
Supercaps for free flight model airplanes

Posted by Ben in Tucson - 2008/12/07 16:42

Hi all . . .

Beyond having a general interest in alternative and renewable energy sources, I like to build and fly small model airplanes. I've recently become aware of ultra and supercapacitors as a power source for models such as this and I'm wanting to start experimenting along these lines.

Supercapacitors have already found their way into inexpensive flying toys. The Estes Aero-X is one that was made a couple of years ago and, as this web page authored by US-based modeller Bill Kuhl demonstrates, the electronic components live on for those of us who enjoy crafting lightweight wood structures (typically with more efficient aerodynamic properties than the clunky and overweight styrofoam winged enclosures that they originally came in) . . .

<http://www.maxconrad.com/aerox.htm>

Notice that this is a dirt simple electronic circuit: the supercap and a motor, with an on/off switch and a charging port in the middle. Since this is a free flight model - not remote controlled (R/C) - and limited power run of, say, 20 or 30 seconds is desired. The supercap seems to be particularly well suited for something like this.

An eventual goal is to design a balsawood/tissue free flight plane that is simple enough for a child to make in a classroom setting that would be supercapacitor powered. I already teach after-school classes where I have 3rd through 6th graders build planes like this. The typical way to power them is with a time-honored twisted strand of rubber, unwinding to spin the propeller. A low cost and simple electronic supercap circuit is something that would pique their interest (it already has mine) and the older students could probably be taught to do their own soldering. Keeping the price of electronic parts per plane to \$10 or less would be ideal.

Rather than scouring the planet for styrofoam toy planes that aren't even being produced any longer to tear apart (although I recent bought a new-in-the-box Aero-X on eBay for less than the cost of shipping with just such a thing in mind,) the logical way to approach this is to buy electronic components off the shelf from a retail supplier. The supercap used in the Aero-X, since it is now a couple of years old, is probably heavier in weight and with rather pedestrian electronic properties compared to the better ones of today.

Panasonic's 3.3F/2.3V 'Gold Cap' (which has found its way into some home made models) from a couple of years ago weighed in at around a portly 4 grams and had a rather chubby outside diameter of 12.5mm. Contrast this to the newer Nesscap 3F/2.7V units, which weigh about 1.5 grams and come in a comparatively thin 8mm diameter enclosure (2.5 grams may not seem like a lot but it can make a big performance difference in a plane like this, as does a smaller physical size.) The latter can be purchased from Digi-Key for around \$2 a piece. Tiny SPST slide switches can be found there for about a Dollar. Elsewhere, there seems to be no shortage of tiny pager motors in the \$3 to \$5 range to complete the package.

Building a suitable plane is something that I'll be doing over the Christmas holiday. I've already got something drawn on the computer that should work just fine. I may need some help, though, with fine points on the electronics . . . and this is why I've joined this group. As I make progress I'll be checking in to show all here what I've come up with and to ask about certain aspects of supercaps (safe charging procedures with only AA batteries, the best motor choices in relation to voltage and resistance specs, etc.) that I still have questions about.

More later . . .

Ben in Tucson

Re:Supercaps for free flight model airplanes

Posted by Michael C - 2008/12/09 11:52

Welcome Ben,

I will start by saying you may have found the right place. There are many experts here that can "generate" info about caps and proper usage. If you ask the question just right then you will get the right answer.

For instance, charging a 2.3 volt cap can be done with 2 - 1.2v NI-MH batteries in series for 2.4 volts. They will charge the caps fast (minutes) and can be recharged themselves later (for hours) at night and be ready for tomorrow. If you get 2 "C" or "D" sized batteries they may last for 3 dozen or more plane charges. If the kids are going to "make" the charger;

"AA" are just fine.

Be sure to get a volt/ohm meter (sometimes called multi-meter) so you can measure the final voltage of the caps. The battery pack also could use a look at its voltage. If you spend over 15 bucks - people will see that nice meter and call you an expert.

Last thing - allelectronics may have surplus parts for a good price.

Have fun!

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Re:Supercaps for free flight model airplanes

Posted by Antonm - 2008/12/13 10:38

Good idea for a portable recharger. I'd add a flashlight bulb in series for a current limiter though, newer NiMH batteries can deliver a lot of current quickly.

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Re:Supercaps for free flight model airplanes

Posted by Ben in Tucson - 2008/12/15 15:52

Hi Michael and Antonm . . .

Thanks for the warm welcome.

Some updates . . . I found one of the Estes Aero-X capacitor powered flying toys on eBay. Time commitments and windy weather here has prevented me from taking it outside to fly, but I should get a chance later this week.

I do have a multimeter, Michael, and I'm sure I'll be dusting it of to impress the kids. But it is an older/inexpensive unit that doesn't measure capacitance. A friend, who is a radio/ television engineer, has better diagnostic gear at his disposal, knows how to use it better than I do, and has offered to help me measure electronic characteristics of anything I put in front of him.

The charger provided with the above toy plane, by the way, is powered by 3 AAA batteries and (as advised by the instructions) completely charges the capacitor-equipped plane in about 10 seconds, with caveats not to do it for too much longer. Static testing without actually launching the plane using Sanyo Eneloop batteries in the charger (see below) indicates that this 10 second charge gives a sufficiently good motor run.

The better performing plane that I plan to build and outfit with new off-the shelf components (nothing to do with the above styrofoam toy) will probably be based around this 3F capacitor . . .

<http://search.digikey.com/scripts/dksearch/dksus.dll?PName?Name=589-1000-ND>

This Digi-Key catalog page has a link on it where you can find a downloadable PDF with complete physical and electronic specs of the entire NessCap 2.7V range. A slightly larger/heavier 5F version is also available.

Batteries for the field charger will be low-self discharge NiMHs. The Sanyo Eneloop brand is what I have on hand in both AA and AAA flavors. Both are rated at 1.2 volt each, with the AAA ones putting out 800mAh and the AA being rated at 2100mAh. These are the nominal factory specs but there is more comprehensive independent tech review of Eneloop batteries that can be found [here](#) . . .

http://www.stefanv.com/electronics/sanyo_eneloop.html

I noted above that the Estes Aero-X uses 3 AAAs in its charger (1.2V X 3 batteries in series = 3.6V) but, since I don't yet have specs on it's cap (still sealed inside the styrofoam interior,) I don't yet know what its recommended voltage rating really is . . . or its capacitance, for that matter. After I have flown the Aero-X toy to satisfaction (i.e.: it suffers enough field damage to make further flying impractical,) I'll be gutting it to get at the components. Measurements of those individual parts will follow and I'll share that information here. What I find out by noting the capacitor's rating (voltage, capacitance) in relation to the motor (voltage, resistance) on this toy plane will give me further ideas on choosing electronic parts for the home-built model.

Given what Antonm says about not wanting to damage the cap with too much amperage, I'm going to assume that the 800mAh AAA batteries will be a better choice for charging any of these smaller caps than the 2100mAh AA ones.

But is excessive voltage while charging something that I should also be worrying about?

Is a 3.6V @ 800mAh battery charge (3 AAA Eneloops in series) OK for a 2.7V/3F capacitor for a very short period?

My guess is that a 2.4V @ 800mAh configuration (2 AAA Eneloops in series) would never get me to full charging potential on a 2.7V cap regardless of the length of the charge. Or is that an incorrect assumption?

Please tell me more about the flashlight battery current limiter idea. Is there a particular voltage and/or resistance rating of the light bulb that I should be looking for?

Thanks again . . .

Ben in Tucson

Re:Supercaps for free flight model airplanes

Posted by Michael C - 2008/12/16 14:16

Ben,

The meter that you have should work just fine. Be sure to put some fresh batteries in.

You don't need to measure capacitance - just voltage and in the rare instance amperage.

The capacitor that you picked may be good depending on your choice of motor. Pick a good motor first - hobby shops have motors and props. Then pick the cap that will run it for a flight.

Actually, excessive voltage IS the reason that the original plane gives instructions to "not charge more than 10 seconds".

An analogy here might help; you have an air tank that has 36 psi (pounds per square inch) and a bike tire 0.1 psi (flat). The tire is rated for 27 psi, so you pressurize (charge) the tire for 10 seconds. You check the pressure with a tire gauge. The company that makes the tire recommends 10 seconds at 36 psi. If you leave it connected the bike tire goes "boom". Now on the other hand if the air tank only has 24 psi then the bike tire will never pop but will never feel hard. It will also take a while for the tank and tire to "equalize" in pressure.

The cap you picked (2.7v 3F) has a max current of 3.3 amps. Two in parallel will allow 6.6 amps. The 5F cap can take 5.7 amps. Three "AAA" will work with either 2 - 3F or 1 - 5F but use 2 - 5F for 3 "AA" batteries. The surge voltage for both caps is 2.85v so disconnect after 10 seconds and use the meter to check voltage. Perhaps you could leave the charger connected for 15 seconds. Using 2 "AA" will charge the caps to about 1.8-2.1 volts while slowing down to a trickle.

The old light bulb limiter trick works like this. The light bulb used is rated at the high voltage or higher (3.6v charger to 4 - 8v bulb) and connected in series. The bulb will only allow a small amount of current to flow - for a 4 volt bulb maybe 0.125 - 0.25 (1/8 - 1/4) amp. Connect 2 in parallel for double the current. Connect the 6 volt bulb for even higher current. That is all the current that can flow through the circuit. Your meter hooked up in series (set for amps) can show you how much current is flowing. The 6 volt (lantern bulb) may handle 0.5 amps at 6 volts but let 3 amps through at 2 volts which will accommodate one 3F cap.

Re:Supercaps for free flight model airplanes

Posted by suely111 - 2008/12/18 00:58

Hi Michael,

Your are very good for your design with the super capacitor.

Maybe you can use our brands super capacitors as back-up power,5.5V0.22F or 5.5v1.0F .

Hope you can finished your design successfully on Christmas day.

Welcome you visit our website:www.forecon.hk

If you have any interest pls contact me .

Best Regards,

Suely

Email:suelydong@yahoo.com

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Re:Supercaps for free flight model airplanes

Posted by Ben in Tucson - 2008/12/20 15:19

Hi Michael . . .

The bicycle pump/tire analogy is very helpful . . . and exactly how I envisioned things would be working in regards to voltage and amperage. Also lot's of good advice here in regards to charging voltages and times in relation to various battery/capacitor configurations.

I knew that I would eventually come up against a "chicken or egg first" scenario when talking about mating a capacitor to a motor. Being no stranger to hobby stores and web suppliers of such wares, I've got the motor/prop situation in hand.

On order from Digi-Key is a healthy assortment of Nesscap's 2.7V caps in 3F, 5F and 10F flavors. Meanwhile, a couple of US based online stores who specialize in micro electric model airplane equipment are sending me various 4mm and 6mm diameter motors in an assortment of voltage and impedance ratings that I think will cover all bases. The Swiss distributor, Didel, buys large quantities of tiny pager motors from various Asian manufacturers, which are then carefully measured and catalogued . . .

<http://www.didel.com/microkit/pricelist/>

<http://www.didel.com/microkit/moteurs/Motors.html>

There will also be no shortage of various props to work with and several samples are already on hand. One of my motors comes with a matched nylon gear reduction unit and a folding propeller! All of this stuff should be showing up on or around Christmas.

Meanwhile, my Estes Aero-X capacitor styrofoam toy plane has now taken to the air several times. The contained power system (5 year old supercap technology) is reasonably impressive but the aerodynamics of the plane itself can certainly be improved upon. It lumbers around the sky like a drunken bumblebee. This sort of marginal flying performance is to be expected on a prefab toy, so I can hardly complain. But I have complete confidence that I'll be able to come up with something far better, crafted from a balsa frame and covered with tissue.

Suely . . .

I've seen Forecon's "commercial announcement" on several different discussion threads on this forum. I visited your site and downloaded the PDF spec sheet for your 2.5V radial caps. Your 2.5V/3.3F unit looks good for the sort of thing that I'm working on and the 10mmx18mm form factors is an attractive option. How many grams does it weigh? Do you have a US distributor who can provide retail sales, where a hobbyist like me can buy a handful to experiment with? Keep up the good work!

Ben in Tucson

Re:Supercaps for free flight model airplanes

Posted by Antonm - 2008/12/28 17:02

Sounds like a very interesting project and a great application for ultracaps as this kind of charge/discharge cycle would be tough on any type of battery. Your best bet is to try a few experiments, with the volt meter across the capacitor so you can monitor the charge. the lantern bulb Mike suggested may work, I would suggest trying a high current bulb at 3v, like maybe a high brightness Krypton bulb designed for a two 'D' cell flashlight. The bulb will lengthen the charge time but add safety and allow you to use 'AA' cells or even 'C's or 'D's. You probably don't need the extra long storage life of what are called "Hybrid" NiMH cells as the standard ones have a bit more capacity and lower cost and still will hold a charge for several months (if you use any major brand). The bulb will also give you a nice charge indicator as it will dim as the charge completes. Another simple way to add protection (in conjunction with the bulb wired in series) would be a one watt Zener diode with an avalanche voltage within a tenth or two of a volt to match the max voltage of the cap you use. You should be able to find these at Digi-Key. It would add very little weight. You install the diode in reverse bias across the capacitor,so the side marked with the band would go to the positive side of the cap and the unmarked side to the negative side of the capacitor. Cheap protection.

Re:Supercaps for free flight model airplanes

Posted by Antonm - 2008/12/28 21:21

That was Zener, not Zerner. Digi-Key has 451 pages of them, After about 5 pages I found some lower voltage ones (down to 1.7v). Most lines of Zener diodes start at 3.3v, a bit much for a 2.7v cap. Probably use their live chat to help you locate one if you use Digi-Key. For 2.7v protection you could also use something like four or five IN4000 (or 4001,4002, etc.) regular diodes in series, forward biased. Four would start to shunt slightly at 2v and in earnest at 2.4volts. Five diodes would shunt at about 3v. And the diodes could be across the output of the charger, so they wouldn't have to be part of the planes payload even though they still would be small and not weigh much if you want the protection to be part of the plane. The 3v series bulb I suggested above would give a slow charge unless you find a high wattage one. Probably a 4.5v/ 3 'D' cell type would be best. Your running one 2.7v cap, right? Anyway, the unique thing about an incandesent bulb is the resistance goes higher as current (and voltage) increases, so it acts like a brake on the current flow but then backs off the resistance when the current/voltage drop falls off as the cap becomes more charged.

Anyway, I guess if you use two NiMH cells the point is moot as you will only have 2.4 or a few tenths higher maybe if freshly charged. It would protect from the chance of someone using it with Alkaline batteries (3.1v) or something. Or I suppose if you had, say five IN4000 diodes (with the bulb upline in series) across the output of the charger you could deliberately use the Alkalines to push the charge to the max 2.7v.

Re:Supercaps for free flight model airplanes

Posted by Cappin Jack - 2009/07/17 08:43

Hiya Ben, this is my first post here so hello to everyone else as well.

I also have an interest in ultracaps for model aircraft applications, although I'm working on other stuff at the moment. If you want to kick around modeling ideas I'll be mostly hangin 'round the diy threads here.

I think your 'off the shelf' approach to exploring the possibilities is a great way to get started. I'll be watching for your posts of results and lessons learned.

Meanwhile I will be playing with building my own ultracaps. If good performance is possible with homebrew devices, then flight applications will be virtually unlimited, provided electrolyte weight can be kept to reasonable limits.

I have in mind for the future, assuming successful diy caps, that I would try building a wing skin as an ultracap. I have a cnc foamcutter for wing cores, off the cuff I'm thinking that an adaptation of standard vacuum forming of carbon wing skins would probably work to produce very large, thin electrodes, with very little weight penalty.

An entire aircraft could be skinned this way, I think. So many Farads... :)

Anyway, just one 'what-if' kinda idea. On the back burner while I play with coils and intense magnetic fields and such...

Happy Landings.

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Re:Supercaps for free flight model airplanes

Posted by Ben in Tucson - 2009/07/21 16:26

Hi Cappin Jack . . .

It's been a long time since I thought about this project.

As a model airplane guy, I'm sure you know about projects that get started and then get shelved when other priorities pop up. This ended up being one of those. I carefully labeled all my supercapacitors and motors with the idea that I would come back to all of this at a later date. I did manage to get a plane started and it's my variation on Bill Hannan's the Stringless Wonder . . .

http://www.jetex.org/images-ben/Stringlessbones_W.jpg

One thing that did slow me down was that I originally wanted to do this as a schoolkid project and keep the cost per plane down to around \$10 per example. But as I began to really get into the finer details, it soon became apparent that I couldn't meet that price point any longer. As I return to this I'm going to go with a geared motor and this makes my propeller selection far easier. A direct drive motor, while cheaper, ends up being more trouble in the end.

The other thing that would add to the cost is the charging mechanism (see above posts from others here.) Granted, none of this stuff is going to break the bank, but when you multiply the cost of each plane/charger by 10 or 12, the difference between \$10 and \$25 per unit becomes significant.

As I get back to this, I will drop the self-imposed straitjacket requirements of non-geared motors and minimalist chargers that consist only of straight batteries. It will turn into one of my own fun projects that gets demonstrated in class. If one of the kids wants to pursue it, I'll share the knowledge but let them pay for their own plane.

Supercaps built into foam wing panels? Sounds interesting. Let me know what you come up with. An idea that I've thought about is a radio controlled glider using flexible film solar panels on the wings which do a quick charge to supercapacitors which, in turn, keep lithium polymer batteries topped off to control the receiver and servos. If done correctly, the plane could perpetually fly forever . . . at least that's the idea.

More to come . . .

Ben in Tucson

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Re:Supercaps for free flight model airplanes

Posted by raya27 - 2009/08/29 19:40

I just found this thread and found it very interesting. what is the latest news on your attempt at running motors off ultra-caps and fitting them to free flight airplane models ? I am an old rubber powered model builder who would like to convert some of these old models to electric.

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Re:Supercaps for free flight model airplanes

Posted by Antonm - 2009/09/27 22:42

Interesting thought, but don't the wings take the brunt of the abuse in model planes?

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Re:Supercaps for free flight model airplanes

Posted by Pearljhonson - 2011/08/23 06:26

Hello,
Thanks for sharing with us information regarding Supercaps for free flight model airplanes. I loved to read this forum. I hope you will keep on updating us with such kind of useful posts.....

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