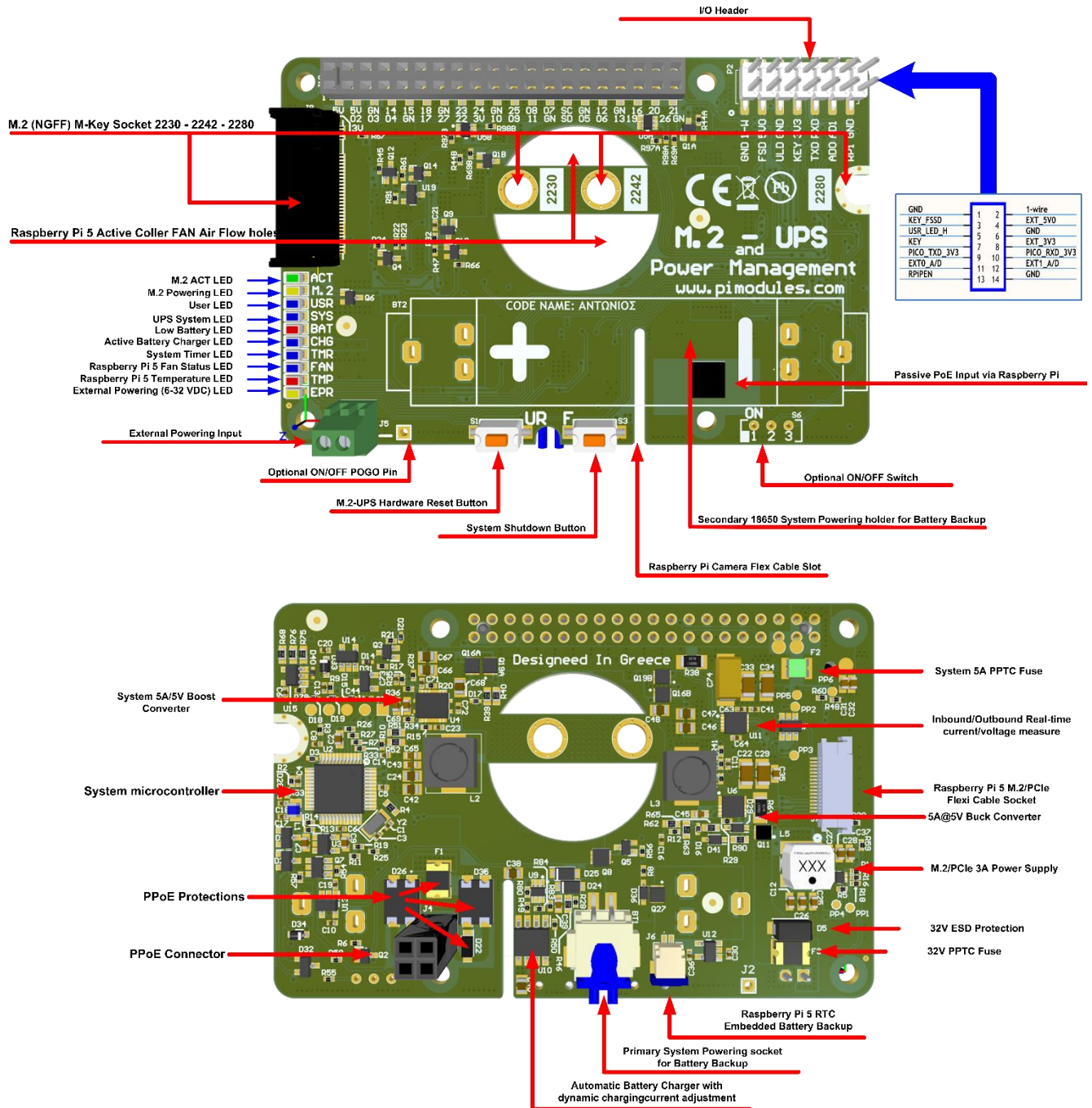# M.2 – UPS
and
Power Management HAT for Raspberry Pi 5
Version Advanced/PPoE

The **M.2 U**ltimate **P**ower Management **S**ystem with RTC, Enhanced **P**eripherals and I²C **co**ntrol Interface
Intelligent **M**obile **P**ower **B**ank Ultra - High Current Extended Buck Supply of 5.0A

I/O Header

M.2 (NGFF) M-Key Socket 2230 - 2242 - 2280

Raspberry Pi 5 Active Coller FAN Air Flow holes

GND	1	2	1-wire
KEY_FSSD	3	4	EXT_5V0
USR_LED_H	5	6	GND
KEY	7	8	EXT_3V3
PICO_TXD_3V3	9	10	PICO_RXD_3V3
EXT0_A/D	11	12	EXT1_A/D
RPiPEN	13	14	GND

M.2 ACT LED → ACT
M.2 Powering LED → M.2
User LED → USR
UPS System LED → SYS
Low Battery LED → BAT
Active Battery Charger LED → CHG
System Timer LED → TMR
Raspberry Pi 5 Fan Status LED → FAN
Raspberry Pi 5 Temperature LED → TMP
External Powering (6-32 VDC) LED → EPR

Passive PoE Input via Raspberry Pi

External Powering Input

Optional ON/OFF POGO Pin

Optional ON/OFF Switch

M.2-UPS Hardware Reset Button

System Shutdown Button

Secondary 18650 System Powering holder for Battery Backup

Raspberry Pi Camera Flex Cable Slot

System 5A/5V Boost Converter

System 5A PPTC Fuse

Inbound/Outbound Real-time current/voltage measure

System microcontroller

Raspberry Pi 5 M.2/PCle Flexi Cable Socket

5A@5V Buck Converter

M.2/PCle 3A Power Supply

PPoE Protections

PPoE Connector

32V ESD Protection

32V PPTC Fuse

Raspberry Pi 5 RTC Embedded Battery Backup

Primary System Powering socket for Battery Backup

Automatic Battery Charger with dynamic chargingcurrent adjustment

Designed and Manufactured in Europe by
Pi Modules Technologies L.P.
www.pimodules.com

Raspberry Pi
DESIGN PARTNER

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(NGFF)** 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** 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 protect and automatically shut-down your **Raspberry Pi® 5** if there is a cable power failure and can be set to automatically monitor and reboot your Pi 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 (once at a time). The wide available on the market Battery **18650** Li-Ion or large selection line of **XH-2.5** connector (600 mAh – 10 000 mAh) cover any extended Battery Backup request.

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**
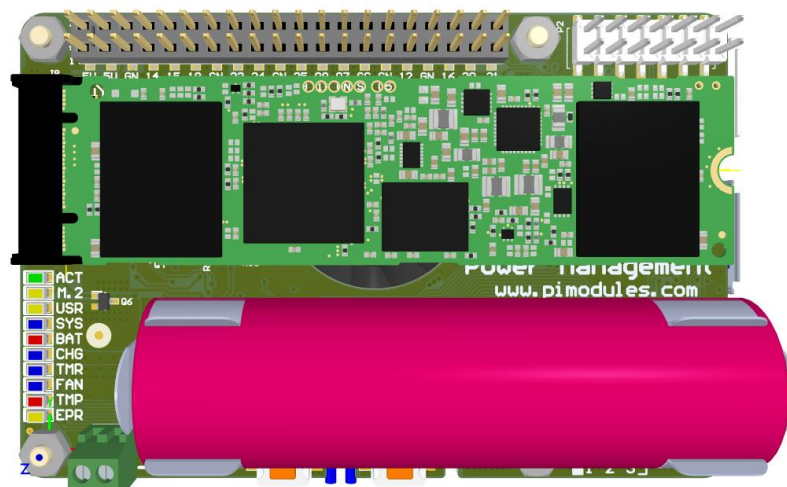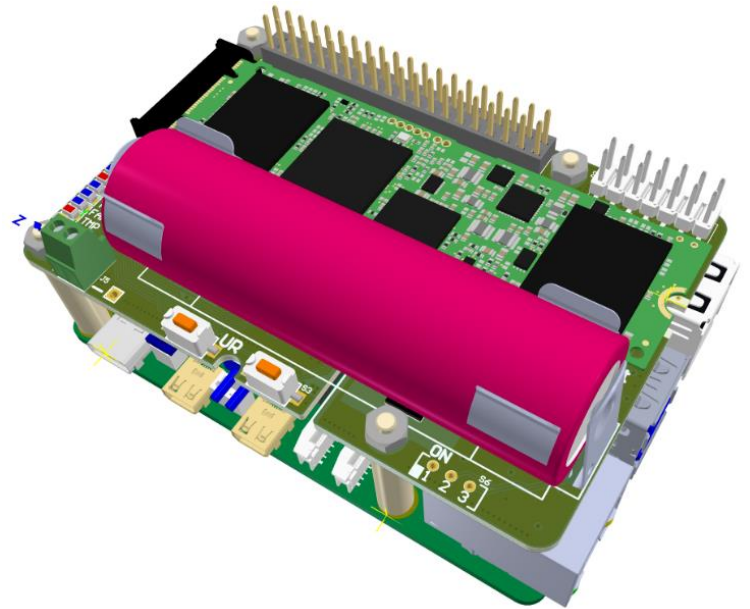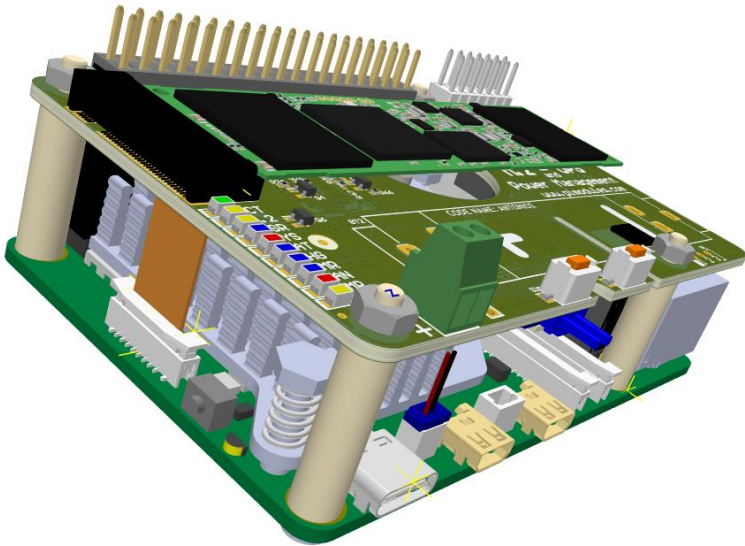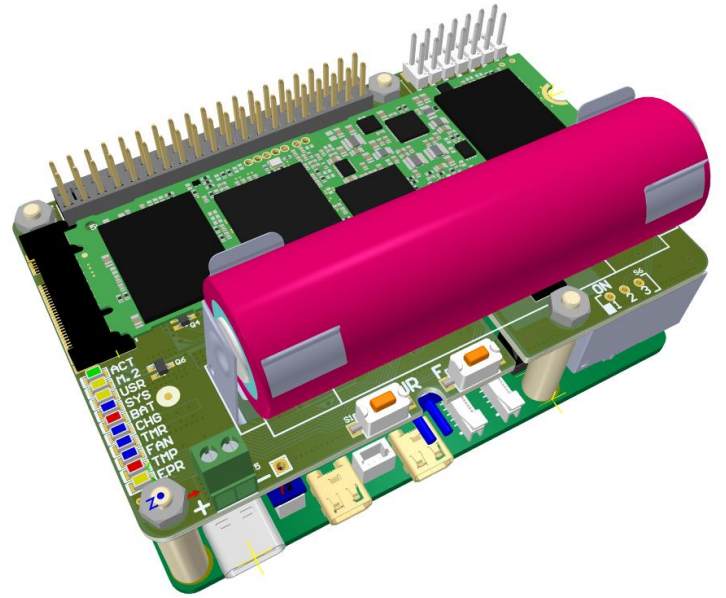
System Specifications

General

- **Dimensions: 85mm x 56mm**
- **Email broadcasting** on events (Cable Power loss/return, Wake-up, User Button, System Status)
- **Plug and Play**
- Ultra-light **System.d Daemon** based on threading
- **GPIO free** (all GPIOs are available for user application) **interaction with Raspberry Pi® via I²C**
- Enhanced System Monitoring and Programming API
- **Labeled J8 Raspberry Pi® 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

Supported Battery Types and Capacities

- Supports a wide range of different Chemistry and capacities batteries and Super Capacitor (LiPO/LiFePO4/Li-Ion/ Super Capacitor 4000F)
- **Support for Li-Ion 18650 low-cost batteries** (from Electronic Cigarettes) with **dedicated holder on top**
- **Support for LiPO 18650 batteries** with **dedicated holder on top**
- **Support for LiFePO4 18650** with **dedicated holder on top**

User/Programmer Interface

- **I²C PIco 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, 0x6B
  - **ALTERNATE1:** 0x58, 0x59, 0x5A, 0x5B, 0x5C, 0x5D, 0x5E, 0x5F
  - **ALTERNATE2:** 0x48, 0x49, 0x4A, 0x4B, 0x4C, 0x4D, 0x4E, 0x4F

Embedded Peripherals and Interfaces

- **1 User Programmable button** - externally accessed
- **1 User Programmable LEDs** (with mapping capability of the system behavior LEDs) - externally accessed
- **12bit 200Ksps A/D** with voltage follower pre scaled to 0-5V0 and 0-25V0 - externally accessed
- Additional **Backed up User Applications Powering Sources 3V3 and 5V0**
- Additional RS232 3V3 for user applications like System Schedule
- **System File Safe Shutdown/Start-up button** with additional cable connectivity to external button (similar/alternative to **Raspberry Pi® 5** but with ultra-low current consumption)
- Integrated **Hardware Real Time Clock (RTC)** with Battery Back-Up in addition and independent (synchronized) to **Raspberry Pi® 5 RTC**
- **Dedicated Cable** for the **Raspberry Pi® 5 RTC** battery Supply

RTC Support and System Scheduler

- **RTC** Scheduler
- **Enhanced shutdown and start-up** system based on various internal/external events: Time stamp, Cable Powering/Loss (UPS), Battery Level, Serial Port data, current etc.

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

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**

Powering Options

- Protected (ESD, over current (PPTC fuse), **5A Supply @5V**
- **2 selectable power back-up** sources: **18650 Battery** or **XH-2P socket cable Battery**
- Enhanced **Line Interactive UPS** functionality (25us response time) powered via **Raspberry Pi® 5 5V GPIO**
- Enhanced **On-Line UPS** functionality when powered via **EPR 5V0-32V0** or **PPoE**
- **Automatic Advanced Proprietary Power Spikes Tracking Algorithm**
- **Additional/Alternative to Raspberry Pi® 5 File Safe Shutdown** and **Start-up** Functionality on a Single Button
- **Continuously 5.0A@5.25V** supply on battery power backup
- **Intelligent Mobile Power Bank** functionality with safe shutdown/start-up, with Internal or External Slide Switch and RTC
- **Backup Supply Source** (via additional Cable to J5) **to Raspberry Pi® 5 RTC**

System Monitoring

- **Status Monitoring** – Powering Mode, Inbound current, Outbound current, Powering Voltage, Battery Voltage, Temperature (**Raspberry Pi® 5** 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, EPR** (optionally selected can be mapped to User LEDs)
- **System Healthy**, that informs user remotely if **Raspberry Pi® 5** Core **and M.2 – UPS & Power Management HAT** are running properly, and system is power protected (based on various internal system triggers)

System Protection

- Optional Direct **Raspberry Pi® 5 Button** via Spring Loaded Pogo Pinpoint to **J2**
- **Programmable Watch-Dog Hardware** feature (**St**ill **A**live Timer)
- **PPTC 5A@5V fuse**
- **ZVD circuit** on all 5V GPIO connections
- **Micro-controller-**based **watchdog**
- Over-Temperature protection
- Over-Current protection
- **PPTC, ESD, Reverse Polarity** on EPR and PPoE powering inputs

Embedded Sensors

- **Inbound/Outbound High-side bi-directional hardware current/voltage sensing monitor** with power calculation on 5V supply
- **onboard** Voltage sensors:
  - Battery Voltage Level
  - Raspberry Pi GPIO 5V level Voltage
  - EPR 5V0-32V0 level Voltage
  - PPoE 5V0-32V0 level Voltage
- **onboard** additional Temperature Sensor

Case Compatibility

- Dedicated Case Coming soon

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

System Indicators

- **M.2 ACT LED**
- **M.2 Powering LED**
- **User LED**
- **UPS System LED**
- **Low Battery LED**
- **Active Battery Charger LED**
- **System Timer LED**
- **Raspberry Pi 5 Fan Status LED**
- **Raspberry Pi 5 Temperature LED**
- **System EPR or PPoE Powering Status LED**

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