Making Your Own Open Source Raspberry Pi HAT

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Agenda

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

Hat

HAT

(Hardware Attached on Top)
Raspberry Pi

- 2009 - Raspberry Pi Foundation
- 2012 - The 1st Raspberry Pi
- 2014 - Raspberry Pi B+
- 2016 - Raspberry Pi Zero
Raspberry Pi Flavors
Important Change in B+

Raspberry Pi B (2011) - 26 pins

Raspberry Pi B+ (2014) - 40 pins
Raspberry Pi Flavors
# 40 Pin Header

## Diagram

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<td>GPIO45</td>
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</tbody>
</table>

## Key
- **5V**: Power
- **Ground**: Ground
- **GPIO**: General Purpose Input/Output
- **I2C**: I2C Interface
- **SPI**: Serial Peripheral Interface
- **SDA**: Serial Data Line
- **SCL**: Serial Clock Line
- **GPIO20**: GPIO Number 20
- **GPIO21**: GPIO Number 21
- **GPIO22**: GPIO Number 22
- **GPIO23**: GPIO Number 23
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://github.com/raspberrypi/hats
pHAT

- 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
Raspberry Pi HATs, pHATs & Add-ons

Click on a HAT, pHAT or add-on for more details and to see which pins it uses!
Making Your 1\textsuperscript{st} 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
Directory `/proc/device-tree/hat`

Information about product name, version, vendor and UUID
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
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
Software

- Python is a 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:

- http://pinout.xyz/
- https://github.com/raspberrypi/hats
- https://github.com/AnaviTech
- http://wiringpi.com/
- http://kicad-pcb.org
- https://oshpark.com/