Open Source Hardware

Portland Science Hack Day
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Design is made publicly available so that anyone can study, modify, distribute, make or sell designs or hardware based on that design.
Open Source Hardware

Documentation required for electronics:

- **Schematics**
- **Board Layout**

Editable source files for CAD software (*KiCad, EAGLE, Altium, etc*)

**Bill of Materials (BOM)**

*Best practice: all components available in low quantity distribution*
Open Source Hardware

Publish documentation with an Open Source license:

- Creative Commons Share-Alike: CC-BY-SA
  - Non-Commercial (NC) clause is NOT acceptable

- Copyleft: GPLv2, GPLv3

- Permissive: Apache, BSD, MIT

- OSHW inspired: CERN OHL, TAPR, SolderPad
CERN Open Hardware Licence

• Originally written for CERN designs hosted in the Open Hardware Repository

• Can used by any designer wishing to share design information using a license compliant with the OSHW definition criteria.

• CERN OHL version 1.2
  Contains the license itself and a guide to its usage
CERN Open Hardware Licence

Myriam Ayass, legal adviser at CERN and author of the CERN OHL:

• **OHL** is to hardware what **GPL** is to software

• Similar principles to Free or Open Source software

• Anyone should be able to: see the source*, study it, modify it and share it

  *the design documentation in case of hardware
Open Hardware Repository

- **Collaborate** on Open Hardware designs
- **Peer review** for small teams or solo designers
- Origins in *experimental physics laboratories*
- Enable teams to **work together** to solve problems
- **More fun** than isolation & results in **better hardware**
Example: **White Rabbit**

White Rabbit is a fully deterministic Ethernet-based network for general purpose data transfer and synchronization. It can synchronize over 1000 nodes with sub-ns accuracy over fiber lengths of up to 10 km. Commercially available.

More info at the Wiki page

- Status: Release
Javier Serrano, Open Hardware at CERN

- Physicist and Electronics Engineer at CERN
- co-author of the CERN Open Hardware License
- creator of the Open Hardware Repository
Licenses, Copyright and Patents can get confusing!

Review of Popular OSHW Licenses

Talk by Ari Douglas at OHS 2014
What is the spirit of Open Source?

- Publish everything that will:
  
  **enable collaborative development**

- The goal is **NOT** to just check a box on a marketing flyer or add keywords to a Kickstarter campaign
Open Source Hardware Association

- US Federal 501(c) non-profit
- Hosts the **OSHW definition**
- “aims to be the voice of the open hardware community, ensuring that technological knowledge is accessible to everyone, and encouraging the collaborative development of technology”
• Best Practices

• Quick Reference Guide

• May and Must attributes (PDF)
Open Hardware Summit (OHS)

- **OHS 2016**: Portland, Oregon

- **6 prior summits**:
  - 2010, 2011: New York Hall of Science
  - 2012: Eyebeam (NYC)
  - 2013: MIT (~Boston)
  - 2014: Roma, Italia!
  - 2015: Philadelphia
Open Hardware Summit (OHS)

2015 videos:

2015 Summit Late Afternoon Sessions
4 months ago

2015 Summit Early Afternoon Sessions
4 months ago

2015 Summit Late Morning Sessions
4 months ago

2015 Summit Early Morning Sessions
4 months ago
Open Hardware Summit (OHS)

2014 videos:

OSHWA’s Videos

47 Videos 0 Appearances 47 Total

Sort: Date / Alphabetical / Plays / Likes / Comments / Duration

Closing Remarks by Simone Cicero and Gabriella Levine
from OSHWA Added 10 months ago ⏳ 30 Heart 0 Share 0
+ More details

John Dimatos - The Open Source Advantage on Kickstarter (2014 OHS)
from OSHWA Added 10 months ago ⏳ 55 Heart 0 Share 0
Session: Implication of Open Source in Business and Culture 2014 Open Hardware Summit https://twitter.com/ohsummit
+ More details

Tristan Copley Smith - EcoHacking the Future (2014 OHS)
from OSHWA Added 10 months ago ⏳ 362 Heart 2 Share 0
Session: Implication of Open Source in Business and Culture 2014 Open Hardware Summit https://twitter.com/ohsummit
+ More details

Achieved Critical Mass by Sharing: Arduino

Arduino Uno

How did it come to be?

Arduino: The Documentary
### Arduino UNO Design Files

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC Current for 3.3v Pin</td>
<td>50 mA</td>
</tr>
<tr>
<td>Flash Memory</td>
<td>32 KB (ATmega328) of which 0.5 KB used by bootloader</td>
</tr>
<tr>
<td>SRAM</td>
<td>2 KB (ATmega328)</td>
</tr>
<tr>
<td>EEPROM</td>
<td>1 KB (ATmega328)</td>
</tr>
<tr>
<td>Clock Speed</td>
<td>16 MHz</td>
</tr>
</tbody>
</table>

### Schematic & Reference Design

**EAGLE files:** arduino-uno-Rev3-reference-design.zip (NOTE: works with Eagle 6.0 and higher)

**Schematic:** arduino-uno-Rev3-schematic.pdf

**Note:** The Arduino reference design can use an Atmega8, 168, or 328. Current model uses ATmega328, but an Atmega8 is shown in the schematic for reference. The pin configuration is consistent with the Atmega8.
OSHW Resources

- Join OSHWA
- Subscribe to the mailing list
- Follow on Twitter:
  - @OHSummit
  - @oshwassociation
- Building Open Source Hardware
  by Alicia Gibb
Section: LINUX on OSHW
• ARM Linux on Open Source Hardware

• Developed by BeagleBoard.org Foundation and BeagleBoard.org Community

• Manufacturers: element14, GHI, Seeed
BeagleBone Black Wireless

- 1 GHz ARM processor, 512 MB RAM
- 2x 32-bit PRU microcontroller for hard real-time
- 4GB eMMC with Debian GNU/Linux installed
- WiFi 802.11 b/g/n, Bluetooth 4.1 with BLE
- HDMI / USB / 65 GPIO pins / 8 PWM outputs
- 7 analog inputs / 4x UART / 2x I^2C / 2x SPI
BeagleBone Black Wireless
(ships November 2016)

- CadSoft EAGLE design files hosted on GitHub
- Bill of Materials: every part available in qty 1
- Octavo System-in-Package (SiP) large pitch BGA simplifies PCB layout and assembly
MinnowBoard

- 64-bit Intel Atom “Bay Trail”
- MinnowBoard Turbot
  - $135: E3826 (dual-core, 1.46 GHz)
- USB 3.0, SATA, PCIe, Gigabit Ethernet, HDMI
- Integrated Intel HD Graphics
  - Open Source Mainline Linux drivers!
MinnowBoard

- Manufactured by ADI and CircuitCo
- Released under Creative Commons CC-BY-SA
- Download:
  - [x] Schematic (Orcad DSN & PDF)
  - [x] Board Layout (Allegro BRD & Gerbers)
  - [x] Bill of Materials
• Low cost OSHW Linux computers

• Designed and manufactured by Olimex in Bulgaria

• Blog post: “Open Source Hardware, why it matters and what is pseudo OSHW”
A64-OlinuXino

- Allwinner A64: Quad Core 64-bit ARM
- Designed with Open Source KiCad
- 1GB RAM, 4GB eMMC, WiFi+BLE4.0
Using FOSS tools for OSHW project

Designing with KiCAD of 64-bit ARM board

Tsvetan Usunov, OLIMEX Ltd

FOSDEM 2016

http://www.slideshare.net/olimexbulgaria/designing-with-kicad-of-64bit-arm-board
CHIP

The World's First $9 Computer

- getchip.com
- Next Thing Co. in Oakland
- Kickstarter in 2015:
  - 39,560 backers
  - $2,071,927 pledged
1GHz + 512MB + 4GB

**Processor**

**Ram**

**Storage**

R8

1GHz Allwinner A13 Compatible SoC

Mali400 GPU w/ OpenGLES 2.0 & OpenVG 1.1

512MB DDR3 Ram

4GB NAND Flash Storage

C.H.I.P. is built with Making in Mind

Realtek 2-in-1 Bluetooth 4.0 + WIFI B/G/N

I2C + SPI + UART + 8 x GPIO

Camera Sensor Support (MIPI-CSI)

Native LCD Support 4.3~8"

Battery Power & Charging

WIFI & Bluetooth

Battery Power & Charging Built In!

Run CHIP for Hours with a Single Cell Lipo.

Composite Video HDMI & VGA Out via adapter

Headphone Audio Out Mic In

Fast Boot Debian Based Linux OS

Over The Air Updates

OpenGLES 2.0

OpenVG 1.1
C.H.I.P. is OSHW

- GitHub: NextThingCo/CHIP-Hardware
  - Schematics
  - PCB Layout
  - Bill of Materials (BoM)
- License:
  - Creative Commons Attribution-ShareAlike (CC-BY-SA)
Section: OSHW in Science

Suggestions from the OSHWA mailing list
Public Lab

“Using inexpensive DIY techniques, we seek to change how people see the world in environmental, social, and political terms.”

• Office in Portland!

• **Riffle: Open Source Water Monitoring**

• **Desktop Spectrometry**

• **Balloon Mapping Kit**
Generic Lab Equipment

- GaudiLabs in Lucern, Switzerland
  - part of the hackteria.org open source biology art network
Generic Lab Equipment

- WebCam Microscope
- Hard Drive Centrifuge
- Incubator Controller
- Gel Box and High Voltage Supply
- Turbidity Meter Kit
- DIY Microvolume Spectrometer
- My Open PCR
- Tube Racks
GOSH 2017

- Gathering for Open Science Hardware
- “growing number of people around world are developing and using Open Science Hardware, and we want to help build self-organising community to drive change in open science”
OpenDrop

- “Desktop Digital Biology Laboratory”
- digital microfluidics platform for research
- part of a bigger ecosystem around digital biology with the aim of making personal lab-automation accessible to more people
OpenTrons

• Robots for Biologists

• “We think biologists should have robots to do pipetting for them.”

• “They should be able to spend their time designing experiments and analyzing data.”
OpenPCR

- PCR is a method of copying DNA molecules.
- OpenPCR is a project to develop open source hardware, software, and protocols to perform PCR and Real-Time PCR reactions.
- community dedicated to openness in science and applying the fundamental technologies of PCR to global problems.
Open Source Imaging (MRI)

- Open Source Magnetic Resonance Imaging
- **Opencore NMR** is an open-source toolkit for implementing an NMR spectrometer
- **LukasW log**: “COSI Magnet: Single ring results look fantastic! Less than 2% difference to simulation”
Hackteria.org

• Collection of DIY Biology, Open Source Art Projects that use Biology, LifeSciences, Biotechnology.
Digital Naturalism

- Investigates the role that Digital Media can play for Biological Field Work
- Uphold the naturalistic values of wilderness exploration, while investigating the new abilities offered by digital technology

Theory and Guidelines by Andrew Quitmeyer
MOST research group

- Joshua Pearce Research Group at Michigan Tech in Open Sustainability Technology (MOST) focuses on open and applied sustainability
- Exploring the way solar photovoltaic technology can sustainably power our society
Libre Space Foundation

- Non-profit for Open Source HW & SW in Space
- **UPSat**: first open hardware satellite bound to be launched to the International Space Station in late December
- **SatNOGS**: open source hardware satellite ground-station network

Claim space, the libre way!
Section: BONUS SLIDES
What about silicon?

**LowRISC:**

“lowRISC is producing fully open hardware systems. From the processor core to the development board, our goal is to create a completely open computing eco-system”
Novena laptop

- Created by Bunnie & xobs!
  - Chumby! Hacking the X-Box! Amazing reverse engineers
  - The Exploration and Exploitation of an SD Memory Card

- 100% Open Source Hardware laptop
- Quad-core 1.2GHz Freescale ARM CPU
- FPGA! 4GB RAM, WiFi, 2x Ethernet, SSD
Lulzbot 3-D Printers

100% Open Source
Hardware & Software

- FSF Respects Your Freedom certified
Thanks

• **Suggestions** from the OSHWA mailing list:
  – Abram Connelly
  – Andrew Plumb
  – Andrew Quitmeyer
  – Eleftherios Kosmas
  – Marcin Jakubowski

• **Jeena Lee** for first telling me of Portland Science Hack Day

• **Max Ogden** for asking me to speak
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- OSH Park Blog