottom of the quadcopter with the other end attached to a "brick" to allow the quad to hover at a 6-foot level above the floor. This height minimizes the "ground effect" of bounced air from the "wash" of the props. A stopwatch is activated as the quad ascends to its height and piloted to maintain only a slight pull on the string at it wanders from air currents and other variations in a five-foot diameter circle. The timing is stopped when the quad flashes or it settles to the floor at the end of the battery life. All batteries were nearly new with similar usage and I suspect as time goes on flight times will diminish. This testing method is not meant to emulate real world flight conditions but is merely a means of scientifically providing reproducible, consistent test results for accurately determining comparable battery flight times. In fact, I was able to achieve a full minute longer flight time using a GOO 600 mah battery in light flying. Your mileage may vary.

Tests were conducted in three quad configurations "naked", "fully-dressed" and "fully-dressed with video on" during the entire flight. Two similar X5C-1 quads and several different batteries used to determine the averages although individual results were very consistent. All aspects of the tests were conducted to achieve the most consistency in the results.

The "naked" configuration tests were conducted without any of these accessories being mounted so that only the quad and its battery were lifted. The actual weight of this naked configuration was 70.7 grams plus battery. It is interesting to note that this difference in weight between the fully-dressed configuration and the naked configuration is about equal to the weight of a 600 mah battery.

The “fully-dressed” configuration sports the quad complete with its landing skids, blade guards, battery door and camera. The camera was not activated in these tests, however, which would have subtracted an additional minute or so. The actual weight of this fully-dressed configuration was 88.3 grams plus battery.

The “fully-dressed with video on” configuration simply measures flight time of the fully-dressed configuration but with the camera turned on for video during the entire flight.

The naked tests were a more consistent and accurate measurement since the battery would fully drain more consistently to the 3.20 volt range when the quad’s lights began flashing. The added weight of the fully dressed configuration caused early crashing before the lights flashed while trying to maintain lift with insufficient battery power. Not only does additional weight consume more power during the duration of the flight, but a higher power threshold is also needed at the end of flight just to keep the quad aloft.

Battery Dimensions

The battery dimensions and weight listed is the average of several “used but not abused” batteries. The GOO 600 mah batteries have gained 2.3 grams and thickened slightly by about 1.4 mm from when they were brand new. The Turnigy batteries did not.

Battery Dimension Table

Battery	Length	Width	Thickness	Weight
Stock 500 mah	43.3 mm	25.5 mm	7.5 mm	14.6 g
GOO 600 mah	41.9 mm	24.5 mm	9.8 mm	17.7 g
GOO 720 mah	42.7 mm	24.1 mm	8.9 mm	15.8 g
Trngy 750 mah	43.6 mm	26.4 mm	9.6 mm	18.5 g

Test Results

The table below shows the average results of multiple tests. I then calculated the seconds per mah of the "stated" ratings labeled on each battery, which completes the story.

Fully-Dressed vs Naked Flight Time Test Results of Various Batteries

Battery	Naked (70.7g)		Fully-Dressed (88.3g)		Full-Dress Video On	
Rating	Flt. Time	Sec./mah	Flt. Time	Sec./mah	Flt. Time	Sec./mah
Stock 500 mah	8:00	0.96	6:35	0.79	5:40	0.68
GOO 600 mah	9:50	0.98	8:05	0.81	6:30	0.65
GOO 720 mah*	8:50	0.73	7:10	0.60	6:00	0.50
Trngy 750 mah	12:10	0.97	10:00	0.80	9:10	0.73

Conclusions:

The seconds per *rated* mah of all the batteries, except the 720 mah one, are remarkably consistent in a given configuration. However, in the "fully-dressed with video on" configuration the extra heavy load on the battery begins to take its toll on the lower quality GOO batteries. The Turnigy battery in particular really shines under heavy load since it can output more current at the lower voltages encountered near the end of flight.

Further Calculations

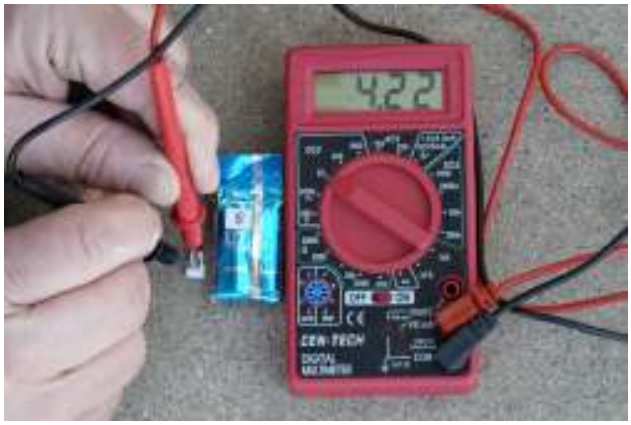
I also took careful voltage measurements before the flight and immediately after. I found that the beginning voltage (fully charged) of 4.20 volts to the fully discharged (on the naked test flights) of about 3.20 volts under load yielded a voltage drop (consumed during flight) of 1.00 volts. This equates to a **flight time of nearly 5.9 seconds per hundredth of a volt** in naked configuration using the 600 mah battery. In theory, that means that overcharging the battery by up to 0.20 additional volts (as the single-port charger often does) should provide additional flight time of nearly 6 seconds per hundredth of a volt at the expense of shorter battery longevity. In my tests, I did in fact achieve a test flight approaching 10:30 using a 600 mah battery charged to 4.27 volts, which proves the theory. This would also indicate why some reviewers of the WSX 4-port battery charger and/or the 600 mah batteries say they noticed reduced flight time as compared to their 500 mah battery charged on the stock, single-port charger.

Wolf in Sheep's Clothing

The GOO 720 mah rated batteries obviously are not properly rated and labeled*. I have done several tests on both of mine and find consistent and disappointing results. Although they performed satisfactorily, all dimensions and test results indicate that these batteries must have an actual rating of about 550 mah, which is way shy of their labeled and advertised 720 mah rating. I am in ongoing dialog with the dealer to cease sale of this battery. Of course he passed the buck to his supplier. Buyer beware!

The Workhorse

The 600 mah batteries, however, are an excellent value although they add slight additional weight to the quadcopter compared to the stock 500 mah battery. As with all the GOO brand batteries, I noticed occasional dropouts during discharge especially under heavier loads. I question their 25C rating or else the discharge output is not linear. Their availability is universal and cost a bit less than the stock 500 mah battery. Despite being a little thicker and more difficult to insert in the quad, they are the best value going and in many ways the standard battery for this quad due to their low price and good performance.



The Shining Star

The Turnigy 750 mah batteries that I purchased from a U.S. dealer for $10 each were the top performers. Although at twice the price, they offer quality and performance that justify the premium. The 25% greater flight time alone may be reason enough for me to declare my allegiance but there is much more to the story. The claims of superior nano-technology enabling nearly double lifetime (longevity), more power and acceleration (due to a greater 35C rating), faster charge rates (using advanced chargers) and cooler operation are additional advantages. I

noticed a more consistent hovering with fewer dropouts and quicker throttle response. Besides the added punch, the discharge output seems to be more linear perhaps due to the higher 35C rating as well. My only complaint is that they do not have that extra foil tab on the top that can be used to safely pull the battery (thicker on the wider edges) from the tight battery compartment after a flight. Also, at first the connector inserts a bit tight and you must use extra force until you feel it snap in place.

Be sure to purchase these and all batteries with the correct polarity of the connectors specifically designed for the X5C. Many other quads use the same batteries with opposite polarity and/or different connectors. Unless you are knowledgeable and capable of modifying the connectors, you will want to be sure to avoid that mistake.