SuperCaps UPS
X2-Series Expansion Board

September 2025

Revision 001

X2BP10XCA *SuperCaps UPS X2-Series Expansion Board*

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Before opening the Strato Pi Max enclosure, disconnect all power sources and any connection to external devices, including USB and Ethernet cables.

Follow all applicable electrical safety standards, guidelines, specifications and regulations for installation, wiring and operations of Strato Pi Max.

Carefully read this document and the Strato Pi Max User Guide before installation.

Strato Pi Max is not authorised for use in safety-critical applications where a failure of the product would reasonably be expected to cause personal injury or death. Safety-critical applications include, without limitation, life support devices and systems, equipment or systems for the operation of nuclear facilities and weapons systems. Strato Pi Max is neither designed nor intended for use in critical military or aerospace applications or environments and for automotive applications or environment. Customer acknowledges and agrees that any such use of Strato Pi Max is solely at Customer's risk, and that Customer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

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Safety information

Carefully and fully read this user guide before installation and retain it for future reference.

Qualified personnel

The product described in this manual must be operated only by personnel qualified for the specific task and installation environment, in accordance with all relevant documentation and safety instructions. A qualified person should be capable of fully identifying all installation and operation risks and avoid potential hazards when working with this product.

Hazard levels

This manual contains information you must observe to ensure your personal safety and prevent damage to property. Safety information in this manual are highlighted by the safety symbols below, graded according to the degree of danger.

DANGER

Indicates a hazardous situation which, if not avoided, **will** result in death or serious personal injury.

WARNING

Indicates a hazardous situation which, if not avoided, **may** result in death or serious personal injury.

CAUTION

Indicates a hazardous situation which, if not avoided, can result in minor or moderate personal injury.

NOTICE

Indicates a situation which, if not avoided, can result in damage of property.

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Safety instructions

General safety instructions

Protect the unit against moisture, dirt and any kind of damage during transport, storage and operation. Do not operate the unit outside the specified technical data.

Never open the housing. If not otherwise specified, install in closed housing (e.g. distribution cabinet). Earth the unit at the terminals provided, if existing, for this purpose. Do not obstruct cooling of the unit. Keep out of the reach of children.

WARNING

Life threatening voltages are present within and around an open control cabinet.

When installing this product in a control cabinet or any other areas where dangerous voltages are present, always switch off the power supply to the cabinet or equipment.

WARNING

Risk of fire if not installed and operated properly.

Follow all applicable electrical safety standards, guidelines, specifications and regulations for installation, wiring and operations of this product.

The Compute Module board could generate a substantial amount of heat when the software forces the CPU and/or GPU to operate at high load levels. Ensure that the product is properly installed and ventilated to prevent overheat.

The Strato Pi Max internal power supply could generate a substantial amount oh heat, particularly when subject to a significant amount of electrical load.

An internal fan significantly improves the airflow and heat dissipation. Depending on external environment conditions, the fan could collect a significant amount of dust or other impurities, that could prevent it from spinning or could reduce its effectiveness. Periodically check that the fan is not blocked or partly obstructed.

NOTICE

The connection of expansion devices to this product may damage the product and other connected systems, and may violate safety rules and regulations regarding radio interference and electromagnetic compatibility.

Use only appropriate tools when installing this product. Using excessive force with tools may damage the product, alter its characteristics or degrade its safety.

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Supercapacitors

This board uses two parallel 50 F EDLC supercapacitors to store electrical energy required to keep the Strato Pi Max powered on when the external power supply is lost.

These components are charged at a low voltage of 2.5V maximum, which doesn't pose a safety risk, but can deliver a very large amount of current for a short time in case of a short circuit between the capacitor's terminals. If a short circuit occurs, the discharge current could pose a significant risk of overheating, fire or explosion.

When Strato Pi Max is turned off with the SuperCaps board in a fully charged state, the capacitors will retain the stored energy for a very long time (up to several days, depending on conditions).

Even when Strato Pi Max turns itself off after a prolonged loss of supply voltage, the supercapacitors will still hold a significant amount of energy.

Always handle Strato Pi Max with an installed X2BP10XCA SuperCaps board assuming the capacitors are fully charged.

The X2BP10XCA SuperCaps board is shipped with the supercapacitors fully discharged from the factory.



Risk of fire if not installed and operated properly.

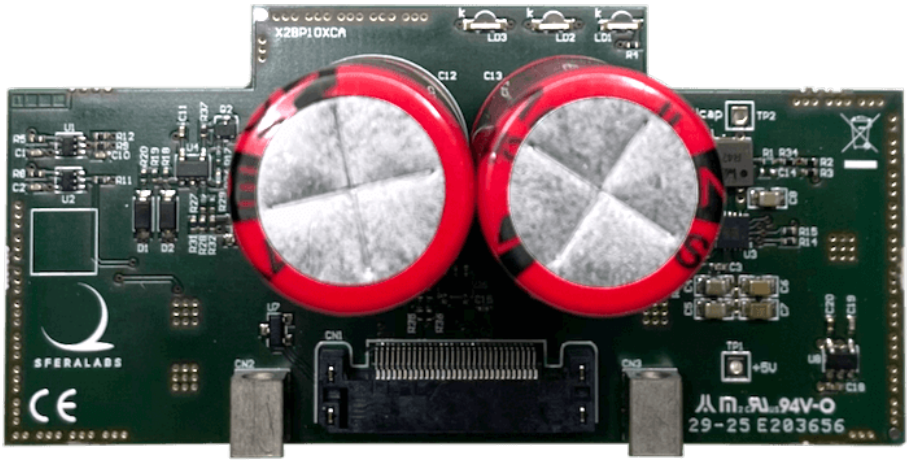
Ensure that no electrical conductive object gets in touch with the supercapacitors' terminals on the back side of the X2BP10XCA SuperCaps board or any other part of the board, even when the device is turned off, or the board is disconnected from the Strato Pi Max circuit board.

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Introduction

The X2-Series X2BP10XCA Supercapacitors Uninterruptible Power Supply (UPS) expansion board provides an integrated backup power supply to the Strato Pi Max XL and Strato Pi Max XS servers.

This manual generally refers to Strato Pi Max XL and Strato Pi Max XS as Strato Pi Max.



X2BP10XCA SUPERCAPS UPS X2-SERIES EXPANSION BOARD

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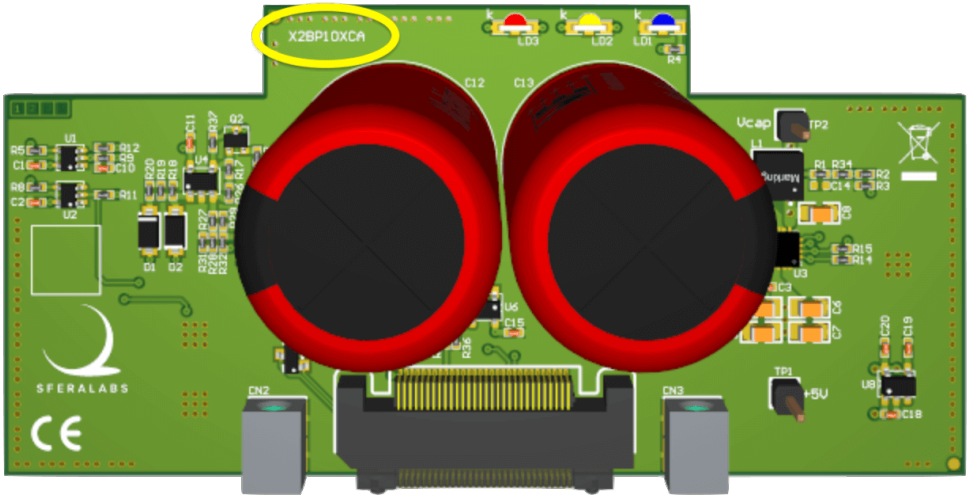
Features

- Integrated uninterruptible power supply (UPS) based on internal supercapacitors, without batteries
- The UPS can be enabled / disabled, configured and monitored by the user
- Front panel LEDs show power and UPS status.

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Device identification

The circuit board is identified by the "**X2BP10XCA**" marking (front view). One or more alphanumeric characters may follow.



CIRCUIT BOARD IDENTIFICATION MARKINGS

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Hardware setup

In order to install or remove the expansion board, the plastic DIN rail enclosure must be removed.

WARNING

Before opening the Strato Pi Max enclosure, wait until the Strato Pi Max turns off after power supply is removed.

Ensure that no electrical conductive object gets in touch with the supercapacitors' terminals on the back side of the X2BP10XCA SuperCaps board or any other part of the board, even when the device is turned off, or the board disconnected from the Strato Pi Max circuit board.

NOTICE

Before opening the Strato Pi Max enclosure, disconnect all power sources and any connection to external devices, including USB and Ethernet cables.

Follow the Strato Pi Max User Guide installation instructions.

This expansion board must be installed in slot 1.

Carefully align the board-to-board connectors and gently push the board in place. Note that the connectors could be damaged if not properly aligned during insertion or removal.

Use the two screws provided with the expansion board to lock the board in place.

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System architecture

UPS

This expansion board is built around a MAX38890 backup regulator connected to two 50 F, 2.7 V supercapacitors.

The regulator's control and feedback lines are interfaced with the RP2040 MCU of the Strato Pi Max, which also monitors both the supercapacitors' output voltage and the main 5 V rail.

Power and status LEDs

This expansion board has three LEDs, visible through the front panel:

A. Blue: is on when the expansion board is powered

B. Yellow: is on when Strato Pi Max power is supplied by the supercapacitors (main power not present)

C. Red: is on when the supercapacitors' charge is below the *READY* threshold (see next chapter)

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Usage

This expansion board provides backup power to the Strato Pi Max, ensuring seamless operation during short power interruptions. In the event of prolonged outages, it enables safeguarding the system by improving data corruption protection, supporting clean shutdowns and issuing alerts.

Monitoring and control are available via I²C or through sysfs files, as described in the Strato Pi Max User Guide.

The SuperCaps UPS Expansion Board requires Strato Pi Max with firmware version 3.37 or later.

Power-up sequence

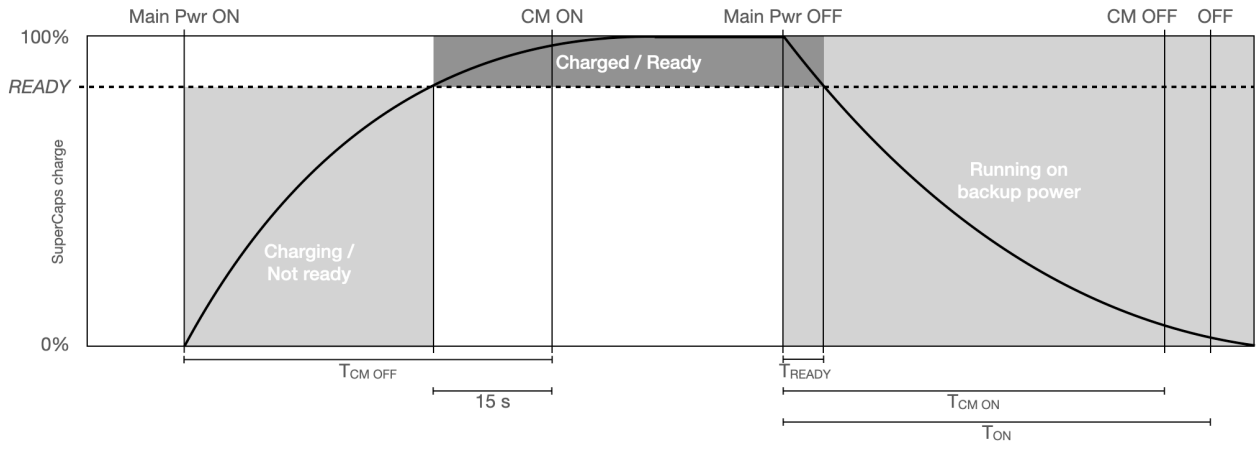
At startup (main power on), the supercapacitors are charged before the Compute Module is powered on. When the capacitors are fully discharged, this charging stage takes approximately one minute. This delay ensures that backup power is always available once the system is running.

If a faster boot is required, the UPS functionality can be configured to remain disabled at power up. In this case, critical tasks should only be started after the UPS has been re-enabled and has reached the *READY* state for at least 15 seconds.

Power failure behaviour

If the main power supply is interrupted, the system continues to operate on the energy stored in the supercapacitors. Once the capacitors' voltage falls below the *READY* threshold, Strato Pi Max remains powered as long as the capacitors retain sufficient charge.

The diagram below illustrates (not to scale) a full power-on and power-off sequence with the corresponding UPS states.



Depending on CPU usage conditions, the Compute Module will variably switch off (CM OFF) before the Strato Pi Max main board and its RP2040 MCU (OFF).

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Performance under different loads

The table below shows typical backup duration (in seconds) when using Strato Pi Max with a Compute Module 4 or 5, with no external peripherals connected, under different CPU usage conditions:

- **Low CPU load**: only OS and lightweight tasks running
- **CPU @ 100%**: one core at constant full load (high resource usage)
- **CPU @ 400%**: all four cores at constant full load (extreme scenario)

	Low CPU load		CPU @ 100%		CPU @ 400%	
	T_{READY}	$T_{CM\ ON}$	T_{READY}	$T_{CM\ ON}$	T_{READY}	$T_{CM\ ON}$
CM 4	12	86	9	65	6	36
CM 5	9	58	5	25	1	2

Note: The SuperCaps UPS board cannot effectively sustain a Compute Module 5 under extreme load conditions. For such use cases, a UPS expansion board with external battery is recommended.

The following table shows typical backup duration (in seconds), under different constant current loads:

Load (mA)	T_{READY}	T_{ON}
300	21	134
600	11	69
900	7	38
1200	4	20
1500	3	9
1800	0	0

Power failure procedure

To maximise uptime and allow sufficient time for a clean shutdown when the main power fails, the following sequence is recommended:

1. Stop CPU-intensive tasks;
2. Synchronise data to storage and send alerts;
3. When running below the *READY* threshold, either:
   - Initiate a safe shutdown, or
   - Continue only non-critical tasks, avoiding SSD/eMMC/µSD write operations.

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Watchdog integration

NOTICE

When UPS functionality is enabled, watchdog support is enforced.

If not already active (which is always recommended), the watchdog is automatically enabled as soon as a power failure is detected. This prevents the Compute Module from remaining in a locked off state, which could occur if main power is restored shortly after the CM is switched off but before the capacitors are completely discharged.

Once power has been restored, the user application may disable the watchdog or simply continue to provide the watchdog heartbeat.

For details on watchdog usage, refer to the Strato Pi Max User Guide.

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Advanced usage

I²C Configuration and control registers

Installing a SuperCaps UPS Expansion Board on Strato Pi Max adds the I²C configuration and control registers described below.

Refer to the Strato Pi Max User Guide for details on registers access and configuration parameters usage.

ADDR	BYTE 1								BYTE 0							
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
100															EN CFG	EN
106									BKP				UPS STAT			

Register 100 [R][W]

Bit 0 **EN**: UPS enabling

0 = disabled

1 = enabled

Bit 1 **EN CFG** [D]: power-up value for **EN** (default: 1)

Bit 15-2 reserved

Register 106 [R]

Bit 3-0 **UPS STAT**: UPS status

0 = idle

4 = charging / not ready

5 = charged / ready

6 = running on backup power

7 = running on backup power, below *READY* threshold

10 = fault

11 = unstable

Bit 6-4 reserved

Bit 7 **BKP**: power source

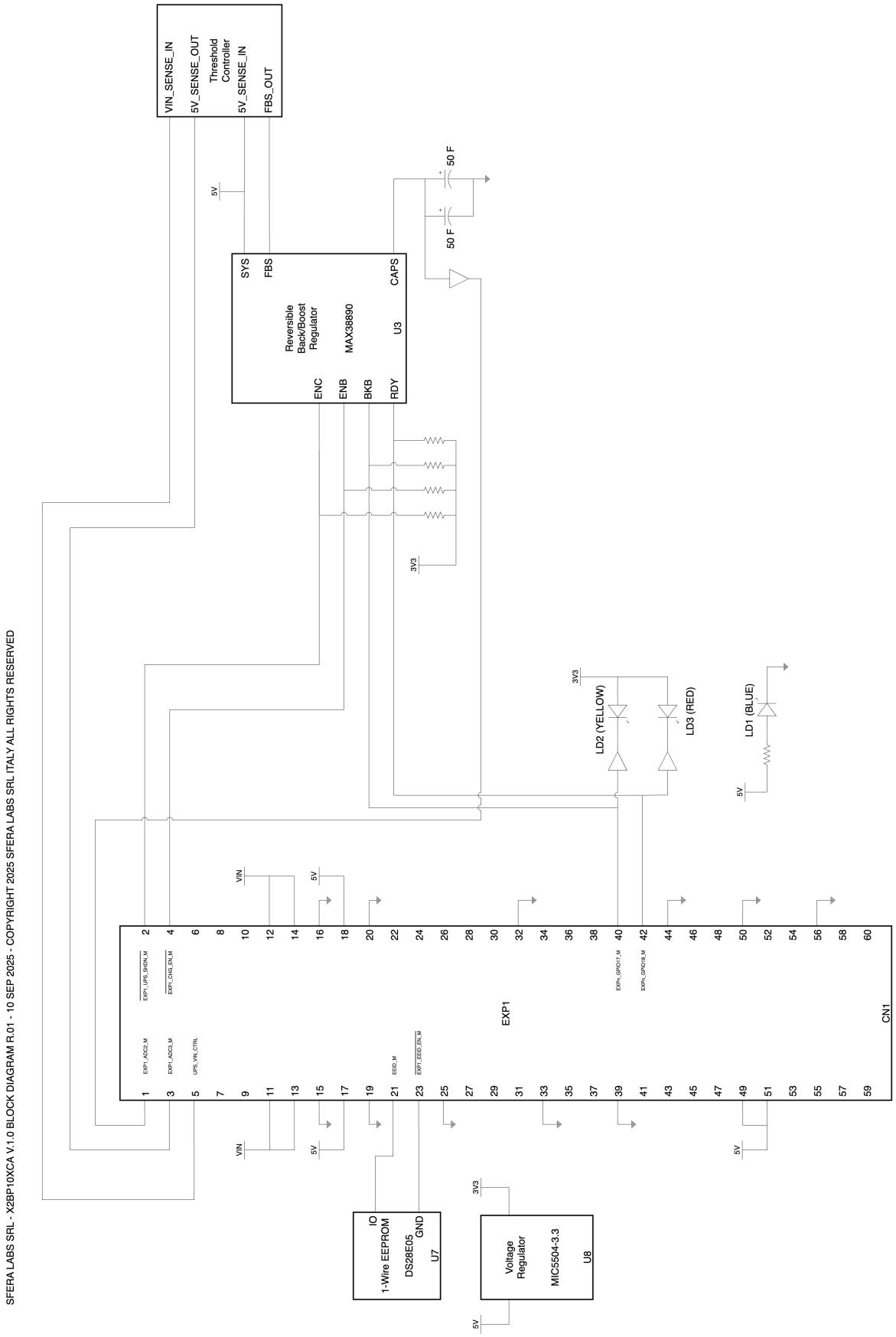
0 = running on main power

1 = running on backup power

Bit 15-8 reserved

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Block diagram



SFERA LABS SRL - X2BP10XCA V.1.0 BLOCK DIAGRAM R.01 - 10 SEP 2025 - COPYRIGHT 2025 SFERA LABS SRL ITALY ALL RIGHTS RESERVED

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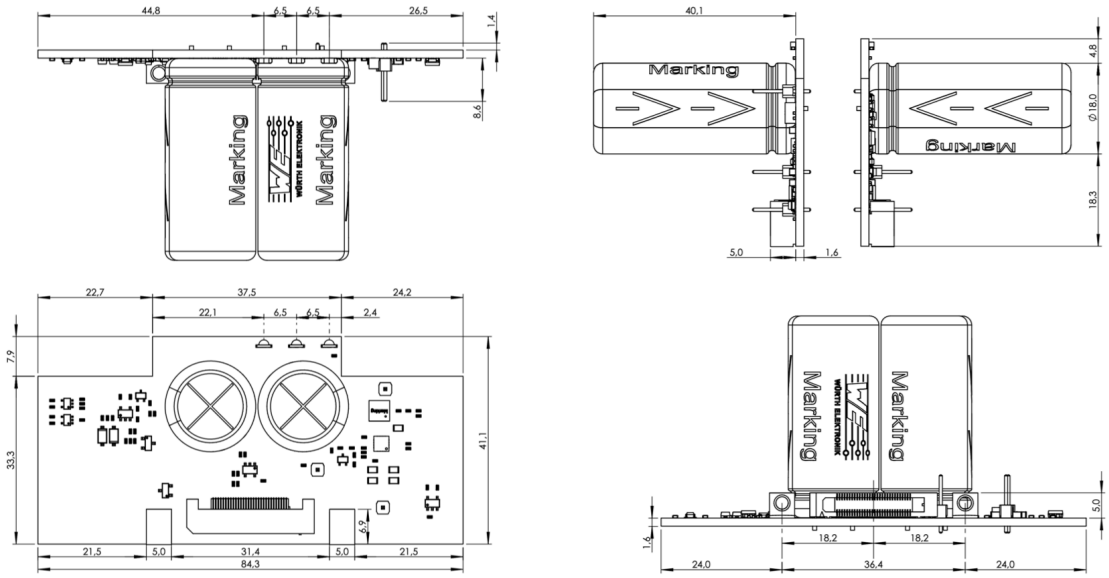
Technical specifications

Note: all values typical, at +25 °C and under normal operating conditions.

SUPERCAPACITORS AND VOLTAGE REGULATOR SPECIFICATIONS	
Total capacitance	100 F (+30% / -10% tolerance, typical conditions)
Maximum charge voltage	2.5 V
Ready state voltage threshold	2.3 V
Maximum backup current on 5 V rail	1.5 A
Maximum stored energy	0.085 Wh
EMI IMMUNITY STANDARDS	
Electromagnetic immunity compliance	EN 61000-4-2 (ESD) EN 61000-4-3 (Radiated RF Field) EN 61000-4-4 (Burst/fast transient) EN 61000-4-5 (Surge) EN 61000-4-6 (Conducted) EN 61000-4-8 (Power frequency magnetic field)
ENVIRONMENTAL	
Operating temperature	-20…+50 °C
Storage temperature	-30…+65 °C
Altitude	Up to 2000 m
Humidity	5% to 95% RH noncondensing
Protection degree	IP20
Vibration IEC 60068-2-6 (Test Fc, Operating)	0.7 g @ 5…100 Hz
MECHANICAL	
Dimensions	width: 84.3 mm height: 41.1 mm depth: 43.1 mm
Weight	41 g (including screws)

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Dimensions

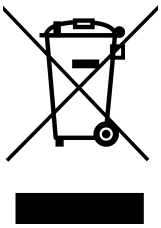


DIMENSIONS (mm)

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Disposal

Waste Electrical & Electronic Equipment



(Applicable in the European Union and other European countries with separate collection systems). This marking on the product, accessories or literature indicates that the product should not be disposed of with other household waste at the end of their working life. To prevent possible harm to the environment or human health from uncontrolled waste disposal, separate these items from other types of waste and recycle them responsibly to promote the sustainable reuse of material resources. Household users should contact either the retailer where they purchased this product, or their local government office, for details of where and how they can take these items for environmentally safe recycling. This product and its electronic accessories should not be mixed with other commercial wastes for disposal.

Strato Pi Max contains a small non rechargeable manganese dioxide lithium coin battery.

In the Strato Pi Max, the battery is not accessible from the outside. You should first remove the case body to gain access to the Strato Pi Max circuit boards. Always remove the battery before disposing of this product.

Installation and use restrictions

Standards and regulations

The design and the setting up of electrical systems must be performed according to the relevant standards, guidelines, specifications and regulations of the relevant country. The installation, configuration and programming of the devices must be carried out by trained personnel.

The installation and wiring of connected devices must be performed according to the recommendations of the manufacturers (reported on the specific data sheet of the product) and according to the applicable standards.

All the relevant safety regulations, e.g. accident prevention regulations, law on technical work equipment, must also be observed.

Safety instructions

Carefully read the safety information section at the beginning of this document.

Set-up

For the first installation of the device proceed according to the following procedure:

- make sure all power supplies are disconnected
- install and wire the device according to the schematic diagrams on the specific product user guide

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- after completing the previous steps, switch on the power supply and other related circuits.

Conformity Information

EU

This device complies with the following applicable European Community harmonised standards:

- 2014/30/EU - Electromagnetic Compatibility Directive (EMC)
- 2011/65/EU and 2015/863/EU - Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 3)

The following harmonised standards have been used to demonstrate conformity to these directives:

- EN61000-6-2:2019 - EMC Immunity standard for industrial environments
- EN 61000-6-3:2021 - EMC Emission standard for residential, commercial and light-industrial environments

The declaration of conformity is available at: https://www.sferalabs.cc

USA

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help.

Shielded cables must be used with this equipment to maintain compliance with FCC regulations.

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.

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CANADA

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

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This product meets the requirements of the standard EN 61000-6-3:2021 - Emission for residential, commercial and light-industrial environments.

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