EPS – BATTERY Sizing

This document refers to the batteries of EPS ECE³SAT.

Specifications

To supply the modules in energy, a rechargeable battery is needed. There are different types of batteries (Typically Li-Ion and NIMH). The technology, the attitude in a cold and hostile environment and the power consumption have to be considered to size the battery module .

Choice of battery

Here is a table with different type of batteries used for CubeSats.

CubeSat	Type	Mass [g]	Capacity [mAh]	Nominal Voltage [V]	Voltage Range [V]
CanX-1	3 Polystor Li-Ion	114 (38 per unit)	3600 (1200 per unit)	3.7	
AAU CubeSat	Li-Ion Polymer	26	920	3.7	3.0 - 4.2
MAST	Li-Ion			3.6	
SEEDS	Li-Ion			3.7	
nCube	Li-Ion				3.7 - 4.2

Since the CubeSats have already a huge rate of failure (due to the hostile environment that they have to face with), the battery considered in the ECE³SAT will be the safest technology designed for space.

Therefore, the battery will be a **LI-Po** because there is a few risk of explosion in comparison with the Li-Ion batteries. The battery will have a voltage of **3.7 V** which is the typical voltage range for this technology and small satellite like ECE³SAT. The capacity will be around 1 Ah according to the feasibility study document.

Energy used

To improve the lifespan of the battery, it has to be neither fully charged nor depth discharged. The level of charge needs to be maintained between 25% and 90% of the total capacity.

Moreover, in average, **2.25Wh** will be needed during an eclipse according to the power budget part.

Thus, a battery will be required with 3.21Wh, or a capacity of **0.87 Ah** with a voltage of 3.7 V. It is in adequation with the 1 Ah generally used.

The CubeSat may also consider the use of a non rechargeable battery to execute one time operation. It could be very interesting for some specific operations such as in the detumbling mode in the ECE³Sat case. So, it would a primary battery of 1Wh.

Vacuum

At low earth orbit, the atmosphere influence at really low level the space environment. Therefore, LEO is considered to be in vacuum conditions.

The battery designed for the CubeSat has to be able to charge and to furnish electricity to modules in these vacuum conditions.

Temperature

The temperature in space is very low and it is important to take in account during the designing of the modules. The battery is always confront to the natural discharge issue, but in a cold environment this problem increases. That means that the battery has to be designed for space, and has to resist to low temperature.

The natural discharge of the battery has to be considered according to this extreme temperature. The battery should be able to work well and without too much loss for a temperature of 0 C°. This is to improve the charge of battery and avoid the depth of discharge.

Heater

The system will include a heater to maintain the temperature between 0°C and 5°C. There is two types of heater: functioning by protection or electric.

The advantage of using a blanket as a protection against cold temperature is that it is a non-electrical solution, which means that it is simple to use and do not consume any energy. The problem is that the protection would be applied on the CubeSat sides, which means it will decrease the surface covered by PV modules. And so, it would decrease the electricity production.

The advantage of using an electric protection is that it is small and it does not consume a lot of energy for the result expected. However, space is “filled” of the vacuum. Therefore, it cannot use the convection thermal exchange (dissipation of energy) because this type of exchange only exists through a fluid.

Since the ECE³SAT needs the more power as possible, the second solution will be considered for the satellite.