

Making Open Source Hardware IoT with Raspberry Pi

Leon Anavi
Konsulko Group
leon.anavi@konsulko.com
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Agenda

- ❑ **Raspberry Pi add-on boards for IoT**
- ❑ **Raspberry Pi HAT**
- ❑ **Raspberry Pi pHAT**
- ❑ **Designing an open source hardware**
- ❑ **Software support**

What is Open Source Hardware? **Konsulko** Group

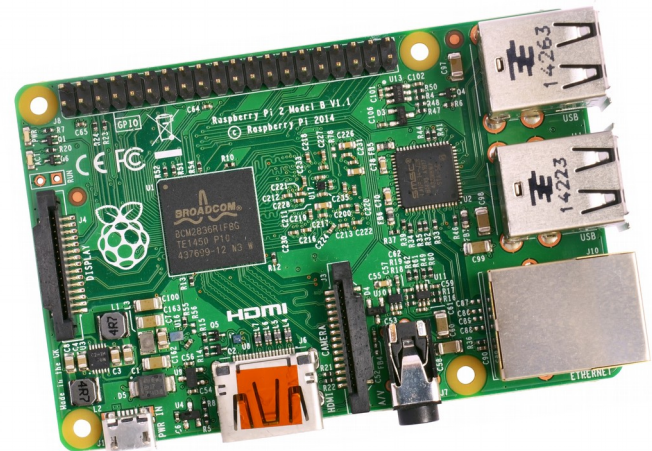
- ❑ **Design of physical objects that is publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design**

Open Source Hardware Licenses

- ❑ **GNU General Public License (GPL)**
- ❑ **Creative Commons Attribution-ShareAlike**
- ❑ **CERN Open Hardware License (OHL)**
- ❑ **TAPR Open Hardware License (OHL)**
- ❑ **FreeBSD**
- ❑ **MIT**
- ❑ **Other**

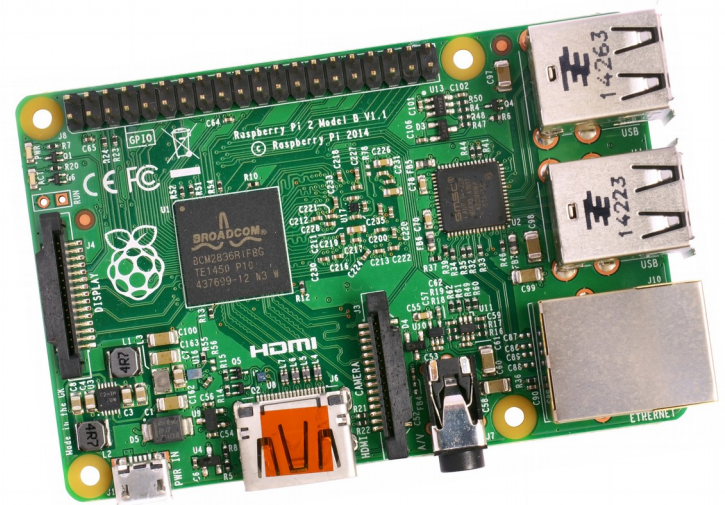
Why Raspberry Pi?

- ❑ **Low cost credit-card-sized computer**
- ❑ **Good software support**
- ❑ **Huge community**
- ❑ **NOT open source hardware!**

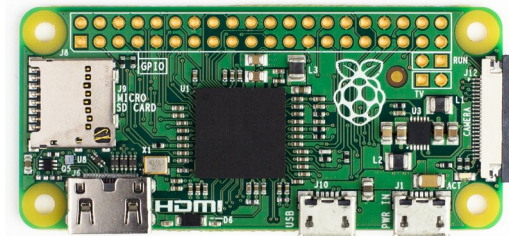
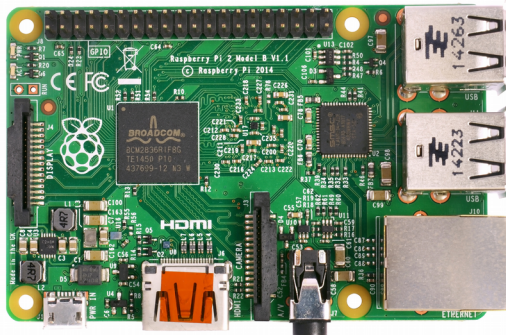
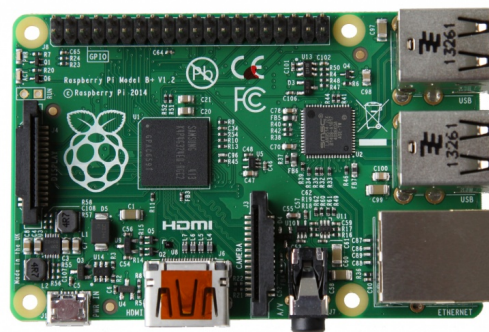
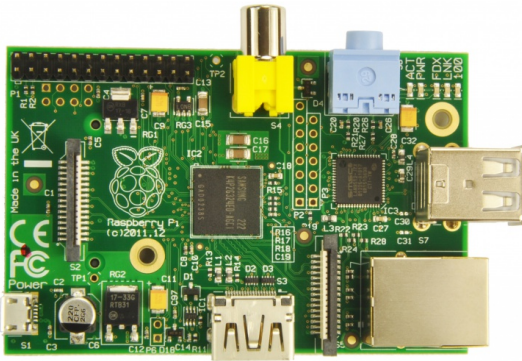


Raspberry Pi

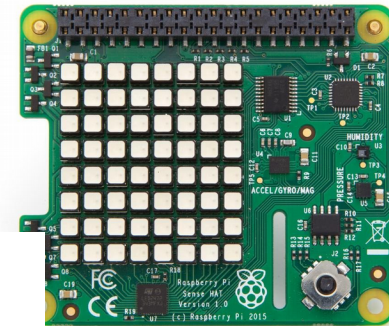
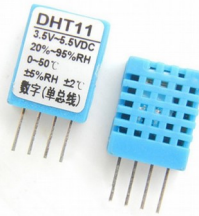
- ❑ **2009 - Raspberry Pi Foundation**
- ❑ **2012 - The 1st Raspberry Pi**
- ❑ **2014 - Raspberry Pi B+**
- ❑ **2016 - Raspberry Pi Zero**



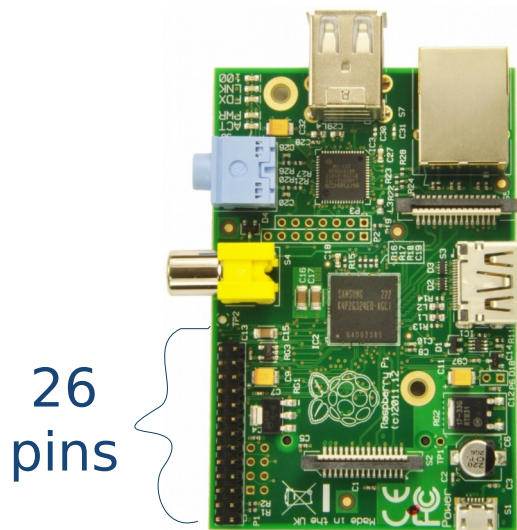
Raspberry Pi Flavors



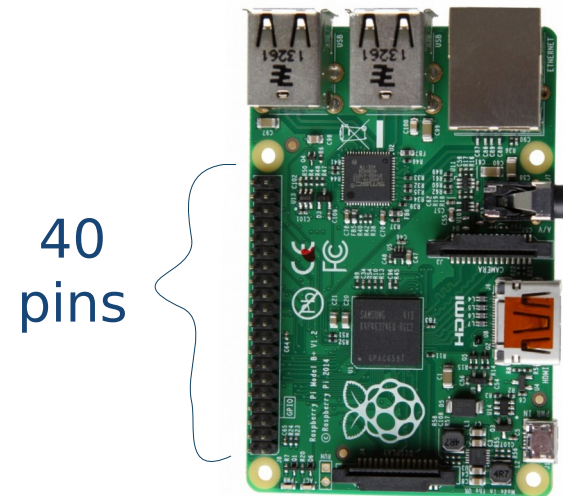
Many add-on boards



Important Change in B+



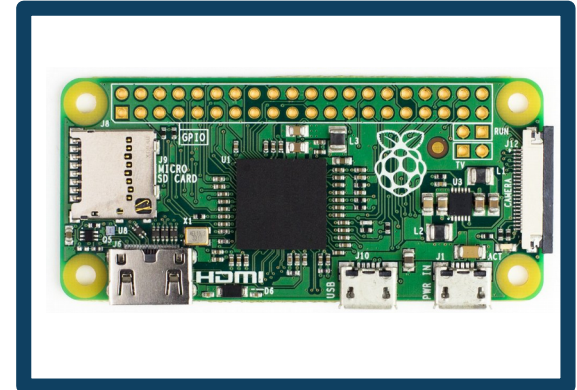
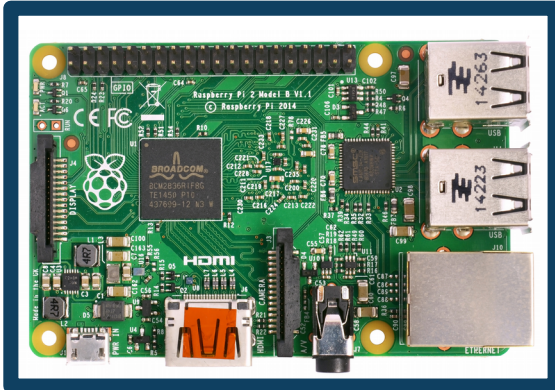
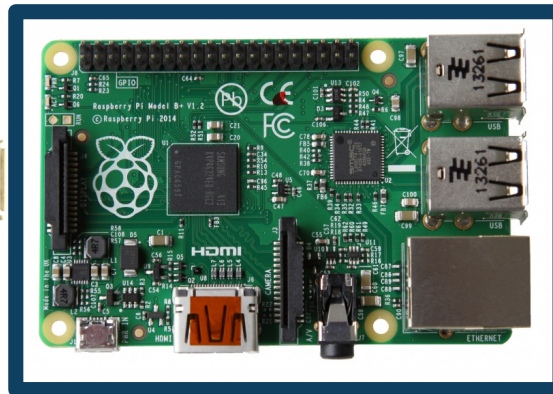
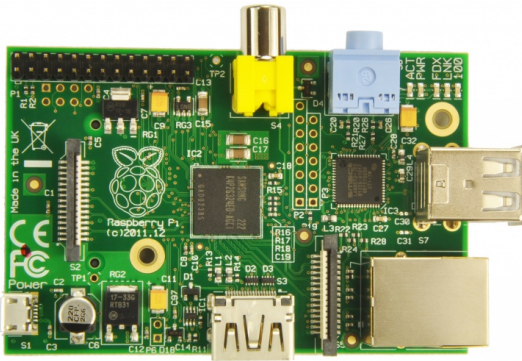
Raspberry Pi B
(2011)



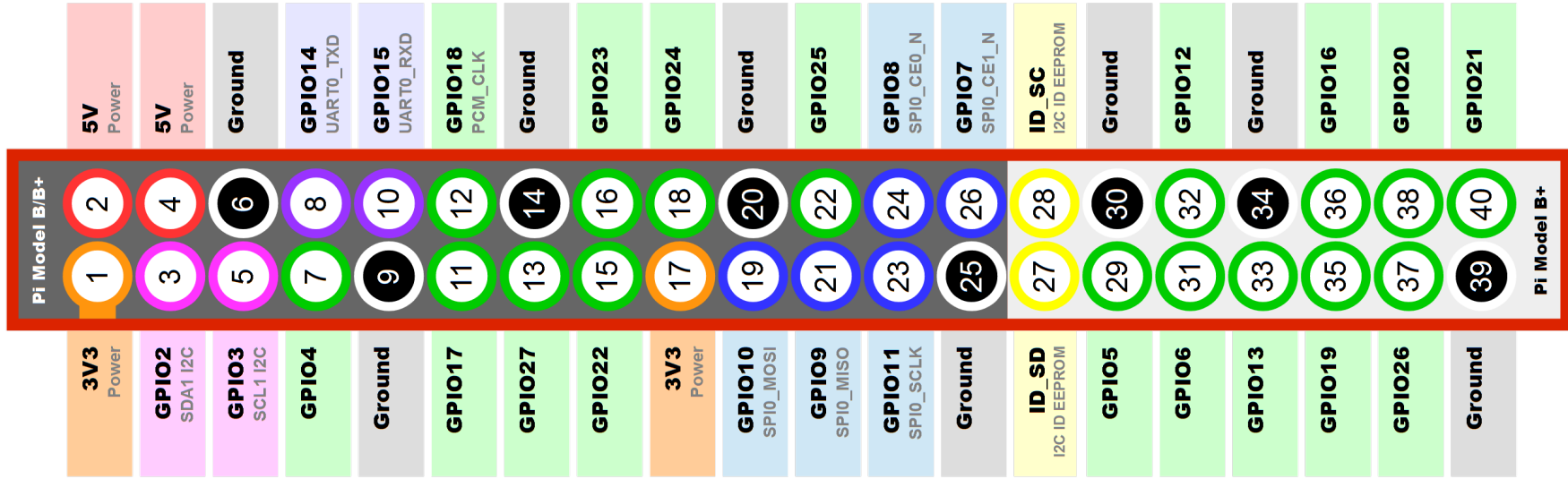
Raspberry Pi B+
(2014)

Raspberry Pi Flavors

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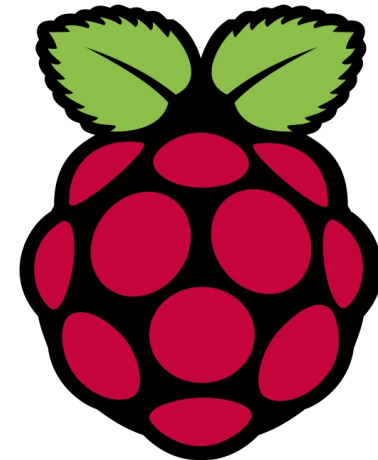
40 Pin Header



Raspberry Pi HAT

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INTRODUCING RASPBERRY PI HATS



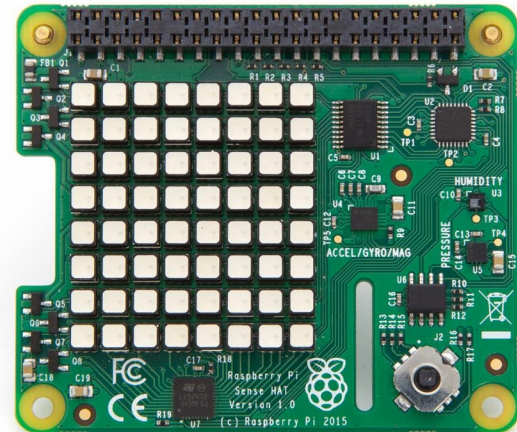
Since 31st July 2014

Raspberry Pi HAT



Hat

!=



HAT

(Hardware Attached on Top)

HAT Requirements

- ❑ **Form factor and dimensions (65x56mm)**
- ❑ **40 pin header compatible with Raspberry Pi B+ and the newer models**
- ❑ **EEPROM with device tree fragment**
- ❑ **Details:**

<https://www.raspberrypi.org/blog/introducing-raspberry-pi-hats/>

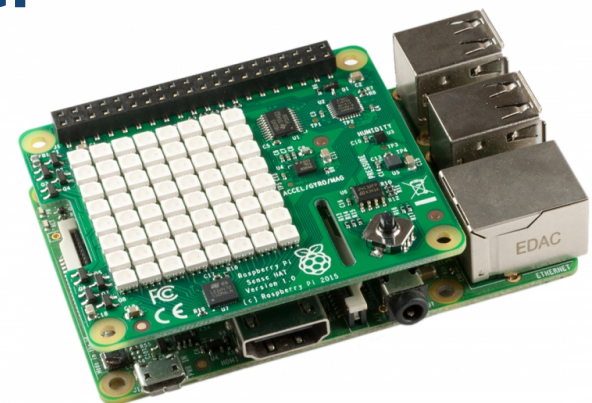
<https://github.com/raspberrypi/hats>

- ❑ **Form factor suitable for Raspberry Pi Zero with 4 mount holes and dimensions 65x30mm**
- ❑ **40 pin through-hole header**
- ❑ **EEPROM not mandatory**

** Not an official standard of the Raspberry Pi Foundation*

Sense HAT

- ❑ **Official product of the Raspberry Pi Foundation**
- ❑ **Sensors for temperature, humidity, barometric pressure, gyroscope, accelerometer, magnetometer**
- ❑ **8x8 RGB LED matrix**
- ❑ **Five-button joystick**



More...

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 **Raspberry Pi
Pinout**

Type

ADC Audio COM Display
Display Gesture GPS
Instrument IO IOT LED
MCU Motor Multi Network
Other Power Relay RTC
Sensor Touch USB

Manufacturer

4tronix AB Electronics Adafruit
Anavi Ciseco Cyntech
Element14 Hot Glue
Infusion Systems IQaudIO
JustBoom Kertatuote Paser
Pi Supply PiBorg Pimoroni
Raspberry Pi RasPiO RedBear
Ryanteck SLNGadget UUGear
Waveshare

Form Factor

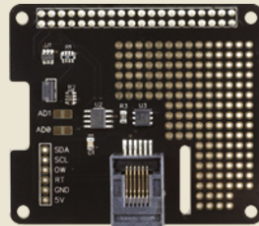
Custom HAT PHAT PHAT
USB

Ground DPI GPCLK JTAG 1-WIRE PCM SDIO I2C SPI UART WiringPi

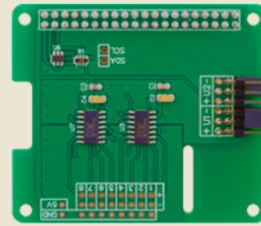
« Return to the Raspberry Pi GPIO Pinout

Raspberry Pi HATs, pHATs & Add-ons

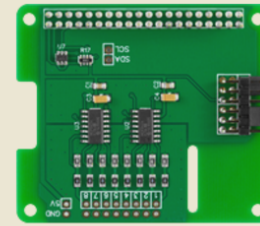
Click on a HAT, pHAT or add-on for more details and to see which pins it uses!



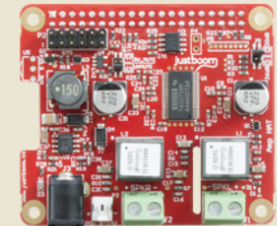
1 Wire Pi Plus



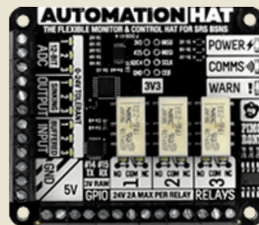
ADC Differential Pi



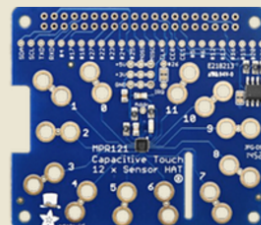
ADC Pi Plus



Amp HAT



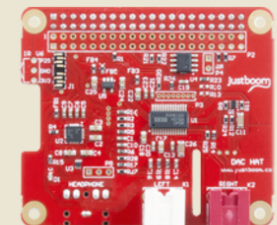
Automation HAT



Capacitive Touch HAT



Cirrus Logic Audio Card



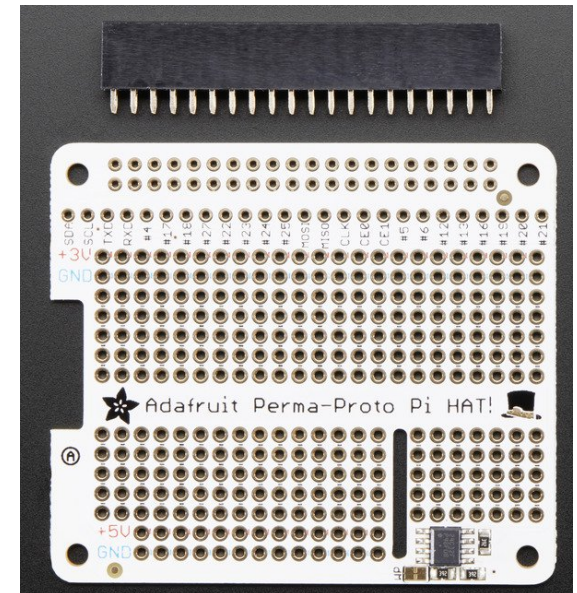
DAC HAT



Making Your 1st HAT

Requirements:

- ❑ **Idea (for example: a blinking LED)**
- ❑ **Soldering equipment**
- ❑ **Adafruit Perma-Proto HAT**
- ❑ **Additional hardware resources (depending on the idea)**



Device Tree Fragment

- ❑ **Data structure with hardware description of the Raspberry Pi HAT stored on EEPROM**
- ❑ **8 pin DIP I2C EEPROM**
- ❑ **Recommended EEPROM CAT24C32**



Flashing the EEPROM

- ❑ **Download and build eepromutils**

<https://github.com/raspberrypi/hats>

- ❑ **Create a text file with description of your HAT using *eeprom_settings.txt* for example**

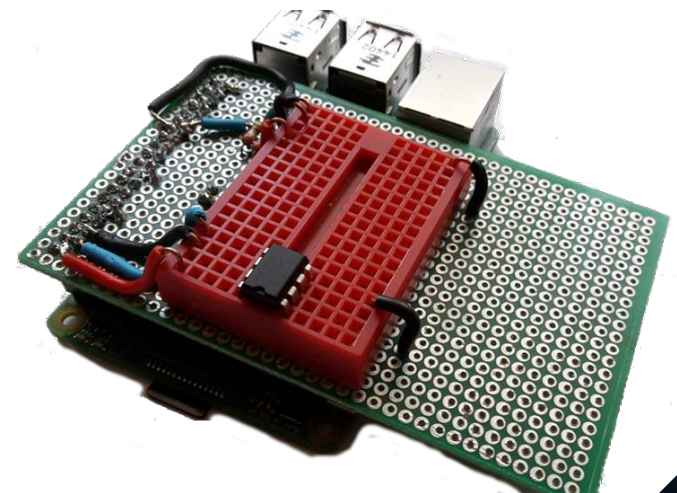
- ❑ **Generate *.epp* file using *eepmake***

- ❑ **Flash the binary file to the EEPROM using *eepflash.sh***

EEPROM Wiring

- ❑ **Flashing the EEPROM: pin 2 and 3**
- ❑ **Reading from the EEPROM: pin 27 and 28**

Pi Model B/B+		5V Power	5V Power	Ground	GPIO14 UART0_TXD	GPIO15 UART0_RXD	GPIO18 PCM_CLK	Ground	GPIO23	GPIO24	Ground	GPIO25	GPIO8 SPI0_CE0_N	GPIO7 SPI0_CE1_N	ID_SC I2C ID EEPROM	Ground	GPIO12	Ground	GPIO16	GPIO20	GPIO21																			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Pi Model B+
3V3 Power	GPIO2 SDA1_I2C	GPIO3 SCL1_I2C	GPIO4	Ground	GPIO17	GPIO27	GPIO22	3V3 Power	GPIO10 SPI0_MOSI	GPIO9 SPI0_MISO	GPIO11 SPI0_SCLK	Ground	ID_SD I2C ID EEPROM	GPIO5	GPIO6	GPIO13	GPIO19	GPIO26	Ground																					



device-tree/hat

- ❑ **Directory /proc/device-tree/hat**
- ❑ **Information about product name, version, vendor and UUID**

```
pi@raspberrypi: ~  
pi@raspberrypi:~ $ ls /proc/device-tree/hat/  
name product product_id product_ver uuid vendor  
pi@raspberrypi:~ $ cat /proc/device-tree/hat/product  
ANAVI Infrared pHATpi@raspberrypi:~ $  
pi@raspberrypi:~ $ cat /proc/device-tree/hat/vendor  
ANAVIpi@raspberrypi:~ $  
pi@raspberrypi:~ $
```

Designing PCB

Electronics Design Automation Suites:

- ❑ **KiCAD (free & open source software)**
- ❑ **Eagle (free for small 2 Layer PCB)**
- ❑ **Other**

KiCAD Advantages

- ❑ **Free & open source software (GPLv3+)**
- ❑ **Cross platform (works on GNU/Linux distributions, MS Windows and Mac OS X)**
- ❑ **Integrated 3D viewer**
- ❑ **Contributions from CERN developers**
- ❑ **Used by Olimex for the design of their new open source hardware boards**

HAT Templates

❑ **KiCAD**

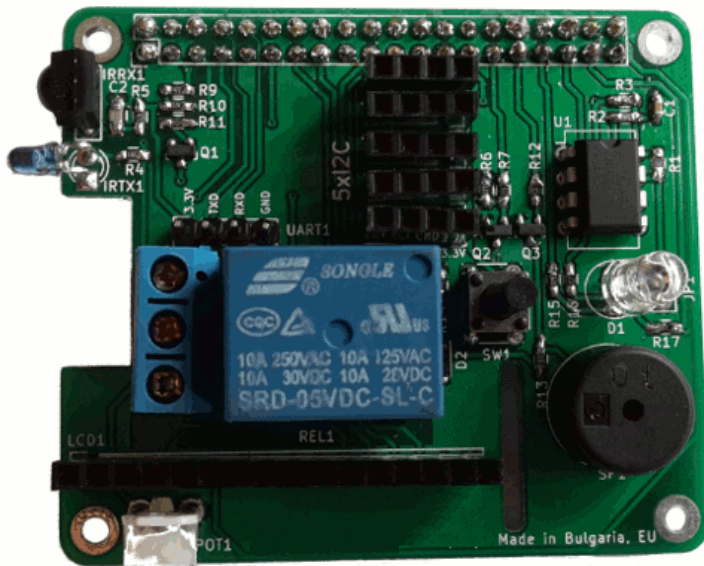
https://github.com/xesscorp/RPi_Hat_Template

<http://gitlab.openfet.com/julien/pihat-template>

❑ **Eagle**

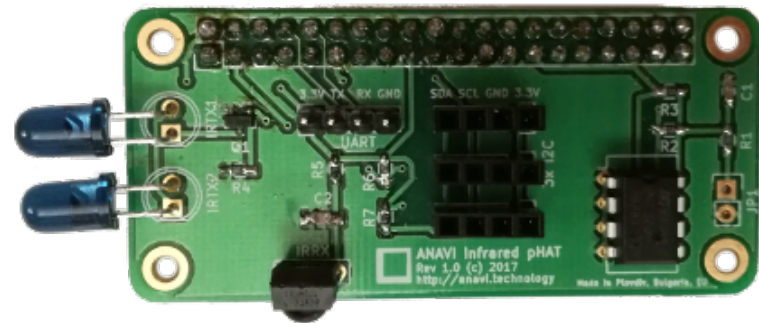
<http://www.flyfish-tech.com/pub/RasPi-BplusHAT.zip>

My OSHW HAT & pHAT



Anavi Flex HAT

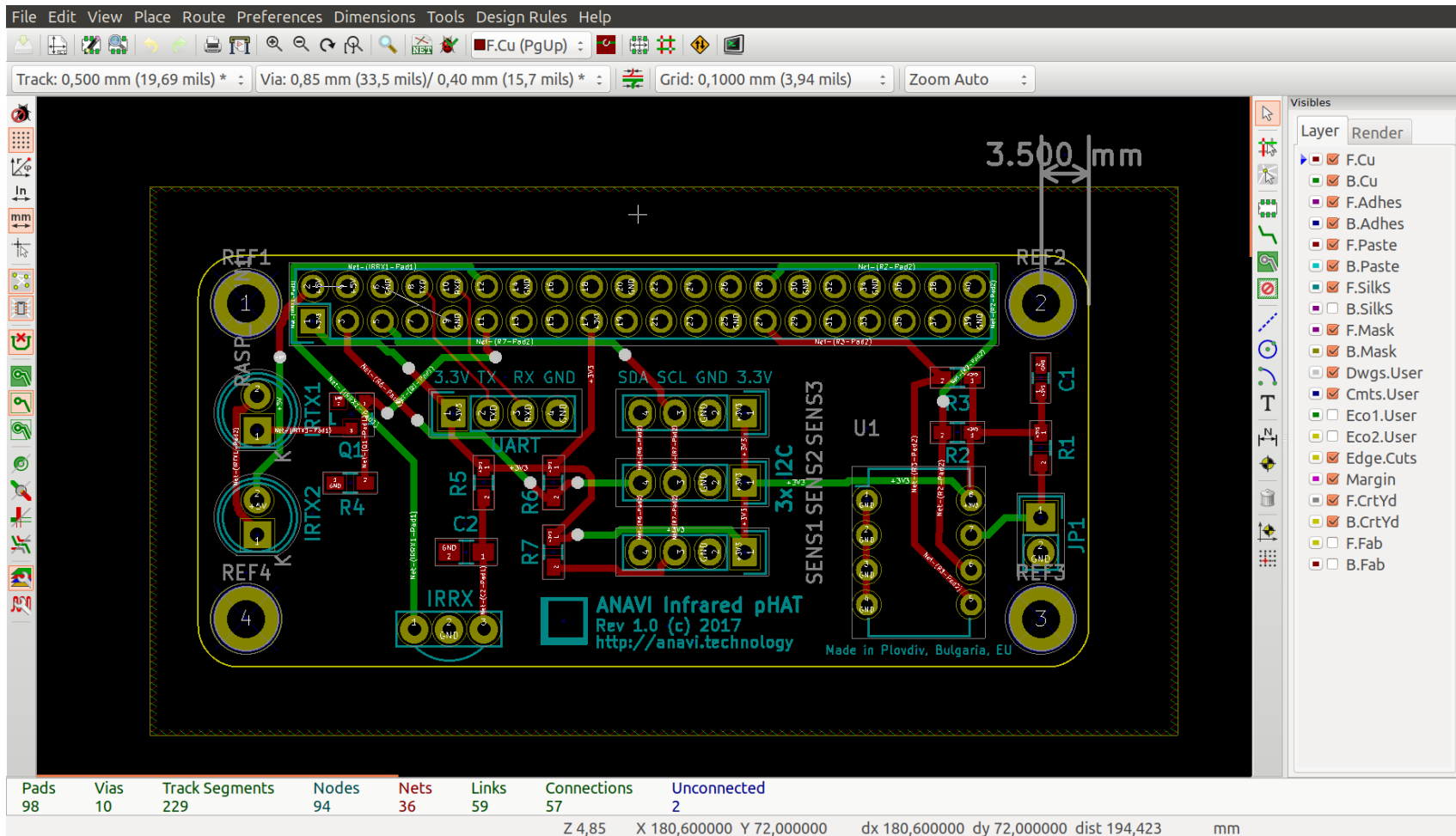
<https://github.com/AnaviTech/anavi-flex>



Anavi Infrared pHAT

<https://github.com/AnaviTech/anavi-infrared>

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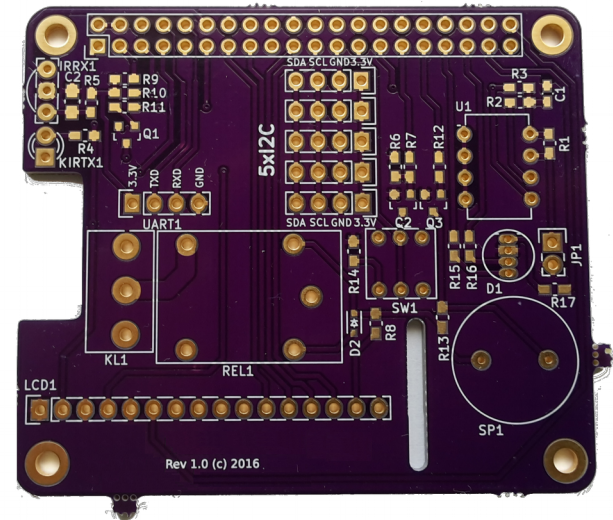
Recommendations

- ❑ **Comply with the minimum requirements of the PCB manufacturer for trace spaces, drills and angular rings**
- ❑ **Keep in mind the complexity of the assembly process while designing the PCB**
- ❑ **Consider the location of Raspberry Pi components while placing components on your HAT and avoid any potential negative impact**

Prototypes

PCB printing services from:

- ❑ **OSHPark (Made in the USA)**
- ❑ **China**
- ❑ **Local**



- ❑ **Python is popular programming language among Raspberry Pi makers**
- ❑ **WiringPi library for C/C++**
- ❑ **WiringPi language bindings: Java, JavaScript (Node.js), PHP, Perl, Go, Rust, etc.**
- ❑ **Other FOSS (LIRC, OpenCV, etc.)**

... and one more thing

**Share your hardware and
software under open
source licenses :)**

Thank You!

Useful links:

- ❑ <https://www.raspberrypi.org/blog/introducing-raspberry-pi-hats/>
- ❑ <https://www.raspberrypi.org/magpi/make-your-own-hat/>
- ❑ <http://pinout.xyz/>
- ❑ <https://github.com/raspberrypi/hats>
- ❑ <https://github.com/AnaviTech>
- ❑ <http://wiringpi.com/>
- ❑ <http://kicad-pcb.org>
- ❑ <https://oshpark.com/>
- ❑ <http://www.slideshare.net/leonanavi/making-open-source-hardware-iot-with-raspberry-pi>

