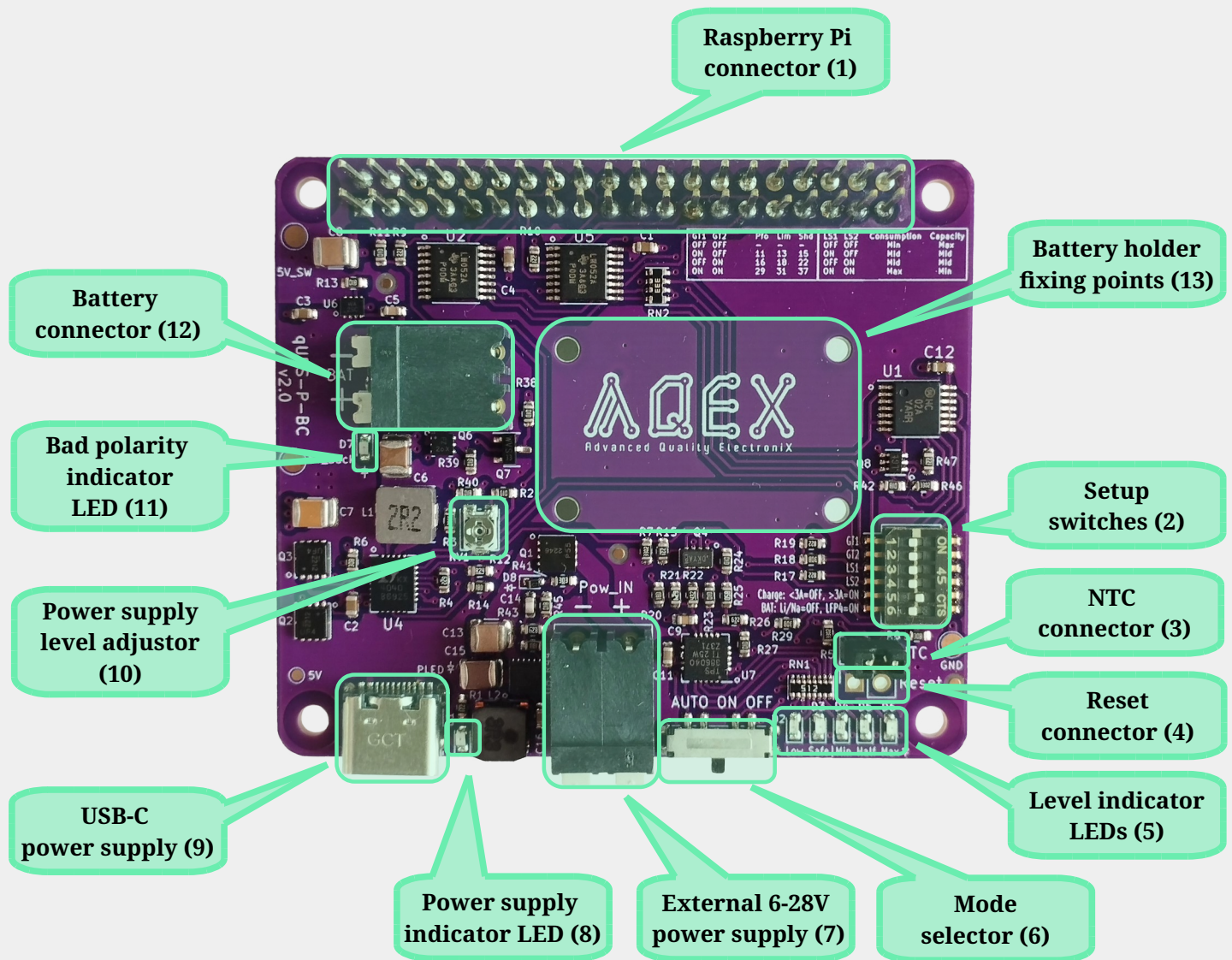


## qUPS-P-BC-v2.0

User Manual v1.1  
2/9/2026

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

The qUPS-BC has several connection, setup and feedback points for using it, highlighted in the figure below. For easy identification, the "( )" indicates the subsequent reference numbers.



## 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 other than the battery - 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 (7) OR (9) 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-BC 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-BC is the battery version of the qUPS family. It has the advantage of longer operating time without power supply. It uses 1 pc Li-ion, Li-Po, LiFePo4 or Sodium-ion battery for energy storage. The uninterrupted operating time determined by the battery capacity and the current consumption of the protected device.

| Raspberry Pi model | No load [min] | 50% load [min] | 100% load [min] |
|--------------------|---------------|----------------|-----------------|
| 2                  | 530           | 365            | 280             |
| 3                  | 450           | 250            | 220             |
| 4                  | 312           | 190            | 144             |
| 5                  | 265           | 168            | 160             |

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

For extremely long operating time requirements, the qUPS-P-BC can be used a battery with any capacity. Rectangular (prismatic) shaped batteries have a significantly higher energy capacity (>300Ah exists) than standard sized cylindrical batteries. The battery must be individually fixed.



Pay attention to compatibility! The current draw can be up to 7.5A, which the battery must be capable of. If this condition is not met, the battery and the environment may be damaged and material and personal injury may occur!



A higher capacity naturally also means longer charging times! At a 2A charging current, a 100Ah battery will be fully charged in about 50 hours. The maximum operating time can be expected, if the battery is fully loaded.

## **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.



The product is configured to use LiFePo4 battery by default. If you are using Li-Ion, Li-PO or Sodium-ion batteries, please make sure that they are set correctly. Details are in [section 3.3.1.1.4](#).

#### 3.1 Power supply

The qUPS requires a 5V DC, min. 2A (min. 3A recommended) power supply. For 5V power supply, use a cable with USB-C (9) connector. For a 5.2-28V power supply, use a cable pair without a connector. In this case, connector (7) can be used for powering the device.

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.

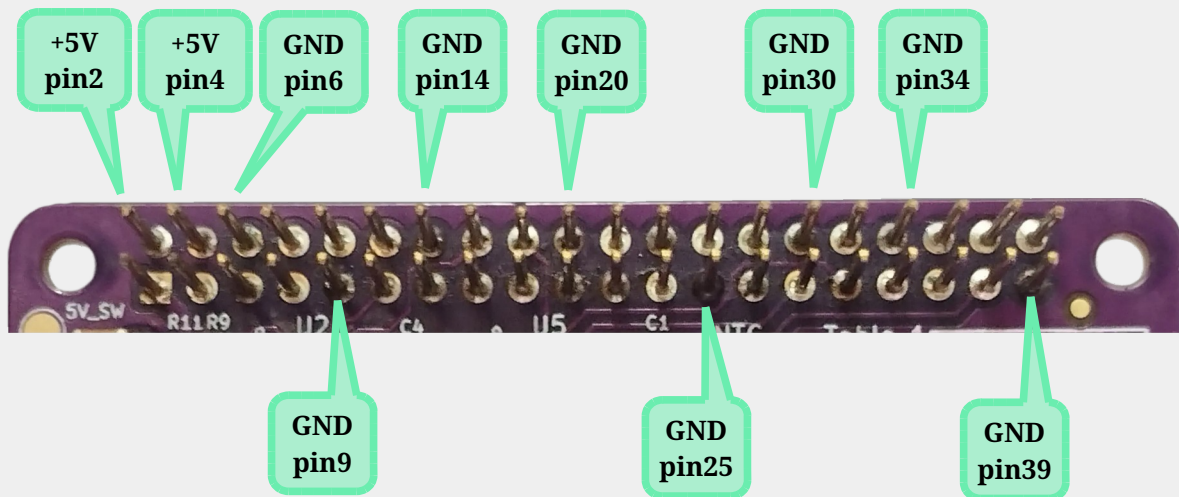
##### 3.2.1 Single board computers (SBC)

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 (7) OR (9).

The USB-C connector (9) can be powered from the standard 5V - 5.2V and the polarity protected connector (7) from 5.2V – 28V.

The presence of power is indicated by LED (8).

 **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 suitable for powering the qUPS.

### 3.2.4 Battery

You can purchase the product with or without battery. In case of using your own battery, you can purchase the battery holder and the necessary screws.

The battery holder can also be produced with your own 3D printer. Anyone can download the 3D design of the holder in STL format from

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<https://github.com/aqexhu/qups-guard> and use it freely. In this case you will also need 6 pieces 2x6mm screws for assembly.



If you are not using a battery supplied and distributed by AQEX, please note the followings for correct operation:

- To reduce losses and ensure proper sensing levels, it is recommended to use a 0.5mm<sup>2</sup> (AWG20) pure copper wire and to minimize the length of the cable.
- For ease of installation, the use of stranded wire is recommended
- The (12) connector is has to be used to connect the battery to the qUPS. The maximum allowed cable size of the connctor is 0,75mm<sup>2</sup> (AWG18)
- The qUPS draws a maximum of 7.5A from the battery. The maximum discharge current of the battery can't be lower than this.

**Pay attention to the polarity!** The system is protected against reverse polarity connction, in which case LED (11) indicates the fault.



In case of Sodium-ion battery the system switches off at 3.1V, if the mode selector (6) is in „AUTO” position, and at 2.5V, if the mode selector is in „ON” position. So the full capacity of the battery cannot be used.

### 3.2.5 Temperature sensing

Battery life is significantly reduced if they are charged at temperatures that are too high or too low. The critical lower and upper temperatures depend on the technology, typically 0°C to +40°C for Li-Ion/LiPo and -20°C to +60°C for LiFePo<sub>4</sub>/Sodium-ion.

The qUPS is capable of stopping the charge if the battery temperature is not within the required limits. A temperature sensor (NTC) is optionally available for the product and must be connected to connector (2). The connector is polarity independent.



The product can also be operated without temperature detection, in which case the (2) terminal must be short-circuited.

### 3.2.6 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 \(3\)](#) are free to be used for any other purpose.

---

### 3.2.7 Reset

The main function of the Reset connector's (4) 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 (4), it is possible to control the power supply of the protected device from an external source, switching it off permanently is also allowed.

## 3.3 Setup

### 3.3.1 Hardware setup

#### 3.3.1.1 6 circuit „Setup switch” (3) – DIP switch

The qUPS-P-BC product has a 6-circuit two-position switch, which controls 4 system parameters:

- Communication pin assignment (GT1 and GT2). Details in [section 3.3.1.1.1](#).
- Level adjustment (LS1 and LS2). Details in [section 3.3.1.1.2](#).
- Charge current (Charge): 1A or 2A. Details in [section 3.3.1.1.3](#).
- Battery technology (BAT): Li-Ion or LiFePo4. Details in [section 3.3.1.1.4](#).

### 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 GT1 and GT2 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) |                                   |                 |
|------------------|---------------------------------------|-----------------------------------|-----------------|
| GT1-GT2          | Power Good (pfo)                      | Capacitor low voltage level (lim) | Shutdown (shd)  |
| OFF-OFF          | -                                     | -                                 | -               |
| ON-OFF           | GPIO17 / Pin 11                       | GPIO27 / Pin 13                   | GPIO22 / Pin 15 |
| OFF-ON           | GPIO23 / Pin 16                       | GPIO24 / Pin 18                   | GPIO25 / Pin 22 |
| ON-ON            | GPIO5 / Pin 29                        | GPIO6 / Pin 31                    | GPIO26 / Pin 37 |

Table 2.

Pin functions:

- 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 Detection level finetuning

The LS1 and LS2 switches adjust the detection levels to the battery capacity and the power 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 can't be used. If the level is too low, there won't be enough time to start the protected device and then to disconnect it stably.

Switching voltage levels from low to high:

- LS1 – OFF    LS2 - OFF
- LS1 – OFF    LS2 – ON
- LS1 – ON    LS2 – OFF
- LS1 – ON    LS2 - ON

| Raspberry type | LS1 | LS2 |
|----------------|-----|-----|
| Pi2            | OFF | OFF |
| Pi3            | OFF | OFF |
| Pi4            | OFF | OFF |
| Pi5            | OFF | ON  |

Table 3: Suggested setup in case of 4000mA LiFePo4 battery

#### 3.3.1.1.3 Charge current

Use the switch to change the charging current of the battery: 1A (OFF) or 2A (ON).

If the power supply is not able to supply the combined load of 2A charge current and the current drawn by the protected device, set the switch to OFF. If even at 1A is not sufficient, replace the power supply.



The external power supply may be able to operate the Raspberry without the qUPS, but not through the qUPS. The reason can be that the power supply does not have enough power to meet the increased current demand caused by the battery charging.



It is recommended to avoid a lower quality power supply. When used, current consumption below the indicated maximum load may cause voltage stability problems. If the voltage drops below the level tolerated by the protected device, shutdown or unstable operation will occur.

#### 3.3.1.1.4 Battery technology (BAT)

The qUPS is suitable for use with Li-Ion/LiPo, LiFePo4 or Sodium-Ion batteries.

For wider temperature ranges and more charging options, we recommend using LiFePo4 or Sodium-ion batteries.



As the voltage levels of the different chemistries are different (Li-Ion/LiPo 3V - 4.2V, LiFePo4 2.5V – 3.6V, Sodium-ion 1.8-4V), the exact setting of the switch is extremely important to protect the battery!

#### 3.3.1.2 Potentiometer (10) for adjusting 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 (10). 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.

### 3.3.1.3 Mode switch (6)

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.

The control program can be downloaded from AQEX github: <https://github.com/aqexhu/qups-guard>

The DIP setting for the GPIO pins used for communication is a mandatory parameter:

```
qups-guard --dip 01
```

Optional parameter for delaying shutdown:

```
--shutdown-delay 20
```

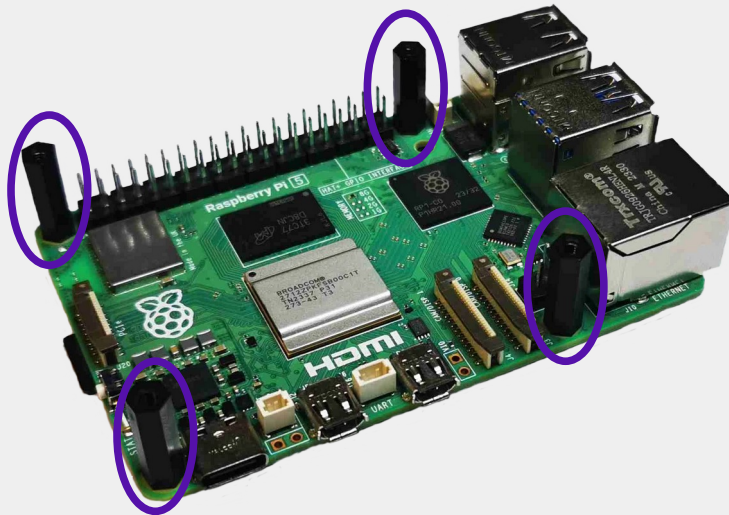
More detailed and continuously updated description on the GitHub page.

## 4 Usage

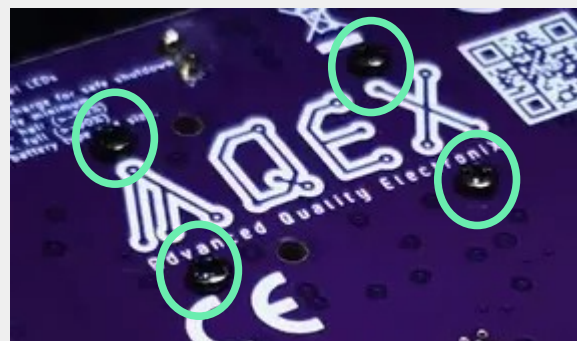
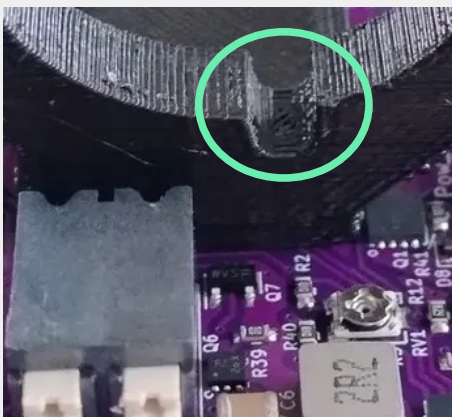
### 4.1 Battery assembly

Whether you connect your own battery or the optional battery offered by AQEX, please follow the assembly sequence suggested below:

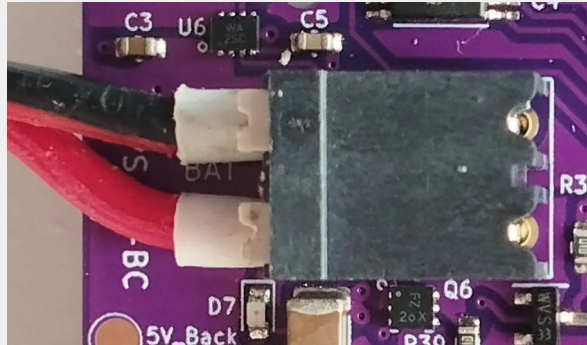
- 1, Set the mode selector switch (6) to "OFF". The protected device is then guaranteed not to be power.
- 2, Screw the 4 spacers included in the qUPS package onto the Raspberry. The package also contains the necessary screws.



- 3, Screw the battery holder with 4 screws. The holder is placed on the component side of the qUPS panel. Please make sure that the cable slot on the battery holder can't be behind the battery connector (12). The screws should be screwed in from the bottom of the panel, as appropriate.



4, Plug the battery cables into the qUPS (12) connector. Make sure the polarity is correct.



5, Insert the battery into the battery holder so that the cables are positioned at the bottom of the holder in the recess.



---

6, Clamp down the battery with the 2 clamping half-rings of the holder. First hook the hooked side of the half-ring into the holder, then unscrew the other side.



7, Fit the qUPS onto the Raspberry as shown in section 3.2.1 and secure with M2.5 screws.

8, The qUPS is ready for operation, you can switch the mode selector switch (6) to "ON" or "AUTO".

## **4.2 Battery disassembly**

The disassembly of the qUPS is done in reverse order of the assembly.



Also before disassembly, remember to set the mode selector switch (6) to "OFF".

## **4.3 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.

## 4.4 *Operating characteristics and safety warnings*

### 4.4.1 **AUTO mode: Intelligent start protection**

In AUTO mode, the primary concern of the qUPS is to maintain system integrity. The protected device (Raspberry Pi) is only powered when the battery charge has reached a safe level that provides sufficient energy for the software shutdown in the event of an immediate power failure.

#### **What can the user expect?**

- **Startup delay:** After connecting the power supply, the system does not start immediately. This waiting time can take up to several minutes, depending on the state of the deeply discharged battery, the capacity of the power supply, and internal settings.
- **Process:** The system first charges the battery to the critical threshold and only then allows the Raspberry Pi to start up.

**Advantage:** This mode of operation ensures that the Raspberry Pi does not enter a boot loop (when the voltage immediately drops below the critical level due to the start-up current consumption and the machine shuts down again).

### 4.4.2 **Operation and risks of ON mode**

In ON mode, the UPS immediately powers up and starts the connected Raspberry Pi, regardless of the current battery charge level or the status of the external power supply.

**Safety warning:** In this mode, software protection features are limited. If the external power supply fails and the battery reaches a critical level before the system shuts down, the Raspberry Pi will shut down **immediately and unexpectedly**.

- **Consequence:** Sudden power loss may result in damage to the operating system (SD card) or data loss.
- **Recommendation:** Use ON mode only for testing purposes or with a stable power supply. AUTO mode is recommended for continuous operation.

#### 4.4.3 Specific features of battery voltage measurement and shutdown process

The voltage measured at the battery terminals does not correspond to the actual chemical voltage of the cell due to internal resistance and system losses (wires, connectors). This difference increases proportionally with the increase in load current.

This phenomenon can be critical when shutting down the system:

- **Low voltage detection:** When the battery is low, the software reaches the threshold value and initiates a safe shutdown of the Raspberry Pi.
- **Voltage rebound:** At the end of the shutdown process, the Pi's current consumption drops dramatically. Due to the removal of the load, the measured battery voltage rises suddenly.
- **The fault phenomenon:** If this increased voltage exceeds the shutdown threshold, the UPS controller detects that the battery has not actually run out, so it does not interrupt the power supply. As a result, the Raspberry Pi remains in "shutdown" mode (it is powered but not running) and does not restart.

**Solution:** A shutdown delay can be set in the qUPS software. This timer ensures that the system continues to draw power from the battery for a sufficient period of time after the shutdown command is issued, so that the voltage remains stable below the critical level even after the load is removed, thus ensuring complete shutdown.

#### 4.4.4 Drip mode and restart threshold

The charging circuit uses trickle charging to protect the battery when the voltage drops below 2.8–2.9 V. In this state, the charging current is much lower than normal, which affects the system's readiness for operation.

**Differences between operating modes and battery types:**

- **Li-ion/Sodium battery (AUTO mode):** Slow charging does not normally occur, as the automatic system disconnects the Raspberry Pi's power supply at around 3 V, keeping the voltage above the trickle charging threshold.
- **LiFePO4 battery or ON position:** In these cases, the battery voltage may drop below the trickle charge level (2.8 V).

**Effect of the phenomenon:** If the battery is deeply discharged, it takes **significantly longer** to reach the voltage level required for restarting, as the charging process starts with limited trickle charging.

---

**Setting option:** The switch-off threshold can be adjusted to optimize the waiting time. By adjusting the switches **LS1 and LS2 in dip-switch (2)**, the lower switch-on level of the automatic system can be raised, thus avoiding deep immersion and a slow drip-filling phase.

#### 4.4.5 Startup instability with a deeply discharged battery

When recharging a completely discharged battery, the system may have difficulty starting up, as indicated by the flashing "Low" (red) LED.

**Cause of the phenomenon:** This typically occurs when the input power supply is insufficient to handle the sudden inrush current.

1. The load causes the supply voltage to drop, which causes the input voltage sensor to disable charging for safety reasons.
2. When the load is removed, the power supply voltage is restored, the system attempts to charge again, and the process repeats.

This cycle usually stabilizes itself within **5–10 seconds**, once the system's internal buffers and the battery reach their minimum levels.

#### **Troubleshooting (if the flashing does not stop):**

If the system does not switch to stable charging after a longer period of time, the following steps can be taken to reduce the starting load:

- **Removing the NTC jumper:** Remove the jumper from the NTC connector. This reduces the starting current consumption. Once the red LED stops flashing and charging becomes stable, replace the jumper to allow the battery to charge normally.
- **Voltage monitoring potentiometer (10):** Starting can also be aided by fine-tuning (lowering) the detection threshold of the potentiometer marked 10.
  - *Caution:* Excessive reduction of the threshold value may cause uncertainty when switching to battery mode.

#### 4.4.6 Important warning regarding storage

The qUPS-P-BC's own control circuits and indicator LEDs consume minimal power from the battery even when switched OFF. This continuous load typically drains the battery within a few days, depending on the battery capacity and condition, without recharging.

#### Deep discharge protection:

- To protect the cells, the system disconnects all consumers at a voltage level of 2.5 V
- **Caution:** Natural self-discharge after protective shutdown can still damage the battery if it is stored for a long period without charging.

**Recommendation for periods of non-use:** To avoid permanent loss of capacity, if you do not use the device for a long period of time, it is recommended that you remove one of the battery wires from the connector, thereby physically interrupting the circuit.

#### 4.4.7 Switch between mains and battery power

The qUPS product detects the loss of external power supply or a voltage drop below the level set by [potentiometer \(10\)](#). In this case it automatically switches to battery power. When the external power supply is restored, it will switch back and recharge the energy consumed from the battery.



The switchover from external power to battery mode is extremely fast (**100-300 µs**). Although a momentary voltage drop may occur — triggering an '*Under-voltage detected!*' warning on the Raspberry Pi — it will not cause malfunctions or reboots due to the short duration.

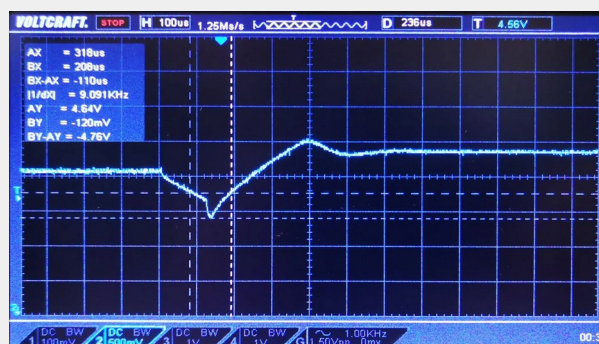


Figure 1: Raspberry Pi 5 at 50% load

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

---

## 4.5 Intelligent functions

The qUPS provides real-time power status and battery charge levels to de protected device, ensuring that during extended outages, the system receives a timely warning to initiate a safe shutdown before the batteries are depleted. Upon sensing the shutdown signal of the protected device, the qUPS cuts the power to guarantee a clean reboot and prevent the system from becoming stuck in a halted state when external power returns.

### 4.5.1 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.

## 4.6 Level indicator

The battery charge is indicated by the LED group numbered (5).

The five 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. Safe (yellow): there is sufficient time for a safe shutdown.

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

4. Half (green): The power level is half.

5. Max (green): Fully charged.



The LEDs indicate the above charge levels, not percentages. These are functional level indicators and do not reflect the battery charge linearly.

## 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   |
|---|---|--|
| Battery is not charging   | The temperature of the battery is outside the safety range (in case of NTC)                           | The battery temperature must be brought within the limit |
| Battery is not charging   | In the absence of NTC, connector (2) is not short-circuited   | Short-circuit connector (2)                              |
| Raspberry Pi won't start despite having an external power supply                | Power supply is insufficient for the combined power requirements of Raspberry Pi and battery charging | Turn the CHARGE pin on switch (3) to OFF                 |
| If an external power supply is present, the "External power LED" (8) is not lit | External power supply problem   | Replace the power supply                                 |
| Raspberry Pi will not start if the "Min" LED is on                              | Mode switch (6) is on OFF state   | Mode switch (6) must be set to ON or AUTO                |
| The circuit does not charge the battery below 2.9V.                             | The circuit charges only with trickle charging.   | See section 4.3.   |
| No charging when battery is discharged, "Low" (red) LED flashes                 | The power supply cannot provide a stable voltage level for the high starting current.                 | See section 4.3.   |