DinDrones.com

DinBox User Manual

Revision	Date	Author	Description
0.1	28 Aug 2023	Din	Initial draft

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1. Overview

DinBox is a field charging solution designed for RC enthusiasts who require independence, efficiency, and mobility. It contains 56 x 5000mAh 21700 cells, forming a 4s14p battery capable of charging 32 x 1400mAh 6s or 34 x 1300mAh 6s batteries from 0 to 100%. In real-life terms, this means it can charge approximately 40-50 batteries, as fully discharging batteries to 0% is detrimental.

DinBox is controlled by a Bluetooth BMS that enables users to monitor the current charge/discharge status, cell voltage, set cutoff voltage, and power off the battery. The BMS will automatically detect overheating during charge/discharge, overcurrent protection (limited to 40A), and will shut down in case of overvoltage (above 16.8V) or undervoltage (below 11V).

Each 21700 cell is individually fused, similar to Tesla's design. In the event of a cell failure, the fuse will burn out, isolating the faulty cell from the system. This can be easily identified by inspecting the box's PCB, and the cell can be replaced, and the fuse can be fixed within minutes.

One of the standout features of the latest DinBox generation is its portability: the cells can be easily removed from the enclosure and stored in your carry-on baggage (individual plastic cases are highly recommended). TSA imposes a capacity limit of 100Wh per battery, but there is no restriction on the quantity of batteries with less than 100Wh that can be carried on board.

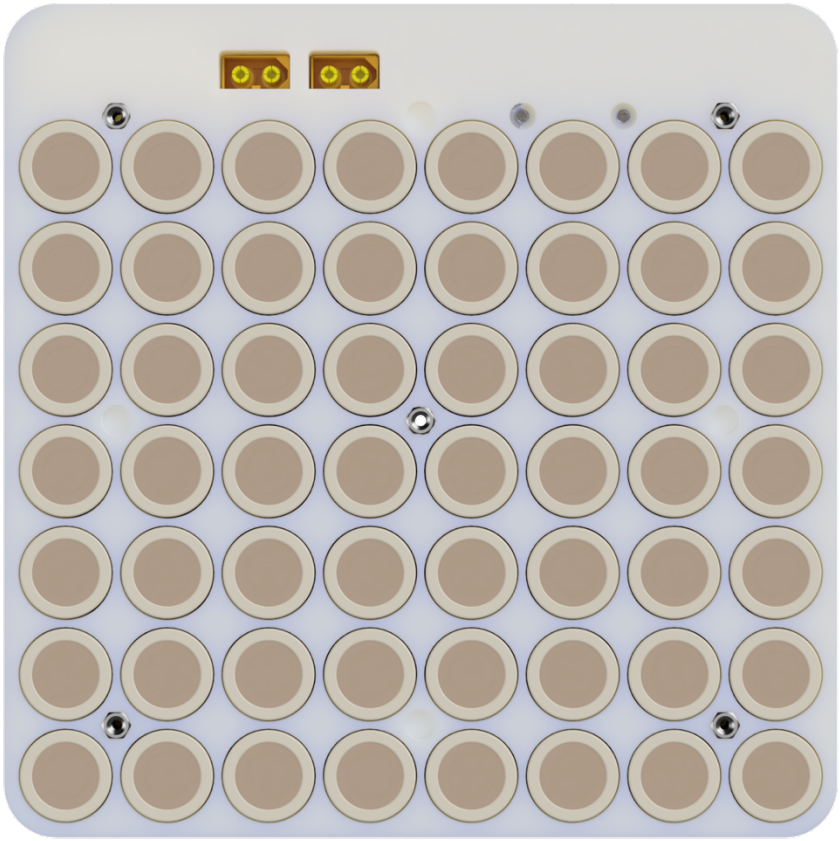
2. Disassembly

a) Front lid

DinBox has lids on both sides, but only one has black and stainless steel screws, which is our front lid. Please do not remove the other lid with all-black screws. Also, avoid unscrewing the black countersunk screws, as they secure the PCB.

To properly disassemble the DinBox, you need to remove 5 x stainless steel screws on the working side and gently lift the lid evenly from all sides.

b) Removing cells



Cells should be inserted into the box with the positive side down and the negative side up, as shown in the picture above. Alternatively, you can remember that the PCB springs should always touch the flat side of the cell.

Once you've removed the front lid, you can flip the box over and remove the cells.

You may reinstall the lid to ensure that the screws are not lost.

3. Traveling

It is highly advisable to obtain TSA Precheck if you plan to travel across the USA. With TSA Precheck, you won't need to open your bags, and you're less likely to engage in conversations about carrying LiPo batteries.

If you do need to transport Lithium batteries, TSA has specific rules:

1. Lithium batteries with more than 100 watt hours
   DinBox, when fully assembled, has a capacity of approximately 1 kWh, making it prohibited for air travel. However, when disassembled into individual cells, each cell has a capacity of 18Wh, and the following rule applies:
2. Lithium batteries with 100 watt hours or less in a device
   This rule refers to the PackSafe FAA Regulation, which stipulates the following:
   - **Carry on**: Batteries must be carried in carry-on baggage only ✅
   - **Size limits**: batteries are limited to a rating of 100 watt hours (Wh) per battery ✅
   - **Quantity limits**: None for most batteries — but batteries must be for use by the passenger. Batteries carried for further sale or distribution (vendor samples, etc.) are prohibited. There is a limit of two spare batteries per person for the larger lithium ion batteries described above (101–160 watt hours per battery) ✅
   - **Batteries must be protected from damage**: Battery terminals (usually the ends) must be protected from short circuit (i.e., the terminals must not come in contact with other metal). Methods include: leaving the batteries in their retail packaging, covering battery terminals with tape, using a battery case, using a battery sleeve in a camera bag, or putting them snugly in a plastic bag or protective pouch ✅

The last point about protection is crucial. It is highly recommended to use plastic cases for 21700 cells and store them in a LiPo bag for quick inspection.

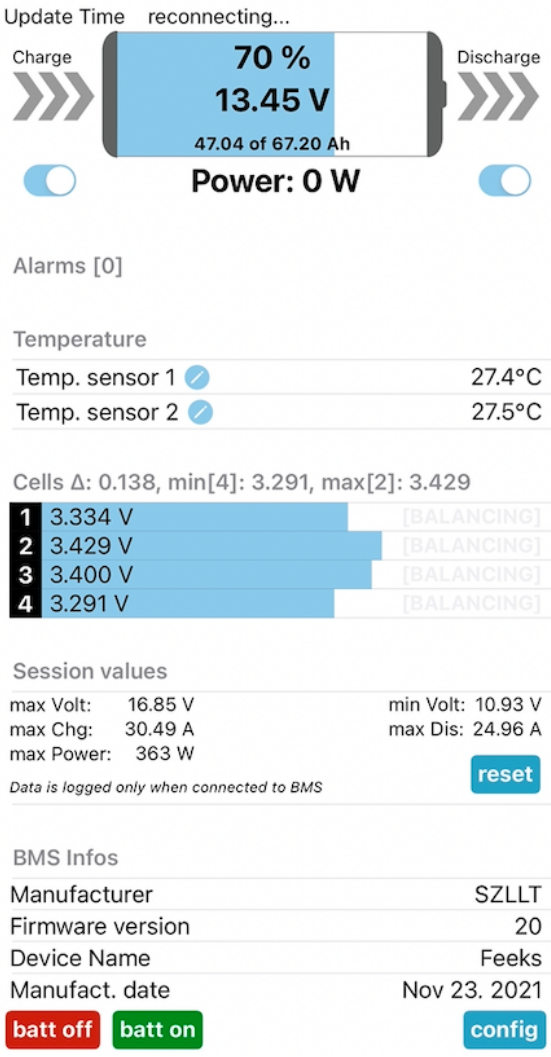
Plastic cases can be found here: https://dindrones.com/products/21700-battery-protective-case-28pcs Or any other retail store.

FPV bag that will perfectly fit DinBox battery inside is: https://www.team-blacksheep.com/products/prod:ethix_txbagv2

4. Bluetooth Smart BMS

When properly assembled, the internal BMS is powered on and can be visible through the app.
Apple Store: https://apps.apple.com/us/app/xiaoxiang-bms/id1375405426
Google Play: https://play.google.com/store/apps/details?id=com.jiabaida.bms

The iOS version is read-only, which is sufficient for viewing voltage, cell balancing, and troubleshooting situations when the BMS locks the FETs. I do not recommend purchasing the Pro version, as all the parameters have been configured to best suit the needs of a field charger.



Once you've downloaded the app and assembled the DinBox, it will appear in the list of devices. At the top of the screen, you can observe charge/discharge arrows, battery capacity, voltage, and power:

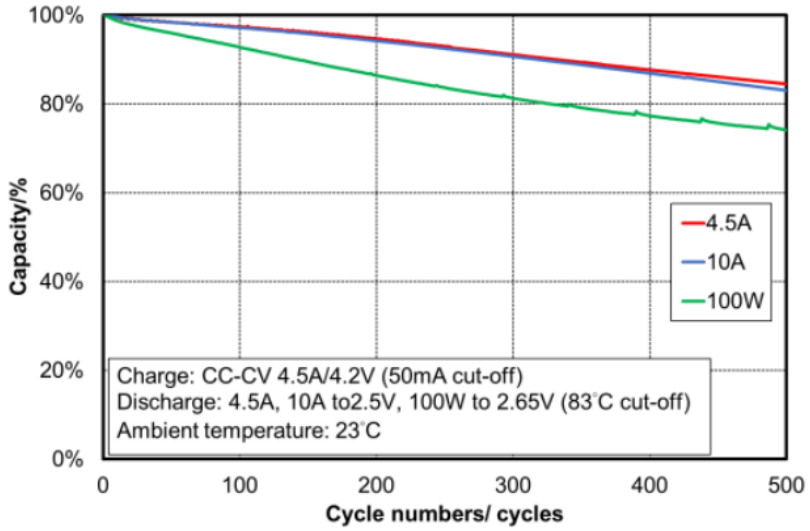
- Charge/discharge will display the amount of amperage flowing into or out of the battery. You can charge and discharge simultaneously, and it will show you the difference between the two.
- Capacity and voltage are interdependent because the BMS does not have information about cell characteristics or the number of cells connected in parallel. It can only provide an approximate total capacity. The higher the load on the battery pack, the more voltage sag you will observe, resulting in lower displayed voltage.
- Power indicates the amount of watts being supplied to or drawn from the battery.
- The BMS includes two temperature sensors: one inside the BMS and one external sensor placed in the hottest part of the DinBox. If either of these sensors exceeds 65C, the BMS will shut down until the temperature drops to 55C.
- DinBox is a 4s14p battery, and BMS can detect it as 4 batteries connected in series, displaying individual voltages for the 14 parallel cells. A deviation of up to 0.2V between cells is normal and will be balanced over time during charging.

The configuration tab of the app (iOS) allows you to change displayed capacity, cell characteristics, and various protections (overvoltage, overcurrent, overtemperature, undervoltage, etc.).

5. Charging / discharging / storage

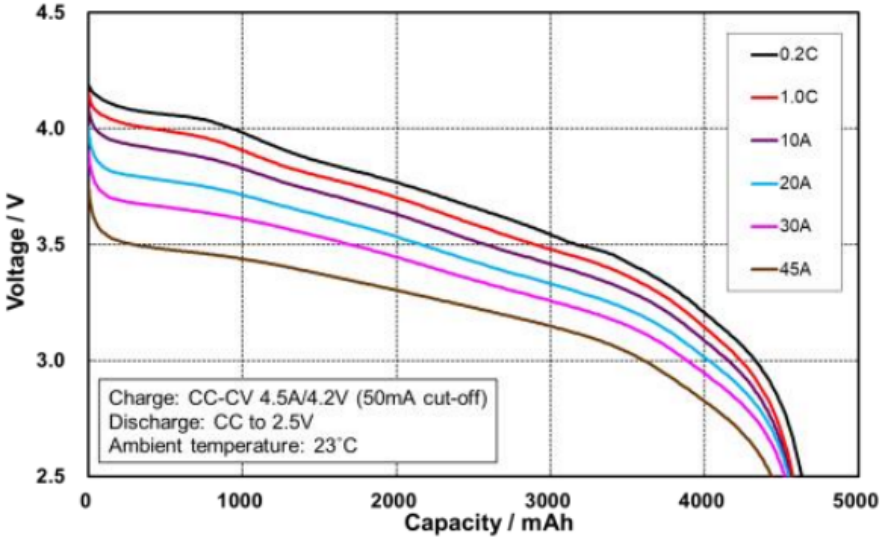
You can treat DinBox as a huge 4s battery without balance leads. Set your charger to 4s LiPo / LiIon battery (16.8v) and charge up to 28A for fast charging, and 14A for standard charging. Balancing will be taken care by internal BMS. Standard charge time is 3 hours.

Cycle characteristics:



The graph is taken from Molicel INR-21700-P45B 4500mah datasheet and represents how charge/discharge ratio can impact LiIon battery capacity over time. In our case, it means that by maintaining 14A charge/discharge, DinBox will keep 85% of its capacity after 500 cycles. Which will happen after 10 years of usage if you use it once a week (500 cycles / 52 weeks = ~10 years).

Discharge rate characteristics:



The cutoff voltage in DinBox is set to 11V (2.75V per cell), striking a balance between extracting maximum energy from each cell and preventing structural damage by avoiding discharge below 10v (2.5V per cell). The graph above, featuring the Molicel INR-21700-P45B 4500mAh cell, illustrates voltage sag under varying loads and the corresponding capacity changes with voltage fluctuations.

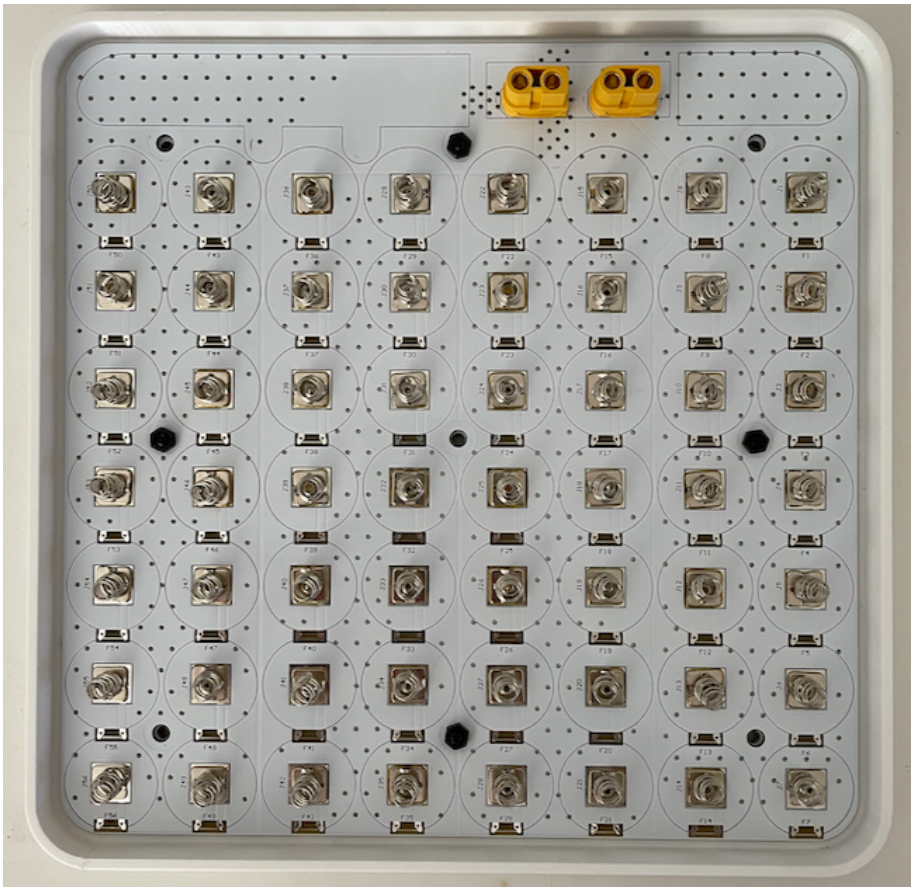
The key takeaway is that between 2.75V (BMS cutoff) and 2.5V (cell cutoff), there's likely only about 2-3% of overall capacity remaining, which isn't worth risking cell damage for. It also highlights that the range between 3.4V and 4.0V offers the most usable capacity of the cell. Therefore, it's important to understand that your battery won't last the same amount of time when operating between 12V-14V and 14V-16.8V.

Storage: Nominal cell voltage of Samsung 50E 21700 5000mAh, currently used in DinBox, is 3.6V. Please keep the DinBox charged at 14.4V if you plan to storage it for a long period of time.

6. Troubleshooting

a) PCB inspection

It is recommended to periodically inspect DinBox for “bad cells”, that lost their capacity and could potentially cause fire. Due to safety mechanism implemented at the PCB level, the risk of fire is minimized.



To be replaced with rendered model.

On the back side of the front lid, you can see very thin traces (fuses), capable of 8-10A throughput, which burn in case of overcurrent accident / wrong assembly / different cell voltage.

You can inspect those fuses closely and see if any of them have a sign of damage. In case you find one, please reach out to: din@dindrones.com Don’t try to fix it yourself.

b) XT60 leads have no power

You can use the app to see if there are any alarms on the main screen:

- Mosfet software locked – BMS has locked the battery. Press the green “batt on” button.
- Cell undervoltage – the load was too high, and most likely cell voltage went below the threshold.
- Cell overtemperature – check the temperature sensors. Possible reasons:
    - ambient temperature too high,
    - direct sunlight is warming up the battery
    - continuous load is too high