

Making Your Own Open Source Raspberry Pi HAT

Leon Anavi
Konsulko Group
leon.anavi@konsulko.com
leon@anavi.org
FOSDEM 2017

Agenda



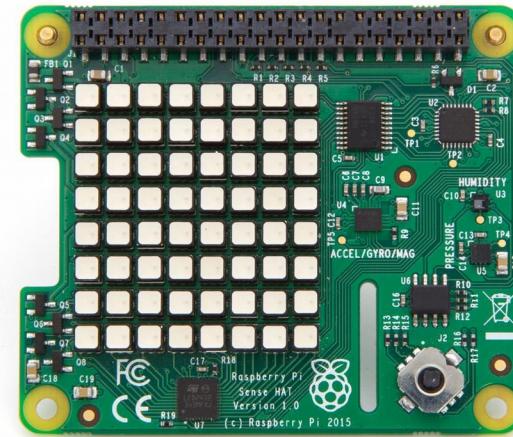
- ❑ **Raspberry Pi HAT**
- ❑ **Designing an open source hardware**
- ❑ **Software support**

Raspberry Pi HAT

Konsulko
Group



!=



Hat

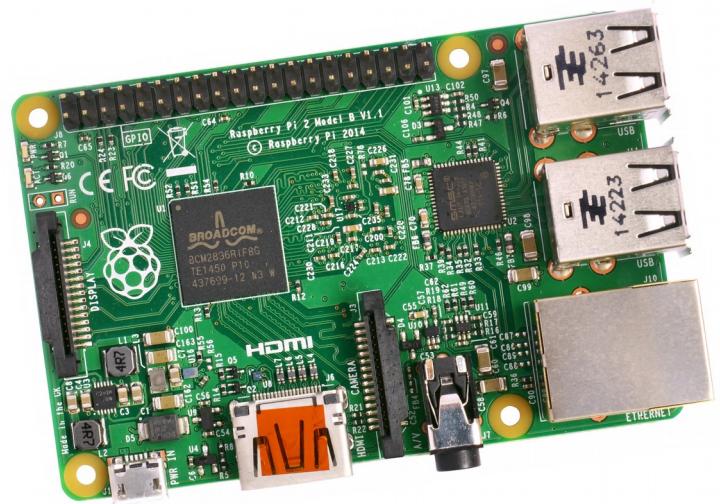
HAT

(Hardware Attached on Top)

Raspberry Pi

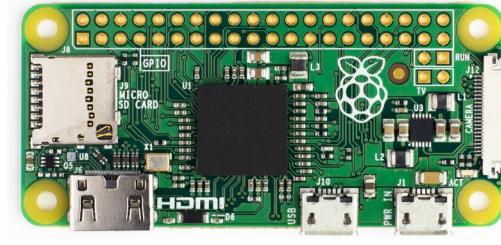
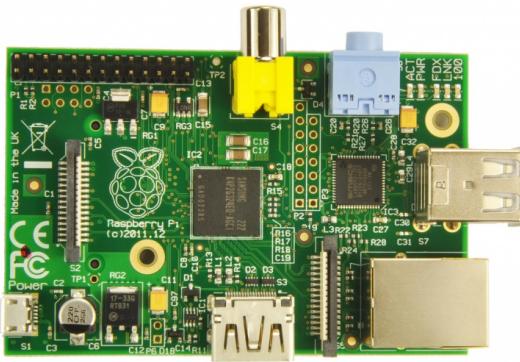
Konsulko
Group

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



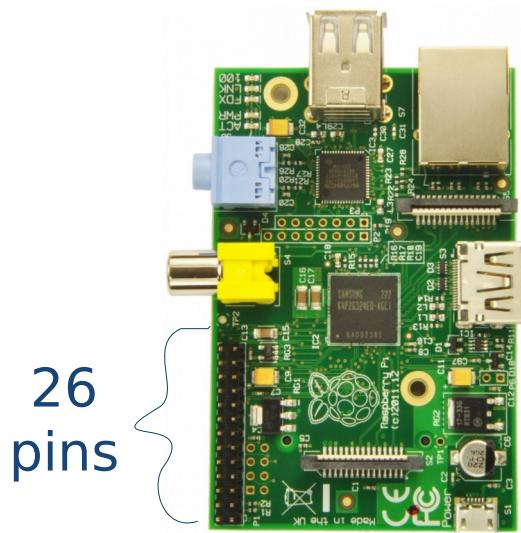
Raspberry Pi Flavors

Konsulko
Group



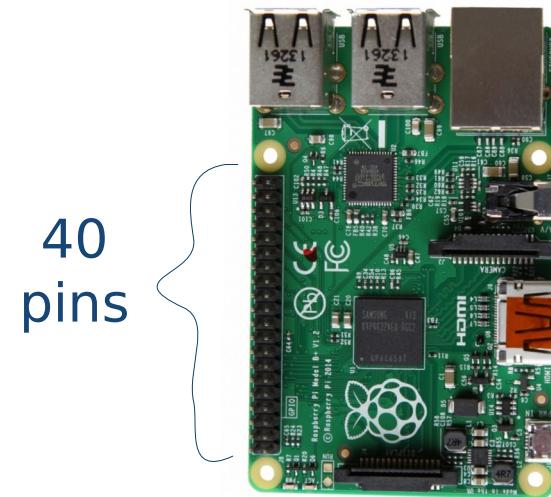
Important Change in B+

Konsulko
Group



26
pins

Raspberry Pi B
(2011)

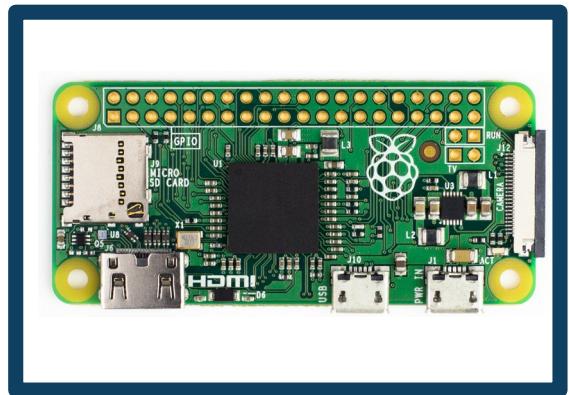
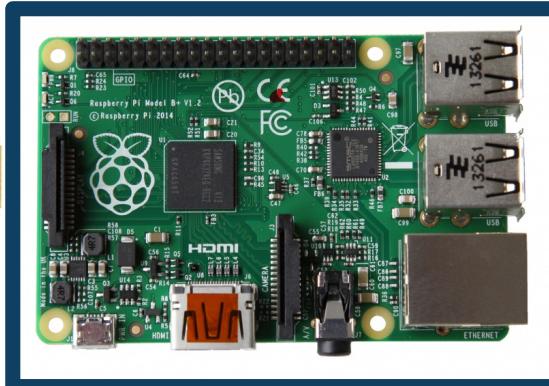
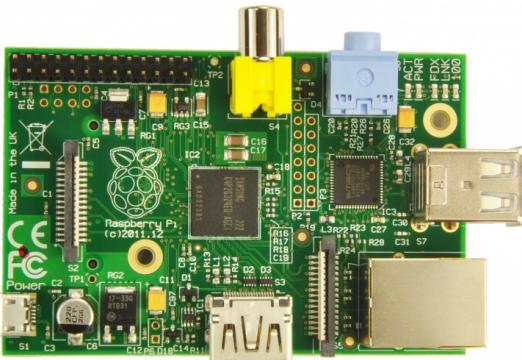


40
pins

Raspberry Pi B+
(2014)

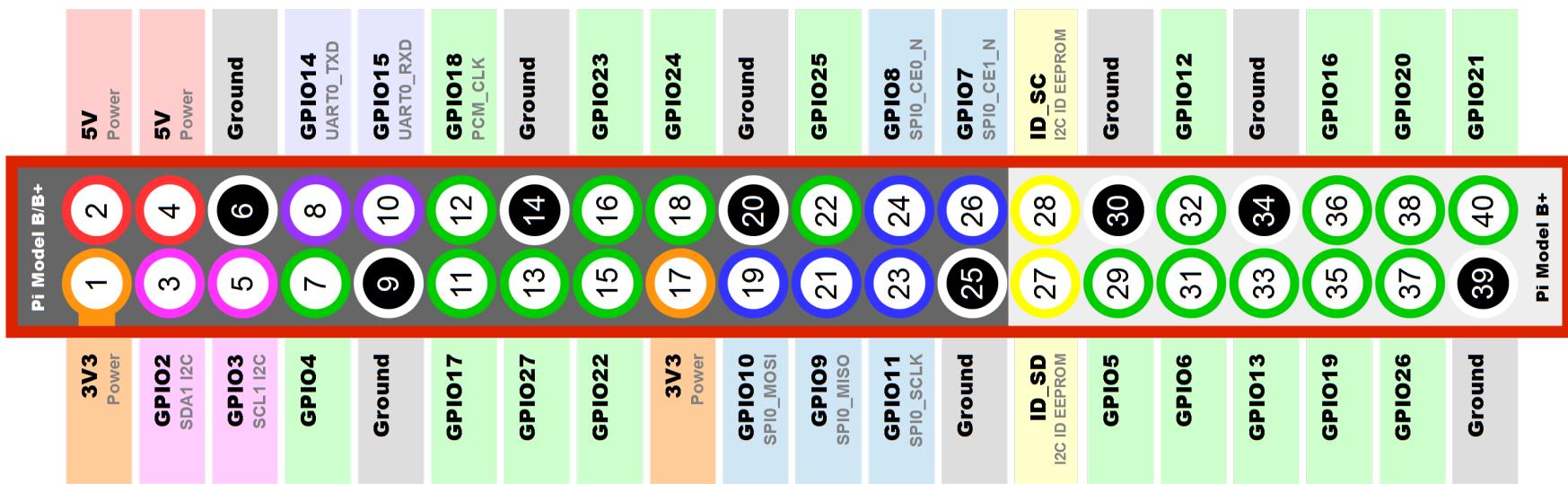
Raspberry Pi Flavors

Konsulko
Group



40 Pin Header

Konsulko
Group



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>

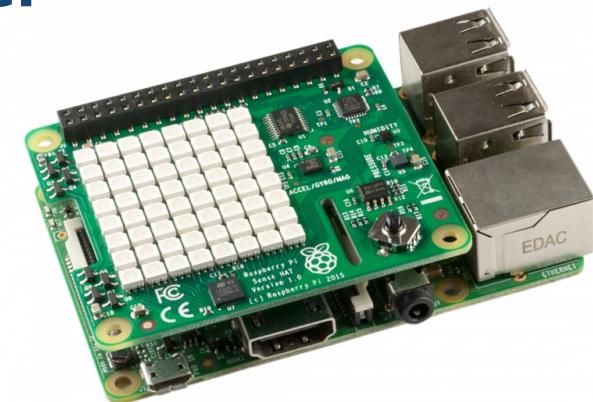
- ❑ **Form factor suitable for Raspberry Pi Zero with 4 mount holes and dimensions 65x30mm**
- ❑ **40 pin through-hole header**
- ❑ **EEPROM not mandatory**

* Not an official standard of the Raspberry Pi Foundation

Sense HAT

Konsulko
Group

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



More...

Konsulko
Group



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!

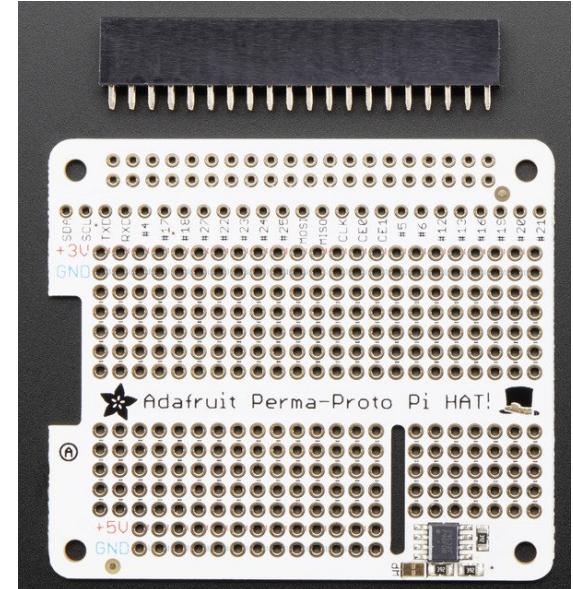
| | | | |
|------------------|----------------------|-------------------------|----------------|
| 1 Wire Pi Plus | ADC Differential Pi | ADC Pi Plus | Amp HAT |
| Automation HAT | Capacitive Touch HAT | Cirrus Logic Audio Card | DAC HAT |
| DISPLAYOTRON HAT | | | DRH08 DRUM HAT |

Making Your 1st HAT

Konsulko
Group

Requirements:

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



Device Tree Fragment

Konsulko
Group

- ❑ 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**

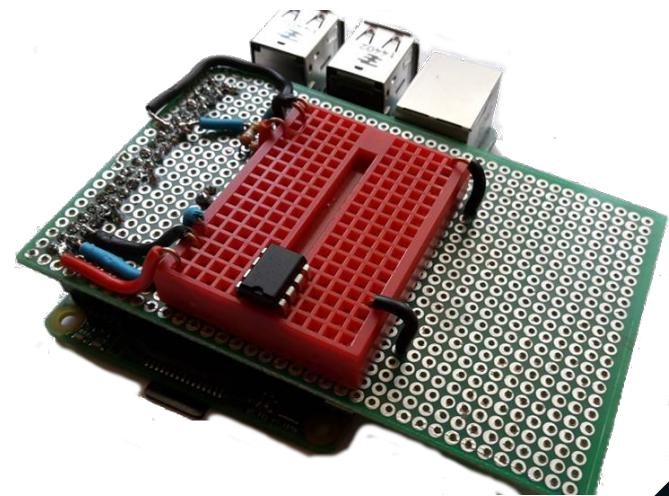
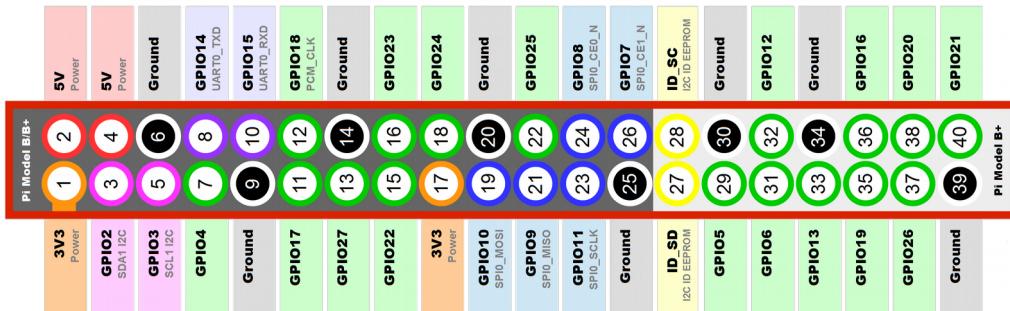
<https://github.com/raspberrypi/hats>

- ❑ **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

Konsulko
Group

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



device-tree/hat

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

```
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

Konsulko
Group

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

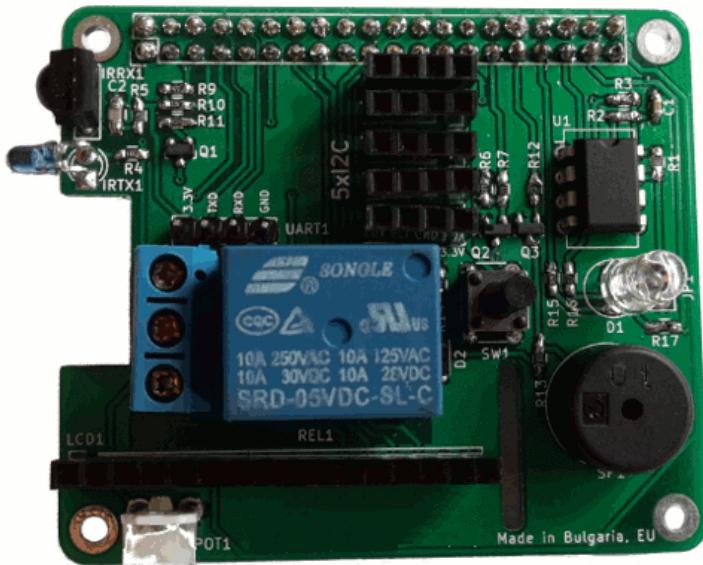
<http://gitlab.openfet.com/julien/pihat-template>

Eagle

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

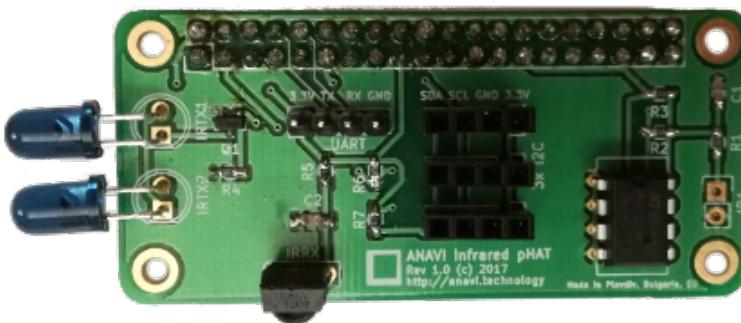
My OSHW HAT & pHAT

Konsulko
Group



Anavi Flex HAT

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

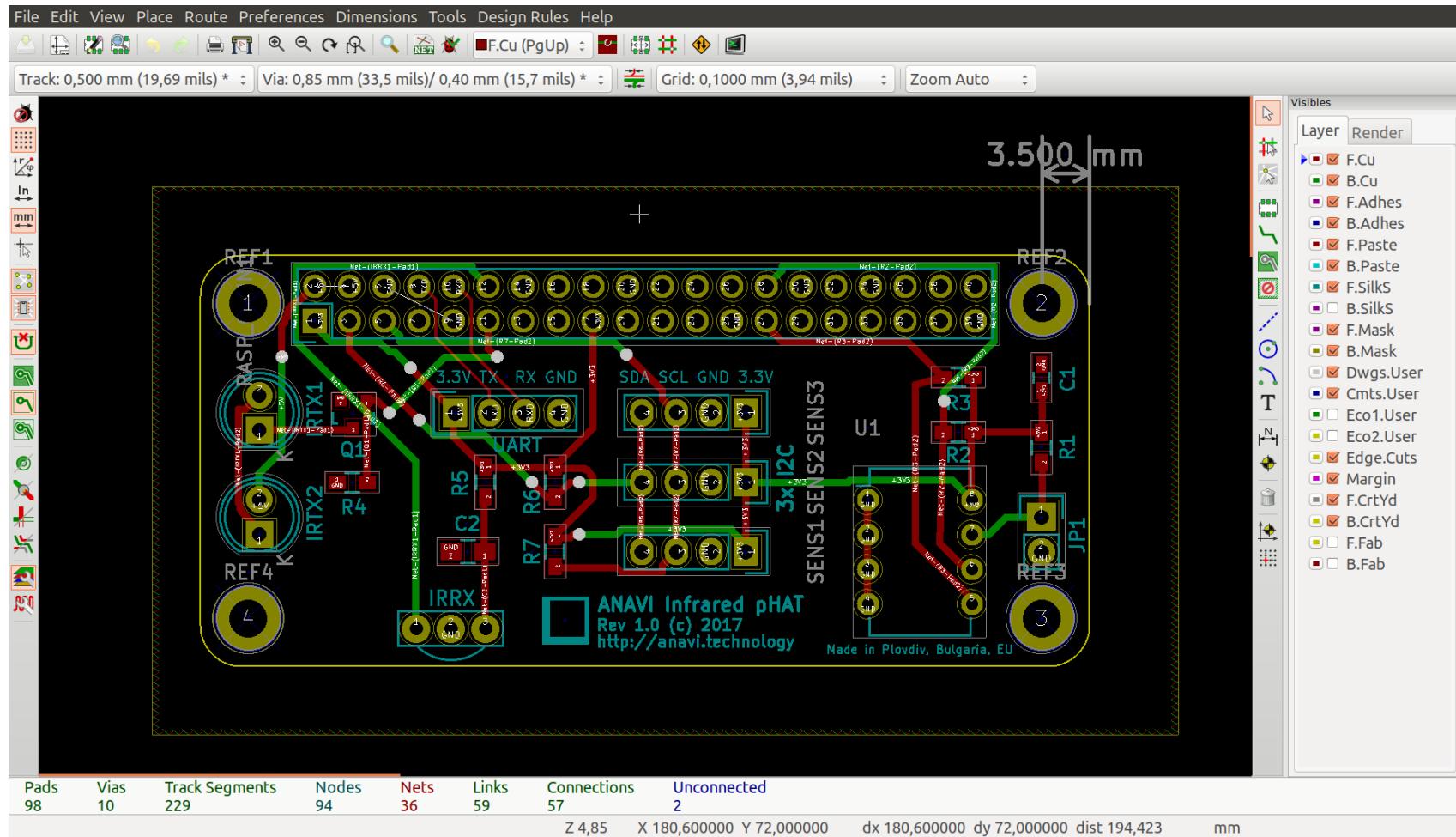


Anavi Infrared pHAT

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

KiCAD Pcbnew

Konsulko
Group



Recommendations



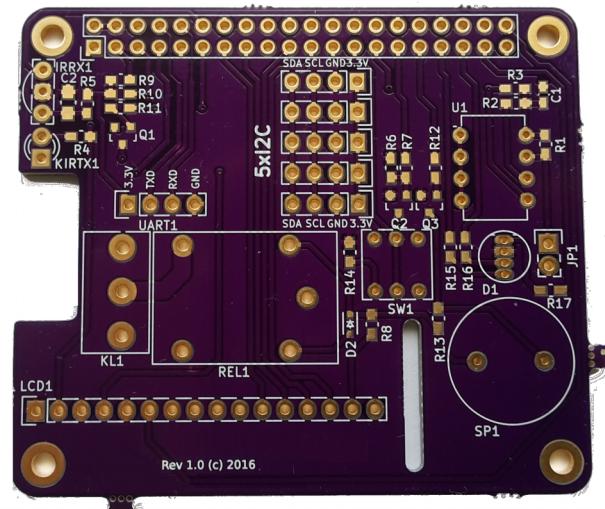
- ❑ Comply with the minimum requirements of the PCB manufacturer for trace spaces, drills and angular rings
- ❑ Keep in mind the complexity of the assembly process while designing the PCB
- ❑ Consider the location of Raspberry Pi components while placing components on your HAT and avoid any potential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

Prototypes

Konsulko
Group

PCB printing services from:

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



Software



- ❑ **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!

Konsulko
Group

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/>

