

M.2 – UPS

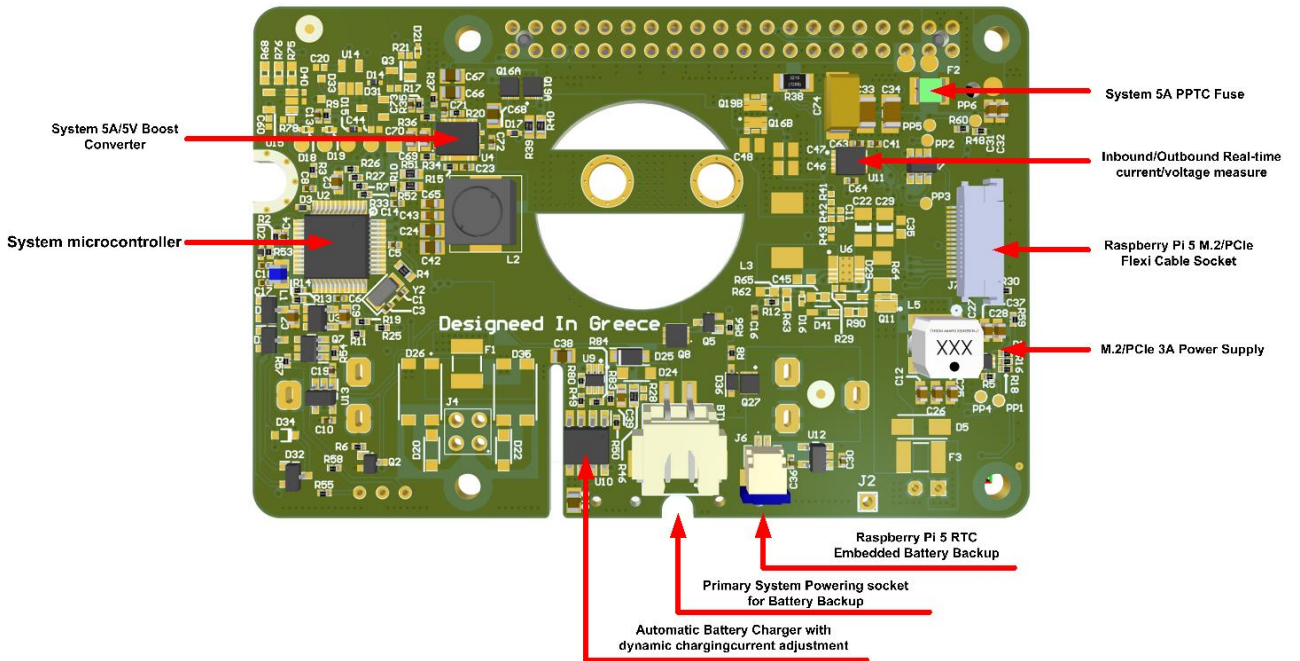
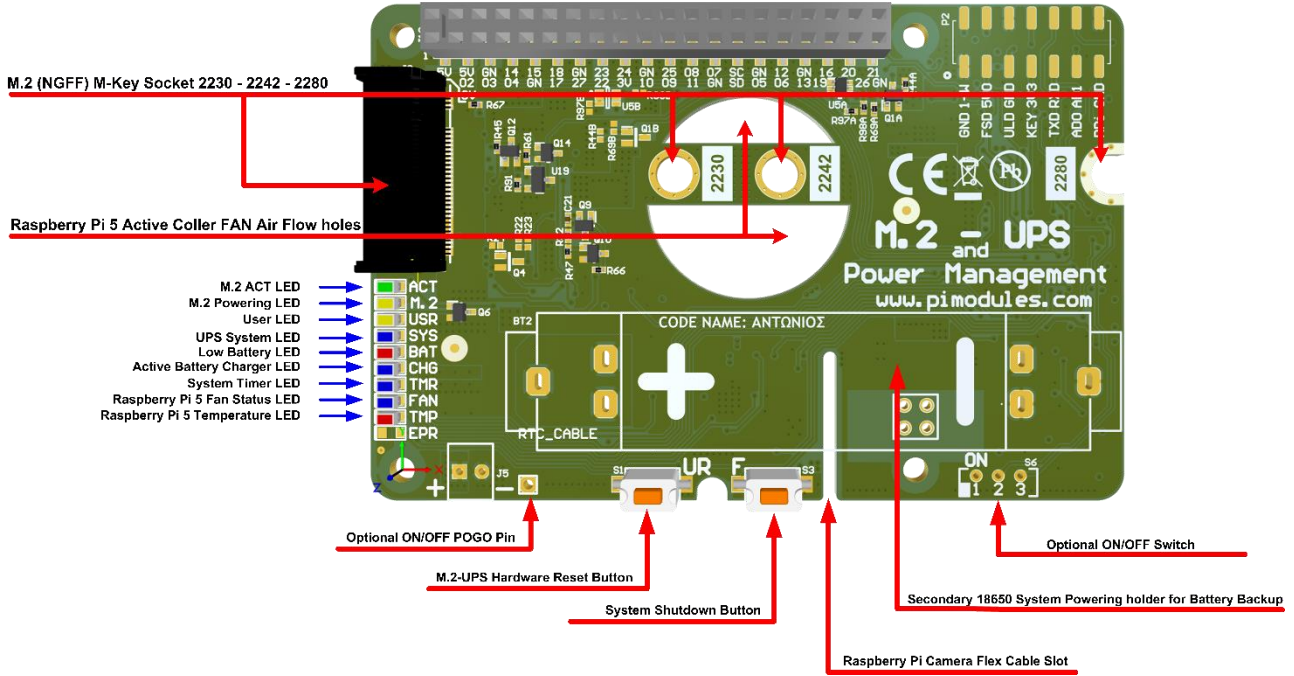
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Power Management HAT for Raspberry Pi 5

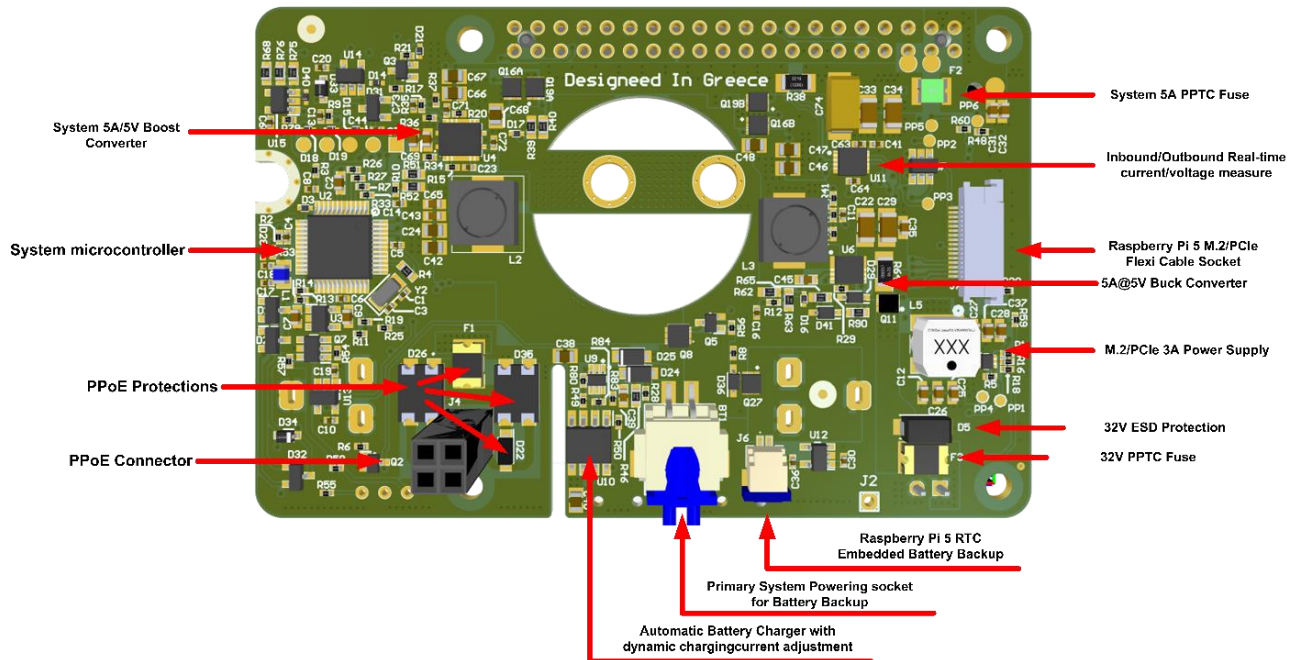
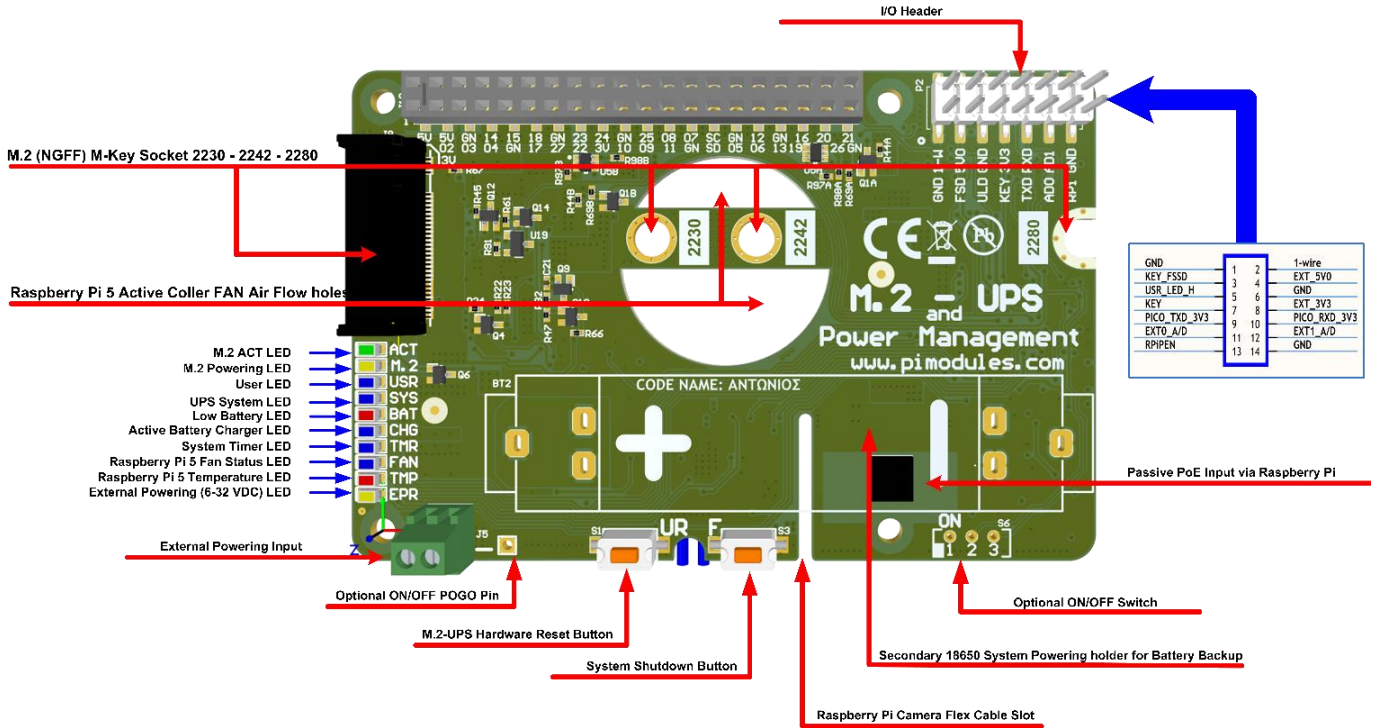
The M.2 **U**ltimate **P**ower Management **S**ystem with
RTC, Enhanced **P**eripherals and **I**²**C** control Interface
Intelligent **M**obile **P**ower **B**ank Ultra - High Current
Extended Buck Supply of 5.0A

FAQs

Version Standard



Version Advanced/PPoE



System Overview

The **M.2 – UPS & Power Management HAT** is an Ultimate Power Management System HAT designed especially for **Raspberry Pi® 5** that open the full functionality of their embedded PCIe (M.2) interface and adds a wealth of innovative powerful and development features to the **Raspberry Pi® 5** microcomputer!

It has been designed especially for the **Raspberry Pi® 5** and considers all enhanced power and cooling requirements of the **Raspberry Pi® 5** models. It has been designed to work with Official Cooler exploring their enhanced cooling capabilities for **Raspberry Pi 5** as also for the added **M.2** devices.

The core functionality of the **M.2 – UPS & Power Management HAT** is to provide an interface for **M.2(NGFF) M-Key (2230, 2242 and 2280)** and at the same time power backup (**UPS**), by protecting during the running time and automatically shut-down your **Raspberry Pi® 5** if there is a cable power failure and reboot your **Raspberry Pi® 5** once cable power has been restored!

However, it is only a small part of plenty and powerful functionalities that are implemented on this small HAT. The new **M.2 – UPS & Power Management HAT** contains two selectable backup power sources that can be used. The wide available on the market Battery 18650 Li-Ion or large selection line of **XH-2.5** connector batteries (600 mAh – 10 000 mAh) as also **Super Capacitor of 4000F**.

The new **M.2 – UPS & Power Management HAT** is the only one that supplies the **Raspberry Pi® 5 RTC** with battery backup (J5) and eliminates the need to use an additional battery for this purpose.

Last but not least is that implemented M.2 interface is equipped with **32786 kHz clock**, similar to the official **Raspberry Pi® 5 M.2 HAT**.

The new **M.2 – UPS & Power Management HAT** does not need any additional powering cable and thanks to the implemented proprietary monitoring algorithm monitors the and current consumption via GPIO and other powering sources.

The new **M.2 – UPS & Power Management HAT** offers an External Powering Input of 5V0 – 32V0 supply that can be easily used with any existing Solar Panel. Due to implemented **Power Tracking** and **Dynamic Charging Algorithm**, adopt the system power needs to the available Solar Power!

The **External Powering** Input and the **GPIO Powering** (via **USB-C**) can be connected at the same time and system decides what Power source will be selected!

In addition to the listed powering sources an extra powering source has been implemented – the **Passive PoE**. Much simpler and much lower cost than the PoE/PoE+. The **M.2 – UPS & Power Management HAT** can be powered through the Ethernet without expensive equipment, just with a simple power injector that costs 2 EURO. This an ideal solution for a low-cost homemade **PoE Systems** based on the **Raspberry Pi 5** and **M.2 – UPS & Power Management HAT**

Applications

The **M.2 – UPS & Power Management HAT** is equipped with plenty of features which make it an extremely useful tool for **Raspberry Pi® 5** project development. It not only provides powering continuity, but also offers extra user programmable LEDs, Sensors, buttons and I/O's. The unit also features a dedicated **12-bit 200 kbps analogue to digital converter** with two channels (preadjusted to 0-5V and to 0-25V) making it the perfect board for remote and unmanned sensor deployment. These extra features result in the **M.2 – UPS & Power Management HAT** being a superior all-in-one device perfect for many innovative projects, and embedded applications. In addition, the embedded **M.2 Interface** equipped with 32786 kHz clock allows a wide range of applications to be used.

It can be used with standard **18650 Li-Ion** battery as also with any type of 10A LiPO battery equipped with **XH-2P** (2.5mm) connector and cable.

Features

The list of features of the **M.2 – UPS & Power Management HAT** is as follows:

Ordered Item contains:

- **M.2 – UPS & Power Management HAT** Standard with all described below long list of features
- Selected by user battery (**XH-2P** (2.5mm) LiPO Battery 600 mAh 15C, 18650 Li-Ion), or Super Capacitor 4000F
- 40 pin headers (not passed through)
- Mounting Spacers, screws, nuts needed to mount on the Raspberry Pi® microcomputer

General

- **Email broadcasting** on events (Cable Power loss/return, Wake-up, User Button, A/D etc.)
- **Plug and Play**
- Ultra-light **System.d** Daemon based on threading
- **GPIO free** (all GPIOs are available for user application) **interaction with Raspberry Pi® 5 via I²C**
- Enhanced System Monitoring and Programming I²C API
- **Labeled J8 Raspberry Pi® 5 GPIO Pins** for Easy Plug & Play of experimental cables
- Standard **THT 40 Pin** connector (not soldered)
- Remote bootloader for Live Firmware Update on remote locations
- Local bootloader for Live Firmware Update

Powering Options

- user battery (**XH-2P** (2.5mm) LiPO Battery 600 mAh 15C, or 18650 Li-Ion) or Super Capacitor 4000F
- Enhanced **Line Interactive UPS** functionality (25us response time) **Version Standard**
- Enhanced **Line Interactive UPS** functionality (25us response time) **Version Advanced**
- **Additional File Safe Shutdown** and **Start-up** Functionality on a Single Button in addition to **Raspberry Pi® 5 button**
- **Continuously 5A@5.2V** supply on battery power backup

- Programmable Battery backed-up of independent power sources of 200@5V and 3V3
- **Intelligent Mobile Power Bank** with ON/OFF switch functionality with save shutdown/start-up, with Internal or External Slide Switch and RTC

Supported Battery Types and Capacities

- Supports a wide range of different Chemistry batteries (LiPO/LiFePO4/Li-Ion/ SAL)
- **Support for Li-Ion 18650 low-cost batteries** (from Electronic Cigarettes) with **dedicated mounting holder soldered on top (reverse polarity protected)**
- **Support for LiPO 18650 batteries** with **dedicated mounting base PCB HAT screwed on top**
- **Support for LiFePO4 18650 batteries** with **dedicated mounting base PCB HAT screwed on top**
- **Support for (XH-2P (2.5mm) Super Capacitor 4000F**

Embedded Peripherals and Interfaces

- **2 User Programmable buttons** (one on board)
- **1 User Programmable LEDs** (with mapping capability of the system behavior LEDs)
- **System File Safe Shutdown/Start-up button** with additional cable connectivity to external button
- **2 x 200 ks/s ESD protected A/D** with **voltage follower** (high impedance), pre scaled to **0-5V** and **0-25V**
- ESD Protected **3V3/5V0 1-wire** interface
- Integrated additional **Hardware Real Time Clock (RTC)** with Battery Back-Up
- Battery power for **Raspberry Pi® 5 RTC** supplied with extra cable to J16
- **3V3 Serial Port**

Embedded Sensors

- **Single High-side bi-directional hardware current sensing monitor** with power calculation
- **onboard** temperature sensor
- Battery Level Voltage
- Raspberry Pi GPIO 5V level

M.2 (NGFF) M-Key Interface

- Supports **2230, 2242** and **2280**
- Implemented **SUSCLK 32.768 kHz**
- Independent 3A Power Supply with Battery Backup
- Connectivity with **Raspberry Pi® 5** via **16 pins FPC**

User/Programmer Interface

- **I²C API Interface** for Control and Monitoring, with over 50 programming registers
- Support for **4 different** users selectable I2C addresses sets:
 - **DEFAULT:** 0x68, 0x69, 0x6A, 0x6B, 0x6C, 0x6D, 0x6E, 0x6F
 - **NO_RTC:** 0x69, 0x6
 - **ALTERNATE1:** 0x58, 0x59, 0x5A, 0x5B, 0x5C, 0x5D, 0x5E, 0x5F
 - **ALTERNATE2:** 0x48, 0x49, 0x4A, 0x4B, 0x4C, 0x4D, 0x4E, 0x4F

RTC Support and System Scheduler

- RTC Scheduler
- **Enhanced shutdown and start-up** system based on various internal/external events: Time stamp, A/D level, RS232 data, Cable Powering/Loss (UPS), Battery Level, I/O Level, etc.

Case Compatibility

- Dedicated - available soon

System Monitoring

- **Status Monitoring** – Powering Mode, Inbound current, Outbound current, Powering Voltage, Battery Voltage, Temperature (Raspberry Pi Core and **M.2 – UPS & Power Management HAT**), Timer State
- **Events Pi** Log feature
- **System LEDs** – **ACT, M.2, USR, SYS, BAT, CHG, TMR, FAN, TMP** (optionally selected can be mapped to **User LED**)
- **System Healthy**, that informs user remotely if Raspberry Pi and **M.2 – UPS & Power Management HAT** are running properly, and system is power protected (based on various internal system triggers)

System Protection

- Direct **Raspberry Pi® 5 Hardware ON/OFF Button** via Spring Loaded POGO Pin point to **J2 (optional)**
- **Programmable Watch-Dog Hardware** feature (**Still Alive Timer**)
- **XH-2P Cable** Batteries reverse polarity protection
- Electronic **18650** battery reverse polarity protection
- **PPTC 5A@5V fuse**
- **ZVD circuit** on all 5V GPIO connections
- **Micro-controller-based watchdog**
- Over Temperature protection
- Over Current protection

System Design

- Designed and Simulated with PDA Analyzer with one of the most advanced CAD/CAM Tools – Altium Designer
- Design Based on Microchip 16-bit 16 MIPS micro controller
- Industrial Originated

PCB Construction

- **2 oz copper** PCB manufactured for proper high current supply and cooling
- 6 mils track/6 mils gap technology **4 layers PCB**
- PCB Surface Finishing – Immersion Gold
- **Multi-layer Copper Thermal Pipes** for increased System Thermal Response and better passive cooling

Frequently Asked Questions & Answers

What is the M.2 – UPS & Power Management HAT?

The **M.2 – UPS & Power Management HAT** is combined multi-system that enables you to connect M.2 peripherals such as NVMe drives and AI accelerators to the **Raspberry Pi® 5** PCIe 2.0 interface. It is also an Ultimate **Raspberry Pi® 5** Power Management System, that contains the UPS functionality, as in addition a plenty of peripherals are integrated in a functional single PCB HAT covering most of possible needs of build-up application based on **Raspberry Pi® 5**. It has been especially designed for **Raspberry Pi® 5**.

How many versions of M.2 – UPS & Power Management HAT are available?

There are 2 versions addressed to different applications sets: **M.2 – UPS & Power Management HAT Standard** and **Advanced / Passive PoE**.

Why do I need to use the M.2 – UPS & Power Management HAT?

Because while you work on the **Raspberry Pi® 5** operating system and user files are continuously written onto the **SD Card** or **M.2 SSD Disk**. An unexpected lack of power during the writing of files can cause loss and/or inconsistency of data, up to possible corruption of the Operating System itself. The **M.2 – UPS & Power Management HAT** handles such power losses and provides battery power backup; in addition to this, **M.2 – UPS & Power Management HAT** provides plenty of extra features that make it a very friendly tool for beginners and advanced users. Our company, based on experience collected during continuously development of these **Raspberry Pi®** powering products since 2014 spent a very long time carefully designing the **M.2 – UPS & Power Management HAT** in order to provide to the user **as many as possible features at the lowest price possible**.

Is the M.2 – UPS & Power Management HAT true Plug and Play?

YES and NO, the **M.2 – UPS & Power Management HAT** is partially Plug and Play. You need just plug it into top of your **Raspberry Pi® 5** and go. You even don't need to change the **USB-C** power connection plugged in to your **Raspberry Pi® 5**. In fact, there is **no other USB-C powering connector** available like in other UPS modules available for the **Raspberry Pi®**. You will just plug in the **M.2 – UPS & Power Management HAT** to the **J8** connector on the top of your **Raspberry Pi®** and use it. As far as software configuration is concerned, all you must do is to install a small Python script on the **Raspberry Pi® 5** that will take care to safely shutdown the **Raspberry Pi®** and will inform your **M.2 – UPS & Power Management HAT** that **Raspberry Pi® 5** is running. It will solve all your possible power problems and offer battery backup.

M.2 – UPS & Power Management HAT fits to existing cases?

The **M.2 – UPS & Power Management HAT** requires a high enough case that holds the **Raspberry Pi® 5**, **Official Cooler** and **M.2 – UPS & Power Management HAT**. Therefore, if such a case is available, they can hold all devices. Such a solution will be soon available.

Is the M.2 – UPS & Power Management HAT compatible with other models of the Raspberry Pi?

NO.

How is it possible that M.2 – UPS & Power Management HAT has no need of additional USB-C power input like other Raspberry Pi[®] UPS available to the market?

The **M.2 – UPS & Power Management HAT** has a bidirectional power connection with the **Raspberry Pi[®] 5**. Through that connection it receives power, when present, from the **Raspberry Pi[®] 5**, and keeps its battery charged. It continuously analyzes powering conditions with proprietary powering analysis algorithms, detects power losses and power restoral and decides within 25 uS to switch between **internal battery** and **cable powering**. This type of UPS is called Line Interactive UPS

Is it possible that M.2 – UPS & Power Management HAT switches to battery powering without reason, when cable power is available.

YES. It could rarely happen. However, it is not affecting the normal functionality of the **Raspberry Pi[®] 5**, as after a short time returns to cable powering mode. It usually happens if battery is deep discharged and require a much bigger amount of power or if the Powering Supply Unit is low quality and not deliver enough power to the system.

The Raspberry Pi[®] 5 has an implemented USB-C PD and can work up to 20 V. How is it possible that M.2 – UPS & Power Management HAT handle this voltage?

The **M.2 – UPS & Power Management HAT** has a bidirectional power connection with the **Raspberry Pi[®] 5**. It is continuously monitoring the J2 5V pins and analyzing it, decides what to do based on proprietary algorithm. Therefore, it is independent from the **Raspberry Pi[®] 5** USB-C.

Can I use the M.2 – UPS & Power Management HAT with other boards on top?

YES. Just plug them on top of it or use the version of the **M.2 – UPS & Power Management HAT** with extended J2 connector, and then plug in the other board on top of it. The **M.2 – UPS & Power Management HAT** Module will power also your additional boards and other existing peripherals.

How long does the power lose that M.2 – UPS & Power Management HAT recognizes and filters?

It is not easy to answer, because the **M.2 – UPS & Power Management HAT**, not only monitors the power absence but also rising and falling edges of the power spikes and based on this cumulative information decide what to do. This decision is made based on multiple parameters that contains Voltage Level, Speed of powering losses, duration of power losses. It is a very complicated and proprietary algorithm.

I see that 18650 holder is metallic. Is it dangerous to short by mistake with other parts of the Raspberry Pi® 5.

NO. It is **NOT POSSIBLE**.

The 18650-battery holder is metallic however it is **covered** with a special **Coating, SCC3, Conformal Coating, Silicone Resin, -70 to 200°C. This guarantees high quality electrical isolation.**

The M.2 – UPS & Power Management HAT accepts 18650 batteries but also XH-2P cable batteries. Can I use both at the same time?

NO. It is **strongly recommended** to use **ONLY one** of them. They are parallel and if both connected, one of them will be charging the other one.

How Raspberry Pi® 5 is protected from direct power provided to the J2?

Following **Raspberry Pi® 5** HAT recommendations there are implemented 3 level of powering protection:

1. ZVD circuit
2. PPTC Fuse of 5A
3. Ultra-Fast FET based Analog Power Switch micro controller supervised

What is the maximum current that Raspberry Pi® 5 can draw from M.2 – UPS & Power Management HAT?

The **M.2 – UPS & Power Management HAT** is able to provide continuously 5A @5.25V.

What type of battery is used by the M.2 – UPS & Power Management HAT?

The **M.2 – UPS & Power Management HAT** can handle 2 types of batteries:

- **Holder 18650** Li-Ion or any other dimensions batteries
- Cable connected **XH-2P** batteries
- Cable connected **XH-2P** Super Capacitor 4000F

Both can vary in capacity as also in chemistry. The capacity starts from 600 mAh and ends at 10 000 mAh. Chemistry covers LiPO, LiFePO₄, Li-Ion, as also a special Super Capacitor of 4000F.

Can be the M.2 – UPS & Power Management HAT used with Super Capacitors?

YES. Only one type of Super Capacitor is allowed to be used with **M.2 – UPS & Power Management HAT**. It is the **4.2V 4000F Super Capacitor**. It can work from -40 +70 Celsius and can handle more than 20K cycles of charging/discharging.

What is the charging current used by M.2 – UPS & Power Management HAT?

The absolute maximum charging current is **1100 mA**. However, it is dynamically changed according to Power Supply capabilities. It starts from 100mA, and dynamically increases or decreases according to available power on cable supply. If during the time the capabilities of the Power Supply are reduced the **M.2 – UPS & Power Management HAT**, dynamically decrease the charging current to appropriate level and increase again when more cable power available.

Is the M.2 – UPS & Power Management HAT integrated battery protected?

YES, the **M.2 – UPS & Power Management HAT** has a built-in multiple battery monitoring and protection systems that features over current, overcharge and over discharge battery protection.

I need my Raspberry Pi® 5 to run on battery for a longer time: days and days. Does the M.2 – UPS & Power Management HAT provide any other way to extend the battery runtime?

YES, the **M.2 – UPS & Power Management HAT** has provided three features that can help in this case:

- the embedded internal **timed ON** feature allows the **M.2 – UPS & Power Management HAT** to automatically switch ON the Raspberry Pi® at a given time for a requested time slot.

- Once it starts, the Raspberry Pi® can invoke the File Safe Shutdown procedure at a preprogrammed time and shut itself down. At the end of shutdown, the **M.2 – UPS & Power Management HAT** will sense the halt state of the **Raspberry Pi® 5** and will switch it off (remove power).
- Supply the **Raspberry Pi® 5** with battery over GPIO 5V and use their new embedded scheduler capabilities.

By using these three features, the **Raspberry Pi® 5** can be activated only during requested time slots and be switched off for the rest of time. With this approach you can save a lot of energy and keep your **Raspberry Pi® 5** functional on battery for days and days.

These features do not need any cable supply and can be used exclusively on battery supply.

These features can be used also with a solar panel running the system only during the day.

Do I have any additional way to run my Raspberry Pi® 5 on dedicated conditions?

YES, the **M.2 – UPS & Power Management HAT** has provided additional features that can help in this case. They are called Event Driven Scheduler. There are some additional inputs like A/D, 1-wire or 3V3 RS-232. These inputs can be used to trigger the **Raspberry Pi® 5** on dedicated conditions. In Example if temperature exceed requested level (using 1-wire or A/D), if there is a light (using A/D and Light sensor) or any other i.e. GPS data using the 3V3 RS232 interface.

What is the I²C API Interface?

The Peripherals I²C Control – The **I²C API Interface** – is an implementation of I²C interface adapted to easy control of the peripheral connected to the **Raspberry Pi® 5** via command line. By using human understandable simple commands, control of peripherals is made extremely simple. Control at programming language level is also possible and easy. The core concept of the **I²C API Interface** is that all peripheral device control and data exchange between it and **Raspberry Pi® 5** variables are common for the **I²C interface** as also for the peripheral itself. Therefore, any change of them by either party, **Raspberry Pi® 5** and the peripheral, causes immediate update and action.

What GPIO Pins are required to have it running?

No one GPIO is needed, however if user install the 1-wire device then the **GPIO_GEN04** is used.

Do I have any indications about the M.2 – UPS & Power Management HAT status?

Yes. You have LEDs informing you about the powering source, battery status, charger status, system temperature as 1 extra LED available for user application. All the indications provided by the LEDs, as also much more, are available via RS232 and **I²C API** interface as well.

Can I control my [M.2 – UPS & Power Management HAT](#) via scripting commands?

YES. There are plenty of commands for full system control. Thanks to the implemented bootloader, the set of commands can be constantly enhanced with new ones, as we release more of them. We are open to customer suggestions about new commands to implement. Customers can propose new commands by e-mail or on our forum: if we find them generally useful, then we will implement them for free and distribute them via our bootloader system. Customized versions of the firmware featuring customer-specific commands are also possible.

What is the bootloader system, why do we need it?

Bootloader System is a live updating procedure for the embedded microcontroller on the **M.2 – UPS & Power Management HAT**. This system gives you access to any new version of the firmware every time that it becomes available.

How can I upload new firmware to the [M.2 – UPS & Power Management HAT](#)?

Just download the XX.HEX file from our website, store it onto the Raspberry Pi® and then update the **M.2 – UPS & Power Management HAT** directly from the **Raspberry Pi® 5** using a simple python script.

What RTC IC does the [M.2 – UPS & Power Management HAT](#) use?

There is no physical RTC IC. The microcontroller controlling all the **M.2 – UPS & Power Management HAT** functionalities emulate the RTC chip. Currently the RTC chip that is emulated is the DS1307, however in the future other chips may be emulated by firmware, which can be uploaded to your **M.2 – UPS & Power Management HAT** via bootloader procedure. The RTC system has its own crystal of 32768 Hz and is powered from the **M.2 – UPS & Power Management HAT** embedded LiPO battery. It can be used independently from the **Raspberry Pi® 5 RTC** or disabled completely.

What is the [ESD protection](#) that provides [M.2 – UPS & Power Management](#)?

The ESD (Electrostatic Discharge) protection is provided on each I/O pin that is handled by the **M.2 – UPS & Power Management HAT** (1-wire, and both A/D interfaces).

Is the M.2 – UPS & Power Management HAT powering the Raspberry Pi® 5 RTC

YES. The **M.2 – UPS & Power Management HAT** offer a dedicated supply, socket and cable that can be used to power the **Raspberry Pi® 5 RTC** independently, therefore user do not need to buy extra battery for that.

What happens if the M.2 – UPS & Power Management HAT initiates the Raspberry Pi® 5 shutdown and during this process the cable power returns?

No Problem at all! The system finalizes the shutdown procedure, and then restarts again as far the cable power supplied.

I see the M.2 (NGFF) M-Key interface. What devices it is supporting?

It is supporting the **2230**, **2242** and **2280** devices.

What is the M.2 (NGFF) M-Key interface clock source of 32786 kHz?

This feature is available only in the official **Raspberry Pi® 5 M.2 HAT+** and **M.2 – UPS & Power Management HAT**. In the M.2 interface, the 32.768 kHz clock is a crucial component for maintaining the RTC and enabling low-power timekeeping and wake functionality, thereby enhancing the overall power management and efficiency of the system.

What are the differences between Standard and Advanced / PPOE Versions?

The main difference is that the **Advanced/PPoE** version has additional cable powering source. It is up to 32 VDC. Therefore, the **Advanced/PPoE** can be used withal types of **Solar Panels**. The Passive PoE can be used with low costs Passive PoE systems. It is an alternative to PoE.

Can I use the External Powering of 32V and PPOE?

NO. Only one source can be used at the time.

Can I use the External Powering of 32V and Raspberry Pi® 5 USB-C powering?

YES. You can use both at the same time, and **M.2 – UPS & Power Management HAT** will select one of them automatically.

What voltage can I supply to the External Powering Input?

Any from 5V0 VDC up to 32 VDC.

What voltage can I supply to the PPOE Input?

Any from 5V0 VDC up to 32 VDC.