The Software Developer’s Guide to Open Source Hardware

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

- Combining open source hardware with free and open source software
- Open source hardware certification
- Low-volume manufacturing
- Crowdfunding opportunities
- Community

Open Source Hardware

- 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
- To be really open source hardware the project needs 4 main elements: hardware, software, documentation, branding

Benefits

Open source hardware is good for:

- Giving confidence that the design will be available if the original manufacturer stops production
- Keeping the prices low
- Enabling customizations and integration in 3rd party products
- Sharing knowledge, educating students and getting feedback and contributions from the community

Open Source Hardware Licenses

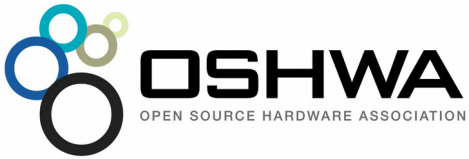
Popular viral licenses:

- GNU General Public License (GPL)
- Creative Commons Attribution-ShareAlike
- CERN Open Hardware License (OHL)
- TAPR Open Hardware License (OHL)

Popular permissive licenses:

- FreeBSD
- MIT
- Solderpad Hardware Licence

Open Source Hardware Certification



Open Source Hardware Association(OSHWA):

- Maintains Certified Projects Directory
- Ensures that the definition of “open source hardware” used by a specific project matches the community definition of open source hardware
- Provides an unique ID for certified hardware based on the country code and a number, for example: BG000007
- Provides an unique logo for the certified ID
- https://certification.oshwa.org/

Who is Using Open Source Hardware?

- Arduino
- Olimex
- SparkFun
- Adafruit
- Intel
- Google
- IBM
- Prusa
- And a lot of other companies and individuals...

Software vs Hardware

- Hardware is expensive
- Often you can’t built hardware at home
- Making hardware prototypes takes more time
- Soldering requires skills and practice
- Debugging hardware requires specific physical tools
- Fixing bugs requires a new version of the hardware
- Testing hardware can be dangerous

Philosophical questions

- Is it worth designing open source hardware with expensive proprietary software tools?
- Can you build a sustainable community if your contributors have to pay gazillions for software licenses to modify and contribute back to your open source hardware project?

Free and Open Source Design Software

Popular Electronic Design Automation (EDA):

- Fritzing
- gEDA
- KiCAD

Popular Computer-aided design (CAD):

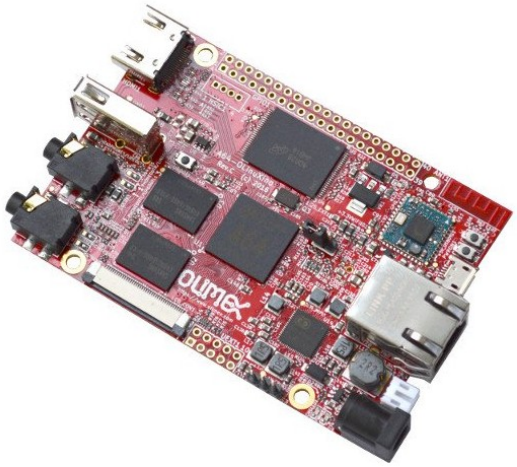
- OpenSCAD
- QCAD
- FreeCAD
- Blender

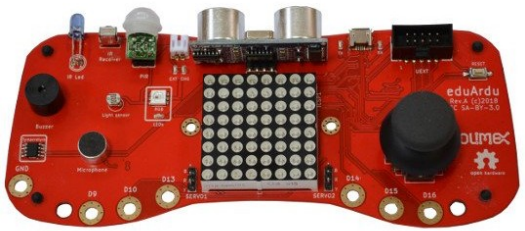
KiCad

- Free & open source EDA software (GPLv3+)
- Cross platform (works on GNU/Linux distributions, MS Windows and Mac OS X)
- Integrated 3D viewer
- Up to 32 copper layers + 14 fixed-purpose technical layers
- Contributions from CERN developers
- Already adopted by the industry
- http://kicad-pcb.org/

Why am I using KiCad?

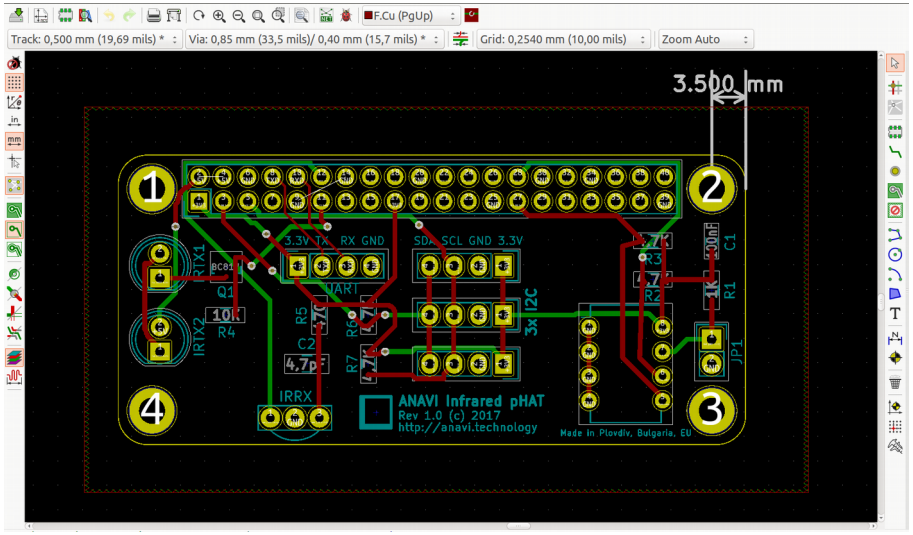
Because it is open source and recommended by:

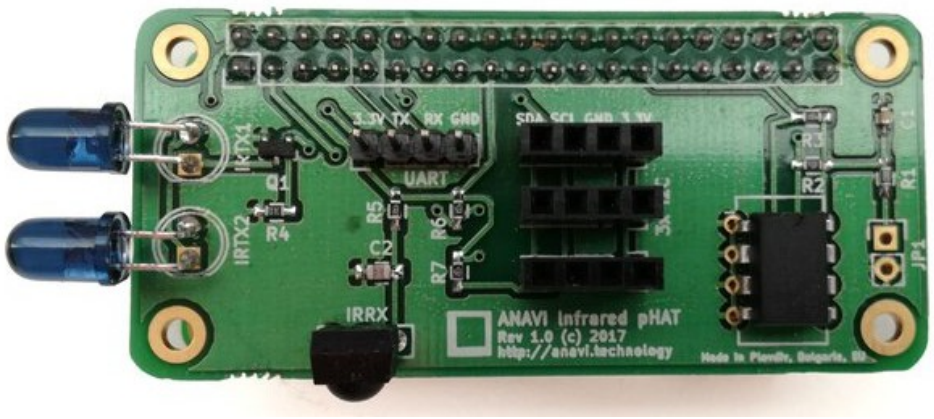




My First Own KiCad Project from Scratch

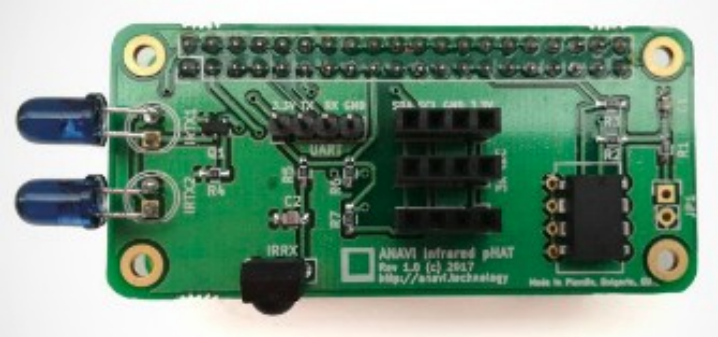
- It all started with an add-on board for Raspberry Pi
- Thanks to Rangel Ivanov & other friends for helping me with KiCad

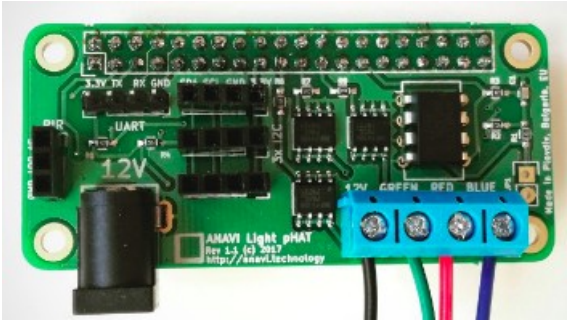


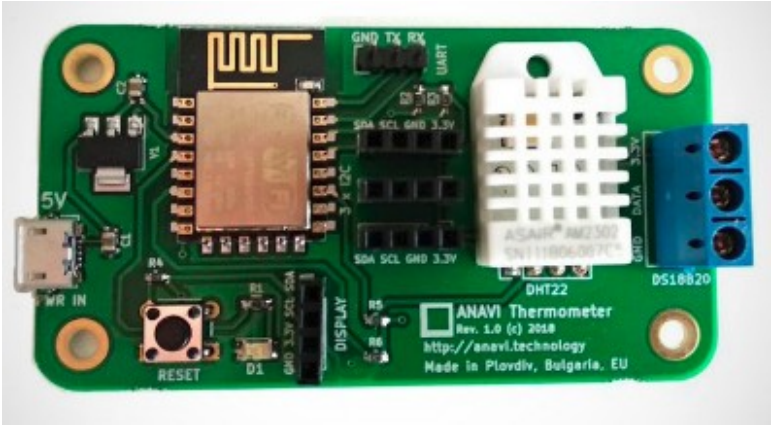


- For details have a look at FOSDEM 2017: Making Your Own Open Source Raspberry Pi HAT
  https://archive.fosdem.org/2017/schedule/event/diy_pi_hat/

It Becomes Easy After Getting Used to KiCad and Open Source Hardware







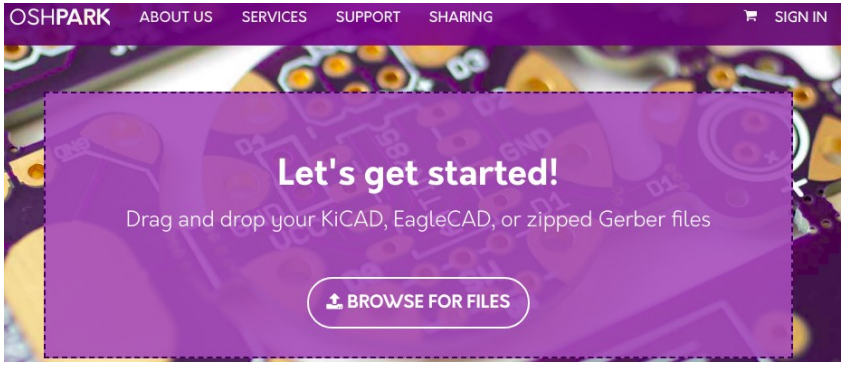
Recommendations

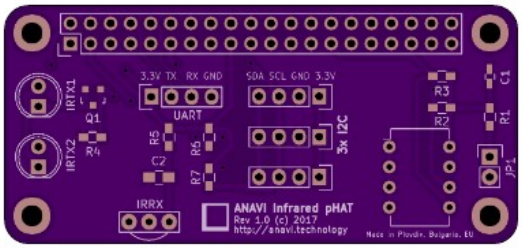
- Comply with the minimum requirements of the PCB manufacturer for trace spaces, drills and angular rings
- Read the datasheets of all components carefully
- Keep in mind the complexity of the assembly process while designing the PCB
- Consider the design of the case simultaneously with the design of the PCB
- Submit often to version control system with a public repository to get early feedback from the community

PCB Prototyping

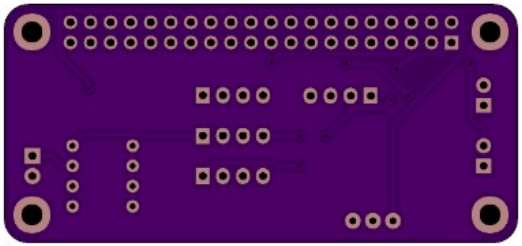
PCB printing services from:

- OSHPark (USA)
- Aisler (Germany)
- Other local European factories
- JLCPCB (China)
- PCBWAY (China)
- Seeed Studio (China)
- ALLPCB (China)
- Other Chinese factories



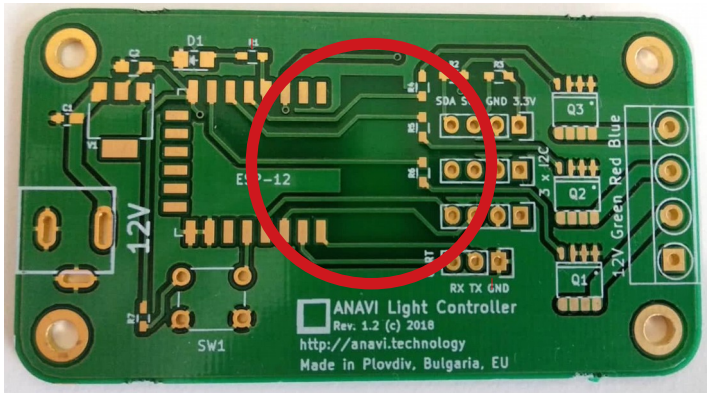


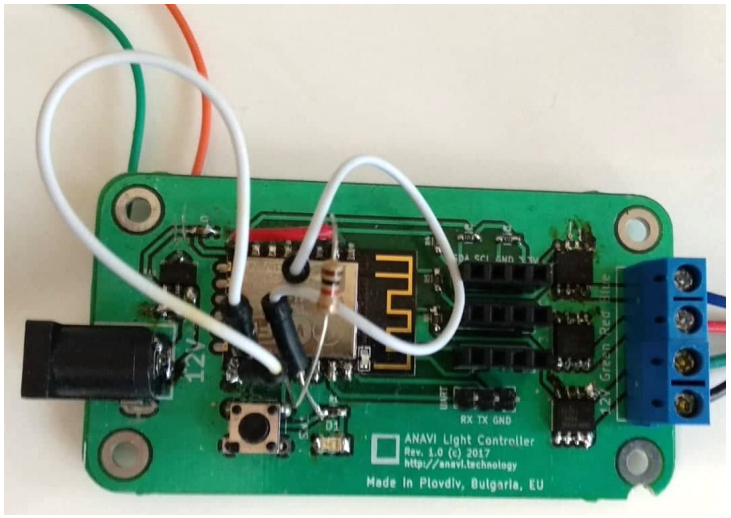
Top



Bottom

Epic Fails


ANAVI Light Controller
Rev. 1.2 (c) 2018
http://anavi.technology
Made in Plovdiv, Bulgaria, EU
12V
SW1
RX TX GND
SDA SCL GND 3.3V
3 x I2C
12V Green Red Blue


ANAVI Light Controller
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12V
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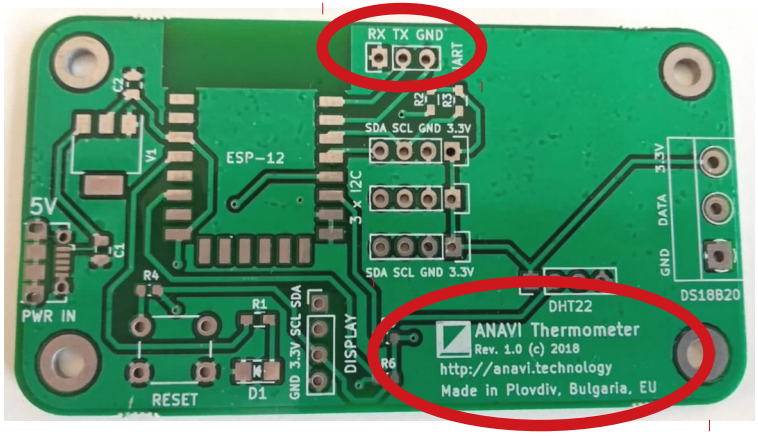
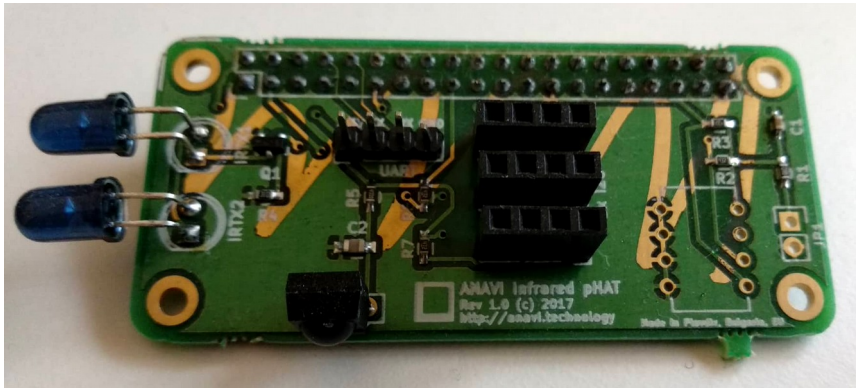
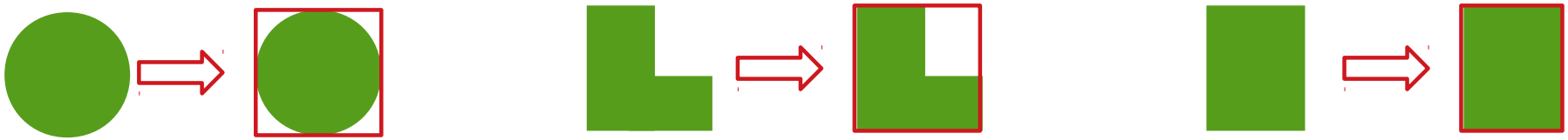

RX TX GND
UART
SDA SCL GND 3.3V
ESP-12
3 x I2C
5V
PWR IN
RESET
D1
DISPLAY
GND 3.3V SCL SDA
DHT22
DS18B20
DATA
GND
3.3V
ANAVI Thermometer
Rev. 1.0 (c) 2018
http://anavi.technology
Made in Plovdiv, Bulgaria, EU

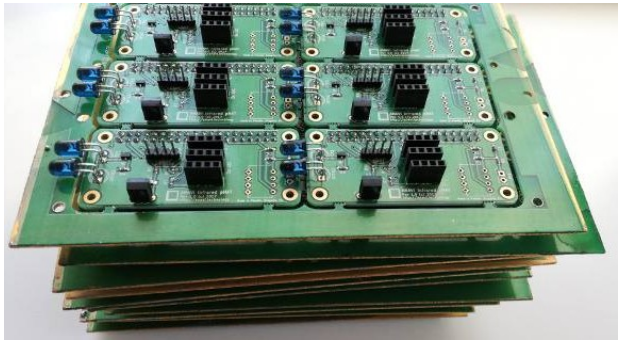

ANAVI Infrared pHAT
Rev 1.0 (c) 2017
http://anavi.technology

Low Volume Manufacturing (1/3)

- Price depends on PCB size



- Several boards are grouped in a panel



- Assembly could be more expensive than the PCB

Low Volume Manufacturing (2/3)

- Assembly could be more expensive than the PCB
- Handsoldering SMD (Surface Mount Devices) might be OK for a prototype but is extremely time consuming and not a reasonable option for low volume manufacturing
- Stencil, solder paste and a reflow oven is required for SMT (Surface Mount Technology)
- Pick and place machine might be too expensive for low volume manufacturing of PCB with just a few SMD

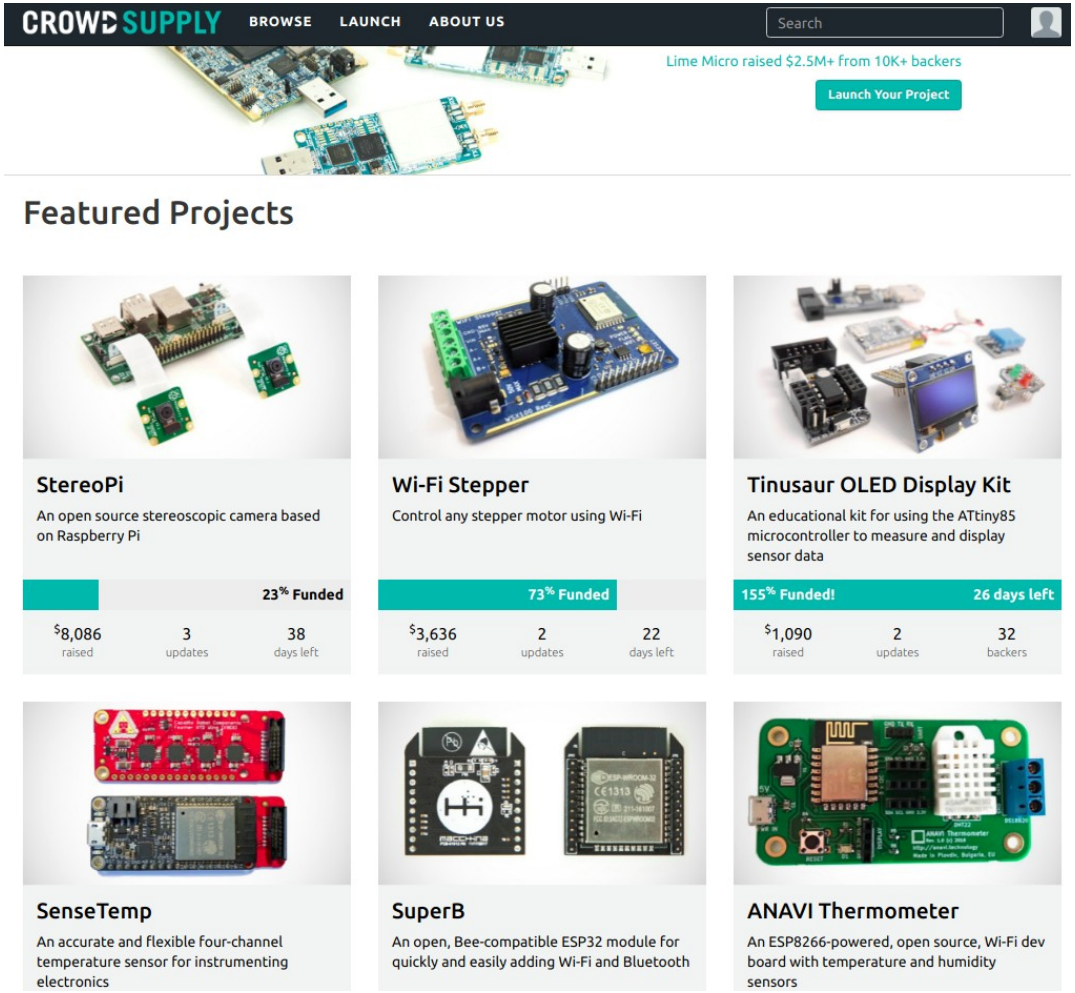
Low Volume Manufacturing (3/3)

- Planning low volume manufacturing from local suppliers avoids delays caused by import procedures and holidays in the country of origin of the components
- Local manufacturing allows better QA during the process
- Local manufacturing may be more expensive but cuts the costs for shipping
- Bonus: it is awesome to see your hometown on a PCB

Crowdfunding Opportunities

- Kickstarter
- IndieGoGo
- Crowd Supply
- GroupGets
- Other

- Tindie
  (marketplace for maker made products)

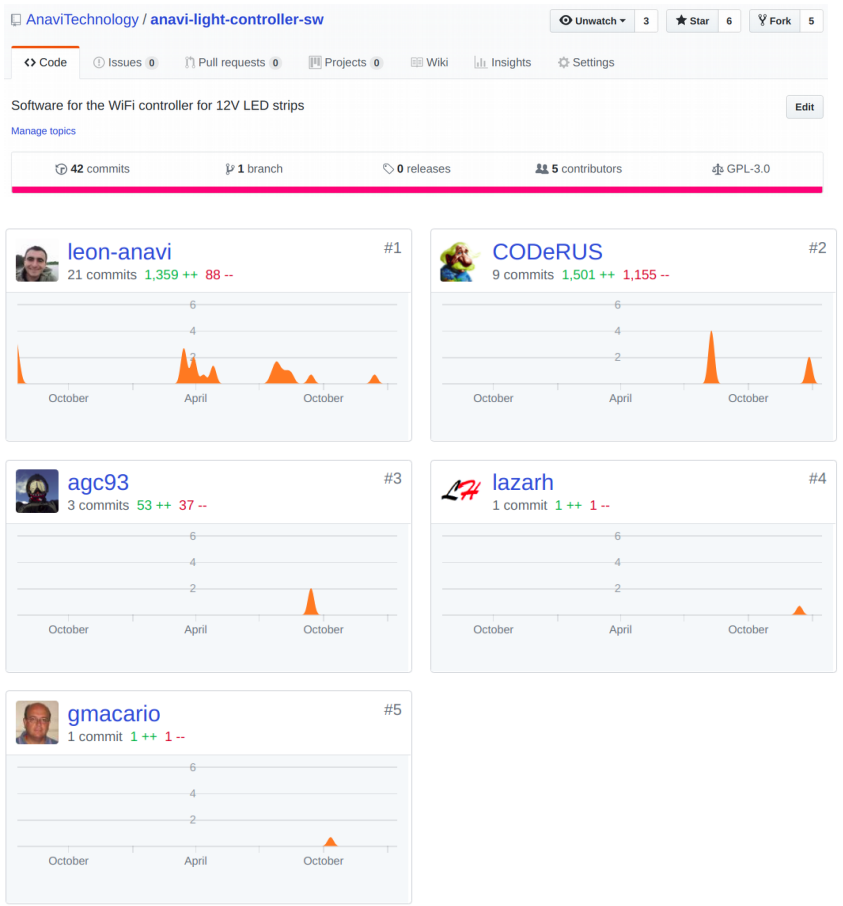


Community

- Community matters
- Keeping the hardware, the software and the documentation in public repositories allows people to contribute back
- Using popular tools and services such as Git and GitHub makes it easier to attract more contributors
- Excellent documentation is always an advantage
- Bloggers have the power to spread to word among the community and influence it
- People enjoy step by step tutorials in YouTube, Instructables, Hackster, hackaday.io, etc.

Recommendations

- Use de-facto industry standard version control system like Git and a popular service like GitHub helps to attract more contributors
- Provide quick feedback to contributors
- Be respectful and thankful for each contribution



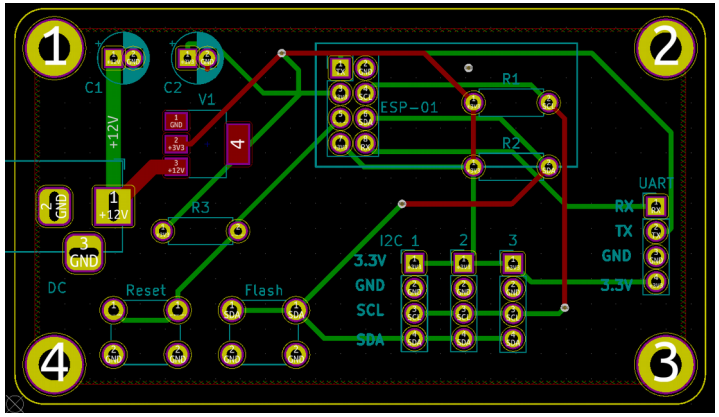
Hardware Improvements

- GitHub pull requests with modifications of the KiCad sources are rare because it could be difficult to tests the change
- Often hardware recommendations are provided by the community and the author should implement them
- It is a good practice to add trailer with credit to the people involved in the modification, for example with trailers in the Git commit message

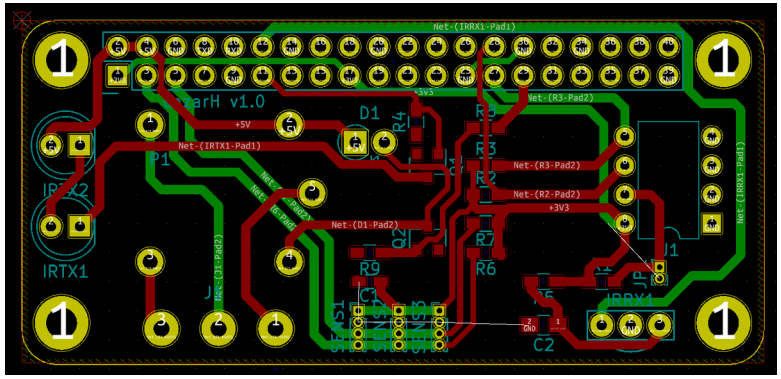
```
commit ec4060aa8f6bd9c3c78772545addae66212a6bf0 (HEAD -> master, origi
n/master)
Author: Leon Anavi <leon@anavi.org>
Date:   Fri Jul 20 16:41:54 2018 +0300

    anavi-buttons.kicad_pcb: Wider GND

    Extend the path that connects the GND fill zone.

    Suggested-by: Lazar Hristov <lhristov@gmail.com>
    Signed-off-by: Leon Anavi <leon@anavi.org>
```

Hardware Modifications

- esp01-i2c-little-board by Nicolas Vion
  https://github.com/zmoostik/esp01-i2c-little-board



- Modified Infrared pHAT by Lazar Hristov
  https://github.com/lazarh/anavi-infrared



Conclusions

- Open source hardware is a viable business model already used by a lot of well-known companies in the industry
- Open source hardware certification by OSHWA is free and guarantees that the products are really open source
- High quality free and open source software tools for designing open source hardware are available
- Building and testing a hardware prototype is often more expensive and time consuming (compared to software)
- **Community** always matters

Thank you!

Useful links:

- https://www.oshwa.org/
- https://certification.oshwa.org/process.html
- http://kicad-pcb.org/
- https://oshpark.com/
- https://docs.oshpark.com/design-tools/kicad/generating-kicad-gerbers/
- https://github.com/AnaviTechnology/
- https://www.crowdsupply.com/
- https://www.tindie.com/