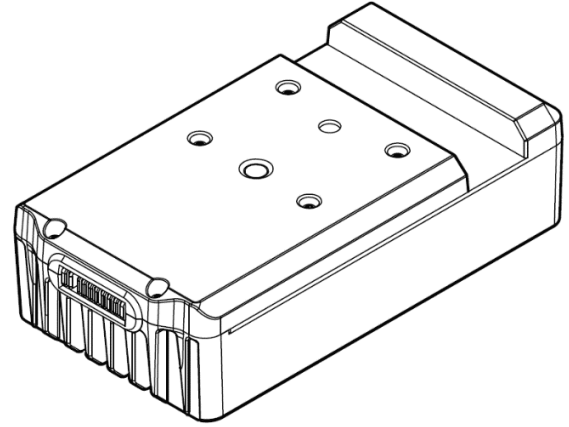


BA30 LiPo Battery

KEY FEATURES

- 33V 1Ah LiPo battery pack with integrated battery management system (BMS)
- High discharge rate cells, perfect for high-pulse robotics applications
- Can be used with the Dephy ExoBoot, or in your own project
- Safety first: built-in safeties to prevent over-charging, over-discharging, and maintain cell balance
- An integrated BMS maintains cell health and enables hundreds of charge / discharge cycles



CERTIFICATIONS AND COMPLIANCE

- UN38.3: Ensures batteries are safe for transportation
- This device complies with Part 15 of the FCC Rules.
- CAN ICES-003(B) / NMB-003(B)
- Compliance information continues on page 7

TABLE 1. SPECIFICATIONS

Chemistry	Lithium Polymer (LiPo)
Cell configuration	9-series, 1-parallel (9S1P)
Nominal voltage	33.3V
Capacity¹	1000 mAh (theoretical) Min 875 mAh (practical)
Charge/discharge cycles	Minimum 300 (5% capacity drop)
Self-Discharge Rate	Up to 240 days
Battery Management System (BMS)	Hardware: CBMS 9S 1.1 Firmware: 20200821-BMS-bms_9S_1.1
Status Indicator	3-color LED on BMS (Green, Yellow, and Red)
Recommended Max. Current	10A
Absolute Max. Ccurrent (OCD)	17.8A for 320ms ²
Short-Circuit Current (SCD)	35.6A for 200µs ²
Undervoltage	3.0V/cell (software) 2.9V/cell (hardware)
Hardware Protection Layer	20A Slow-Blow fuse + TVS
Thermal Protection	65°C on one or more of the sensors (2x Cell, 1x PCB)
Connector	Blade Connector (8 pins)
Charger	CCCV 37.8V and 1A, supplied by Dephy. Do NOT use a non-Dephy charger.

Other Feature	Protected UART Bootloader External Boot/Nap
Mass	263 g
Size	62.2 mm x 31.9mm x 117.9mm
Certifications & Compliance	UN38.3, FCC Part 15, ICES-003

¹ Capacity: measured at 1A constant current discharge, 25C ambient temperature

² Accuracy of the time limit and current is ±20%. OCD and SCD limits tested on either side of 10% I2t limit to confirm safety transitions.

LED COLORS AND SPEED

The battery management system (BMS) has three LEDs: Green, Yellow, and Red. Three different blinking patterns are used for different conditions. The Rainbow Pattern is a special case; the LED color will change every blink.

In some states more than one LED will be used, either at the same time or in alternance.

Blinking Speed	On time	Period	Duty Cycle
Slow	25ms	3s	0.83%
Fast	25ms	650ms	3.85%
Very fast	50ms	250ms	20.00%
Rainbow pattern	50ms	750ms	6.67%

GAS GAUGE

The **gas gauge** is our battery charge level indicator. It is active during the IDLE and DISCHARGE modes. During charging similar patterns are used, but the thresholds are different.

Cell Voltage	Stack Voltage (9S)	Indicator
> 3.78V	> 34.00V	Green ●
3.64V - 3.78V	32.75 - 34.00V	Yellow ●
< 3.64V	< 32.75V	Red ●

FIGURE 1: BATTERY DIMENSIONS

[Download STEP/STL](#) ↓

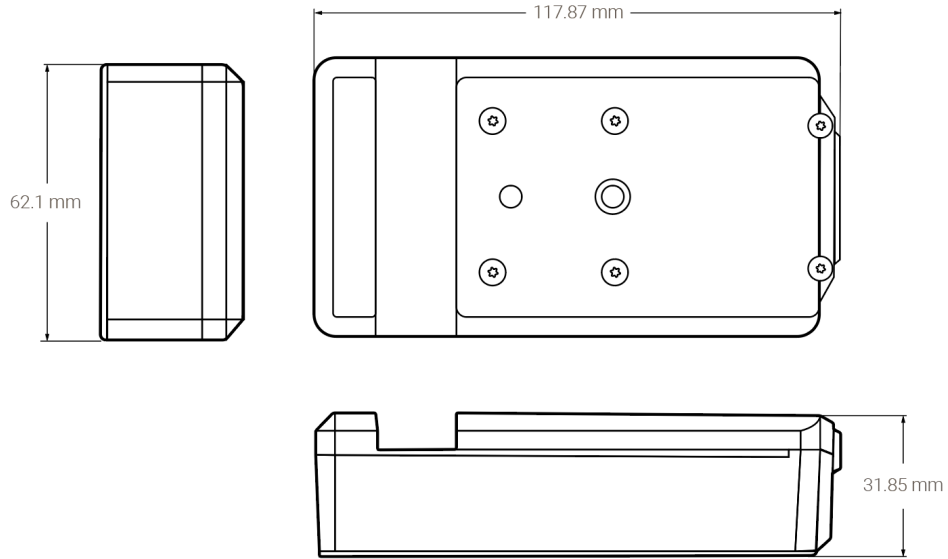
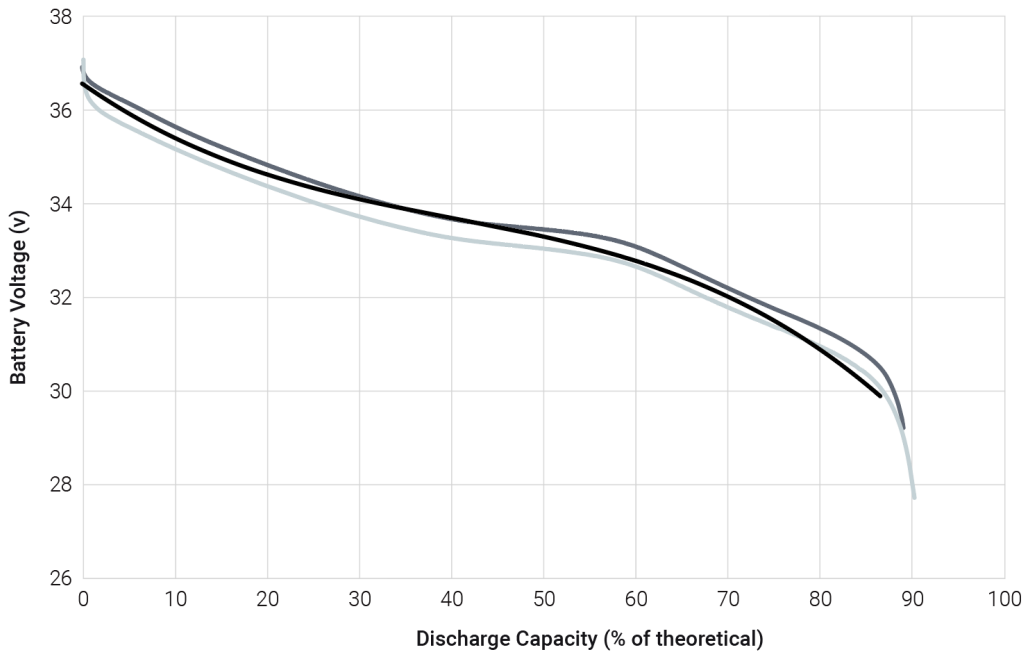


FIGURE 2: DISCHARGE CURVES



- 1 A CC
- 2 A CC
- Pulsed

Notes:

All curves are obtained by discharging a fully charged BA30 battery with a programmable load. The discharge ends when the BMS cuts the output off (based on the lowest cell).

The curves should be used as a reference only (logged on 1 particular unit, not aggregated from tens or hundred of units).











Explanation for the three curves:

- **1A:** constant current, 1A.
- **2A:** constant current, 2A.
- **Pulsed:** 10A for 100ms, 250mA for 900ms. This 10% duty cycle is representative of typical walking robot applications.




TECHNICAL DETAILS

- **Make sure to read and understand the Battery Safe Use Guide (next section).**
- **Pack capacity:** theory vs practice. The cells we use are rated for 1000mAh. Following market conventions, we are rating the pack at 1Ah. In practice, our BMS is stopping the discharge before the limit to ensure safety and longevity.
 - One way we do this is by selecting a higher cut-off voltage (3V/cell)
 - A second way is to use the lowest cell voltage instead of the average pack voltage
- **Output Voltage vs. State of Charge:** Charging and discharging limits are based on the highest and lowest cell voltages. A pack may read 28V just before turning off (instead of 27V) if one cell is significantly lower than the others.
- **Self-discharge:** any BMS will draw some current. Our design will take up to 240 days to fully discharge a pack. If this happens, the pack will enter Nap Mode and will not be damaged. To use the battery, take it out of Nap Mode and charge it immediately.
- **Long Term Storage** Batteries that will not be used for more than two months should be 50% charged, then put in Nap Mode. We recommend storing them in a LiPo bag.
- **Maximizing capacity:** leave the battery on the charger for longer. After the cells are charged they will get balanced. Charging for an extra 15 or 30 minutes will lead to a more balanced pack, and typically that leads to a longer discharge time.
- **Automatic Nap:** In the condition that the battery pack voltage has dropped below an acceptable threshold, the device will switch to Nap Mode. In this mode, the resting current draw is reduced to essentially 0 μ A to protect the battery cells.
- **To exit Nap Mode:**
 1. Connect the BA30 to a Smart Dock
 2. Press the button (briefly)
 3. The BA30 LED will show the rainbow pattern
 4. Charge the battery immediately
- **To Enter Nap Mode:**
 1. Connect the BA30 to a Smart Dock
 2. Press the button 3 times. The Smart Dock LED will pulse Red. The BA30 LED will pulse Green, then be Steady Red for a brief moment.
 3. All LEDs will turn OFF, the battery is now napping indefinitely.
- **End of charge:** at the end of a charge cycle the battery will enter the CHARGING_COMPLETE state (Green LED, steady ON). After some time, the battery will transition to a lower power mode, IDLE (Green, slow blinking). Both LED patterns indicate that a full charge has been completed.

BMS STATES AND BEHAVIORS = TYPICAL USAGE

Mode	LED Pattern	Details
IDLE	Gas Gauge, Slow Blinking 	No charger and no load (ex. pack sitting on a table)
CONDITIONING	Rainbow Pattern 	After the battery is programmed or taken out of Nap Mode, it executes a conditioning routine, essentially a long balancing period (up to 6 hrs).
IDLE_BALANCING	Yellow & Green, Very Fast Blinking 	Near the end of the charging cycle, we balance without charging. This is on a 2-min. timer. Expect your pack to oscillate between this and BMS_CHARGING_FINAL.
CHARGING_START	Red, Fast Blinking 	Bulk charging, no balancing. Stays here until one cell reaches 3.75 V, then it transitions to BMS_CHARGING_BALANCING.
CHARGING_BALANCING	Yellow, Fast Blinking 	Charging while balancing. Stays here until one cell reaches 4.2 V, then it transitions to BMS_CHARGING_FINAL.
CHARGING_FINALIZING	Green, Fast Blinking 	Used in conjunction with IDLE_BALANCING. If the highest cell is lower than 4.2V we keep the charger connected and we balance. If not, IDLE_BALANCING will lower the voltage. If the pack is fully charged and balanced it will transition to CHARGING_COMPLETE.
CHARGING_COMPLETE	Green, Steady ON 	The battery is fully charged and ready to be removed from the charger. After some time in this mode the battery may transition to IDLE.
BMS_DISCHARGING	Gas Gauge, Fast Blinking 	Allows discharging as long as the lowest cell is above 3 V.
BMS_SHUTDOWN	Red, Very Fast Blinking 	A problem was detected. Pack output and input are disabled, the battery can't be charged or discharged. If the fault is removed, it will eventually timeout and go back to BMS_IDLE. Period depends on the fault. The GUI can connect. Special Case: During the transition from short-circuit detection to shut down, the LED might be solid red; it should not remain solid red for more than 2 seconds.
BMS_NAP	All LEDs OFF 	Nap Mode is triggered when the cells are discharged below an acceptable level. The BMS will not be powered; no firmware will be running, the pack output will be disconnected, the GUI will not be able to connect. A boot signal is required to wake up the pack.

BMS STATES AND BEHAVIORS—SPECIAL CASES

Mode	LED Pattern	Details
BUTTON_PRESSED	Green, Steady ON 	When the Smart Dock's button is pressed the LED will turn ON for as long as the button is pressed.
ENTERING_NAP_MODE	Red, Steady ON, then All OFF 	After the button sequence has been received.
BOOTLOADER	All Steady ON, then All Slow Blinking 	The bootloader connects to the BMS.

SAFETY INFORMATION

The BA30 is intended for use by academic and industrial researchers in a controlled environment. For general product safety information please refer to <https://dephy.com/safety>.

- Do not disassemble battery
- Do not puncture battery
- Do not drop battery
- Avoid placing battery packs on surfaces higher than 2.5 meters to avoid drops
- Inspect any dropped battery for cracks; remove any battery with visible damage from service
- Remove any battery dropped for more than 1.2 meters from service
- Do not submerge battery in any liquids
- Do not short the output of the battery
- Do not leave the battery in direct sunlight for extended periods.
- Only charge and discharge battery between 10°Celsius and 45°Celsius
- Inspect BA30 terminals before use to ensure connector integrity
- Inspect BA30 terminals before use and remove any debris (using a non-conductive tool)
- Only use Dephy chargers and accessories (Smart Dock, Receptacle)
- Only use battery with BA30 Receptacle or Dephy product (ex.: EB60) to prevent connector damage
- Do not leave charging batteries unattended for longer than 1.5 hours
- Contact Dephy if a battery does not exit Nap mode after the wake up procedure
- Do not use battery outside of the operating conditions listed in the specifications
- Place batteries stored for more than two months in Nap Mode, after charging them to 50%
- A LiPo safe bag is provided in the event that your battery becomes damaged. Best practice is to store any unused LiPo batteries in a LiPo bag until ready for use.
- Dephy batteries are designed with several safety features to minimize the risks of creating hazardous conditions. One safety mechanism is the venting of gasses in the event of an internal short within the battery cells. The gas released by a venting Li-ion cell is mainly carbon dioxide (CO₂). Other gases that form through heating may contain vaporized electrolyte consisting of hydrogen fluoride (HF), and phosphoryl fluoride (POF₃), combustion products and organic solvents¹ In the event of a battery vent occurrence:
 - Disconnect any charger or load
 - Place battery in a LiPo safe bag or similar container and move battery to an area with good ventilation
 - Ventilate the room and vacate area if smoke and gases are present
- A fire involving Dephy products, including LiPo batteries can be handled like any other combustible fire. For best results use a foam extinguisher, CO₂, ABC dry chemical, powdered graphite, copper powder or soda (sodium carbonate).
- If a semi sweet smell is detected emanating from the battery, place the unit in LiPo safe bag and contact Dephy.
- Contact Dephy for appropriate shipping directives before returning a defective or damaged battery

¹For more information, please refer to https://batteryuniversity.com/learn/article/safety_concerns_with_li_ion

ACCESSORIES

- BA30 Smart Dock
- Battery Charger
- BA30 Battery Receptacle
- Dephy Plan GUI

COMPLIANCE

- FCC

Supplier's Declaration of Conformity
47 CFR § 2.1077 Compliance Information

Unique Identifier: BA30 LiPO Battery


Responsible Party – U.S. Contact Information

Dephy, Inc.
63 Great Road
Suite 204
Maynard, MA 01754
admin@dephy.com

FCC Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Date	April 29, 2021
Revision	C_0002_DS_0001_V03_BA30DATA
Created by	JF Duval
Reviewed by	Matt Mooney
Approved by	Luke Mooney  <small>Luke Mooney (Apr 29, 2021 16:46 EDT)</small>
Purpose	Datasheet for the BA30 LiPo Battery that has been reviewed and approved for release





C_0002_DS_0001_V03_BA30DATA

Final Audit Report

2021-04-29

Created:	2021-04-29
By:	Matt Mooney (mmooney@dephy.com)
Status:	Signed
Transaction ID:	CBJCHBCAABAAQyf2Lc6e8KULDnn0GEe4dRHZoJ7AKta8

"C_0002_DS_0001_V03_BA30DATA" History

-  Document created by Matt Mooney (mmooney@dephy.com)
2021-04-29 - 7:33:51 PM GMT- IP address: 73.69.178.3
-  Document emailed to Luke Mooney (lmooney@dephy.com) for signature
2021-04-29 - 7:34:26 PM GMT
-  Email viewed by Luke Mooney (lmooney@dephy.com)
2021-04-29 - 8:45:35 PM GMT- IP address: 66.102.8.90
-  Document e-signed by Luke Mooney (lmooney@dephy.com)
Signature Date: 2021-04-29 - 8:46:13 PM GMT - Time Source: server- IP address: 73.69.178.3
-  Agreement completed.
2021-04-29 - 8:46:13 PM GMT