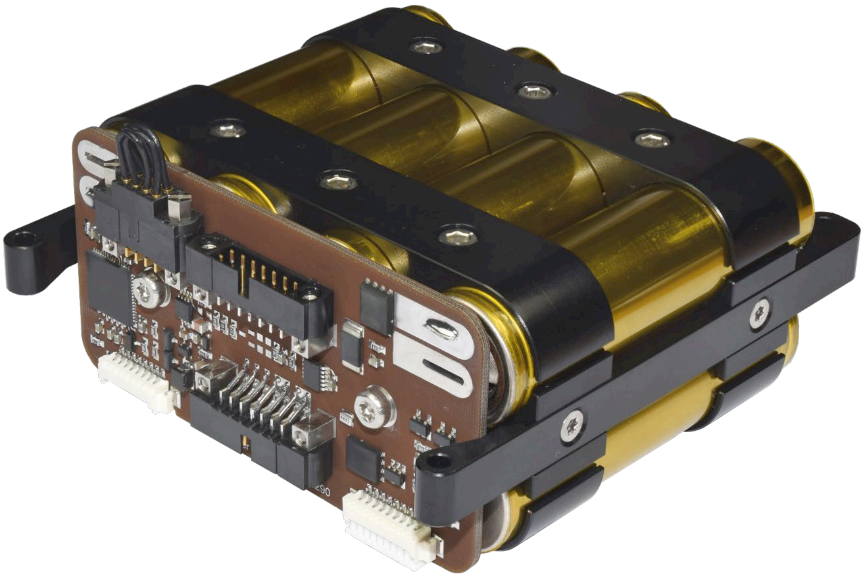

NanoPower

BPX 100 Wh

Datasheet

Datasheet for the NanoPower BPX 100 Wh battery pack

NanoPower BPX 100 Wh

Datasheet for the NanoPower BPX 100 Wh battery pack

Document reference: DS 1076870
Source reference: doc-nanopower-bpX-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 BPX 100 Wh (BPX) is a high-capacity lithium-ion battery pack with a heater for nanosatellites. Several BPX battery packs can be coupled in parallel if greater capacity is needed.

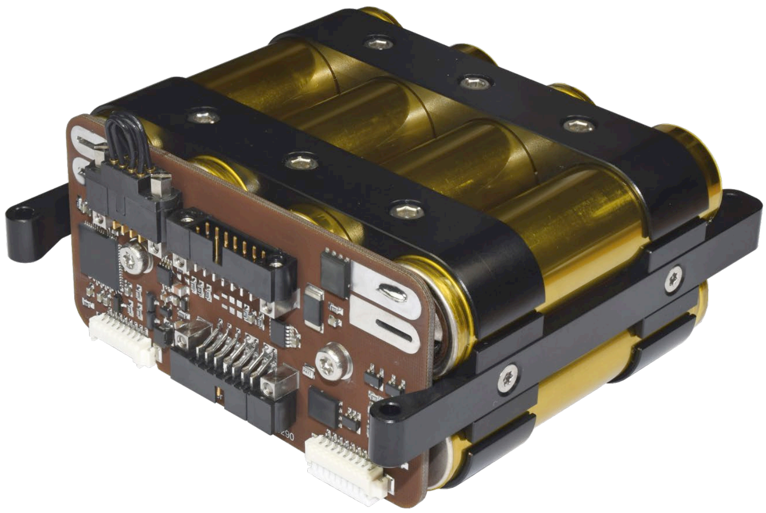


Figure 1.1: The NanoPower BPX

1.2 Highlighted features

- Lithium-ion battery pack for space applications
- Utilizes 18650 Lithium-ion cells with nominal capacity of 3500m Ah (3000m Ah in recommended operating range)
- Can be configured for nominal voltages of 14.4 or V 28.8 V
- Nominal capacity of 100 Wh (86 Wh in recommended operating range)
- Provides telemetry over I2C
    - Voltage
    - Temperature
- Autonomous heater system
- Fits standard PC104
- Weight: 500 g
- PCB material: Glass/Polyimide IPC 6012C cl. 3/A
- IPC-A-610 Class 3 assembly
- CAN and I2C communication using Cubesat Space Protocol (CSP)

1.3 Customization Options

As GomSpace realizes that different applications place different requirements to a power system, the NanoPower products present a variety of options for customization. Options are to be agreed upon time of order placement.

Below are the standard configurations. It is possible to connect several BPX in parallel using PBAT1 and PBAT2 connectors to get higher total capacity.

To find the nominal voltage of the chosen battery pack use the following equation (Vnom(cell) is found in the battery datasheet):

*Vnom(pack) = Vnom(cell) * Number of series cells*

To find the current capacity of the battery pack use the following equation:

*Icap(pack) = Icap(cell) * Number of parallel cells*

To find the nominal capacity (Wh) of the battery pack use the following equation:

*Pcap(pack) = Vnom(pack) * Icap(pack)*

Configuration	Number of cells	Capacity [Wh]	V_{range} [V]	$V_{nominel}$ [V]	Capacity [Ah]
4S-2P	8	100	12 - 16.8	14.4 V	7.0
8S-1P	8	100	24 - 33.6	28.8 V	3.5

1.4 Measurements

The NanoPower BPX provides several measurement points that enable monitoring of the condition of the system. These measurements are available as digital readings retrievable through the I^{2}C interface. Measurements include:

- Battery voltage
- Four temperature measurements
- Heater current measurement

1.5 Short Circuit Protection

PBAT1 and PBAT2 have raw battery, and no short-circuit protection.

1.6 Enable Pin

The raw unprotected battery power is accessible through the PBAT1 and PBAT2 all other functions of the BPX are powered off.

The enable pin on PBAT1 and PBAT2 (active high) is used to activate the battery packs onboard functions: housekeeping, heater control.

1.7 Block Diagram

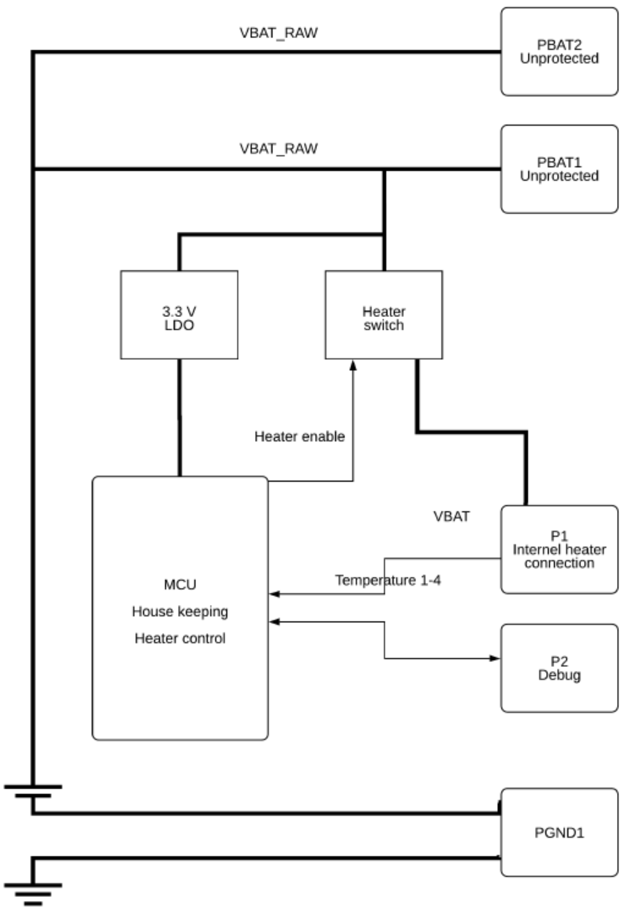


Figure 1.2: NanoPower BPX Block Diagram

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 BPX 100 Wh.

Table 2.1: Absolute maximum specifications

Parameter		Min	Typ	Max	Unit
V_{BAT}	Battery voltage (8S1P)	19.5		33.6	V
	Battery voltage (4S2P)	9.75		16.8	V
T_{OP}	Operating temperature				
	Discharge	−20.0		60.0	°C
	Charge	0.0		45.0	°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	8S1P 4S2P	23.6 11.8	28.8 14.4	32.0 16.0	V V
E_{BAT}	Power capacity	V_{BAT}= 23.6V to 32.0V V_{BAT}= 23.6V to 33.6V		87 89		Wh
V_{CHG}	Charging voltage			32.0	33.6	V
I_{OUT}	Discharge current	Four power pins can handle up to 6 A with derating according to ECSS-Q-ST-30-11C			6.0	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}= *16*V/32V, ENA active V_{BAT}= *16*V/32V, ENA inactive	3.5 25	5.0 50	8.0 120	mA µA
V_L	ENA logic Input low Input high	Active high Onboard 300kΩ	 0 2.0		 0.4 VBAT	V V
I_{SQ}	Self-discharge [2]	Ground breaker disconnected		30		µA
P_H	Heater power usage			6.0		W

3 Hardware layout

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

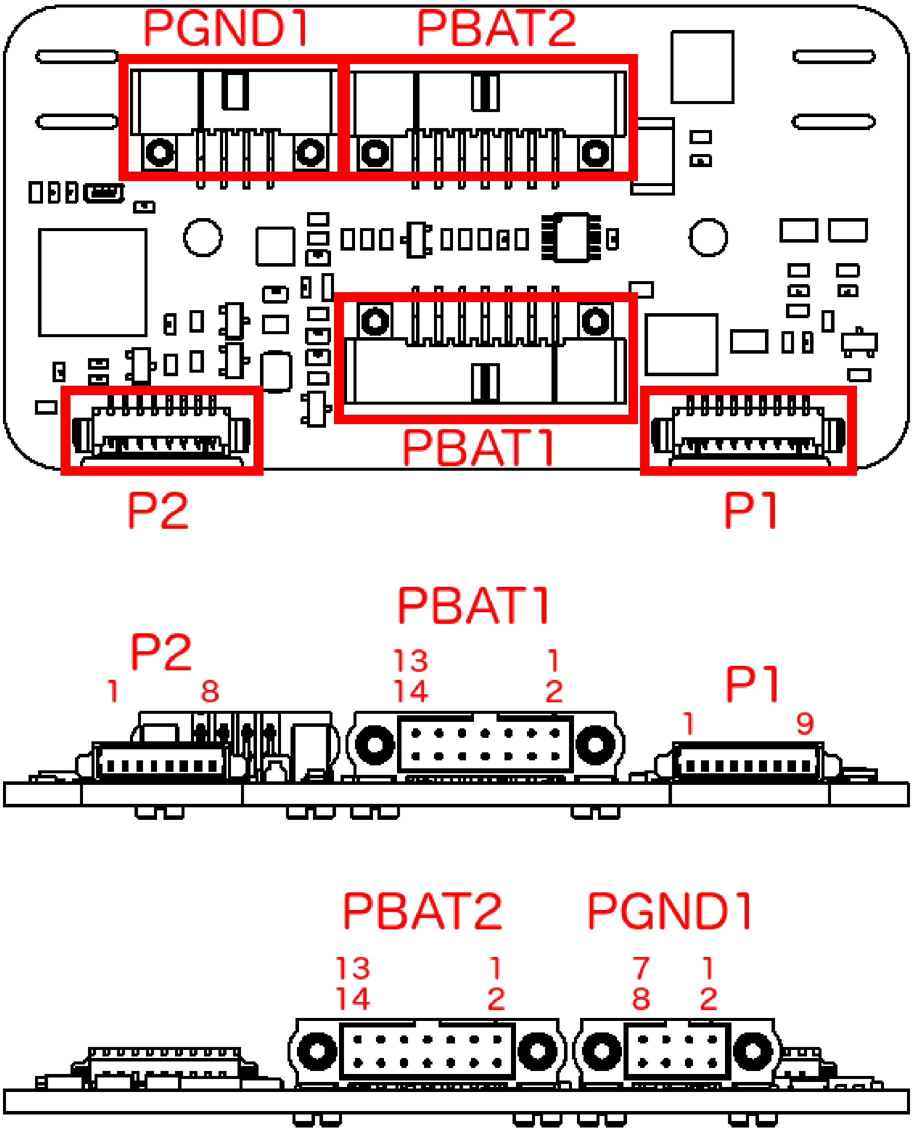


Figure 3.1: Connector positions on BPX 100Wh

3.1 P1 – Heater Connector

Picoblade Molex 0532610971

Pin	Description	Pin	Description
1	Heater Supply	2	Heater Supply
3	GND	4	GND
5	3.3 V to temperature sensor heater	6	Vtemp 1
7	Vtemp 2	8	Vtemp 3
9	Vtemp 4		

3.2 P2 – Debug

Picoblade Molex 0532610871

Used by GomSpace for MCU programming.

Pin	Description	Pin	Description
1	GND	2	VCC 3.3 V
3	UART RX	4	UART TX
5	Reset	6	ISP SCK
7	ISP MOSI	8	ISP MISO

3.3 PBAT1 – Battery Connector

Harwin M80-5421442.

Four power pins can handle up to 6 A with derating according to ECSS-Q-ST-30-11C

The I^2C, the Enable BPX pins are the same net on PBAT1 and PBAT2

Pin	Description	Pin	Description
1	GND	2	GND
3	GND	4	GND
5	VBAT	6	VBAT
7	VBAT	8	VBAT
9	I^2C SCK	10	Enable BPX
11	I^2C Data	12	GND
13	NC	14	NC

3.4 PBAT2 – Battery Connector

Harwin M80-5421442.

Four power pins can handle up to 6 A with derating according to ECSS-Q-ST-30-11C

The I^2C, the Enable BPX pins are the same net on PBAT1 and PBAT2

Pin	Description	Pin	Description
1	GND	2	GND
3	GND	4	GND
5	VBAT	6	VBAT
7	VBAT	8	VBAT
9	I^2C SCK	10	Enable BPX
11	I^2C Data	12	GND
13	NC	14	NC

3.5 PGND1 – Ground Breaker

Harwin M80-5430805.

Pin	Description	Pin	Description
1	Battery GND	2	Battery GND
3	Battery GND	4	Battery GND
5	System GND	6	System GND
7	System GND	8	System GND

4 Data Interface

The NanoPower BPX 100 Wh uses the CubeSat Space Protocol (CSP) to transfer data to and from CSP nodes on-board the main system bus. CSP is a routed network protocol that can be used to transmit data packets between individual subsystems on the satellite bus and between the satellite and ground station. For more information about CSP please read the documentation on http://www.libcsp.org

4.1 I²C

The standard method to communicate with the BPX is over multi-master I²C. Please note that since the CSP router sends out an I²C message automatically when data is ready for a subsystem residing on the I²C bus, the bus needs to be operated in I²C multi-master mode.

The BPX uses the same I²C address as the CSP network address per default. BPX's own I²C address is 0x07 per default.

4.2 I²C Slave mode

Slave mode operation disables the use of the CSP stack, and uses a slave-mode only protocol instead. A limited set of the CSP commands is available in this mode.

5 Debug Interface

The debug interface is a USART that uses the GomSpace Shell (GOSH) to present a console-like interface to the user. GOSH is a general feature present on all GomSpace products. Supported baud rate is 38400 8 bit, no parity and one stop-bit (8N1).

The console can be used during checkout of the BPX to send commands and set parameter. During integration into the satellite, the debug interface can be used to evaluate and see incoming and outgoing traffic through the BPX. Telemetry and housekeeping parameters can also be monitored. Here is a short list of features of the debug interface:

- Inspect CSP traffic (incoming and outgoing)
- Inspect I²C driver (useful during early driver development)
- Inspect runtime performance
- Run tests (ping, etc.)
- Modify routing table
- Modify, save and restore default parameters

6 Heater and Temperature Sensor

Lithium-ion batteries cannot charge in low temperatures (see battery datasheet). Using a heater to maintain temperature above charging threshold is a software option. Software default mode is set to manual.

The heater PCB contains four heating elements each placed between two batteries. Each element has its own temperature sensor. Below are two pictures of the PCB with the elements and sensors:

Figure 6.1: Heater top

Figure 6.2: Heater bottom

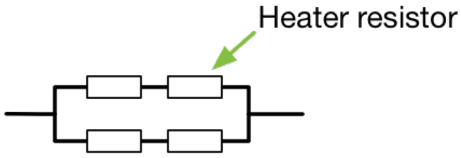
Red marks = heater

Green marks = Temperature sensor

Table 6.1: Heater characteristics

Parameter	Condition	Min.	Typ.	Max.	Unit
Heater Element					
Heater resistance	16 V 4S-2P		40		Ω
	32 V 8S-1P		150		Ω
Heater power	16 V 4S-2P		6		W
	32 V 8S-1P		6		W

Heater resistor circuit setup is shown to the right.



Two temperature sensors with an analog interface are mounted just under each battery-set to provide battery temperatures for housekeeping purposes. A complete thermal control system can be implemented using the two optional heater elements.

For SPI communication details please see the datasheet for the Texas Instruments LM60CIM3.

Table 6.2: Temperature sensors specification

Parameter	Min.	Typ.	Max.	Unit
Temperature Sensors				
- Range	-40		125	°C
- Accuracy	-2	1.5	2	°C

7 Physical Dimensions

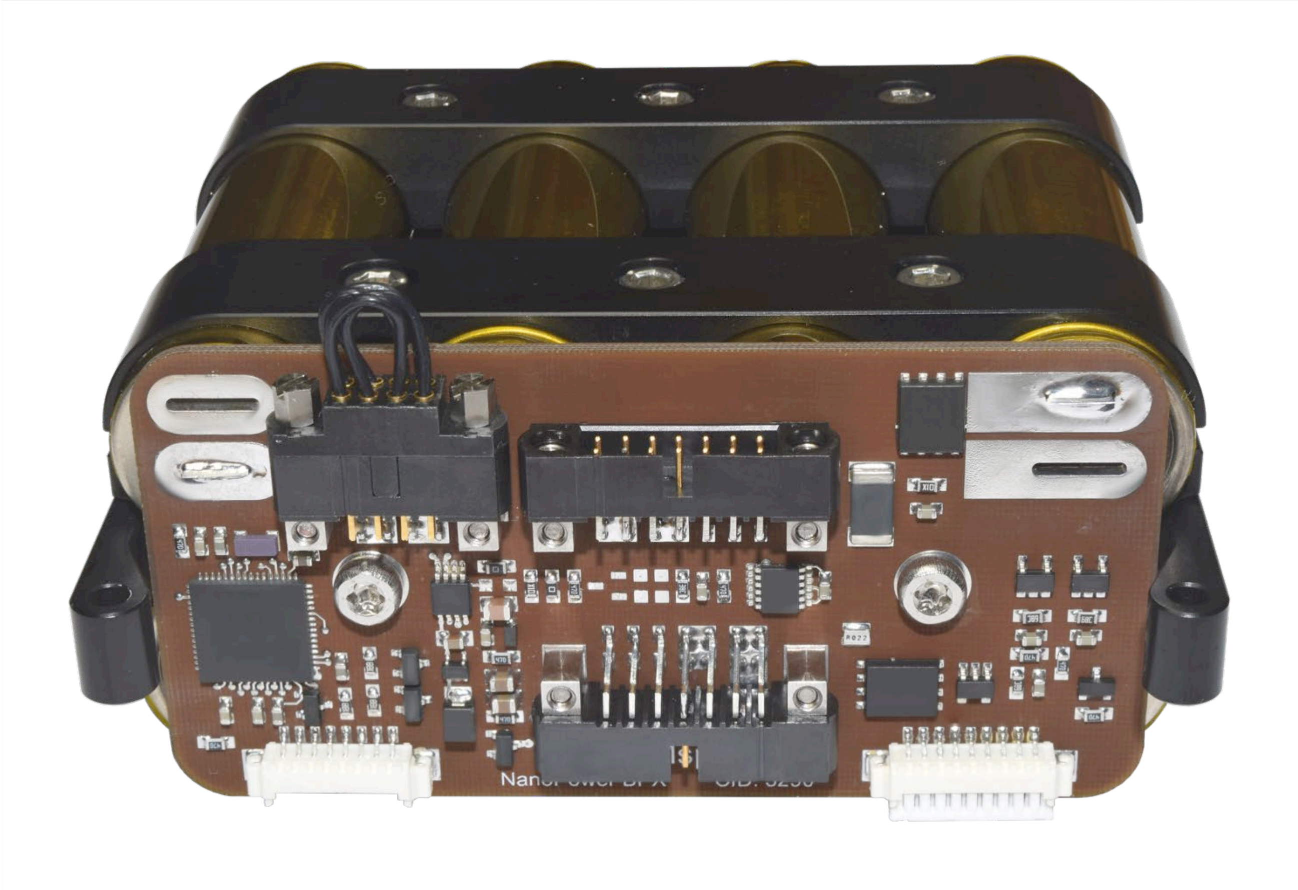
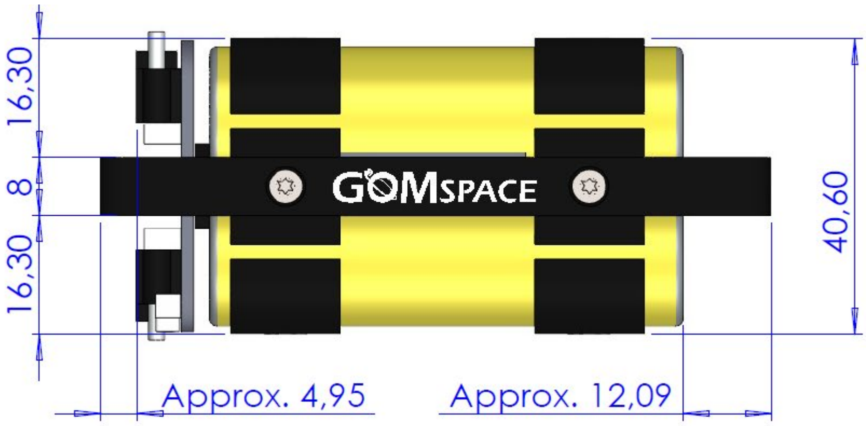


Figure 7.1: Physical layout



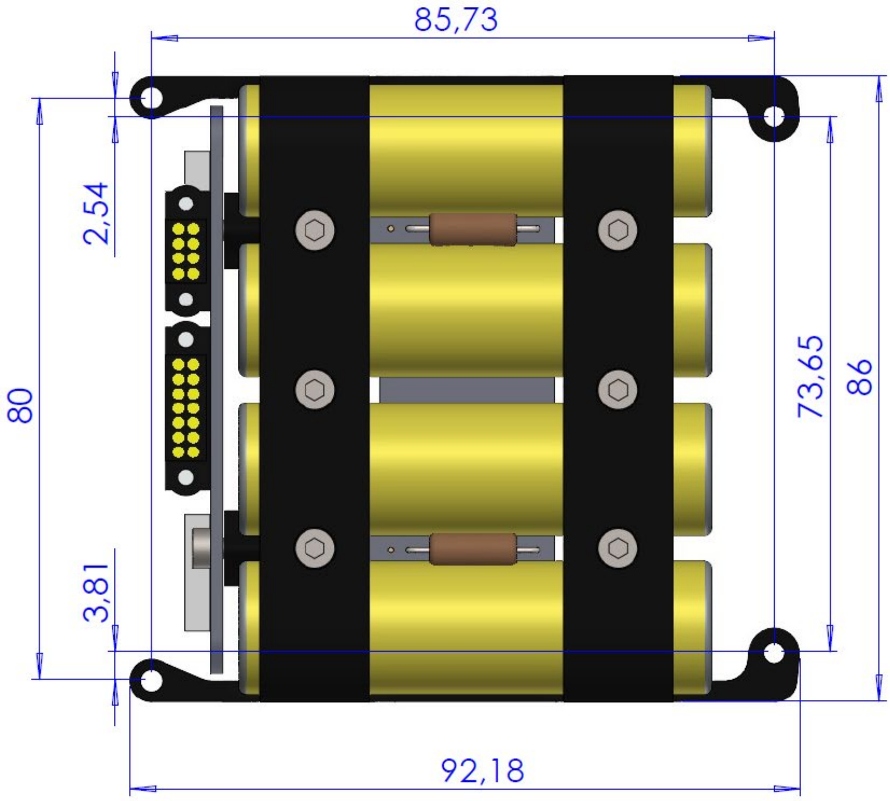


Figure 7.2: The NanoPower BPX all measures in mm

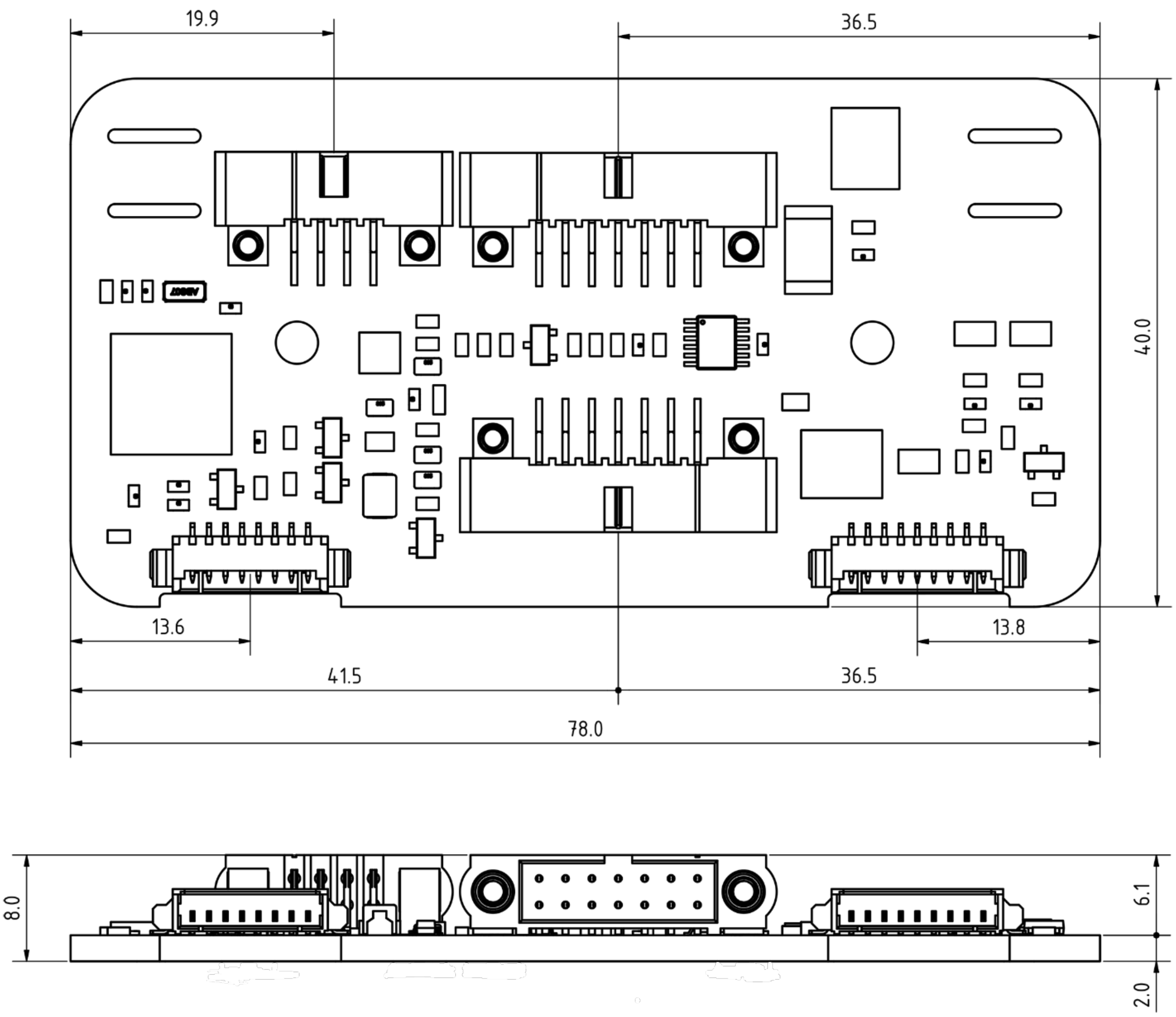


Figure 7.3: NanoPower BPX Connector positions all measures in mm

Parameter	Value	Unit
Mass	500	g
Size	Fits in a PC104 stack 93 x 86 x 41 (L x W x H)	mm

Table 7.1: Physical characteristics

8 References

[1] **GomSpace** Manual 1076873
NanoPower BPX 100 Wh