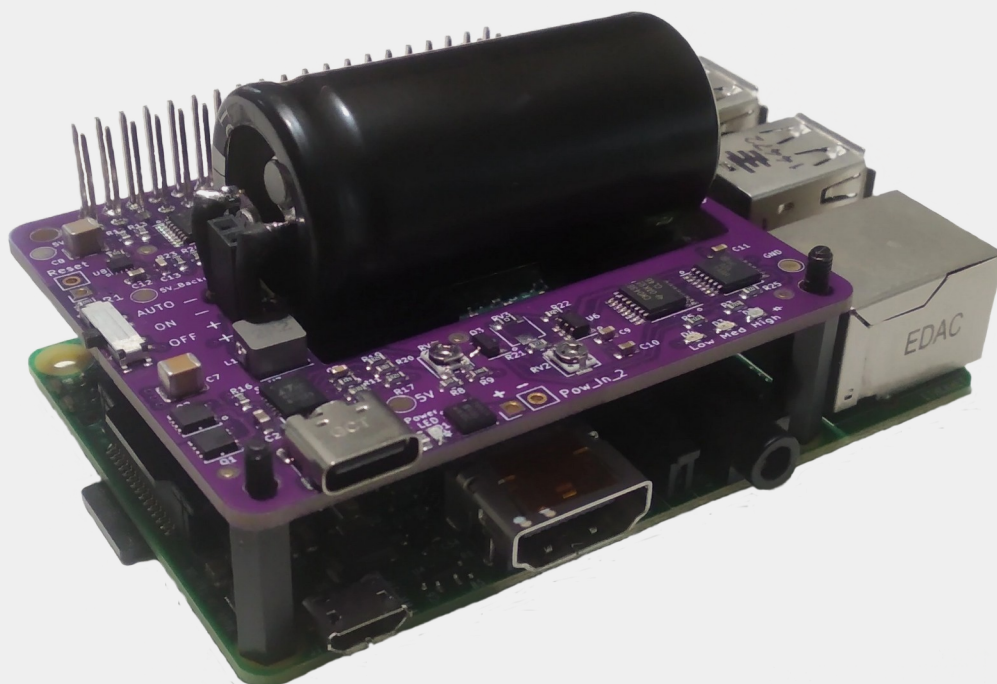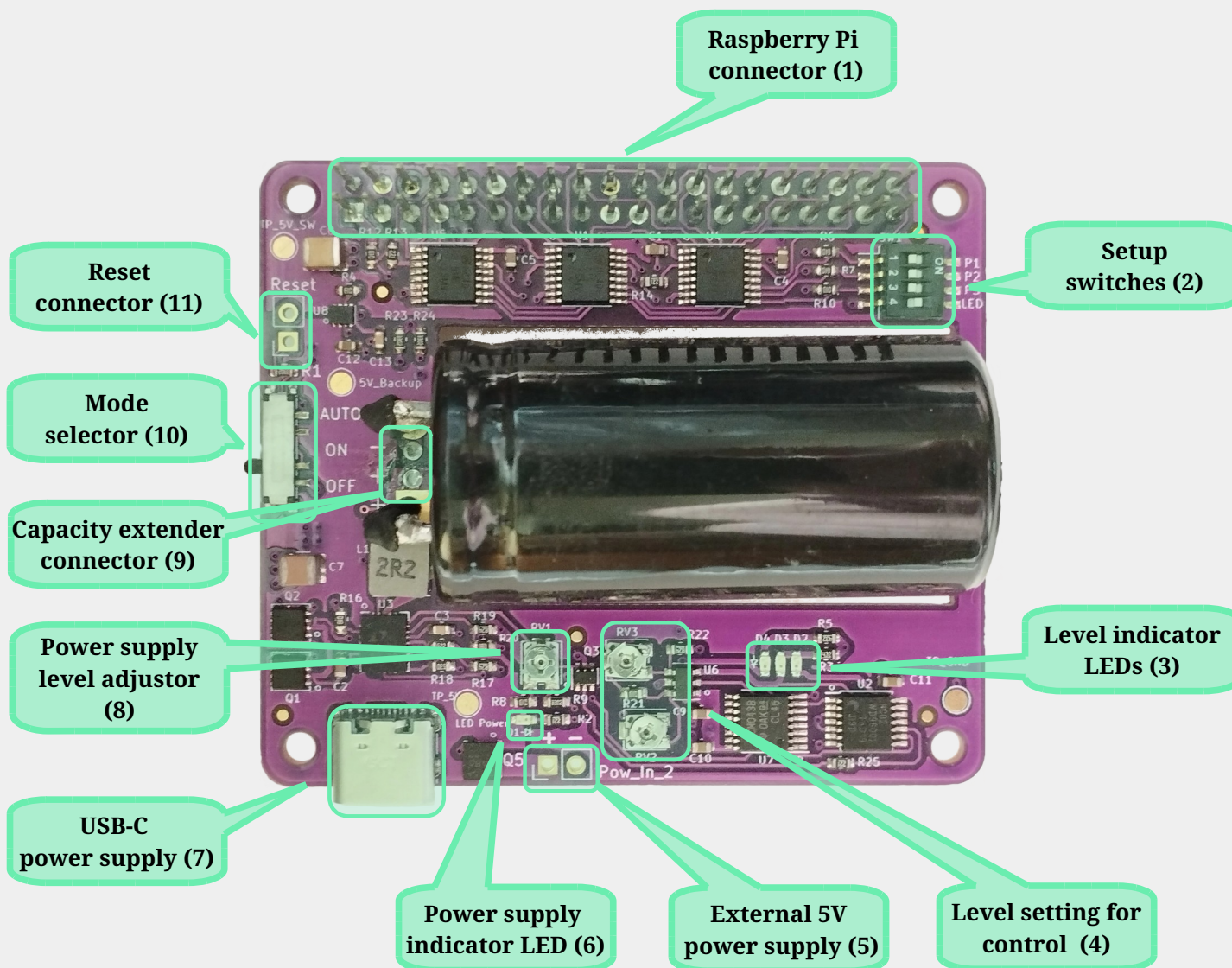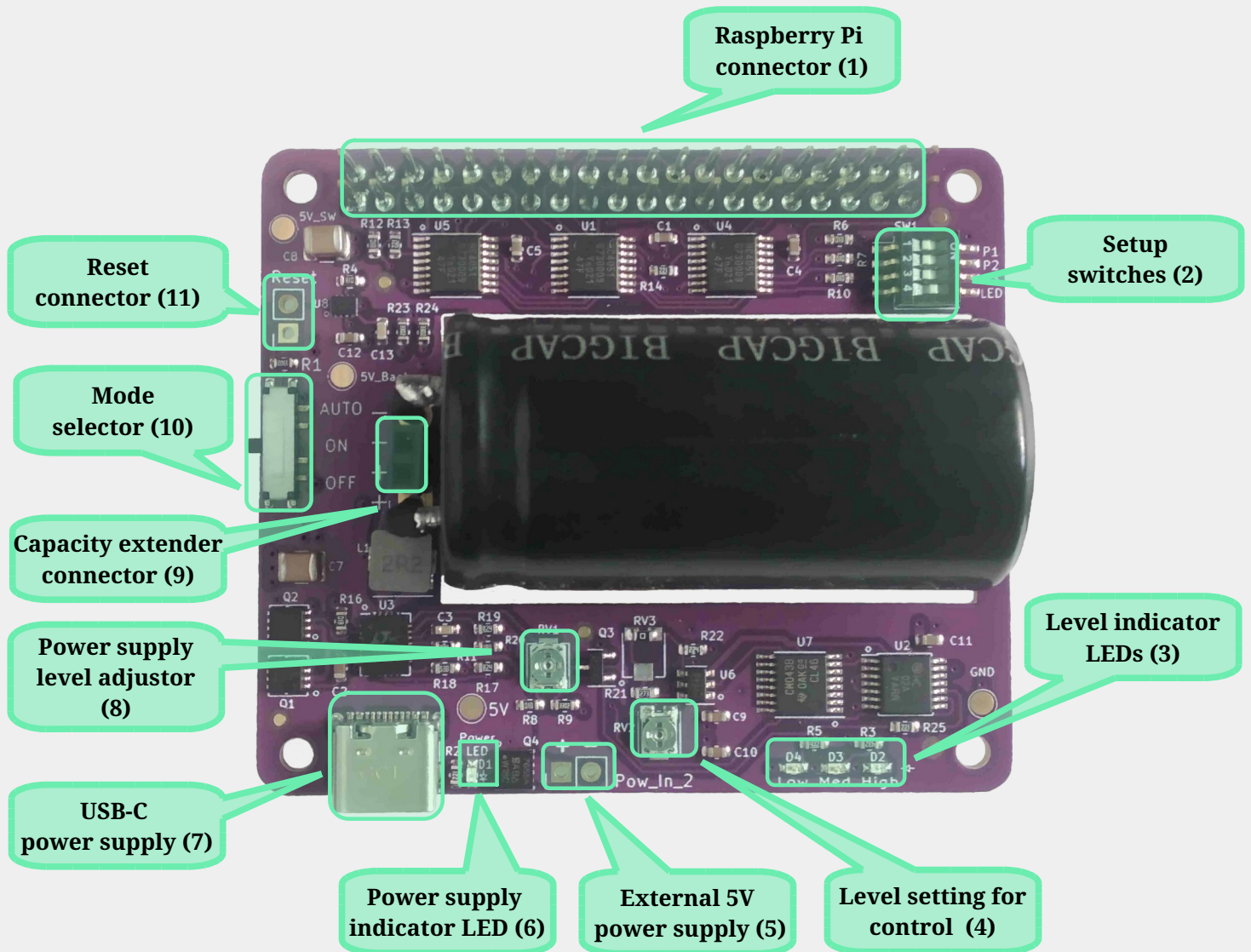# AQEX

qUPS-P-SC-v1.1 & 1.2

User Manual v1.1
8/1/2025

Please read the instruction manual for safe use and a user experience tailored to your needs.

The qUPS-SC has several connection, setup and feedback points for using it, highlighted in the figure below. For easy identification, the "( )" indicates the subsequent reference numbers. The important points for the user of qUPS-P-SC v1.1 and v1.2 are shown in the following figures.

Raspberry Pi connector (1)

Setup switches (2)

Reset connector (11)

Mode selector (10)

Capacity extender connector (9)

Level indicator LEDs (3)

Power supply level adjustor (8)

USB-C power supply (7)

Power supply indicator LED (6)

External 5V power supply (5)

Level setting for control (4)

The important points for the user of qUPS-P-SC v1.1

The important points for the user of qUPS-P-SC v1.2

1 Safety regulations

1.1 Personal safety

⚠️ The qUPS product has an energy storage system that can be energised even when not connected to the mains.

The qUPS-BC has no replaceable parts - only the manufacturer or an accredited service centre can carry out repairs and maintenance.

1.2 Product safety

⚠️ The qUPS product should be protected from too high or too low temperatures, direct sunlight. It should be kept in a dry place for 24 hours before installation.

Conductive liquids, plastic materials may cause short circuiting and permanent product damage, therefore avoid installation in such environments.

The qUPS system should only be powered through the (5) OR (7) connector of the qUPS product.

🛑 **POWERING THE PROTECTED DEVICE FROM ANOTHER SOURCE IS FORBIDDEN!!**

The qUPS must not be operated together with another qUPS product and/or other uninterruptible power supply via connector (1) (40-pin terminal) !

1.3 Precautions

The system operates from 5V, which is low voltage, so it is protected from electric shock in a life-safety sense. In case of short circuits caused by foreign matter, the contacts may heat up and cause injury!

2   Introduction

Thank you for choosing AQEX smart qUPS-P-SC to protect your electronic device!

The qUPS family has been carefully and thoroughly designed to provide the most efficient way to ensure smooth operation in a wide range of conditions, to meet a wide range of user requirements.

The qUPS family is designed for uninterruptible operation of Raspberry Pi compatible microcomputers. It can also protect any device requiring 5V DC with a maximum power consumption of 2.5 A. Hereafter, we will refer to the connected product collectively as "Protected Device".

The qUPS-P-SC is the super-capacity version of the qUPS family. It offers the advantage of a wide temperature range and maintenance-free operation due to an outstanding number of charge cycles. The uninterrupted operating time is determined by the current consumption of the protected device.

Raspberry Pi model	No load [min]	50% load [min]	100% load [min]
2	168	148	80
3	171	70	41
4	84	44	29
5	74	20	8

Table 1: Expected operating time [seconds] in case of 4000mA LIFEPO4 battery

It is also possible to increase the operating time. The capacity expander available for the qUPS-P-SC allows up to 4 times (qUPS-P-CX450), 8 times (qUPS-P-CX900) or 15 times (qUPS-P-CX1700) the operating time. Higher expansion is also possible on request.

2.1 Optimal circumstances of use

Thanks to the high capacity of the battery connected to the qUPS, the product can be used in places where several hours of power outage or power surges can compromise reliable operation. With a sufficiently large battery capacity, several days of operation are guaranteed.

The qUPS family is suitable for microcomputers, single board computers, microcontrollers and any 5V DC powered devices:

- for protection against power failure
- for overvoltage protection
- to achieve safe disconnection
- to ensure tasks and communication before disconnection
- for safe restart after a power failure

2.2 Non optimal circumstances of use

It is not suitable for protecting high-power computers due to the device's maximum current drain of 2.5A (12.5W power consumption). Other products are better suited for higher current needs.

3   Commissioning

The qUPS product is ready for use immediately after preparation and unpacking. For computers using a Raspberry PI compatible 40 pin header, the connection is plug-and-play based, while in other cases the two pin +/- connection can be used.

3.1   Power supply

The qUPS requires a 5V DC, min. 2A (min. 3A recommended) power supply. The output should be either a pair of unplugged cables (7) or a cable with a USB-C connector (9).

See Appendix for a list of tested power supplies and Troubleshooting.

3.2   Connections

The protected device can be connected to the qUPS product in different ways.

3.2.1   Single board computers (SBC)

If the SBC is equipped with a Raspberry PI compatible 40 pin header, the qUPS product is suitable for HAT connection. Simply plug the qUPS product's (1) socket onto the computer's pin header as shown in the picture below.
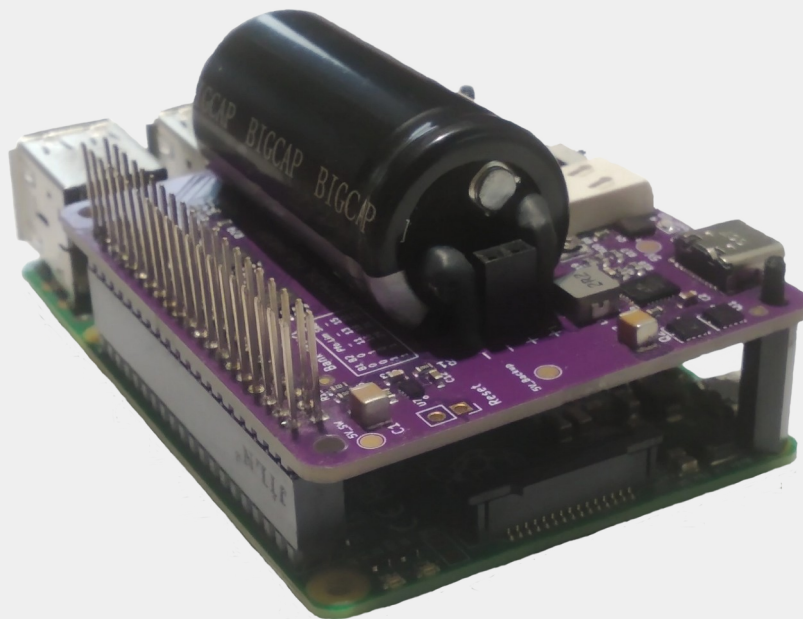
3.2.2 Other devices

Any device that operates from 5 V DC can be connected to the qUPS product using the appropriate contacts on the 40-pin header (1).
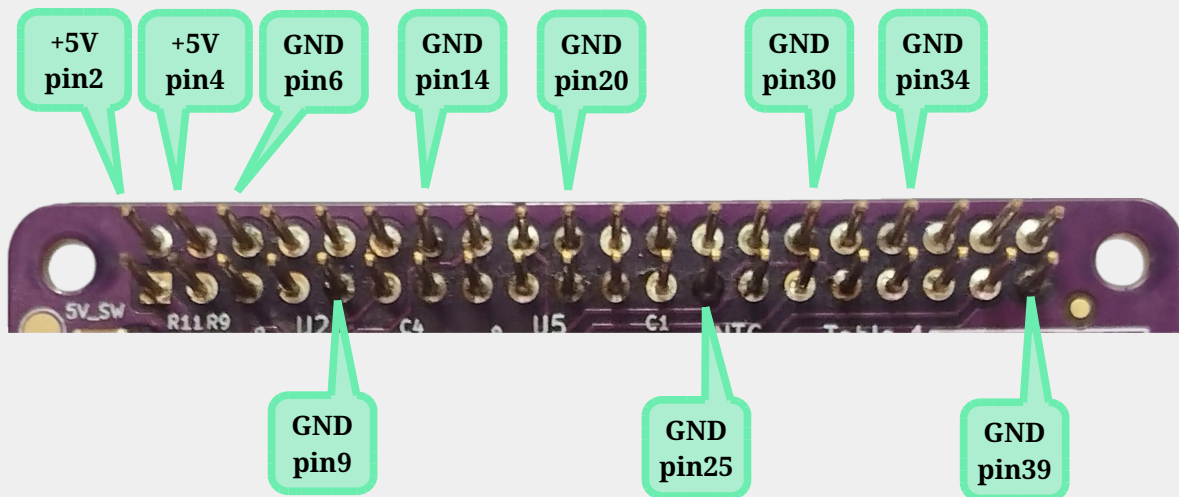
3.2.3 Powering the unit

The qUPS should be powered via connector (5) OR (7).

Connector (5) is polarity protected. The presence of power is indicated by LED (6).

⚠️ **The two power connector MUST NOT be fed from 2 separate sources!**

⚠️ Safety power supplies that disable 5V at their output in the absence of a connected device (e.g. official Raspberry Pi 5 PSU) are not suitable for powering the qUPS.

3.2.4 GPIO pins

All GPIO pins of the protected device connected via the 40 pin row (1) can be accessed on the top side of the qUPS. All but the 3 GPIO pins selected on connector (2) are free to be used for any other purpose.

3.2.5 Reset

The main function of the Reset connector's (11) is the momentary power interruption. It is possible to solder in a cable, push button, standard 2.54 mm pin header or switch. If a short circuit occurs between the two contacts, the qUPS product will cut the power and the operation of the protected device will be stopped for the duration of the short circuit (reset function).

The contact is polarity independent.

⚠ **Voltage control is not allowed, only contact („short-circuit" or „open-circuit") can be used.**

Via the Reset connector (11), it is possible to control the power supply of the protected device from an external source, switching it off permanently is also allowed.

3.2.6 Capacity extension

It is possible to increase the capacity of the energy storage via connection (9). The operating time can be increased by approximately 4 times, 8 times and 15 times. If required, larger extensions are possible. The qUPS-P-CX expansion module can be purchased with the product.

3.3 Setup

3.3.1 Hardware setup

3.3.1.1 4 circuit „Setup switch" (2) – DIP switch

The qUPS-P-BC product has a 4-circuit two-position switch, which controls 2 system parameters:

- Communication pin assignment (P1, P2 and P3). Details in <u>section 3.3.1.1.1</u>.

- LED activator. Details in <u>section 3.3.1.1.2.</u>

3.3.1.1.1 Communication pins

The qUPS product uses three GPIO pins to exchange information with the computer in a flexible and configurable way. If there is no need for communication, the GPIO legs can be freed for further use - in this case the operation of the GPIO pins is completely transparent and not affected by the qUPS product.

The state of the P1, P2 and P3 switches determines the pin allocation for communication with the protected device as shown in the table below:

DIP switch setup	GPIO BCM / BOARD pin on connector (1)		
P1-P2-P3	Power Good (pfo)	Capacitor low voltage level (lim)	Shutdown (shd)
OFF-OFF-OFF	-	-	-
OFF-OFF-ON	GPIO17 / Pin 11	GPIO22 / Pin 15	GPIO27 / Pin 13
OFF-ON-OFF	GPIO12 / Pin 32	GPIO20 / Pin 38	GPIO16 / Pin 36
OFF-ON-ON	GPIO14 / Pin 8	GPIO18 / Pin 12	GPIO15 / Pin 10
ON-OFF-OFF	GPIO19 / Pin 35	GPIO21 / Pin 40	GPIO26 / Pin 37

ON-OFF-ON	GPIO25 / Pin 22	GPIO07 / Pin 26	GPIO08 / Pin 24
ON-ON-OFF	GPIO10 / Pin 19	GPIO11 / Pin 23	GPIO09 / Pin 21
ON-ON-ON	GPIO04 / Pin 7	GPIO24 / Pin 18	GPIO23 / Pin 16

Table 2.

Pin fucntions:

- pfo: „power good"

  When the voltage on the pin is high (logic 1, TRUE), the protected device is powered from the mains, and when it is low (logic 0, FALSE), the qUPS product does not receive power from the mains, so it uses the energy stored in the battery to power the protected device.

- lim: „limit", battery charge state is above the limit

  If the voltage on the pin is high (logic 1, TRUE), the energy stored in the battery is above the level set by switches LS1 and LS2. If the voltage level on the leg is low (logic 0, FALSE), the energy stored by the qUPS product has reached a critical level and a safe shutdown process should be initiated if required.

- shd: „shutdown", protected device is operational

  Indication to the qUPS product that the protected device is in operation. Its purpose is to ensure that the device restarts correctly after software shutdown, when power is restored and the energy storage has reached the correct charge level.

- The protected device indicates to the qUPS that it is operational by pulling up the "shd" pin (logic 1, TRUE). Loss of external power and the energy storage falling below critical level may result in software shutdown of the protected device. In this case, the pin will be set to a low voltage level (logic 0, FALSE). This will signal to the qUPS product that the protected device must be restarted in any case when external power is restored. If the energy storage is below the low charge level, the system will first recharge it to high charge level and then power on the protected device.

3.3.1.1.2 LED activator

In the "ON" position, the level indicator LEDs (3) indicate the levels, in the "OFF" position there is no visual indication. The LED consumption is very low, but if no indication is required (e.g. product in a closed box), the "OFF" position can be used to increase the operating time slightly.

3.3.1.2 Level setting for control (4)

The potentiometers adjust the detection levels to the consumption of the protected device. If the level is too high, the waiting time from the start of charging to the start of the device will be unnecessarily long or the full capacity will not be used. If the level is too low, there will not be enough time to start the protected device and then to disconnect it stably.

3.3.1.3 Potentiometer (8) for adjucting the threshold of the input voltage

The reason for this adjustability is to enable the device to operate optimally with different power supply type and any protected device pair.

The threshold voltage of the external power supply can be adjusted by the potentiometer (8). Below this voltage level, the qUPS product switches to uninterruptible mode and above it to external power supply.

⚠️ If the level is set too high, the device will switch between modes unnecessarily, and in extreme cases it may switch permanently.

⚠️ If the level is set too low, the device will not switch to uninterruptible mode in a timely manner and the Raspberry may shut down. The Raspberry model 5 is particularly sensitive to power supply voltage.

3.3.1.4 Mode selector (10)

The mode switch has three positions, which are indicated on the panel.

- „OFF" mode

  The qUPS product will remove power from the protected device (regardless of the presence of an external power source and the power level of the energy storage device).

- „ON" mode

  The qUPS product shall provide power to the protected device if an external power source is available or if there is sufficient power in the energy storage device.

> ⚠️ If the charge level of the energy storage device is low and the external power supply is cut off, the protected device will not be able to perform a guaranteed regular load/unload cycle.

- „AUTO" (automatic) mode

  The system shall guarantee the execution of a regular boot/shutdown cycle regardless of the loss of external power supply.

3.3.2 Software settings

The qUPS is able to share information with the protected device about the power supply and its own status. This allows the protected device to safely perform the necessary steps for saving and exit before the battery is completely discharged.

The exact details of the power-off and power-on function can be set in software.

The feedback pins in chapter 3.3.1.1.1 are intended to provide information to the device and to perform adjustments on the qUPS product.

4 Usage

4.1 Operation

If properly connected, the system will work under normal conditions with default settings.

The qUPS product will start charging the energy storage after the power supply is connected.

⚠️ In AUTO mode, the protected device will only be powered when the battery is sufficiently charged. This can take up to minutes depending on the power supply and the qUPS product settings.

⚠️ In ON mode, the protected device is immediately powered up and starts. If the power supply is interrupted before the battery reaches a critical power level, the protected device can't be safely shut down.

4.2 Switch power from mains to energy storage

The qUPS product detects the loss of external power supply or a voltage drop below the level set by [potentiometer (8)](). In this case it automatically switches to the energy storage. When the external power supply is restored, it will switch back and recharge the energy consumed from the supercapacitor.

⚠️ The transition take time of course, but the duration is very short (100-300 µs,). At this point the output voltage may drop below the operating threshold voltage of the protected device. In case of Raspberry Pi, this state may be detected by the operating system and a "Under-voltage detected! (0x00050005)" alarm may be sent to the user. Due to the short duration of this transient state, it does not cause any downtime or malfunctioning of the Raspberry Pi.

Figure 1: Raspberry Pi 5 at 50% load

No alarm in the event of a switch back to mains power.

4.3 Intelligent functions

In addition to providing power to the protected device, the qUPS product can also provide information about the power status and the charge level of the energy storage.

The operation of the qUPS can be influenced by the settings of the protected device.

With this information, the protected device can intelligently and safely prepare for possible power failures that will inevitably occur when the power supply is interrupted. The qUPS provides sufficient time to inform the protected device, which can perform critical pre-shutdown tasks and shutdown safely. This prevents property damage, information security risks and other undesired events.

4.3.1 Event handling

The operating system or program running on the protected device can be prepared to detect in real time the information communicated by the qUPS product and perform various tasks in this context.

Two types of status indications are continuously displayed on the qUPS product:

- presence of external power supply - pfo

- energy storage battery charge level - lim

Via the presetted GPIO pins, the service or program running on the device detects the changes and provides the possibility to trigger pre-set mechanisms.

For more information and utilities written in C and Python, see the https://github.com/aqexhu/qups-guard page.

4.4 Level indicator

The supercapacitor charge is indicated by the LED group numbered (3).

The three different coloured LEDs indicate the following battery power levels:

1. Low (red): low level, the device can be switched off at any time.

⚠️ If the device is in "AUTO" mode and the corresponding SHD pin is at low level, this level will disconnect the power from the protected device when reached.

2. Med (yellow): there is sufficient time for a safe shutdown.

3. High (green): There is sufficient time for one start-up and one shutdown - in "AUTO" mode the protected device will start.

⚠️ The lights indicate the existence of the above charge levels, not a percentage. These levels are not proportional at all.

5   Appendix

5.1   List of supported power adapters

- RaspberryPi official power adapter [5V@2.4A](#)

- RaspberryPi 5 official power adapter 5V@5A

- Goobay 43651 5V@2.1A

5.2 Troubleshooting

Symptom	Cause of error	Solution
If an external power supply is present, the "External power LED" (6) is not lit	External power supply problem	Replace the power supply
Raspberry Pi will not start if the "Min" LED is on	Mode switch (4) is on OFF state	Mode switch (4) must be set to ON or AUTO