Battery Engineering

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Exercise 2 - Determination of LIB performances based on datasheet

1. Looking at the following datasheet try to answer to those questions:

    a) What is the nominal voltage?
    b) How is the nominal voltage defined and why do we need it for sizing?
    c) What is the capacity (Ah) of the battery cells?
    d) There are two ways of computing the battery capacity based on the available data on the datasheet. Could you indicate another way with respect the one you used in point c?
    e) According to you, why on the datasheet the producer indicates two energy values? Nominal and Minimum?
    f) What energy will you achieve if you connect 7 cells in parallel and 13 cells in series (7p13s)?
    g) What power can be achieved by running the battery module defined in point f with 2Crate?
    h) Considering the value of pulse power in 4.2.8 at which current you can run the battery to achieve the peak power of 80W? Is it possible to use this current in continuous mode?
    i) Why does the capacity of the cell decrease with decreasing temperature?

Solution:

a) 3.63V

b) The voltage of a battery can vary throughout its discharge cycle, starting from a higher voltage when fully charged and decreasing gradually as it discharges. The nominal voltage serves as a standardized reference point for the battery's voltage characteristics and when the battery discharges to around this value, it has delivered approximately half of its stored energy.

c) 18.2Wh/3.63=5Ah nominal – 17.6Wh/3.63V=4.85Ah (guaranteed) minimum

d) Second method is to consider the indicated Crate: 0.3C (1,455mA) or 0.2C (970mA) both result in a capacity of: 1455/0.3=970/0.2=4850mAh=4.85Ah

e) There might be a manufacturing variability among cells but generally the producer should indicate the minimum capacity at standard charge/discharge operating condition (temperature and current)

f) 7p=7*5Ah=35Ah 13s=13*3.63V=47.19V →1.65kWh

g) 70A (2C) *47.19V=3.3kW

h) 80W/3.65V=22A corresponding to 4.4C – max continuous Crate is 3C

i) At lower temperatures different mechanisms are limiting Li ion battery performances:

- chemical reactions slow down, this slowdown can limit the rate at which the battery can deliver energy also because the rate of diffusion of lithium ions in lithium-ion batteries may slow down significantly at colder temperatures.
- Increased Internal Resistance, higher internal resistance means that more of the energy stored in the battery is lost as heat when the battery is discharged.
- The electrolyte in a battery plays a crucial role in facilitating the movement of ions between the battery's electrodes during charging and discharging. At lower temperatures, the electrolyte's conductivity decreases, reducing ion movement and reducing the battery's overall performance.