Guide to using Lipo batteries in DLG's

Chris Gibbs – Feb 2008

Introduction

DLG (F3K) type models in general, have the requirement to be powered by a lightweight battery pack that can supply adequate voltage and current to power a receiver and a number of servos. In addition other on-board devices may need to be powered, such as micro-altimeters, logging systems, etc.

Most commercially available Radio Control products are designed to be operated at a nominal voltage of 4.8V, a standard established during the general usage of Nickel cadmium cells (Nicads) where a pack of four Nicad cells, delivering approx 1.2V per cell, would be used to supply a model's receiver and servos with power.

In the 1990's Nickel Metal Hydride cells (NiMH) became popular, offering a similar voltage per cell to Nicads, but with far higher capacity. In many cases NiMH cells have replaced Nicads in popular usage.

Over the last few years Lithium Polymer (Lipo) cells have become a prevalent source of battery power, with many household devices such as mobile phones, MP3 players, laptop computers, etc now using Lipo cells as their source of power.

Lipo cells offer the following advantages over NiMH and Nicad cells;

- Higher capacity for a given weight
- Far lower self-discharge, when not in use
- Easier to charge and less prone to cell damage via charging especially at the smaller cell sizes typically used for DLG (providing a suitable charger is used)

On the negative side, Lipo cells are more physically fragile than Nicad or NiMH cells, will not tolerate deep discharging or misuse and they operate at a nominal cell voltage of 3.7V per cell, which then presents an issue of how to get the 4.8V we need for RC usage.

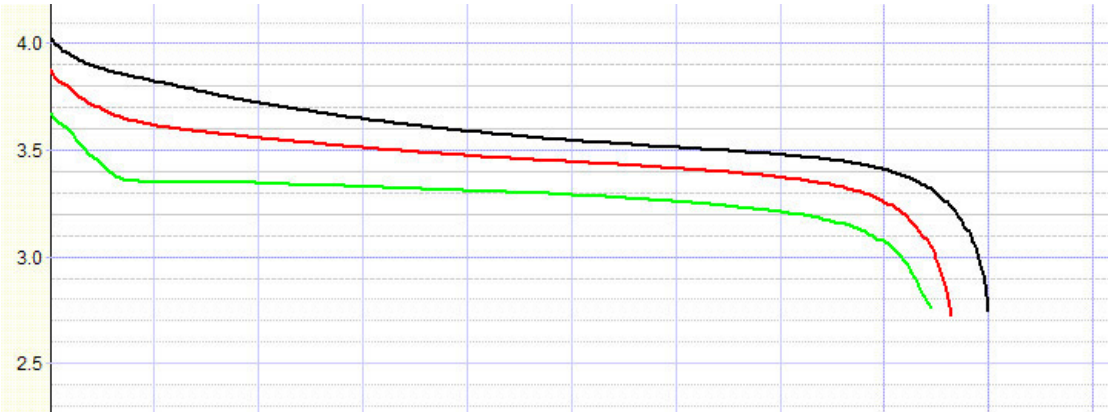
On this note let's cover a few key points.

Discharge – due to the chemistry of a Lipo cell, you should never allow the cell to discharge completely. As a rough guide, a Lipo cell should never be allowed to discharge below 3V a cell.

Misuse – Lipo cells must never be short circuited (like any battery) and must be charged via a proper Lipo battery charger. Never try to cycle a Lipo cell (you can if you know what you are doing, but for the purposes of this guide there is no need). The cells are not as physically robust as a NiMH cell, so be careful when handling them and locating them in the model, do not bend or twist them (they are not 'fragile' as such, but just need a bit of care and common sense in using them and avoiding puncture or distortion of the cells).

Voltage – Lipo cells have a nominal voltage of 3.7V and as already stated, most RC gear is designed to work at around 4.8V. Although it is possible to operate some RC gear at 3.7V off a single Lipo cell (and some DLG fliers have done this with good results) for the purposes of this guide we will be considering the use of a 2 cell Lipo pack, which gives a nominal voltage of 7.4V. This is commonly described as a *2s1p 7.4v Lipo battery pack* (meaning 2 cells in series). Due to the higher voltage this then means we must use a voltage regulator to step the voltage down from 7.4V to a more usable 5V.

Regarding Lipo cell voltage, although the nominal cell voltage is stated at 3.7V, you will see from the black line on the graph below that a single Lipo cell's voltage when fully charged, actually starts off at approx 4V. It then reaches 3.7V approx half way though it's discharge cycle and when the cell is almost fully discharged it drops to approx 3.5V, after which voltage quickly falls off.



Discharge curve of a single 300mAH Lipo cell – black line is a discharge cycle at 2amps.

Because the graph above is showing a discharge at 2 amps (far more than a DLG would typically use) it is likely that the starting point of the Lipo cell voltage for our purposes will be actually at a point between 4V and 4.5V.

This means that the 2s1p 7.4V Lipo pack we would use in a DLG will actually start off with a pack voltage of between 8V and 9V when fully charged and that we need to careful that this 2 cell pack is never discharged below 6V.

How much power does a DLG require?

As already stated, for the purposes of this guide we will presume a supply voltage of 5V is required. The current required at this voltage is impossible to answer accurately, as it will vary from model to model, the nature of flying being done and will also vary dependant on the type/make of receiver and servos being used.

As a rough guide however - somewhere between 100mA and 200mA appears to be the average DLG current load in normal flight conditions. As an example an 'Aspirin' DLG fitted with 4 x JR D281 digital servos, was monitored using an on-board 'Servosense' current logger (from Dimension engineering) on a 40 minute flying session.

The results were;

Average current draw 150mAh
Max current draw 800mAh.
Max current draw for 15+secs 350mAh.

In terms of peak current (ie worst case current draw) The D4.7 / SD150 servo has a stall current of approx 300mA, meaning that if a model had all 4 servos stalled then approx 1.2A would be required.

In practice however it is very unlikely that this kind of current will be drawn and a 'real world' peak current of below 1A can probably be expected. It should be noted that many of the modern digital micro servos have a similar current requirement (such as the JR digital DS381 and JR281).

So, in summary, for a DLG we generally need a battery system that can reliably supply 100mA – 200 mA for long periods of time, with peaks of current requirement up to approx 1A.

What Lipo pack for a DLG ?

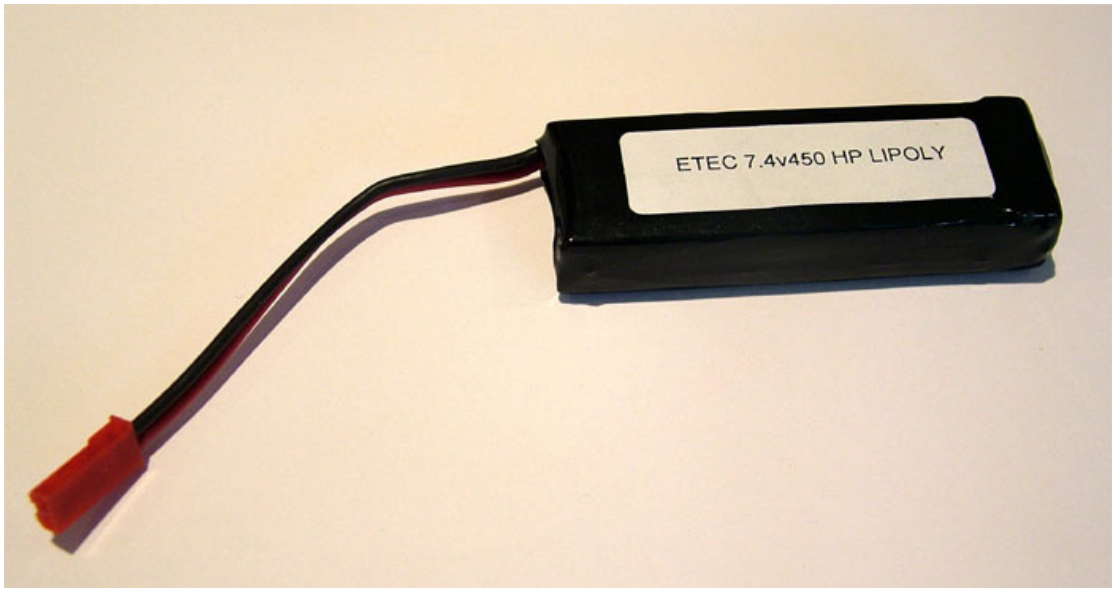
To use a Lipo pack in a DLG we will require a suitable 2s1p 7.4V Lipo pack and a suitable 5V voltage regulator.

Since a DLG model will inevitably require nose weight to give the correct C of G and most DLG designs use the battery pack as part of the required nose weight, it makes sense to use a Lipo pack which when combined with a 5V regulator (which typically weighs 3 or 4 g) gives almost the weight of the typical NiMH pack that would be used in the model (eg a Kan 400 4.8v 2/3AAA Nimh RX pack weighs approx 32g).

Although there won't be much of an overall weight saving on the model, you will gain higher battery capacity, easier charging and lower self-discharge.

We also require a Lipo pack that will fit easily in the model, typically in the nose of the model.

Therefore I would recommend using a Etec 450mAH 2s1P 7.4v pack;



E-Tec 450mAH pack 2s1P 7.4V (60 x 20 x 10 mm / 2.4 x 0.79 x 0.39 " at a weight of 24.7 grams / .87 oz.)

- Or alternatively if you need to save a few more grams of weight - E-Tec 300mAH pack 2s1P 7.4V. (63mm x 22mm x 9mm at a weight of 21g)

Both of these packs will easily fit in the nose of a DLG, usually with enough space to place the receiver on top of the battery pack.

I'm sure there are other suitable Lipo packs around, but the Etec 450mAH 2s1P pack has worked well for me and the physical form factor fits in a typical DLG fuselage nose section very well, also enabling the Rx to be placed on top of it.

For mounting (after testing) I secure the Lipo pack semi-permanently in the model with a few drops of CA glue. Although I could remove the pack if really necessary, since the Lipo pack lifespan is probably as long as the DLG model in practical terms, there is no need. This also enables a tidy and efficient installation.

Which voltage regulator for a DLG ?

There are several high quality 5V voltage regulators commercially available.

My current recommendation is a new 5V regulator unit from PLD, specifically made for DLG usage. It is available in a small and light form factor and has an on-board alarm which gives both under and over voltage alarms, as well as a self test alarm on start up.

More details at www.pldaniels.com/rcshop

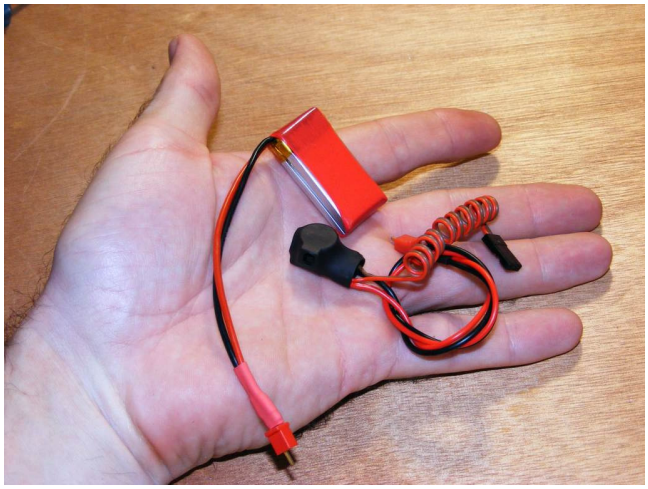
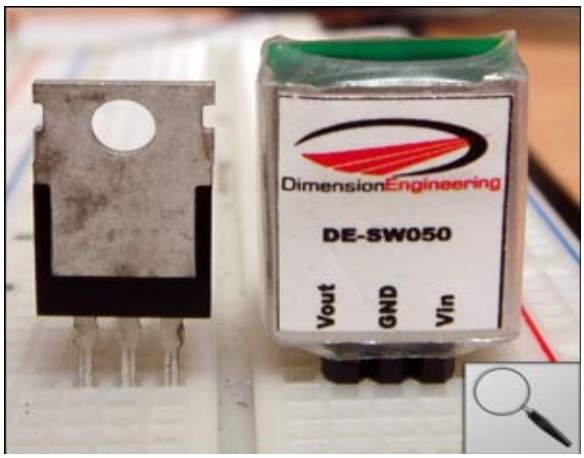


Photo of the PLD-BAC alongside a Lipo cell.

Others to consider;

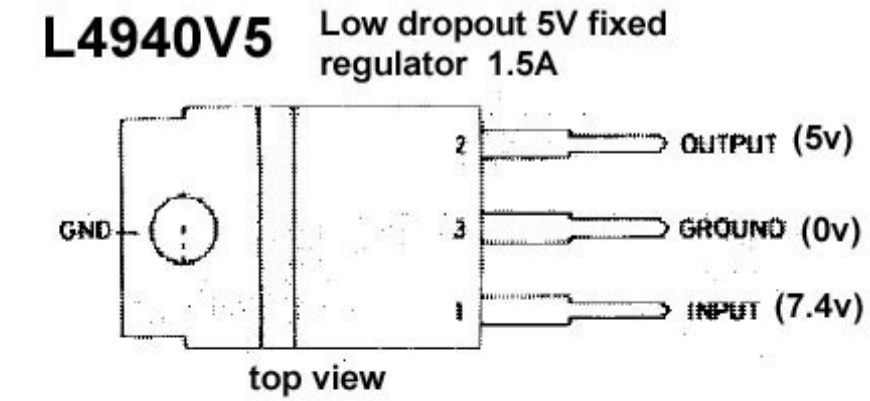
The FMA "SPORT" VRLI regulator (www.fmadirect.com) at 5g weight, offers 5V regulation at up to 2A current. It also offers warning of low battery condition via LEDs.

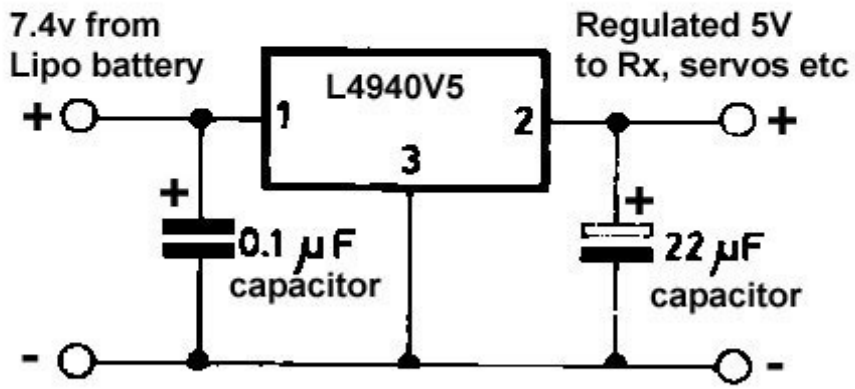
5V 1A (1.25A peak) Switching voltage regulator at 4g weight, from Dimension engineering (www.dimensionengineering.com)



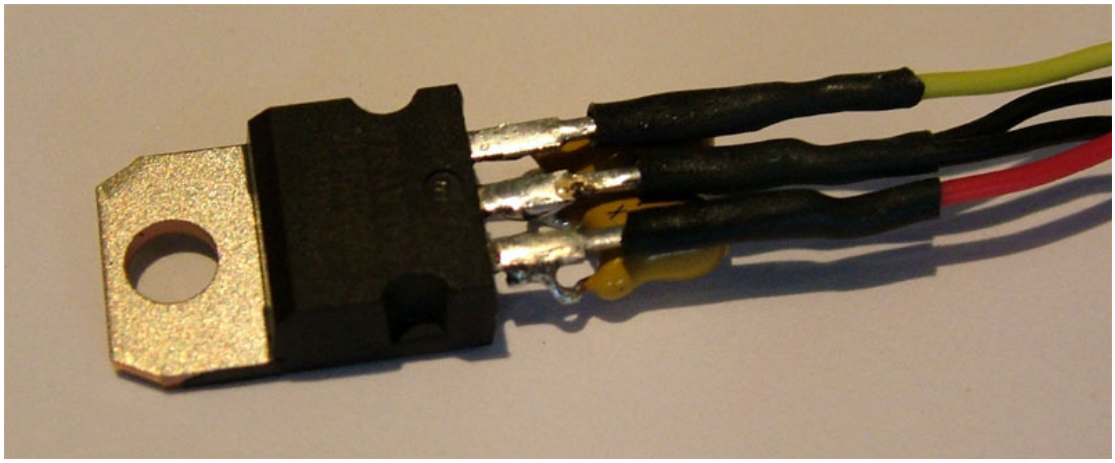
Build your own Voltage regulator

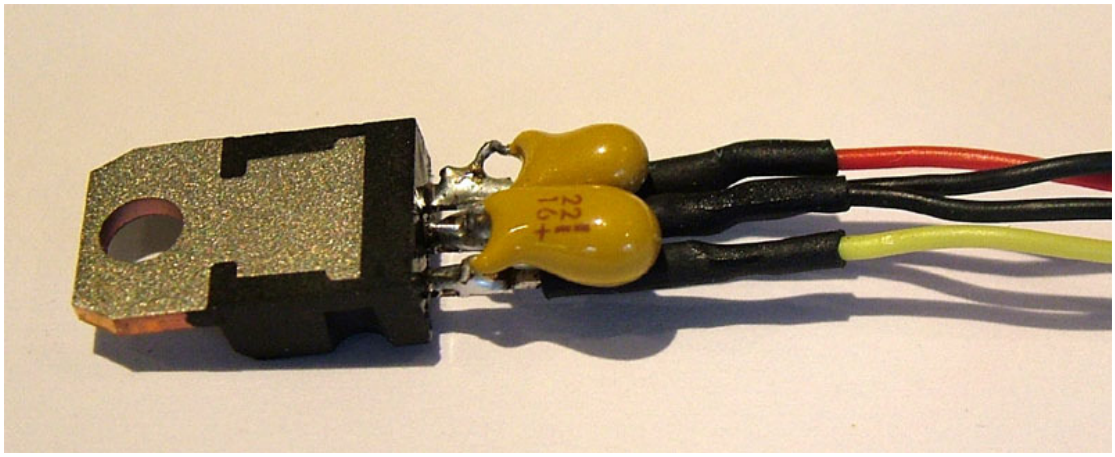
You can make your own 5V voltage regulator for DLG usage, at a low cost, using only 3 components and some wire. Using a L4940V5 low dropout voltage regulator and two capacitors (do a web seach for the components, they are easily sourced from several online suppliers) a 5V 1.5A regulator weighing 4g can be easily made. See diagram below and photos overleaf.





Photos overleaf - showing the finished regulator (NOTE – make sure you align the tantalum bead capacitors with the '+' symbol connected to the + supply rails as shown in the diagram above – also, when built, wrap the regulator in insulating tape or heatshrink sleeve to prevent any short circuits when inside the fuselage – especially against any carbon fibre which will conduct electricity!!)





In the photos above, the red wire is the +7.4V from the Lipo battery pack, the yellow wire is the regulated +5V to the Rx and servos and the two black wires are the 0V (ground) to the Lipo battery negative terminal and the Ov for the Rx and servos. The '+' symbols on the capacitors face towards the outside pins of the regulator. The centre pin of the regulator is Ov (Gnd).

Which Charger to use?

There are many, good quality battery chargers available for Lipo battery pack use. If you haven't already got one and need a charger for DLG usage, I would recommend the Graupner Lipo charger 4. It is compact, auto-sensing, very low cost and is perfect for charging DLG Lipo packs, easily and without worry of charge rates, overcharging, etc. It's just a case of plug and play. It works from a 12V source, so with a bit of cable making it's easy to power it from a car's cigarette lighter socket etc. For home use I power it from a cheap 12V DC 1 amp power supply.

How to wire it all up ?

The easiest way to wire the Lipo cell and regulator together, is to wire them via a 2.5mm mono jack socket, with an internal switched contact. Using a switched socket allows the battery to be switched on/off (power is turned off when a 2.5mm mono plug is inserted into the socket) as well as use the socket for battery charging, all without ever having to open the model canopy up for access.

I would recommend you use a good quality, closed body 2.5mm mono jack socket from Switchcraft (RS No 329-9679), rather than a cheaper open-body version, which may not be as reliable and also prone to dust and dirt ingress.

Basic wiring is that the + connection of the Lipo pack goes to the centre tip connection of the socket (the socket contact that always makes connection with the tip of the jack plug when inserted). With negative from the Lipo pack going to the ring/ground connector of the socket.

The remaining switched connection on the socket is then fed to the + input of the voltage regulator.

This means that the battery is connected to the regulator (and the model is turned on) when no jack plug is inserted in the socket and that the battery is disconnected when a jack plug is inserted.

When the plug is inserted, the tip of the plug is then connected to the battery – this means you can charge via the jack socket, by making up a charging lead with a 2.5mm mono plug (+ on tip of plug and – on ring).

I also use the jack socket to check Lipo voltage (and make sure I'm above 6V) , using a commercial voltage meter and a lead with a 2.5mm jack plug on it