redbear / **IoT_pHAT**

WiFi + Bluetooth, designed for the Raspberry Pi Zero

⊙ **65** commits	⑂ **1** branch	◌ **0** releases	⚏ **4** contributors

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👤 **Cheong2K** Adds hardware resource.		Latest commit 49eaccf on May 31

| 📁 docs	Fixes to the folder name typo.	3 years ago
📁 eeprom	EEPROM v0.5 released for NOOBS 2.4.1 that fixes the Bluetooth not wor…	2 years ago
📄 IoT pHAT V1.0 schematic and PCB…	Adds hardware resource.	2 months ago
📄 README.md	Update README.md	2 years ago

📖 **README.md**

IoT pHAT

RedBear IoT pHAT, designed for the Raspberry Pi Zero (other RPi boards with 40-pin header will also work).

The RPi Zero is a nice board, it is small in size which is very good for developing IoT projects and prototypes. However, it lacks of wireless features such as WiFi and Bluetooth.

With the IoT pHAT, now, your RPi Zero will get more powerful than before. It adds WiFi and Bluetooth wireless technologies to the RPi Zero.
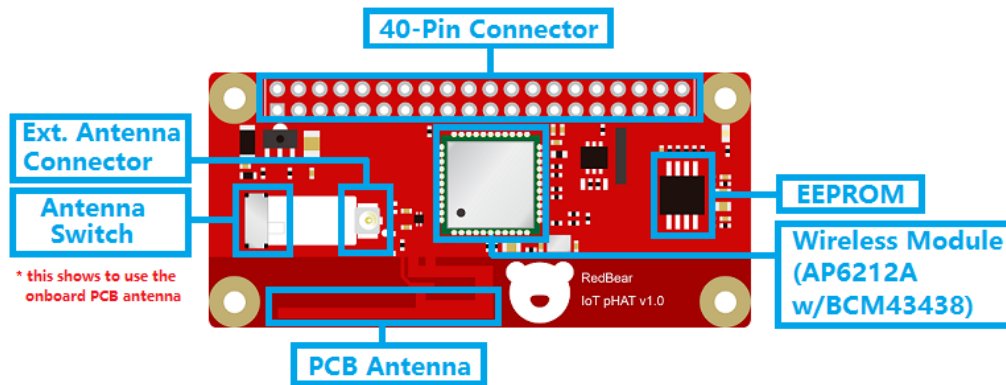
- Front View
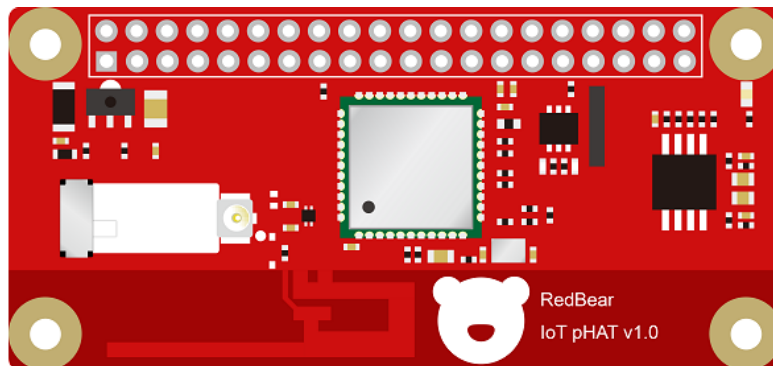
- Back View
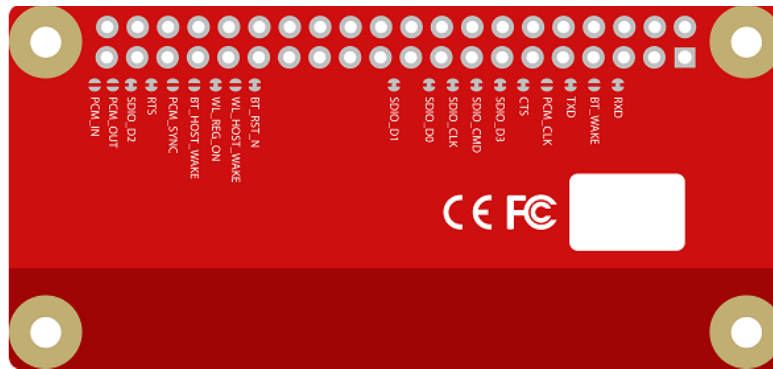
Block Diagram

Features

- AMPAK AP6212A Wireless Module (Broadcom BCM43438 A1 chip inside)
  - WiFi (802.11bgn / 2.4GHz)
  - Bluetooth (4.1) and BLE support
- Single antenna for concurrent WiFi and Bluetooth operations
  - Onboard PCB antenna
  - External antenna connector
  - Antenna switch for external antenna
- 32 Kbit (4 KByte) EEPROM for DTOverlay configuration
- 40-pin connector
  - WiFi: SDIO v2.0 - up to 20 MHz clock rate
  - Bluetooth: UART (up to 4 Mbps)
- FCC/CE certified

How to play

Prerequisites

- WiFi Router or Access Point (2.4 GHz enabled) and connected to the Internet

- Raspberry Pi Zero or other models with 40 pin connector header

  - HDMI Cable
  - USB Keyboard

- Power adapter (5V) with micro USB connector

- SD Card with NOOBS or Raspbian installed (tested on NOOBS 2.4.1 with 21-06-2017 version of Raspbian)

- Additional Items for RPi Zero

  - Mini HDMI to normal HDMI converter
  - Micro to Type-A USB converter

- Optional

  - Bluetooth Keyboard
  - Bluetooth Mouse
  - Bluetooth Gamepad

Setting up the boards
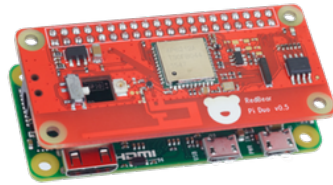
- Stack the IoT pHAT on top of the RPi Zero
- Connect the board to your TV or monitor via the HDMI cable
- Connect your RPi with a wired keyboard (For associating WiFi to access point and pair Bluetooth accessories)
- Power on with an micro USB cable with power adpater

The IoT pHAT will also work on other 40-pin RPi boards such as RPi Model A+ and RPi 2.
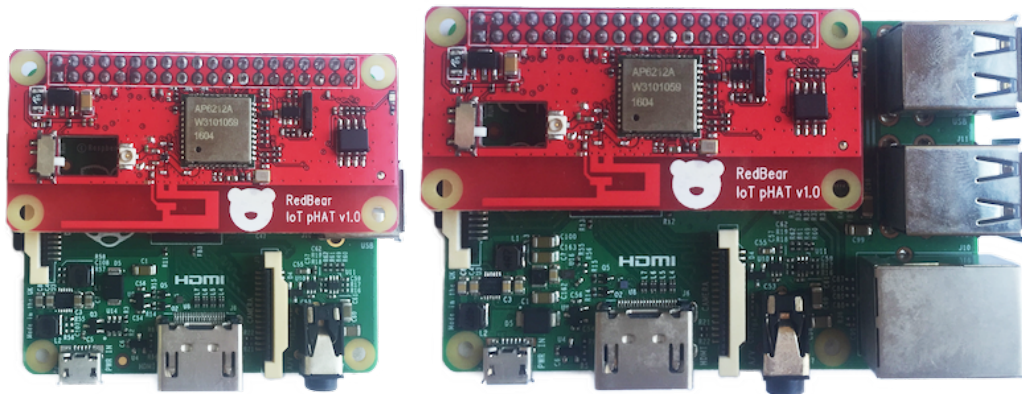
Updating the EEPROM

- Check EEPROM firmware version

  - `$ cat /proc/device-tree/hat/product`

- Follow this guide to update the EEPROM if your one is not the latest version.

WiFi

- After booting up, the Linux kernel will read the configuration from the onboard EEPROM, it will turn on the WiFi driver

- Now you can use WiFi to connect to your wireless router or access point directly.

- You will see the WiFi driver (wlan0) is up by typing the follow command using the command line,

  ```
  $ ifconfig
  ```

- if you are in the command line, you can add your WiFi credentials to this file, it will connect to the AP automatically.

  Edit the file,

  ```
  $ sudo nano /etc/wpa_supplicant/wpa_supplicant.conf
  ```

  Add,

  ```
  network={
          ssid="Your AP"
          psk="Your PIN"
          key_mgmt=WPA-PSK
  }
  ```

  Reboot,

  ```
  $ sudo reboot
  ```

- After associating to your router/AP, your RPi will broadcast mDNS service, so you do not need to know the IP address and the default host name is `raspberrypi.local` , you can use `ssh` to control your RPi from your computer remotely, we only tested on macOS and Linux, for Windows, you need a ssh utility and mDNS tool (e.g. Apple Bonjour SDK).

  ```
  $ ssh pi@raspberrypi.local
  ```

  The default login password is, `raspberry` .

- Trouble-shooting

  - if you do not see the wlan0 device using `ifconfig` , then use the following command, you should see there is a folder named `iothat` . It should be something wrong if you do not see it.

    ```
    $ ls /proc/device-tree/soc/
    ```

  - check if your board comes without the 40-pin connector soldered, make sure your soldering is correct and check the I2C ID EEPROM pins (see the pinout diagram for details).

Bluetooth

- Also, upon booting up the board, the Kernel will read from the EEPROM for all settings for the Bluetooth including the UART which maps UART0 to GPIO 14 and 15.

- You will see the Bluetooth is ready to use by using the Bluetooth manager (the Bluetooth icon) near to the clock (upper-right corner) or using the command line,

  ```
  $ hciconfig
  ```

  or

  ```
  $ systemctl status hciuart.service
  ```

Pairing Bluetooth Keyboard/Mouse/Gamepad

You can use the command line tool `bluetoothctl` or the Bluetooth manager to pair your Bluetooth accessories.

Keyboard

-

Example for using the command line, AA:BB:CC:DD:EE:FF here should be your Bluetooth keyboard MAC address. Make your keyboard into pairing mode first,

```
$ sudo bluetoothctl
[bluetooth]# agent KeyboardDisplay
[bluetooth]# default-agent
[bluetooth]# scan on
[bluetooth]# pair AA:BB:CC:DD:EE:FF
Enter the PIN code from the Bluetooth keyboard
[bluetooth]# connect AA:BB:CC:DD:EE:FF
[bluetooth]# trust AA:BB:CC:DD:EE:FF
[bluetooth]# quit
```

Note: It seems that the BlueZ does not support BLE keyboard and mouse.

Gamepad (8Bitdo Zero)

Prerequisites:

- Charging the gamepad for a while.
- Make sure it is turned off (holding the `START` button for 2 seconds to power ON/OFF).

To pairing:

- Set the gamepad to the correct mode by pressing and holding the `START` button until you see a white LED light on. Release the button, it will enter to the power off state.

- Turn on the gamepad by holding the `START` button for 2 seconds.

- Holding the `SELECT` button for 3 seconds to clear any previous pairing, you will see the white LED flash once, release it.

- Use the follow steps:

  ```
  $ sudo bluetoothctl
  [bluetooth]# scan on
  [bluetooth]# pair AA:BB:CC:DD:EE:FF
  [bluetooth]# connect AA:BB:CC:DD:EE:FF
  [bluetooth]# trust AA:BB:CC:DD:EE:FF
  [bluetooth]# quit
  ```

- To test the gamepad

  ```
  $ sudo apt-get install joystick
  $ jstest /dev/input/js0
  ```
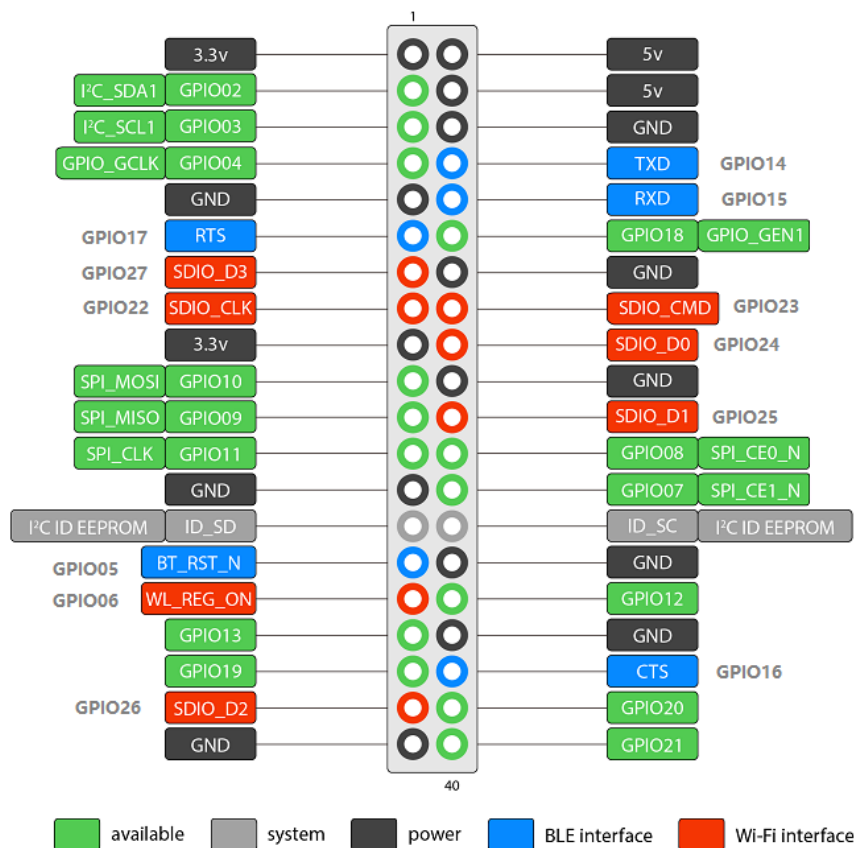
- If you paired two gamepad, the 2nd one will be the `/dev/input/js1` device.

Pinout

The following diagram shows the pins of the RPi 40-pin connector occupied by the IoT pHAT board.

Note that, the TXD on the RPi (as shown in the diagram) will connect to the RXD of the IoT pHAT, the same case applied to the RXD, CTS and RTS pins.

| available | system | power | BLE interface | Wi-Fi interface |

Specification

General

- Model Name : IoT pHAT
- Product Description : WiFi and Bluetooth connectivity add-on board for Raspberry Pi Zero
- Dimension : 64 mm x 30 mm
- WiFi Interface : SDIO v2.0
- Bluetooth Interface : UART / PCM
- Operating voltage : 3.3V
- Operating temperature : -30˚C to 85˚C
- Storage temperature : -40˚C to 85˚C
- Humidity : Operating Humidity 10% to 95% Non-Condensing

WiFi

Conditions : VBAT=3.6V ; VDDIO=3.3V ; Temp:25°C

Feature	Description
WLAN Standard	IEEE 802.11b/g/n, WiFi compliant
Frequency Range	2.400 GHz ~ 2.497 GHz (2.4 GHz ISM Band)
Number of Channels	2.4GHz : Ch1 ~ Ch14
Modulation	802.11b : DQPSK, DBPSK, CCK
	802.11 g/n : OFDM /64-QAM,16-QAM, QPSK, BPSK
Output Power	802.11b /11Mbps : 16 dBm ± 1.5 dB @ EVM ≤ -9dB
	802.11g /54Mbps : 15 dBm ± 1.5 dB @ EVM ≤ -25dB
	802.11n /65Mbps : 14 dBm ± 1.5 dB @ EVM ≤ -28dB
Receive Sensitivity (11n,20MHz) @10% PER	- MCS=0 PER @ -85 dBm, typical
	- MCS=1 PER @ -84 dBm, typical
	- MCS=2 PER @ -82 dBm, typical
	- MCS=3 PER @ -80 dBm, typical
	- MCS=4 PER @ -77 dBm, typical
	- MCS=5 PER @ -73 dBm, typical
	- MCS=6 PER @ -71 dBm, typical
	- MCS=7 PER @ -68 dBm, typical
Receive Sensitivity (11g) @10% PER	- 6Mbps PER @ -86 dBm, typical
	- 9Mbps PER @ -85 dBm, typical
	- 12Mbps PER @ -85 dBm, typical
	- 18Mbps PER @ -83 dBm, typical
	- 24Mbps PER @ -81 dBm, typical
	- 36Mbps PER @ -78 dBm, typical
	- 48Mbps PER @ -73 dBm, typical
	- 54Mbps PER @ -71 dBm, typical
Receive Sensitivity (11b) @8% PER	- 1Mbps PER @ -90 dBm, typical
	- 2Mbps PER @ -88 dBm, typical
	- 5.5Mbps PER @ -87 dBm, typical
	- 11Mbps PER @ -84 dBm, typical
Data Rate	802.11b : 1, 2, 5.5, 11Mbps
	802.11g : 6, 9, 12, 18, 24, 36, 48, 54Mbps
Data Rate (20MHz ,Long GI,800ns)	802.11n: 6.5, 13, 19.5, 26, 39, 52, 58.5, 65Mbps
Data Rate (20MHz ,short GI,400ns)	802.11n : 7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65,72.2Mbps
Maximum Input Level	802.11b : -10 dBm
	802.11g/n : -20 dBm
Antenna Reference	Small antennas with 0~2 dBi peak gain

Bluetooth

Conditions : VBAT=3.6V ; VDDIO=3.3V ; Temp:25°C

Feature	Description		
General Specification			
Bluetooth Standard	Bluetooth V4.0 of 1, 2 and 3 Mbps.		
Host Interface	UART		
Antenna Reference	Small antennas with 0~2 dBi peak gain		
Frequency Band	2402MHz ~ 2480MHz		
Number of Channels	79 channels		
Modulation	FHSS, GFSK, DPSK, DQPSK		
RF Specification			
	Min.	Typical.	Max.
Output Power (Class 1.5)		9 dBm	
Sensitivity @ BER=0.1% for GFSK (1Mbps)		-86 dBm	
Sensitivity @ BER=0.01% for π/4-DQPSK (2Mbps)		-86 dBm	
Sensitivity @ BER=0.01% for 8DPSK (3Mbps)		-80 dBm	
Maximum Input Level	GFSK (1Mbps):-20dBm		
	π/4-DQPSK (2Mbps) :-20dBm		
	8DPSK (3Mbps) :-20dBm		

Known Issues

- Default EEPROM firmware is v0.2
  - The BT UART1 is not stable, modify the EEPROM with v0.3 which will use UART0 instead
  - The WiFi is not stable, modify the EEPROM with 0.3 to lower the SDIO clock from 40MHz to 20MHz.

Resources

RedBear

- IoT pHAT Product Website
- Technical Support Forum
- FCC/CE Certs

External

- Linux iBeacon
- Raspberry Pi HATs

Limitations

- FM is not supported with the board
- Although the board supports Bluetooth keyboard, you still need to use a wired keyboard to set it up first.
- The TXD and RXD pins are used by the IoT pHAT, so you will not be able to use serial debug and BT at the same time for your RPi. Also, you will not be able to connect to other serial devices such as a GPS module.