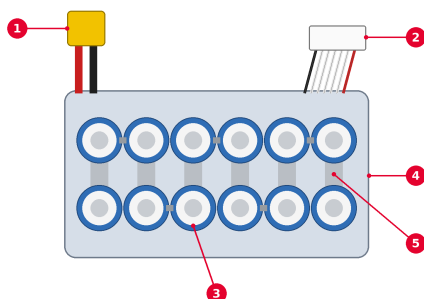




Li-ion Batteries and Cells

User Manual

Li-ion packs and cylindrical cells for RC models, FPV
drones and radios



Read this entire manual carefully before first use and keep it for future reference. Incorrect charging, discharging or storage may cause fire or explosion. This product is not a toy - it is intended for persons aged 14 and over.

Universal manual for Li-ion batteries and cells sold by Rotorama, s.r.o.

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1. General information and technical parameters

1.1 What is a Li-ion battery

A lithium-ion (Li-ion) battery has a higher energy density than a LiPo battery, but it is designed for lower to medium discharge currents. Thanks to its excellent capacity-to-weight ratio it is well suited for long, efficient flights (long range, cruise) and for powering radios and FPV goggles. The battery does not suffer from the memory effect, can be recharged from any state of charge, needs no forming and has minimal self-discharge.

This manual applies to **Li-ion packs** (cells connected in series and possibly in parallel) as well as to **single cylindrical cells** (e.g. 18650, 18350 and 21700).

1.2 Cells and packs, designation

The cell size designation gives its dimensions: **18650** = diameter 18 mm, length 65 mm; **21700** = diameter 21 mm, length 70 mm; **18350** = diameter 18 mm, length 35 mm. A cell has a nominal voltage of 3.6 V to 3.7 V (depending on the specific chemistry) and is charged to 4.20 V.

A pack consists of cells connected in series (**S**) and possibly in parallel (**P**). For example 6S2P = 6 series groups of 2 parallel cells, 12 cells in total. Nominal pack voltage = nominal cell voltage × number of cells in series (4S = 14.4 V; pack manufacturers often state 3.7 V/cell, i.e. 14.8 V). Pack capacity = cell capacity × number of cells in parallel.

1.3 Technical parameters

Parameter	Value	Note
Nominal voltage (cell)	3.6–3.7 V	depending on the cell type
Maximum voltage (cell)	4.20 V	for most cells; see ch. 1.5
Storage voltage (cell)	3.6–3.8 V	for storage of 14 days or longer
End-of-flight voltage (cell)	2.8 V	under load – land
Minimum voltage (cell)	2.5 V	typical; as per cell datasheet
Charging current	0.5–1C	never above the cell manufacturer's maximum (ch. 1.5)
Maximum discharge current	as per label / datasheet	see chapter 1.5
Temperature when charging	0–45 °C	never charge below 0 °C
Temperature when discharging	0–50 °C	recommended; preheat in winter
Storage temperature	up to 25 °C	dry, dark, non-flammable container

1.4 Description of the cell and the pack



Fig. 1 – Cylindrical cell: ① positive terminal (+), ② insulating ring, ③ shrink wrap (sleeve), ④ negative terminal (–)

- The metal can of the cell is connected to the **negative terminal** (④). The shrink wrap (③) and the insulating ring (②) are the only insulation between the two terminals – if they are damaged, there is a risk of short circuit.
- Single cells **have no protection electronics** (protection against overcharge, overdischarge, short circuit and overheating). Cell manufacturers intend them to be built into packs and devices with a protection circuit (BMS) or with voltage monitoring, e.g. in the drone's flight controller (FC) or in a radio.

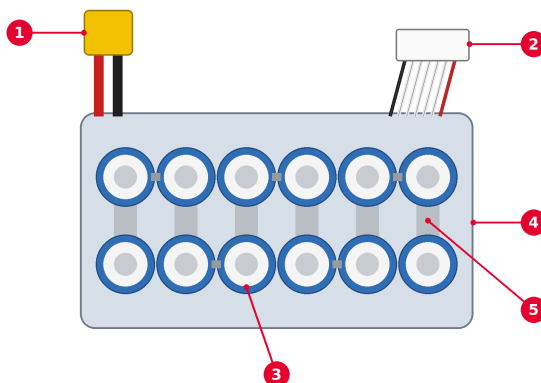


Fig. 2 – Li-ion pack: ① main connector (here XT60), ② JST-XH balance connector, ③ cell, ④ shrink wrap, ⑤ connecting strip of a parallel group

- The **main connector** (①) is connected to the first and last cell and carries the full pack voltage. The connector type is chosen according to the expected current.
- The **balance connector** (②) has one contact more than the number of series cells and is used to monitor and balance the voltage of the individual cells during charging.

- The cell connections (Ⓢ) are spot-welded. Never solder, bend or modify them.

1.5 Parameters of a specific cell

Individual types of Li-ion cells differ considerably in their permissible charging and discharging currents and cut-off voltage. Before you start using a cell or pack, find its parameters in the **cell manufacturer's datasheet** (the cell type is printed on its sleeve; for packs it is on the label or in the product description at www.rotorama.cz). Look in particular for:

- **charging (final) voltage** – 4.20 V for most cells used in RC models,
- **standard and maximum charging current** – for some cells the maximum is only about 0.5C,
- **cut-off (discharge) voltage** – usually 2.5 V, higher for some cells,
- **maximum continuous discharge current** – manufacturers often state two values: a lower one without restriction and a higher one only with cell temperature monitoring and cut-off at the limit temperature (typically 75–80 °C),
- **temperatures** for charging, discharging and storage.

For a pack, the datasheet values apply to one cell. The pack current is a multiple of the number of parallel cells (P), unless the pack manufacturer states a lower value. If the pack or cell manufacturer states a stricter limit than this manual, the stricter value always applies.

2. Safety

WARNING – FIRE HAZARD

- ▶ **Incorrect use of Li-ion batteries may cause fire or explosion!**
- ▶ **The short-circuit current of Li-ion cells is enormous - connectors may melt and a fire may start.**
- ▶ **NEVER leave batteries charging unattended!**
- ▶ **The seller accepts no liability for damage caused by improper use of the batteries.**

2.1 Rules for safe use

- This product is not a toy. It is intended for persons aged 14 and over; keep it out of the reach of children.
- Do not use damaged, dented or otherwise defective batteries and cells. Cells in a rigid can usually do not swell, but mechanical damage to the can is dangerous.
- Never short-circuit the contacts of a battery or cell.
- Never exceed the charging voltage of 4.20 V/cell.
- Do not discharge the battery below the minimum voltage of the cell manufacturer (usually 2.5 V/cell) – risk of permanent damage.
- Do not exceed the maximum discharging or charging current.
- Do not throw batteries into fire or into general waste.
- Do not puncture or disassemble batteries and do not modify their spot-welded connections – risk of short circuit and ignition.
- Do not expose batteries to water, moisture or extreme temperatures.
- Always disconnect the battery from the model after the flight.

2.2 Single cells

- Single cells are intended to be built into packs or devices. Building packs by spot welding is only for experienced users with proper equipment – never solder directly onto the cell can.
- Carry and store cells in a protective case or box, never loose in a pocket or bag together with metal objects (keys, coins).
- Check the shrink wrap and the insulating ring before use. Do not use a cell with a torn wrap until the wrap has been replaced.
- Always insert cells into a device with the correct polarity and do not mix cells of different types, ages or states of charge.
- Do not use single cells in devices that are not designed for unprotected Li-ion cells.

2.3 Damaged or burning battery

- Stop using a battery or cell with a damaged can, or one that is dented, deformed, overheated or leaking electrolyte, immediately and do not charge it.
- Disconnect it and place it on a non-flammable surface or in a fireproof container away from flammable materials, ideally outdoors; let it cool down under supervision.
- Then hand it over for disposal (chapter 8.3). Never send it via a courier or parcel service (chapter 9.2).
- If the battery starts to smoke or burn, do not touch it, leave the area, do not inhale the smoke and call the fire brigade (112).

3. Voltage levels

3.1 Voltage per cell

Voltage / cell	State	Note
4.20 V	Fully charged	Disconnect from the charger
3.6–3.8 V	Storage	Ideal for storage of 14 days or longer
2.8 V (under load)	Discharged	Land; charge before the next flight
2.5 V	Minimum	Typical cut-off voltage – check the cell datasheet
below 2.5 V	CELL DAMAGE	The cell may be permanently damaged

3.2 Voltage of the complete battery

Voltage of the complete battery = voltage per cell × number of cells in series (S).
The nominal voltage is calculated with 3.6 V/cell; the pack label may state it with 3.7 V/cell.

Number of cells	Nominal	Fully charged	End of flight	Minimum	Storage
1S	3.6 V	4.20 V	2.8 V	2.5 V	3.6–3.8 V
2S	7.2 V	8.40 V	5.6 V	5.0 V	7.2–7.6 V
3S	10.8 V	12.60 V	8.4 V	7.5 V	10.8–11.4 V
4S	14.4 V	16.80 V	11.2 V	10.0 V	14.4–15.2 V
6S	21.6 V	25.20 V	16.8 V	15.0 V	21.6–22.8 V

4. Charging

⚠ IMPORTANT - NEVER LEAVE BATTERIES CHARGING UNATTENDED

- ▶ Charge only with a professional hobby charger with the **Balance Charge** function.
- ▶ Always charge batteries in a non-flammable container or on a fireproof surface.
- ▶ Always check the set number of cells (S) and the charging current before charging.

4.1 Choosing the charger program

Most Li-ion cells used in RC models have a final charging voltage of **4.20 V** (check the cell datasheet, ch. 1.5). However, the *Lilon* program of many hobby chargers ends at **4.10 V/cell** by default, and on some chargers this cannot be changed.

- Charge cells and packs with a final voltage of 4.20 V with the **LiPo** program (4.20 V/cell), or with the *Lilon* program if it can be set to 4.20 V on your charger.
- Charging with the *Lilon* program to 4.10 V is safe, but the battery will not be fully charged.
- **Never** use the *LiHV* program (4.35 V/cell).
- Always follow the final voltage stated by the manufacturer of the specific cell and the instructions in the charger manual.

4.2 Charging procedure for packs

- ① Visually inspect the battery – it must not be damaged, dented or otherwise defective.
- ② Connect the balance connector to the balance port of the charger.
- ③ Connect the main connector to the charger.
- ④ Set the program (chapter 4.1), the number of cells in series as per the label and a charging current of 0.5–1C.
- ⑤ Check the settings and start the *Balance Charge* mode.
- ⑥ Continuously check the voltage of the individual cells and the battery temperature.
- ⑦ Disconnect the battery when charging is complete.

4.3 Charging current

- The usual charging current is **0.5–1C** (e.g. charge a 4000 mAh pack at 2–4 A). Fast charging at high currents harms Li-ion cells and shortens their service life.
- The pack charging current must not exceed the maximum charging current of the cell × the number of parallel cells (P) – see chapter 1.5. For some cells the maximum is only about 0.5C.

- Do not charge the battery until it has cooled down after the flight, and never charge it below 0 °C.

4.4 Charging single cells

- Charge single cells with a charger designed for cylindrical Li-ion cells with a final voltage of 4.20 V, or in a device intended for this purpose (e.g. a radio with a built-in charger), according to its manual.
- Observe the maximum charging current as per chapter 1.5 and check the temperature of the cells.

5. Discharging and operation

- Li-ion batteries are designed for smooth, long flights. Sudden throttle punches (freestyle, sprint) cause a large voltage drop (sag).
- Do not exceed the maximum discharge current of the pack. Pack current = maximum cell current × number of parallel cells (P), unless the pack manufacturer states a lower value.
- Land as soon as the voltage under load drops to **2.8 V/cell**. Set up a warning in the OSD, in the radio telemetry or on the electronic speed controller (ESC). Never discharge below the minimum voltage of the cell manufacturer.
- The cells heat up under high load. Ensure sufficient cooling (airflow) and check the battery temperature after the flight.
- Discharge batteries at a temperature of 0-50 °C. In colder months, preheat them before take-off.
- The actual usable capacity decreases with higher current draw and lower temperature.
- Insert a fully charged battery into the model before the flight and always disconnect it after the flight.

6. Storage

- If you do not plan to use the battery for more than 14 days, charge or discharge it to a storage voltage of **3.6-3.8 V/cell** (the *Storage* program of the charger).
- Store at a temperature of up to 25 °C, in a dry place, away from direct sunlight and heat sources.
- Store in a non-flammable container (battery bag or metal box), away from flammable materials.
- Store single cells in a case or box so that their terminals cannot touch each other or metal objects.
- Do not store in a car parked in the sun.

7. Transport

- Transport batteries and cells at storage voltage with the contacts protected against short circuit (original packaging, case, a separate bag or taped connectors).
- Do not transport damaged batteries and cells.
- For air travel, follow the IATA rules and your airline's conditions. Spare lithium batteries and cells belong **in carry-on baggage only**. Rules change – check them with your airline before travelling.
- Batteries up to 100 Wh may be carried without airline approval, from 100 to 160 Wh only with airline approval; above 160 Wh carriage by passengers is prohibited.
- Examples: 21700 cell 5000 mAh = 18 Wh; 4S2P pack 10,000 mAh = 144 Wh (approval required); 6S2P pack 10,000 mAh = 216 Wh (may not be carried by passengers).

8. Information for the EU and Czech Market

Chapters 8 and 9 describe the situation under the law of the Czech Republic, where you purchase the product. However, the law of the country in which the product is used is decisive – if you use it in another country, follow that country's regulations (e.g. on waste management and transport).

8.1 Importer and responsible person in the EU

The product is placed on the European Union market by the importer stated below, who is at the same time the responsible person within the meaning of Article 16 of Regulation (EU) 2023/988 of the European Parliament and of the Council on general product safety (GPSR).

Importer / responsible person in the EU	Rotorama, s.r.o.
Company ID (IČO)	051 57 692
VAT ID (DIČ)	CZ05157692
Registered office	Okrajová 1351, 674 01 Třebíč, Czech Republic
E-mail	info@rotorama.cz
Phone	+420 252 252 098
Website	www.rotorama.cz

8.2 Product conformity



- The product bears the **CE** marking and complies with the requirements of the applicable European Union harmonisation legislation.
- A copy of the **EU Declaration of Conformity** is available from the importer at the address stated above or at the e-mail address info@rotorama.cz.
- **Product identification:** the manufacturer and the type designation (for cells the manufacturer's type designation; for packs the capacity and configuration, e.g. 6S2P) are given on the cell sleeve, on the battery label or on its packaging.

8.3 Disposal of batteries and accumulators



- The crossed-out wheeled bin symbol on the battery, its packaging or in the documentation means that the used battery **must not be disposed of together with mixed municipal waste**.
- Fully discharge a battery intended for disposal and cover the connector contacts with insulating tape to prevent a short circuit.
- Hand it over at a battery take-back point, at a collection yard, into a battery collection container or at the retailer. Take-back is free of charge for the end user and does not require the purchase of a new product.
- Lithium batteries contain a flammable electrolyte and compounds of lithium and other metals (e.g. nickel, cobalt and copper). Improper disposal may cause fires in collection vehicles and sorting lines and the release of substances harmful to the environment and human health.
- Correct charging, operation and storage according to this manual extend the service life of the battery and help prevent waste.
- The obligations under Act No. 542/2020 Coll., on end-of-life products, and Regulation (EU) 2023/1542 concerning batteries are fulfilled by the importer through a collective take-back system.

Through its contractual partner **ASEKOL a.s.**, the company ensures the take-back of waste electrical equipment from households and the separate collection of waste electrical equipment, batteries and accumulators in accordance with the applicable legislation. The customer is entitled to hand over old electrical equipment or a battery or accumulator at any collection point of the above contractual partner. The addresses of these take-back points are listed at www.asekol.cz, www.ecobat.cz and also <https://visoh2.mzp.cz/RegistrMistZO/RegistrMistZOPublic/MapaMistZpetOdberu>.

9. Warranty and rights arising from defective performance

9.1 Rights of the buyer under Czech law

The rights and obligations of the contracting parties are governed by Czech law, in particular by Act No. 89/2012 Coll., the Civil Code, and Act No. 634/1992 Coll., on consumer protection. The warranty terms set out below (Chapter 9.2) **do not in any way limit** the buyer's rights arising from these regulations.

- The seller is liable to the buyer for the product being free of defects on receipt. If the buyer is a consumer, a defect may be notified **within two years of receipt** of the product (Section 2165 of the Civil Code).
- If a defect appears within **one year** of receipt, the product is deemed to have been defective already at the time of receipt (Section 2161(5) of the Civil Code).
- When purchasing online, a consumer has the right to **withdraw from the contract within 14 days** of receiving the goods without giving a reason (Section 1829 of the Civil Code).
- Claims should be made with the retailer from whom you purchased the product. The importer's contact details are given in Chapter 8.1.
- The competent body for out-of-court settlement of consumer disputes is the **Czech Trade Inspection Authority**, Štěpánská 796/44, 110 00 Prague 1, www.coi.cz.

9.2 Warranty and claim terms for Li-ion batteries and cells

❖ **The following terms are set by the seller Rotorama, s.r.o.**

When making a claim for a defective battery, follow the instructions on the seller's website: www.rotorاما.cz/reklamace-a-vraceni-zbozi.

The seller provides a warranty of **24 months** on batteries. The warranty period begins on the day the consumer receives the goods. The warranty covers manufacturing defects in material and workmanship.

The warranty does not cover:

- damage caused by incorrect charging or discharging (exceeding the maximum voltage, charging current or temperature),
- damage caused by discharging below the minimum permitted voltage or by exceeding the maximum discharge current,
- mechanical damage (puncture, crushing, impact),
- damage caused by water, moisture or corrosion,
- natural wear of the cells and loss of capacity resulting from normal use,
- damage caused by using an unsuitable charger or charging program,

- batteries that have been modified, disassembled or repaired, and cells damaged by soldering or improper pack assembly,
- damage resulting from failure to follow this user manual.

To make a warranty claim, you must present proof of purchase (receipt or invoice) and deliver the defective product to the seller's address. The claim can be made in person or by sending the product to the seller's address. The seller will settle the claim within 30 days of it being made. In the case of a justified claim, the consumer is entitled to free repair, replacement of the product or a refund of the purchase price in accordance with the Civil Code (Act No. 89/2012 Coll.) and Act No. 634/1992 Coll., on consumer protection.

Never send damaged batteries and cells (dented can, damaged wrap, electrolyte leakage) via a courier or parcel service. In such a case, please contact us first by e-mail at info@rotorama.cz.

Li-ion batteries and single cells are consumable products with a limited service life. Their capacity and performance naturally decrease depending on the number of charging cycles, the way they are used and the storage conditions. A gradual loss of capacity caused by normal use is a natural property of lithium batteries and is not considered a manufacturing defect; therefore it cannot be the subject of a warranty claim.