LIBRARY · REFERENCE GUIDE

LIPO AND LI-ION SAFETY

Lithium cells are energy-dense and unforgiving. The 4.2 V ceiling, the empty limit, the protection circuit every cell needs, and the physical care that prevents a fire.

ONE THOUSAND DRONES ENGINEERING TEAM · VERIFIED 2026-07

Lithium cells pack more energy into less mass than any common battery, and that density cuts both ways. Charged too high, drained too low, shorted, or physically damaged, a lithium cell can vent, catch fire, or worse. A few firm rules keep it safe.

> **RESPECT THE VOLTAGE WINDOW AND NEVER BYPASS PROTECTION**
> A single lithium cell lives between about 4.2 V full and 3.0 V empty. Charging past 4.2 V or draining below its cutoff damages the cell and can start a fire. Never charge a pack unattended, never puncture or crush a cell, and never use a bare cell without a protection circuit.

THE SAFE VOLTAGE WINDOW

4.2 V is the hard ceiling for a standard single cell, and 3.0 V is the empty mark. Above the ceiling the chemistry breaks down and can go into thermal runaway. Drain it well below empty and the cell is damaged and may short internally on the next charge. A charger and a protection circuit exist to keep the cell inside that band.

- Battery University. BU-409: Charging Lithium-ion (the 4.20V/cell charge ceiling). batteryuniversity.com

OVER-CHARGE, OVER-DISCHARGE, AND SHORT

Three faults do the damage. Over-charge pushes the voltage past the ceiling and overheats the cell. Over-discharge drops it below empty and ruins it. A short circuit dumps enormous current in an instant, and a lithium cell can deliver hundreds of amps into a dead short. Each fault is exactly what the protection circuit watches for.

THE PROTECTION CIRCUIT

A bare lithium cell has no brain of its own. A protection circuit, a small board called a PCM, or part of a larger battery management system, sits on the cell and disconnects it on over-charge, over-discharge, or over-current. Most protected cells and every good pack have one built in. A raw cell is only safe behind a circuit that provides that protection.

THE PROTECTION CIRCUIT TRIPS JUST OUTSIDE THE 4.2 V TO 3.0 V WINDOW.

DEEP DIVE · WHAT THERMAL RUNAWAY ACTUALLY IS

The danger word for a lithium fire is thermal runaway. A cell pushed too hard heats up; the heat speeds the internal reaction; the faster reaction makes more heat. Past a tipping point the loop feeds itself and the cell vents flammable gas and can ignite, with no outside energy needed to keep it going. That self-sustaining loop is why a lithium fault is not gentle and why the voltage and current limits are hard rules rather than suggestions. (Battery University)

- Battery University. BU-304a: Safety Concerns with Li-ion (voltage limits, thermal runaway). batteryuniversity.com

On a real build, the L2.01 battery power module course puts these rules into hardware, adding a charger and a protection circuit to a single cell the right way.

CHECKPOINT

1. What is the danger of charging a single Li-ion cell past `4.2 V`?

a. Nothing, it just charges faster

b. Over-charge that overheats the cell and risks a fire

c. The cell reports a lower capacity

ANSWER · B

4.2 V is the hard ceiling; above it the chemistry breaks down toward thermal runaway.

2. Why does a bare lithium cell need a protection circuit?

a. To make it charge faster

b. To change its nominal voltage

c. Because the cell cannot stop over-charge, over-discharge, or a short on its own

ANSWER · C

A PCM or BMS disconnects the cell on the faults it cannot survive by itself.

3. The safe window for a standard single lithium cell is about what?

a. `4.2 V` full down to `3.0 V` empty

b. `5 V` full down to `1 V` empty

c. `3.3 V` full down to `0 V` empty

ANSWER · A

Full is about 4.2 V and empty about 3.0 V; the charger and protection keep it there.

- Prerequisite: batteries 101
- See it on a real board: the L2.01 battery power module
- Next: battery charging