# Strato Pi Plus User Guide

*November 2026*

*Revision 004*

**SPMP10**xy**41** *Strato Pi Plus with Raspberry Pi 4B 1GB*
**SPMP10**xy**42** *Strato Pi Plus with Raspberry Pi 4B 2GB*
**SPMP10**xy**44** *Strato Pi Plus with Raspberry Pi 4B 4GB*
**SPMP10**xy**48** *Strato Pi Plus with Raspberry Pi 4B 8GB*
**SPMP10**xy**51** *Strato Pi Plus with Raspberry Pi 5 1GB*
**SPMP10**xy**52** *Strato Pi Plus with Raspberry Pi 5 2GB*
**SPMP10**xy**54** *Strato Pi Plus with Raspberry Pi 5 4GB*
**SPMP10**xy**58** *Strato Pi Plus with Raspberry Pi 5 8GB*
**SPMP10**xy**516** *Strato Pi Plus with Raspberry Pi 5 16GB*

x variant:

- **A** = with 4 x RS-485 interfaces, CAN interface, relay
- **B** = with 1 x RS-485 interface, CAN interface, relay
- **C** = with 1 x RS-485 interface

y variant:

- **X** = no fan
- **F** = with fan

SFERALABS

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**Before opening the Strato Pi Plus 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 Plus.**

**Carefully read this user guide before installation.**

Strato Pi Plus 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 Plus 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 Plus 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.

# 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 Raspberry Pi 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 Plus internal power supply could generate a substantial amount of 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.

## Battery

Strato Pi Plus uses a small lithium non-rechargeable battery to power its internal real time clock (RTC).

**WARNING**

Improper handling of lithium batteries can result in an explosion of the batteries and/or release of harmful substances.

Worn-out or defective batteries can compromise the function of this product.

Replace the RTC lithium battery before it is completely discharged. The lithium battery must be replaced only with an identical battery. See the "Replacing the RTC backup battery" section for instructions.

Do not throw lithium batteries into fire, do not solder on the cell body, do not recharge, do not open, do not short-circuit, do not reverse polarity, do not heat above 85°C and protect from direct sunlight, moisture and condensation.

Dispose of used batteries according to local regulations and the battery manufacturer's instructions.

# Introduction

Strato Pi Plus is an industrial edge server based on the Raspberry Pi 4 or Raspberry Pi 5, designed for reliable edge computing in industrial automation and IoT applications requiring continuous, unattended operation.

Its hybrid architecture pairs the Raspberry Pi with a dedicated Raspberry Pi RP2354 microcontroller that independently manages real-time functions, system supervision, and a hardware watchdog, enabling automatic fault detection and recovery. The platform provides up to four galvanically isolated RS-485 and CAN (V2.0B/CAN FD) interfaces with ESD protection, a wide-range 10-50 V DC power supply, a power relay, industrial-grade protections, an integrated RTC, and a hardware secure element based on the Microchip ATECC608.

Housed in a compact DIN-rail enclosure, Strato Pi Plus combines the flexibility of the Raspberry Pi ecosystem with the reliability and connectivity required for demanding industrial environments.




**STRATO PI PLUS**

# Features

**Cores:**

- Raspberry Pi 4B or 5
- Raspberry Pi RP2354

**Mounting:**

- 4 modules DIN rail case
- power supply, I/O, and serial connections on pluggable screw terminal blocks

**Power supply:**

- 10-50 V DC power supply, with surge and reverse polarity protection, and 3.3A resettable fuse

**Serial interfaces:**

- up to four individually galvanically isolated RS-485 interfaces with electrostatic discharge protection and configurable line termination and A/B lines inversion
- Controller Area Network (CAN) V2.0B and CAN-FD interface, support speeds up to 8 Mb/s, with opto-isolator and electrostatic discharge protection

**I/O:**

- optional relay output rated for 1A at 48 V DC, with NO and NC contacts

**LEDs:**

- Power supply
- RS-485 and CAN TX/RX activity
- User application

**High reliability and security:**

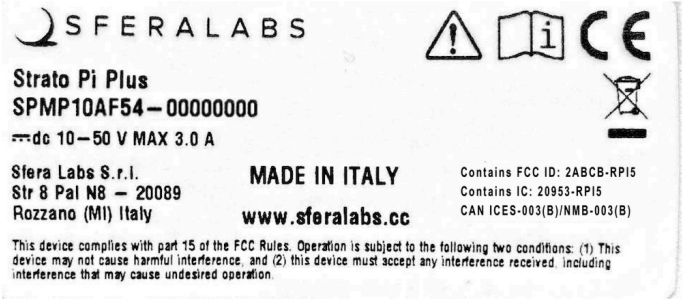
- hardware watchdog implemented in the RP2354, fully independent from the Raspberry Pi board
- highly accurate real time clock (RTC) with temperature compensated oscillator and replaceable back-up battery
- embedded Microchip ATECC608 secure element chip
- OTA support for in-field RP2354 firmware upgrades directly from the Raspberry Pi
- optional internal fan for active cooling
- optional 3-axis accelerometer for motion and tamper detection

**Raspberry Pi embedded:**

- 1 x Ethernet
- 4 x USB
- 2 x Micro HDMI
- 1 x microSD card slot
- Wi-Fi
- Bluetooth/BLE

# Device identification

The device can be identified with the information provided in the rating and identification plate, permanently attached to the side of the case.



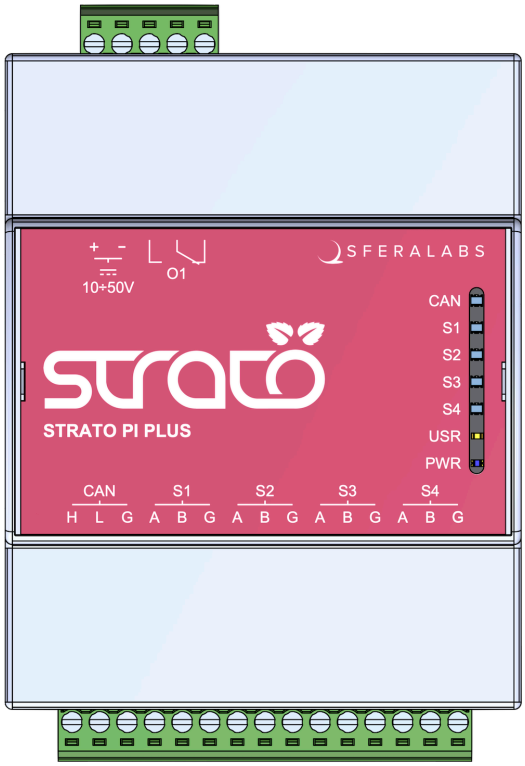

**EXAMPLE STRATO PI PLUS RATING AND IDENTIFICATION PLATE**

# Device overview

Strato Pi Plus is available in multiple variants, featuring different Raspberry Pi versions, a variable number of RS-485 and CAN interfaces, and optional features such as a power relay, accelerometer, and internal cooling fan.

The illustration below shows the front view of the "A" variant of Strato Pi Plus, which exposes all available external connections and features. In other variants, some terminal block pins may be unused.

Unless otherwise specified, the information in this manual applies to all versions.




**FRONT VIEW - VARIANT "A"**

The core of Strato Pi Plus is a standard Raspberry Pi single-board computer. It uses a microSD card as its boot and storage device and supports any operating system and software stack compatible with the Raspberry Pi platform.

To get started, install and configure your preferred operating system on the microSD card following the official Raspberry Pi documentation. Then proceed with the hardware setup described in the next chapter to power up and operate the device.

# Hardware setup

## MicroSD card

Strato Pi Plus uses a microSD card (not included) as its boot and storage device. The card can be inserted through the small opening on the top side of the enclosure. Use a small pen or paper clip to gently push the card in or to release and remove it.

## Terminal blocks

Strato Pi Plus features two 3.81 mm pitch pluggable terminal blocks.

- **Top terminal block**: used for the DC power supply connection (+ / –). On variants equipped with the relay option, this connector also provides the relay common, normally open (NO), and normally closed (NC) contacts.
- **Bottom terminal block**: provides A, B, and Ground (G) connections for each available RS-485 interface, and H, L, and Ground (G) connections for the CAN interface.

The maximum conductor cross-section is 1.3 $mm^2$ (16 AWG), or 0.5 $mm^2$ when using ferrules (highly recommended). The recommended stripping length is 6 mm. Terminal screws are M2; do not exceed a tightening torque of 0.3 Nm.

## Power supply

Strato Pi Plus must be powered with DC voltage only:

- **DC input voltage**: 10.0 V to 50.0 V (nominal range)
- **Maximum input current**: 3 A

Ensure correct polarity (+ / –) when connecting the power supply. The input stage includes reverse polarity protection with auto-resetting fuses and surge protection. The resettable fuse threshold is 3.3 A at 20 °C ambient temperature.

The blue PWR LED, visible on the front panel of the DIN-rail enclosure, indicates that input power is present.

The internal power supply stage is optimized to deliver up to 30 W through the main 5 V regulator, which generates all required internal supply voltages.

## Replacing the RTC backup battery

Strato Pi Plus includes a hardware real-time clock (RTC) powered by a dedicated long-life, non-rechargeable backup battery.

The device is shipped with a CR1220[1] Lithium/Manganese Dioxide ($Li/MnO_2$) battery pre-installed. This battery powers the RTC only when the main supply is not available. Depending on operating and environmental conditions, it is expected to last three or more

[1] BR1220 batteries (Lithium Poly-carbonmonofluoride) can also be used, for improved shelf and service life.

years if the device remains unpowered for extended periods, or up to the battery's nominal lifetime when external power is regularly applied.

The battery is not externally accessible. To replace it, first remove the enclosure to access the internal circuit board assembly. Follow the procedure described below to open the case.

**WARNING**

Improper handling of lithium batteries can result in an explosion of the batteries and/or release of harmful substances.

Worn-out or defective batteries can compromise the function of this product.

**KEEP OUT OF REACH OF CHILDREN**. Swallowing may lead to serious injury or death in as little as 2 hours due to chemical burns and potential perforation of the esophagus. Immediately see doctor.

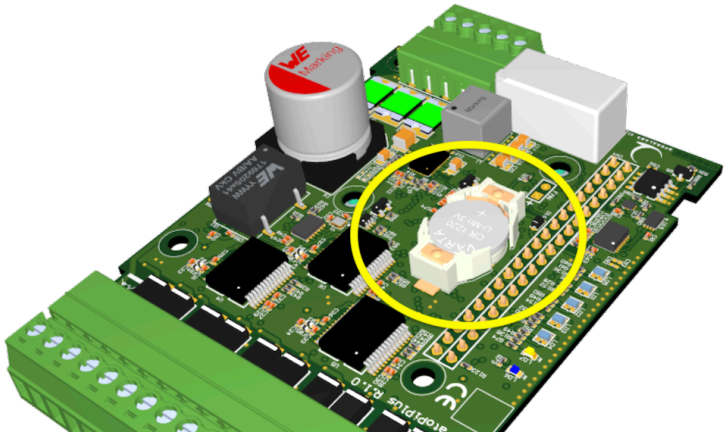
**WARNING**

Replace the RTC lithium battery before it is completely discharged. Replace the battery every 5 years even if the battery is still working properly. The lithium battery must be replaced only with an identical **CR1220** or **BR1220** battery.

**WARNING**

Do not throw lithium batteries into fire, do not solder on the cell body, do not recharge, do not open, do not short-circuit, do not reverse polarity, do not heat above 85 °C and protect from direct sunlight, moisture and condensation.

Dispose of used batteries according to local regulations and the battery manufacturer's instructions.



**RTC BACKUP BATTERY**

Once the circuit board assembly has been removed from the enclosure, use a non-conductive pin or small tool to carefully extract the battery from its holder. Insert the new battery with a gentle push; no tools are required for installation, as it is secured by a spring contact.

Ensure that the negative (–) terminal faces the circuit board and makes contact with the central pad of the battery holder, as shown in the image above.

The real-time clock will immediately reset when the backup battery is disconnected.

## Case opening and battery replacement procedure

**NOTICE**

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

Follow the steps below in the exact order:

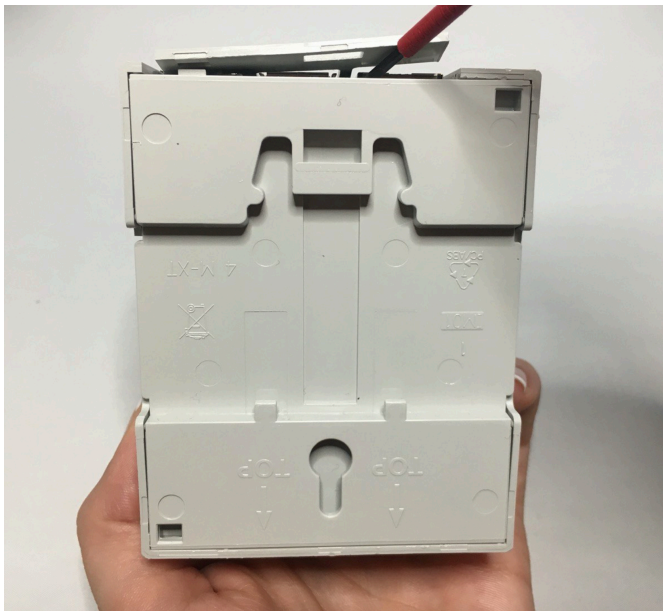
1. **Remove the microSD card**

**NOTICE**

Opening the case with the microSD card inserted will damage both the card and the Raspberry Pi board.

2. Remove the black plastic DIN-rail hook
3. Using a small flat screwdriver, gently separate the bottom part of the enclosure (with the board assembly) from the top cover (see image below)
4. Use a non-conductive pin or small tool to remove the battery from its holder
5. Insert the new battery with a gentle push, ensuring correct polarity (negative terminal facing the PCB)

6. Refit the bottom part of the enclosure, applying gentle pressure on the corners until it snaps into place
7. Reinstall the black plastic DIN-rail hook
8. Reinsert the microSD card.



**OPENING THE CASE**

# System architecture

Strato Pi Plus features two processing units: the Raspberry Pi single-board computer (SBC) and a dedicated Raspberry Pi RP2354 microcontroller.

In the standard configuration, the RP2354 is preloaded with firmware implementing the functional logic described in this manual. It operates as an I²C slave device on the Raspberry Pi's I²C bus, receiving commands and configuration parameters from the SBC.

The Raspberry Pi and RP2354 are interconnected through additional interfaces and linked to the subsystems described below. Refer to the schematic diagram for details.

The Raspberry Pi remains fully available for user applications, allowing developers to build and deploy their own solutions while leveraging all hardware resources and system features of Strato Pi Plus.

To simplify integration, a driver for Raspberry Pi OS (Debian-based Linux) is provided. It exposes RP2354-controlled parameters and other subsystem features via the sysfs file system, enabling interaction through simple file read/write operations from any programming language or tool that supports standard file access. Refer to the "Software installation and usage" chapter for details.

For specialized configurations, alternative operating modes, or custom RP2354 firmware development, refer to the "Advanced Usage chapter".

## Power Control

Strato Pi Plus features a power control system that manages and monitors the power supply of all its subsystems, including the Raspberry Pi and the RP2354 microcontroller.

The standard RP2354 firmware provides a comprehensive set of functions for system monitoring, user control, and automated power management to enhance reliability and recovery.

A configurable power-up delay ensures that the Raspberry Pi is powered only after the main power source has remained stable for a specified duration.

The system can be configured to perform controlled power cycles of the Raspberry Pi with customizable logic and timing parameters.

A power cycle can be triggered directly by the user application or automatically in response to a watchdog timeout.

The power supply input voltage and current are monitored and accessible to the user.

## PWR LED

The blue PWR LED, visible through the front panel of the DIN-rail case, is lit when power supply is available.

## USR LED

The yellow USR LED can be used for custom signaling or configured to indicate specific system states. System states are shown through short blink sequences, repeated every two seconds:

| Blinks | State |
|---|---|
| 1 | Watchdog enabled |
| 2 | Watchdog timeout expired, power cycle not initiated |
| 3 | Power cycle initiated, down delay running |
| 4 | Raspberry Pi powered off by power cycle |
| 5 | User-defined power-up delay active |
| 7 | Power-up delay due to low or unstable voltage detected on power supply input |

User control priority can be configured to allow both user-defined and system-driven signaling on the same LED.

By default the USR LED is configured to report all the system states above, except the first one (watchdog enabled), but priority is given to user commands.

## CAN and S1-S4 LEDs

Each available CAN and RS-485 interface (S1-S4) is equipped with a dedicated bi-color status LED to indicate communication activity.

The LED blinks green during data transmission (TX) and red during data reception (RX).

## RS-485 interfaces

Depending on the selected variant, Strato Pi Plus provides up to four RS-485 interfaces, identified as S1 through S4. The A, B, and isolated ground (G) signals of each interface are available on the terminal block.

Each interface is individually galvanically isolated and built around the Analog Devices ADM2861E transceiver, supporting data rates up to 500 kbps. Local echo of the transmitted data, line termination, and A/B polarity inversion can be configured programmatically for each interface.

The TX and RX signals of every RS-485 channel are connected to the UARTs of both the Raspberry Pi (up to four independent UARTs) and the RP2354 (two independent UARTs).

In the standard configuration, RS-485 communication is assigned to the Raspberry Pi. The RP2354 manages the TX-enable control (DE/$\overline{\text{RE}}$ lines) of each transceiver, either by mirroring the Raspberry Pi UART RTS signal (when used) or by automatically detecting the baud rate and bits settings of the transmitted data.

The table below shows the mapping between each RS-485 interface and the corresponding UART and GPIO pins of the Raspberry Pi 4 or 5.

| Interface | Raspberry Pi 4 UART | Raspberry Pi 5 UART | GPIOs |
|---|---|---|---|
| **S1** | UART2 | UART1 | 0-3 |
| **S2** | UART3 | UART2 | 4-7 |
| **S3** | UART4 | UART3 | 8-11 |
| **S4** | UART5 | UART4 | 12-15 |

## CAN interface

On supported variants, Strato Pi Plus includes a CAN interface based on the Microchip MCP2518FD CAN FD controller and the Microchip MCP2558FD high-speed CAN FD transceiver. The interface supports both CAN 2.0B and CAN FD modes, with data rates up to 8 Mbps (data phase) and 1 Mbps (arbitration phase). CAN H, CAN L, and isolated ground (G) signals are available on the terminal block.

The TX and RX lines between the controller and transceiver are isolated from the controller and the Raspberry Pi cores using dedicated opto-couplers. A termination resistor between H and L can be enabled programmatically.

In the standard configuration, CAN communication is handled by the MCP2518FD controller, which is connected to the Raspberry Pi via SPI1 (GPIOs 19-21) with chip enable on GPIO 18 (SPI1 CE0).

The RP2354 is also connected to the TX and RX lines of the MCP2558FD transceiver. With custom firmware, the RP2354 can implement CAN communication by directly managing the transceiver.

## Relay output

Strato Pi Plus has one optional relay with change-over (CO), Single Pole Double Throw (SPDT) terminals rated for 1A at 48 V DC.

The relay is controlled by a GPIO pin of the RP2354.

## Real Time Clock

Strato Pi Plus has a NXP PCF2131 hardware real time clock (RTC) connected to the I²C bus (address 0x53), with a dedicated long-life non-rechargeable back-up battery.

Once the RTC driver is properly installed, you will simply use the standard date and time commands to control the hardware clock.

## ATECC608 secure element

Strato Pi Plus embeds the ATECC608A or ATECC608B (depending on production lot) secure element chip from Microchip. The ATECC608 is connected via I²C bus (address 0x60).

Its key features are:

- Cryptographic co-processor with secure hardware-based key storage
- Protected storage for up to 16 Keys, certificates or data
- Hardware support for asymmetric sign, verify, key agreement – ECDSA: FIPS186-3 Elliptic Curve Digital Signature
  - ECDH: FIPS SP800-56A Elliptic Curve Diffie-Hellman
  - NIST standard P256 elliptic curve support
- Hardware support for symmetric algorithms
  - SHA-256 & HMAC hash including off-chip context save/restore
  - AES-128: encrypt/decrypt, Galois field multiply for GCM
- Networking key management support
  - Turnkey PRF/HKDF calculation for TLS 1.2 & 1.3
  - Ephemeral key generation and key agreement in SRAM – Small message encryption with keys entirely protected
- Secure boot support
  - Full ECDSA code signature validation, optional stored digest/signature – optional communication key disablement prior to secure boot
  - Encryption/Authentication for messages to prevent on-board attacks
- Internal high-quality FIPS 800-90 A/B/C Random Number Generator (RNG)
- Two high-endurance monotonic counters
- Guaranteed unique 72-bit serial number.

Refer to its documentation and Microchip's software resources for usage details.

## Accelerometer

Strato Pi Plus optionally embeds the IIS2DLPC high-performance three-axis linear accelerometer, connected to the I²C bus (address 0x19). The IIS2DLPC has user selectable full scales of ±2g/±4g/±8g/±16g and is capable of measuring accelerations with output data rates from 1.6 Hz to 1600 Hz.

The accelerometer can be used as a tamper detection sensor, triggered when the Strato Pi Plus case is moved or tilted, as well as for other motion-related applications, like vibration monitoring and impact recognition.

## Hardware watchdog

Strato Pi Plus implements a dedicated hardware watchdog logic, controlled by the RP2354, that triggers a power cycle of the Raspberry Pi when unresponsive.

The watchdog is disabled by default and can be configured to be always active, which is highly recommended on deployed systems.

When enabled, you should update the heartbeat faster than the configured timeout. After timeout expiration, a second configurable delay is started, after which a power cycle is initiated.

## Internal fan

Strato Pi Plus has an optional internal fan, controlled by the RP2354, with user-configurable activation thresholds to improve heat dissipation inside its DIN-rail enclosure.

# Software installation and usage

All features of Strato Pi Plus can be used with any operating system, programming language or framework compatible with Raspberry Pi.

Visit the link below for drivers and resources for Raspberry Pi OS (Linux Debian):

https://github.com/sfera-labs/strato-pi-plus

# Advanced usage

## RP2354 firmware

The standard firmware running on the RP2354 microcontroller implements all the functional logic described in the previous chapters.

You can download the latest version of the standard firmware here:

https://www.sferalabs.cc/files/stratopiplus/fw/latest/strato_pi_plus.elf

The microcontroller can be programmed with user-developed custom firmware, that can replace the factory installed version.

**WARNING**

The RP2354 microcontroller firmware implements critical logic and checks to ensure safe and reliable operations of Strato Pi Plus including, but not limited to, watchdog and power distribution voltages, currents and internal temperature monitoring.

In order to develop a safe and reliable custom firmware, you should be fully aware of the internal hardware architecture of Strato Pi Plus, and of all safety and control requirements needed for your application and installation constraints.

### Firmware update and development

The SWDIO and SWCLK lines of the RP2354 are connected to GPIO 24 and GPIO 25 of the Raspberry Pi respectively, enabling on-device firmware upload and development.

OpenOCD[2] can be used under Raspberry Pi OS or other Linux distributions to program the RP2354 via SWD.

Visit the link below for resources and examples:

https://github.com/sfera-labs/strato-pi-plus

## I²C configuration and control

The standard firmware running on the RP2354 implements an I²C slave device with address 0x35. Its registers can be used to control and configure all features described in the previous chapters.

The Linux driver uses this protocol internally to implement all its functionalities.

The RP2354 I²C interface is connected to GPIO 22 (SDA) and GPIO 23 (SCL) of the Raspberry Pi. These correspond to i2c6 on the Raspberry Pi 4 and i2c3 on the Raspberry Pi 5.

The following sections describe the available control and configuration registers in detail.

[2] https://openocd.org/

Configuration parameters (marked [C] or [D] below) are persisted and retained across power cycles. Those marked [D] hold the default value copied to their corresponding runtime control field (detailed in their description) upon power-up of the Raspberry Pi.

A power-up of the Raspberry Pi occurs when:

- the unit is powered on (power supply connected);
- a power cycle is explicitly initiated with the dedicated I²C request; or
- a power cycle is initiated by another process configured to do so (e.g. watchdog timeout expiration).

A software reboot of the does not correspond to a power-up.

The following attributes denote the access mode of each register/field:

[R]: readable

[W]: writable

[Z]: can be set to zero only, i.e. cleared

The data payload of write requests have the following structure:

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE LSB | ... | VALUE MSB | OPTIONAL MASK LSB | ... | OPTIONAL MASK MSB | CRC |

The data payload of read responses have the following structure:

| | | | |
|---|---|---|---|
| VALUE LSB | ... | VALUE MSB | CRC |

Registers containing values that span on multiple bytes store the least significant byte (LSB) in the first byte (byte 0) and the most significant one (MSB) in the last byte.

Write requests on registers containing multiple fields can include an optional mask value (same length of the register bytes) to specify which bits of the register shall be written.

The CRC byte value is calculated using a CRC-8 function with polynomial $x^8 + x^5 + x^3 + x^2 + x + 1$ (i.e. 0x2F) and initial value of 0xFF. The function is applied starting with the register's address number, followed by the value bytes and the optional mask bytes from least to most significant.

## FIRMWARE VERSION

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 1 | MAJOR | | | | | | | | MINOR | | | | | | | |

**Register 1** [R]

Bit 7-0 **MINOR**: minor version of the installed firmware

Bit 15-8 **MAJOR**: major version of the installed firmware

## CONFIGURATION COMMANDS

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 5 | KEY | | | | | | | | CMD | | | | | | | |
| 6 | | | | | ERR | BUSY | FAIL | OK | CMD | | | | | | | |

**Register 5** [W]

Bit 15-8 **KEY**: set to 0x2A

Bit 7-0 **CMD**: command

0x52 ('R' ASCII) = restore factory default configuration

0x43 ('C' ASCII) = skip initial Pi power off on next RP2354 boot (needed during firmware update)

**Register 6** [R]

Result of command written to register 5

Bit 7-0 **CMD**: processed command

Bit 8 **OK**: set to 1 when command successfully terminated

Bit 9 **FAIL**: set to 1 when command failed

Bit 10 **BUSY**: set to 1 when command being executed

Bit 11 **ERR**: set to 1 when invalid values are written in command register

Bit 15-12 reserved

## HW CONFIGURATION

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 10 | | | | | | | | | | | REL | CAN | RS4 | RS3 | RS2 | RS1 |

**Register 10** [R]

Detected hardware interfaces. Used to identify Strato Pi Plus variant.

Bit 0, ..., 3 **RS*n***: RS-485 interface *n*

0 = not detected

1 = detected

Bit 4 **CAN**: CAN interface

0 = not detected

1 = detected

Bit 5 **REL**: relay

0 = not detected

1 = detected

## USR LED

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 14 | T ON | | | | | | | | | | | | | | | |
| 15 | T OFF | | | | | | | | | | | | | | | |
| 16 | REPS | | | | | | | | | | | | | | | |
| 17 | USR PRI | | | | | | | | | | | WDT EXP | WDT EN | PWR OFF | PWR DWN | PWR UP |

**Register 14** [R][W]

Bit 15-0 **T ON**: LED cycle ON time in milliseconds, applied when REPS is written

**Register 15** [R][W]

Bit 15-0 **T OFF**: LED cycle OFF time in milliseconds, applied when REPS is written

**Register 16** [R][W]

Bit 15-0 **REPS**: LED cycle repetitions, cycle starts when written. Set to zero to repeat indefinitely

**Register 17** [R][W][C]

Configuration register for system state blink patterns (see **USR LED**).

Bit 0 **PWR UP**: power up delay states

0 = don't show

1 = show (default)

Bit 1 **PWR DWN**: power cycle down delay state

0 = don't show

1 = show (default)

Bit 2 **PWR OFF**: power cycle off state

0 = don't show

1 = show (default)

Bit 3 **WDT EN**: watchdog enabled state

0 = don't show (default)

1 = show

Bit 4 **WDT EXP**: watchdog expired state

0 = don't show

1 = show (default)

Bit 14-5 reserved

Bit 15 **USR PRI**: user commands priority

0 = blink sequences of enabled system states will override any user command

1 = after a user command (write to **REPS** register), system blink sequences won't be shown until this bit is reset to 0 (default)

## RS-485

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 21 | | | | | | ECH1 | INV1 | TRM1 | | | | | | | MODE1 | |
| 22 | | | | | | ECH2 | INV2 | TRM2 | | | | | | | MODE2 | |
| 23 | | | | | | ECH3 | INV3 | TRM3 | | | | | | | MODE3 | |
| 24 | | | | | | ECH4 | INV4 | TRM4 | | | | | | | MODE4 | |

**Registers 21, ..., 24** [R][W][C]

Bit 1-0 **MODE*n***: RS-485 interface *n* mode configuration

0 = disabled

1 = auto (default): if the Raspberry Pi UART is controlling the RTS signal (i.e. it is set low at any time) mode is switched to 2. Otherwise the TX-enable (DE) line of the interface is controlled by automatically detecting the baud rate and bits settings of the transmitted data

2 = passthrough: the TX-enable (DE) line of the interface mirrors the Raspberry Pi UART RTS signal

3 = passive: the TX-enable (DE) line of the interface mirrors the Raspberry Pi UART TX signal (this mode requires external pull-up/pull-down on the A/B lines)

Bit 7-2 reserved

Bit 8 **TRM*n***: RS-485 interface *n* line termination configuration

0 = disabled (default)

1 = enabled

Bit 9 **INV*n***: RS-485 interface *n* A/B polarity inversion configuration

0 = disabled (default)

1 = enabled

Bit 10 **ECH*n***: RS-485 interface *n* local echo configuration

0 = disabled (default): reception disabled while transmitting

1 = enabled: reception enabled while transmitting

Bit 15-11 reserved

## CAN

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 33 | | | | | | | | | | | | | | | | TRM |

**Register 33** [R][W]

Bit 0 **TRM**: H/L lines termination control

0 = disabled (default)

1 = enabled

Bit 15-1 reserved

## RELAY

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 37 | | | | | | | | | | | | | | | | CTRL |

**Register 37** [R][W]

Bit 0 **CTRL**: relay control

0 = rest position (default)

1 = switched position

Bit 15-1 reserved

## PCIE

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 41 | | | | | | | | | | | | | | | EN CFG | EN |

**Register 41** [R][W]

Bit 0 **EN**: PCIe control

0 = disabled

1 = enabled (default)

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

0 = disabled

1 = enabled (default)

Bit 15-2 reserved

## WATCHDOG

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 48 | | | | | | | | | | | | | | EXP | EN CFG | EN |
| 49 | TIMEOUT | | | | | | | | | | | | | | | |
| 50 | TIMEOUT CFG | | | | | | | | | | | | | | | |
| 51 | DOWN DELAY | | | | | | | | | | | | | | | |
| 52 | PCIE EN | | | | | | | | | | | | | | | |

**Register 48**

A write request to this register updates the watchdog heartbeat.

Bit 0 **EN** [R][W]: watchdog enable control

0 = disabled (default)

1 = enabled

Bit 1 **EN CFG** [R][W][D]: power-up value for **EN**

Bit 2 **EXP** [R]: timeout state

0 = watchdog timeout not expired

1 = watchdog timeout expired

Bit 15-3 reserved

**Register 49** [R][W]

Bit 15-0 **TIMEOUT**: heartbeat timeout, in seconds (default = 60)

**Register 50** [R][W][D]

Bit 15-0 **TIMEOUT CFG**: power-up value for **TIMEOUT**

**Register 51** [R][W][C]

Bit 15-0 **DOWN DELAY**: forced power cycle delay after timeout expiration, in seconds (default = 60)

**Register 52** [R][W][C]

Bit 15-0 **PCIE EN**: PCIe power control configuration on watchdog reset

0 = disabled (default)

1 = toggle PCIe power state upon each watchdog reset

$N \geq 2$ = toggle PCIe power state after $N$ consecutive watchdog resets with no heartbeat received in between. Requires **EN CFG** set to 1

## POWER CYCLE

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 56 | | | | | | | | | | | | | PCIE | | | EN |
| 57 | DOWN DELAY | | | | | | | | | | | | | | | |
| 58 | OFF TIME | | | | | | | | | | | | | | | |
| 59 | UP DELAY | | | | | | | | | | | | | | | |

**Register 56** [R][W]

Bit 0 **EN**: power cycle control

0 = disabled

1 = power cycle initiated

Bit 1-2 reserved

Bit 3 **PCIE** [C]: PCIe power control configuration on power cycle

0 = disabled (default)

1 = toggle PCIe power state upon each power cycle

Bit 15-4 reserved

**Register 57** [R][W][C]

Bit 15-0 **DOWN DELAY**: shutdown delay from enabling, in seconds (default = 60)

**Register 58** [R][W][C]

Bit 15-0 **OFF TIME**: duration of power-off, in seconds (default = 5)

**Register 59** [R][W][C]

Bit 15-0 **UP DELAY**: power-up delay after main power is enabled/restored, in seconds (default = 0)

## POWER MONITORING

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 63 | VIN V | | | | | | | | | | | | | | | |
| 64 | VIN I | | | | | | | | | | | | | | | |

**Register 63** [R]

Bit 15-0 **VIN V**: voltage measured on power supply input, in mV

**Register 64** [R]

Bit 15-0 **VIN I**: current drain measured on power supply input, in mA

## TEMPERATURE

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 68 | TEMP | | | | | | | | | | | | | | | |
| 69 | FAN ON | | | | | | | | | | | | | | | |
| 70 | FAN OFF | | | | | | | | | | | | | | | |

**Register 68** [R]

Bit 15-0 **TEMP**: temperature measured by the RP2354 internal sensor, in °C/100 signed

**Register 69** [R][W]

Bit 15-0 **FAN ON**: temperature threshold for fan activation, in °C/100 signed

**Register 70** [R][W]

Bit 15-0 **FAN OFF**: temperature threshold for fan deactivation, in °C/100 signed

## SYSTEM ERRORS

| ADDR | BYTE 1 | | | | | | | | BYTE 0 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| 74 | | RS4 | | RS3 | | RS2 | | RS1 | | | | I2C SLV | CFG | RP RST | RP | STUP |

The registers' bits are set to 1 when the corresponding error occurs and reset to 0 only when cleared by the user.

**Register 74** [R][Z]

Bit 0 **STUP**: system setup failure

Bit 1 **RP**: RP2354 failure

Bit 2 **RP RST**: RP2354 reset occurred

Bit 3 **CFG**: configuration loading/saving error

Bit 4 **I2C SLV**: RP2354 I²C slave failure

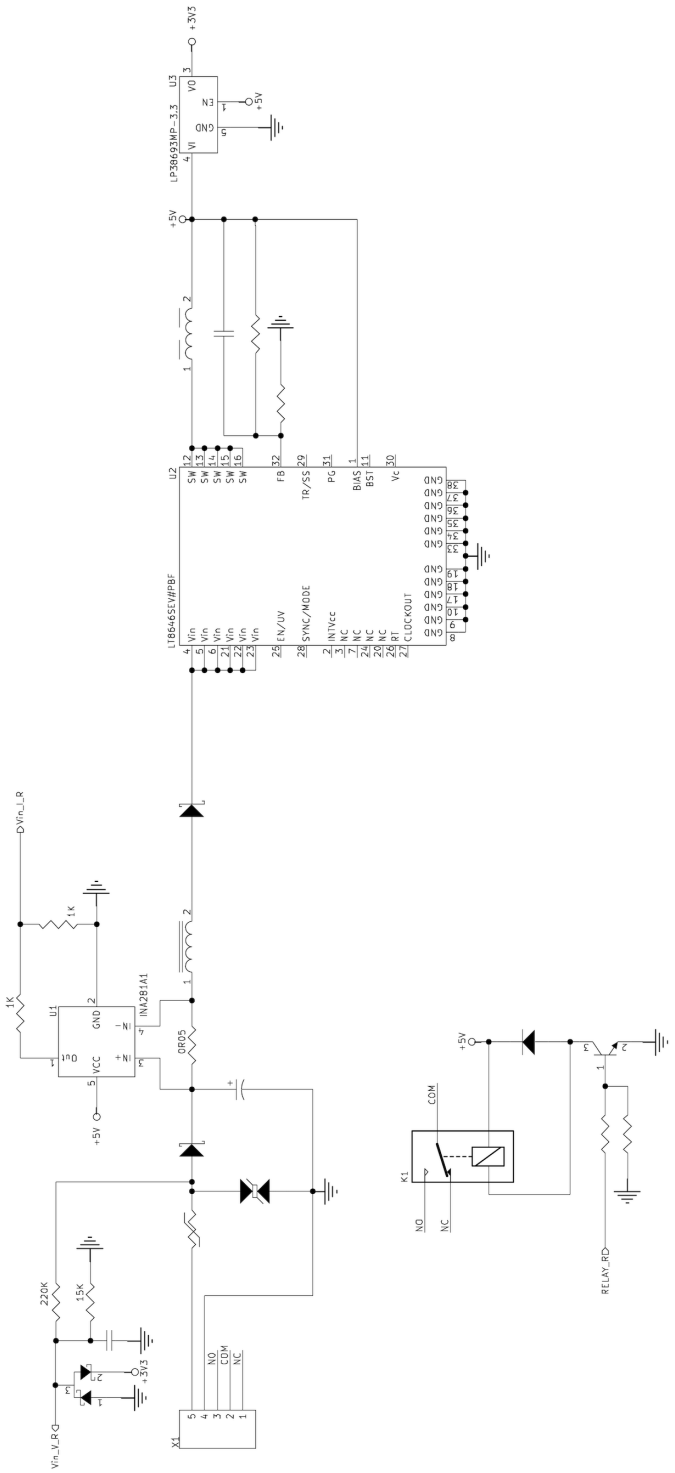
Bit 5-7 reserved

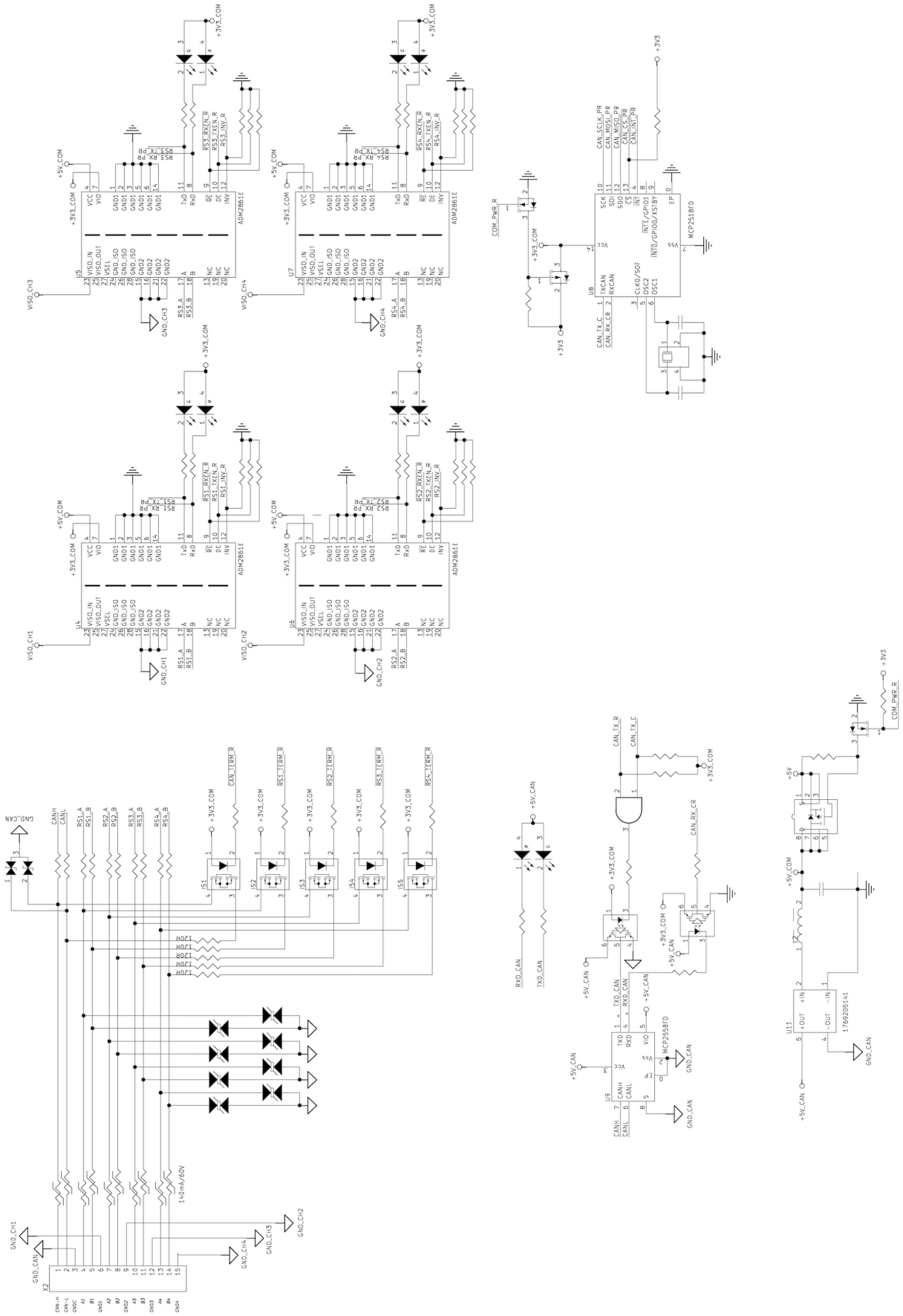
Bit 8, 10, 12, 14 **RS*n***: RS-485 interface *n* failure

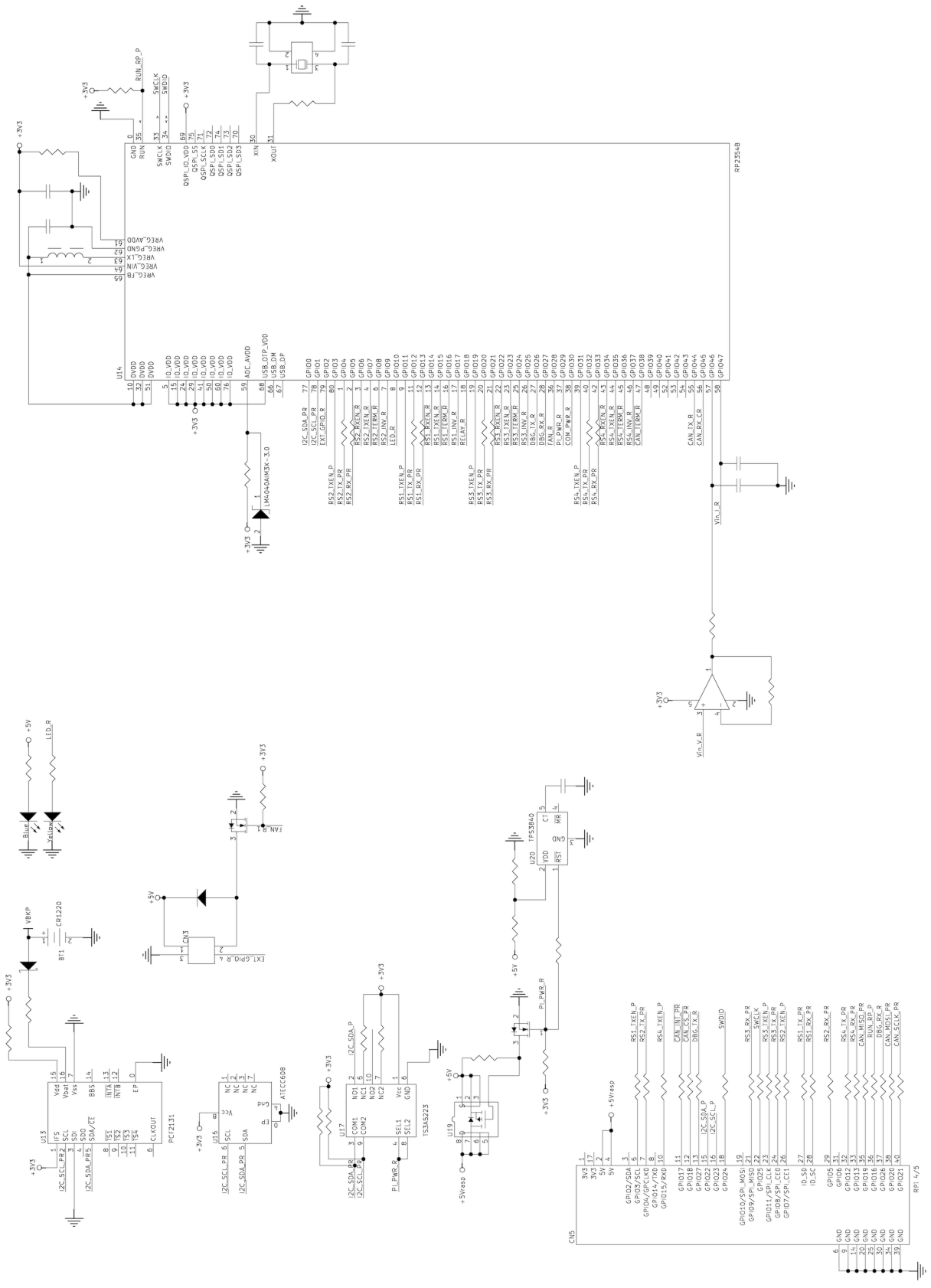
Bit 9, 11, 13, 15 reserved

# Schematic diagram

This simplified schematic illustrates only essential interconnections between main functional blocks and omits supporting components, bypass capacitors, and secondary signal paths.







# Technical specifications

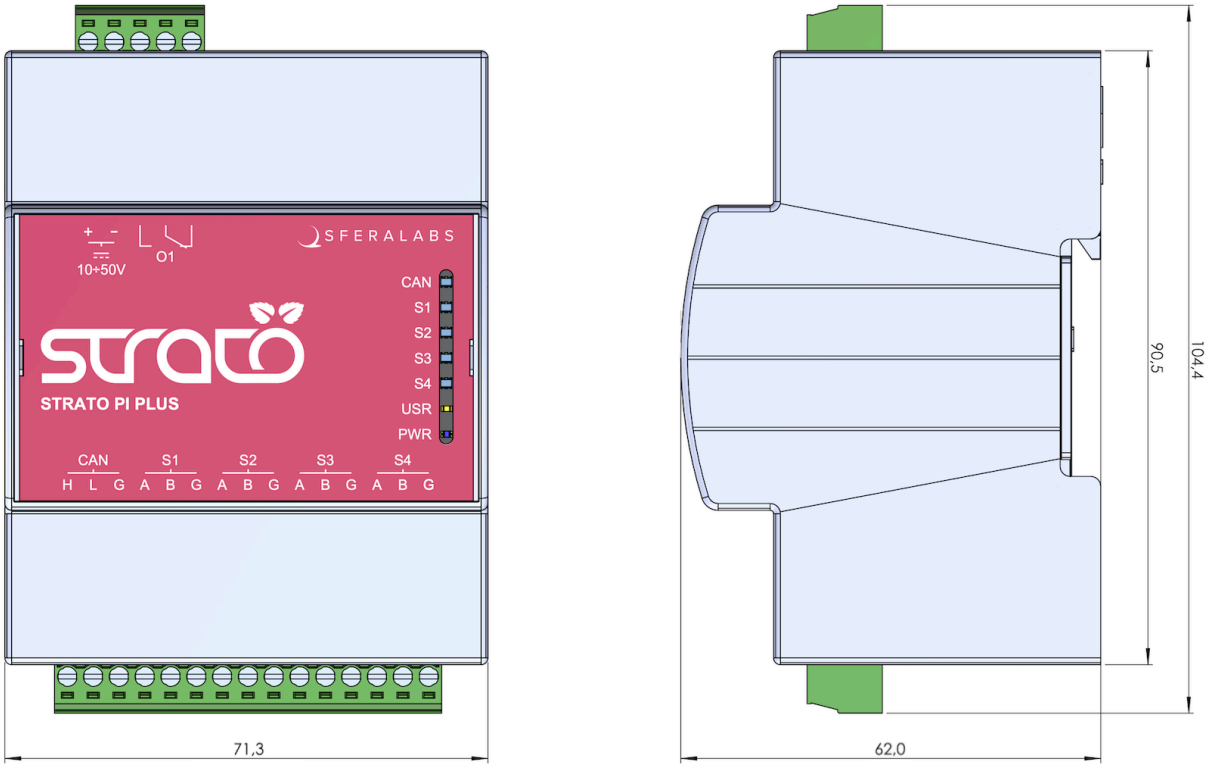
Note: all values typical, at +25 °C and under normal operating conditions.

| | |
|---|---|
| **POWER SUPPLY** | |
| Power supply operating voltage (VS) | ⎓dc 24 V nominal (range 10-50 V), max 3.0 A<br><br>An absolute maximum input voltage of 60 V is tolerated, with reduced surge protection<br><br>Reverse polarity and surge protection with 3.3 A resettable fuse |
| Current consumption at VS+ 12 V⎓<br>including Raspberry Pi 5, with Ethernet connected, no USB devices | low CPU load: 350 mA,<br>100% CPU load, before throttling: 1 A<br>100% CPU load, throttled: 530 mA<br>Fan option, add: 50 mA<br><br>Actual current consumption may vary based on working conditions |
| Current consumption at VS+ 24 V⎓<br>including Raspberry Pi 5, with Ethernet connected, no USB devices | low CPU load: 180 mA,<br>100% CPU load, before throttling: 470 mA<br>100% CPU load, throttled: 270 mA<br>Fan option, add: 25 mA<br><br>Actual current consumption may vary based on working conditions |
| **RASPBERRY PI COMPATIBILITY** | |
| Raspberry platform compatibility | Raspberry Pi 4 Model B<br>Raspberry Pi 5 |
| **RS-485 INTERFACES** | |
| Max. transfer rate with slew limiter | 500 kbps |
| Transfer rate for EMI compliance tests | 115.2 kbps |
| ESD-Protection Voltage on A, B | ±14 kV air discharge<br>±8 kV contact discharge |
| Fail safe feature | Guarantees a logic high receiver output when the receiver inputs are shorted, open, or connected to a terminated transmission line with all drivers disabled |
| **CAN INTERFACE** | |
| Max. transfer rate with slew limiter | 8 Mbps (CAN-FD) |
| Transfer rate for EMI compliance tests | 250 kbps |
| ESD-Protection Voltage on CANH, CANL | ±14 kV human body model<br>±8 kV contact discharge |
| Transient Voltage protection on CANH, CANL | -150 V to +100 V (waveforms of the applied transients in accordance with ISO-7637, Part 1, test pulses 1, 2, 3a and 3b) |
| **RELAY** | |

| | |
|---|---|
| Rated current | 1A |
| Rated voltage | 48 V DC |
| Mechanical life (DC) | $20 \cdot 10^6$ cycles |
| Operate/release time | 6/4 ms |
| **REAL TIME CLOCK** | |
| Oscillator frequency | 32768 kHz |
| Frequency Tolerance | ±3 ppm |
| Backup battery | Only use CR1220 or BR1220 Lithium / Manganese Dioxide (Li/MnO2) batteries.<br><br>Expected battery life without main power supply: 3 or more years, depending on environmental conditions |
| **ACCELEROMETER (OPTIONAL)** | |
| Range | ±2g/±4g/±8g/±16g full scale |
| Data rates | from 1.6 Hz to 1600 Hz |
| Bandwidth | up to 800 Hz |
| **INTERNAL POWER SUPPLY VOLTAGE SENSOR** | |
| Voltage range | 0…58 V |
| Total Unadjusted Error (TUE) | ±2.5 % of full-scale |
| Resolution | 12 bits (8.7 RP2354 ENOB) |
| **INTERNAL POWER SUPPLY CURRENT SENSOR** | |
| Current range | 0…4 A |
| Total Unadjusted Error (TUE) | ±2.5 % of full-scale |
| Resolution | 12 bits (8.7 RP2354 ENOB) |
| **EMI IMMUNITY STANDARDS** | |
| Electromagnetic immunity compliance | EN 61000-4-2: 2025 (ESD)<br>EN 61000-4-3: 2020 (Radiated RF Field)<br>EN 61000-4-4: 2012 (Burst/fast transient)<br>EN 61000-4-5: 2014 / A1: 2017 (Surge)<br>EN 61000-4-6: 2023 (Conducted)<br>EN 61000-4-8: 2010 (Power freq. magnetic field) |
| **ENVIRONMENTAL** | |
| Operating temperature | -20…+60 °C |
| Storage temperature | -30…+80 °C |
| Altitude | Up to 2000 m |
| Humidity | 5% to 95% RH noncondensing |

| | |
|---|---|
| Protection degree | IP20 |
| **MECHANICAL** | |
| 3.81 mm pitch terminal block characteristics | Maximum conductor cross section: 1.3 $mm^2$ (16 AWG)<br>Recommended stripping length: 6 mm<br>Screw thread: M2<br>Maximum screws tightening torque: 0.3 Nm |
| Dimensions | 4 module Din Rail enclosure<br>width: 71.3 mm<br>height: 91.0 mm<br>depth: 62.0 mm |
| Weight (model SPMP10AF54) | 200 g |

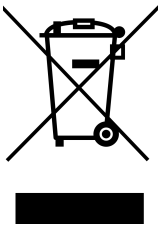
# Dimensions




**DIMENSIONS (mm)**

# 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 Plus contains a small non rechargeable manganese dioxide lithium coin battery.

In the Strato Pi Plus, the battery is not accessible from the outside. You should first remove the case body to gain access to the Strato Pi Plus 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;

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

# Conformity Information

## EU

This device complies with the following Union harmonisation legislation:

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

The following harmonised standards and other technical specifications have been applied:

- EN IEC 61000-6-2:2019 - EMC Immunity standard for industrial environments
- EN IEC 61000-6-3:2021 - EMC Emission standard for equipment in residential environments
- EN IEC 63000:2018 - Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

The EU 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.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

**Responsible party:** Sfera Labs US LLC, 1209 Mountain Road Pl NE, Ste N, Albuquerque, NM 87110, USA - compliance@sferalabs.cc

The FCC Supplier's Declaration of Conformity is available at: https://www.sferalabs.cc

## CANADA

CAN ICES-003(B)/NMB-003(B)

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.

## RCM AUSTRALIA / NEW ZEALAND

This product does not bear the RCM mark, and Sfera Labs does not declare its compliance with the Australian and New Zealand EMC requirements. For suppliers seeking RCM compliance for these markets, the relevant emission standard the product complies with is:

- EN IEC 61000-6-3:2021 - EMC Emission standard for equipment in residential environments

# Compliance information for Raspberry Pi

Strato Pi contains a Raspberry Pi 4 Model B or Raspberry Pi 5 single-board computer. These boards have WiFi and Bluetooth radios. They are user accessible and replaceable.

## EU

On models supplied with a Raspberry Pi, wireless functions are provided exclusively by the user-replaceable Raspberry Pi, which is covered by its own EU Declaration of Conformity under Directive 2014/53/EU issued by Raspberry Pi Ltd. This product adds no radio function.

## USA

Models supplied with:

- Raspberry Pi 4 Model B contain FCC ID **2ABCB-RPI4B**
- Raspberry Pi 5 contain FCC ID **2ABCB-RPI5**

Each unit's label shows the applicable FCC ID.

The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction

with any other antenna or transmitter, except in accordance with FCC multi-transmitter product guidelines. This (WiFi DTS) device has 20 MHz bandwidth mode.

## CANADA

Models supplied with:

- Raspberry Pi 4 Model B contain IC **20953-RPI4B**
- Raspberry Pi 5 contain IC **20953-RPI5**

Each unit's label shows the applicable IC number.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.