Pi18650 DUAL Li Ion Battery HAT

Disclaimer:

LITHIUM ION BATTERIES CAN BE DANGEROUS IF NOT HANDLED PROPERLY AND CONSULT YOUR BATTERY MANUFACTURER OR SUPPLIER FOR PROPER OPERATING, STORING, CHARGING AND HANDLING SAFETY PROCEDURES. ONLY PROTECTED BATTERIES MUST BE USED IN THIS PRODUCT TO ENSURE SAFETY.

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Description:

The Pi18650 is an add on HAT which plugs into the 26/40 pin connector on the Raspberry Pi. This HAT allows you to operate your Raspberry Pi without a power cable and can use various capacity 18650 Lithium Ion batteries. On board are two 1A battery charging circuits for charging the batteries individually. The Pi18650 development board also includes a 4x2 100mil header for use with a ESP8266 (ESP-01) wifi module for remote monitoring and CLOUD integration or a custom designed board. Included is one additional stacking header for extra clearance when stacking other HAT's on top of the Pi18650 DUAL BATTERY HAT. How Long Can The Pi Last? As an example the Raspberry Pi Zero uses approximately 87mA without and 103mA with a USB dongle plugged in. With a fully charged single 3000mAh battery, the Pi would last 34.5 Hrs with nothing attached. Using two batteries would double the run time.

The Pi18650 DUAL BATTERY HAT has additional features added to the single battery version. As with two batteries the design becomes more complex and we have added an LED indicator to show the battery has power and connected to the load. A comparator circuit monitors the battery voltage level and when it gets too low it will be automatically cut off from the load with a small current drain on the battery giving it longer standby time before being recharged or replaced. The batteries can be swapped on the fly by the user.

How It Works:

The Pi18650 DUAL BATTERY HAT holds two single cell lithium Ion 18650 form factor batteries which should have integrated battery protection circuits. The boost circuit maintains the voltage to the Pi at 5.1V for battery voltages of 3.7V to

4.2V. The jumper allows you to disable power to the Pi and Isolate the battery circuit or start the Pi. This jumper can be used with an external relay providing automatic control from circuit or system. It also includes two charging IC's which can charge up to 1A from the USB Micro connector and has two battery monitoring IC's which communicates to the Pi via I2C. We have coded a Python script using I2C SMBUS for you to read the battery status along with a shutdown script for low battery voltage. Charging LEDs show the status of the charging process. The Pi18650 DUAL BATTERY HAT can also be used with other development and SBC boards. Any DC power supply, adaptor or solar panel up to 18V max can be used with the charger. Use a good quality USB Micro cable as we found the flat style thinner cables did not work well with the charger and current was limited. The thicker round USB Micro cables work well.

STAT1 (ON)

STAT2 (OFF) - Pre-Conditioning or Fast Charge Mode

STAT2 (ON) STAT1 (OFF) - Charge Complete

PWRGD (ON) - Power Is Good For Charge

Features:

- 200mA Charge Current Max for each battery
- Up to 6A for Raspberry Pi/SBC via Li-Ion Battery
- Up to 18V DC Input for UPS and Charging
- I2C Battery Monitoring (Python Script)
- DUAL 18650 Single Cell Lithium Ion Holder
- 40 Pin Connector for Raspberry Pi
- USB Micro Connector for Charging
- Jumper for Pi/SBC On/Off/Charge
- Voltage Regulation 5.1V
- Use as a UPS or with Solar Panel
- Wifi Header for ESP8266 (8 Pin Board)
- Additional Micro USB connector for powering other devices
- Screw Terminal for power external boards
- A 3-Pin Jumper to Switch USB Micro and Terminal Connection
- Individual Load Cutoff Circuits for Low Battery
- Reverse Battery Protection

- Battery To Load ON LED's
- Power Robots, Motors and More

Use Cases:

- UPS (with various backup times depending on battery capacity and load)
- Remote battery operation
- Remote Data logging w/ Pi
- Research and Development

Technical Specifications:

Charge Current:	200mA DC
Operating Temperature:	Per battery specifications
Charge Time:	Varies with battery capacity
Backup/Operating Time:	Varies with battery capacity
ROHS Compliant:	Yes
Operating Input Voltage:	5V - 18V DC
UPS Mode:	Up to 1.2A for Raspberry Pi/SBC from supply
Battery Only Mode:	Up to 6A for Raspberry Pi/SBC

Calculating Operating Times:

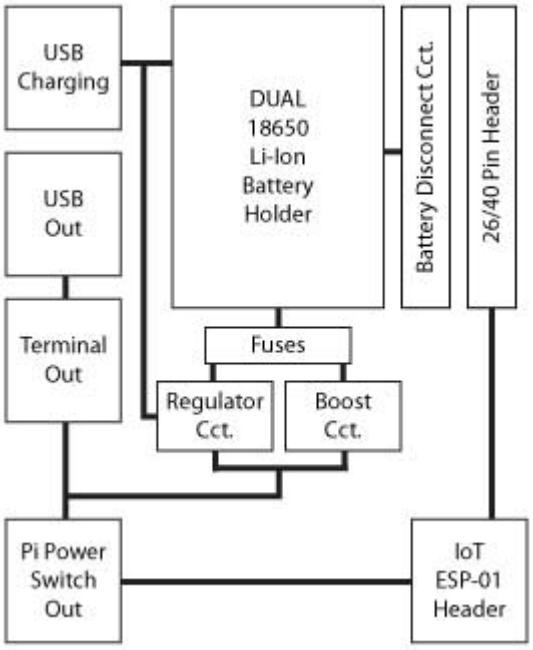
The Pi18650 uses 18650 form factor Li Ion batteries which come in various sizes of capacity. To calculate the run time on a battery, an example is provided below. The total current consumption or all attached peripherals to the Raspberry Pi/SBC can be measured via the jumper by the +ve battery terminal.

As an example the Raspberry Pi Zero uses approximately 87mA without and 103mA with a USB dongle plugged in. With a fully charged 3000mAh battery, the Pi would last 34.5 Hrs with nothing attached and load at 87mA.

Battery Capacitry / Load = Run Time

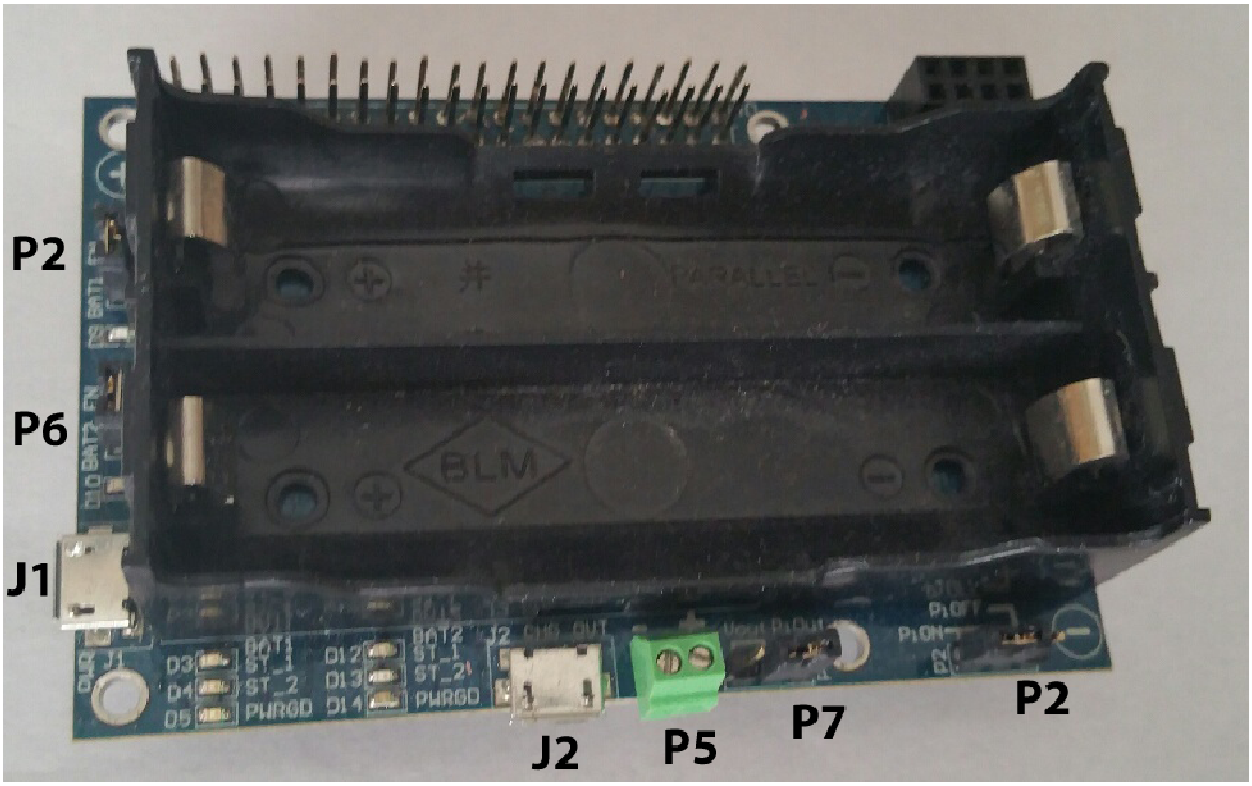
3000mAh / 103mA = 29hrs

Block Diagram:



Operating Instructions:

The Pi18650 DUAL HAT has several jumpers for operation of the device seen in the image below.



Jumpers P2 and P6 are used to completely disconnect the battery from the load for storage.

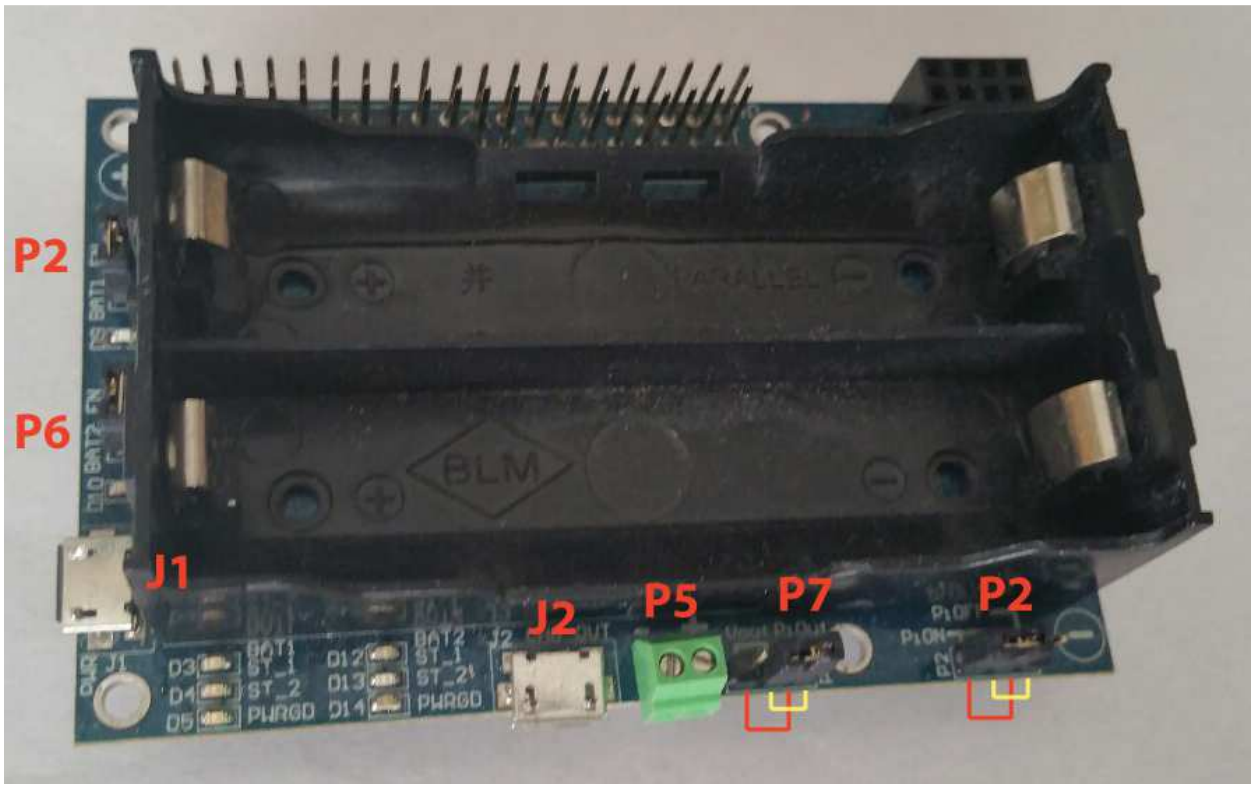
USB Micro connector J1 is used to supply power to the HAT whether batteries are installed or not. When batteries are present the HAT and output will be supplied by the Power on input on J1. **Care must be taken not to apply too much upwards force on J1 as the connector is a surface mount version and will lift off the board pulling up the traces and will be unusable. Hold J1 when inserting and removing the Micro USB cable.

USB Micro connector J2 is used as an Output only and Fused at 1.1A. Use this for other devices or boards. The output of J2 is controlled P7 and described in the next image.

Terminal connector P5 is another Output only with 6A Fuse and also controlled by P7. The Positive (+) terminal is on the Right looking down at the image above and the (-) terminal is on the left also identified on the PCB silkscreen with a + and - symbol.

Jumper P7 is used to control the Outputs of P5 and J2 to either be on all the time or only when P2 is set to Pi-ON position.

Jumper P2 can either be set to provide Power to the 26/40 Pin header 5V pins on the Raspberry Pi.



The Positive side of the batteries is on the side by P2 and P6. The Negative terminals are on the opposite end of the holder. These holders have multiple

polarity markers on the inside of the battery and should be ignored. Polarity markings are also provided on the PCB silkscreen in the TOP left and BOTTOM right of the board.

In the image above, P7 can be set to only provide power to J2 and P5 when P7 is set to YELLOW position and when P2 is set to Pi-ON in the RED jumper position or always on when P7 is set to the RED position regardless of P2 position.

The LED's D3,D4,D5 identify charging status of Battery 1 and D12, D13, D14 identify the charging status of Battery 2.

ST_1 (ON)

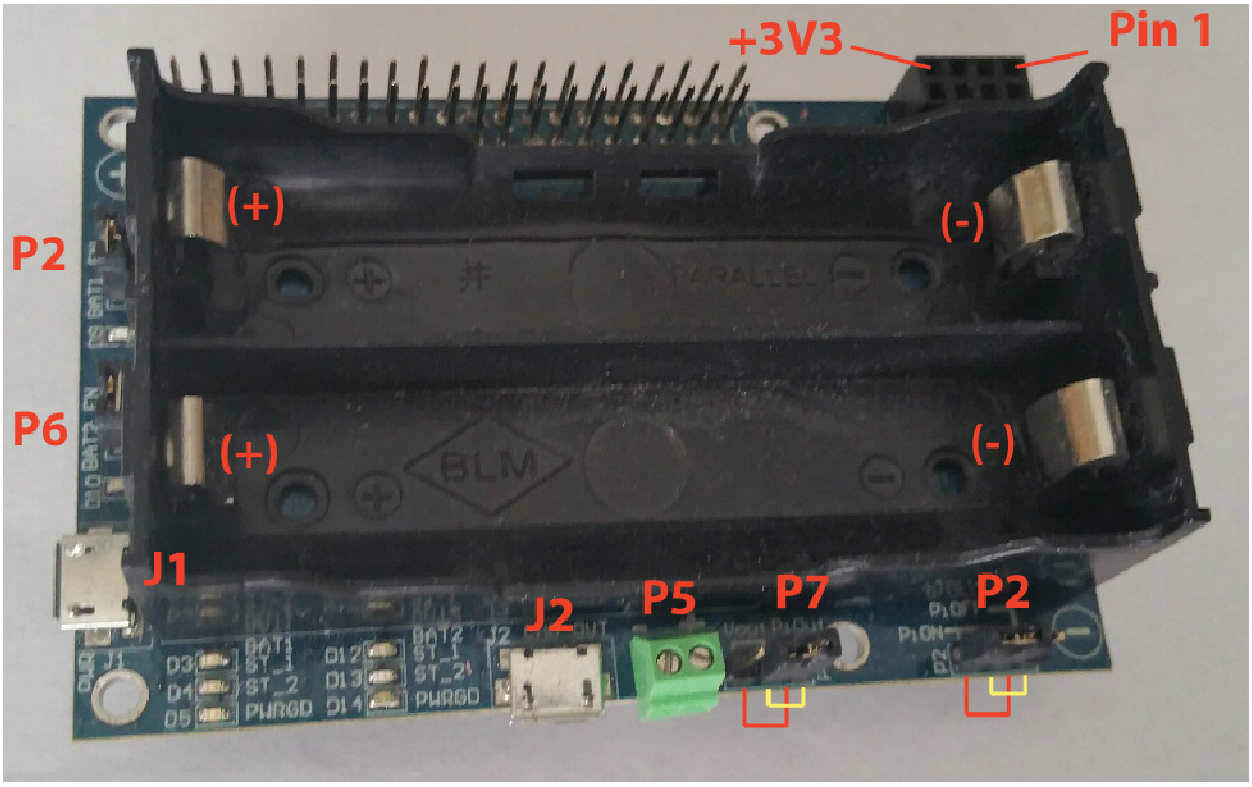
ST_2 (OFF) - Pre-Conditioning or Fast Charge Mode

ST_2 (ON) ST_1 (OFF) - Charge Complete

PWRGD (ON) - Power Is Good For Charge

It is imperative to use a good quality THICK USB Micro cable as we found significant increase in Charge Current and reduced charging times while using this type of cable. Do not use THIN or FLAT style USB Micro cables as they do not work well and when running in the UPS configuration, no enough current will be available to charge the batteries quickly and run the Pi at the same time.

Batteries can be replaced on the fly as long as one battery is present. Batteries should be removed from the Negative side upwards and then lifting the Positive side out. The reason for this is that you may short the 18650 battery type as the plastic covering on the battery can peel off after continuous removal if pulled out from the Positive side first. Make sure there is not too much tension on the battery terminals when inserting them.



Note: Battery Polarity in the Image Above

The Pi will run off one battery installed or two. For more power output for additional peripherals, install two batteries.

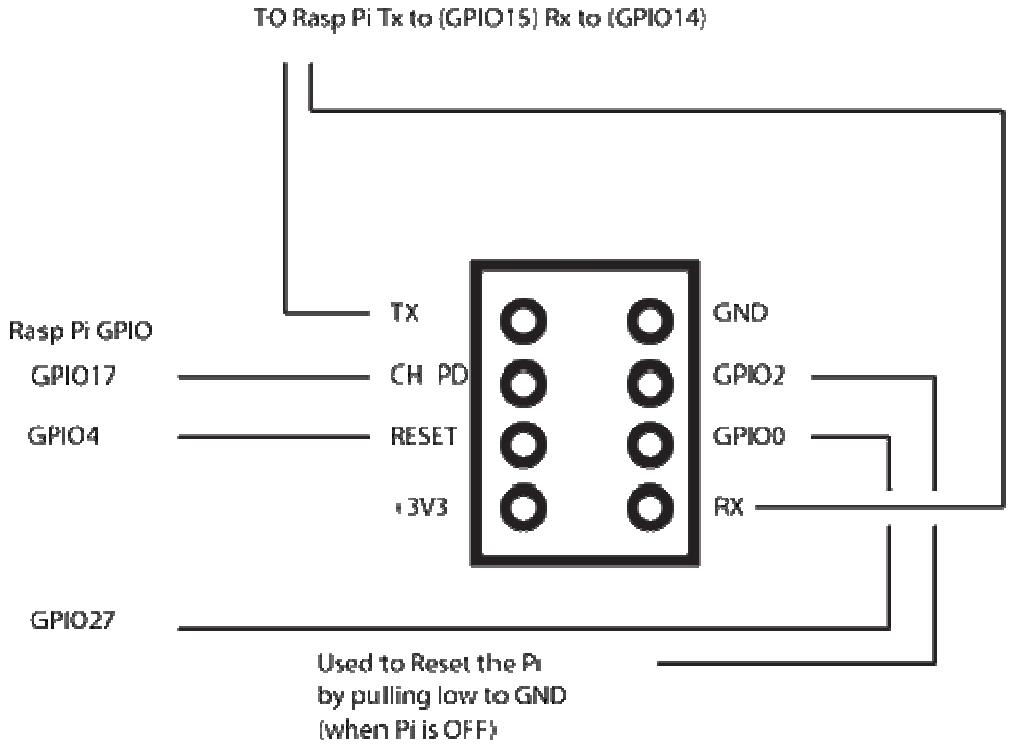
When the batteries are installed the BLUE Battery-To-Load LED will turn on and will only go off if the battery voltage is approximately 3.2V (which will cause the comparator circuit to cut the load from the battery), the battery is removed or when the USB power is plugged in. The BLUE LED's are located beside each P2 and P6 connector respectively.

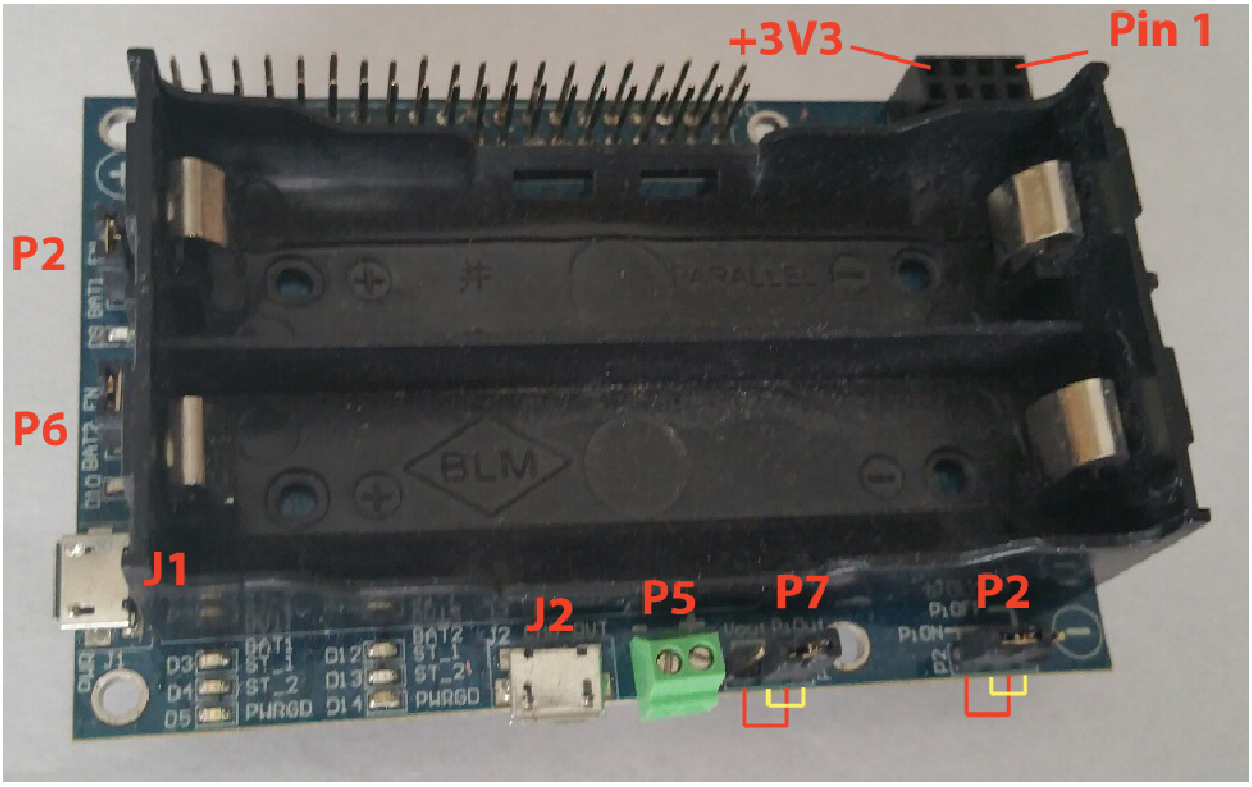
We noticed that some 18650 batteries are longer than others so the (+) and (-) terminals in the battery holder can be bent in or outwards to allow different sized batteries to be installed without too much tension on the battery.

ESP8266 Connections:

On the Pi18650 DUAL HAT there is a 2x4 Pin 100mil header to accommodate an ESP8266-01 (ESP-01) or custom module to for remote reboot operations on the Pi. A device tree blob (dt-blob) file is needed to keep the output to a mosfet high while the Pi is running in order to prevent false reboots from the module.

The image below depicts the connections to the header. Pin 1 is (Tx) below and located at the top right corner of the board. See image on the next page for +3V3 Pin.




+3V3
Pin 1
P2
P6
J1
J2
P5
P7
P2