

1S3P LTO Battery Pack with Smart BMS

Designed for Meshtastic and Outdoor Low-Power Applications

1. Overview

This 1S3P Lithium Titanate (LTO) battery pack is designed for low-power outdoor applications such as Meshtastic nodes, IoT, HAM radio setups, and DIY electronics. It features an integrated smart Battery Management System (BMS) with voltage, current, and energy measurement, along with protection features including under-voltage lockout (UVLO), over-voltage lockout (OVLO), and overcurrent protection (OC). The battery pack communicates via I²C, allowing real-time monitoring of power parameters.

This project is **partially open-source**, with public schematics, 3D model in STEP format, 3D printable enclosure, bill of materials (BOM), and firmware.

2. Features

- **Battery Chemistry:** Lithium Titanate (LTO) for an extended lifespan and extreme temperature resilience.
- **Configuration:** 1S3P (three LTO 18650 cells in parallel).
- **Nominal Voltage:** 2.4 V
- **Voltage Range:** 1.5 - 2.8 V
- **Capacity:** 3.9 Ah (1300 mAh per cell)
- **BMS Features:**
 - Overvoltage and undervoltage protection
 - Overcurrent protection
 - I2C communication for real-time battery monitoring (voltage, current, power)
 - User-upgradable firmware (UPDI programming interface)
- **Firmware:** Open-source and available on github.com/slntak/lto-bms

- **Applications:**

- Meshtastic devices
- Remote sensors and IoT
- Low-power outdoor electronics
- HAM radio setups

3. Electrical Specifications

Parameter	Value
Battery Type	Lithium Titanate (LTO)
Nominal Voltage	2.4V
Capacity	3.9Ah
Maximum Charge Voltage	2.8V
Minimum Discharge Voltage	1.5V
Continuous Discharge Current	600 mA
Peak Discharge Current	1000 mA
Recommended Charge Current	600 mA
Maximum Charge Current	1000 mA
BMS Communication	I2C (slave mode)
BMS Protection Features	UVLO, OVLO, Overcurrent

4. Protection Features

- **Overvoltage Lockout (OVLO):**
Prevents charging if voltage exceeds **2.8 V per cell**

- **Undervoltage Lockout (UVLO):** Disconnects load if voltage drops below **1.7 V per cell**
- **Overcurrent Protection:** Limits excessive current draw to prevent overheating or damage
- **Short-Circuit Protection:** Automatic cutoff in case of short circuit

5. Mechanical Specifications

- **Dimensions:** Custom triangular form factor, 83×43×40 mm
- **Connectors:**
 - **Main Power:** Screw terminal block
 - **I2C Communication:** JST-SH (1 mm) connector
- **Enclosure:** 3D printable protective casing

6. Pinout (I²C)

Pin	Function
1	GND
2	3.3 V
3	I ² C SDA
4	I ² C SCL

7. Firmware

The smart BMS firmware is open-source and hosted on [GitHub](#). It allows users to:

- Monitor real-time battery voltage, current, and energy consumption via I2C
- Configure protection thresholds and power management settings
- Update firmware via UPDI

Community contributions are welcome! Users can fork the repository and submit pull

requests to improve functionality or add features.

8. Typical Use-Case

The LTO battery pack is ideal for outdoor low-power applications such as Meshtastic nodes, remote sensing stations, and emergency communication setups. Its extreme temperature durability and long cycle life make it superior to conventional Li-ion or LiFePO4 batteries.

9. Ordering Information

- **Product Name:** 1S3P LTO Battery Pack with Smart BMS
- **Revision:** B
- **Availability:** Sold via [uart.cz store on Lectronz](#)
- **Support & Documentation:** Available at [uart.cz](#)

10. Detailed Description of the LTO

LTO batteries have lower energy density than other types, so less Ah fits into the same package. They have a lower operating voltage, a minimum of 1.5 V (some sources and manufacturers report 1.7 V), and a maximum of 2.8 V (again, you may read 2.9 V elsewhere). They support high charging and discharging currents due to their low internal resistance. This is thanks to the titanium nanostructure inside, which has a large surface area (hundreds of $\text{m}^2\cdot\text{g}^{-1}$ versus units of $\text{m}^2\cdot\text{g}^{-1}$ in Li-Ion), allowing electrons to move across the anode much faster. Another great advantage is their longer lifespan, which is stated to be up to 7000 cycles.

LTO batteries are chemically very stable, posing no risks of swelling, fires, or explosions like Li-Ion or Li-Poly cells. Some manufacturers claim that LTO can be discharged to 0 V and overcharged above 3 V without exploding or getting damaged. However, such usage would shorten the lifetime of the cell and is not recommended.

LTO are the only lithium-based cells that can be charged at temperatures around -10°C without damaging the battery or significantly shortening its lifespan. For the temperatures in Central Europe, it's an ideal type of battery for outdoor use.

11. Discharge Curve

The voltage on LTO batteries drops rapidly from 2.8 V to about 2.6 V during discharge and then decreases very slowly to 2.3 V. Once the battery is nearly discharged, the voltage plummets from 2.3 to below 1.7 V, even with a small load.

With a larger load (faster discharge), the curve is similar but slightly lower (about 0.3 V lower at 1C and 0.5 V lower at 5C), and the sharp drop in the nearly discharged state begins sooner.

12. Photos of the BMS PCB



