PI-OT 2

Content Overview

Welcome to the Pi-oT family! Each Module contains the following-

- 1x Pi-oT 2 Base Board & Enclosure
- 2x 0.1” Spacers
- 2x Hex Standoffs
- 4x Nylon Screws
- 3x Short Self-tapping Screws
- 4x Long Enclosure Lid Screws
- 1x 5V fan
- 2x 4-40x1/2 Pan Head Screws
- 1x Ethernet Jumper Cable
- 1x UPS Board (Optional).

Step 1: Attaching Raspberry Pi and UPS

- Start by attaching your Raspberry Pi 4 to the 40 Pin receptacle on the bottom of the base board.
- Once attached, slide the 2 0.1” Spacers between the Raspberry Pi and the Pi-oT 2 Baseboard as shown in Figure 1.
- Thirdly, insert 2 Nylon Screws through the Pi and secure to the Pi-oT Baseboard with 2 Hex Standoffs.
- If active cooling is needed, install the 5V fan with the 2 4-40 screws, and plug the fan into the 5V header in the top right of the board.
- Next, install the UPS Board onto the Pi-oT 2 Baseboard by first aligning 2 mounting holes on the UPS Board with the 2 Hex Standoffs. This will ensure the 5 pin connector is properly aligned. CAUTION: If the UPS board is not properly connected, damage may occur to either board.
- Once aligned properly and connected, the remaining 2 Nylon Screws can be used to secure the UPS Board to the Hex Standoffs.
- If ethernet connection is needed, connect the Raspberry Pi’s ethernet to the Pi-oT 2 Baseboard with the supplied Ethernet Jumper cable. Excess cable can be tucked under the assembly or above if needed.

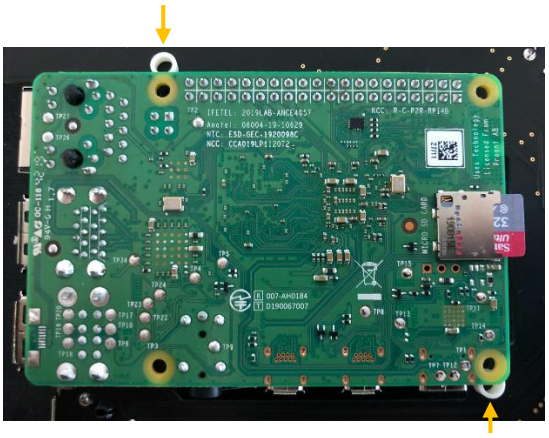


Figure 1: Inserting Spacers

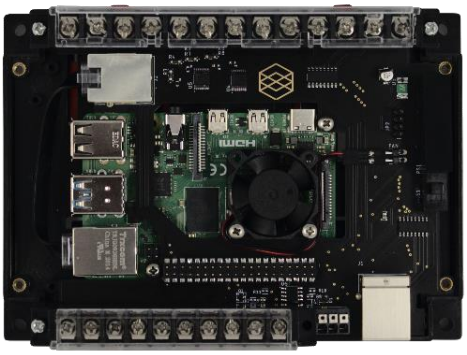


Figure 2: Baseboard Installed

Step 2: Final Assembly

- Start by screwing the Pi-oT 2 Baseboard into the bottom tray with the 3 provided self-tapping screws shown in Figure 2.
- Finally, the enclosure lid is ready to be installed with the 4 long machine screws, once the Module is programmed and configured, shown in Figure 3.

Figure 3: Fully Assembled Module

Step 3: Battery Choice and UPS Configuration

The Pi-oT 2 features an optional UPS powered by 2 LiFePO4 18650 batteries. The preferred cell for this product is the Lithium Werks APR18650M1B. The UPS charges the cells to 3.4 Volts at a maximum charge rate of 1 amp. The UPS will prioritize the system load over battery charging if the maximum current draw is reached.

CAUTION: To maximize efficiency, no reverse current protection is present on the UPS. Use care when installing the LiFePO4 cells.

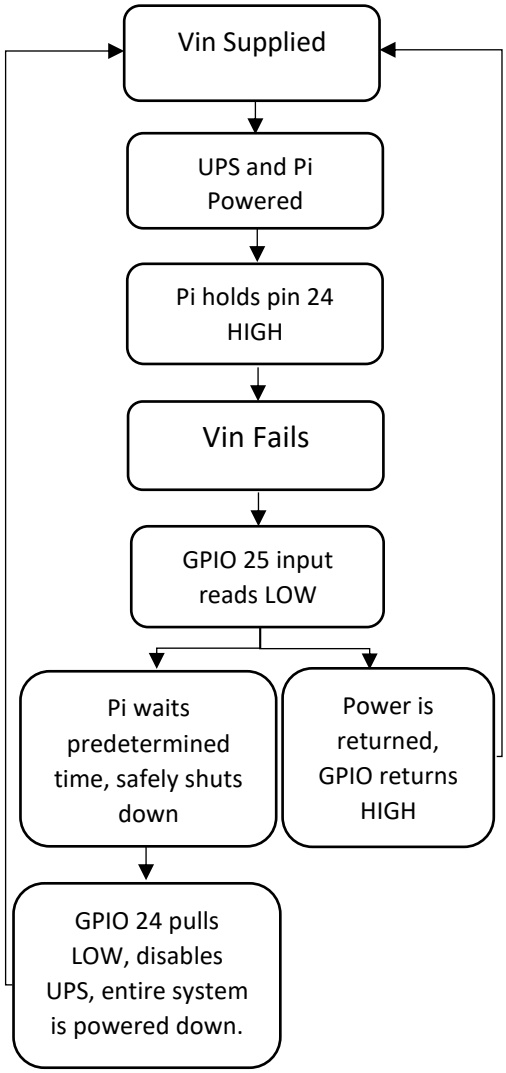
The UPS communicates to the Raspberry Pi via 2 GPIO channels:

In the event of power failure, GPIO pin 25 (BCM) will be pulled Low to signal the UPS is supplying power from the LiFePO4 cells.

The UPS is controlled by GPIO pin 24 (BCM), where logic Low disables the UPS. This signal is held High when Vin is present, thus allowing the Module to power on when Vin is initially supplied.

The configuration of these two signals allows for the following logic to control the Module-

1. The Raspberry Pi and UPS power on when Vin is first supplied.
2. The GPIO pin 24 is held high via a python script or similar.
3. GPIO pin 25 is used as an input to monitor for power failure.
4. Once GPIO pin 25 is pulled low, the Raspberry Pi can set a time to wait for power to resume before safely shutting down.
   CAUTION: The UPS will stop delivering power once a dangerously low voltage level in the cells is detected. This safety measure should not be used as a backstop and only as an emergency condition. Please calculate a reasonable time to run off battery power based on your individual use case, and battery choice.
5. Once the Raspberry Pi shuts down, the GPIO pin 24 will go Low, thus removing all power to the system.
6. If power is returned to Vin, the UPS will power on and the process repeats.



Step 4: Configuring Power

The Pi-oT 2 Precision Series features an on-board DC-DC converter to allow the Module to be powered by either a 5V or 12-24V input. To configure which power level, adjust the switch on the right side of the board.

CAUTION: Applying 12-24V while configured to 5V will damage the boards and cause extreme damage to any batteries installed. Please use extreme care when configuring this device.

Once configured, attach the Positive and GND leads to the screw terminals, using a 3-Watt capable power supply.

Power Supply	
Rated Voltage	5 or 12-24V
Power Consumption	3 W Typical 15 W Max.
Reverse Polarity Protection	None

Step 5: Interfacing the Raspberry Pi with the Pi-oT 2 Baseboard

The Pi-oT 2 has 4 main IO groups:

1. Digital Inputs
2. Digital Outputs
3. Analog Inputs
4. RS485

Digital Inputs:

The **Precision model** has 4x 24 volt inputs which are connected the GPIO pins 12, 17, 22, and 27. When interfacing these DI with switches or sensors in the field, the FGND terminal should be used as the ground. This ensures proper galvanic isolation between the sensor inputs and the rest of the circuit board. For more information on the input thresholds, refer to EN 61131-2.

The **PLUS model** uses the same GPIOs without 24V capabilities. These 4 IOs can be used as normal GPIOs.

Digital Inputs The digital inputs are tied to the GPIO pins 12, 17, 22, 27 (BCM).		
Product	Precision	Plus
Voltage Range	0-24 V	0-3 V
Threshold	EN 61131-2 Type III	N/A
Common	FGND	GND
Galvanic isolation	Yes	No

Digital Outputs:

The Open Collector outputs 1 through 6 are controlled by GPIO pins 16, 20, 21, 26, 19, and 13, respectively. The open collectors have a maximum voltage of 50V and a maximum current capability of 500 mA for a single channel.

Note: When driving inductive loads, to avoid kick-back voltages, tie the coil supply voltage to VSUP.

Digital Outputs The ULN2003a powered open collector digital outputs are triggered by the GPIO pins 16, 20, 21, 26, 19, 13 (BCM).	
No. of outputs	6
Maximum Voltage	50 V
Maximum Current per Channel	500 mA
Common	GND
Galvanic isolation	None
Flyback Suppression	Yes, VSUP pin

Analog Inputs:

The 8x 0-5V analog inputs interface to the Raspberry Pi via the SPI 0 channel. With a resolution of 12 Bits, the MCP3208 chip be best used with the *gpiozero* Python library. The MCP3208 IC is also capable of operating in differential mode. In this mode one channel is read relative to the value of a second channel. For more information, refer to the *gpiozero* documentation or the MCP3208 datasheet.

Note: The AGND pin and GND are connected via a 40 Ohm resistor internal to the MCP3208 IC. The best practice is to operate the Module and sensor on the same ground plane.

Analog Inputs	
The MCP3208 powered inputs communicate with the Raspberry Pi via the SPI 0 channel.	
No. of Inputs	8
Resolution	12 Bit
Voltage Range	0-5 V
Common	AGND
Sampling Rate	100 ksps
Galvanic isolation	None

RS485 Terminal:

The Precision model contains a single RS485 terminal that is connected to the Raspberry Pi TX and RX pins. The circuitry converts the RS485 level signals to standard serial level in order for the Raspberry Pi to read it. Open-source Python Libraries such as *pyserial* or *minimalmodbus* work best for interpreting the signals.

In order for the Module to be used as a Master on an RS485 bus, termination or bias resistors are not included in the on-board circuit, and thus may need to be implemented elsewhere on the bus.

RS485	
The SN65HVD72 powered port converts RS485 signals directly to serial logic, allowing the Raspberry Pi to communicate with standard RS485 devices via pins 14 and 15 (BCM).	
Surge Protection	≥500-V surge transients
Termination R.	0 Ohm
Bias R.	0 Ohm
Galvanic Isolation	None