

1 Battery Parameters

Problem 1

In the third video, the narrator says “...when creating a battery pack we typically connect cells in parallel first and then connect them in series,...” (Figure 1).

Why do we not connect 6 cells in series and then connect the 2 sets in parallel?

Answer 1

Connecting cells in parallel first allows for better thermal and electrical stability. In contrast, connecting in series first means that the same current flows through all cells, which will make them heat up disproportionately, and thus, reduce their lifespan. Note: Battery Management Systems (BMS) find it easier to monitor and balance parallel groups due to the above provided reason, and therefore, in general, the parallel-first approach is preferred (6s2p).

Problem 2

Go through the specifications of the battery pack given and answer the questions that follow. GenX Ultra 22.2V 21000mah 20C Premium Lithium Ion Rechargeable Battery.

- On average, what is the amount of current the battery can discharge continuously?
- What would the energy rating (in Wh) of the battery pack be if 5 cells were removed such that the configuration becomes 5S5P of each?
- What would the capacity (in mAh) of a 3S2P configuration of the individual cells be? What would the nominal voltage across the ends of this configuration be?

Answer 2

Parameter	Battery Pack (6S5P)	Individual Cell	Formula / Reasoning
Nominal Voltage (V)	22.2 V	3.7 V	$\frac{22.2}{6} = 3.7 \text{ V}$
Capacity (mAh)	21000 mAh	4200 mAh	$\frac{21000}{5} = 4200 \text{ mAh}$
Energy (Wh)	466.2 Wh	15.54 Wh	$3.7 \times 4.2 = 15.54 \text{ Wh}$
C-Rating	20C	20C	Same as pack; assumed consistent across cells
Max Continuous Discharge Current (A)	420 A	84 A	$4.2 \times 20 = 84 \text{ A}$
Configuration	6S5P	—	6 cells in series (for voltage), 5 in parallel (for capacity)

Comparison of battery pack vs. individual cell specifications

1. Continuous Discharge Current:

The battery has a **20C** rating and a total capacity of **21000 mAh = 21 Ah**. Thus, the maximum continuous discharge current is:

$$20 \times 21 = 420 \text{ A}$$

2. Energy of 5S5P Configuration:

Original configuration is 6S5P.

Each cell has a nominal voltage of $\frac{22.2\text{V}}{6} = 3.7 \text{ V}$.

Removing 5 cells \rightarrow new config: **5S5P**.

- New voltage: $5 \times 3.7 = 18.5 \text{ V}$
- Capacity remains unchanged: 21 Ah
- Energy rating: $18.5 \times 21 = 388.5 \text{ Wh}$

3. Specs of 3S2P Configuration:

- Capacity of 2P: $2 \times 4200 = 8400 \text{ mAh}$
- Voltage of 3S: $3 \times 3.7 = 11.1 \text{ V}$

2 Custom Battery Packs and Management Systems

Problem 3

Do your own research!: The videos above mention what a BMS does. Propose a method in terms of how to connect a BMS to a custom 3S2P battery pack by doing the appropriate research. Cite the research paper(s)/other source(s) you have used (for us to check that it is not AI-generated). Explain in your own words why your method works and what it does, very briefly (4 to 5 lines are sufficient).

Answer 3