# NanoPower
# BP8

# Datasheet

**Datasheet for the NanoPower BP8 battery pack**

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# List of Abbreviations

**CAN** Controller Area Network.

**CSP** Cubesat Space Protocol.

**GOSH** GomSpace Shell.

**I2C** Inter-Integrated Circuit.

**MCU** microcontroller unit.

**OVLO** Overvoltage lockout.

**UART** Universal Asynchronous Receiver/Transmitter.

**UVLO** Undervoltage lockout.

# 1 Introduction

## 1.1 Overview

The NanoPower BP8 is a high-capacity (8S1P) lithium-ion battery pack with integrated protection system, cell balancing, cell fault detection and heating system. Two BP8 battery packs can be coupled in parallel using the two on-board connectors, to increase the capacity of the battery string. Please refer to the NanoPower BP8 manual [1].

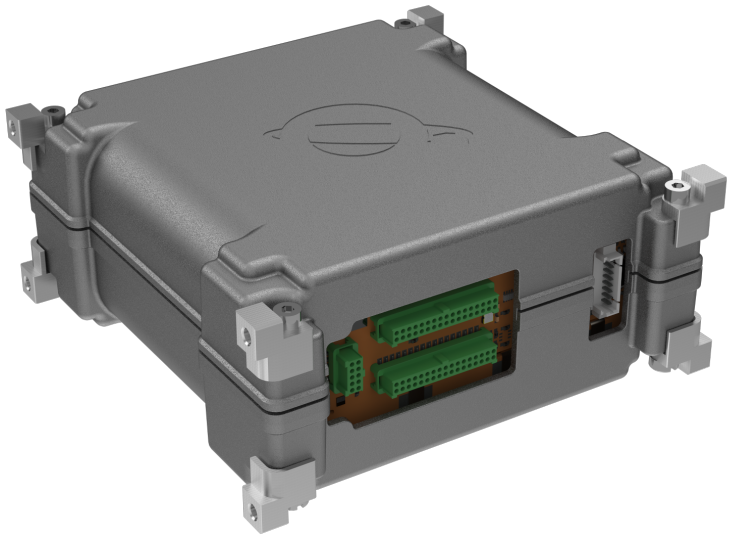

**Figure 1.1:** The NanoPower BP8

## 1.2 Highlighted features

- Lithium-ion battery pack for space applications
- 8S1P configuration with nominal capacity of 3000 mA h per cell (2100 mA h usable)
- Nominal capacity of 86.4 W h (60.4 W h usable)
- Charge and discharge current of 4 A per battery pack
- Multiple battery packs can be connected in parallel
- Battery current, voltage and temperature measurement
- Over- and undervoltage protection
- Overcurrent protection
- State of Charge estimation
- Cell balancing for battery longevity
- Cell monitoring for bad cell detection
- Autonomous/manual heating system
- Battery pack cut-out (passivation) system
- CAN and I2C communication using Cubesat Space Protocol (CSP)

## 1.3 Functional description

An overview of the BP8's features are shown in the block diagram below, see Figure 1.2.

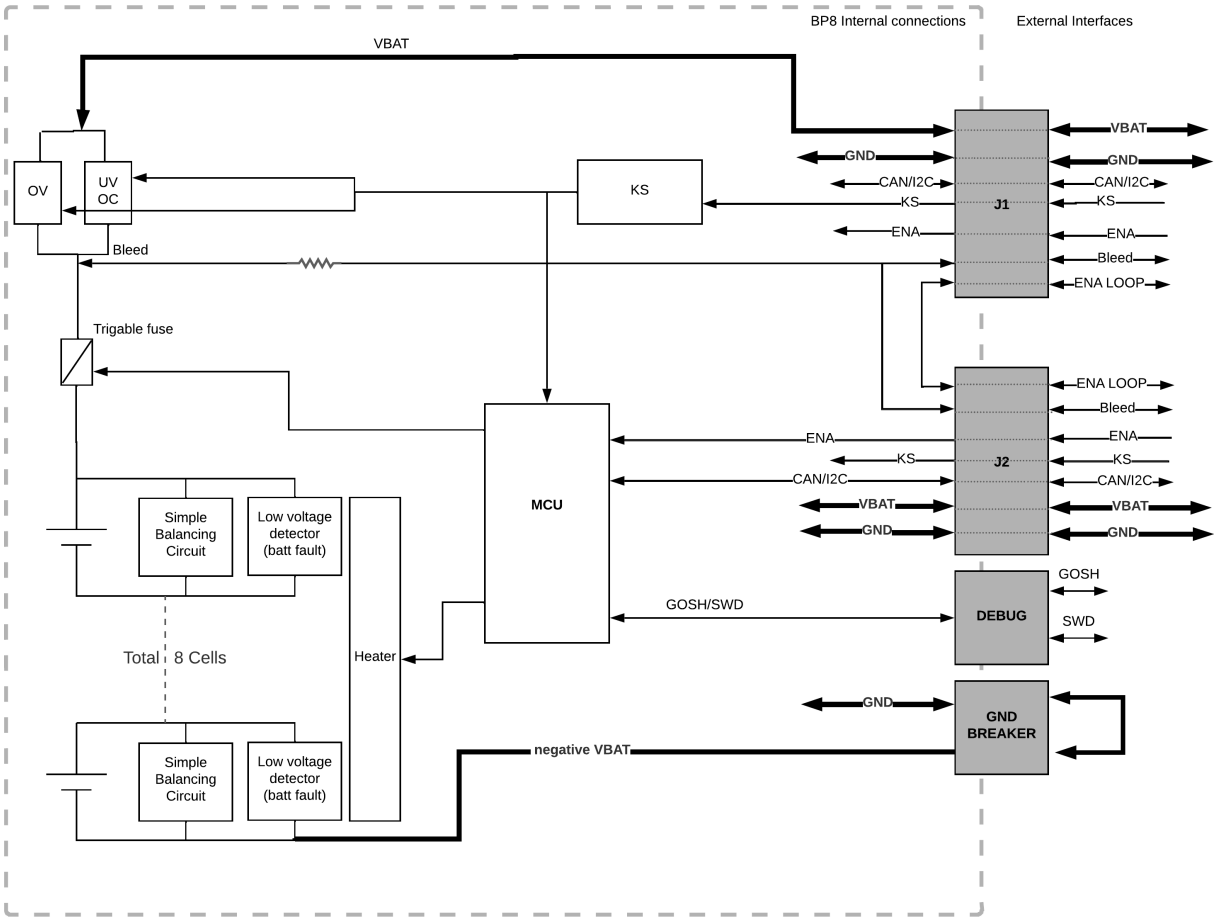


**Figure 1.2:** NanoPower BP8 functional block diagram

### 1.3.1 Hardware interfaces

Three physical data interfaces are supported by the BP8, this being:

- Controller Area Network (CAN)
- Inter-Integrated Circuit (I2C)
- Universal Asynchronous Receiver/Transmitter (UART)

The UART interface is only used for debugging and setup, while the CAN and I2C is used for integration. The CSP protocol is used to interface with CAN and I2C, while GOSH is used for debugging over UART, please refer to the BP8 manual [1] for further details.

**NOTE:** CSP over I2C requires multi-master support.

### 1.3.2 Killswitch functionality

The Kill Switch (KS) signal disables the VBAT output (battery voltage) and shuts off the BP8 MCU. This ensures that no current can go in or out of the BP8. The KS-signal is active LOW and must be connected to an open drain output with an output impedance that is greater than 500 kΩ. The BP8 will pull up the KS-signal to VBAT through a high impedance (1.6 MΩ). To activate the killswitch the KS-signal must be pulled to system GND. The kill-switch is labeled “KILL_SW” in the pinout table.

### 1.3.3 Enable functionality

The enable (ENA) signal will enable the BP8 MCU when pulled to GND (ENA is active low). The BP8’s internal 560 kΩ pull-up will pull up the ENA-signal to 3.3 V.

### 1.3.4 Bleed functionality

The bleed pin is intended to keep multiple parallel BP8 packs balanced, allowing a small current to run between packs when killswitched. The bleed pin is connected to VBAT through a large resistance, allowing a maximum current of 0.5 mA.

### 1.3.5 Battery protection system

The BP8 incorporates multiple protection circuits, to protect the battery pack:

- Overvoltage lockout (OVLO) disconnects the charge path, but keeps the discharge path open.
- Undervoltage lockout (UVLO) disconnects the discharge path, but keeps the charge path open.
- Overcurrent protection disconnects the discharge path when the discharge current is too high, while the charge path is still active.

Besides these, cell preservation using balancing and thermal management is done autonomously, while cell condition and overall battery health are monitored and available through telemetry.

> ⚠ **CAUTION:** Over- and undervoltage protection cannot protect against battery cell self-dischage. Always charge battery before storage, please refer to the manual [1].

> ⚠ **WARNING:** During undervoltage lockout, the battery’s internal protection logic consumes power as defined in Table 2.2. If the voltage drops below 11.5 V the battery can become unrecoverable due to permanent cell damage. Charge within 48 hours during an undervoltage event to prevent damage.

### 1.3.6 Battery decommission

In the case of a permanent cell fault in a satellite with more packs in parallel, the operator can cut out the battery pack, which has the faulty cell to prolong the life of the satellite. In addition, the functionality is utilized as a part of the decommissioning phase. Please refer to BP8 manual [1] for further details regarding this functionality.

# 2 Specifications

## 2.1 Absolute maximum

Stresses at or beyond those given in Table 2.1 may cause permanent damage and affect the reliability of the NanoPower BP8.

**Table 2.1:** Absolute maximum specifications

| Parameter | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| $V_{BAT}$ | Battery voltage | 19.5 | | 33.6 | V |
| $T_{OP}$ | Operating temperature | −10.0 | | 50.0 | °C |

## 2.2 Electrical

The electrical specifications are givin in Table 2.2.

**Table 2.2:** Electrical specifications

| Parameter | | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{BAT}$ | Operating voltage | | 23.6 | 28.8 | 32.0 | V |
| $E_{BAT}$ | Usable power capacity | | | 60.4 | | W h |
| $V_{CHG}$ | Charging voltage | | | | 32.0 | V |
| $I_{OUT}$ | Discharge current | | | | 4.0 | A |
| $I_{CHG}$ | Charge current | | | | 4.0 | A |
| $I_{OC}$ | Overcurrent protection | | 4.8 | 5.0 | 5.2 | A |
| $I_S$ | Standby current usage | $V_{BAT} = 32\,V$, ENA active, KS inactive<br>$V_{BAT} = 32\,V$, ENA inactive, KS active | 2.5<br>0.09 | 4.0<br>0.1 | 4.5<br>0.15 | mA |
| $I_{UV}$ | Standby current at UVLO | $V_{BAT} = 19.5\,V$, ENA inactive, KS inactive | | 1.5 | | mA |
| $I_{SQ}$ | Self-discharge [1] | Ground breaker disconnected | | 30 | | µA |
| $P_H$ | Heater power usage | | | 6.0 | | W |
| $V_L$ | ENA logic low voltage | | 0 | | 0.6 | V |
| $V_{OV}$ | Overvoltage lockout | Activate<br>Release | 33.1<br>31.2 | 33.3<br>31.3 | 33.6<br>31.6 | V |
| $V_{UV}$ | Undervoltage lockout | Activate<br>Release | 19.3<br>21.0 | 19.5<br>21.5 | 19.8<br>21.7 | V |

Continued on next page

**Table 2.2:** Electrical specifications (Continued)

| Parameter | | Condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{TH}$ | Cell balance threshold | Activate | | 4.085 | | V |
| | | Release | | 3.975 | | |

[1] The current $I_{SQ}$ is for electronics only, please refer to the cell datasheet [2] for battery self-discharge.

# 3 Hardware layout

The connector positions and pinouts are covered in this chapter. Figure 3.1 illustrates the connector positions on BP8.

| Designator | Description | Part No. |
|---|---|---|
| J1 | Main battery connector | G125-FS13405L0R |
| J2 | Secondary battery connector | G125-FS13405L0R |
| J3 | Ground breaker connector | G125-FS11005L0R |
| J5 | GOSH connector for configuration | Picoblade 53398-0871 |

**Table 3.1:** Overview of connectors function and type

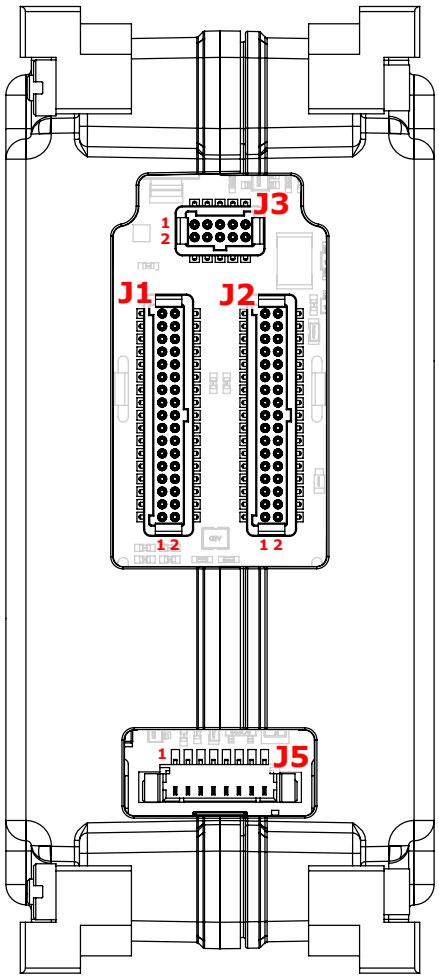


**Figure 3.1:** Placement of connector J1, J2, J3 and J5

⚠ **CAUTION:** It must be noted that pin numbering arrangement of Figure 3.1 differ from the pin numbering arrangement given by Harwin. Special care must be taken when making and assembling harnesses.

## 3.1 J1, J2 - Battery connectors

Table 3.2 shows the pinout of J1 and J2.

**Table 3.2:** Pinout of battery connector J1 and J2

| Pin | Description | Pin | Description |
|---|---|---|---|
| 1 | SDA | 2 | CANH |
| 3 | GND | 4 | CANL |
| 5 | SCL | 6 | GND |
| 7 | ENA_LOOP | 8 | GND |
| 9 | ENA | 10 | GND |
| 11 | BLEED | 12 | KILL_SW |
| 13 | GND | 14 | GND |
| 15 | GND | 16 | GND |
| 17 | GND | 18 | GND |
| 19 | GND | 20 | GND |
| 21 | GND | 22 | GND |
| 23 | NC | 24 | NC |
| 25 | VBAT | 26 | VBAT |
| 27 | VBAT | 28 | VBAT |
| 29 | VBAT | 30 | VBAT |
| 31 | VBAT | 32 | VBAT |
| 33 | VBAT | 34 | VBAT |

**ENA:** Enable pin (active low). Powers on the onboard microcontroller unit (MCU), allowing telemetry and control.

**ENA_LOOP:** Connects J1 pin 7 to J2 pin 7, see Figure 3.2. Only relevant in multi-pack setups.

**BLEED:** Bleed pin. Allows a low current to flow between killswitched BP8's to balance voltage levels. Only relevant in multi-pack setups.

**KILL_SW:** Killswitch input (active low). Disconnects the VBAT output and powers off the MCU.

**SDA:** Data line for the I2C bus.

**SCL:** Clock line for the I2C bus.

**CANH:** High signal for the CAN bus.

**CANL:** Low signal for the CAN bus.

**VBAT:** Positive battery voltage output. Use to charge and discharge battery.

**GND:** Negative battery voltage output. Use as system ground and power return path.

**NC:** Not connected (reserved).

## 3.2 J3 - Ground Breaker

The ground breaker connector J3, breaks the power path to the negative battery terminal. Table 3.3 shows the pinout of J3.

**Table 3.3:** Pinout of ground breaker connector J3

| Pin | Description | Pin | Description |
|---|---|---|---|
| 1 | -VBAT | 2 | GND |
| 3 | -VBAT | 4 | GND |
| 5 | -VBAT | 6 | GND |
| 7 | -VBAT | 8 | GND |
| 9 | -VBAT | 10 | GND |

**-VBAT:** Negative battery terminal. Connect to GND to power on battery pack.

**GND:** System ground.

## 3.3 J5 - Debug

Table 3.4 shows the pinout of J5.

**Table 3.4:** Pinout of GOSH connector J5

| Pin | Description |
|---|---|
| 1 | RESERVED |
| 2 | RESERVED |
| 3 | GND |
| 4 | RESERVED |
| 5 | RESERVED |
| 6 | RESERVED |
| 7 | RXD |
| 8 | TXD |

**RXD:** Serial input (RX) for GOSH over UART. Used for configuration before flight.

**TXD:** Serial output (TX) for GOSH over UART. Used for configuration before flight.

**RESERVED:** Reserved by GomSpace. Leave these floating.

**GND:** System ground.

## 3.4 NanoPower example wiring

Figure 3.2 shows how to connect two BP8's in parallel. Note the harness where pin 7 and pin 9 are cross connected, enabling the P80's enable signals to be looped to the second BP8, see Figure 3.2.

| P80 J1/J13 | | BP8 - A J1 | | BP8 - A J2 | | BP8 - B J1 | | BP8 - B J2 | |
|---|---|---|---|---|---|---|---|---|---|
| Pin | Description | Pin | Description | Pin | Description | Pin | Description | Pin | Description |
| 1 | SDA | 1 | SDA | 1 | SDA | 1 | SDA | 1 | SDA |
| 3 | GND | 3 | GND | 3 | GND | 3 | GND | 3 | GND |
| 5 | SCL | 5 | SCL | 5 | SCL | 5 | SCL | 5 | SCL |
| 7 | EN0 | 7 | J1-J2 Relay | 7 | J1-J2 Relay | 7 | J1-J2 Relay | 7 | J1-J2 Relay |
| 9 | EN1 | 9 | ENA | 9 | ENA | 9 | ENA | 9 | ENA |
| 11 | BLEED | 11 | BLEED | 11 | BLEED | 11 | BLEED | 11 | BLEED |
| 13 | GND | 13 | GND | 13 | GND | 13 | GND | 13 | GND |
| 15 | GND | 15 | GND | 15 | GND | 15 | GND | 15 | GND |
| 17 | GND | 17 | GND | 17 | GND | 17 | GND | 17 | GND |
| 19 | GND | 19 | GND | 19 | GND | 19 | GND | 19 | GND |
| 21 | GND | 21 | GND | 21 | GND | 21 | GND | 21 | GND |
| 23 | n.c. | 23 | n.c. | 23 | n.c. | 23 | n.c. | 23 | n.c. |
| 25 | VBAT | 25 | VBAT_PROTECTED | 25 | VBAT_PROTECTED | 25 | VBAT_PROTECTED | 25 | VBAT_PROTECTED |
| 27 | VBAT | 27 | VBAT_PROTECTED | 27 | VBAT_PROTECTED | 27 | VBAT_PROTECTED | 27 | VBAT_PROTECTED |
| 29 | VBAT | 29 | VBAT_PROTECTED | 29 | VBAT_PROTECTED | 29 | VBAT_PROTECTED | 29 | VBAT_PROTECTED |
| 31 | VBAT | 31 | VBAT_PROTECTED | 31 | VBAT_PROTECTED | 31 | VBAT_PROTECTED | 31 | VBAT_PROTECTED |
| 33 | VBAT | 33 | VBAT_PROTECTED | 33 | VBAT_PROTECTED | 33 | VBAT_PROTECTED | 33 | VBAT_PROTECTED |
| Pin | Description | Pin | Description | Pin | Description | Pin | Description | Pin | Description |
| 2 | CANH | 2 | CANH | 2 | CANH | 2 | CANH | 2 | CANH |
| 4 | CANL | 4 | CANL | 4 | CANL | 4 | CANL | 4 | CANL |
| 6 | GND | 6 | GND | 6 | GND | 6 | GND | 6 | GND |
| 8 | GND | 8 | GND | 8 | GND | 8 | GND | 8 | GND |
| 10 | GND | 10 | GND | 10 | GND | 10 | GND | 10 | GND |
| 12 | KS | 12 | KILL_SW | 12 | KILL_SW | 12 | KILL_SW | 12 | KILL_SW |
| 14 | GND | 14 | GND | 14 | GND | 14 | GND | 14 | GND |
| 16 | GND | 16 | GND | 16 | GND | 16 | GND | 16 | GND |
| 18 | GND | 18 | GND | 18 | GND | 18 | GND | 18 | GND |
| 20 | GND | 20 | GND | 20 | GND | 20 | GND | 20 | GND |
| 22 | GND | 22 | GND | 22 | GND | 22 | GND | 22 | GND |
| 24 | n.c. | 24 | n.c. | 24 | n.c. | 24 | n.c. | 24 | n.c. |
| 26 | VBAT | 26 | VBAT_PROTECTED | 26 | VBAT_PROTECTED | 26 | VBAT_PROTECTED | 26 | VBAT_PROTECTED |
| 28 | VBAT | 28 | VBAT_PROTECTED | 28 | VBAT_PROTECTED | 28 | VBAT_PROTECTED | 28 | VBAT_PROTECTED |
| 30 | VBAT | 30 | VBAT_PROTECTED | 30 | VBAT_PROTECTED | 30 | VBAT_PROTECTED | 30 | VBAT_PROTECTED |
| 32 | VBAT | 32 | VBAT_PROTECTED | 32 | VBAT_PROTECTED | 32 | VBAT_PROTECTED | 32 | VBAT_PROTECTED |
| 34 | VBAT | 34 | VBAT_PROTECTED | 34 | VBAT_PROTECTED | 34 | VBAT_PROTECTED | 34 | VBAT_PROTECTED |

**Figure 3.2:** P80 and two BP8 units' connection pinout

# 4 Physical Dimensions

Please note that all dimensions are given in mm.

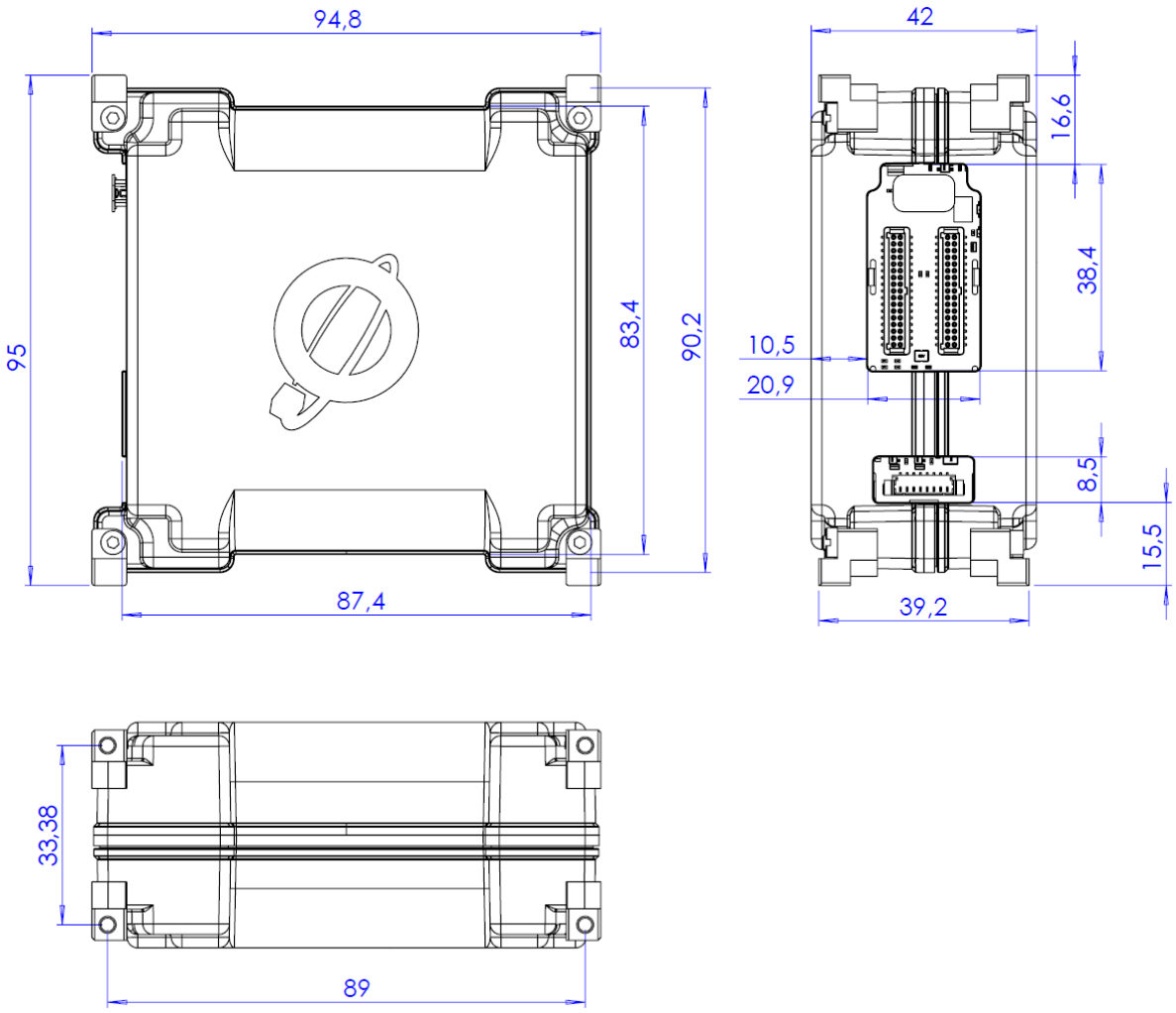


**Figure 4.1:** Dimensions of the NanoPower BP8 battery pack

| Parameter | Value | Unit |
|---|---|---|
| Mass | 486 | g |
| Size | 94.8 x 95 x 42 (L x W x H) | mm |

**Table 4.1:** Physical characteristics

# 5 References

[1] **GomSpace**
Manual 1034929
*NanoPower BP8*
Cited on pages 1–3

[2] **GomSpace**
Datasheet 1022248
*NanoPower Battery 3000mAh*
Cited on page 5