NanoPower

BP8 100 Wh

Datasheet

Datasheet for the NanoPower BP8 100 Wh battery pack

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Document reference: DS 1069134
Source reference: doc-nanopower-bp8-datasheet
Date: January 16, 2026
Revision: 1.0.0

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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 100 Wh (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].

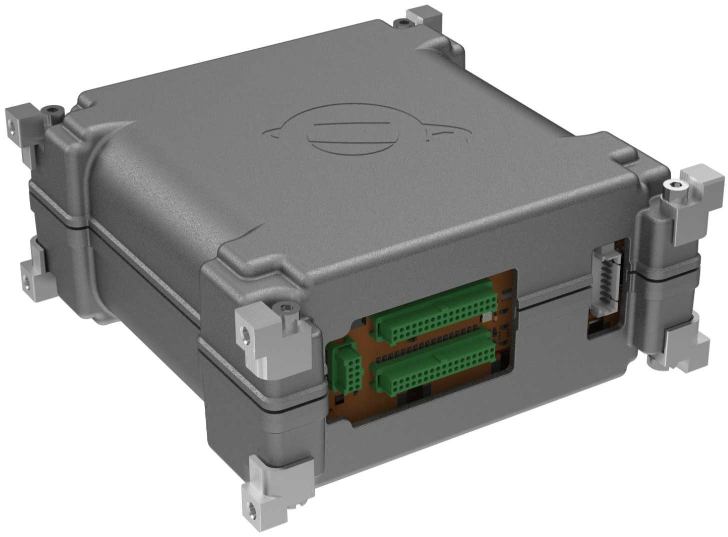

Figure 1.1: The NanoPower BP8

1.2 Highlighted features

- Lithium-ion battery pack for space applications
- 8S1P configuration with nominal capacity of 3500m Ah (3000m Ah in recommended operating range)
- Nominal capacity of 100 Wh (86 Wh in recommended operating range)
- Charge and discharge current of 4A 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.

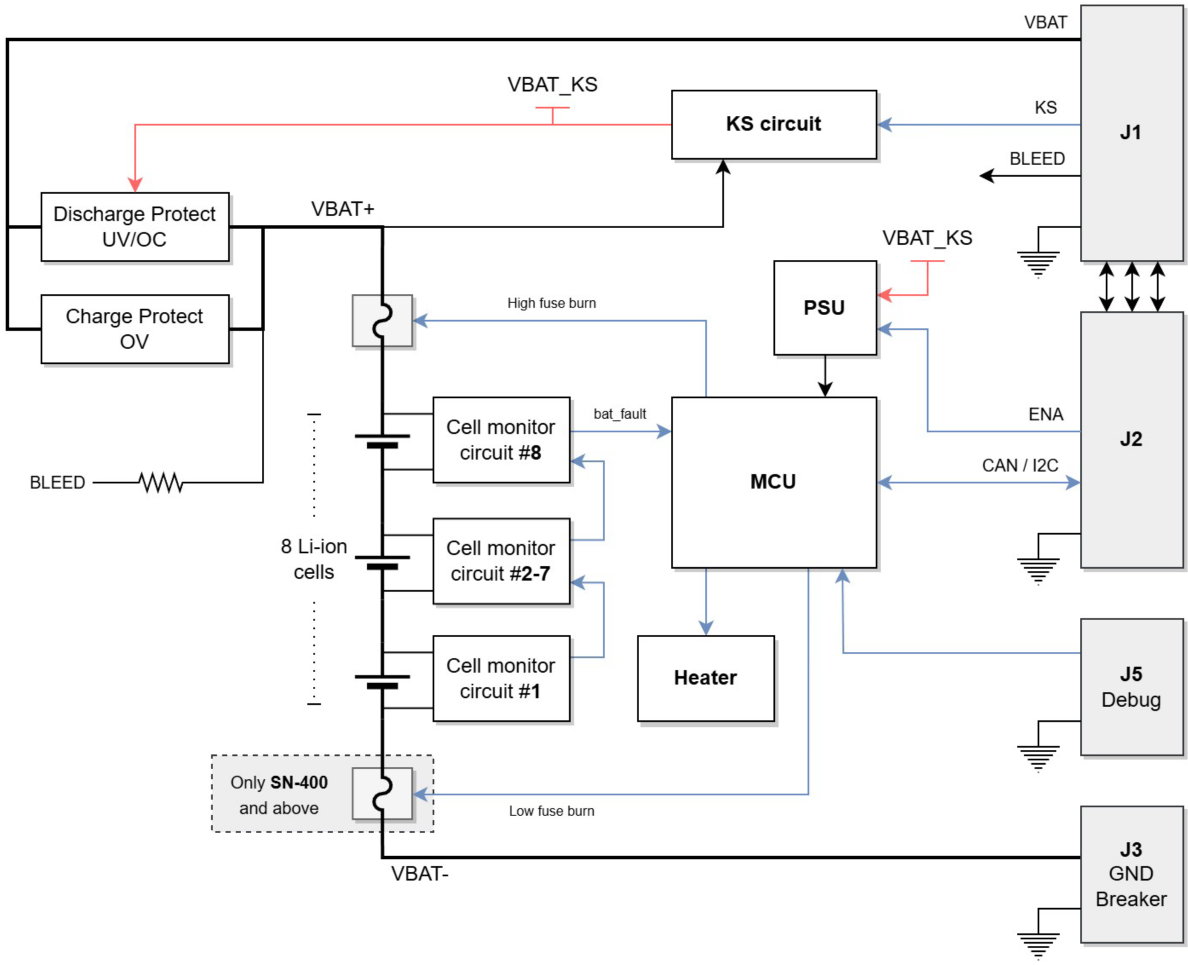

Figure 1.2: NanoPower BP8 functional block diagram

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 killswitch (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 (please see note below).

The KS-signal is active LOW and must be connected to an open drain output with an output impedance that is greater than 500kΩ. The BP8 will pull up the KS-signal to VBAT through a high impedance (1.6MΩ). To activate the killswitch the KS-signal must be pulled to system GND. The kill-switch is labeled "KILL_SW" in the pinout table.

NOTE: For SN-400 and above the killswitch does not disable charging, allowing charging at all times.

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 560kΩ pull-up will pull up the ENA-signal to 3.3V.

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 0.5mA.

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 11.5V 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 given in Table 2.2.

Table 2.2: Electrical specifications

Parameter		Condition	Min	Typ	Max	Unit
V_{OP}	Recommended operating voltage		23.6	28.8	32.0	V
E_{BAT}	Power capacity	V_{BAT}= 23.6V to 32.0V V_{BAT}= 23.6V to 33.6V		86 89		Wh
V_{CHG}	Charging voltage			32.0	33.6	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}= 32V, ENA active V_{BAT}= 32V, ENA inactive V_{BAT}= 32V, KS active	3.5 1.8 0.09	5.0 1.9 0.1	5.5 2.1 0.15	mA
I_{UV}	Standby current at UVLO	V_{BAT}= 19V, ENA inactive		1.5 0.95 [1]		mA
I_{SQ}	Self-discharge [2]	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 Release	33.1 31.2	33.3 31.3	33.6 31.6	V

Continued on next page

Table 2.2: Electrical specifications (Continued)

Parameter		Condition	Min	Typ	Max	Unit
V_{UV}	Undervoltage lockout	Activate Release	19.3 21.0	19.5 21.5	19.8 21.7	V
V_{TH}	Cell balance threshold	Activate Release		4.085 3.975		V
I_{BAL}	Cell balance current	Cell balance active @ V_{CELL}= 4.0V		50		mA

[1] Only for SN-400 and above

[2] The current I_{SQ} is for electronics only.

3 Hardware layout

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

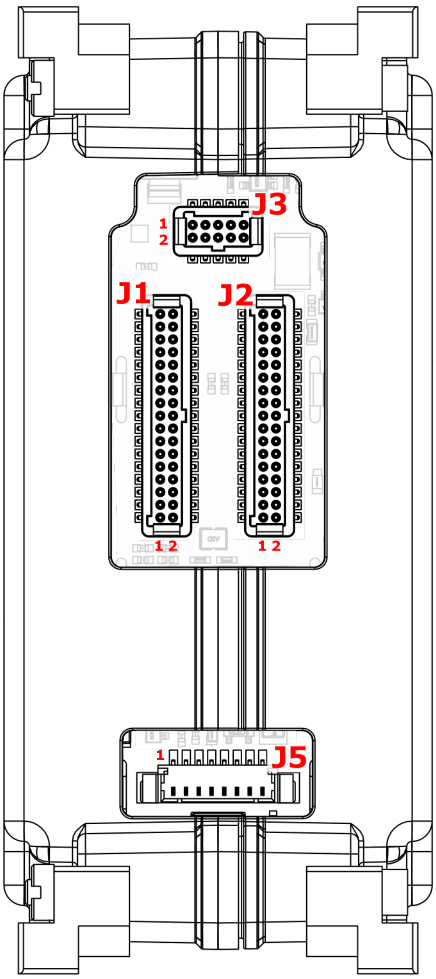

Figure 3.1: Placement of connector J1, J2, J3 and J5

⚠ **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. Allow a low current to flow between kill switched 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		BP8 - A				BP8 - B			
J1/J13		J1		J2		J1		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.

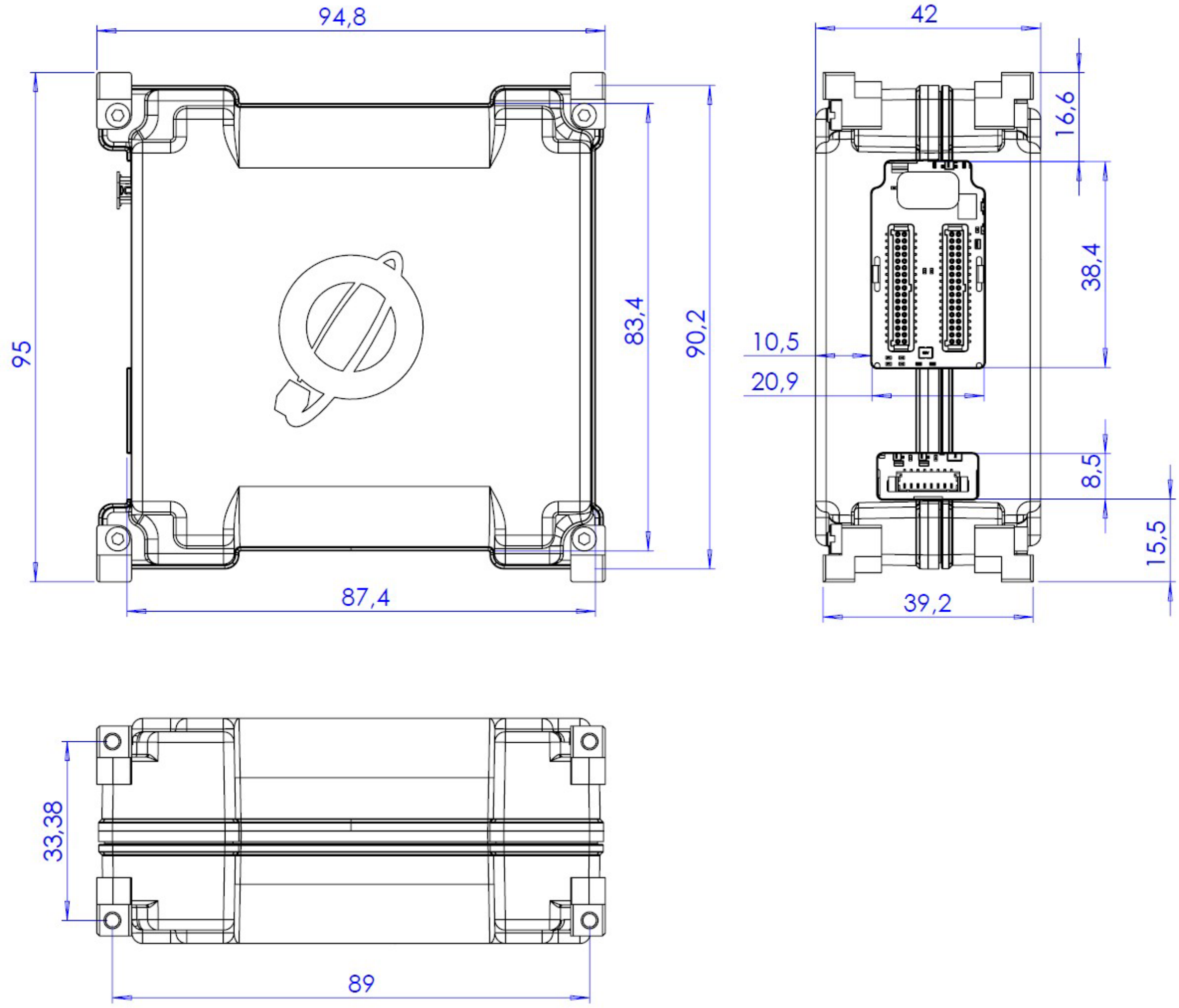

Figure 4.1: Dimensions of the NanoPower BP8 battery pack

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

Table 4.1: Physical characteristics

4.1 Mechanical interface

The NanoPower BP8 100 Wh is equipped with specially designed corner brackets that have the ability to rotate. This design feature allows the brackets to conform to the mounting surface when the product is mounted to a structure from both sides.

Important Note:

- **Rotation by Design:** The rotation of the corner brackets is an intentional design feature. It ensures a secure and adaptable fit to various mounting surfaces.
- **Secure Fit:** While the brackets can rotate, they are securely fixed and will not become loose under normal usage conditions.

This design provides flexibility during installation and ensures that the product can be mounted effectively on uneven or angled surfaces.

5 References

[1] **GomSpace** Manual 1069136
NanoPower BP8 100 Wh
Cited on pages 1–4