

# F\*WATCH, making a watch differently!

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# What is it?



## Retirement gift for a timing Hacker

### Gift Requirement

- 1 customization of the gift
- 2 hackable gift
- 3 free/open source
- 4 use only FOSS tools

# Development organization



## Components selection criteria

- Low power consumption
- Available in small quantity from main suppliers
- Small size (footprint)

## Micro-controller (EFM32)

- Silicon Labs
- 32-bit Cortex-M3
- 1MB flash
- 128kB RAM
- 1.1uA deep sleep



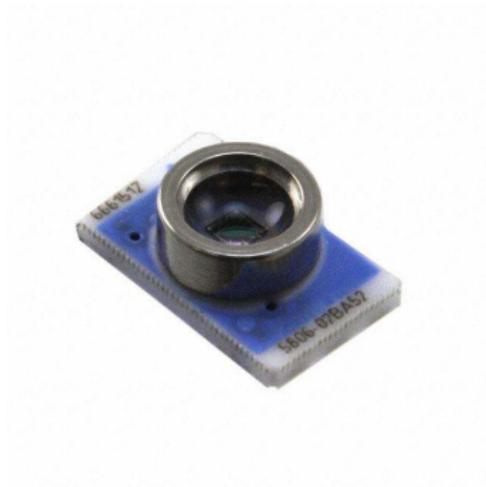
## GPS module

- Antenova
- 13 x 9.5 x 1.8mm
- Integrated antenna



## Altimeter module (pressure sensor)

- Measurement Specialties
- 6.4 x 4 x 2.8mm
- Water-resistant
- Includes a thermometer



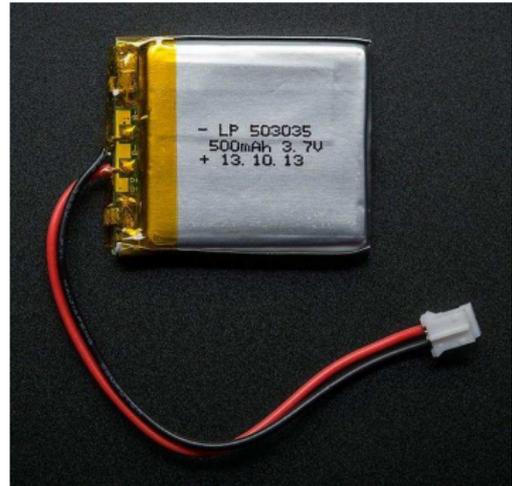
## Memory LCD display

- Sharp
- 128 x 128 pixels
- 1.28 inches
- Ultra low current



## Battery

- Adafruit
- Li-ion 500mAh
- Big capacity
- Lightweight
- Rechargeable



## Other features

- 3-axis accelerometer + compass
- Ambient light sensor
- micro-SD card slot
- Battery charger + fuel gauge
- micro-USB connector
- Buzzer
- Vibrating motor

## Foreseen improvements

- Bluetooth LE
- Low noise amplifier for the GPS antenna
- Power management



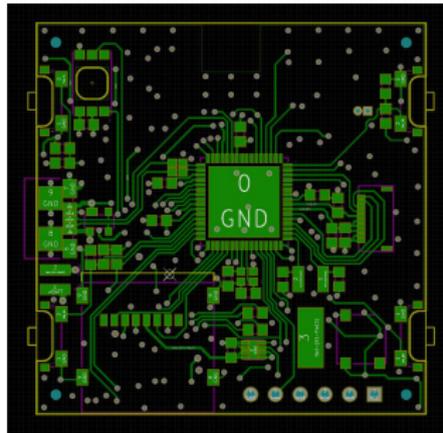
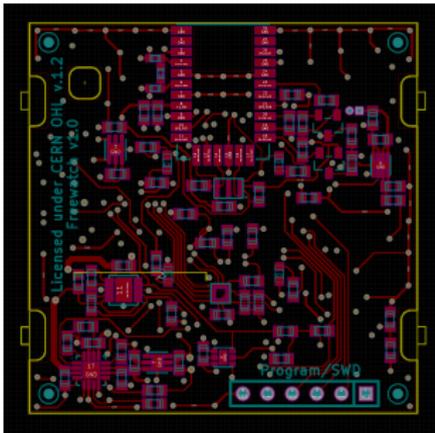
- CERN is contributing
- Developers in the team (help, bugfix, feedback)
- New features making routing easier (e.g push&shove)
- Script to generate placement pdf

Interested in knowing more about KiCad developments?

- Visit the EDA dev room (AW1.124) tomorrow

## Characteristics

- 4 x 4 cm
- 4 layers
- Components on both sides
- Licensed under CERN OHL v1.2

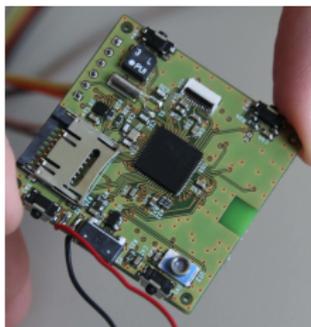


Prototypes assembled by hand

Fully working, except two minor bugs

- Error in a datasheet
- MCU interrupt scheme

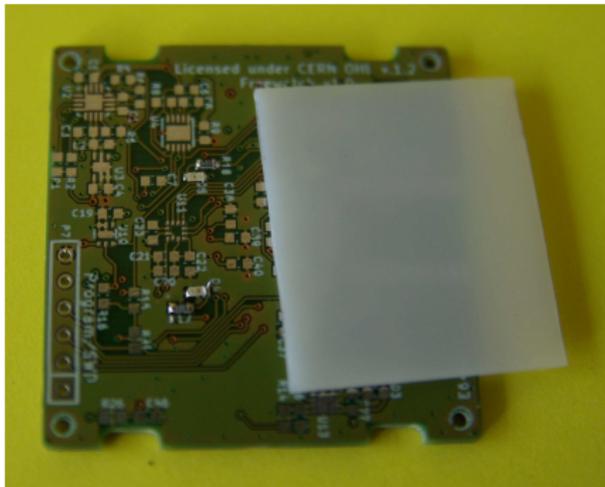
→ Fixed with few cuts and wires!



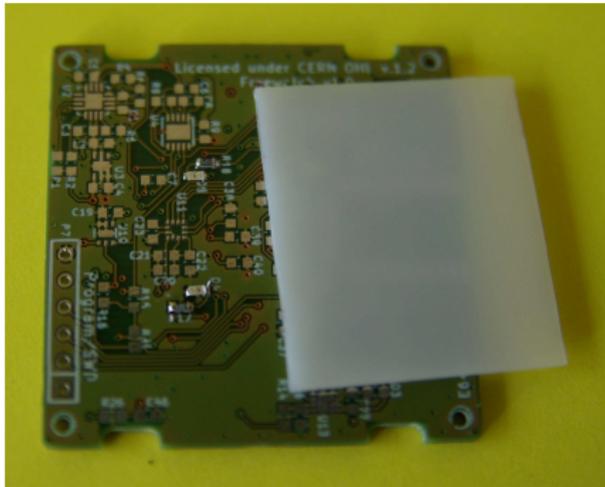
A long story...

- To read display in the dark
- No backlight available

First try: LEDs + opaque Plexiglas

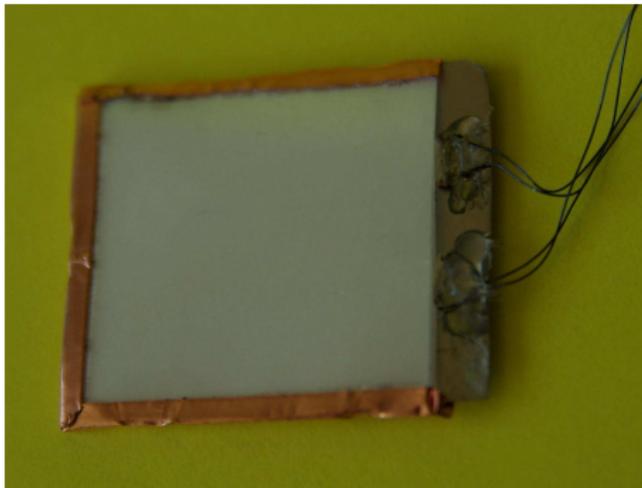


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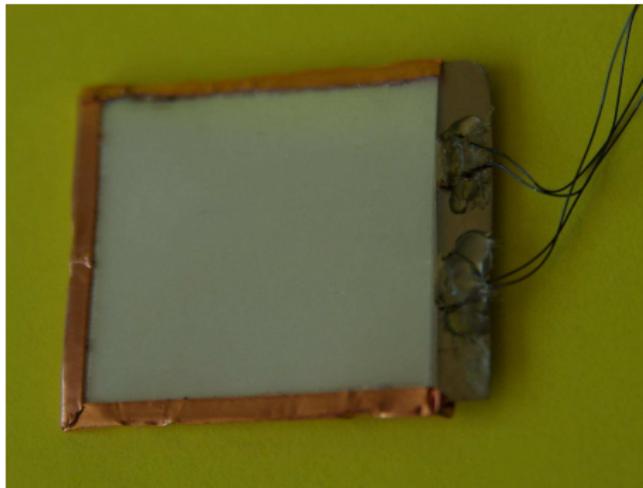


**Not good!**

## Second try: Recycled smartphone backlight

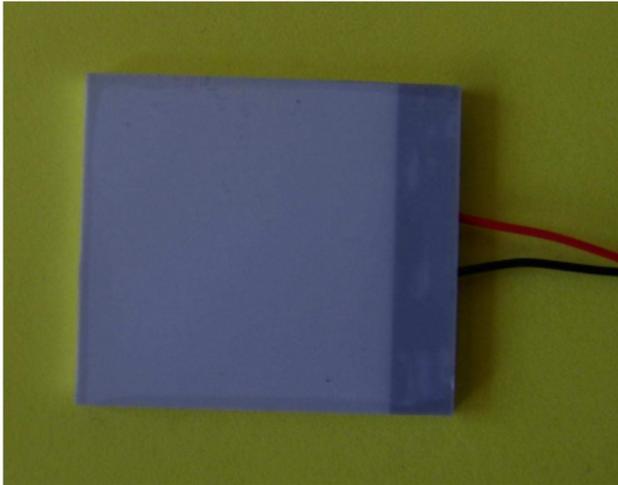


Second try: Recycled smartphone backlight

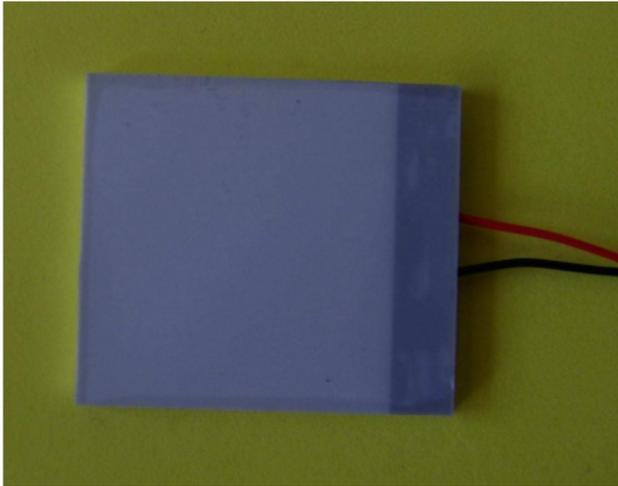


**Better, but...**

Current try: Custom-made module  
→ Low quantity, cheap (< 5\$/pces)



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**The solution**

## CAD tool selection

- No mechanical engineer
- No experience in 3D design/printing
- Evaluate existing free CAD tools  
FreeCAD, OpenSCAD, Open CASCADE, ...

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Decided to use **FreeCAD**



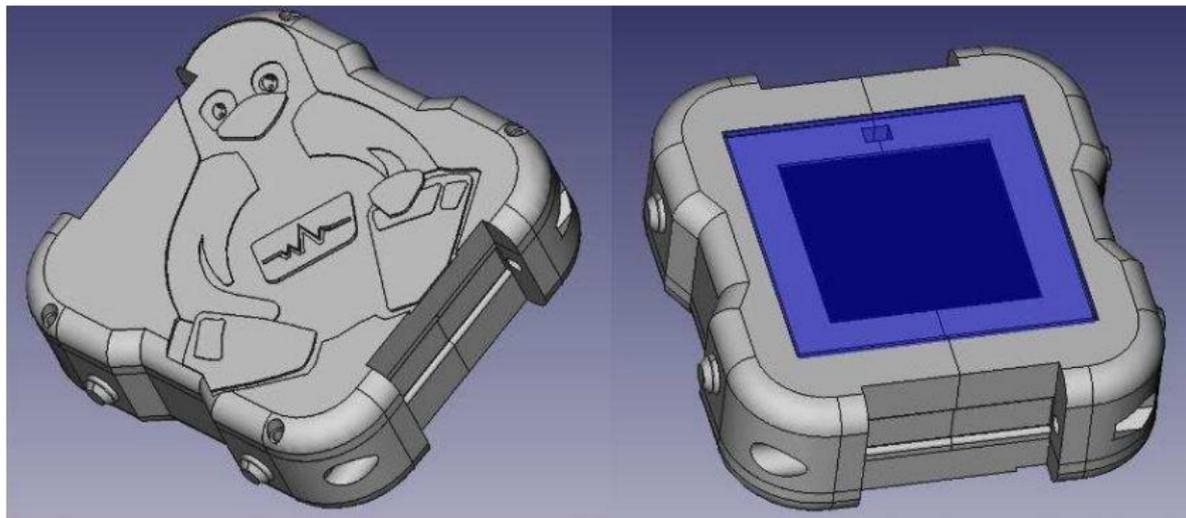
## Full of new challenges

- Learn FreeCAD from scratch
- Design a watch case
- 3D print it

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It's time for a live demo!



Making of movie (6 hours summarised in 5 minutes)

<http://www.ohwr.org/projects/f-watch/wiki/Movies>

- Fused plastic material - Low-cost 3D printer



**Poor resolution, not good enough**

- Plastic material (powder)



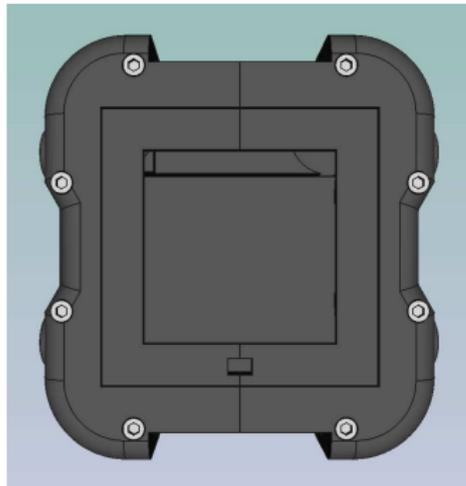
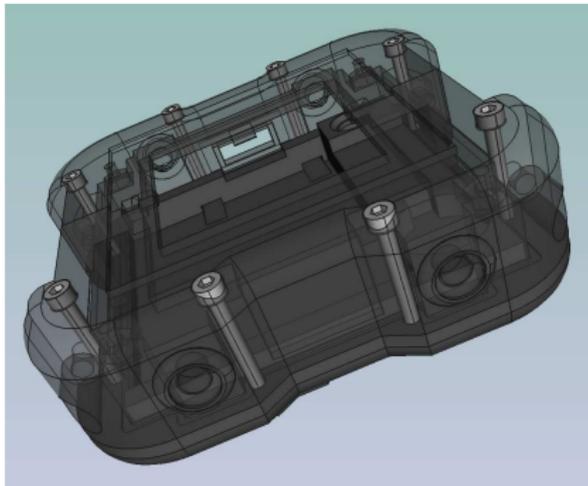
**Good resolution, but not smooth, not water-proof**

- Resin material

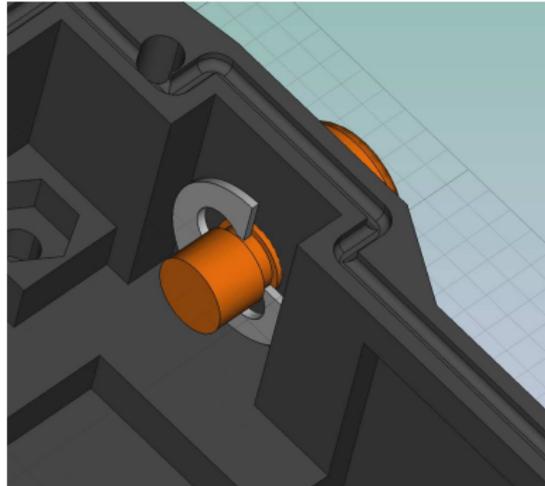
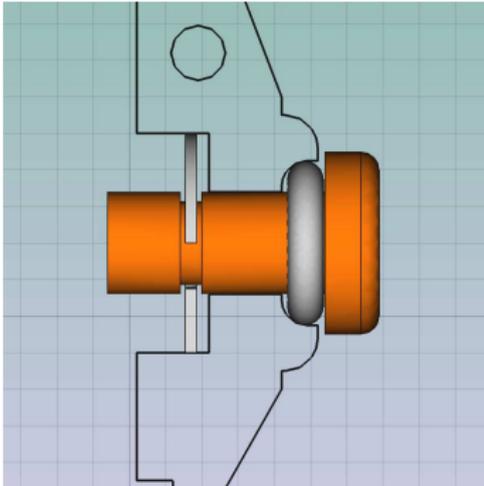


**Smooth, water-proof, but bad fastening**

- Resin material
- Improved case parts fastening



## The buttons



# Building the watch

- Buy electronics/mechanical components
- Download circuit Gerber files and order PCB
- Assemble the board
- Download case/button models and order 3D print
- Buy/build a programmer (bootloader)
- Optional: Milling machine (Plexiglas)



## Software

- Download sources from the GIT repo
- No binary releases (yet)
- Compile bootloader and flash it (using a programmer)
- Compile application sw and flash it (using the bootloader)
- Modify, re-flash, test, etc...

```
git://ohwr.org/f-watch.git
```

# How much does it cost?

Estimated cost for small series (without shipping)

	Number of watches		
	1	10	50
Pcb + components	175 €	94 €	81 €
Pcb assembly	-	118 €	67 €
Case + buttons + screws	68 €	67 €	61 €
<b>TOTAL per watch</b>	<b>243 €</b>	<b>278 €</b>	<b>209 €</b>
<b>TOTAL</b>	<b>243 €</b>	<b>2'784 €</b>	<b>10'455 €</b>

3D print : 60 €

PCB : 77 €

Pressure sensor : 19 €

GPS module : 19 €

Display : 17 €

free and open source software

A lot of integration examples

Well documented

free bootloader provided by SiliconLab

support for IAR, Keil uVision

migrate to gcc toolchain

(don't use gcc optimization!)

	FreeRTOS	uC/OS-III	RTX	TNKernel
License	Mod. GPL	restrictive	BSD	BSD
EFM32	yes	yes	yes	no
USB	no	yes	no	yes
FAT	no	yes	no	yes

## FreeRTOS

- nice documentation
- big community
- a lot of examples

## Keil RTX

- nice documentation
- community?
- few examples

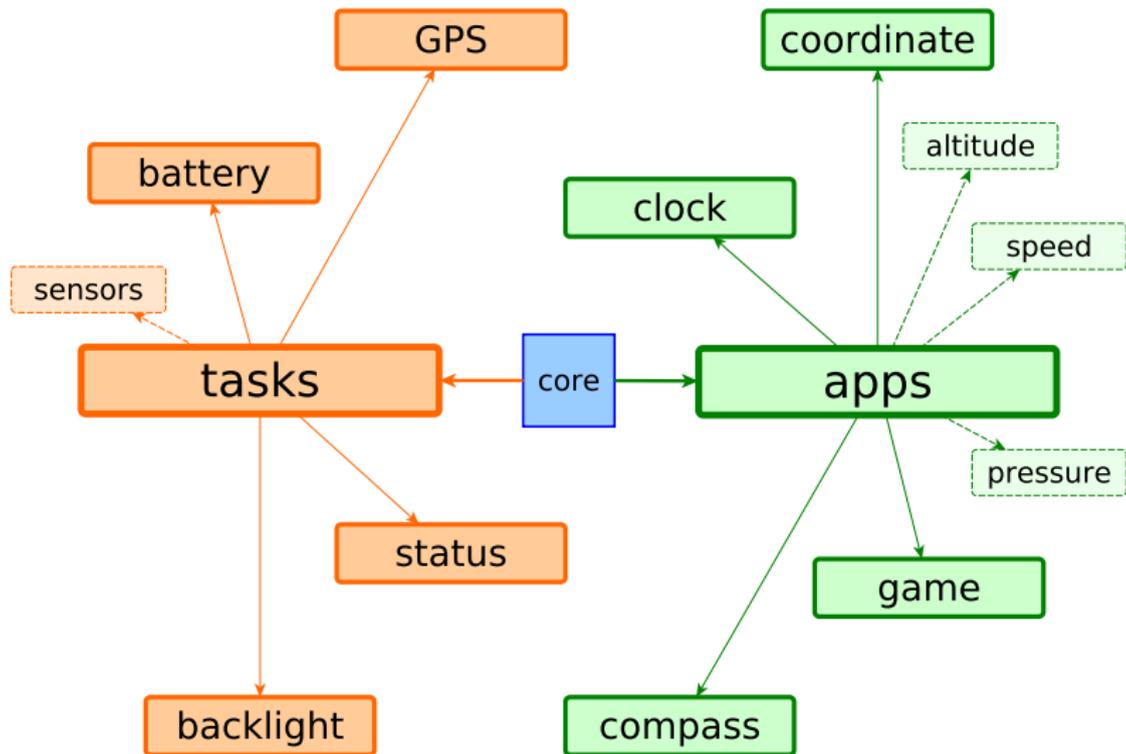
tiny 2D graphic library

adapt the library to our screen

## Features

- write text
- draw simple geometry and icons
- event management

# Applications





Applications demonstration video

[www.ohwr.org/projects/f-watch/wiki](http://www.ohwr.org/projects/f-watch/wiki)

- how to configure your machine
- how to write applications
- details about the project

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**free** development  
for  
**free** products

# Free Development Needs Free Tools



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How difficult can it be?

Competitive free tools

Specialized company in 3D printing

Specialized company in PCB manufacturing

Easy to ship everywhere

Free products are real

cars, robots, watches, bikes, houses, phones, ...

3D Metal printers

# What can it be?





Not a real product

Make it a good example

Join the project