**Boundary Conditions**

The battery manager needs to do a couple of things:

* Regulate the voltage at 12V using a buck or boost converter (depending on battery voltage) because secondary will run on 12V
* Burn a fuse at 5A, because that’s the maximum current the MCU’s can handle
* Shut off the battery if the cells reach 3V to keep the LiPo in good health
* Have a maximum current output of 2A

**Battery choice**

After some research, it appears that Boosting is less efficient than Bucking for a couple of reasons mentioned in this article: <https://www.eetimes.com/document.asp?doc_id=1273121>

Because we need 12V in the secondary system and Bucking is the most efficient way to reach that voltage, we need a battery that stays above that voltage even if the cells are at a low voltage. Considering the minimum cell voltage is 3V because we don’t want to blow up our battery, we need one with at least 4 cells in series.

To pick the right batteries I have made the following calculations:

There are in total 30 white LEDs, 18 yellow LEDs and 16 red LEDs in the lighting system of the car.

The specifications are as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **White** | **Yellow** | **Red** |
| **Max forward current** | 180mA | 150mA | 150mA |
| **Max forward voltage** | 3,3V | 3,0v | 3,0v |
| **Max power use for light** | 594mW | 450mW | 450mW |
| **Max power dissipation** | 630mW | 495mW | 450mW |
| **Total power use** | 1,2W | 0,95W | 0,9W |

The total power use of the lighting system in general will be 30\*1,2+18\*0,95+16\*0,9 = 67,5W

Assuming the max time of an attempt in the SEM is 39 minutes (which was the case in the SEM 2017) the energy use equals 67,5W\*0,65h = **43,9Wh**.

The amount of energy we can draw from the batteries will be as follows:

|  |  |  |
| --- | --- | --- |
|  | **4s (@14,8V)** | **6s (@22,2V)** |
| **10000mAh** | 148Wh | 222Wh |
| **16000mAh** | 236,8Wh | 355,2Wh |
| **20000mAh** | 296Wh | 444Wh |

This is of course assuming that the voltage stays the same while the battery is draining (which it doesn’t) and that we can use every single mAh in the battery (which will not be the case, it will be more likely to give 80% also because we won’t completely drain the cells). Taking this into account as well as the fact that the rest of the secondary system will draw an (in comparison negligible but still present) amount of energy, even the 4s 10000mAh will still deliver enough energy to have quite a bit of wiggle-room during the SEM attempts.

As the higher capacity batteries are more expensive while not delivering a real benefit they are not really a viable option so the choice comes down to a 4s 10000mAh battery or a 6s 10000mAh battery. Because buck converting is more efficient over lower voltage differences, a 4s clearly has the advantage (14,8V to 12V conversion vs 22,2 to 12V conversion) which is the reason we will use a 4s 10000mAh battery.

**Buck converter choice**

To pick a good buck converter, I used the TI WEBENCH power designer. For an input min/max of 12V/16.8V and a preferred output voltage of 12V with a max current of 2A, it suggested the LM5176PWPR.