iEPS Type A, Type B and Type C Datasheet

ISIS-iEPS2_0-DS-00001, version 1.0

Compact and highly configurable power system suitable for up to 3U CubeSat missions.

Applications

The iEPS is a compact solution which follows a PC104 form factor, tailored for 1U-3U sized platforms and LEO missions. Available in three configurations which supply from 22.5Whr to 45Whr.

Product Features

- Communication over I2C, UART for testing
- FRAM-based MCUs for improved radiation tolerance
- Low (idle) power consumption, dedicated emergency low power mode for EPS survivability
- Easy to disconnect battery harness
- Hardware over-current protection
- Hardware supervisor including watchdog
- Low-power MCU for control and Telemetry (TLM)
- I2C Watchdog (stack reset on comms failure)
- Firecode stack reset capability
- Hardware based maximum power point tracking
- GaN-FETs implemented for improved power conversion efficiency and performance
- Automatic integrated battery heater control

Optional Features

- Optional battery capacities:
  - 2-cell pack: 8V and 4A or 32W
  - 4-cell pack: 16V and 4A or 64W
- Customizable voltage output channels through mountable add-on daughterboard.[1]

General Description

The ISIS Electrical Power System (iEPS) is the second-generation compact power system for nanosatellites. It is an off-the-shelf Electrical Power System available in three standard configurations (Type A/B/C), ideal for powering 1U – 3U Cubesats. The system leverages wide bandgap semiconductor technologies, implementing GaN-FETs to improve solar power conversion efficiency and performance. It is equipped with an integrated heater, hardware-based Maximum Power Point Tracking (MPPT) and hardware voltage and over-current protection. The iEPS provides 3.3V and 5V regulated buses, as well as an unregulated bus. An add-on daughterboard allows additional configurations to suitably power the system and payload instruments.

Compatibility

- Interoperable with ISIS Solar Panels, On-Board Computer (iOBC) and Antenna System (AntS)
- Compliant to CubeSat standard.

Flight heritage and quality assurance

- Design based on heritage from PEASSS Cubesat (2016).
- Second generation improvements flown on the Hiber 1,2 Cubesats (2018).
- Qualification Thermal Testing, -40 to +80 ºC.
- Design qualification load Static +10.8 [g], three axes.
- Sine and Random Vibration ASAP5 Qualification Levels.
- Flight units thermally acceptance tested for workmanship.
- IPC-A-610 Class 3 PCB and assembly, flight units thermally acceptance tested.

Ordering information

Please contact sales@isispace.nl for ordering information

[1] Only voltages lower than the battery voltage are possible.

Specification

Parameter			Value	Unit
Environmental Characteristics				
Operational temperature			-40 to +70[a]	°C
Storage temperature			-40 to +85[a]	°C
Storage lifetime			12	months
Electrical Characteristics				
Static (Idle) consumption			90	mW
Power output	Number of output channels [VD0]		1	-
	Output voltage [VD0]	Type A	6.5 – 8.0[b]	V
		Type B and C	12.8 – 16.0[b]	
	Number of output channels for each domain VD1 and VD2		4	-
	Output voltage [VD1]		5	V
	Output voltage [VD2]		3.3	
	Maximum output current per channel for [VD0], [VD1] and [VD2]		2.5	A
	Total maximum output current for VD1 domain		4[c]	A
	Total maximum output current for VD2 domain		3.95[c]	
Solar panel input	Number of MPPTs inputs		3 (+2 on DB)	-
	Maximum input voltage	Type A	8.0[b]	V
		Type B and C	16.0[b]	
	Minimum input voltage to start MPPT		3.5	V
	Minimum input voltage if another channel's voltage is sufficient to start MPPTs		2.0	V
	Maximum input current per channel		2[d]	A
Battery segment	Battery Cell Nominal Voltage		3.6	V
	Battery Cell Min/Max Voltage (absolute maximum)		2.5, 4.2[e]	V
	Battery Cell Nominal Capacity		3200[e]	mAh
	Battery Pack Configuration	Type A	2 in series	-
		Type B and C	4 in series	
	Battery Pack Operating Voltage (Hardware limits)	Type A	5.5 – 8.0	V
		Type B and C	10.9 – 16.0	
	Battery Pack Operating Voltage (Software bounded range enhances longevity)	Type A	6.5 – 8.0	V
		Type B and C	12.8 – 16.0	
	Battery Pack Max Input Current		Bounded by satellite design	-
	Battery Pack Max Output Current		4	A
	Maximum heater power	Type A	1.2	W
		Type B and C	2.5	
EGSE	Maximum input voltage	Type A	8	V
		Type B and C	16	V
	Maximum input current	Charge Batteries	1	A
		Power Satellite	4	

Parameter		Value	Unit
Physical characteristics			
Mass	Type A	184 ± 5	Grams
	Type B	310 ± 5	
	Type C	360 ± 5	
Volume (excluding CSKB)	Type A	96 x 92 x 26.5	mm^3
	Type B PCB	96 x 92 x 11.3	
	Type C PCB	96 x 92 x 16	
	4-cell battery	94 x 89 x 21.0	
Digital characteristics			
I^2C Specifications			
Bus logic low-level input voltage		0- 1	V DC
Bus logic low-level output voltage		0.47 – 0.6	V DC
Bus logic high-level voltage		2.3- 3.3	V DC
Supported I^2C modes	Standard-mode	Up to 100	kbits/sec
	Fast-mode	Up to 400	
Supported address types		7 bits	-
I^2C node type		Slave only	-
I^2C general call supported		No	-

[a] Estimated values only

[b] Unregulated battery voltage.

[c] If only one voltage domain is used (VD1 or VD2) the current limit for this domain is 6A.

[d] Contact ISIS if higher input current is required.

[e] For default cells, can vary for special cell selection.

Functional Description

The sections below provide an overview iEPS and detail the functioning of the main segments. Followed by information on the role of the MCU, features of the daughterboard and a detailed block diagram visualizing the system architecture. The iEPS is divided into three main segments. The battery segment, satellite segment and the solar panel segment. A single MCU gathers housekeeping data and controls the iEPS. Additionally, a standard daughterboard can be added to the iEPS to increase functionality.

Battery segment

The battery segment is used to charge the batteries or alternatively power the satellite. The Lithium-Ion batteries can be charged from either the Solar Panels or from the Electrical Ground Support Equipment (EGSE). This segment includes battery heaters and control, also protects the batteries from short circuits and can completely disconnect the batteries if needed.

Satellite segment

The satellite segment is used to distribute the power to the satellite. This segment can provide battery voltage output, four 3.3V switchable outputs along with four 5V switchable outputs. One switchable output of each voltage domain is configured as permanent. For each output current, voltage and power are measured. The system includes over voltage protection and a 2A fixed current limit. This segment also facilitates slew rate control at 6V/ms.

Solar power segment

The solar panel segment consists of three channels, each equipped with an individual hardware based MPPT (Maximum Power Point Tracker). The MPPTs use GaN FETs to preserve solar power conversion efficiency and are less susceptible to radiation damage than comparable Silicon components. Several solar cell strings can be connected in parallel to the same channel input if they have the same voltage domain. The MPPTs assume that any parallel strings connected to one MPPT input have blocking diodes. Two more channels are available on the daughterboard of iEPS. The solar panel interface delivers power to both the battery segment and the satellite segment. If no batteries are connected the solar panels can be used to power the satellite.

Controller

The MCU on the iEPS interfaces with the three building blocks: solar panel, battery and satellite segment. For the solar panel segment the MCU gathers data from the MPPTs. In the battery segment the MCU is used as an additional safeguard by setting a software bound and entering the emergency low power mode. On the satellite segment the MCU controls all the output load switches and gathers data on the battery power consumption and each of the output's switches.

Daughterboard

The daughterboard provides two additional solar panel channels, as well as seven switchable outputs in three voltage domains. Also included on the daughterboard is the option to read out data from outboard/solar panel sensors (thermistors and photodiodes).

Detailed interface information and CAD models of the entire iEPS may be delivered on request.

Electrical Description

The ISIS Electrical Power System (iEPS) is the second-generation compact power system for nanosatellites designed and manufactured by ISIS. It is an off-the-shelf Electrical Power System available in three standard configurations (Type A/B/C), ideal for powering 1U - 3U CubeSats. Type A is the compact configuration with an iEPS board and top-mounted 2-cell battery pack, Type B consists of an iEPS board and 4-cell battery back and the Type C configuration includes the iEPS board, four-cell battery pack and a daughter board with additional satellite and solar panel interfaces. Figure 1 shows a detailed block diagram of the iEPS.

This second-generation system leverages wide bandgap semiconductor technologies, implementing GaN-FETs to improve solar power conversion efficiency and performance. The system is equipped with hardware based Maximum Power Point Tracking (MPPT), voltage and over-current protection. The iEPS provides 3.3V and 5V regulated buses, as well as an unregulated bus. An add-on daughterboard (DB) allows additional configurations to suitably power the system and payload instruments.

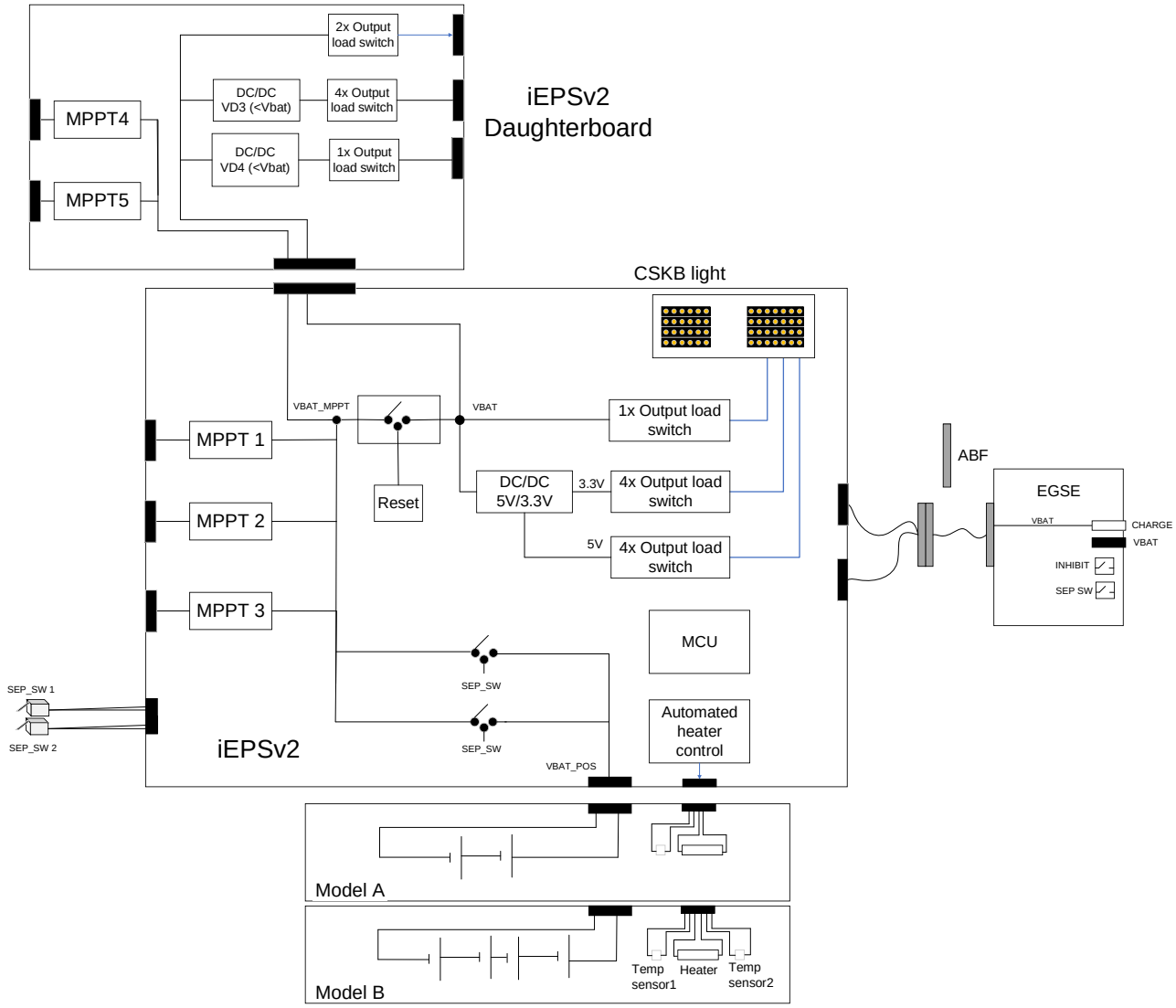


Figure 1 iEPS detailed block diagram

Solar panel input to battery output efficiency

The efficiency of MPPTs for the four-battery cell configuration is shown Figure 2 . The efficiency of the MPPTs in the two-battery cell configuration is shown in Figure 3. Efficiency is measured for the entire chain from solar panel input to battery output. All efficiencies include static losses.

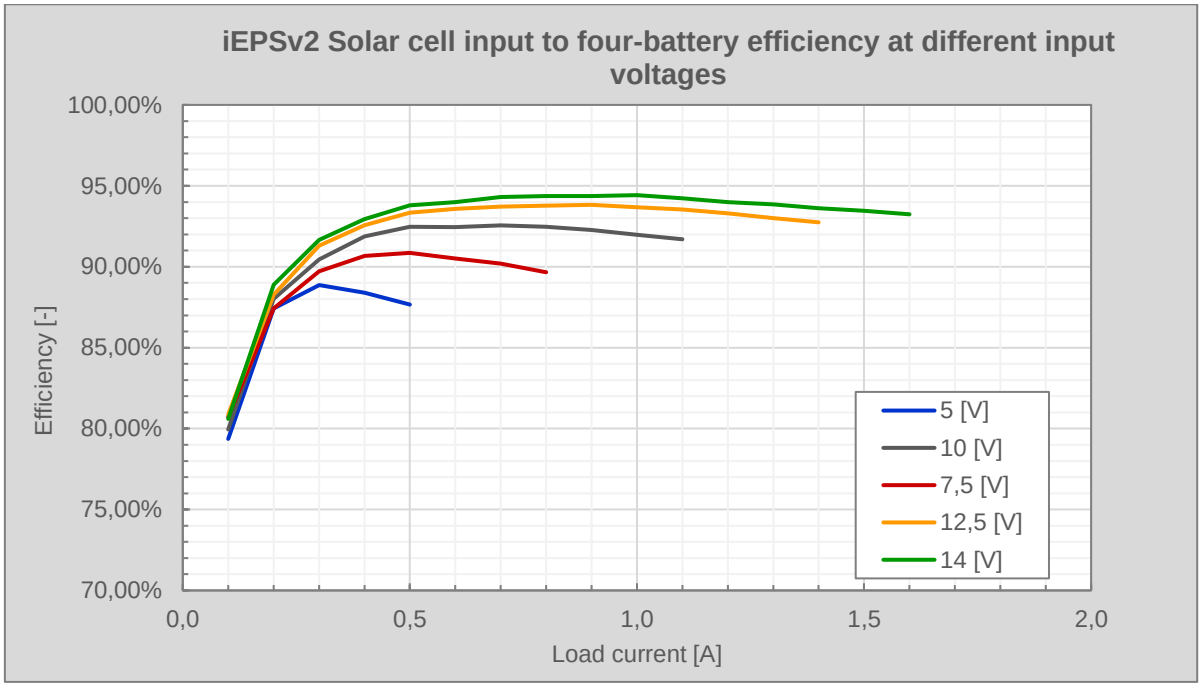


Figure 2 iEPS Solar cell input to four-battery efficiency at different input voltages

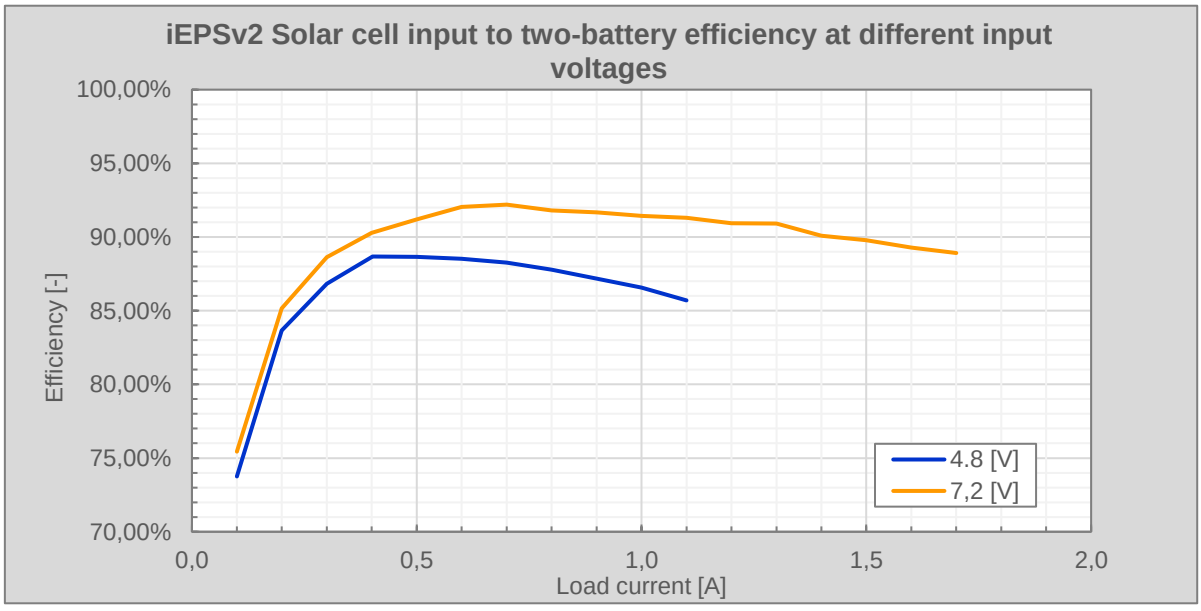


Figure 3 iEPS MPPT converter input to two-battery efficiency at different input voltages input voltages

Battery input to CSKB efficiency

Efficiencies of output power bus at different voltage domains are shown for the four-battery configuration in Figure 4 and two-battery configuration in Figure 5. Efficiency is measured from battery input to the output on the CSKB. All measurements include static losses.

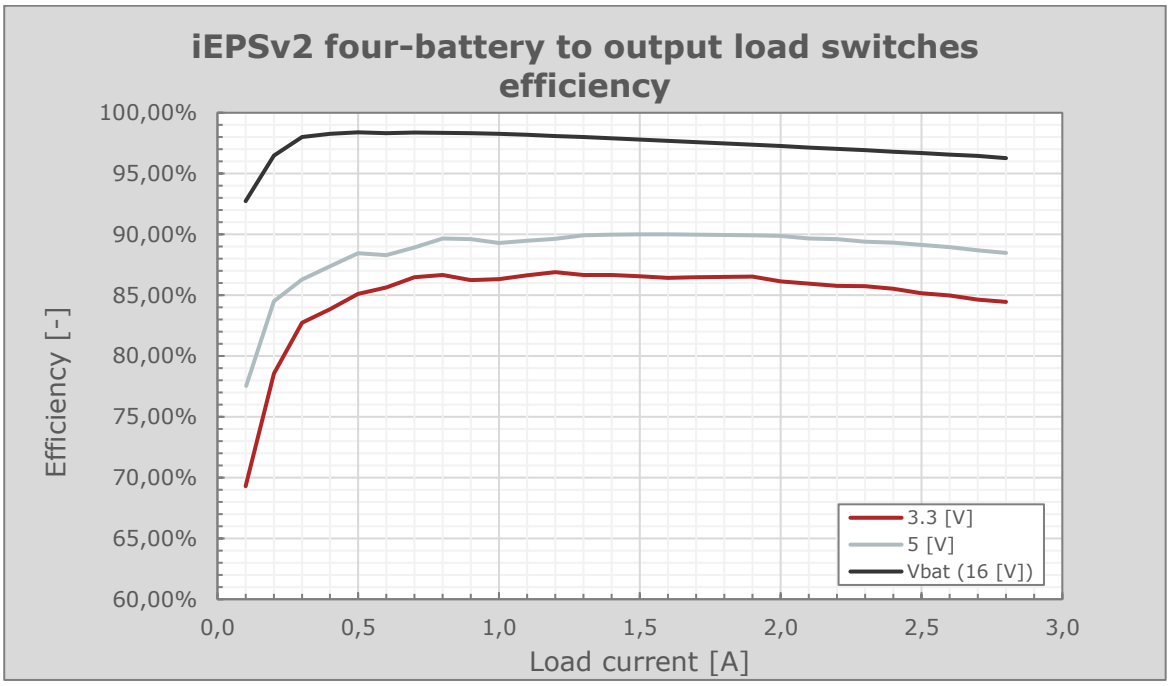


Figure 4 Output bus efficiencies with four-battery cell configuration.

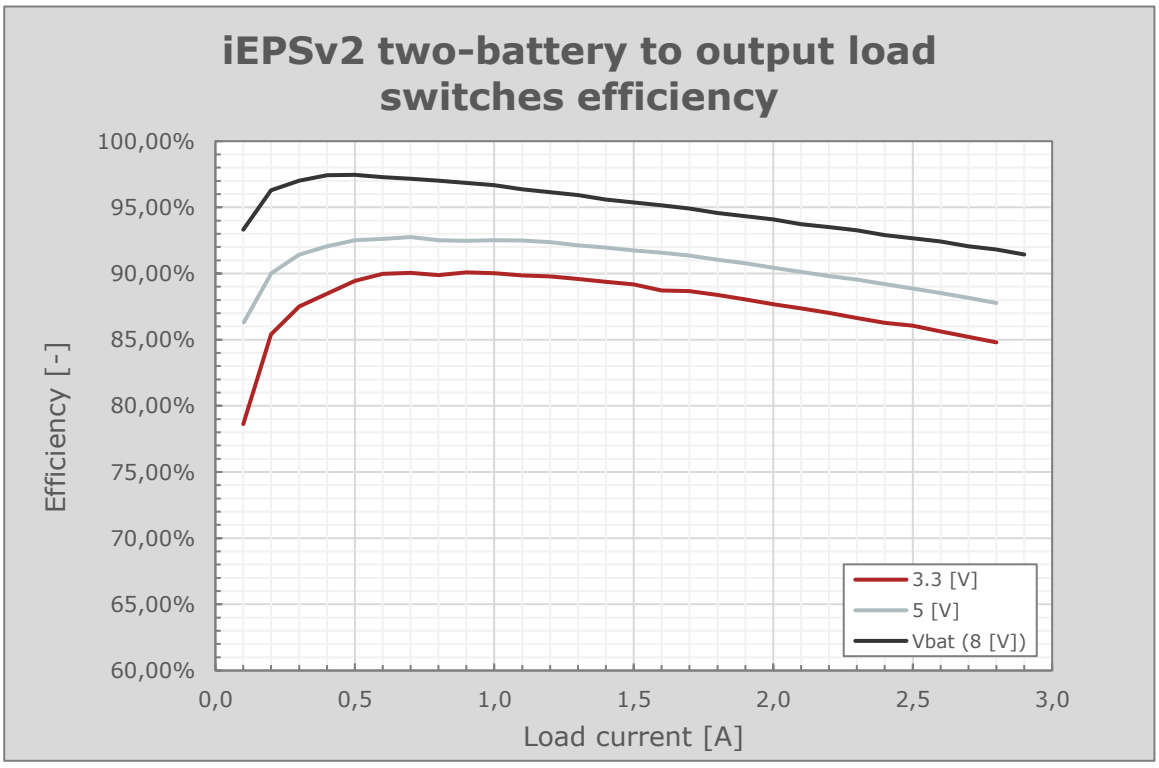


Figure 5 Output bus efficiencies with two-battery cell configuration.

Mechanical Description

The ISIS iEPS design is fully compatible with the CubeSat standard as defined by CalPoly and compatible with ISIS CubeSat structures. When supplied, the iEPS Type A is already fully assembled, with the 2-cell battery pack integrated to the motherboard as shown in Figure 6. Both the Type B and Type C motherboards are supplied independent from the 4-cell battery pack as it can be place freely within the stack, see Figure 7 and Figure 8. The Type C motherboard and its daughterboard as supplied integrated to each other as per Figure 8.

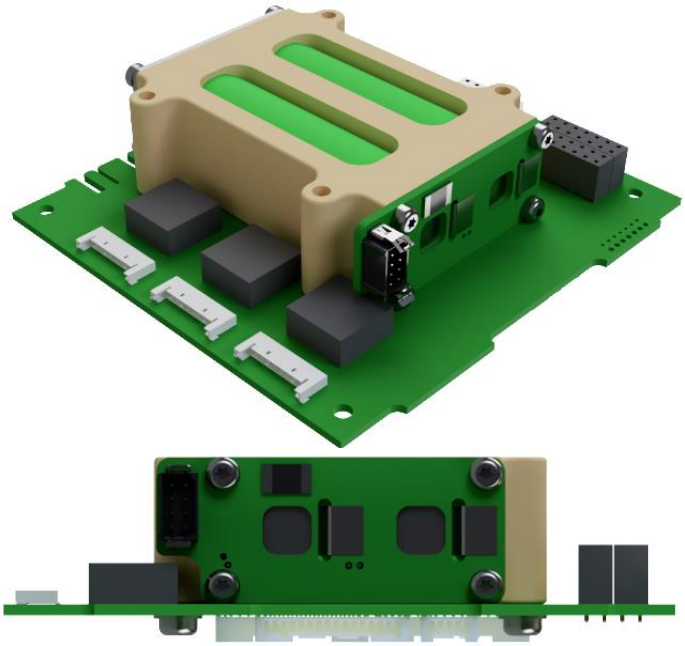
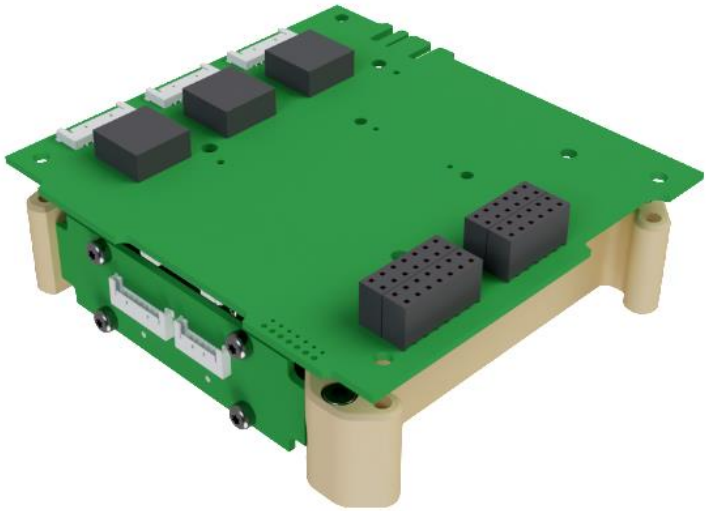


Figure 6 Type A (Motherboard + Battery pack (2 Cells))



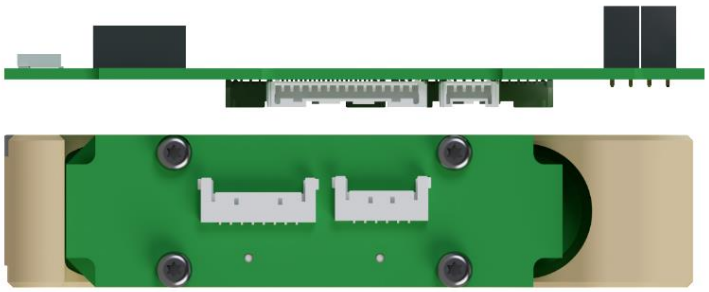


Figure 7 Type B (Motherboard)

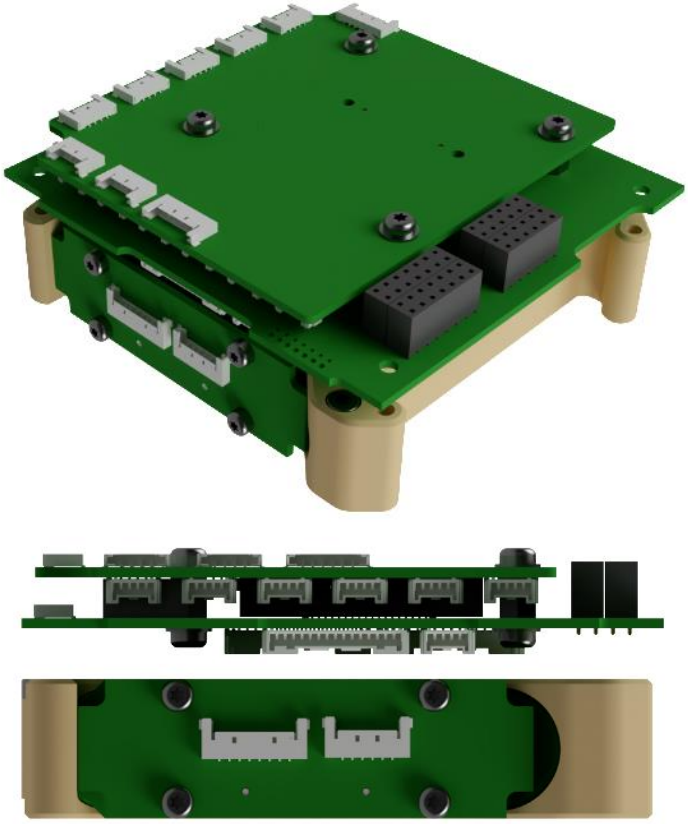


Figure 8 Type C (Motherboard + Daughterboard)

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