Pi-UpTime UPS 2.0

New

UPS for Raspberry Pi-4 using Li-Ion or Li-Phosphate batteries

Key Features:
- **Provides UPS functionality for Raspberry Pi.**
- **Includes USB-C and a micro-USB connector for Power In.**
- **Use 18650 size Li-FePO4 or Li-Ion/Li-Polymer battery – jumper selectable. Batteries not included.**
- **Attach external battery to solder points provided using JST, term-block or solder.**
- **No reboot when power fails. UPS power is provided seamlessly.**
- **Ideal diode power OR – minimal heating or power loss.**
- **External connection points for I²C, input V, output V and battery.**
- **Monitor Input, Output, Battery Voltage and temperature via ADC using I²C. Up to three I²C addresses. 3mV sensitivity. Sample Python code provided.**
- **Add power on/off switch to turn off all power to Pi. All power, including UPS power, is off when switch is off. Battery charging continues.**
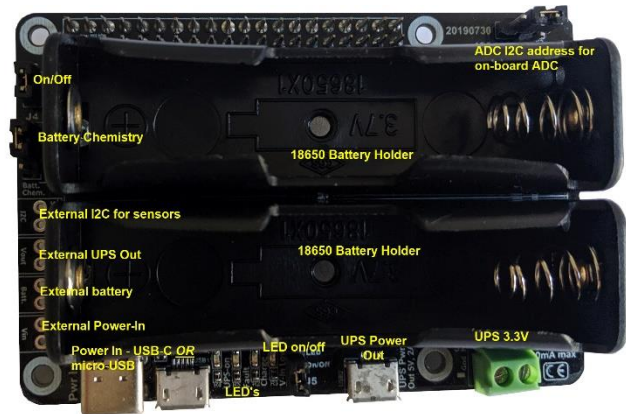- **UPS Power - 5V, 2.5A and USB. 3.3V, 0.7A**

Pi-UpTime UPS 2.0 is a new and improved version of the Pi-UpTime UPS. Pi-UpTime UPS 2.0 is designed to work with the Pi-4 or other SBC's, such as Odroid, Asus, Arduino etc. Power is supplied via the 40-pin header or via the micro-USB out port. Powering the Pi and charging the battery is done on the Pi-UpTime UPS 2.0 via a USB-C or a micro-USB connector. Only one connector can be used at any time for power.

Pi-Z-UpTime UPS 2.0. See pictures enclosed in data sheet for additional information.

The micro-USB connector is provided for backward compatibility. The Pi-UpTime 2.0 has the same dimensions as a Pi-4 (or Pi2, Pi3, etc.) and can be mounted securely on a Raspberry Pi using 20 mm spacers for a compact, mechanically secure connection.

An on-board 12-bit ADC monitors Vin, Vout and battery Voltage for accurate information on operating conditions. Temperature sensor below the battery provides accurate battery temperature information. Battery charging takes place between 0^oC and 50^oC. **No GPIO connections or GPIO monitoring is needed.** ADC provides information via the I²C. Up to three different I²C address can be selected via jumpers J11, J12 to avoid conflict with other I²C devices. Sample python code is provided for monitoring system parameters and shutdown the system when power fails, and battery is low. Sample code can be downloaded from www.alchemy-power.com

External connections, via solder points, are available for I²C, Vin, Battery and Vout. The connections can be accessed via 2.54mm (100 mil) terminal blocks or by direct soldering. Terminal blocks are not included. External sensors or external controllers such as an Arduino controllers or other embedded micro-controllers can tie into the I²C connection.

These connection points can be used for an external battery[1], external Vin or external Vout. Max current for the overall system is 2.5A. External battery can be Li-Polymer, Li-Ion or Li-PO4. Please use Jumper J4 to select chemistry. Li-Ion and Li-Polymer share the same jumper setting.

Current for the UPS is limited to 2.5A via a current limit resistor. Since the USB connector provides power for charging the battery and is also providing power to devices connected via Pi-UpTime UPS 2.0, a 3.5A power supply is recommended. We also recommend using good quality USB cables to minimize power loss via USB cables. Using the USB-C connector is recommended for Power In.

3.3V UPS power is available via terminal block J2. Maximum of 0.7 Amps can be drawn from this connection. This is useful to provide power to external sensors, IoT and other electronic devices.

Batteries or spacers are not included.

Key Features

- Provides UPS using one or two rechargeable 18650 Lithium batteries in battery holder or connecting an external battery. Batteries are not included. An external battery can be used instead of onboard battery connectors. Unit is agnostic to battery capacity. Charge and UPS run-time will vary according to battery capacity.
- Choice of Li-Ion, Li-Polymer or Lithium-Phosphate batteries. Jumper selectable (Li-Ion / Li-PO4) battery chemistry via jumper J4. Both batteries in the battery holder must be identical. Battery chemistry selection is done via J4. Default selection is for Li-Ion. Li-Polymer batteries can be used with an external connector. For Lithium Polymer batteries, use the Li-Ion battery setting on jumper J4.
- Install one or two 18650 batteries (not included). Please ensure the batteries are installed with the proper polarity. Reversing the polarity will damage the electronics.
- Includes full Battery Management System (BMS). Charges the battery when power is available using CC-CV charging methods. Depleted batteries are charged initially at a low current, allowing batteries to recover.
- On board ADC allows Vin, Vout, Battery V and temperature monitoring via I^{2}C. Sample Python code can be downloaded for use. The sample code can be modified to adapt to your needs. NO GPIOs are used. Only an I^{2}C bus is shared with other I^{2}C peripherals. Valid I^{2}C addresses are 0x48, 0x49, 0x4B. Default address is 0x49.
- System turns off all power and shuts down when batteries fall below 2.6V, protecting the batteries.
- Power reset is done by pulling off the Power on/off shunt on Jumper J3. By connection an on/off switch to jumper J3, power can be turned on or off as needed. Switch can be connected via a 2.54mm cable header. This cable can be purchased from several places. Such a cable is available, for example, on Amazon from Alchemy Power, product id B07FXXDN2M.
- Using spacers, Pi-UpTime-UPS can mount securely on Raspberry Pi-4, Pi 3B+, 3, Model A etc.
- Maximum battery charge current is limited to 1A. Battery charge time will vary based on battery capacity and battery charge level.
- Several safety features are built-in on Pi-UpTime UPS 2.0.
  - Includes Battery Management System (BMS) which maintains CC-CV charging and maintains the charge level for Li-Ion or Li-PO4 batteries, once the batteries are charged.

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[1] If an external battery is used via the external connection point provided, do not insert batteries in the battery holders provided. You can remove the battery holders in this situation to save space. Only the external battery should be used **or** the 18650 batteries in the battery holders should be used.

- A temperature sensor senses ambient temperature around the batteries and shuts down charging when it gets hot. Operating conditions for battery charging are 0°C to 50°C.
  - An initial slow charge for depleted batteries is provided to allow batteries heavily drained to recover gracefully.
  - A PTC fuse is provided for second battery to prevent battery current loops. Battery current loops are created when a charged battery and a discharged battery is connected.
  - Charging current is limited to 1.2A. This reduces heat and improves operating conditions.
  - Total current is limited to 2.5A, thus protecting the overall system.
- All LED's can be turned off. This is done by removing shunt on J5.
- Power to the Pi is provided via the 2x20 pin header, pins 2,4.
- UPS out – regulated 5 V and 3.3V. A maximum of 2.5 Amps for overall UPS system. 0.7Amps for 3.3V UPS power. Please make sure the battery can sustain 2.5 Amps or more as output or discharge current. Many Li-Polymer batteries cannot sustain such current load and may discharge rapidly.
- LEDs indicators:
  - **Green** – Battery is charging. LED is on when the battery is charging. Off when battery is charged. LED also indicates Power via USB is on.
  - **Blue** – UPS is on and operational.
  - **Red** – Fault. Attention should be provided to ensure the system shuts down properly or provide an alternate power source of power.
  - **Yellow** – Power supply input V is below 4.8V and battery may not charge. At this Voltage the Raspbian OS also shows a lightining bolt as well.
- Sample Python code to monitor system is available. Download from Alchemy Power Inc. website or at www.alchemypower.com/downloads .
- Output Voltage – UPS generates regulated 5.0V (±2% across full load range). When the Power is available (via the Power on port), the power is passed through to the output via a very low loss ideal diode.
- Power In can be via the USB-C port (recommended) OR via the micro-USB port. Micro-USB port power adapters usually do not provide enough power (amps) and drop the Voltage when there is a heavy load demanded. This situation will cause the Yellow LED to be on and may also display the lightning bolt on Raspbian.

Please visit www.alchemypower.com/products for additional information and sample python code.

Recommended installation steps

1. Remove Jumper J3 to turn off all power to the Pi and external power sources (USB-out, 3.3V).
   a. Insert an on/off switch if desired at Jumper J3. Ensure the switch is in the off position.
2. Select the battery chemistry based on battery you are planning to use on jumper J4.
   a. For Li-Polymer battery, use the same setting as Li-Ion.
   b. For a Li-Phosphate battery, switch the jumper to the Li-PO4 setting.
3. Insert the battery in the battery holders. Make sure you follow the proper polarity. Improper battery insertion can damage the electronics.
   a. The Blue UPS light comes on when the UPS is functioning properly.
4. Mount the Pi-UpTime UPS 2.0 board on the Pi. Recommend using 20mm spacers to mechanically secure the unit.

5. Plug in the USB power to USB-In port on Pi-UpTime UPS 2.0. The green LED comes on indicating battery is charging. If there is no light, battery is charged.
6. Once the Pi-UpTime UPS 2.0 is connected to the Pi (the 2x20 pin connectors are mated), insert the shunt on Jumper J3, or if a switch is installed, turn the switch to on. This applies the power. The Pi will boot up once power is applied.

Table 1: Pi-UpTime UPS vs Pi-UpTime-UPS 2.0

This table compares the older version of Pi-UpTime UPS with the current version of Pi-UpTime-UPS 2.0

	Pi-UpTime-UPS	Pi-UpTime-UPS 2.0
Charge Current	Max 1.0 A	Max 1.2A
Battery Chemistry (battery not supplied)	Li-Ion 18650 battery	Li-Ion/Li-Polymer **OR** Lithium Phosphate, jumper selectable
Battery Holder	On top, 2x18650 size	On top, like previous version **OR** external via terminal block
Access to Vin, Vout, Battery	No	Yes, via terminal blocks, and in software via the on-board ADC
Input V	Max 5.5V, via micro USB only	Max 5.5V, via micro-USB (in) **OR** via terminal blocks (not included)
Output V	4.6V to 5.1V	Vin, when present is passed through. UPS output regulated to 5V out (±2%). No irritating "bolts" on Raspbian
Max Current	1A	**2.5A**
On/Off Switch	None. Only power reset switch is provided	Can attach an external on/off switch for manual on/off. Power reset by pulling shunt out/in
UPS USB Out	Yes, via micro-USB	Yes, via micro-USB **OR** via terminal blocks
GPIO used	Yes	None – internal ADC is used
Vin, Vout, Battery and temperature info	None	Available via an on-board 4 channel 12-bit ADC, accurate to 3mV (Temp =±2°C)

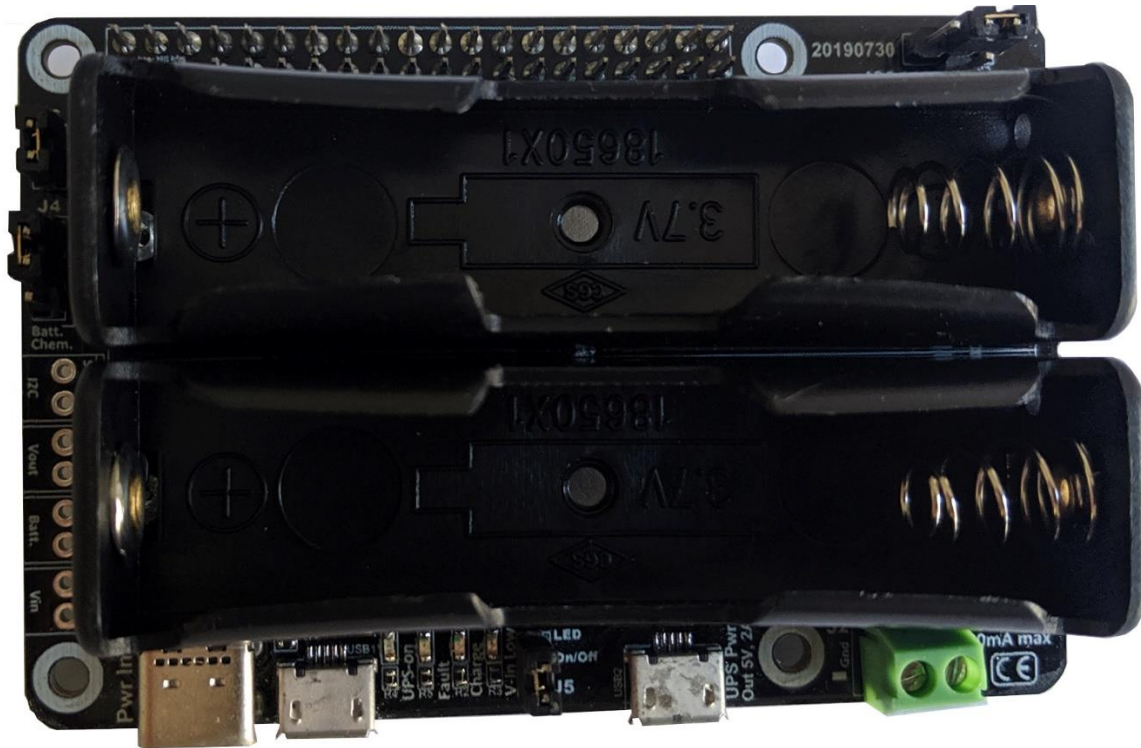|	Pi-UpTime-UPS	Pi-UpTime-UPS 2.0
Python code for shutdown	Yes, depends on GPIO indicators	Yes. Python code provides Vin, Vout, board temperature and Battery level. Can be modified for different use cases
External Battery	None. Battery attached via the 18650-battery holder on board	Battery attached via 18650 battery holder **OR** connected via terminal block. Terminal block is 2.54mm and is not included. Digikey part number ED10561-ND
Battery size	One or two 18650 Li-Ion battery. Recommended capacity < 3500 mAh	Can be any capacity. Higher capacity takes longer to charge & provides longer UPS run time
Battery Management	CC-CV charging. Battery charge level maintained over time	CC-CV charging. Battery charge level maintained over time
Safety	CCCV charging, temperature monitoring	CCCV charging, temperature monitoring, PTZ fuse to prevent battery loop current. System current limit of 2.5A
LED's	Many	Green – Battery is charging Blue – UPS is on Yellow – Input V is below 4.8V Red – Fault
Power in	Via micro-USB	Via USB-C or micro-USB or Terminal Blocks (not included)
UPS Power out	Via micro USB	Via micro USB or Terminal Blocks
Other	Many units in use worldwide.	Uses Ideal diode – very little heat or power loss – an efficient operation and seamless transition to battery backup for UPS
Shutdown Trigger point	Hardware – cannot be modified	Can be modified in software. Battery V level determines when shutdown is triggered and can be changed
Battery management / charging	Built on board, uses CCCV charging	Built on board, uses CCCV charging

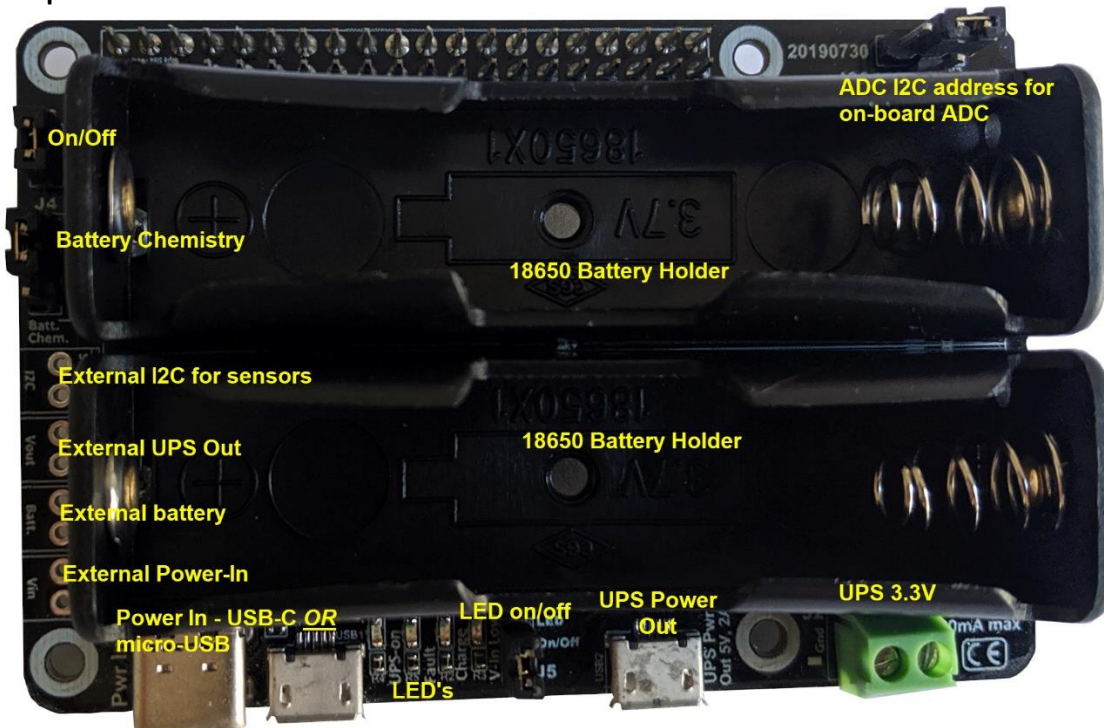|	Pi-UpTime-UPS	Pi-UpTime-UPS 2.0
Board Color	Green with white text	Black with white text
Planned use / future	Legacy. Not recommended for new designs	Recommended for new designs
Other	Provides 3.3V, 0.8A max UPS, protected by PTZ fuse	Provides 3.3V, 0.8A max UPS, protected by PTZ fuse
I^2C	NA	Onboard ADC uses I^2C. I^2C can be extended to external sensors via terminal block.
UPC code	691852747139	708088352584

Table 2: Comparing UpTime family

	Tiny-UPS	PiZ-UpTime 2.0	Pi-UpTime UPS 2.0
Functionality	"In-Line" UPS for USB Power, inline to USB Power	UPS for a Pi-Zero or Pi-A, typically mounted on a Pi-Zero or Pi-A	UPS for a Pi-4, Pi-3 etc. Typically mounted on a Pi-4 or Pi-3
Battery Chemistry	Li-Ion or Li-Polymer	Li-Ion or Li-Polymer	Li-Ion, Li-Polymer **or Li-Phosphate**, jumper selectable.
Battery connection	External via Terminal Block	External via Terminal Block	Onboard two 18650 battery or External battery via Terminal Block
Max Current	2A	2A	2.5A
Output V	5V±2% regulated	5V±2% regulated or Vin from Power supply	5V±2% regulated or Vin from Power supply
Indicator / measurement	Battery low via GPIO. Power off via GPIO	Vin, Vout, Battery V and temperature monitored via on board 12-bit ADC	Vin, Vout, Battery V and temperature monitored via on board 12-bit ADC
Shutdown routine	Sample Python code provided	Sample Python code provided	Sample Python code provided
Adjust battery level to trigger shutdown	No	Yes, controlled in software	Yes, controlled in software
LEDs	Charging, charge complete	Charging	Charging. UPS on when Input V < 4.8V (brown-out)
Charge current	1A	0.5A	1.2A
Models supported	Any, up to 2A current	Pi-Zero and others	All, including Pi-4
Max battery capacity	No upper limit – takes longer to charge	No upper limit – takes longer to charge	No upper limit – takes longer to charge
Vin Power supply	Via micro USB only	Via micro USB or terminal block	Via USB-C, micro USB or terminal block
UPS Vout	5V, via micro USB or terminal block (not provided)	5V via micro USB or terminal block	5V via micro USB or terminal block. 3.3V, 0.7A via terminal block
I^2C bus access for external sensors	None	None	I^2C connection to the Pi is accessible via terminal block for external sensors etc.
GPIO	External. Jump wires needed to connect to Pi or another device.	No GPIO used	No GPIO used

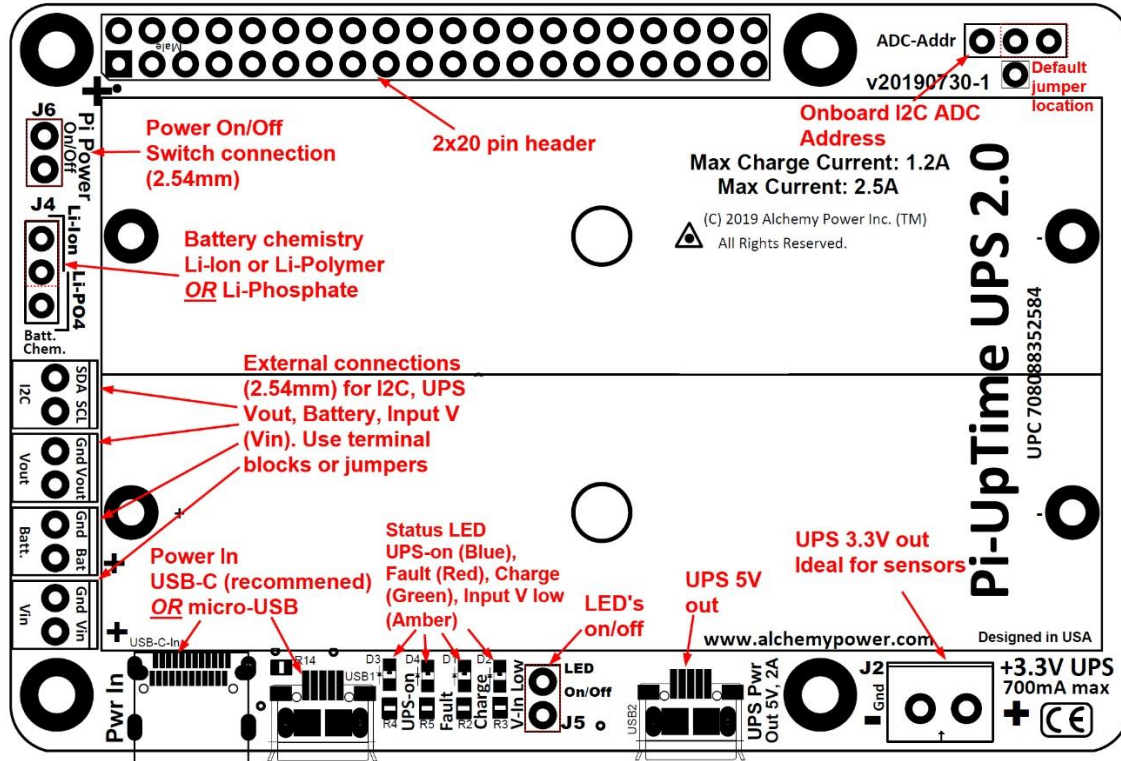|	Tiny-UPS	PiZ-UpTime 2.0	Pi-UpTime UPS 2.0
Temperature	Not applicable as battery is external	Board temperature is provided. When it is too hot or too cold, the Pi can be shutdown. Sample routine will need modification	Board temperature is monitored and BMS disables charging when it is too hot or too cold
Shutdown Trigger	External when battery is low	Software driven, with check for battery low and Power off	Software driven, with check for battery low and Power off
Battery Management	CC-CV charging. Battery charge level maintained over time	CC-CV charging. Battery charge level maintained over time	CC-CV charging. Battery charge level maintained over time
Additional Battery Safety	Max charge current monitoring	Provides board temperature. Software can decide what to do next. Max charge current monitoring	Active temperature monitoring. Battery charging is disabled when it's too hot or too cold. PTC fuse protection between batteries to prevent current loops. Max charge and use current monitoring & current limits
Current limit	Only for charge current	Only for charge current	Charge current and max current monitoring
Board Color	Green	Black	Black
Board dimensions	35mm x 28mm x 12mm 4 mounting holes. Can be mounted on a Pi-Zero.	65mm x 30mm x 12mm Bottom connector 11mm. Ideal for mounting on a Pi-Zero. Can be mounted on Pi-A or Pi-3 family	85mm x 56 mm x 22mm (with 18650 battery holder). Bottom connector 13.5mm
Mounting	4 mounting points. Long edge aligns with Raspberry Pi-Zero short edge for mounting	Mounts to Raspberry Pi Zero. Long edge aligns with Raspberry Pi-3 or Pi-A dimensions. Recommend 11mm spacers.	Designed to mount on Raspberry Pi-4, Pi-3. Recommend 20mm spacers.
Recommended spacers	Depends on unit connected to. For Pi-Zero, 11 mm or 15 mm spacers recommended	For Pi-Zero, 11 mm spacers recommended	For a Pi-3 or Pi-4, 20mm spacers recommended
Board weight	15 grams	20 grams	50 grams
UPC Code	708088352553	708088352577	708088352584

Picture Gallery

Pi-Z-UpTime UPS 2.0

ADC I2C address for on-board ADC

On/Off

Battery Chemistry

18650 Battery Holder

External I2C for sensors

External UPS Out

18650 Battery Holder

External battery

External Power-In

UPS 3.3V

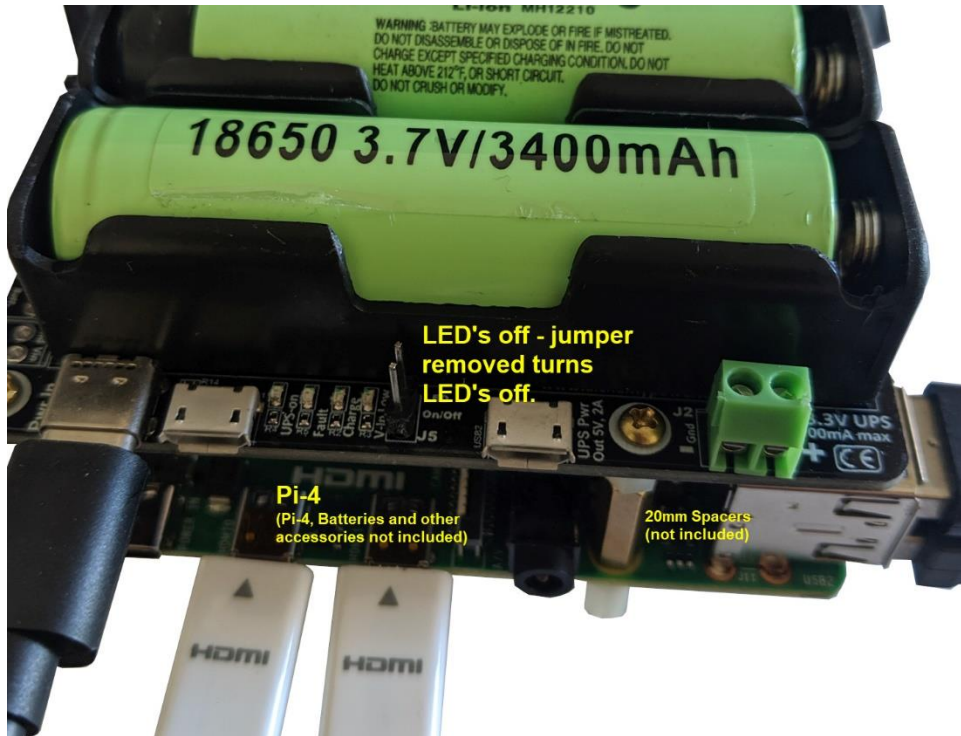Power In - USB-C *OR* micro-USB

LED on/off

UPS Power Out

LED's

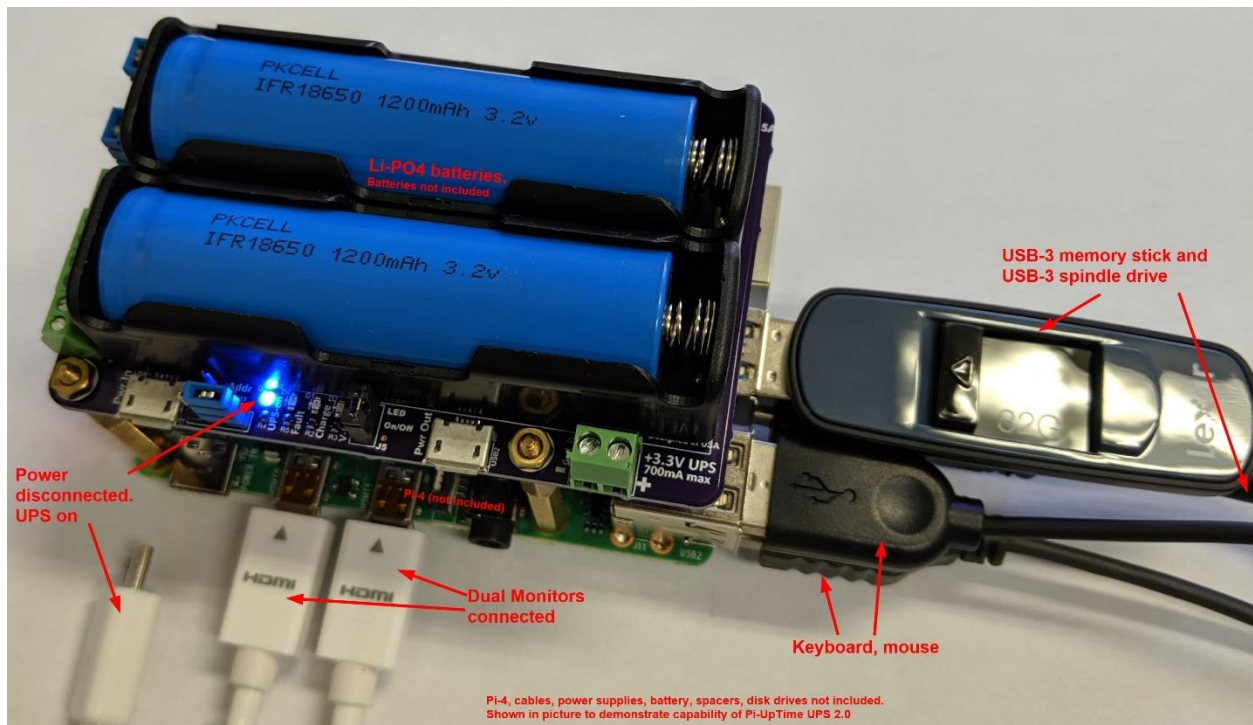**Pi-UpTime UPS 2.0 with the functions**

CAD outline with functions

Pi-UpTime UPS 2.0 with On-Off Switch and charging LED on

LED jumper is off, turning off all LED's. Shows mounted on a Pi-4 model

PI-UpTime UPS 2.0 with Li-PO4 (Lithium Phosphate) batteries, connected to disk-drive and USB disk

Packaging. Insert card recommends install steps

Specifications

General Information

Model Number: Pi-UpTime-UPS 2.0

Raspberry Pi Models supported

Any Raspberry Pi (including Pi-4) or SBC with a 40-pin header compliant to Raspberry Pi Foundation header definition. Pins 2,4 are used for power. I^2C (pins 3,5) is shared to monitor operating parameters. Pi-2, Pi-3, Pi-Zero family, Odroid, Asus Tinker, etc. Other boards can be powered using USB out port.

Power

Input Power: Power-in via USB-C (recommended) OR micro USB connector on Pi-UpTime UPS 2.0. 5V. 3.0A power adapter recommended. Batteries are charged only when power is provided to USB-In connector on Pi-UpTime UPS 2.0.

Power Adapter: Not included.

Maximum Charge Current: 1.2 Amps total.

Maximum Current: 2.5A – limited by current limit resistor.

Input Operating range: 4.8 V to 5.5V. Below 4.8V, power is assumed to be off and UPS is triggered. Above 5.5V the circuit will be damaged.

Output

UPS 5V Power: 5.0 V, available via OTG micro-USB or external connect points. Power is provided to the Raspberry Pi via the 40-pin header, pins (2,4) and pin 6 (ground). Power shutoff at 2.5A.

Maximum UPS current: 2.5A. Power is off when current exceeds 2.5A.

Ripple: Less than 25mV p-p.

UPS Power regulation: <±2% across operating range.

UPS 3.3V: 3.3V power via attached terminal block. Power derived from 5V bus on Pi-UpTime UPS 2.0. Since max power is limited to 2.5A, power consumed by 3.3V UPS reduces available amps to the 5V UPS system proportionally.

Output Step up (Boost) Frequency: 2 MHz

Batteries

Batteries: One or two 18650 Li-Ion or Li-PO4 unprotected batteries in battery holder. External battery via Batt. and Ground connect points. Either use external battery **or** 18650 battery in the battery holder. Using both external batteries and batteries in the holder can cause current loops and damage the circuitry. Internal or external battery can be Li-Polymer, Li-Ion or Pi-PO4. Battery chemistry selection via Jumper J4. Li-Ion and Li-Poly use the same setting.

Make sure battery chemistry is selected via Jumper J4 BEFORE batteries are inserted.

Battery capacity: Recommend 2000 mAh to 3500 mAh for Li-Ion battery. 1200 to 2000 mAh for Li-FePO4 batteries. Please make sure batteries can support 2.5A discharge current.

LEDs: Battery charge (Green), Charge Complete Green LED is off. UPS on (Blue). Fault (Red) is on when batteries are bad or its too hot/cold to charge the batteries. Low Voltage (Yellow) LED is on when Vin is below 4.8V. Note – a lightining bolt also appears on the Raspbian-OS when Vin falls below 4.8V.

Battery polarity: Both batteries are inserted with positive polarity on the same side. **Inserting batteries incorrectly will damage the electronics and can cause the board to get very hot.**

Battery holder: Self-extinguishing Thermoplastic Polyester, black color. Sized for unprotected batteries. 302 Stainless Steel Nickle coated springs. RoHS 2 compliant.

Safety: Onboard circuitry prevent over charging, deep discharging. If the battery is depleted, the charging is done slowly initially. After safe level, the CCCV charging method is initiated. Temperature monitor checks temperature and shuts down charging if battery is too hot or too cold. Safe operating temperature range is from 0°C to 50°C.

Battery Charging: Uses CC-CV charging method.

Depleted Batteries: Senses depleted batteries and uses low current charging to bring charge level up

and then CC-CV charging. Initial charging for depleted batteries is a max of 100mA.

Monitoring: Monitor Input V, Output V, Battery V and board (battery) temperature using an on-board ADC. Sample Python Code provides capabilities to monitor ADC and shutdown the Pi when the battery V is low.

ADC capabilities: A 12-bit, delta-sigma (ΔΣ) analog-to-digital converter (ADC). Three I^{2}C addresses are available, jumper selectable. Minimum sensitivity is 3mV. Sensitivity can be improved by changing Python code.

ADC used: TI TLA2024IRUGR

ADC Addresses: 0x49 (default), 0x48, 0x4B

Battery Full Charge Voltage: Li-Ion, Li-Polymer 4.2 V; Li-FePO4 3.2 V

Spacers

M2.5x20mm spacers recommended. Spacers are recommended for mechanical stability and to clear USB and Ethernet connectors and provide ambient cooling air space. Four spacers are needed.

Connection Points

Connection points are spaced 2.54mm (100 mils) apart. Jumpers, terminal-blocks or JST connectors can be used for connections. Connections are marked on the board top layer as well as on the bottom layer.

Terminal Blocks recommended/used: Two Position Wire-to-Board Terminal Block, Horizontal with Board, 2.54mm (0.1inch) pitch, green color (color may vary), Thermoplastic, -30°C ~ 105°C, 6A, 125V. 20-30AWG wire can be used. Steel Zinc Screws, max torque 0.15 Nm (1.3 lb-in). Brass contact and clam material. RoHS 2 compliant. Recommend Onshore Technology Inc OSTVN02A150 Terminal blocks. Other manufacturers also provide equivalent terminal blocks, which can also be used

Terminal Blocks 3.3V UPS: Soldered. 3.5mm spacing.

Power on/off Switch

Reset: Turn power off by pulling out Power On/Off jumper shunt. Turn power back on by inserting jumper shunt. Power shunt remove-reinsert sequence causes a power reset and a reboot.

External Switch: Instead of a shunt, an external on/off switch can be connected to the jumpers. The jumpers are 2.54mm – any 2.54mm connector can be used. Please make sure the switch can sustain a minimum of 5V, 3A.

On/Off Switch cable: Available at several web sites. An example is via Amazon, product-id B07FXXDN2M.

Dimensions

Board dimensions: 83mm x 35mm x 70mm (3.3" x 2.2" x 1.4").

Weight: About 50g (1.7 oz.) without batteries. Note each 18650 battery adds approximately 50 grams of weight.

Header: Female pins on bottom. Male pins on the top. Pin thickness appx. 0.6mm. Female pin height appx 16 mm. Male pin height appx 7 mm.

Warranty

90-day limited warranty. Warranty voided by improper use.

Other Information

Battery Charging Temperature: -10°C to +50°C, outside this range, battery charging is disabled.

Electronics, battery holder: -40°C to 85°C

Operating Humidity: 10% to 80% non-condensing.

Recommended peripherals

Please visit www.alchemy-power.com/products for other recommended products.

RoHS Compliance: Electronic components, board etc. are RoHS compliant.

Other: CE Compliance certificate available on request.

Code download: www.alchemypower.com

Alchemy Power Inc.

2098 Walsh Avenue, Suite A, Santa Clara, CA 95050-2544.

Phone: 650.823.2316

Email: sales@alchemypower.com
www.alchemypower.com