

simple spectro

<http://github.com/hackuarium/simple-spectro>

<http://www.hackuarium.ch>

oceane@patiny.com

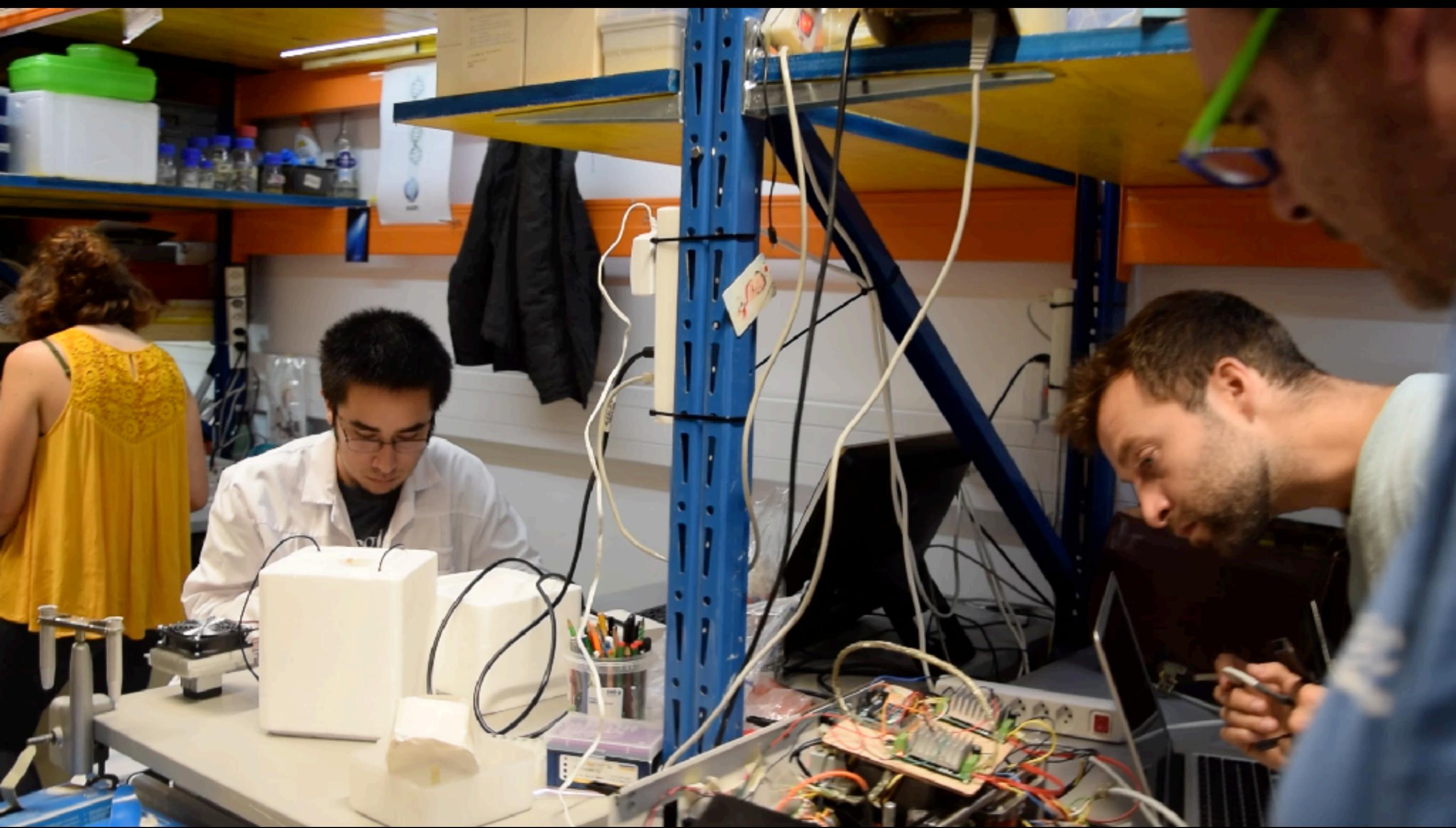
florian@patiny.com

luc@patiny.com

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DIX biology

Do It Together biology
and more ...

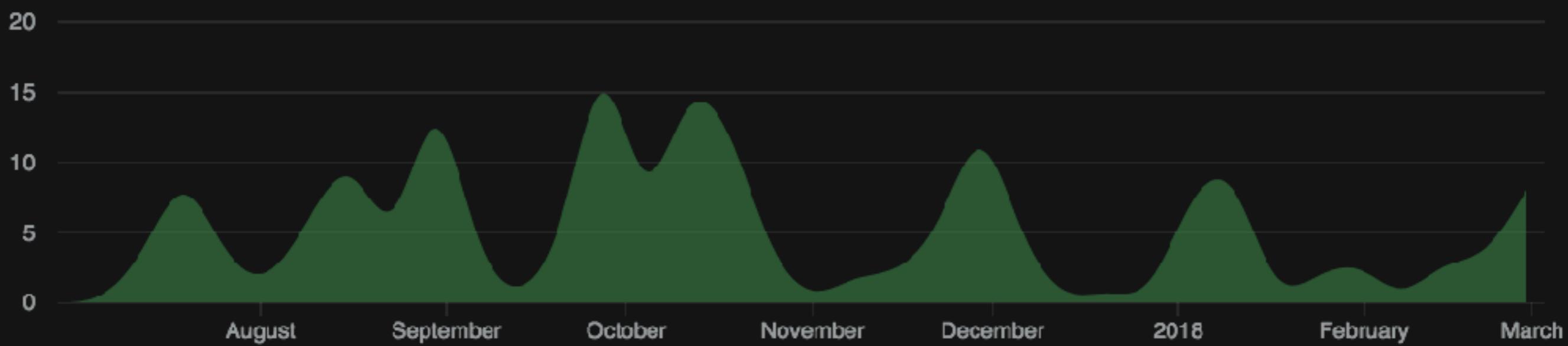
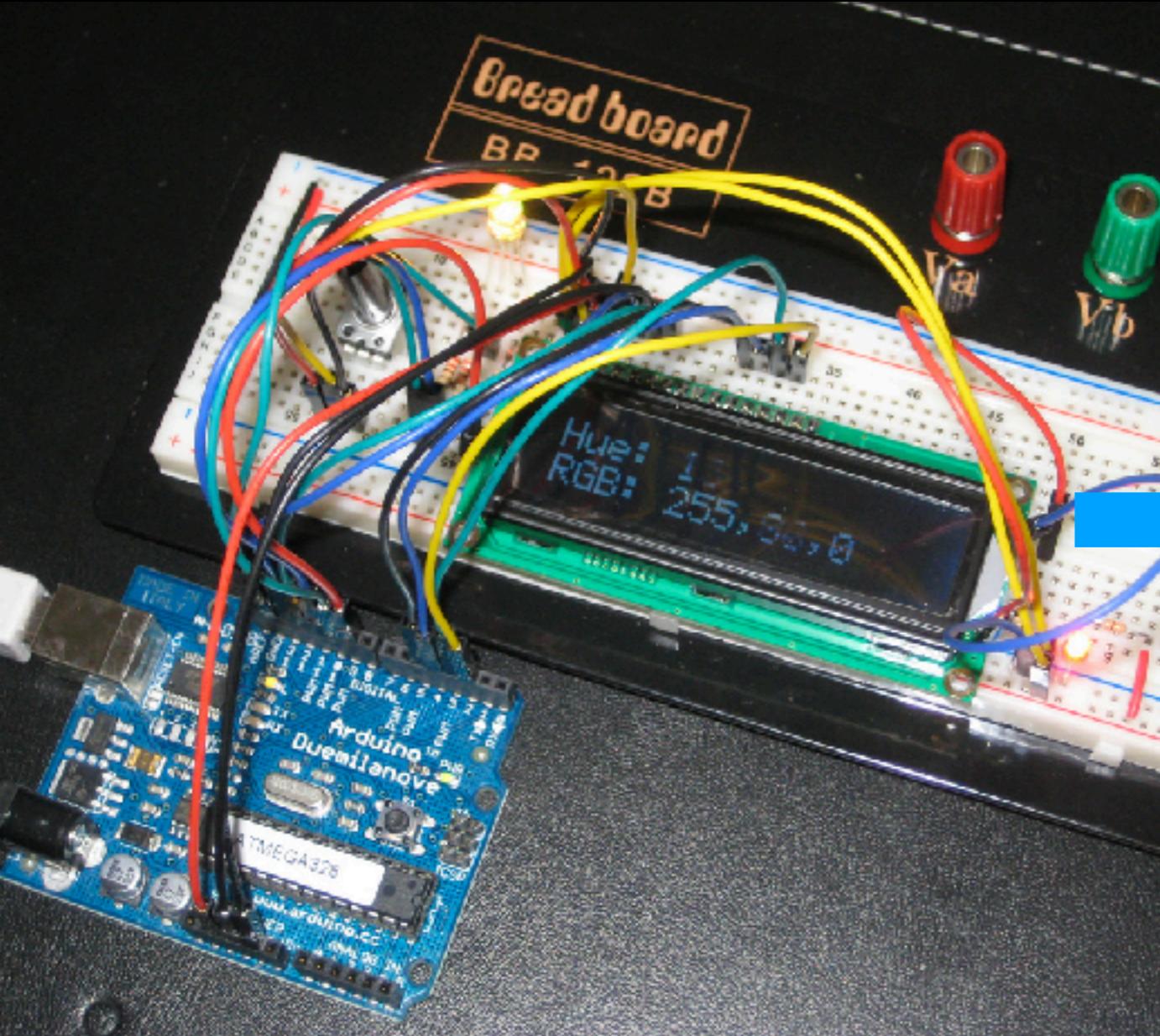
Meet us every Wednesday evening, 7.30pm-10.30pm

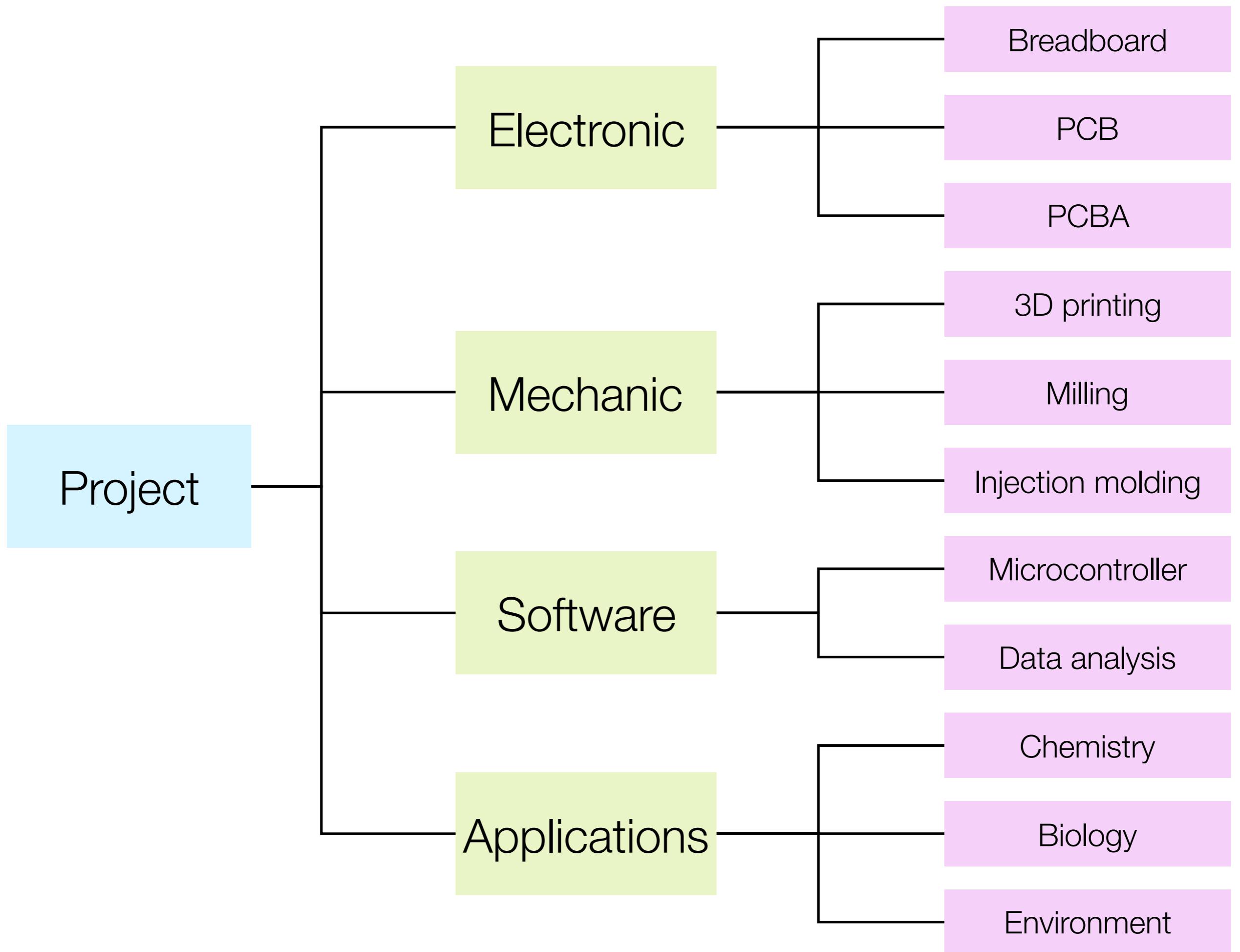
www.hackuarium.ch

UNIVERCITÉ



@Hackuarium



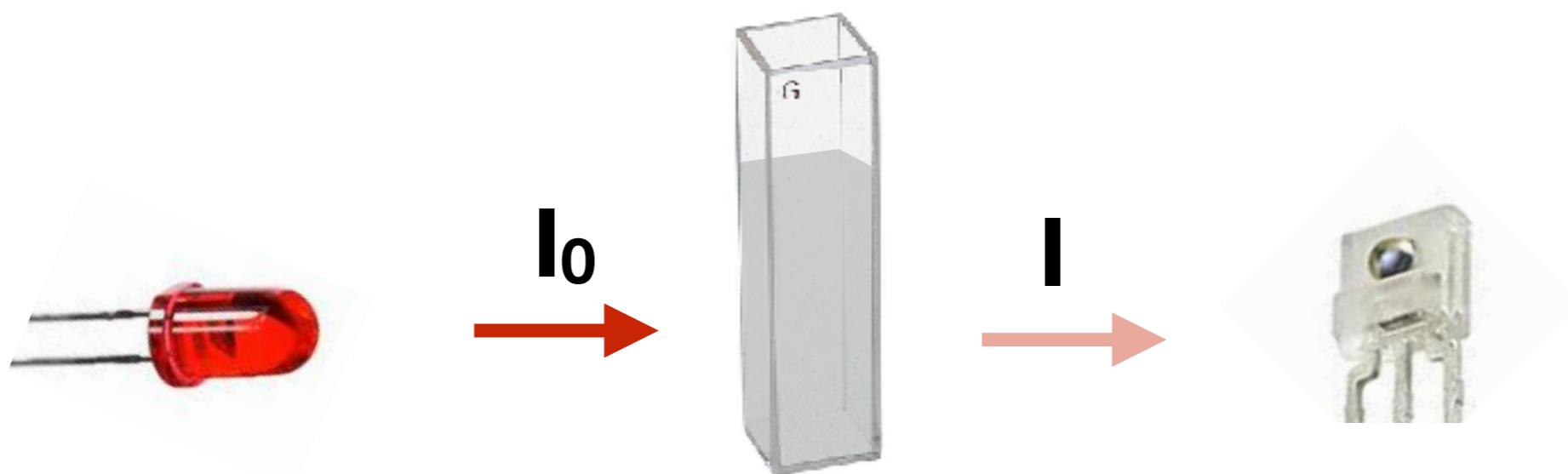


Agenda

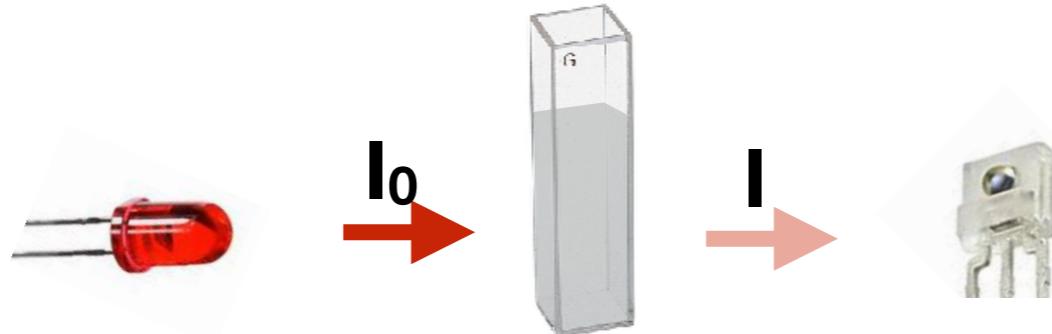
- 1. General overview**
- 2. Electronics**
- 3. Mechanics**
- 4. Programming**
- 5. Experiments**

General overview

Spectrophotometer ?



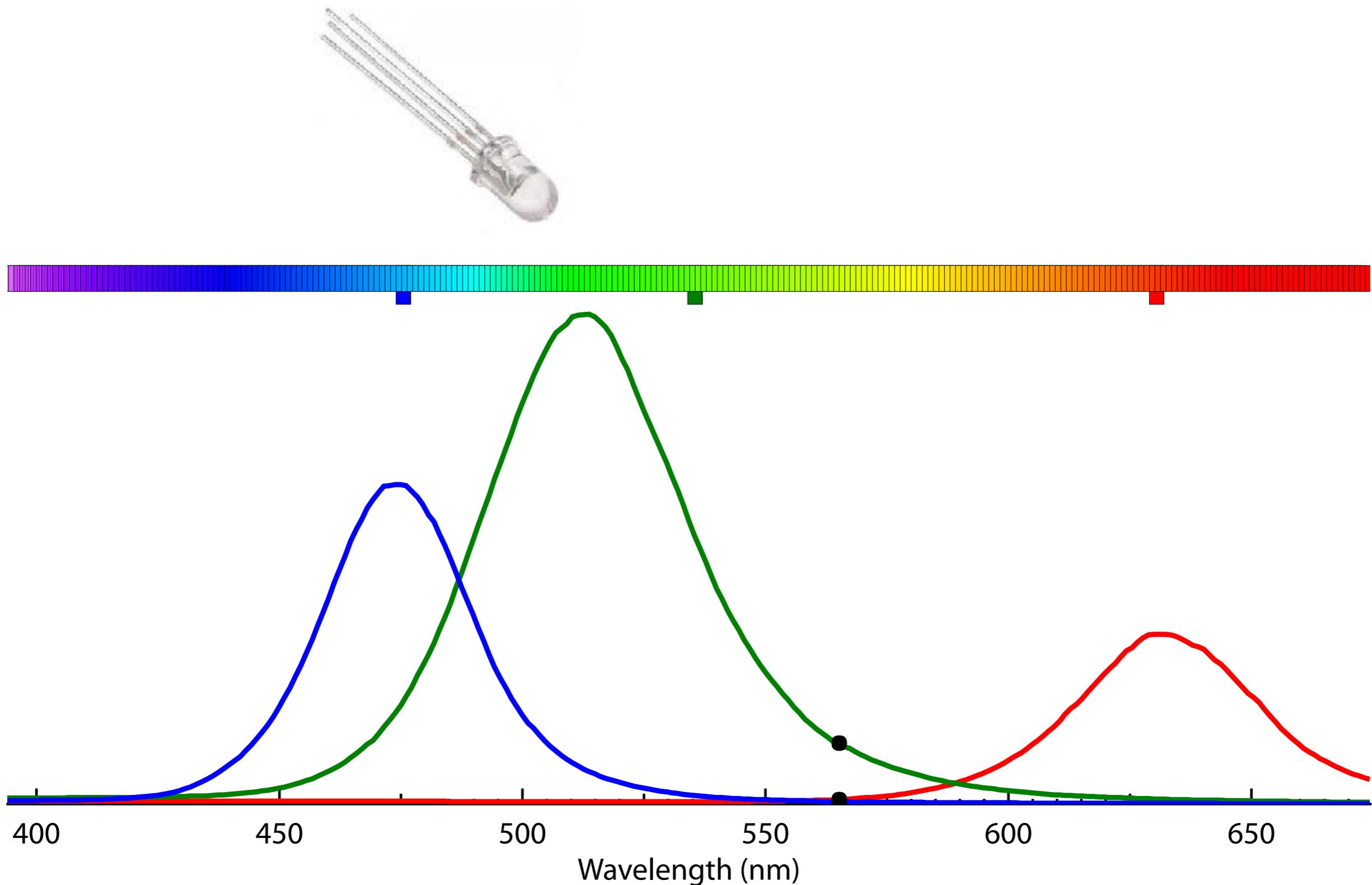
Beer-Lambert law

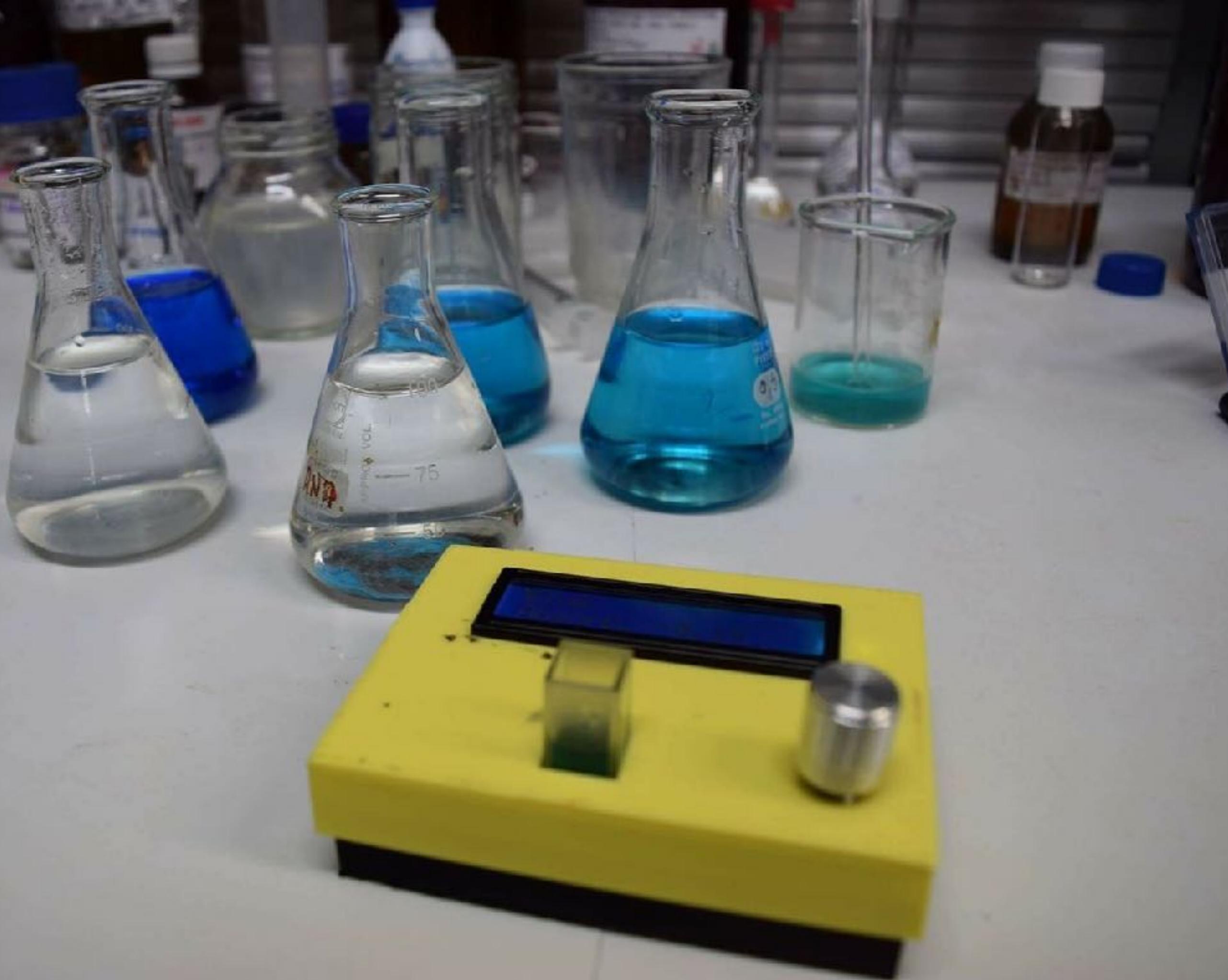


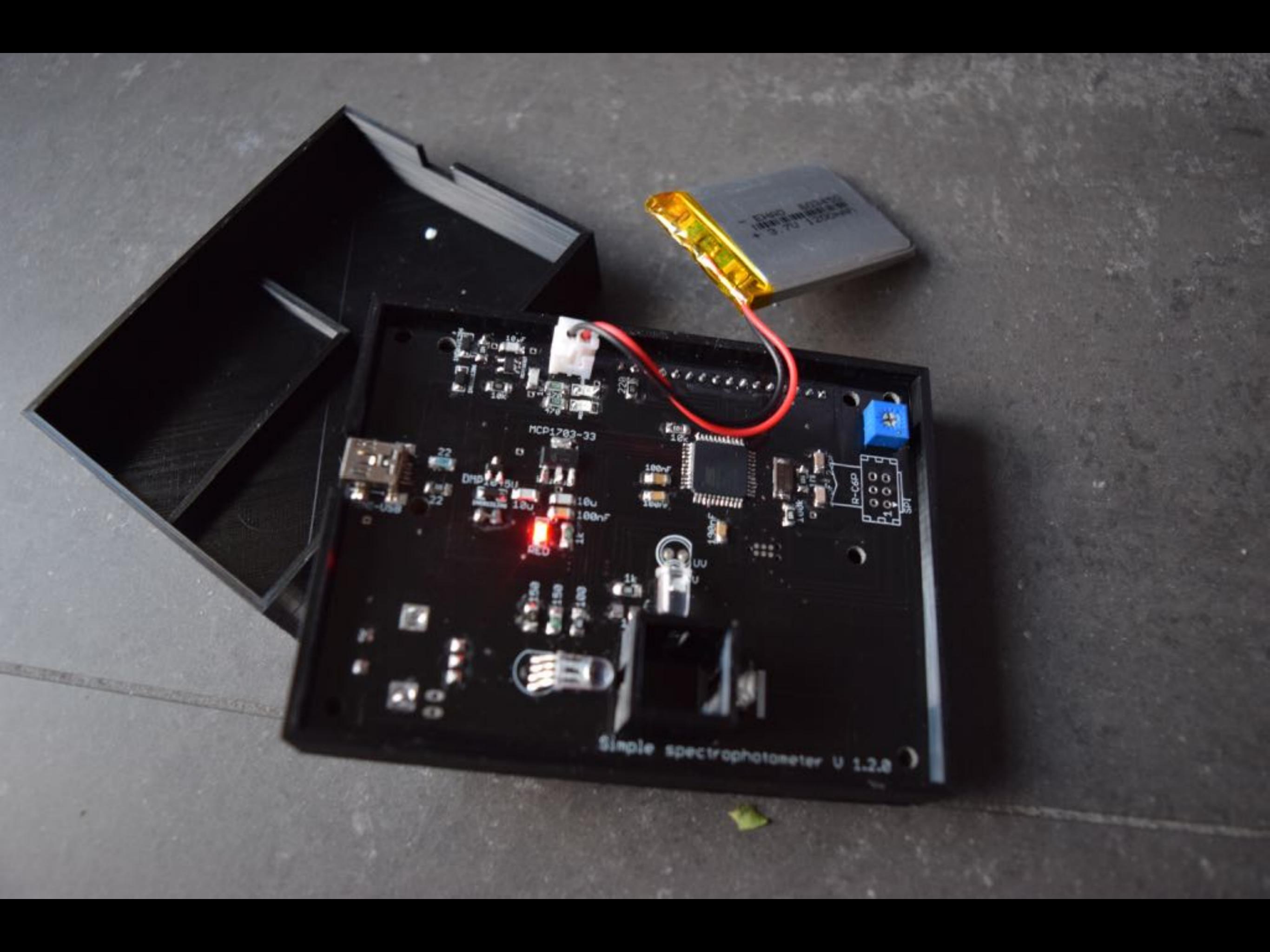
$$A = - \log (T) = - \log (I / I_0) = \epsilon L c$$

- A: absorbance
- T: transmittance
- I_0 : intensity of the light
- I: intensity of the light after the cell
- L: length of the cell
- c: concentration (M)
- ϵ : molar attenuation coefficient

RGB led ?







Single spectrophotometer V 1.2.0

1.*Acquire
2. Kinetic

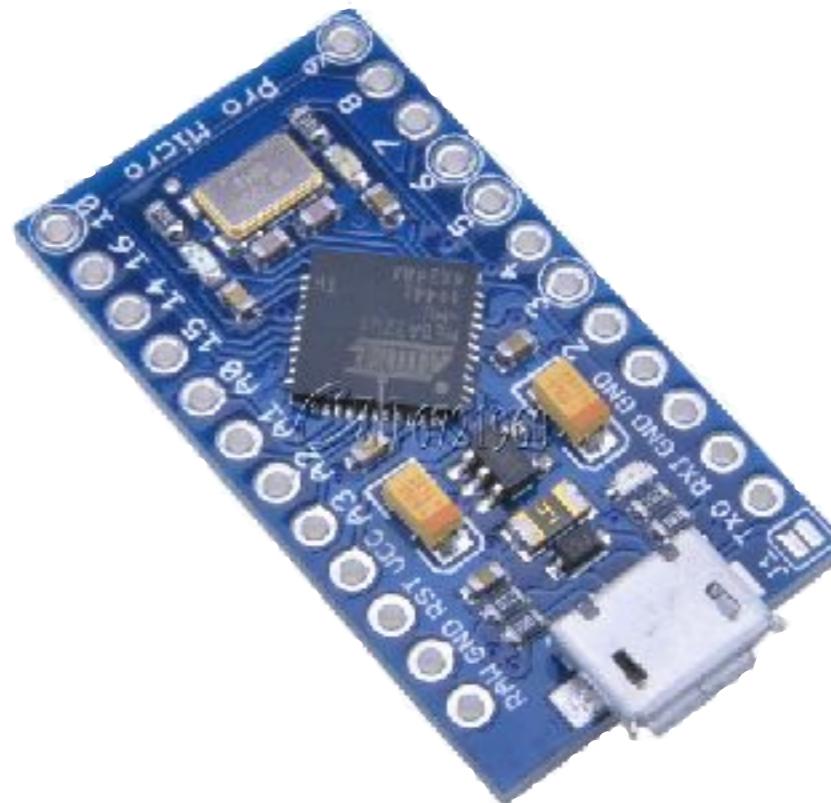
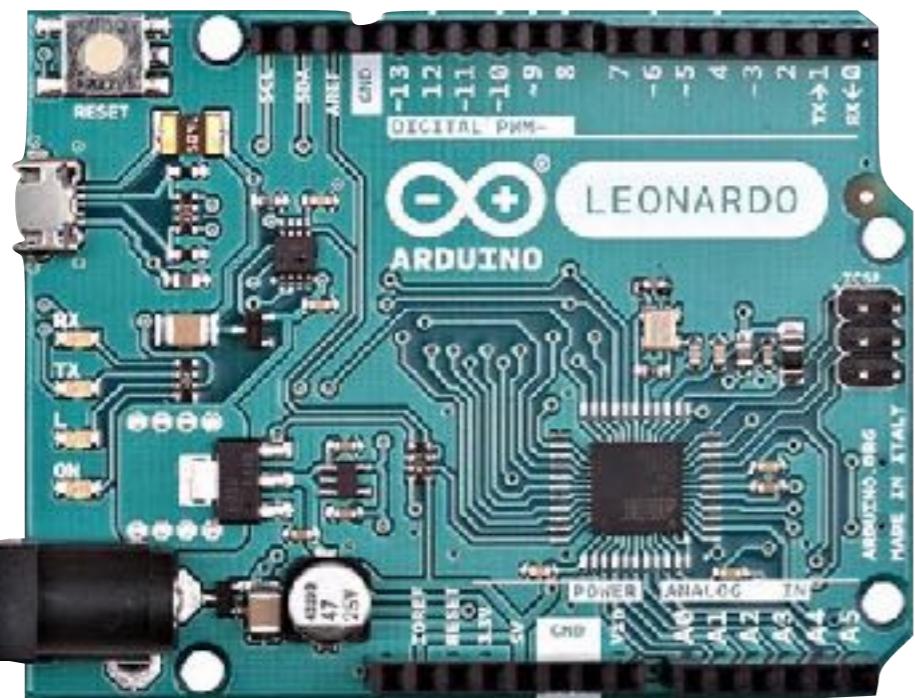


Electronics

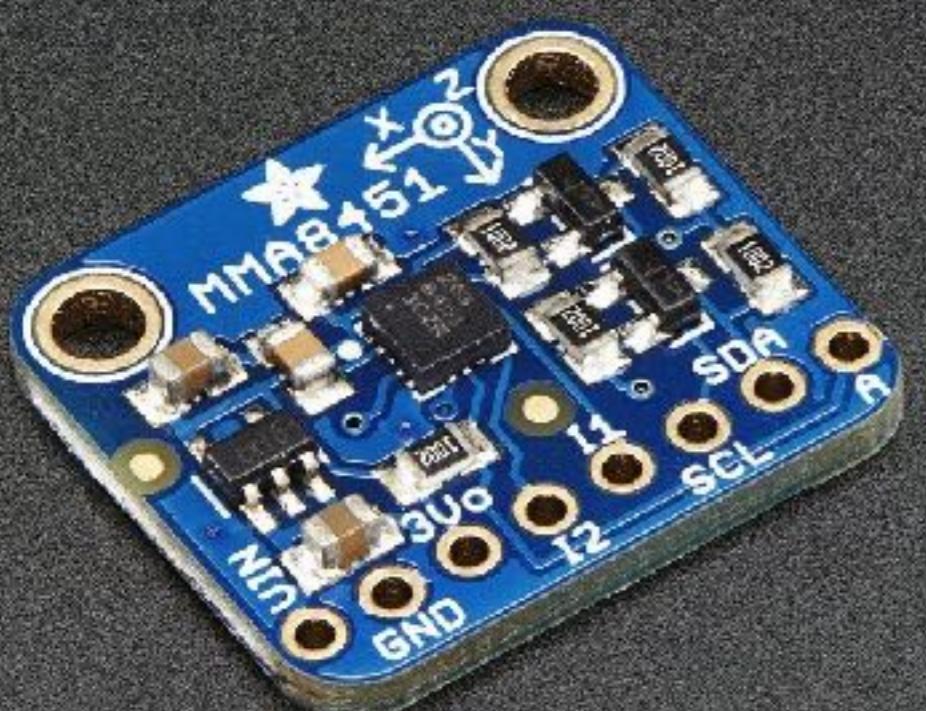
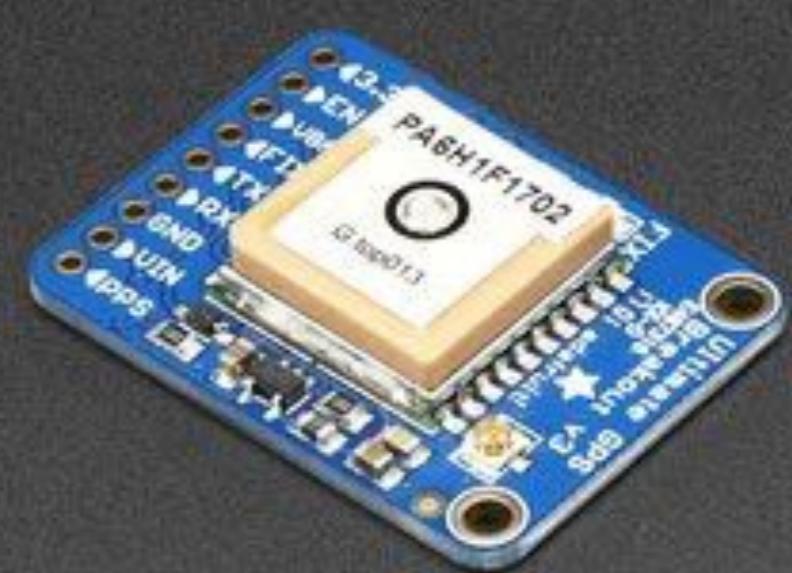
Arduino ...

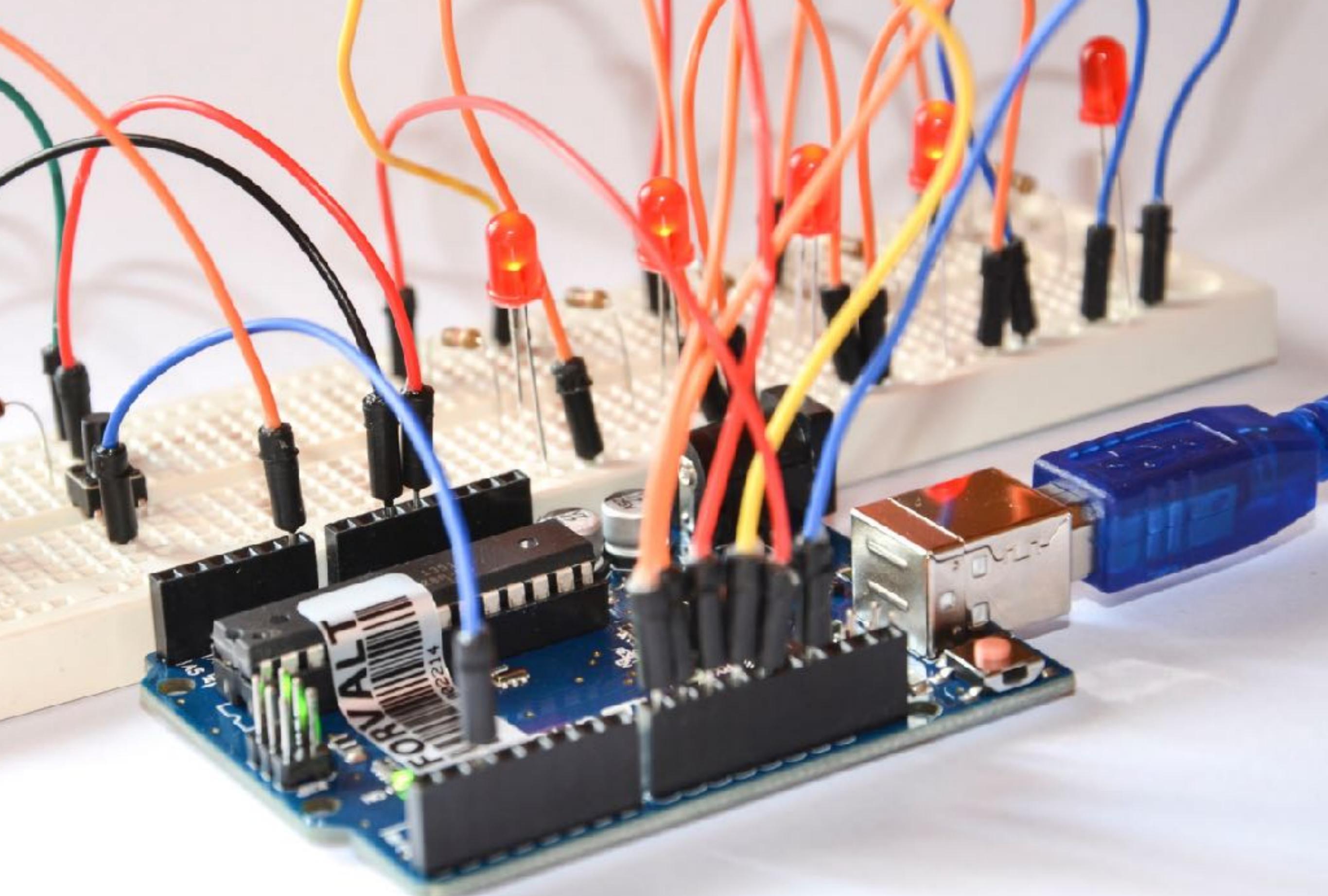
Classical approach

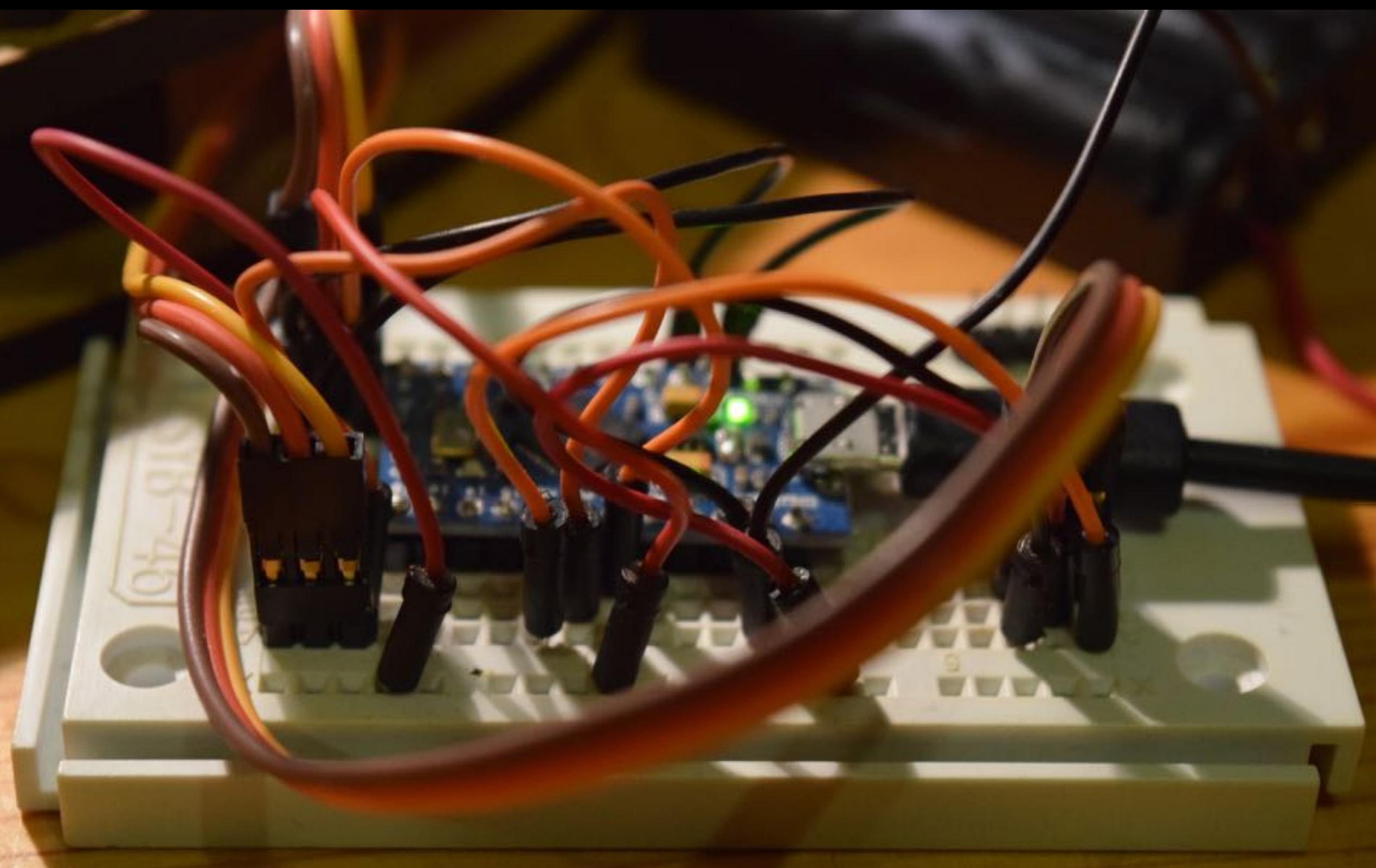
Arduino platform



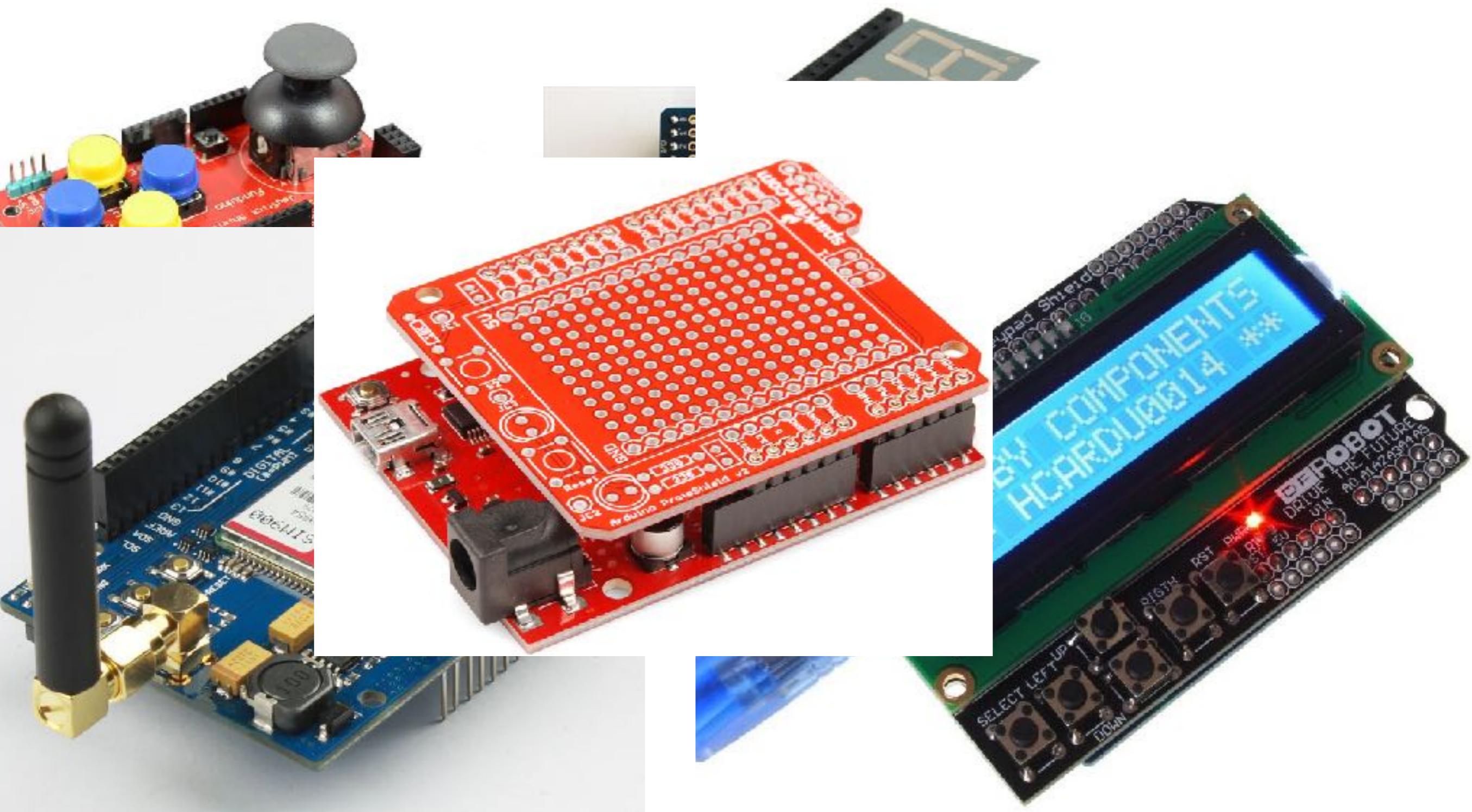
<https://www.adafruit.com/?q=breakout>



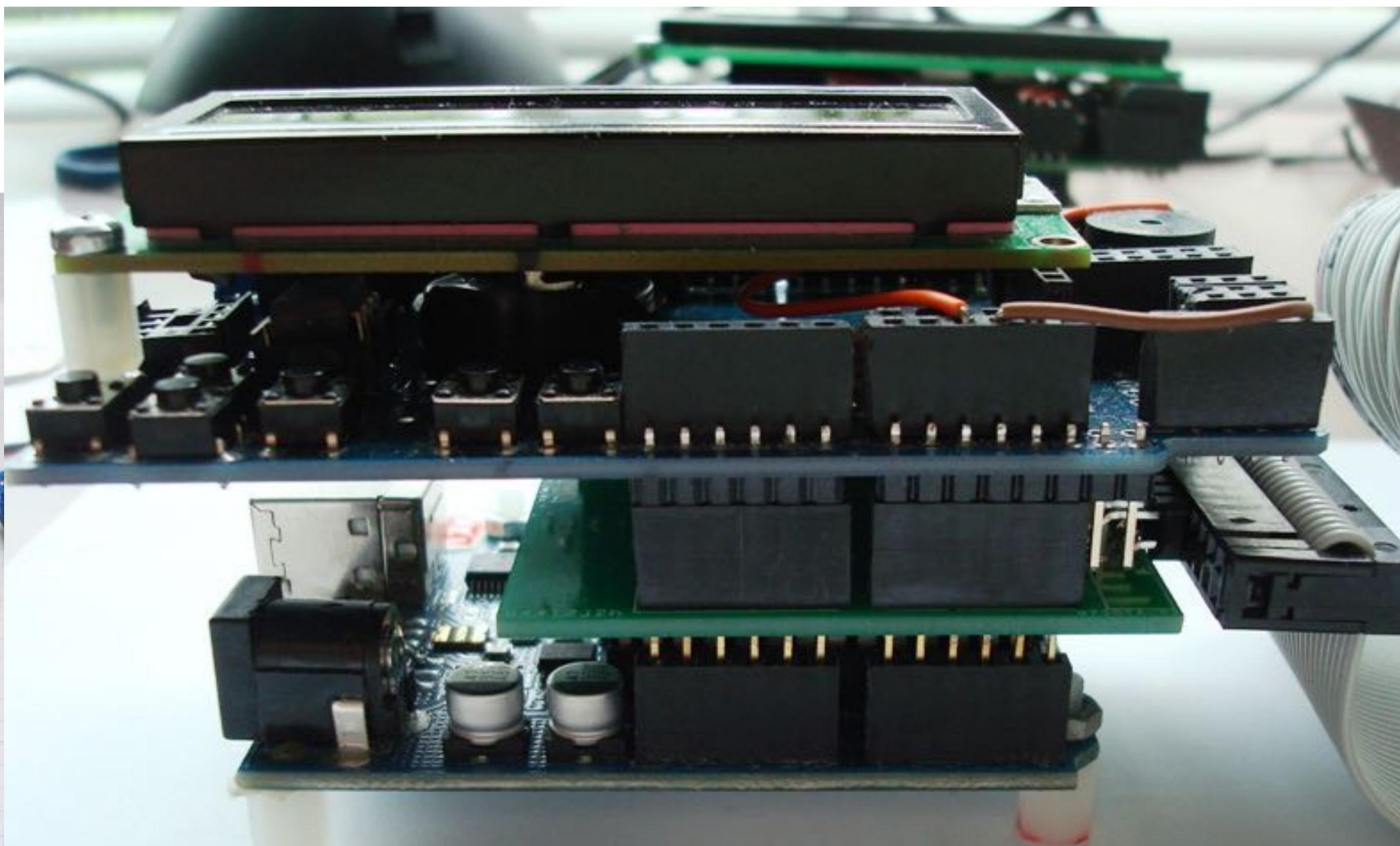




A solution : use of shields



May become a little bit complex ...

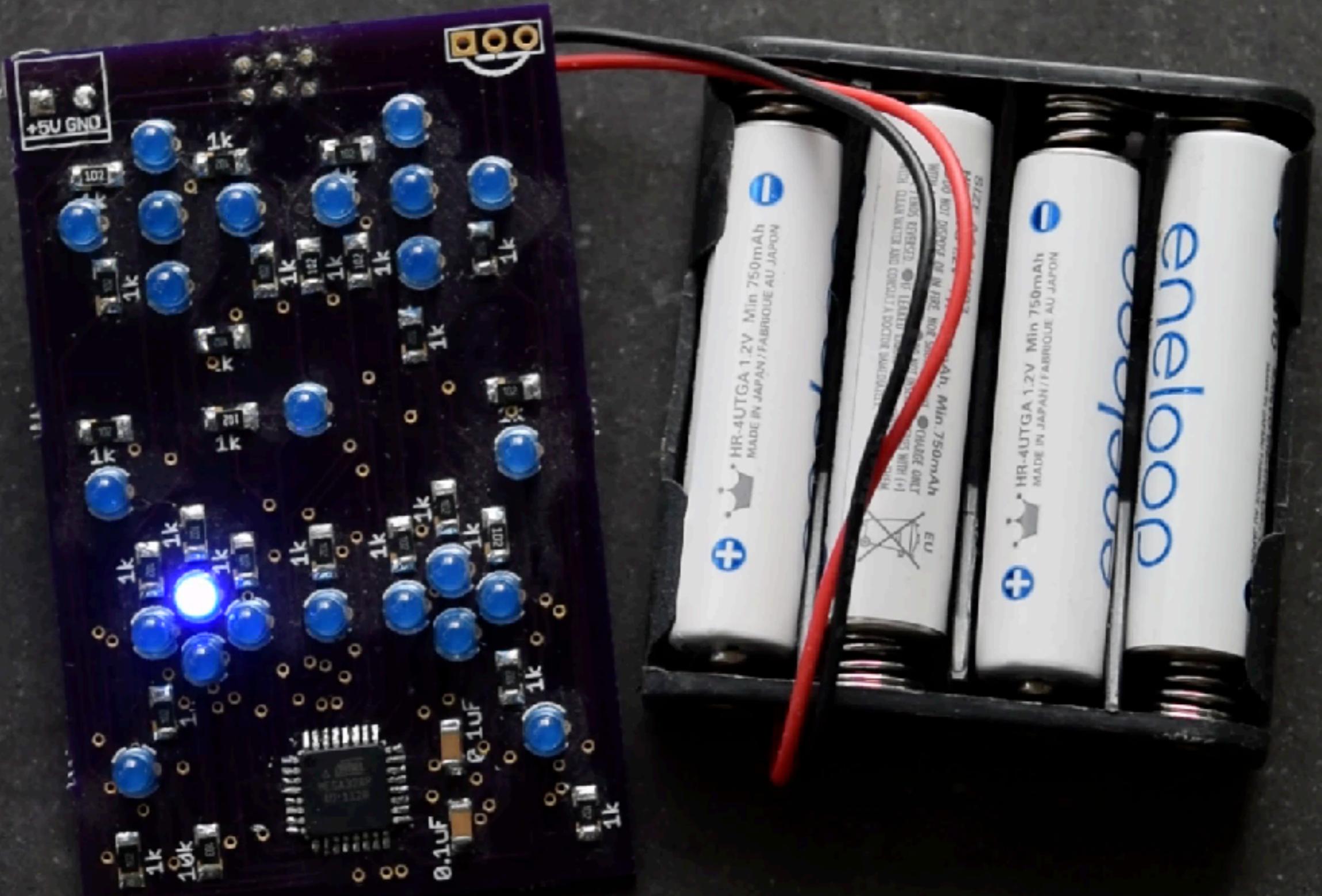


We tried this approach

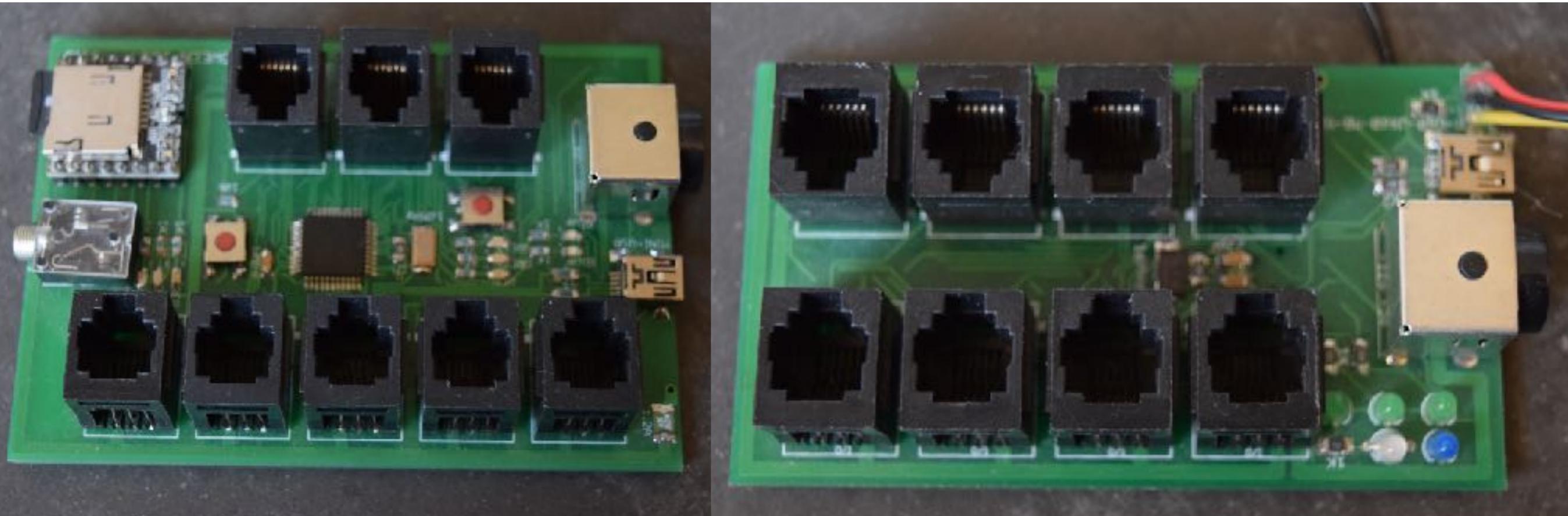
- **Arduino MEGA**
- **Extensions board for halloween decoration**
- **"This is what is need for my bioreactor"**



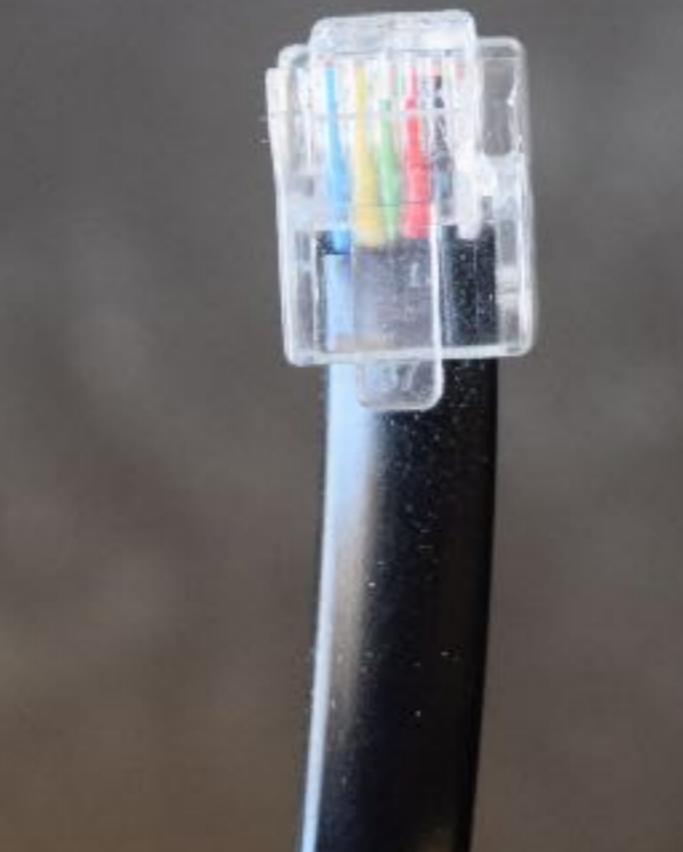
Can we make our own Arduino ?



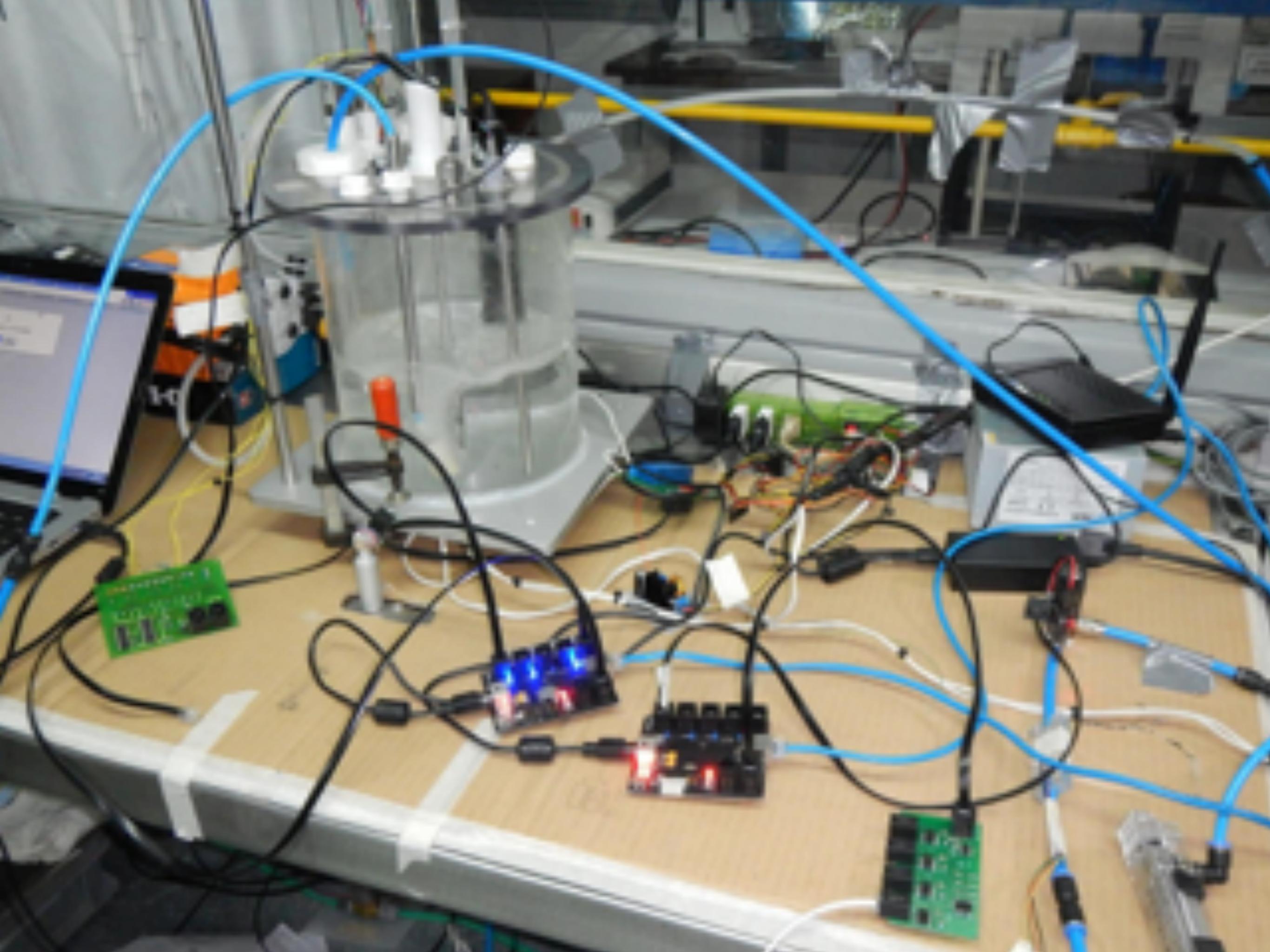
Legoino : master board

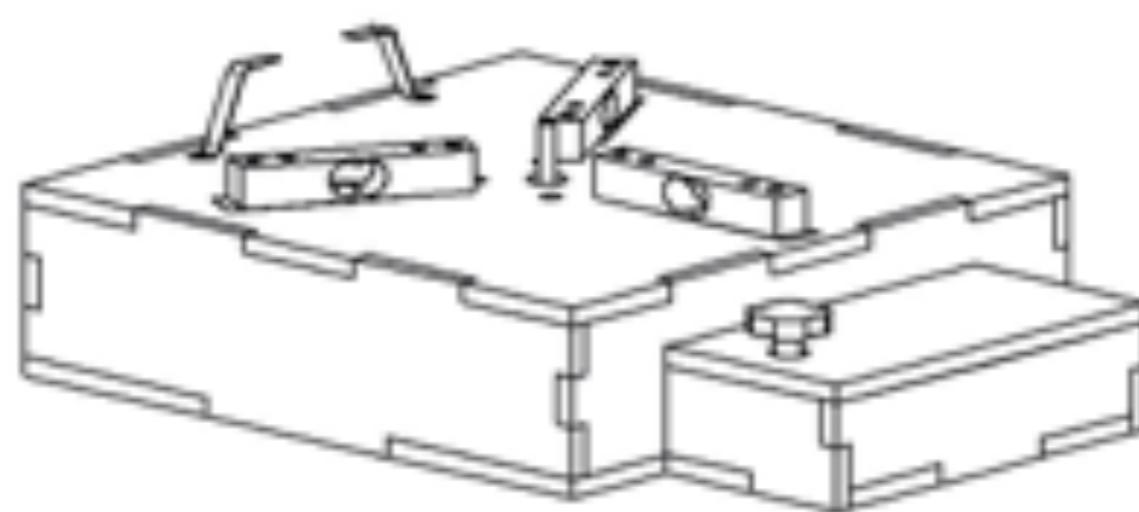
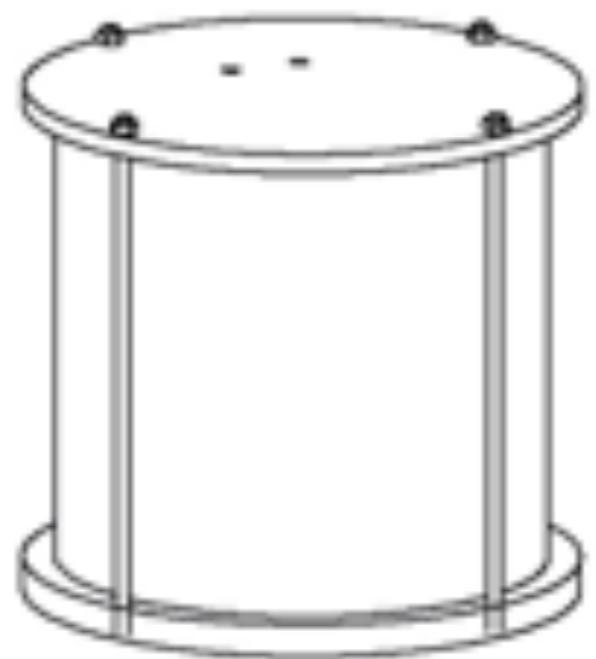


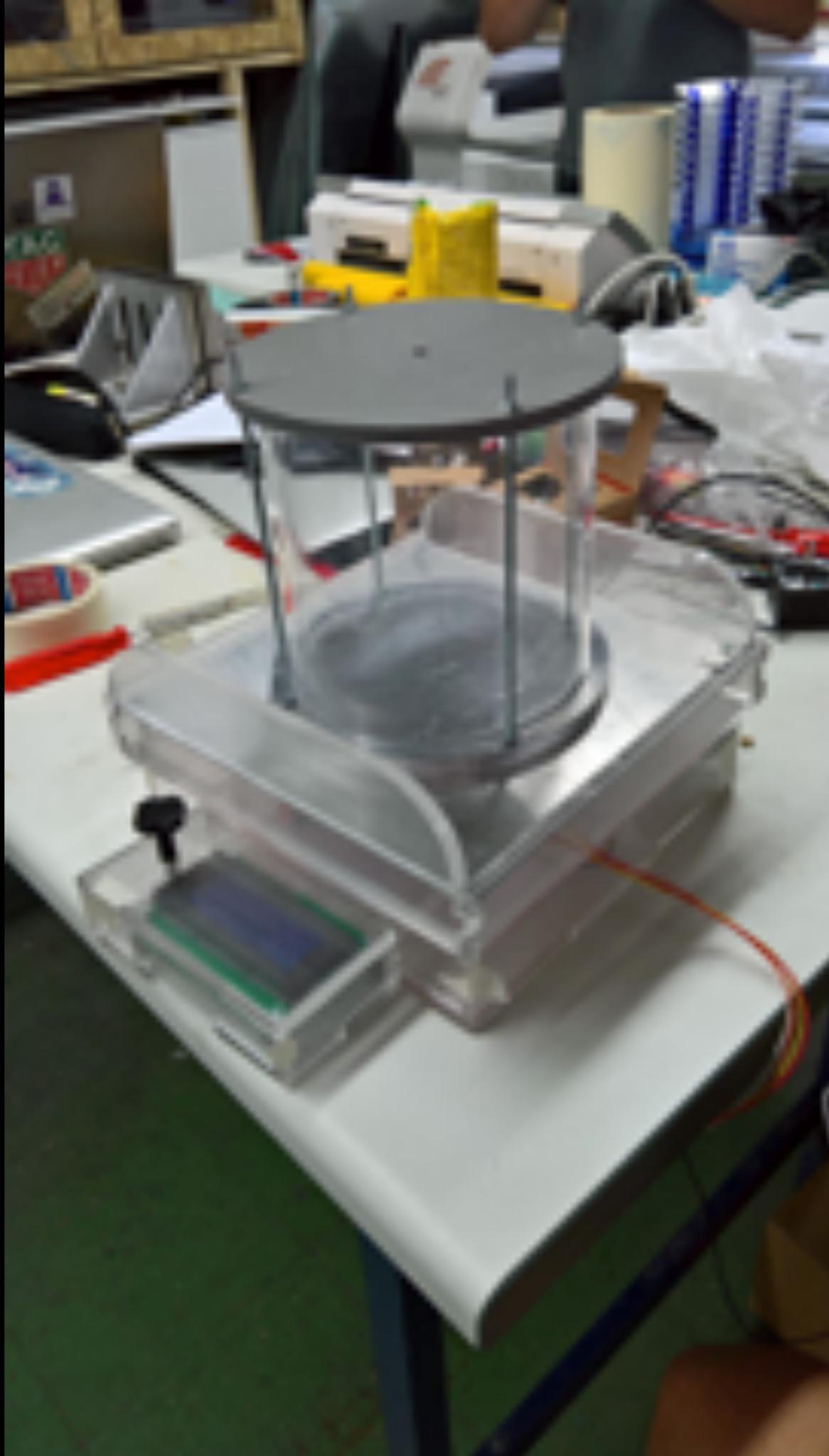
Legoino : extensions











Arduino Leonardo

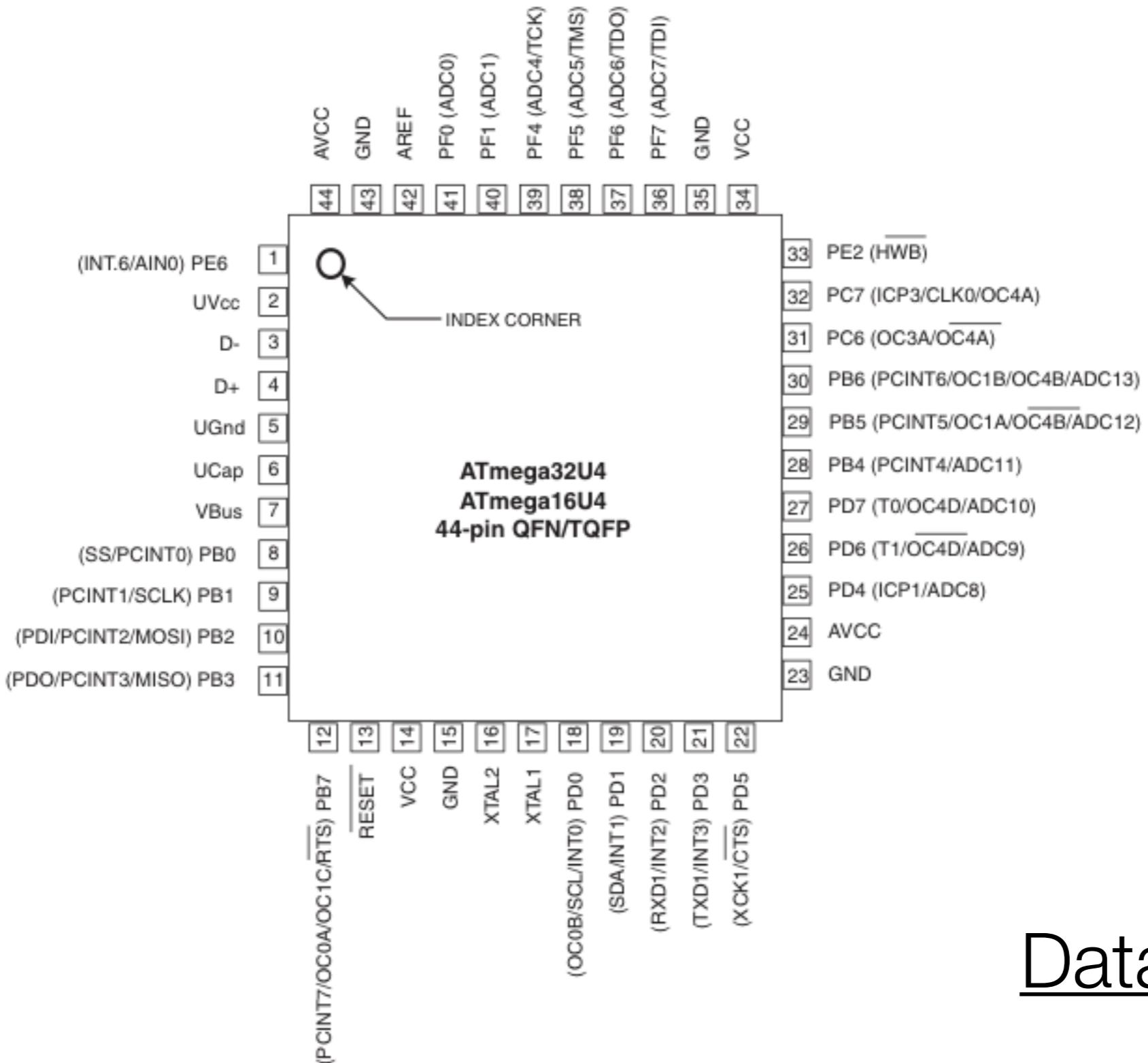
Arduino platform



Microcontroller : ATMEGA32U4

- **32 kb of programmable flash memory**
- **2.5 kb SRAM (Static random-access memory)**
- **1 kb EEPROM (Electrically Erasable Programmable Read-Only Memory)**
- **Operating voltage: 2.7v to 5.5V**
- **8 (min 2.7V) / 16 (min 4.5V) MHz**
- **26 I/O, 12 x 10bits ADC**
- **USART, I2C, USB, SPI**
- **2 x 16bits Timer / Counter**
- **4 x PWM 16 bits, 6 x PWM 11 bits**

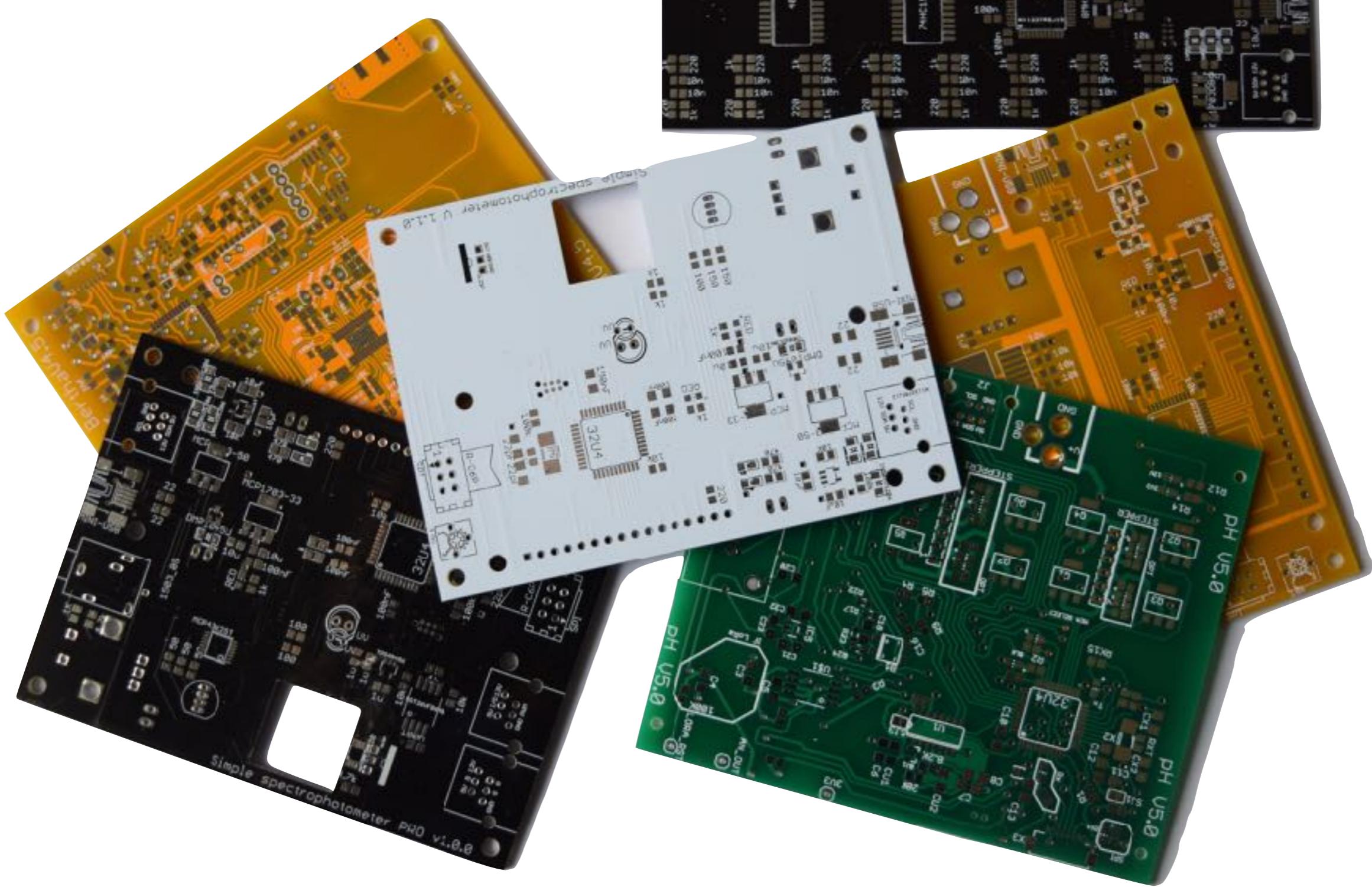
Microcontroller : ATMEGA32U4



Datasheet

Making your own PCB

www.pcbway.com - www.seedstudio.com



PCB production

- \$5 for 5 to 10 PCBs 10x10cm
- + shipping ... \$10 to \$25
- Numerous suppliers
 - <http://www.pcbway.com> (currently my preferred one)
 - <http://www.seedstudio.com>
 - <http://www.elecrow.com>
 - <https://oshpark.com> - \$5 for 3 per square inch
- You need Gerber Files



www.pcbway.com

To:Luc Patiny
From: PCBWay.com

NO:G118393
Date:11/27/2017

| | |
|------------------|------------------------------------------------------|
| Recipient Buyer | Luc Patiny |
| Contact | Luc Patiny |
| Shipping address | ruelle des Châtaigniers 5, DENGES, 1026, SWITZERLAND |
| Tel | +41 78 909 84 68 |
| Email | luc@patiny.com |
| Payment method | PayPal |
| Shipping method | DHL |

Order Information

| Part No. and description | Size (mm) | Qty | Unit price (USD) | Amount (USD) | Freight cost (USD) | Bank fee (USD) | Discount (USD) | Total (USD) |
|----------------------------------------------------------------------------------------------------------------------------|-----------|-----|------------------|--------------|--------------------|----------------|----------------|-------------|
| Electronic PCB: FR-4 1.6mm 1 oz 2layers Black mask White legend HASL with lead No. : W11337ASJ24 ledDisplay | 92.7*68.6 | 10 | 0.500 | 5.00 | 25.00 | 2.00 | -1.00 | 31.00 |



combine shipping

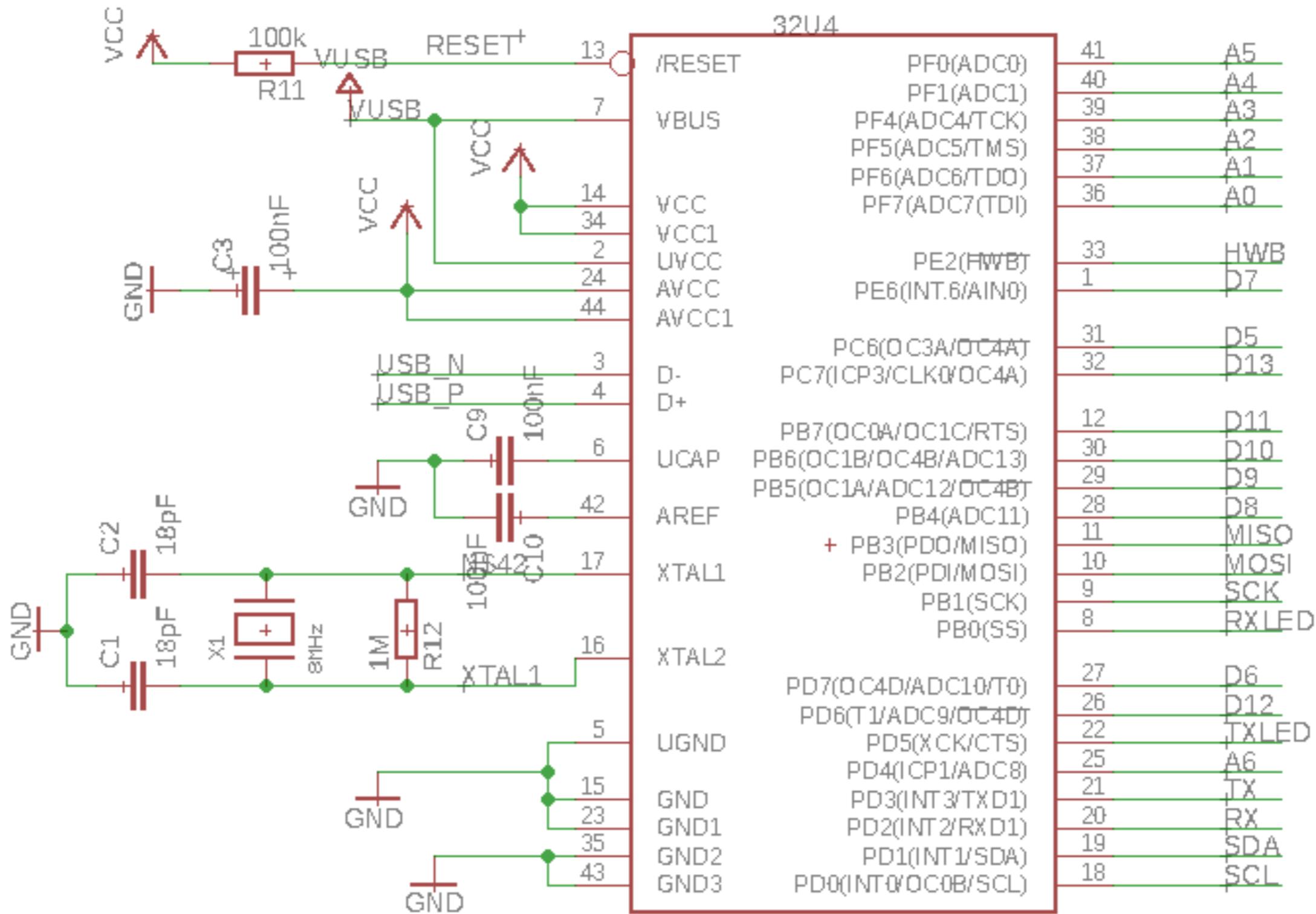
eagle

<https://www.autodesk.com/products/eagle/>

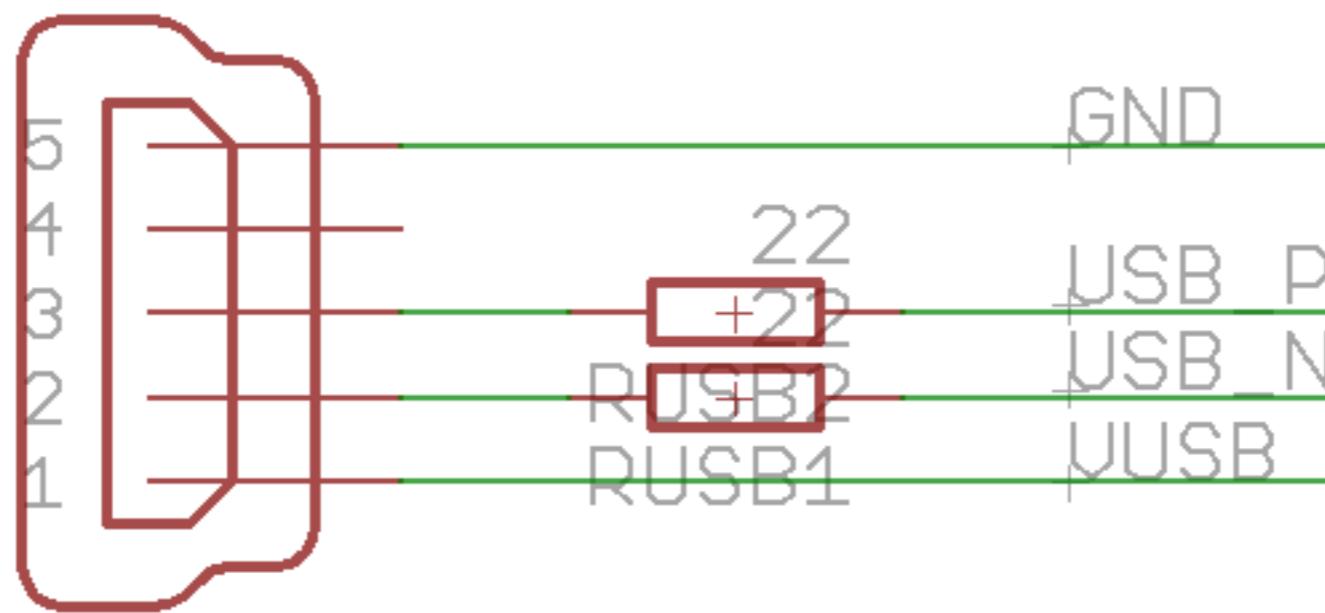
Opensource alternative: KiCad

<http://kicad-pcb.org/>

Schematic

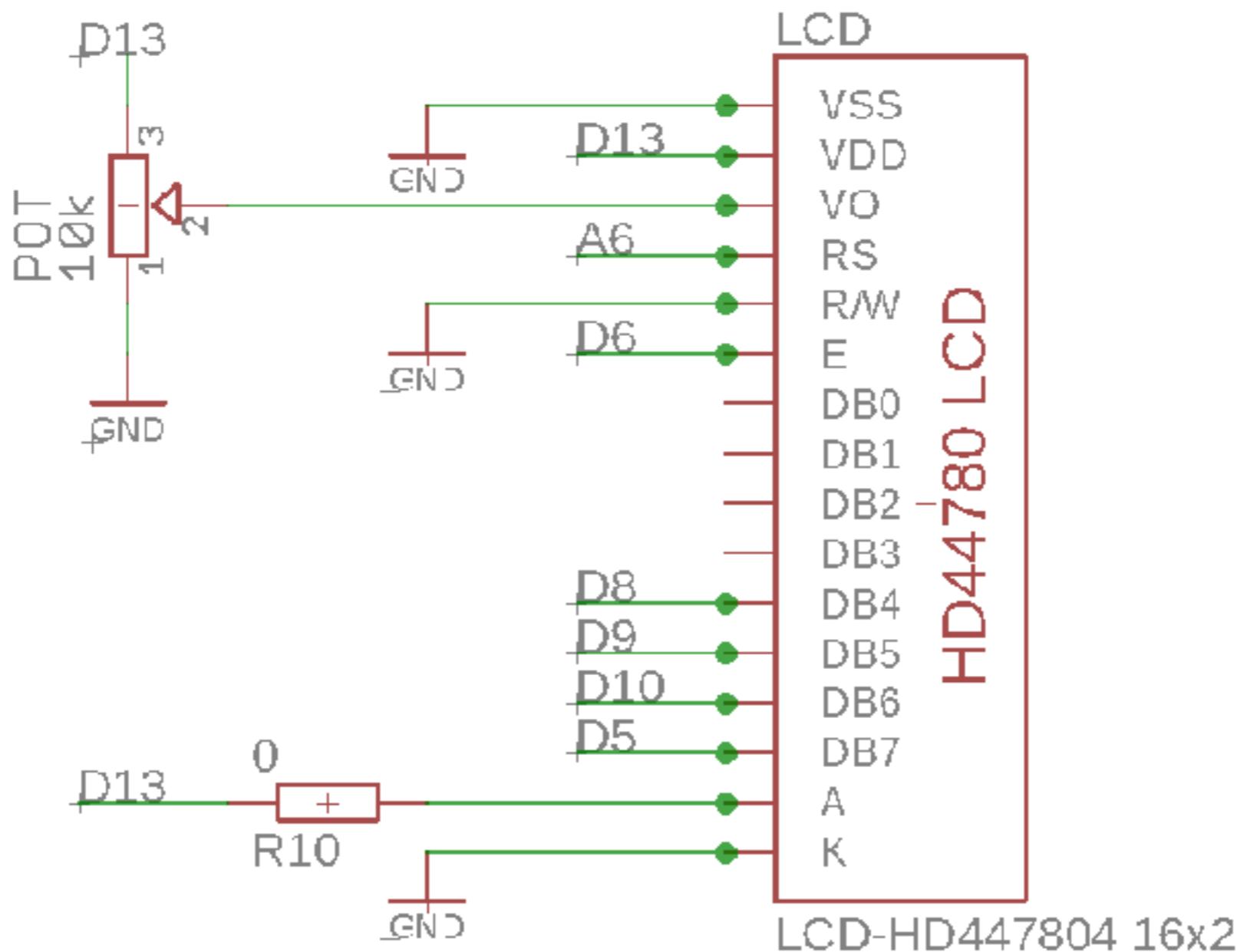


USB

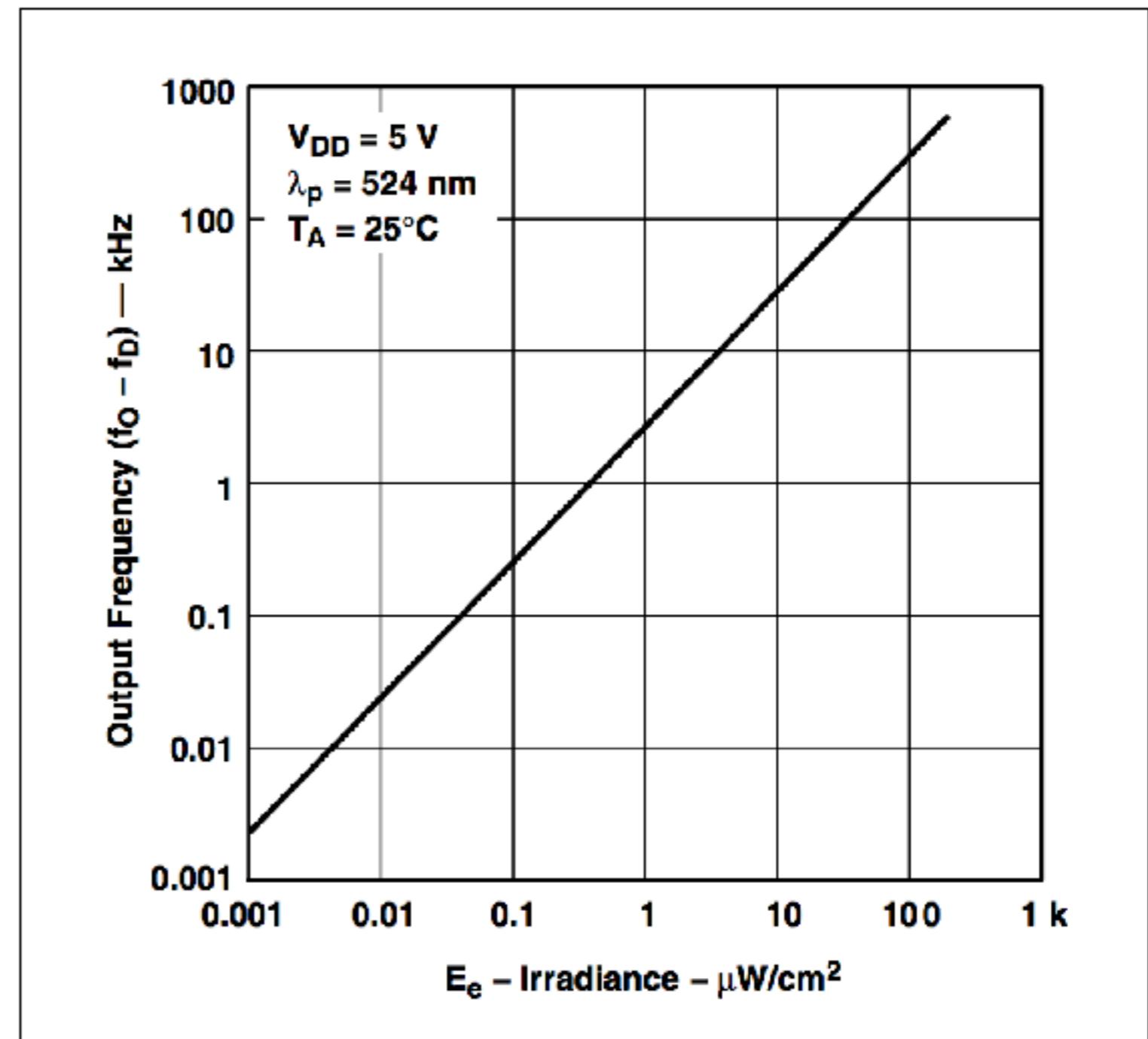
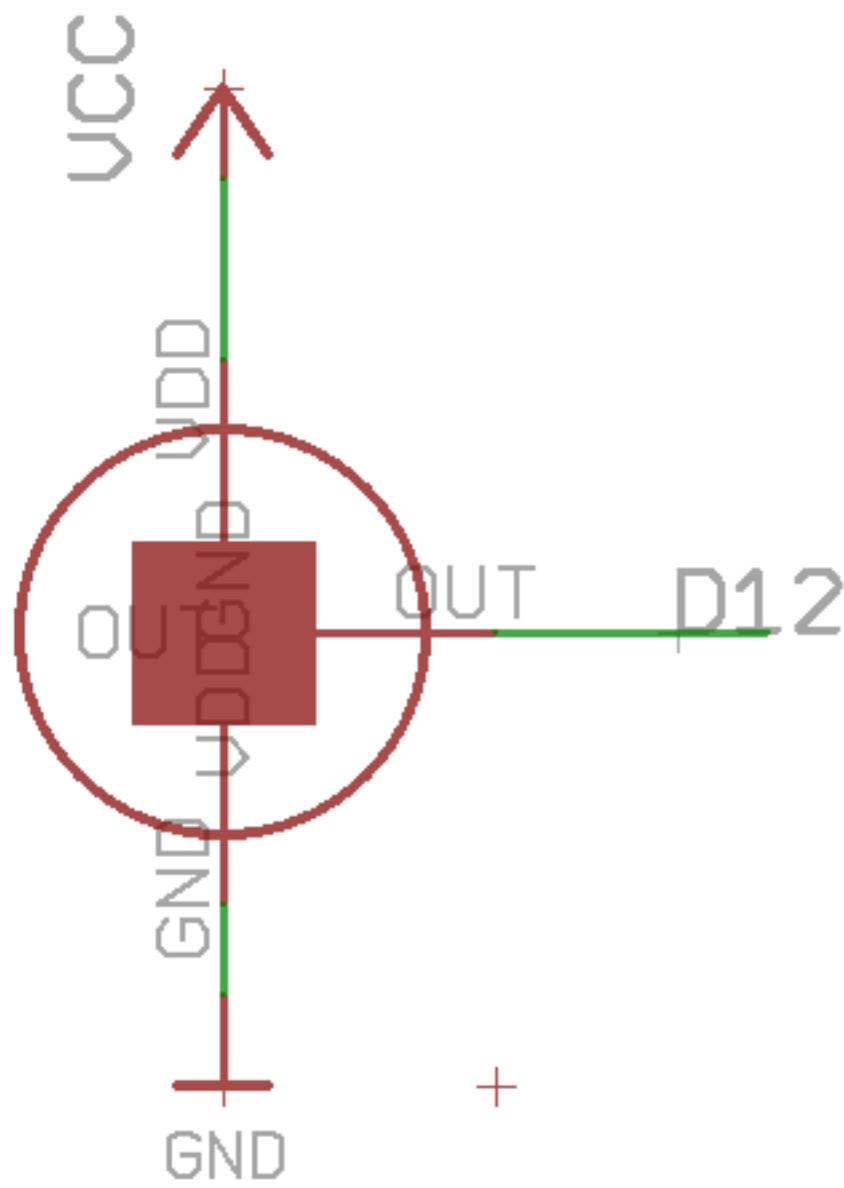


LCD

LCD 16x2



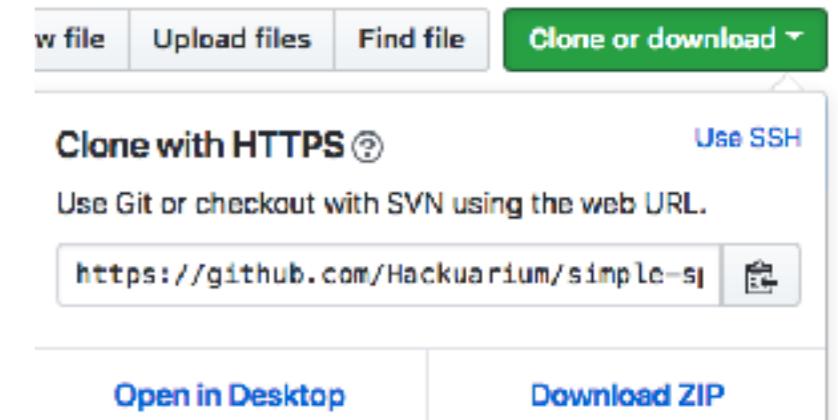
Light to frequency - TSL 237



Exercise

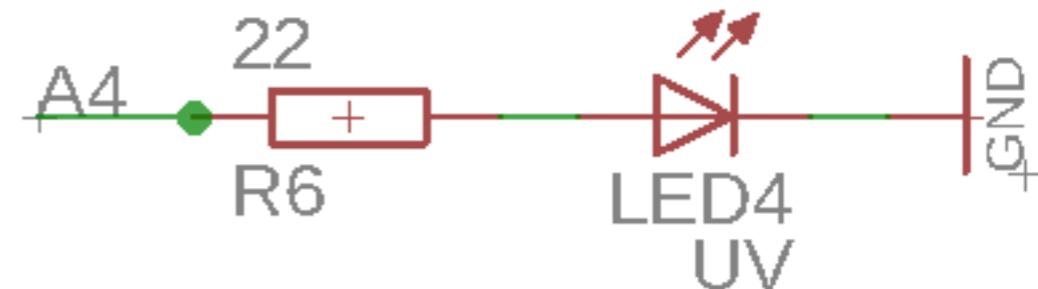
- **Download the project**

- <https://github.com/hackuarium/simple-spectro>

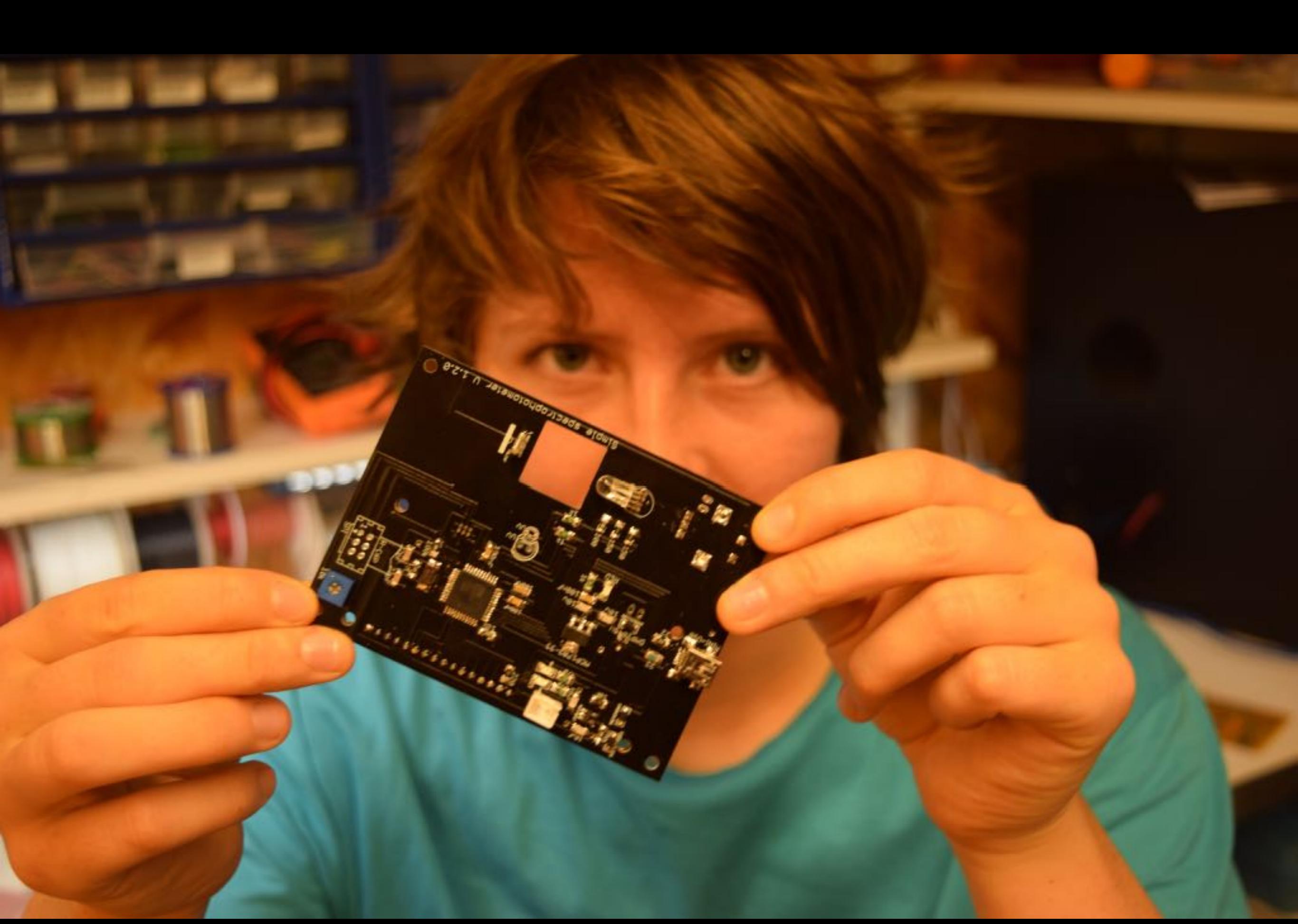


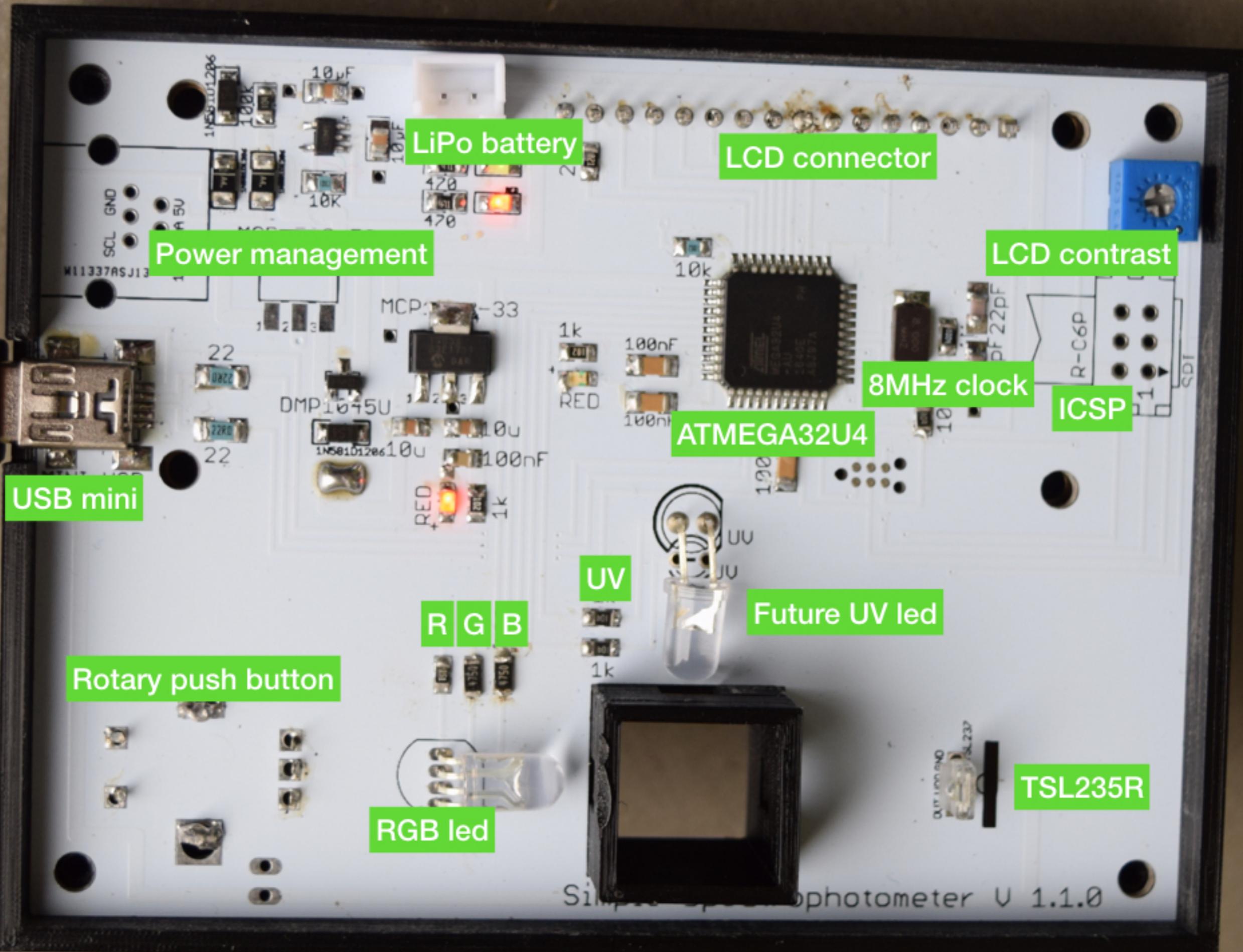
- **In eagle**

- Open Schematic: tutorial/eagle/tutorial.sch
 - Add 3 leds with corresponding resistors on pins A0, A1 and A2
- Board
 - Routing
 - Check
 - Create Gerber files
 - Check Gerber : <https://gerber-viewer.eeasyeda.com/>

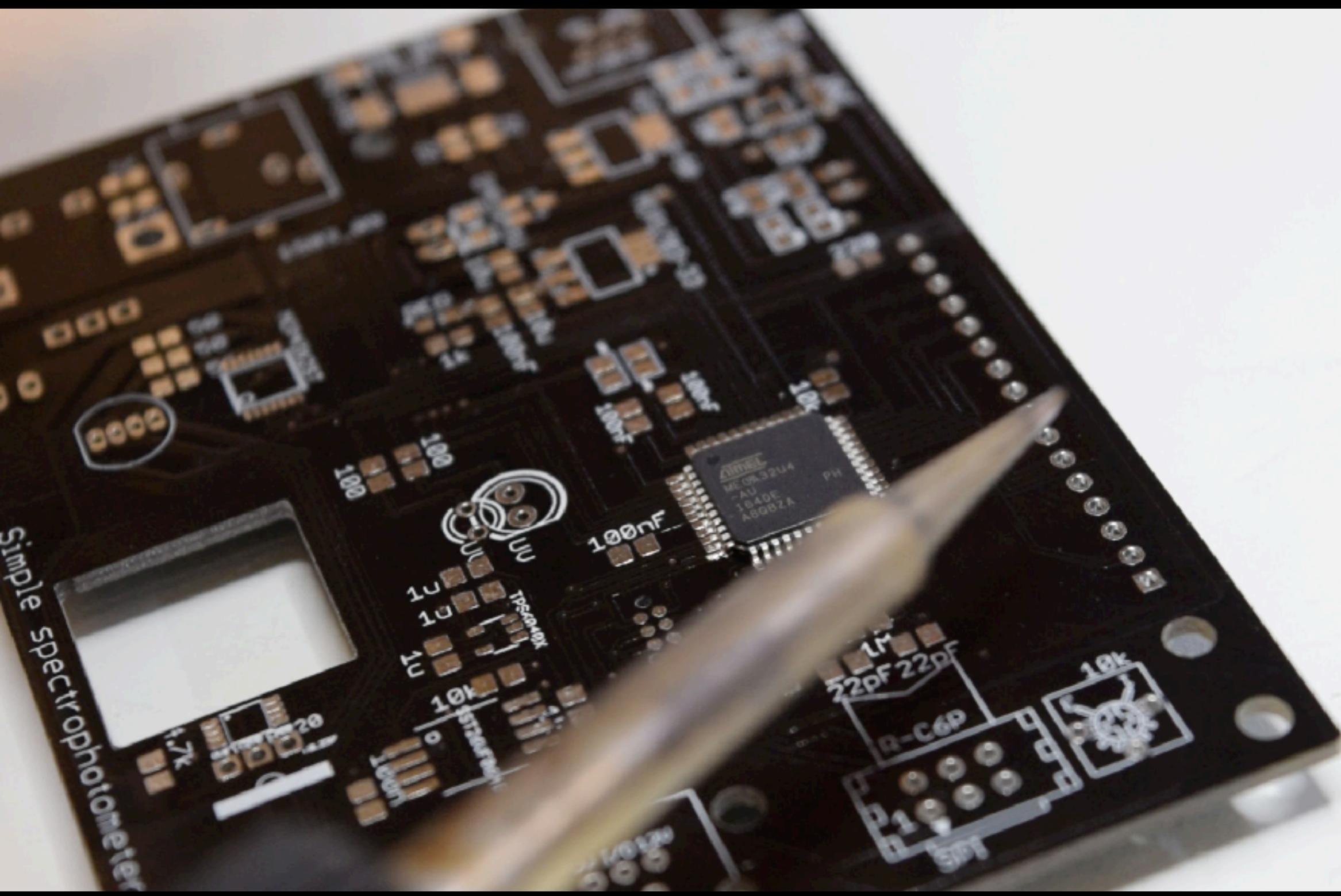


Soldering the PCB





Simple spectrophotometer



PCBA

Printed Circuit Board Assembly

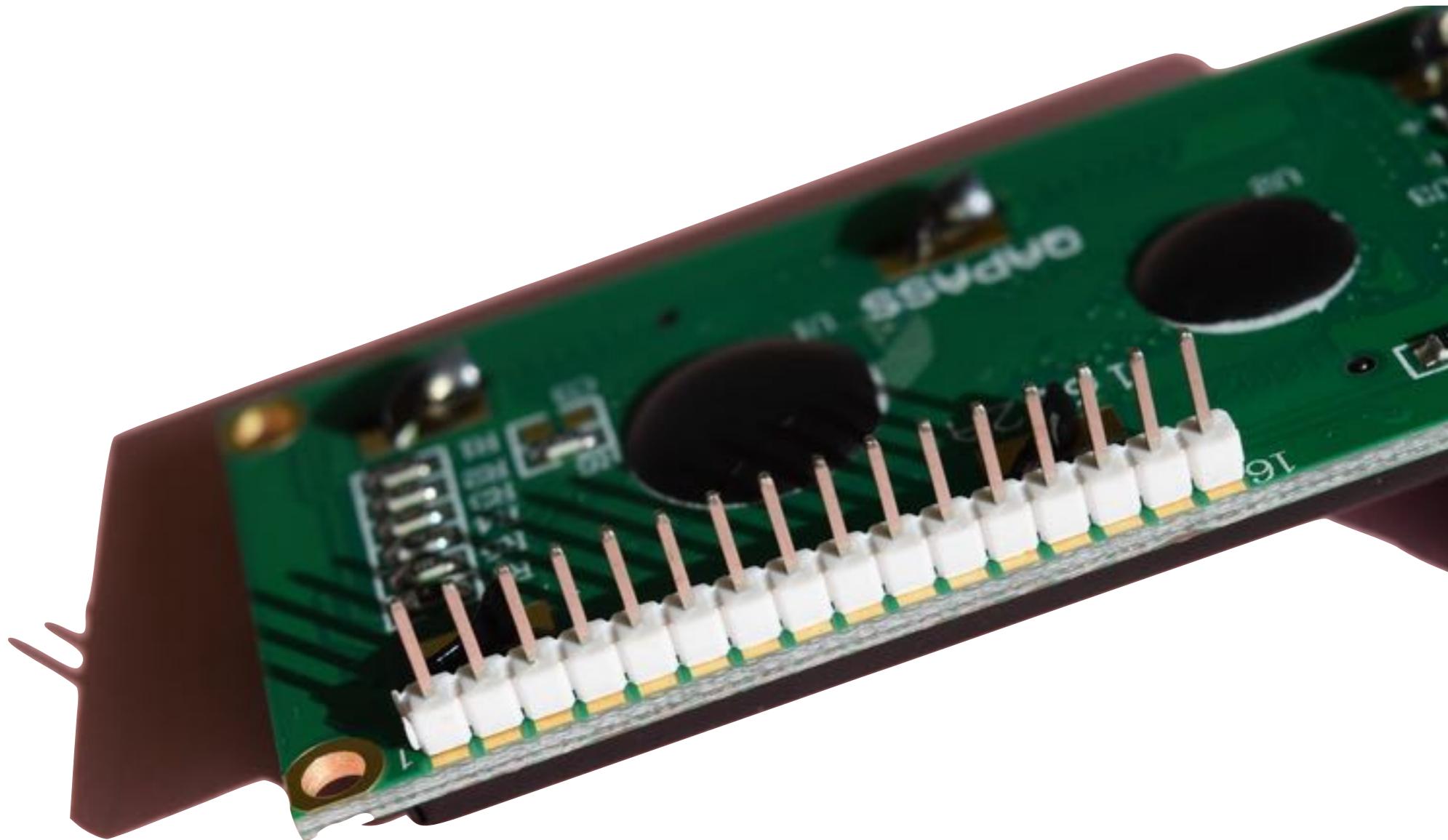
www.elecrow.com

- **Free components list**
 - <https://www.elecrow.com/pcb-assembly-p-366.html>
 - 120 SMD capacitors
 - 235 SMD resistors
- **Provider: <https://lcsc.com/>**
- **In Eagle:**
 - 'attr', add LCSC Part # (or free components)
 - 'run ULP ➔ bom', export as CSV
 - 'export ➔ mount SMD' : export .mnb and .mnt

www.elecrow.com

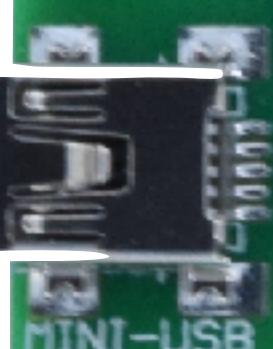
| For PCB fabricate | | | | | | | |
|---------------------------------|-----------------|---------------------------------------|--------------|------------------|--------------------------------------------------|--------------|--------------------------------------------------------------------------|
| Project Name | Layers | Dimension/cm | Thickness/mm | Surface Finished | Solder Mask | Qty | Quotation (\$) |
| simple-spectro | 2-layer | 10*10 | 1.6 | HASL leadfree | Green | 20 100 | \$26.90 \$123.78 |
| Stencil for assembly | | | | | | 1 | \$18.00 |
| | | | | | | | 20pcs Total with stencil: \$44.90 100pcs Total with stencil: \$141.78 |
| For PCB Assembly | | | | | | | |
| Project Name | Pads | Qty | Price | Qty of Boards | Quotation | Remark | |
| simple-spectro | SMT | 135 | 0.030 | 20 | \$81.00 | | |
| | | | | 100 | \$202.50 | 50% discount | |
| | | | | | 20pcs Total : \$81.00 100pcs Total : \$202.50 | | |
| Engineer Start | | | | | | | |
| 20pcs Total : | \$10.00 | | | | | | |
| 100pcs Total : | \$0.00 | Free | | | | | |
| Components purchased by Eelcrow | | | | | | | |
| 20pcs Total : | \$149.800 | Remark 20\$ added for sourcing fee | | | | | |
| 100pcs Total : | \$623.00 | | | | | | |
| Shipping | | | | | | | |
| Products | Shipping Method | Weight(g) | Quotation | Remark | | | |
| 20PCBAs | DHL | 2500.00 | \$29.40 | | | | |
| 100PCBAs | | 8000.00 | \$71.35 | | | | |
| | | 20pcs Total : | \$29.40 | | | | |
| | | 100pcs Total : | \$71.35 | | | | |
| | | | | | 20pcs Total Quotation(\$): | \$315.10 | |
| | | | | | 100pcs Total Quotation(\$): | \$1'038.63 | |

Through holes components



1. Solder pins on LCD screen
2. Check the screen !!!!

5



MINI-USB

3



Simple spectro
V1.4.1

1

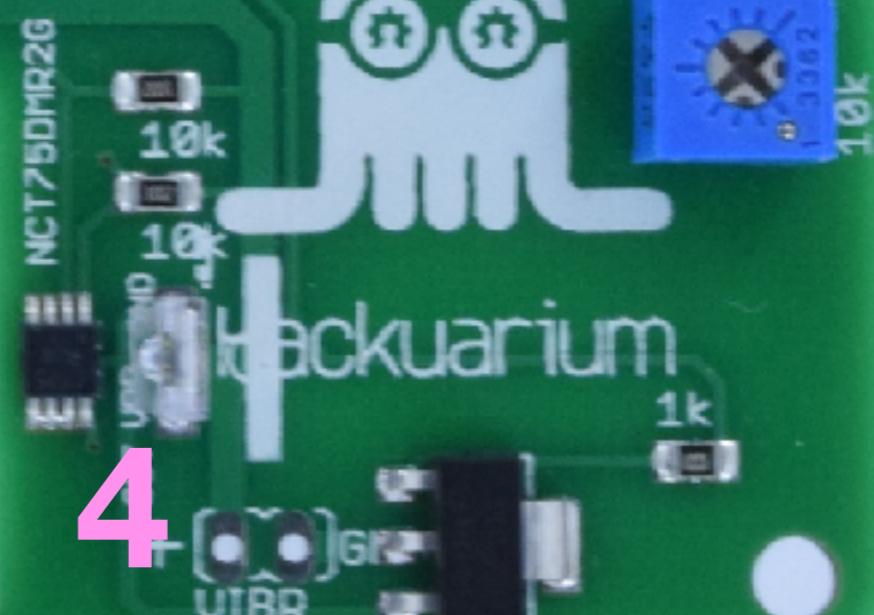


22

2

Hackuarium

4



NCT750MR2G

10k

1k

GND

220

100nF

10k

100nF

100nF

120nF

10k

10k

100k 1k
18pF 18pF

R-C6P

GND

SPI

DMP2615U or DMP2302
10u 100nF
10u 100nF
1k

LM1117S-3.3

22

22

22



GND



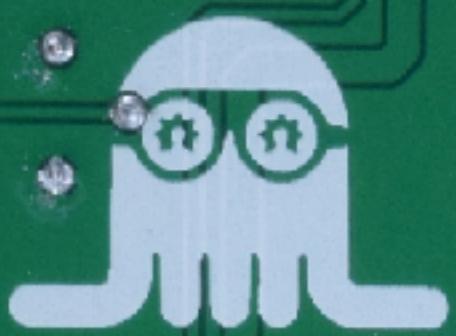
GND

GND

GND

6

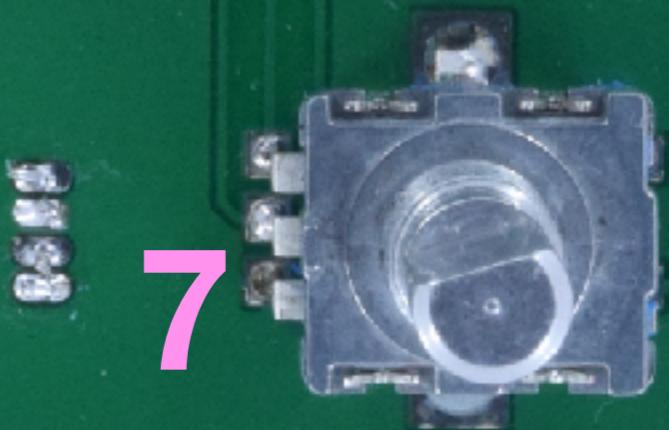
1 VSS VDD V0 RS RW E D0 D1 D2 D3 D4 D5 D6 D7 A/K 16



Hackuarium
Simple spectro

v 1.4.1

7



Mechanics



Various strategies

3D printing

- ✓ any shape
- ✗ slow
- ✗ not that cheap

Laser cutting

- ✓ fast and cheap
- ✗ limited shapes (2D)

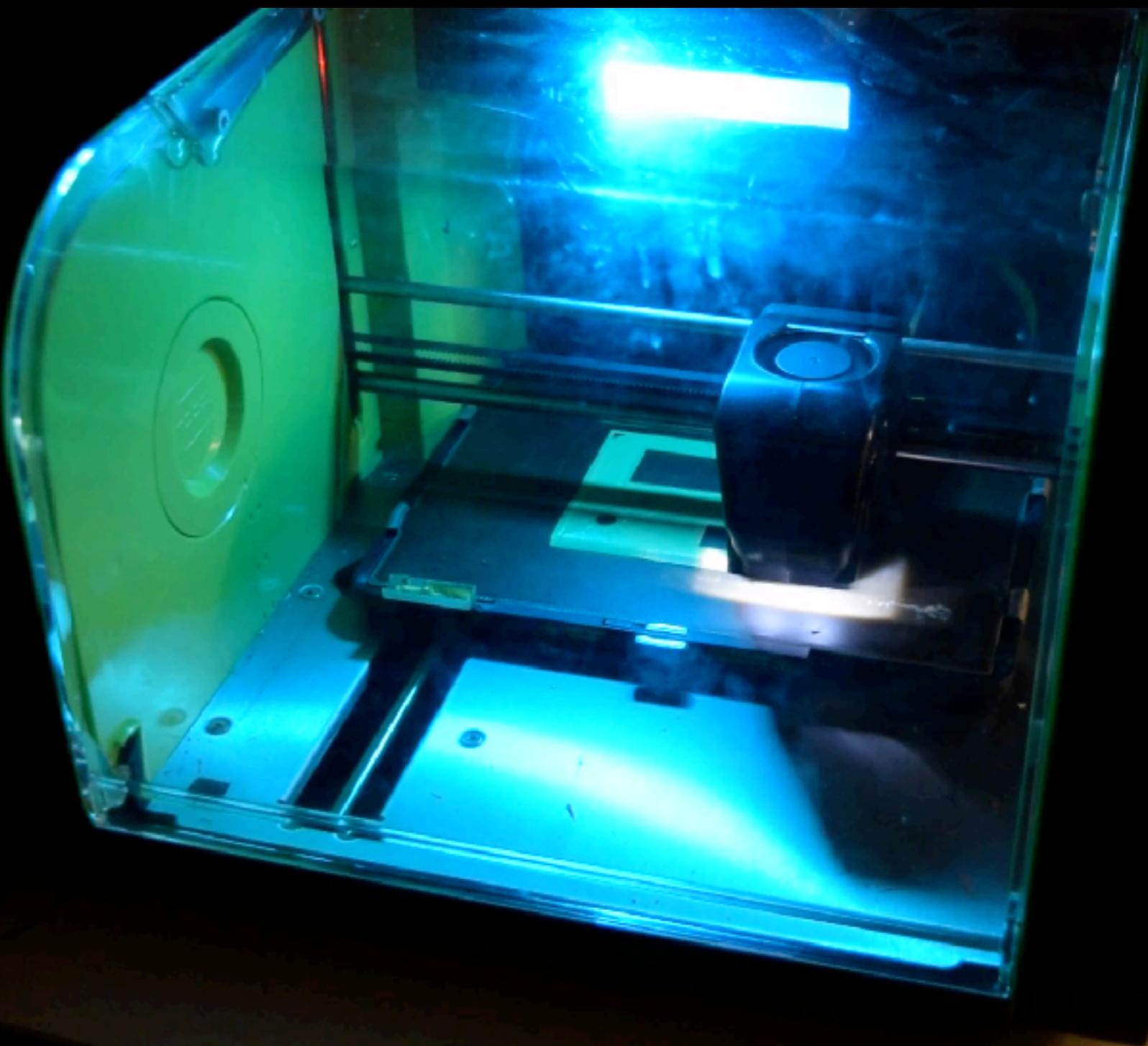
Milling

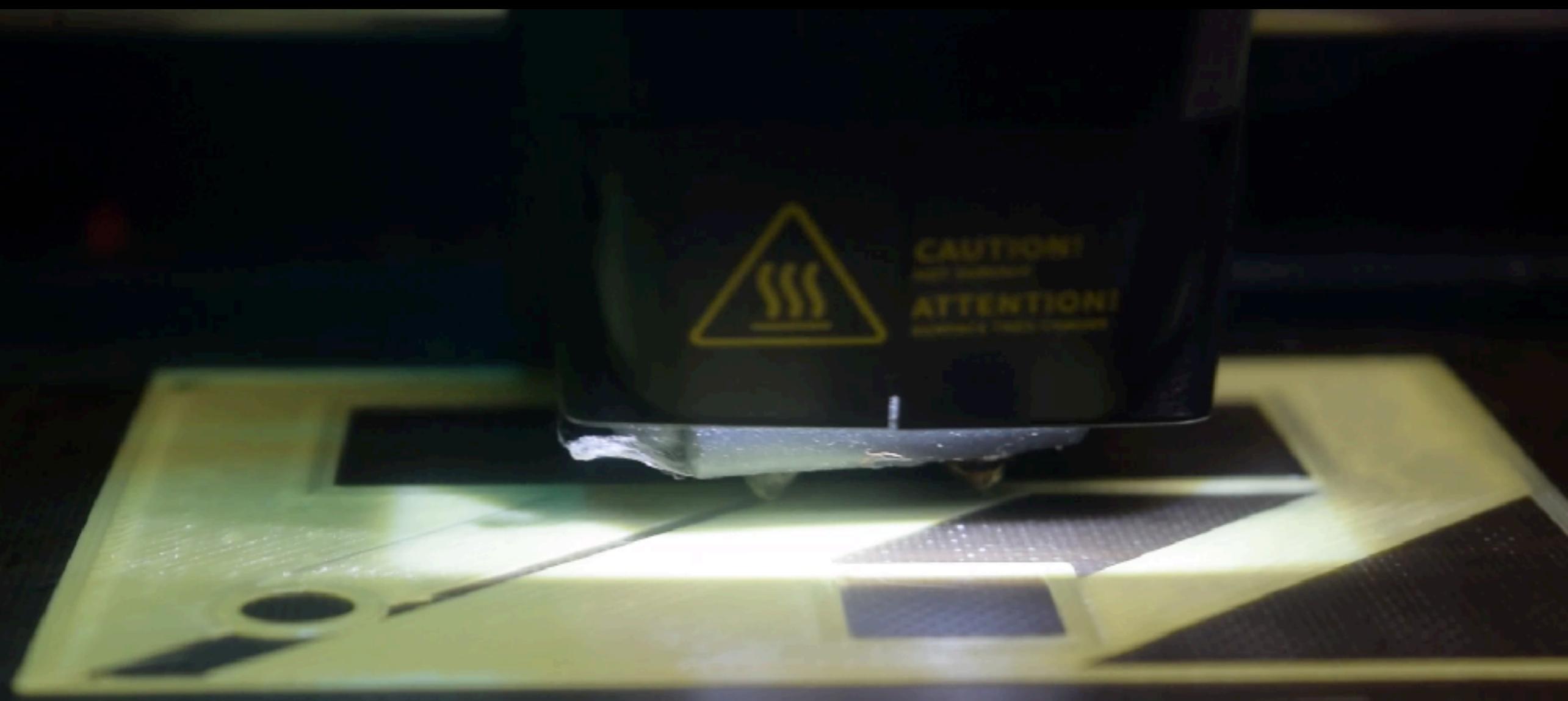
- ✓ perfect quality
- ✗ cost
- ✗ time

Molding

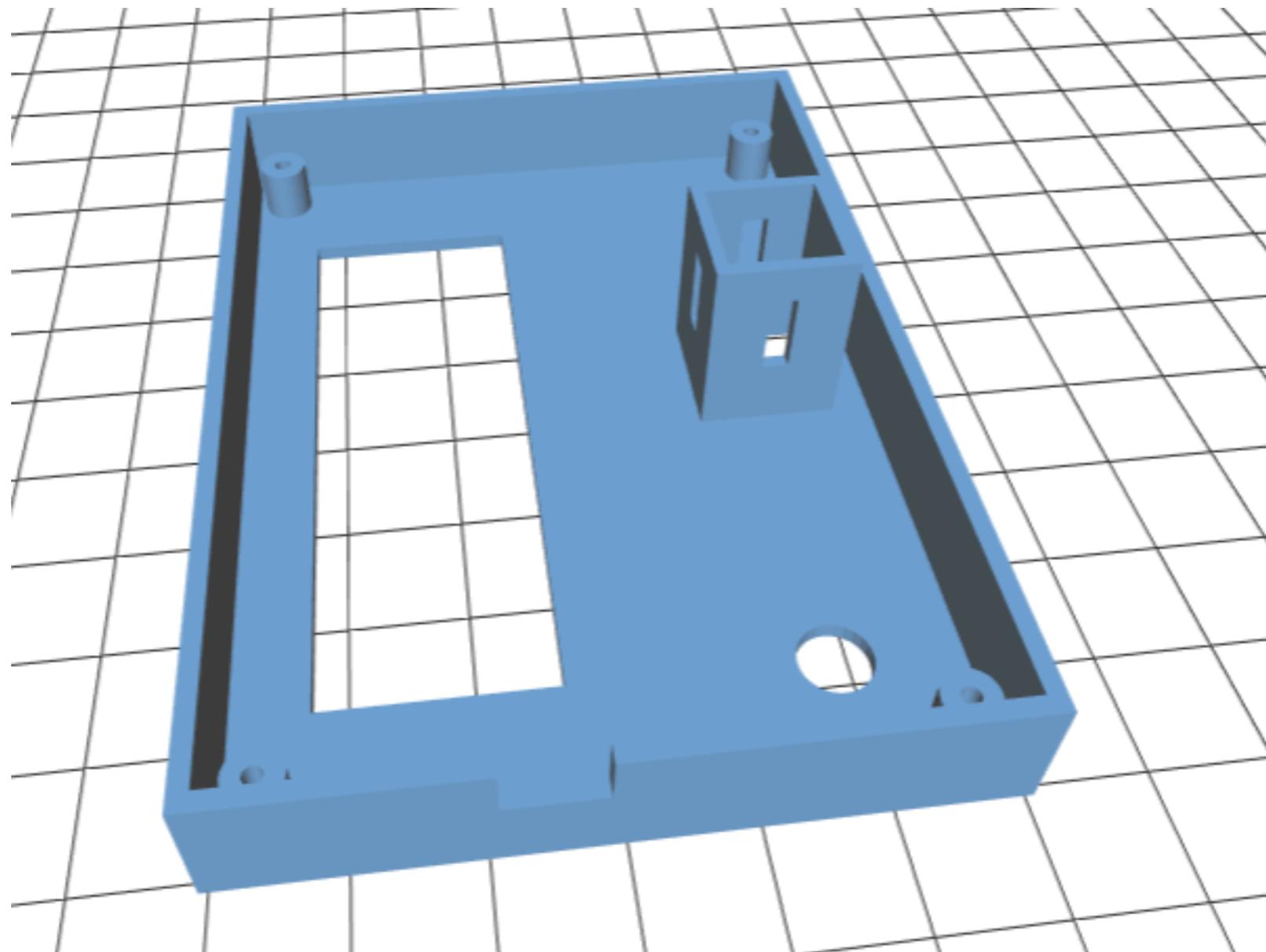
- ✓ cheap for large series
- ✗ setup cost
- ✗ time

3D printing





You need an **STL** file



<https://github.com/Hackuarium/simple-spectro/tree/master/CAD/open-box>

About



Robox : Desktop 3D Printer and Micro-Manufacturing Platform

[Portishead, UK](#) [3D Printing](#)

£280,891

pledged of £100,000 goal

435

backers

Pledge £700 or more

PRE-ORDER price.

Order now and we will ship your Robox® as soon as it first rolls off the production line. You will have the first Kickstarter production build. Dressed in the limited edition Kickstarter colours and supplied with 2 taster reels of filament. You'll also get a custom appearance in our community.

ESTIMATED DELIVERY

Mar 2014

SHIPS TO

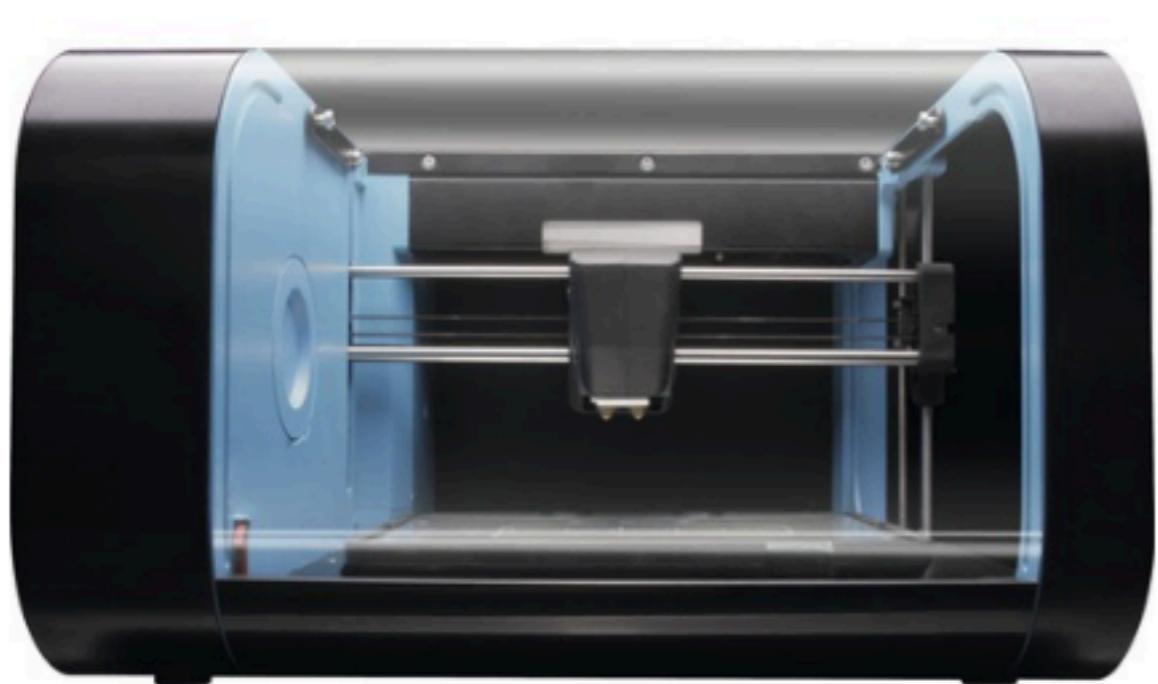
Anywhere in the world

Limited

259 backers

Funding period

Nov 21 2013 - Dec 21 2013 (30 days)



Imprimante 3D Robox RBX1

Art. 5843151

Pas encore évalué [Écrire une évaluation](#)

[Plus de détails sur l'article >](#)

990.00 CHF *

/ pce



Marquer
 Comparer

Filament Robox rose PLA

Pas encore évalué

36.00 CHF * / pce



Marquer
 Comparer

Filament Robox violet PLA

Pas encore évalué

36.00 CHF * / pce



Marquer
 Comparer

Filament Robox bleu PLA

Pas encore évalué

36.00 CHF * / pce



Marquer
 Comparer

Filament Robox vert PLA

Pas encore évalué

36.00 CHF * / pce

The cost of 3D printing

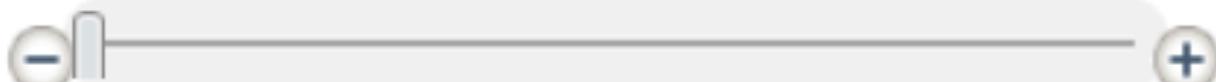
- Printer 1000 CHF
- Case 50g: 3 CHF



Consumable parts are not covered by this Limited Warranty (these include the printing head, extruder, ThermoSurface™ bed sheet, Bowden tube, filament feed path, filament, accessories (trimming kit, bed wipes, lubricant, tweezers, USB flash drive), power cable, USB cable and on-board microSD card). In particular, the warranty period for the printhead is 500 hours, as defined by the 'Head hours' counter on the chip of the printhead, or 100 days from the date of purchase – whichever is greater. Warranty services may be provided by CEL, an Affiliated/Authorised Reseller, or a third party service provider designated by CEL.



Double click on above image to view full picture



RBX01-S2 - Single Material Dual Nozzle Head- Version 2



Tweet



Like

Be the first of your friends to like this.

Email to a Friend

Be the first to review this product

Availability: In stock.

Quantity Available: 4

Available from:

£149.90

Qty:

ADD TO CART

or check out instantly with:

Check out with **PayPal**

-OR-

PayPal CREDIT

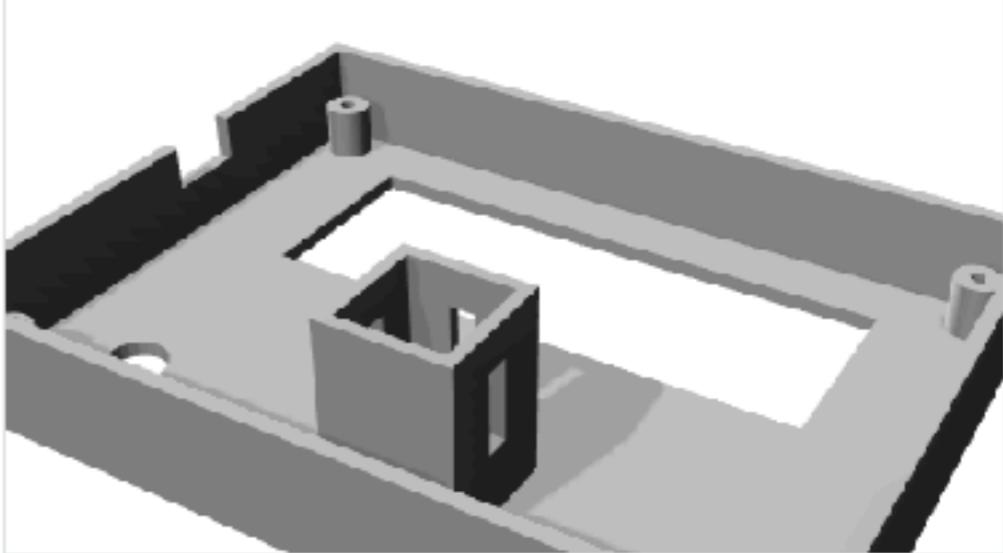
<https://www.shapeways.com/>

FILE
 [UPDATE](#)

SIZE (cm)
10.37 7.82 2.5 [RESIZE](#)
X Y Z

CATEGORY

[SHOW DETAILS ▾](#)



Materials Details History

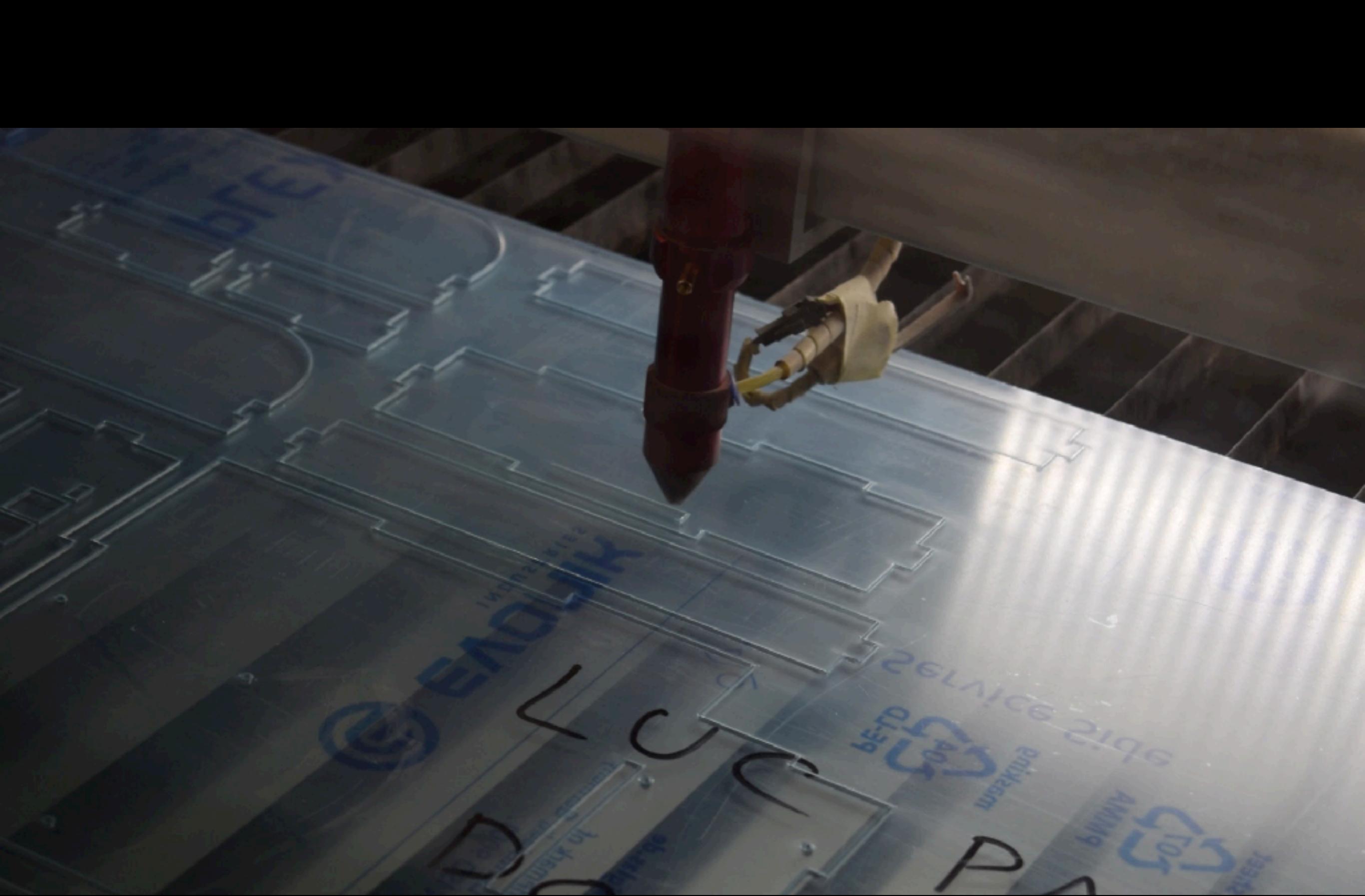
[Show All Materials](#) Strong & Flexible Plastic Metallic Plastic Frosted Detail Plastic Acrylic Plastic (Detail Plastic) Stainless Steel
Precious Metal Sandstone Wax Porcelain Aluminum High Definition Acrylate PLA HP Nylon Plastic

Strong & Flexible Plastic [SET 3D PRINTING ORIENTATION](#)

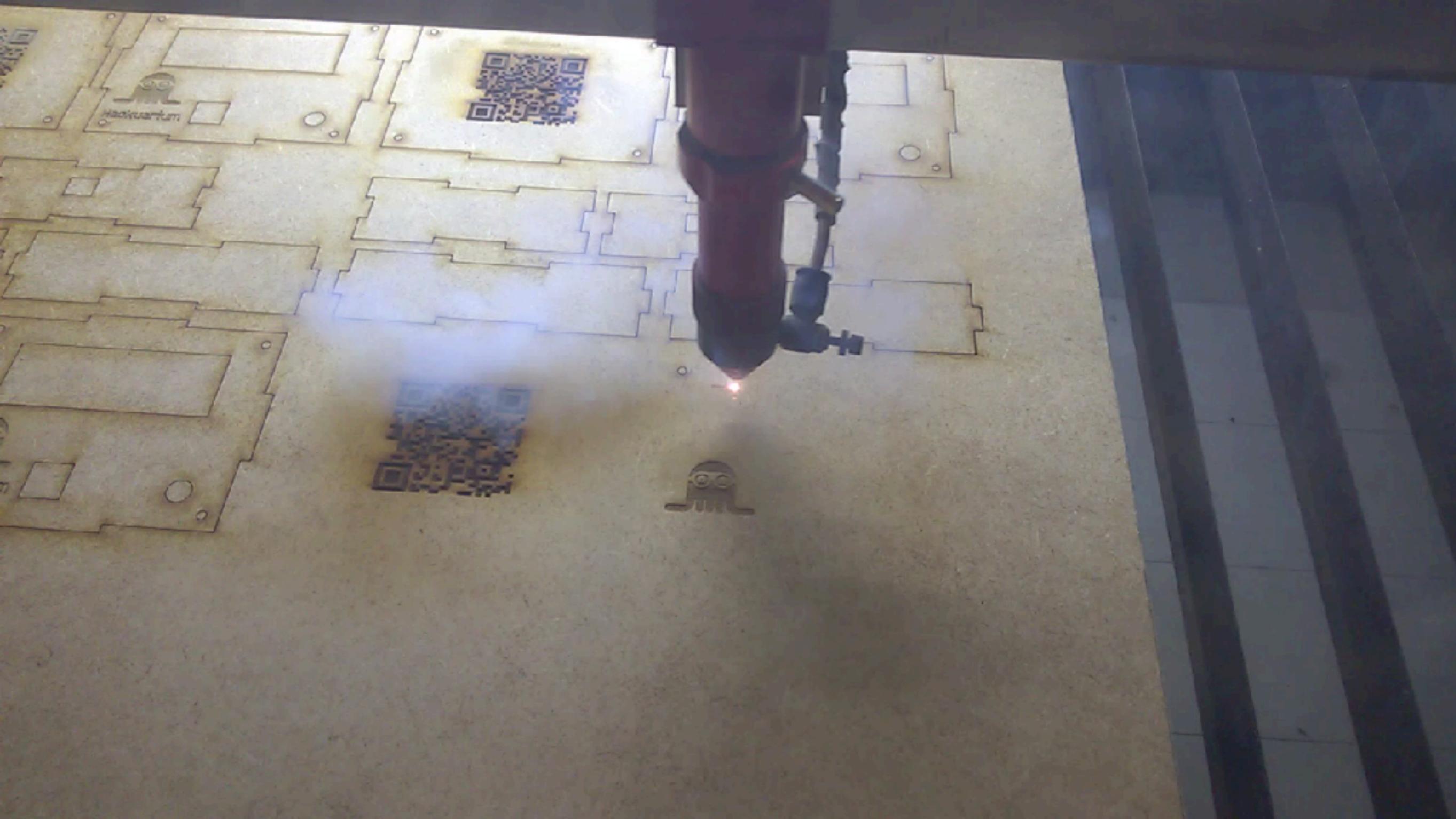
| OVERVIEW | CHARACTERISTICS | COMMON USES | TECHNOLOGY |
|--------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|---------------------------|
| This nylon plastic is our most versatile material suggested for both functional and decorative products. | <ul style="list-style-type: none">• Strong and durable• Supports complex geometry | <ul style="list-style-type: none">• Phone cases• RC car chassis• Jewelry | Selective Laser Sintering |

| Material Finish | Auto Checks | Manual Checks | Success Rate | Price | Qty. | |
|--------------------------------------------------------------------------------------------------------------------------------------------|-------------|---------------|--------------|---------|--------------------------------|-----------------------------|
|  White View 3D tools | Loading | — | — | \$24.27 | <input type="text" value="1"/> | ADD TO CART |
|  Black View 3D tools | Loading | — | — | \$25.27 | <input type="text" value="1"/> | ADD TO CART |

Laser cutting







The cost of laser cutting

- Machine 2000 CHF
- Plexiglas 3mm: 70 CHF / m²
 - <https://roehmschweiz.ch/fr/produits/plaques/plexiglas/gs-allround/>
- MDF 3mm: 10 CHF / m²



Condition: New

Quantity: 1 More than 10 available
51 sold / See feedback

Price: US \$1,999.00 [Buy it Now](#)

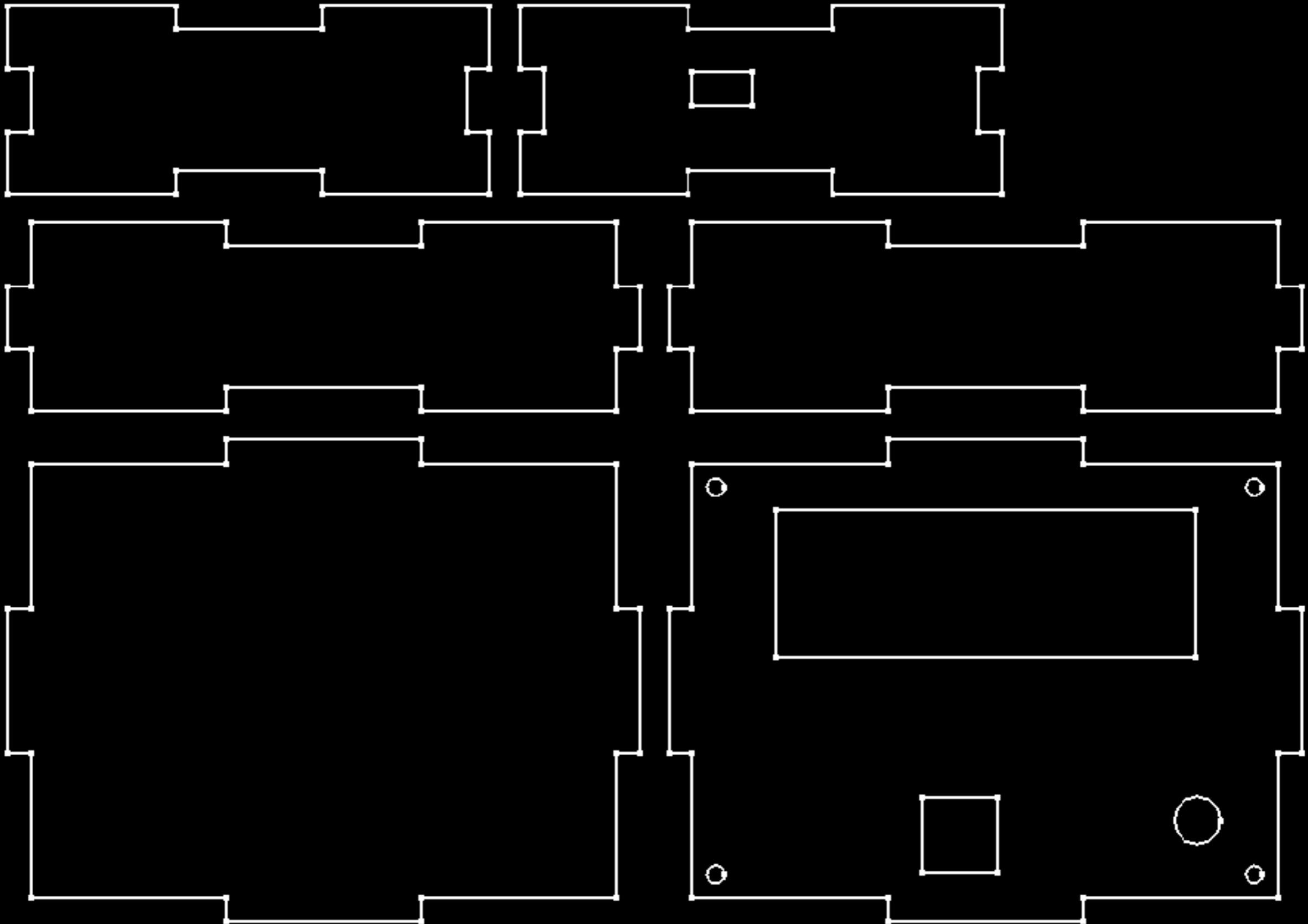
[Add to cart](#)

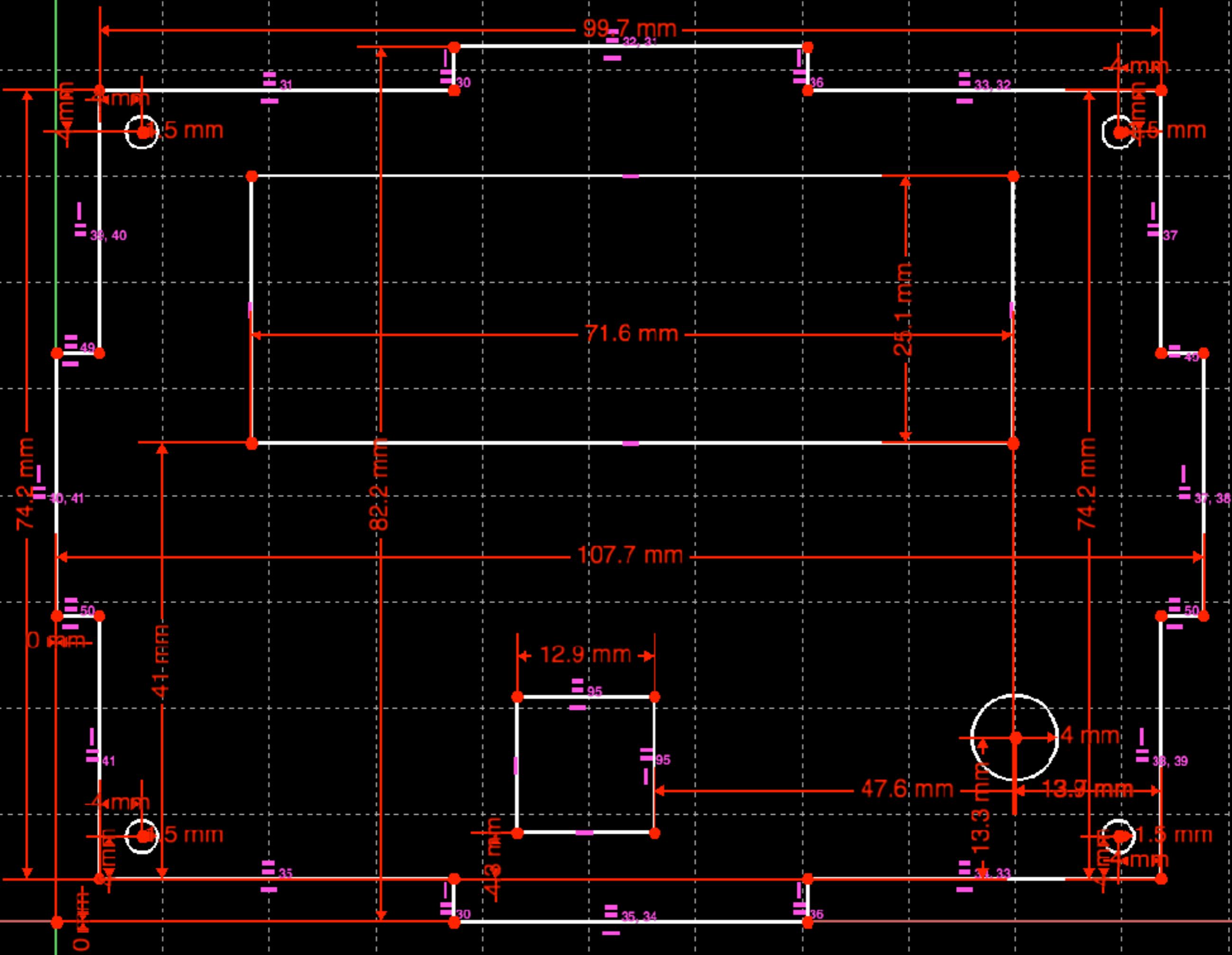
• Add to watch list
★ Add to collection

100% buyer satisfaction 51 sold More than 76% sold

Shipping: FREE Standard International Shipping | [See details](#).
See details about International shipping here. (1)

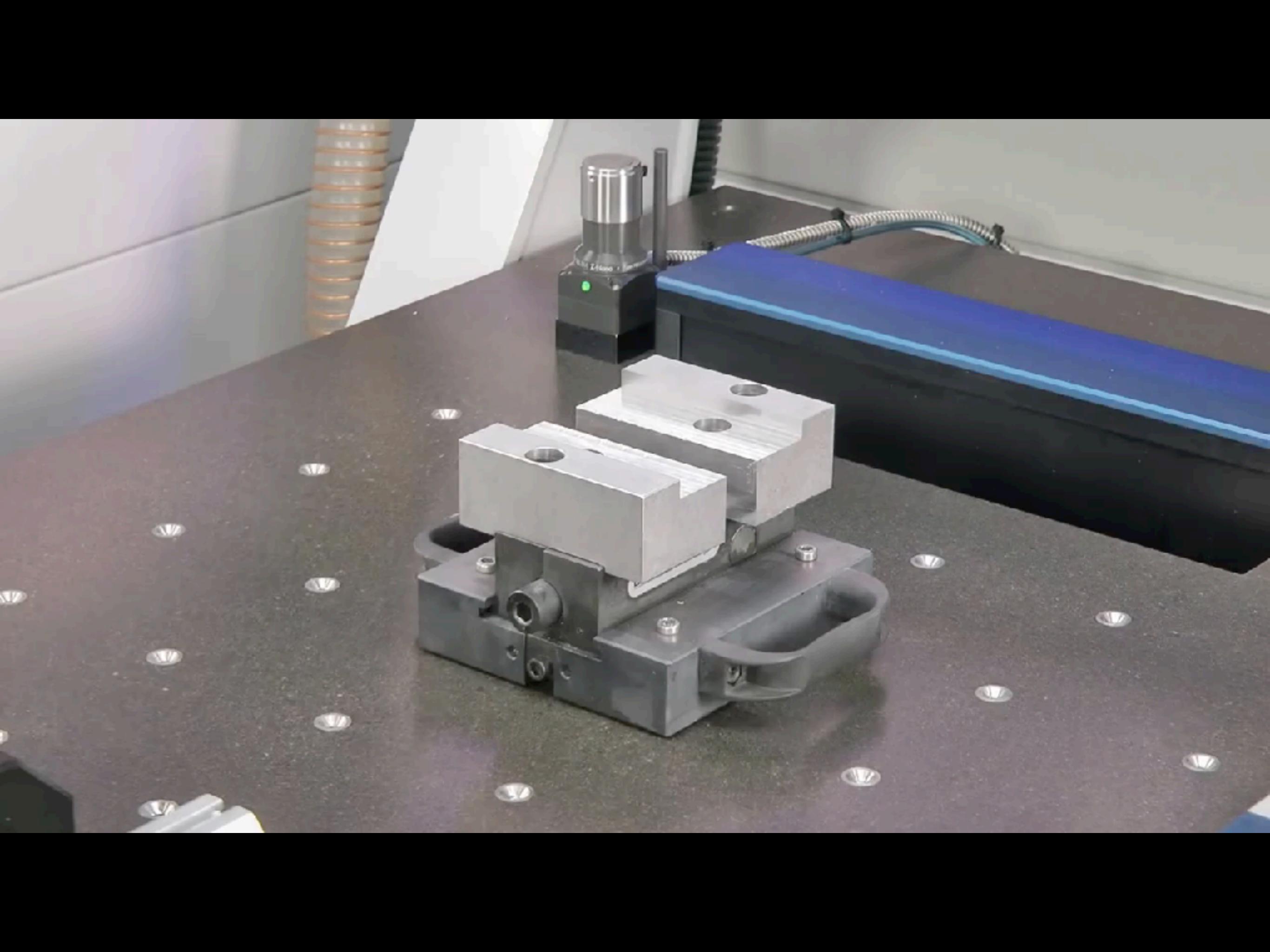
Item location: CN, China
Ships to: Worldwide





| | A | B | C |
|----|---------------|-------|--------------------------|
| 1 | width | 107.7 | mm |
| 2 | depth | 82.2 | mm |
| 3 | height | 32 | mm |
| 4 | thickness | 4 | mm |
| 5 | space | 5 | mm |
| 6 | pcbLength | 98.7 | mm |
| 7 | pcbWidth | 73.2 | mm |
| 8 | pcbSpace | 0.5 | mm |
| 9 | supportX | 4 | from box internal corner |
| 10 | supportY | 4 | from box internal corner |
| 11 | supportRadius | 1.5 | |
| 12 | holeWidth | 12.9 | |
| 13 | holeX | 47.6 | from box internal corner |
| 14 | holeY | 4.3 | from box internal corner |
| 15 | screenLength | 71.6 | |
| 16 | screenWidth | 25.1 | |
| 17 | screenX | 13.9 | from box internal corner |
| 18 | screenY | 41 | from box internal corner |
| 19 | rotaryX | 13.7 | |
| 20 | rotaryY | 13.3 | |
| 21 | rotaryRadius | 4 | |
| 22 | usbWidth | 10 | |
| 23 | usbHeight | 6 | |
| 24 | usbY | 38.7 | |
| 25 | usbZ | 7 | |

Milling



Aluminum case

- **Aluminium milling**
- **Black anodizing**
- **Logo laser engraving**
- **ISO 10303 (STEP file, Standard for the Exchange of Product model data)**

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manage your 2D/3D CAD files
online and instantly create RFQs
from your stored parts.



Patrick Neikes

Business Development | Central-Europe

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Mail patrick.neikes@starrapid.com

Web www.starrapid.com



[Facebook](#) | [Twitter](#) | [LinkedIn](#) | [Instagram](#)

** We have a new company name. All information can be found on our website **

- full.step - 20 pcs - EUR 1140,00 - 14 calendar-days production time
- full.step - 50 pcs - EUR 2245,00 - 16 calendar-days production time
- full.step - 100 pcs - EUR 3625,00 - 20 calendar-days production time



| | |
|---------------|---------------------|
| Quotation | - Shipping Included |
| Quote Number: | 69996 |
| Date: | 2017-10-27 |
| Sales Person: | Jennifer Hurd |
| Valid Until: | 2017-11-06 |
| Phone: | 1-866-849-3911 |
| Email: | jhurd@protocase.com |
| Website: | www.protocase.com |

69996-1 Group004 Rev(-) Quantity 20 Lead Time: 7-8 business days

| Quantity | Product | Unit Price | Ext. Price |
|----------|---------------------------------------------|------------|------------|
| 20 | Group004 Rev(-) | \$77.40 | \$1548.00 |
| 1 | Setup Fee | \$70.00 | \$70.00 |
| 1 | Design Services Fee | \$80.00 | \$80.00 |
| 1 | Black Anodize (Mil-A-8625 Type II, Class 2) | \$409.67 | \$409.67 |

Part Details (quantities are per assembly)

1 of COVER

- Bar Stock, Aluminum 6061-T6, 1in x 4in x 20ft

-

1 of BASE

- Bar Stock, Aluminum 6061-T6, 1in x 6in x 20ft

-

Subtotal: \$2107.67
Currency: USD

ZXM Technology Co., Ltd.

Hua feng industry ,Songgang Town, Shengzhen City, Guangdong Province , China

FAX :86-0755-27154623 Mobile :86-13556671200

Contact person :Patrick zhu Website :<http://www.cnc-machiningservices.com>

Mail address :zxm@cnc-machiningservices.com/zxmprecision66@gmail.com

Skype :Patrick85858 QQ:597145002

Quotation List

Date :Oct/24/2017

| Products name (Drawings NO) | Material | Surface treatment | Quantity (pcs) | unit price (usd) | total price | shipping |
|--------------------------------|----------|-------------------|-------------------|---------------------|--------------|----------|
| Box (include two parts) | AL-5052 | Black anodized | 20 | \$36. 20 | \$724. 00 | DHL |
| | | | 50 | \$33. 00 | \$1, 650. 00 | |
| | | | 100 | \$31. 00 | \$3, 100. 00 | |
| Total value | | | | | | |

NOTES:

USD:RMB=1.0:6.5

1. This price is DOOR TO DOOR PRICE and keeps valid for 30 days .
2. Delivery is 20-25days upon confirmation of purchasing Oder and down payment
3. The payment term is 100% deposit by T/T.

Molding

Molding

<http://www.emold.net/>

Part Information

Product Size : 10.00 cm * 8.00 cm * 2.50 cm

Cavity : 1

Life : <5000

Plastic : PTFE (teflon)

Mold Price Calculation

Mold Frame : 121.21 USD

Mold Core : 90.91 USD, p20 China Made

Copper Electrode : 90.91 USD

Total material : 303 USD

Production Cost : 400 USD

Hot Runner : 0.0 USD

Management Cost : 20%

Tax : 68.0 USD

Total Mold Price : 912 USD

Product Price Calculation

Material Unit Price : 10.61 USD/kg

Product Material Cost : 0.53 USD

Production Speed : 60 seconds

Chosen Injection Machine : 600 Ton

Production Cost : 0.48 USD

Profit : 10%

Tax : 10%

Product weight : 0.05 kg

Product Unit Price : 1.25 USD (Note)

Generating the files

Alternatives to Fusion 360

<https://www.autodesk.com/products/fusion-360>

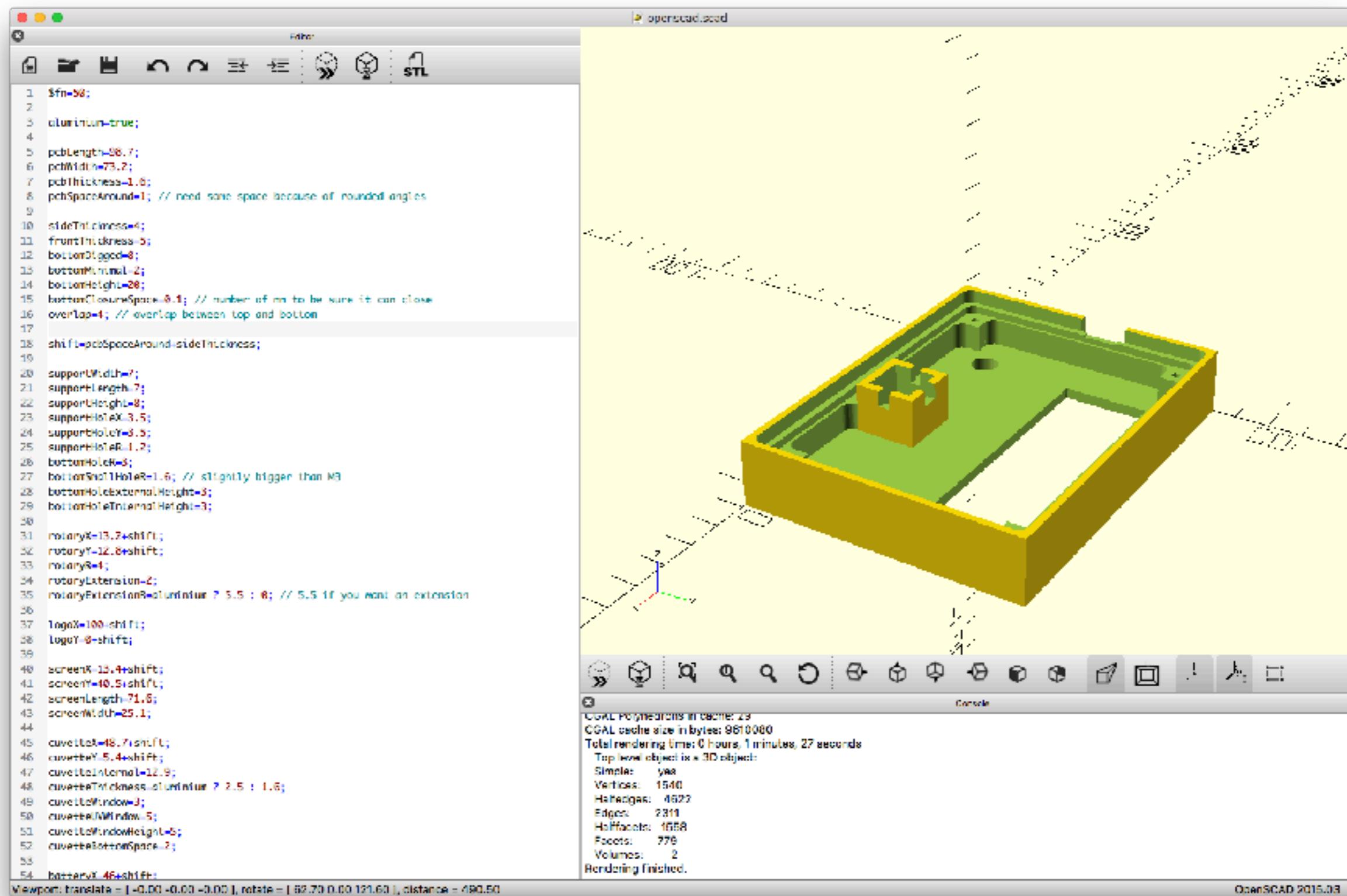
FreeCAD

- **2D**
- **3D**
- **open-source**
- **STL file (Standard Triangle Language)**
- **<https://www.freecadweb.org>**

OpenSCAD

- **2D**
- **3D**
- **open-source**
- **command line**
- **<http://www.openscad.org>**
- **full integration in FreeCAD**

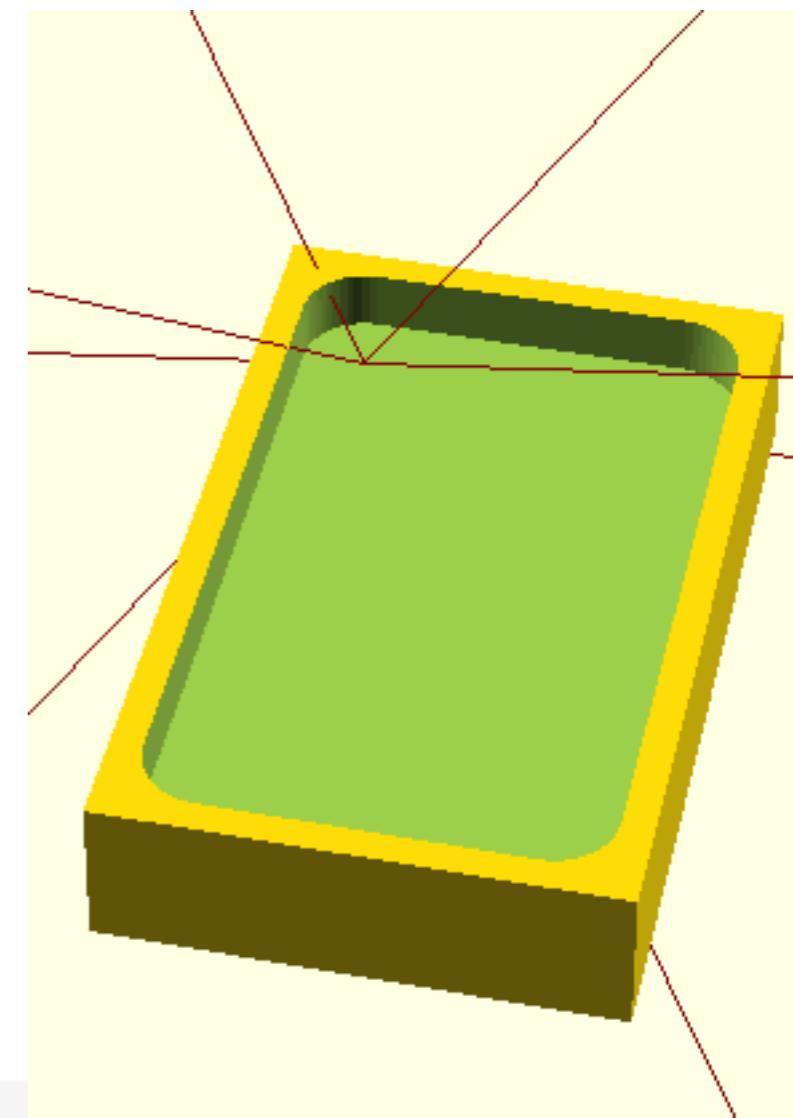
OpenSCAD



OpenSCAD

```
height=2;
width=20;
depth=10;
radius=2;
thickness=3;

difference() {
    translate([-thickness, -thickness, -thickness])
        cube([width+2*thickness, depth+2*thickness, height+thickness]);
    hull() {
        translate([0,0,0]) cylinder(h=height, r=radius);
        translate([width,0,0]) cylinder(h=height, r=radius);
        translate([0,depth,0]) cylinder(h=height, r=radius);
        translate([width,depth,0]) cylinder(h=height, r=radius);
    }
}
```



Programming

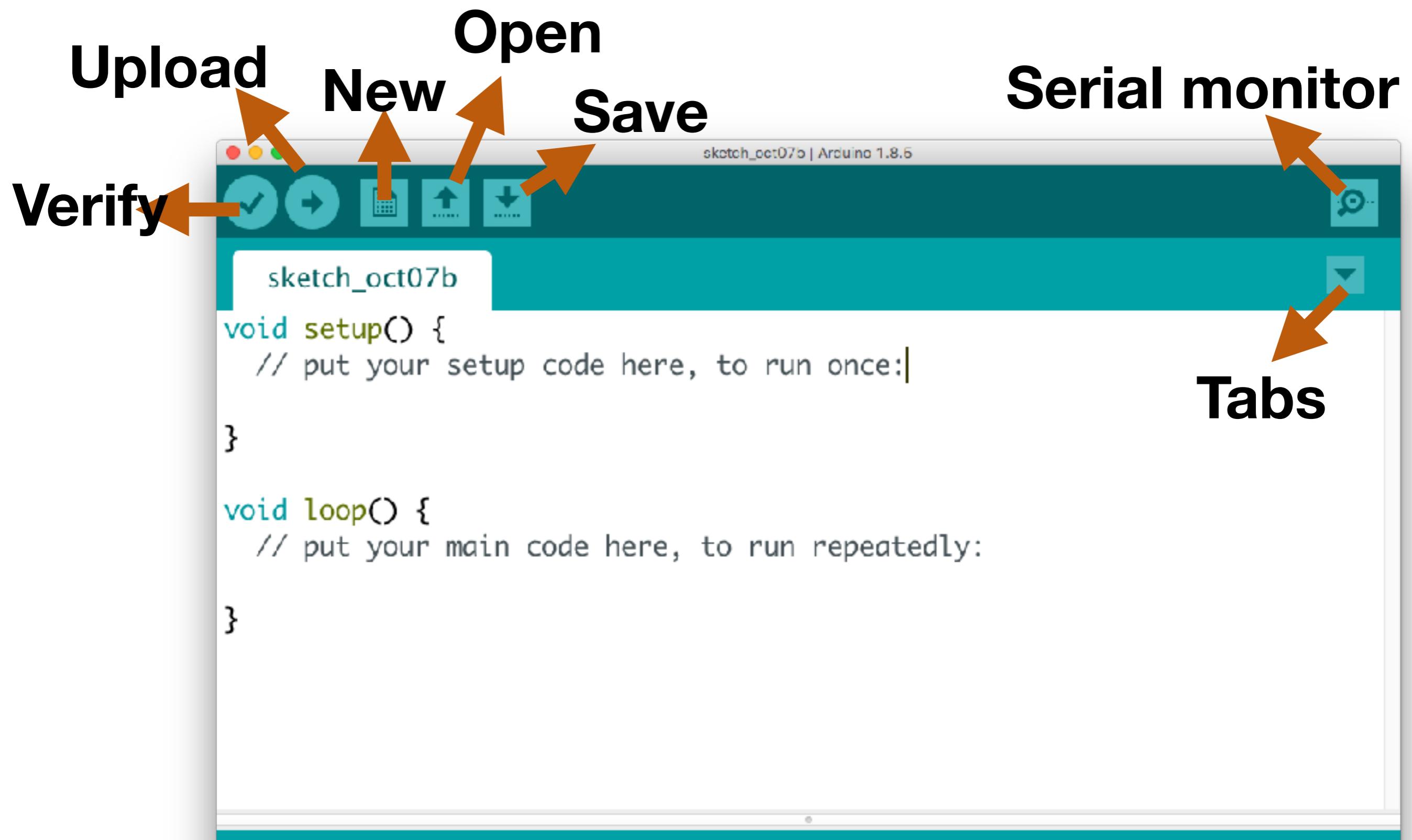
<https://www.arduino.cc/en/Main/Software>

Arduino: the basics

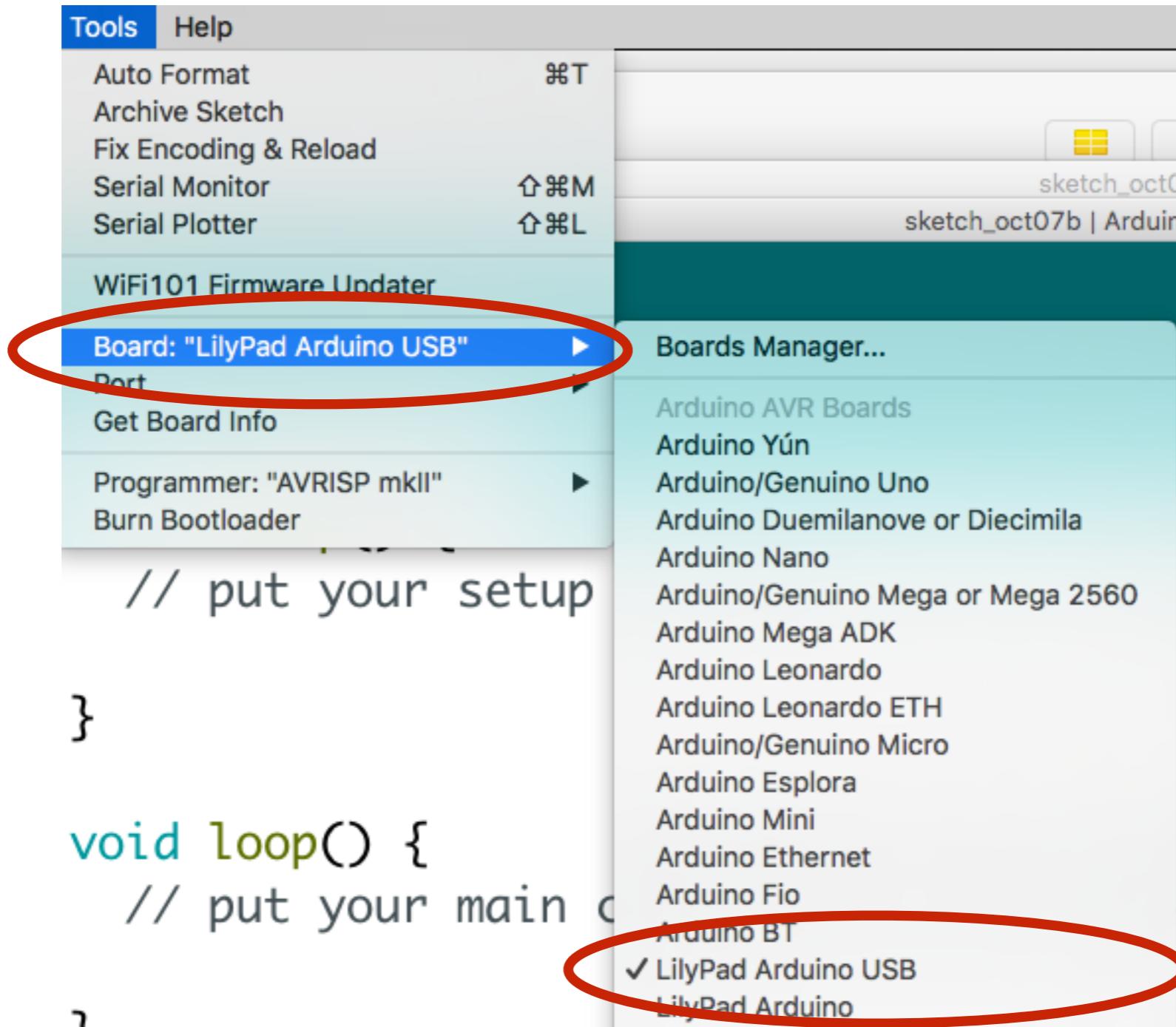
Install the software:

<https://www.arduino.cc/en/Main/Software>

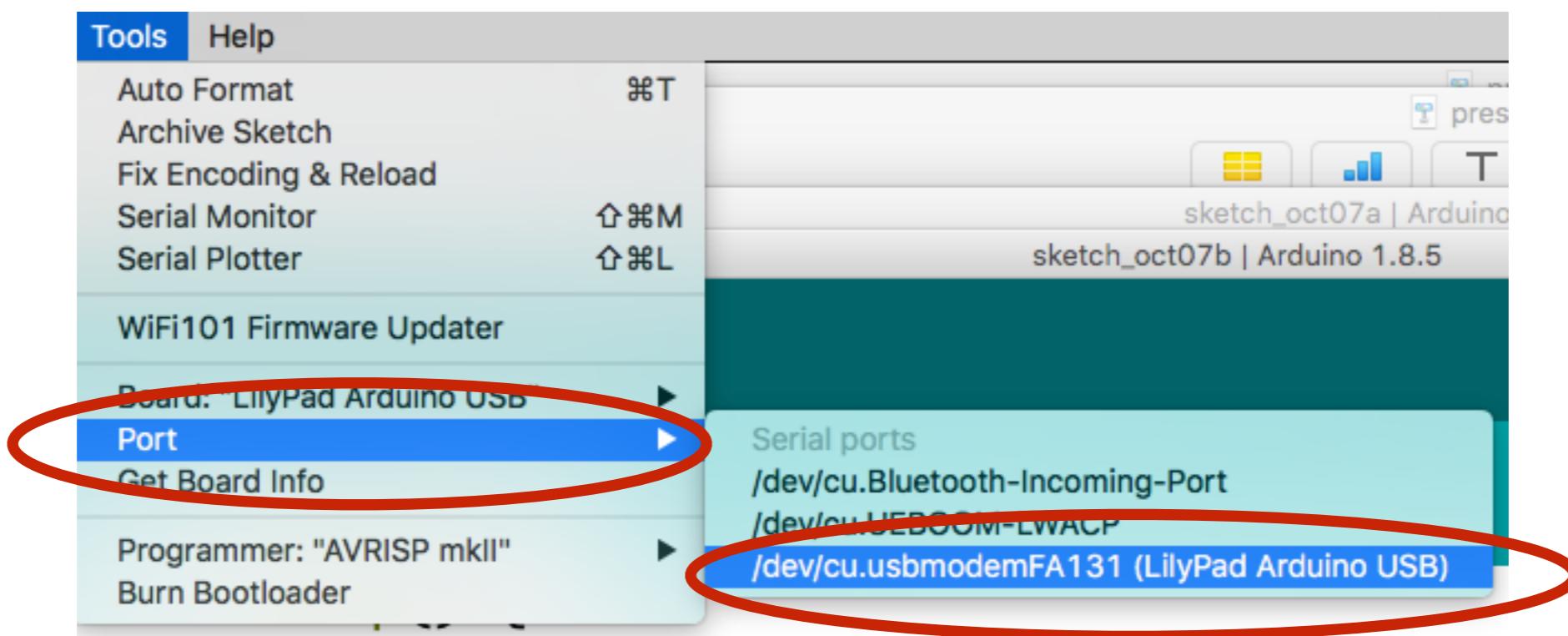
Arduino IDE (Integrated Development Environment)



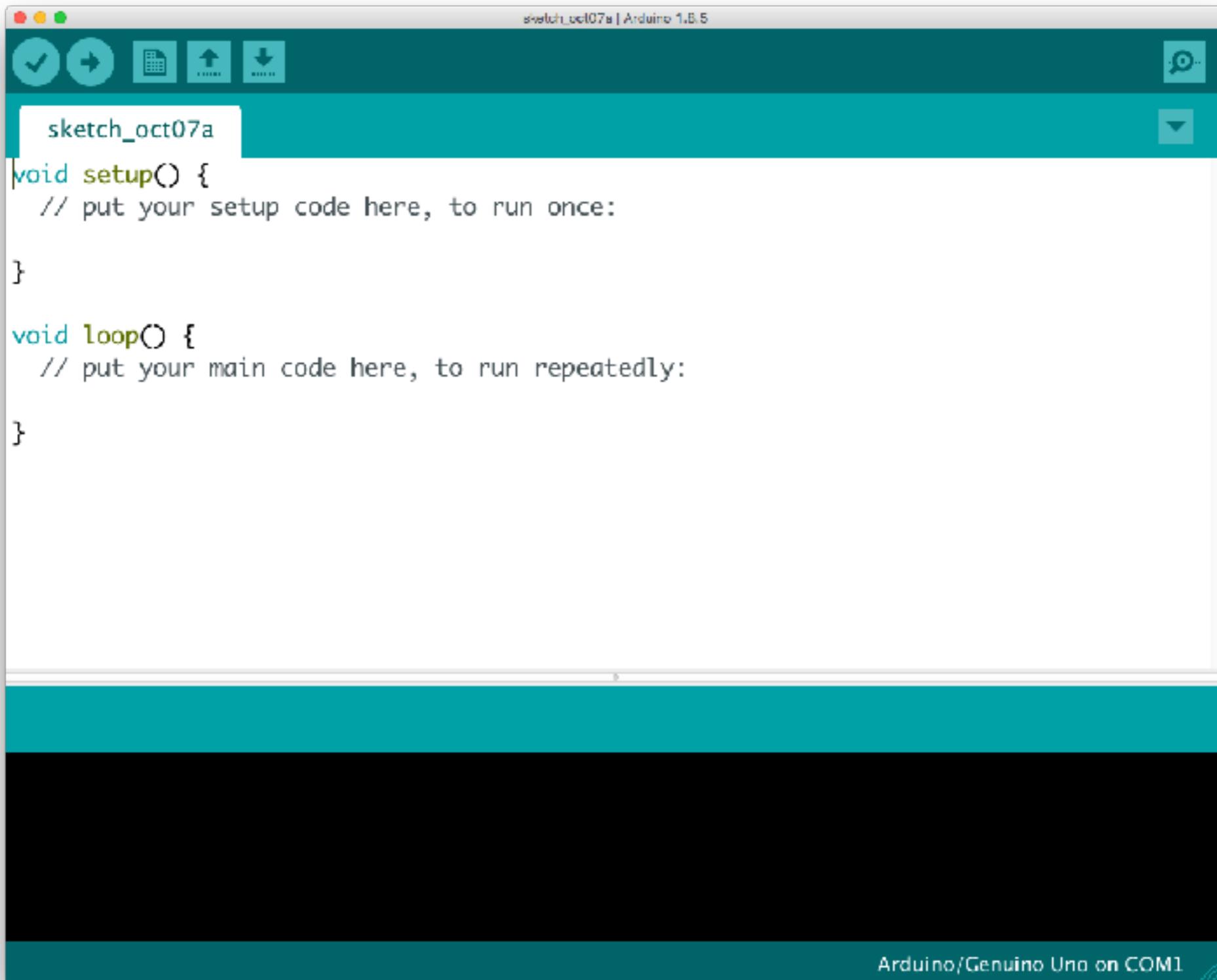
Select the right Arduino



Select the connected Arduino



Arduino IDE: setup and loop



The screenshot shows the Arduino IDE interface with a sketch titled "sketch_oct07a". The code consists of two main functions: `void setup()` and `void loop()`. The `setup()` function contains a comment indicating it should be used for initial setup code. The `loop()` function contains a comment indicating it should be used for repeated main code.

```
sketch_oct07a | Arduino 1.8.5

void setup() {
  // put your setup code here, to run once:

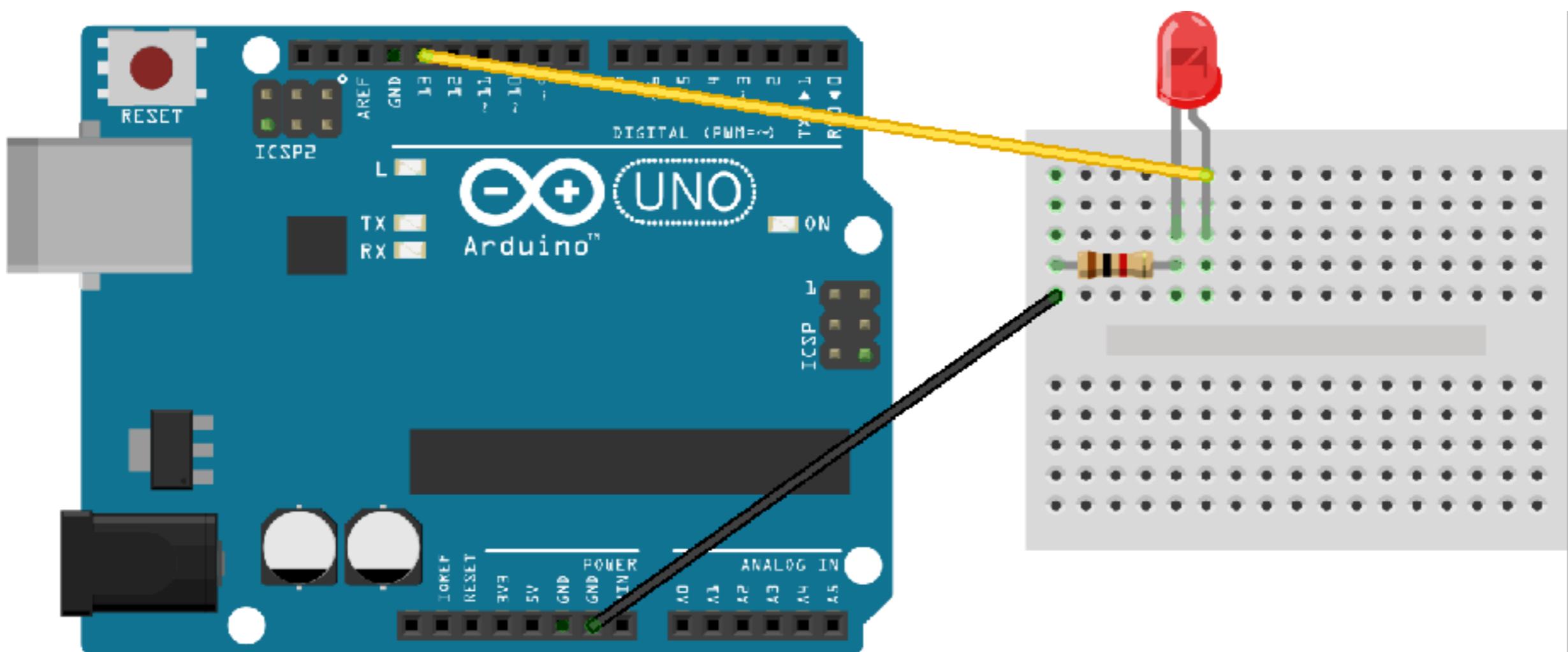
}

void loop() {
  // put your main code here, to run repeatedly:

}
```

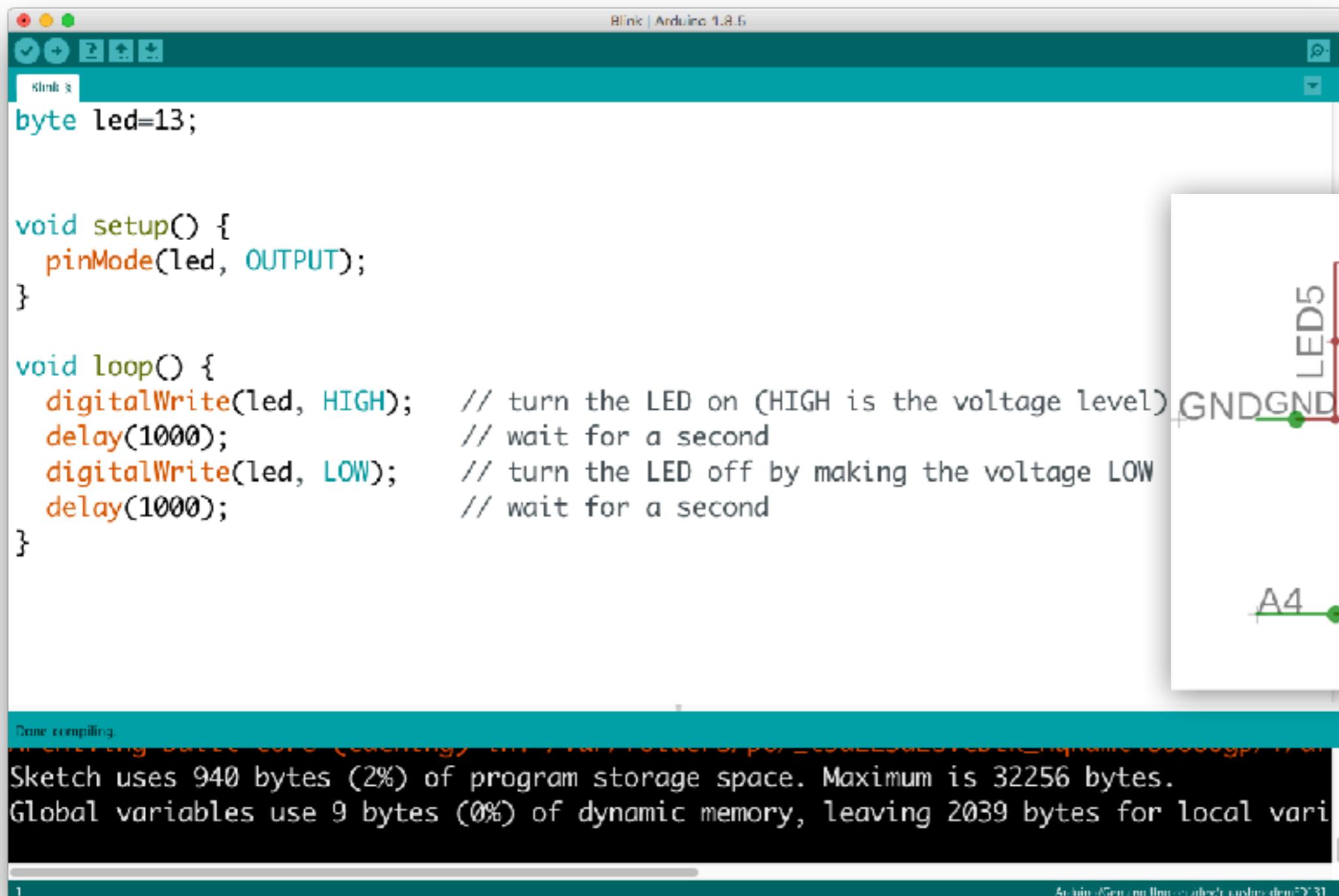
Arduino/Genuino Uno on COM1

Blink



Made with  Fritzing.org

Testing the LEDs



The image shows the Arduino IDE interface. The top bar says "Blink | Arduino 1.8.6". The code area contains the classic "Blink" sketch:

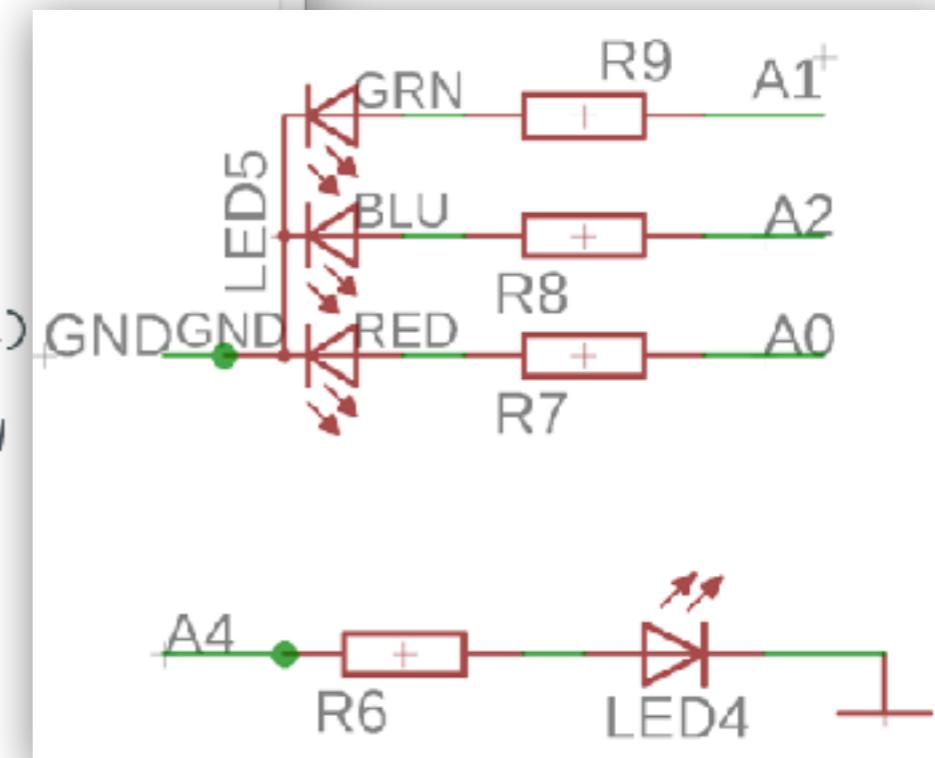
```
byte led=13;

void setup() {
  pinMode(led, OUTPUT);
}

void loop() {
  digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(led, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}
```

The bottom status bar shows the compilation results:

```
Done compiling.
Sketch uses 940 bytes (2%) of program storage space. Maximum is 32256 bytes.
Global variables use 9 bytes (0%) of dynamic memory, leaving 2039 bytes for local vari
```



Exercise: Create an RGB sequence

More advanced

Microcontroller : addressing pins

- **3 registers: DDRx, PORTx, and PINx**
- **DDR_x: 0=INPUT, 1=OUTPUT**
- **PORT_x:**
 - INPUT: pull-up if 1
 - OUTPUT: 1: drive pin HIGH, 0, drive pin LOW
- **PIN_x: toggle the pin**

DDRB: input / output ?

DDR: Data direction register

Initial:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

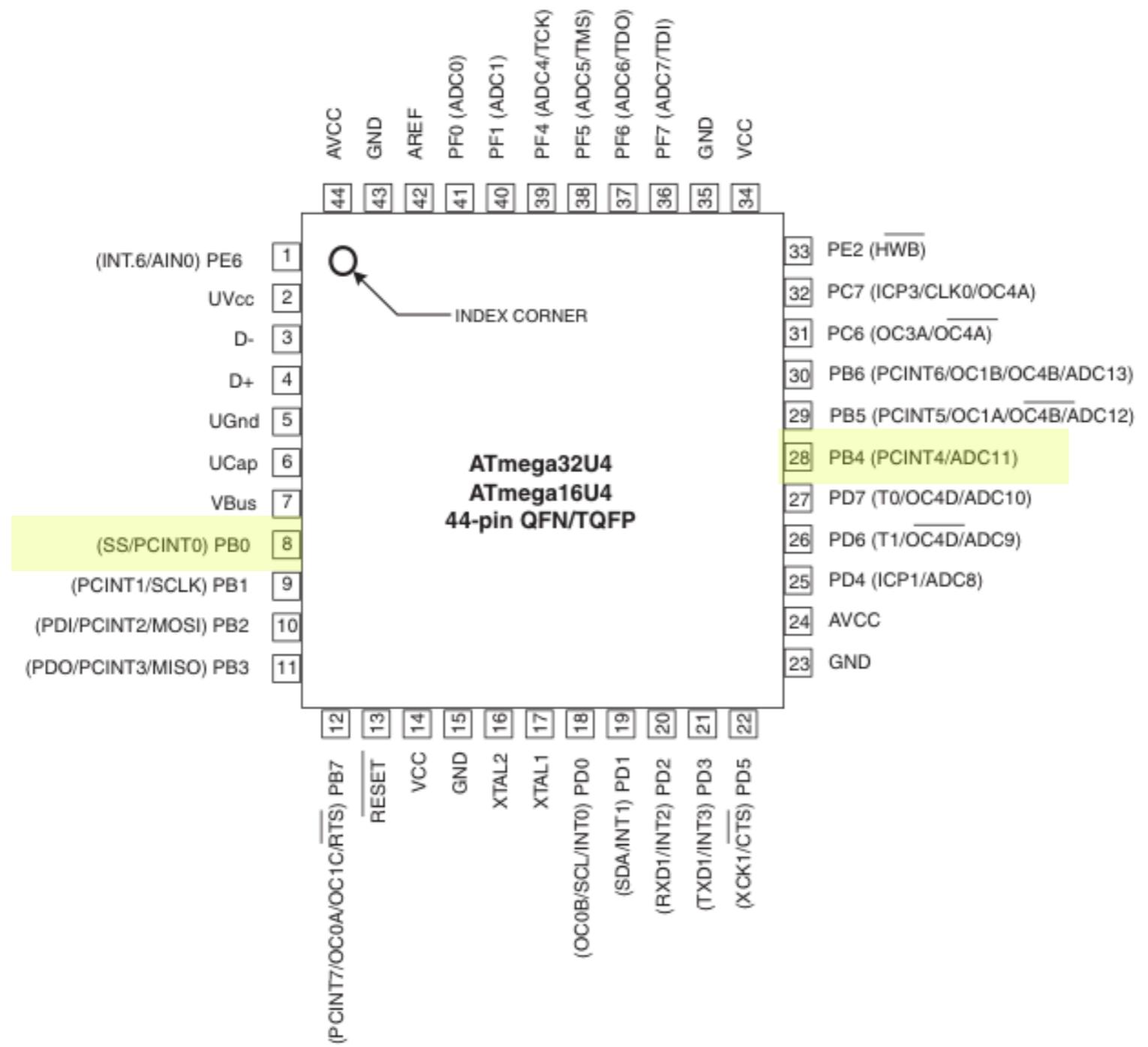
DDRB = (1 << DDB4) | (1 << DDB0);
or **bit shift**

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

=

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |

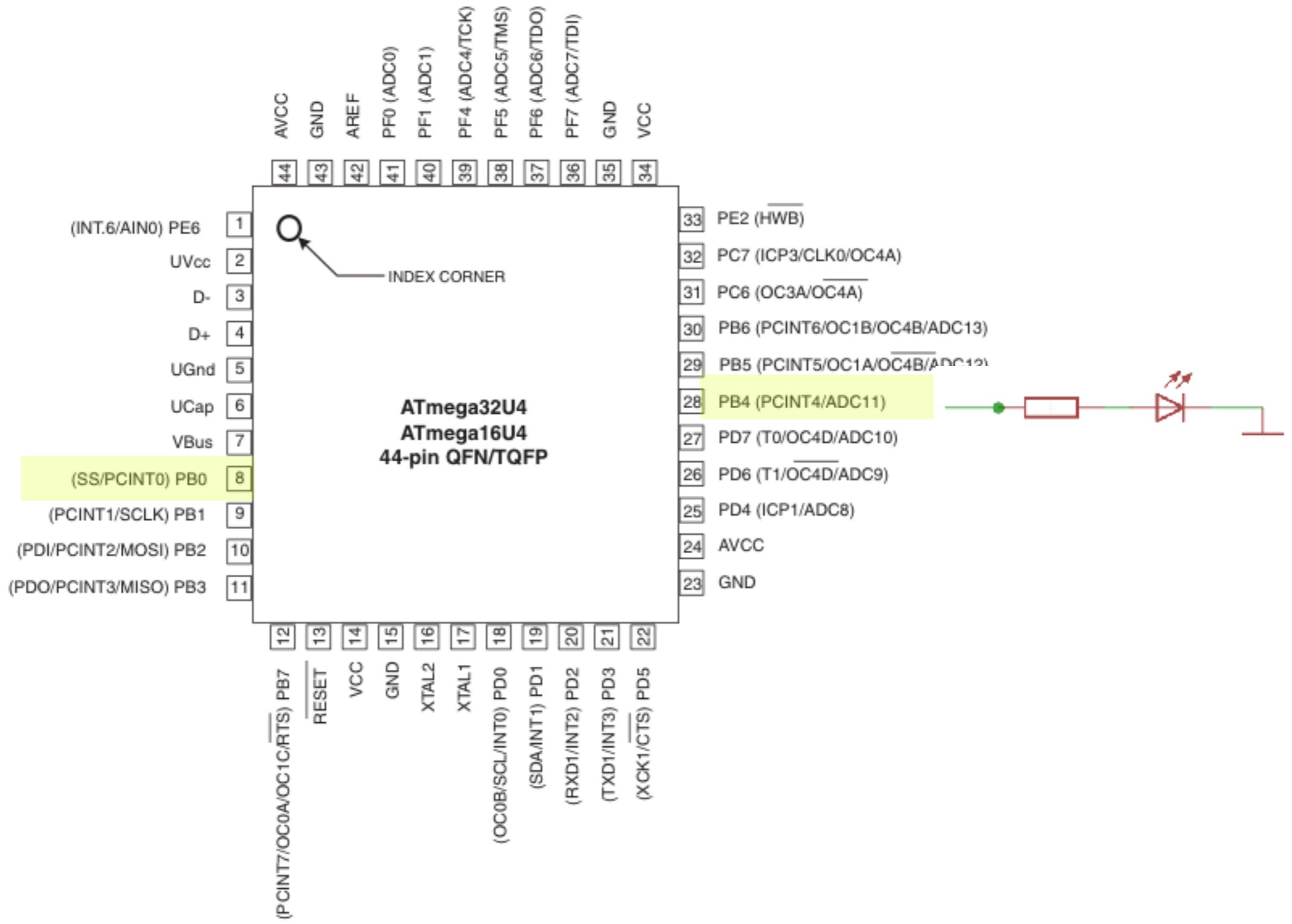
Microcontroller : ATMEGA32U4



Microcontroller : addressing pins

```
// pin 0 and 4 of PORT B to output  
DDRB = (1 << DDB4) | (1 << DDB0);  
  
// drive pin 0 and 4 of PORT B to HIGH  
PORTB = (1 << PB4) | (1 << PB0);
```

Microcontroller : ATMEGA32U4



THE DEFINITIVE ARDUINO LEONARDO PINOUT DIAGRAM

This provides a logic reference voltage for shields that use it. It is connected to the 5V bus.

Not Connected

IOREF

RESET

13 RESET

3V3

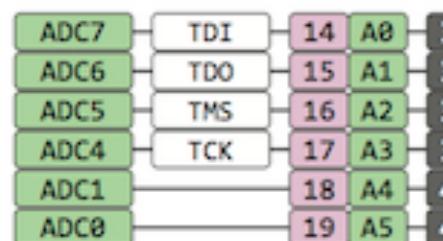
5V

GND

GND

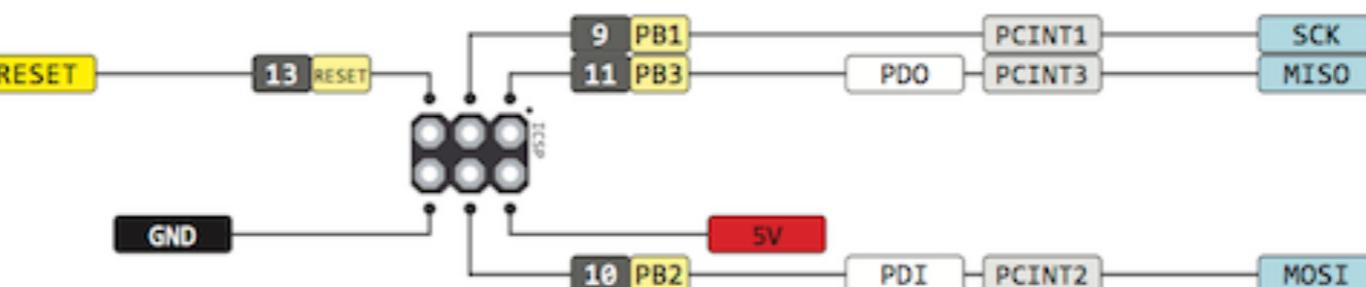
VIN

The input voltage to the Arduino board when it is running from external power.
Not USB bus power.



POWER
GND
3.3V
5V
GND
GND
VIN

DIGITAL (PWM)
A0
A1
A2
A3
A4
A5



PWM type

- PWM 18bit
- PWM 8/16bit
- PWM 16bit
- PWM HS
- PWM 8bit



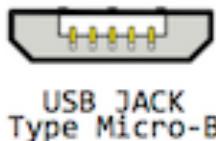
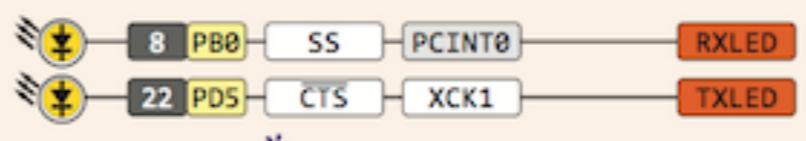
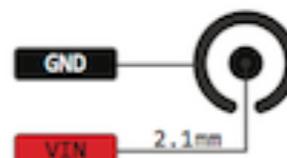
www.pighxxx.com



08 MAR 2013

ver 2 rev 0 - 08.03.2013

① 7-12V Depending on current drawn



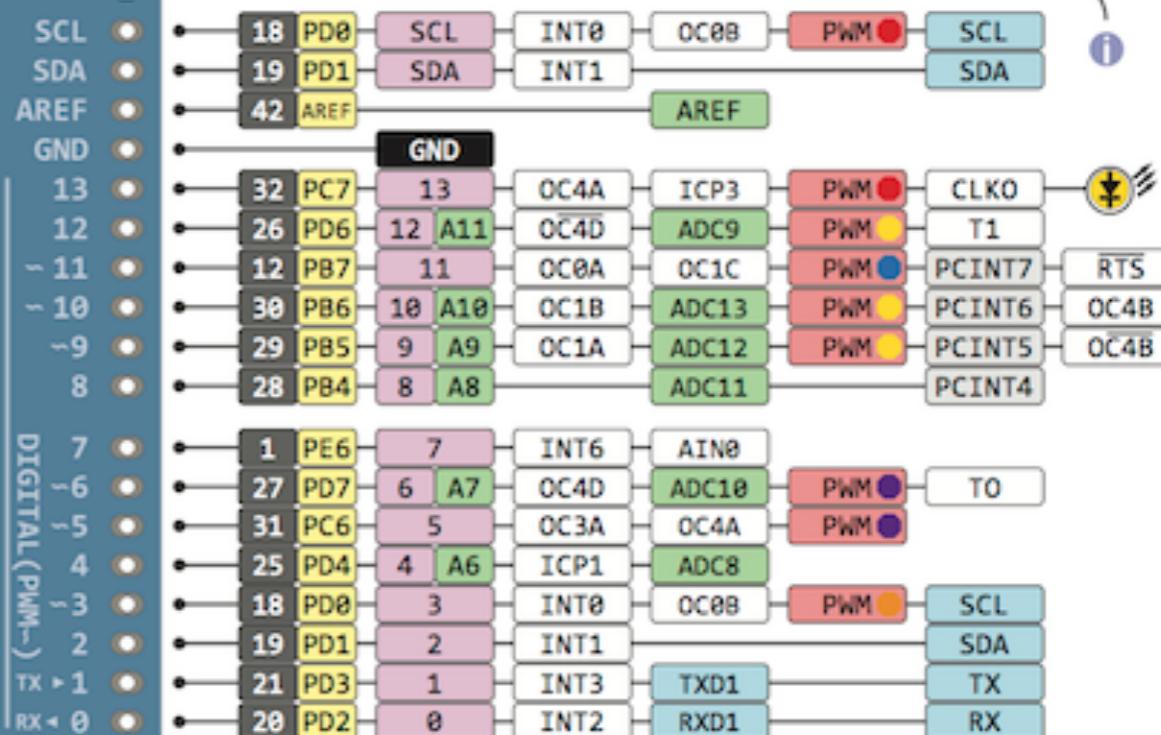
USB JACK Type Micro-B

⚠ Absolute max per pin 40mA recommended 20mA

⚠ Absolute max 200mA for entire package



RESET Button



Legend:

- GND
- Power
- Control
- Physical Pin
- Port Pin
- Pin Function
- Digital Pin
- Analog Related Pin
- PWM Pin
- Serial Pin
- IDE

sketch_oct07a | Arduino 1.8.5

```
sketch_oct07a §

void setup() {
  pinMode(13, OUTPUT);
}

void loop() {
  digitalWrite(13, HIGH);
  digitalWrite(13, LOW);
}
```

Auto Format finished.

Arduino/Genuino Uno on COM1

Hantek



0.000s



W

8.00us

Measure

Frequency

46.55KHz

Period

21.48us

Mean

-1.60V

►Pk-Pk

4.32V

Minimum

-3.68V

Maximum

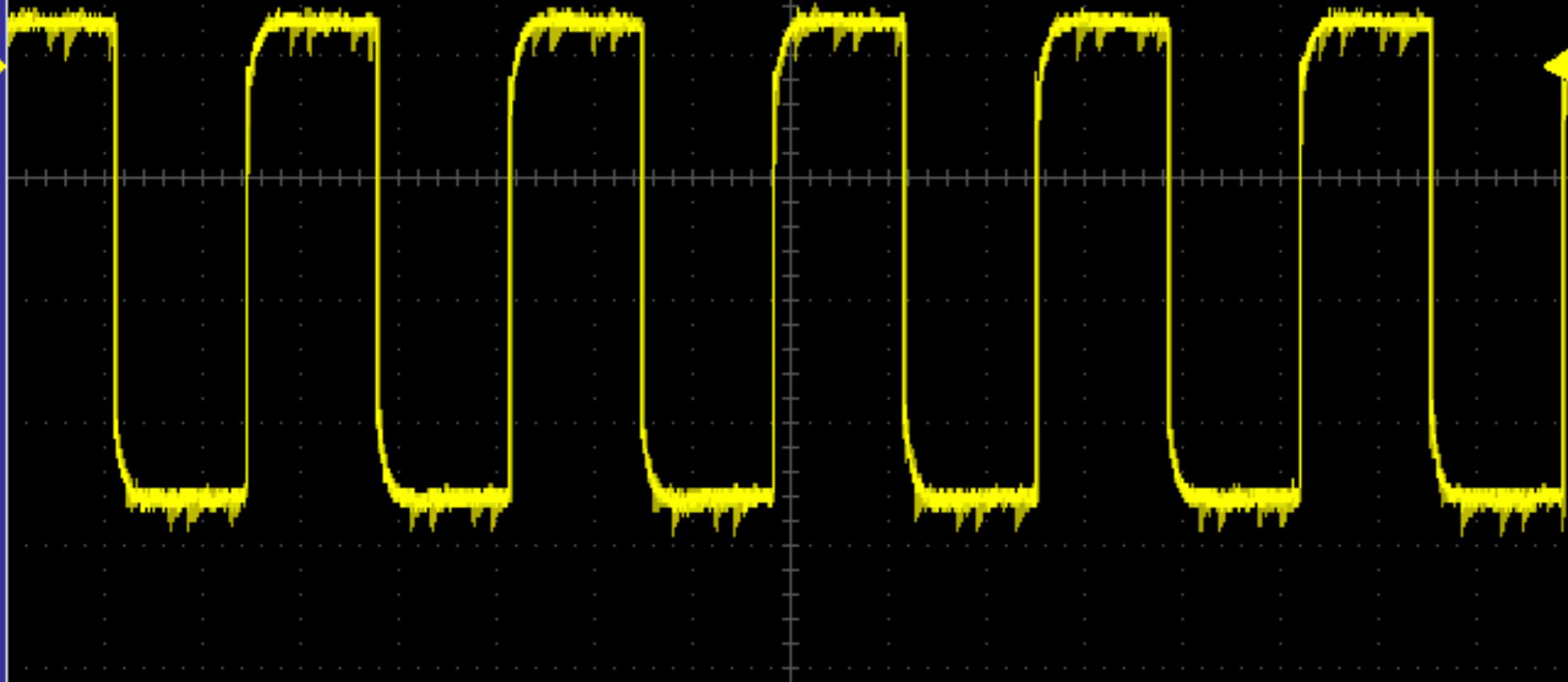
640mV

+Pulse Width

10.72us

Rise Time

960.0ns



DC 20 mV

1.00V

CH1 0.00V

45.8360KHz

Modify

The screenshot shows the Arduino IDE interface. The title bar reads "sketch_oct07a | Arduino 1.8.5". The toolbar at the top includes icons for file operations (checkmark, arrow, file, upload, download) and a search function. The main code editor window displays the following C++ code:

```
sketch_oct07a §

void setup() {
  pinMode(13, OUTPUT);
}

void loop() {
  PORTC |= 1 << 7;
  PORTC &= ~ (1 << 7);
}
```

A message in the status bar at the bottom left says "Auto Format finished." The status bar also indicates the connection is "LilyPad Arduino USB on COM1".

Hantek



T



400ns

Measure



Frequency

1.000MHz

Period

1.000us

Mean

-2.24V

Pk-Pk

4.16V

Minimum

-3.48V

►Maximum

680mV

+Pulse Width

252.5ns

Rise Time

25.00ns

Modify

0.000s



1.00V

CH1 0.00V

960.964KHz

sketch_oct07a | Arduino 1.6.5

```
sketch_oct07a §

void setup() {
  pinMode(13, OUTPUT);
}

void loop() {
  PORTC = 255;
  PORTC = 0;
}
```

Auto Format finished.

Hantek



T



400ns

Measure



Frequency

1.333MHz

Period

750.0ns

Mean

-2.68V

Pk-Pk

4.16V

Minimum

-3.60V

►Maximum

560mV

+Pulse Width

125.0ns

Rise Time

22.50ns

Modify

0.000s



DC 20mV 1.00V

CH1 0.00V

1.08623MHz

sketch_oct07a | Arduino 1.8.5

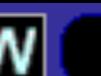
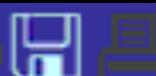
```
sketch_oct07a §

void setup() {
  pinMode(13, OUTPUT);
}

void loop() {
  while (true) {
    PORTC = 255;
    PORTC = 0;
  }
}
```

Auto Format finished.

Hantek



400ns

Measure

Frequency

2.000MHz

Period

500.0ns

Mean

-2.28V

Pk-Pk

4.00V

Minimum

-3.44V

►Maximum

560mV

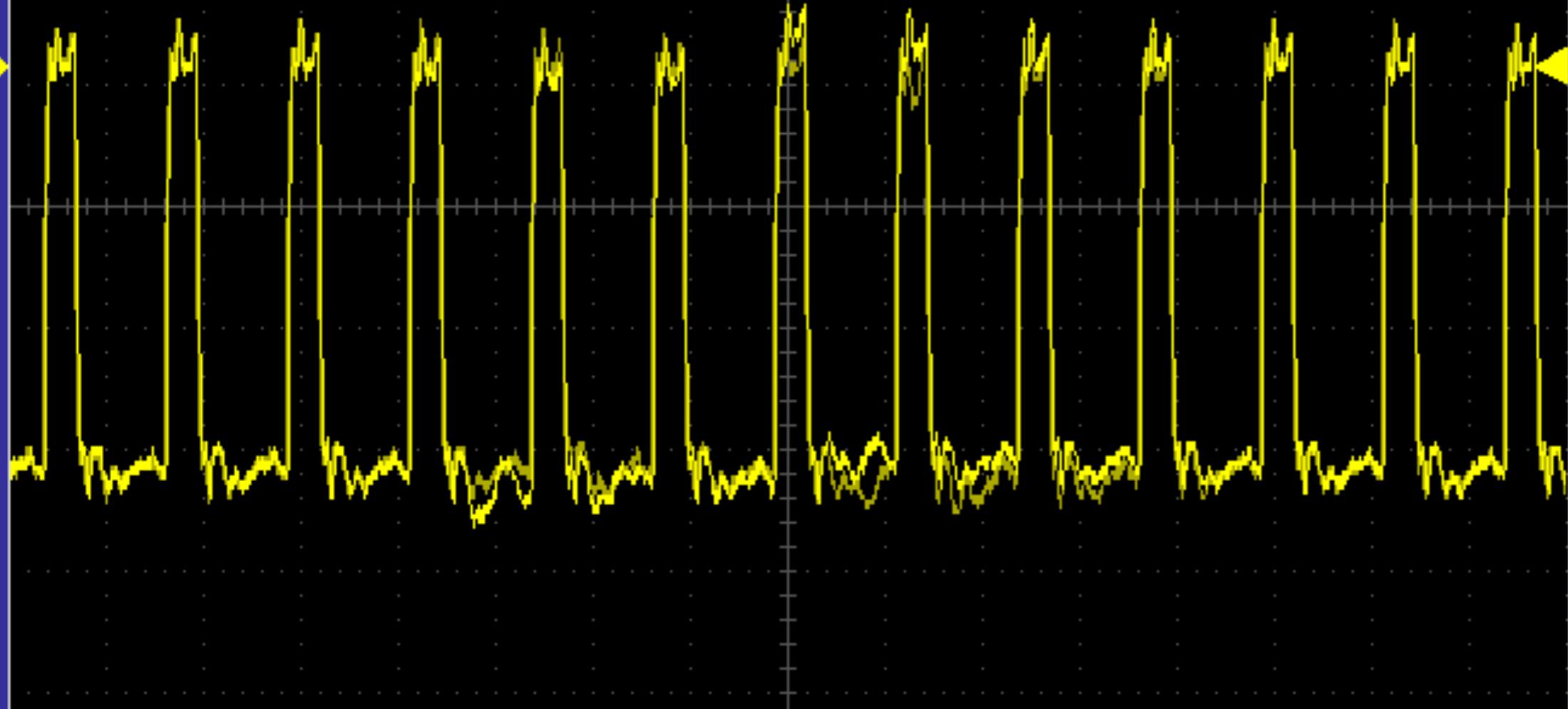
+Pulse Width

127.5ns

Rise Time

25.00ns

Modify



DC 1.00V

CH1 0.00V

1.68150MHz

Debug using Serial.println

The image shows the Arduino IDE interface. The top bar indicates the project is named "Blink" and is using version 1.8.5. The left sidebar shows the file structure: "Blink §". The main code editor contains the following sketch:

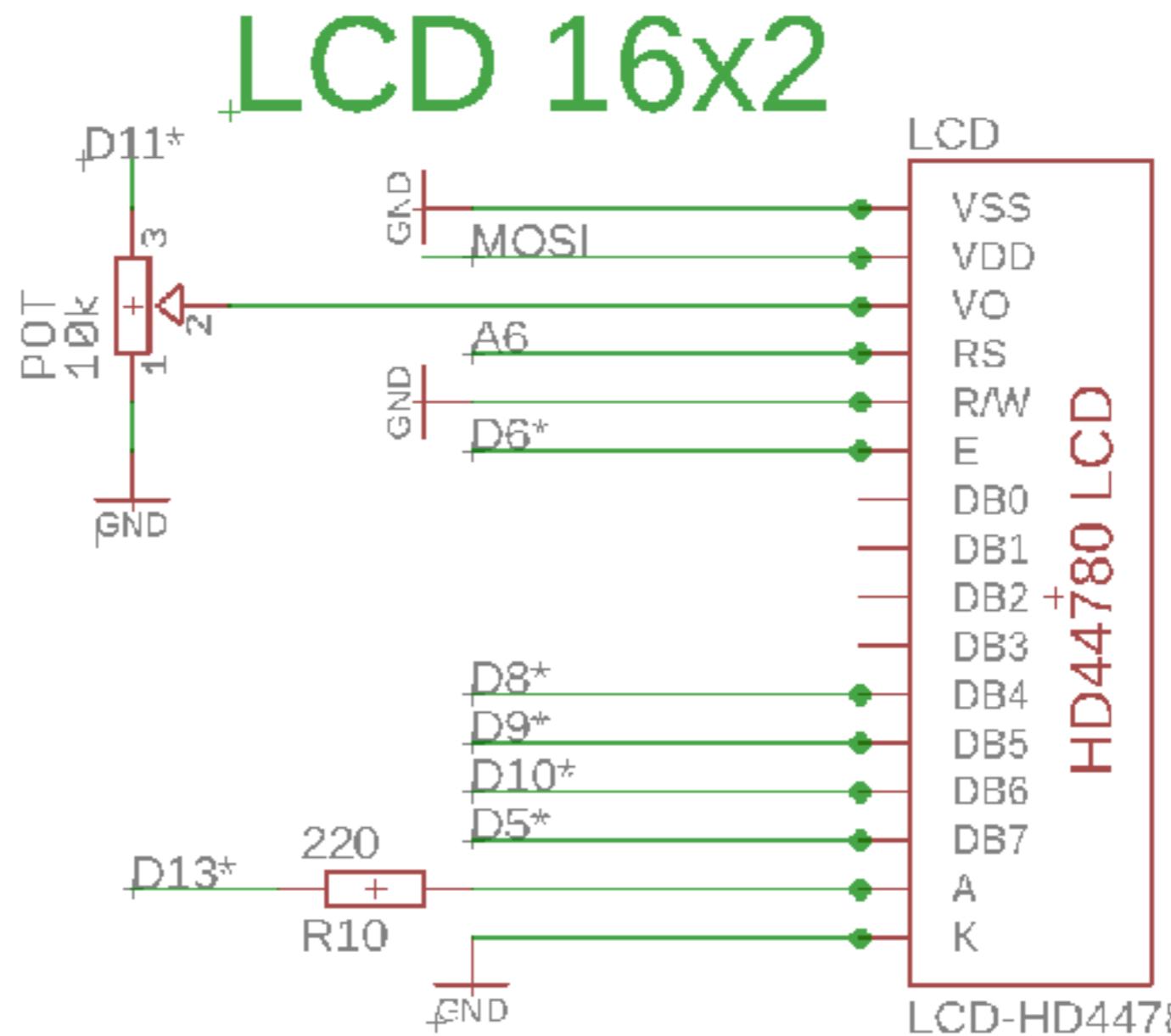
```
void setup() {
  Serial.begin(9600);
}

void loop() {
  Serial.print("Millis: ");
  Serial.println(millis());
  delay(1000);
}
```

In the bottom status bar, it says "Done uploading.". To the right of the IDE, a separate terminal window is open, showing the serial output for the Arduino Leonardo connected via "/dev/cu.usbmodemFA131". The output displays the current millisecond value every second:

```
Millis: 5001
Millis: 6001
Millis: 7002
Millis: 8001
Millis: 9001
Millis: 10002
Millis: 11002
Millis: 12003
Millis: 13002
```

Test all the functionalities

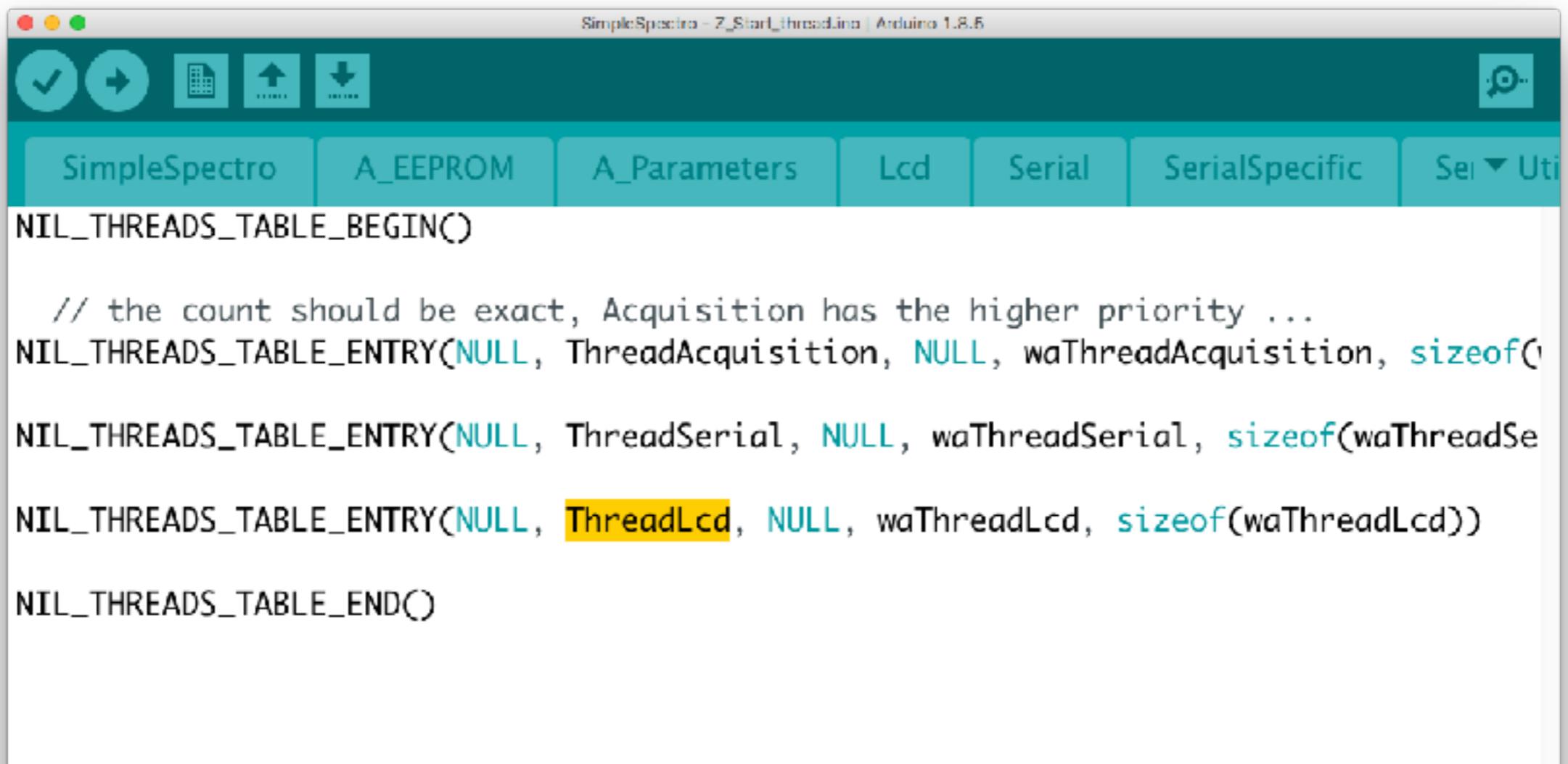


Exercise: Test LCD display

Multithread

Scalable way of programming

- Tabs
- NilRTOS (multi-thread)



The screenshot shows the Arduino IDE interface with the title bar "SimpleSpectro - Z_Start_thread.ino | Arduino 1.8.6". The top menu bar includes File, Edit, Tools, Sketch, Help, and a search bar. Below the menu is a toolbar with icons for Save, Undo, Redo, Open, Upload, and Download. The main window displays the following C++ code:

```
SimpleSpectro A_EEPROM A_Parameters Lcd Serial SerialSpecific Sei ▾ Util
NIL_THREADS_TABLE_BEGIN()

// the count should be exact, Acquisition has the higher priority ...
NIL_THREADS_TABLE_ENTRY(NULL, ThreadAcquisition, NULL, waThreadAcquisition, sizeof(waThreadAcquisition))

NIL_THREADS_TABLE_ENTRY(NULL, ThreadSerial, NULL, waThreadSerial, sizeof(waThreadSerial))

NIL_THREADS_TABLE_ENTRY(NULL, ThreadLcd, NULL, waThreadLcd, sizeof(waThreadLcd))

NIL_THREADS_TABLE_END()
```



BasicNil

```
#include <NilRTOS.h>

void setup() {
  nilSysBegin();
}
void loop() {}

NIL_WORKING_AREA(waThread1, 16);
NIL_THREAD(Thread1, arg) {
  const uint8_t LED_PIN = 10;
  pinMode(LED_PIN, OUTPUT);
  while (TRUE) {
    digitalWrite(LED_PIN, HIGH);
    digitalWrite(LED_PIN, LOW);
    nilThdSleep(1); // need to use this method otherwise next thread will not be executed
  }
}

NIL_WORKING_AREA(waThread2, 128);
NIL_THREAD(Thread2, arg) {
  Serial.begin(9600);
  while (TRUE) {
    Serial.println(millis()); // really bad to nilThdSleep
  }
}

NIL_THREADS_TABLE_BEGIN()
NIL_THREADS_TABLE_ENTRY("thread1", Thread1, NULL, waThread1, sizeof(waThread1))
NIL_THREADS_TABLE_ENTRY("thread2", Thread2, NULL, waThread2, sizeof(waThread2))
NIL_THREADS_TABLE_END()
```

Hantek



T



2.00ms

Measure



Frequency

487.8Hz

Period

2.050ms

Mean

40.0mV

Pk-Pk

4.12V

Minimum

-120mV

►Maximum

4.00V

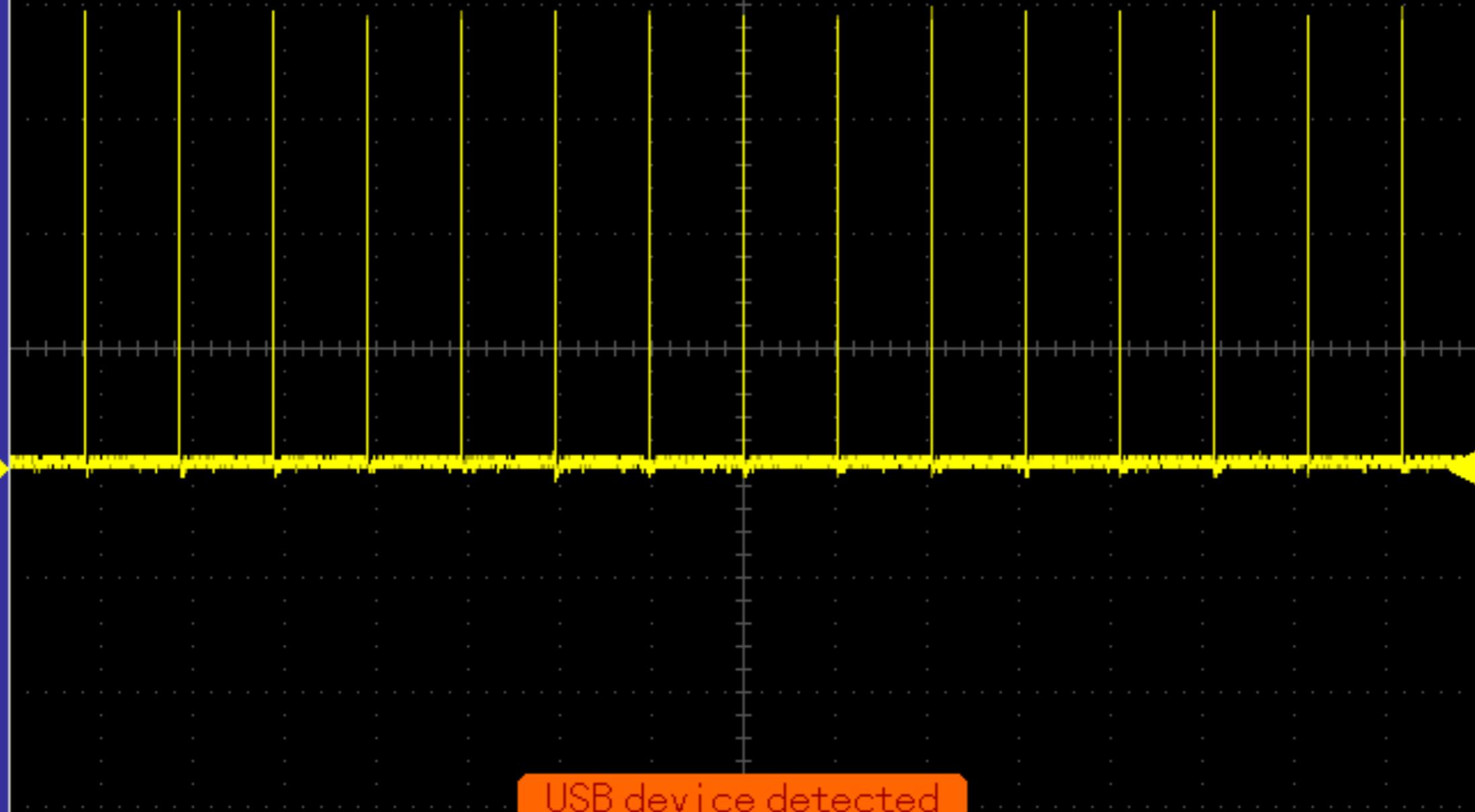
+Pulse Width

10.00us

Rise Time

10.00us

0.000s



USB device detected

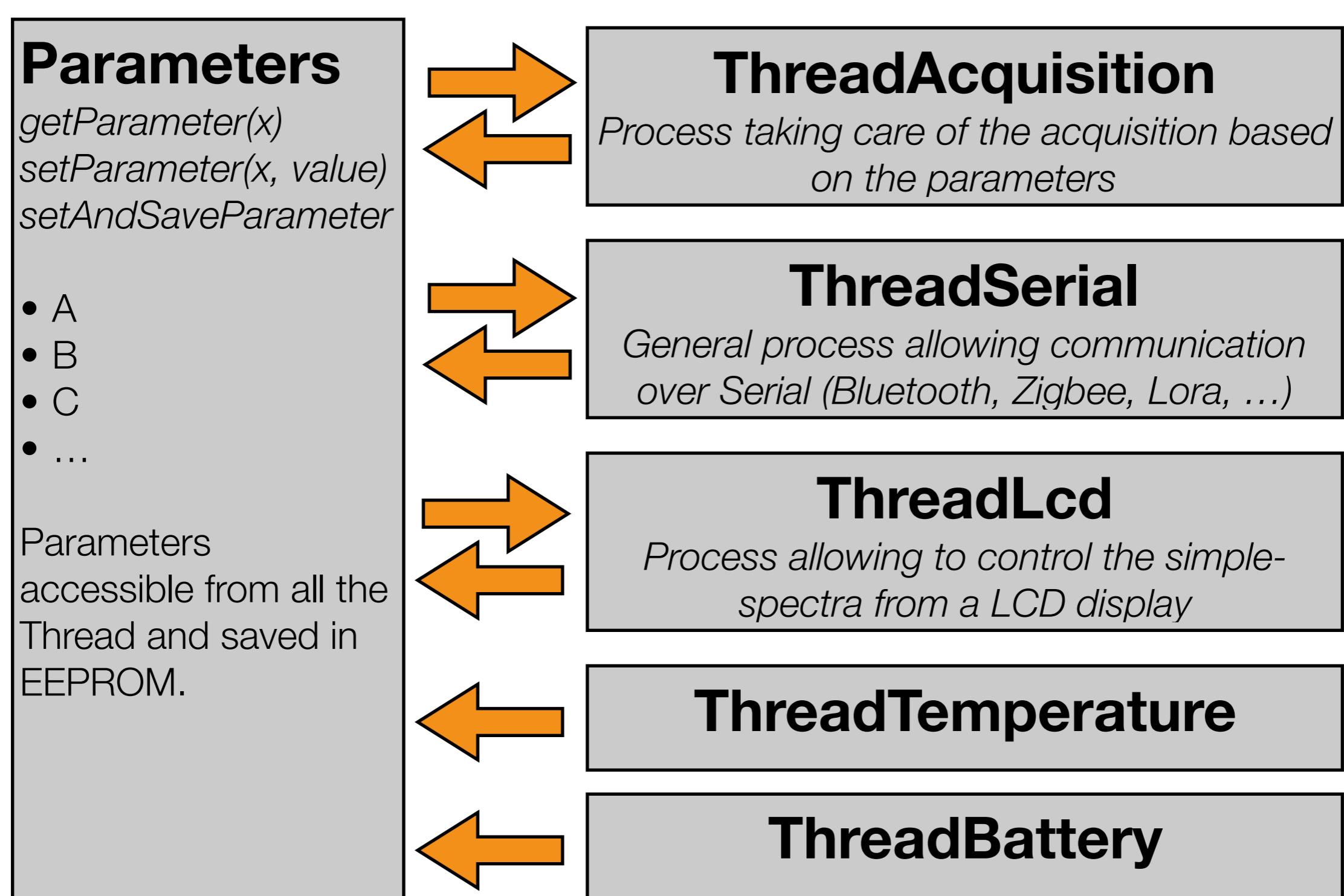
DC 20 1.00V

CH1 0.00V

488.000Hz

Modify

Multithread with Shared parameters



| | | | |
|----|---|---------------|---------------------------------------------------------------|
| 0 | A | COLOR_1 | Red value for sample |
| 1 | B | COLOR_2 | Green value for sample |
| 2 | C | COLOR_3 | Blue value for sample |
| 3 | D | COLOR_4 | UV value for sample |
| 4 | E | COLOR_5 | Not used |
| 5 | F | BLANK_1 | Red value for blank |
| 6 | G | BLANK_2 | Green value for blank |
| 7 | H | BLANK_3 | Blue value for blank |
| 8 | I | BLANK_4 | UV value for blank |
| 9 | J | BLANK_5 | Not used |
| 10 | K | BEFORE_DELAY | Delay before taking blank |
| 11 | L | FIRST_DELAY | Delay between blank and first experiment |
| 12 | M | INTER_DELAY | Delay between experiments |
| 13 | N | NUMPER_EXP | Number of experiments |
| 14 | O | NEXT_EXP | Next experiment, 0 blank and then for kinetic |
| 15 | P | WAIT | Current time to wait |
| 16 | Q | NUMBER_ACQ | number of acquisition of 100ms that will be taken |
| 17 | R | INVERT_ROTARY | invert rotary direction |
| 18 | S | BATTERY | battery voltage (hundredths of volt) |
| 19 | T | TEMPERATURE | temperature (hundredths of degree) |
| 21 | V | ACTIVE_LEDS | as a binary code (red, green, blue, uv, temperature, battery) |

Connecting to spectro

Serial monitor



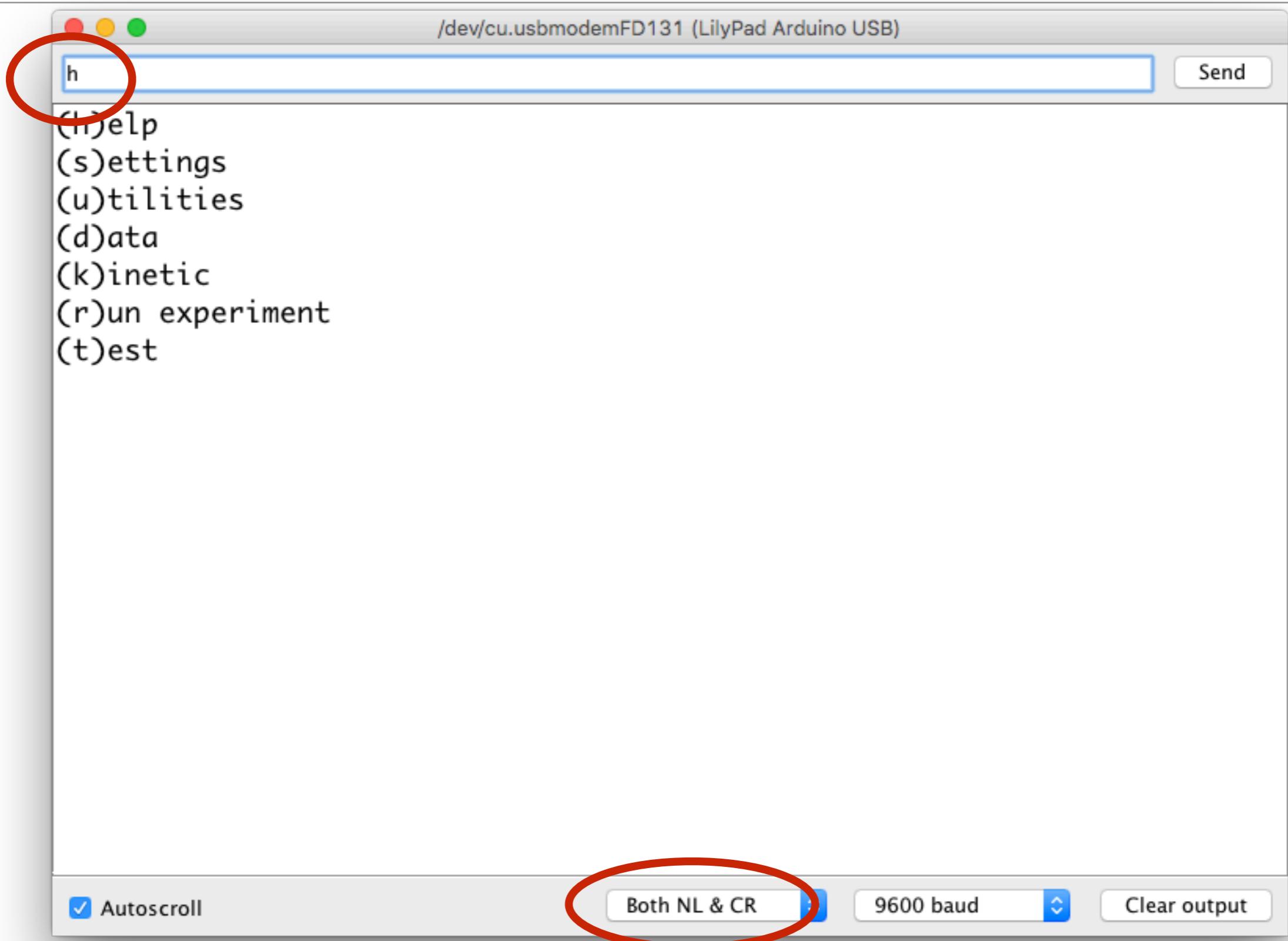
The screenshot shows the Arduino IDE interface. The title bar reads "sketch_oct07b | Arduino 1.8.6". Below the title bar is a toolbar with various icons: a checkmark, a play button, a file icon, an upload icon, a download icon, and a magnifying glass. To the right of the toolbar is a small dropdown menu. The main area contains the following code:

```
sketch_oct07b
void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```

An orange arrow points to the magnifying glass icon in the toolbar, which typically represents the Serial monitor function.

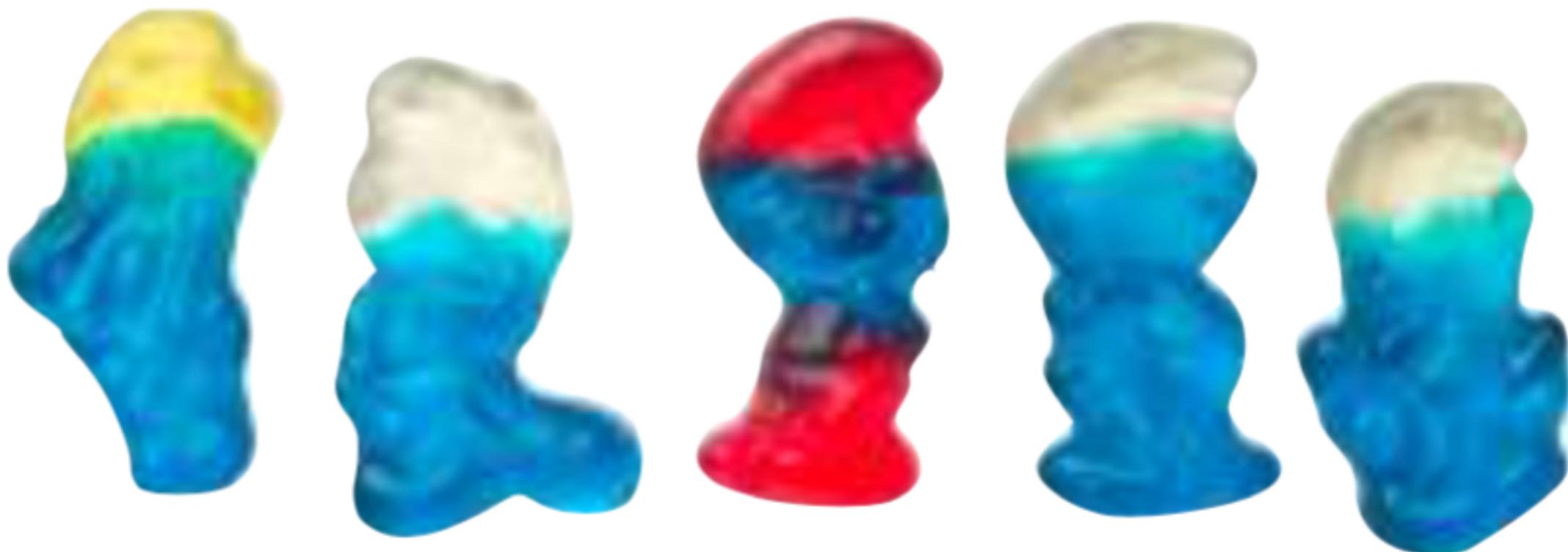
Arduino IDE (Integrated Development Environment)



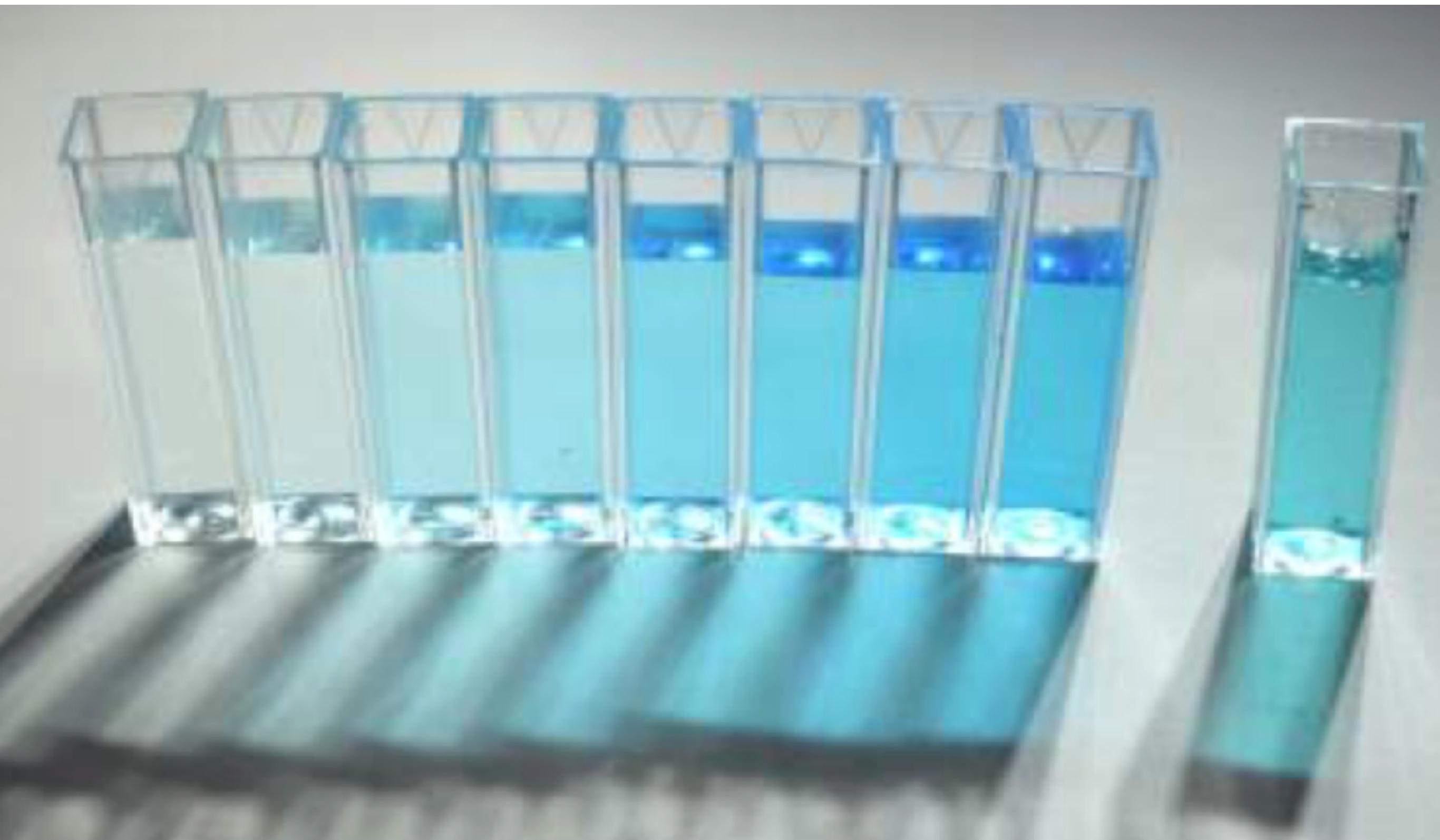
Plot data

Experiments

E131 in Haribo smurfs

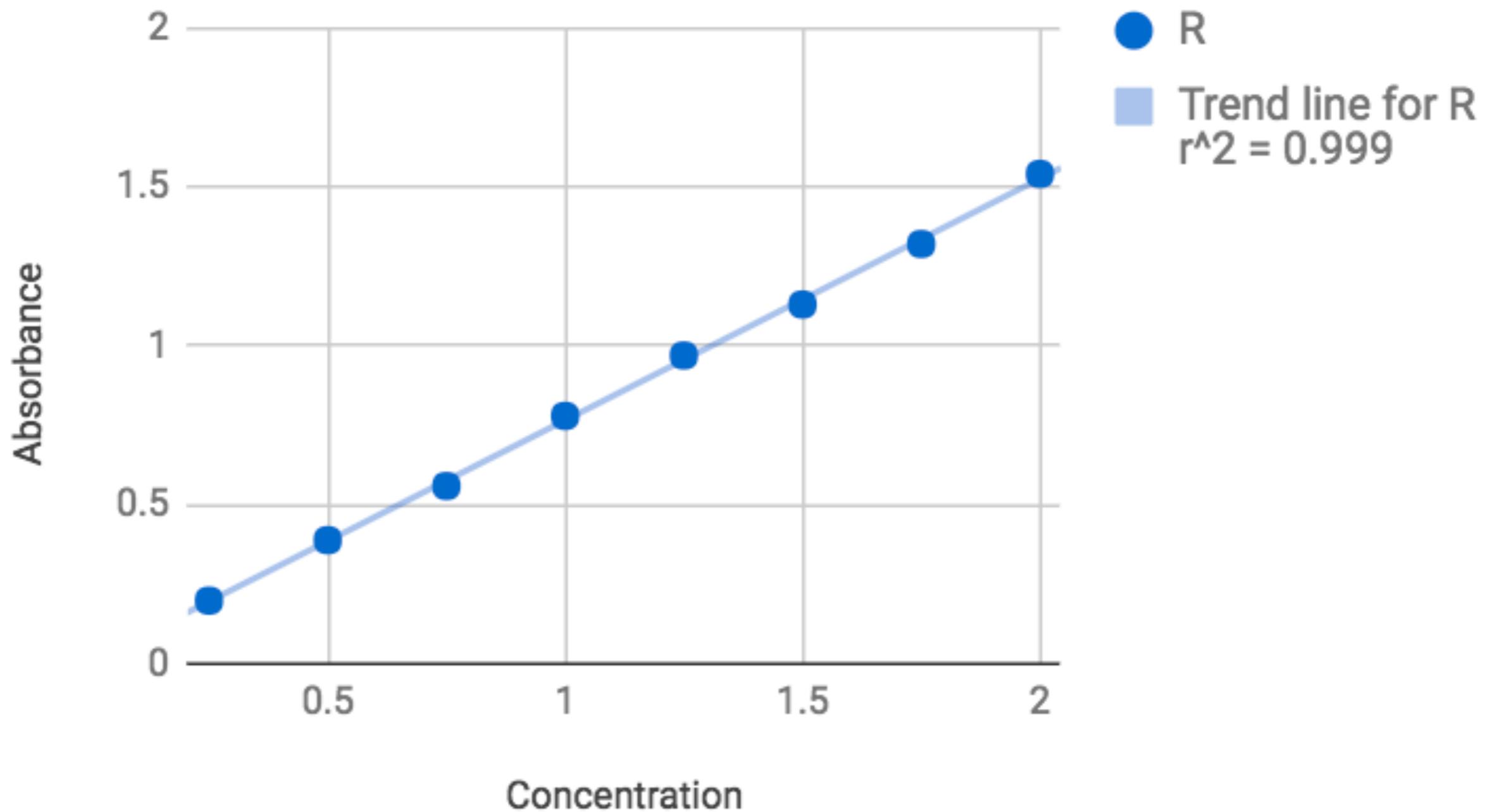


Left: known [], right: Haribo

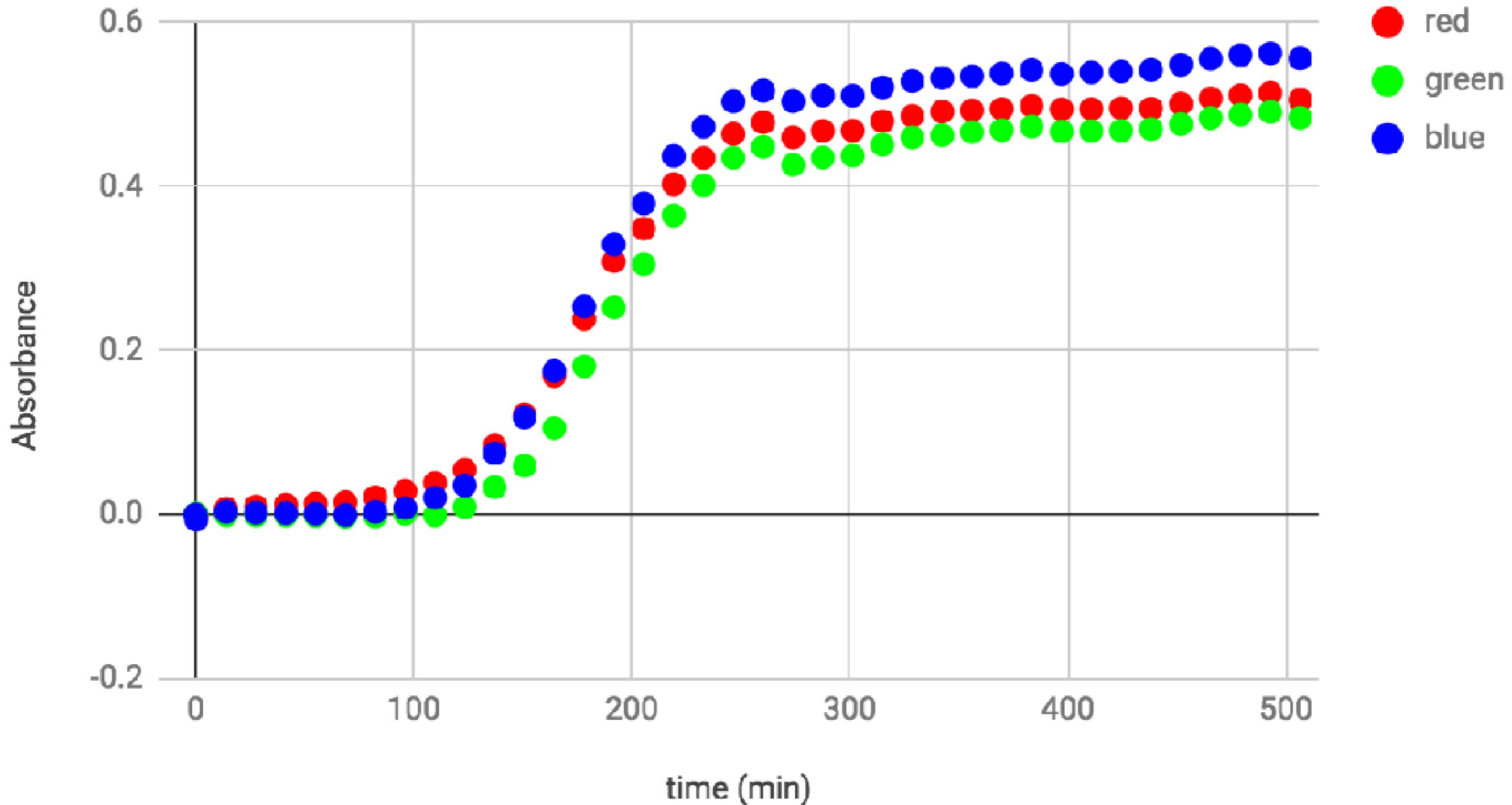




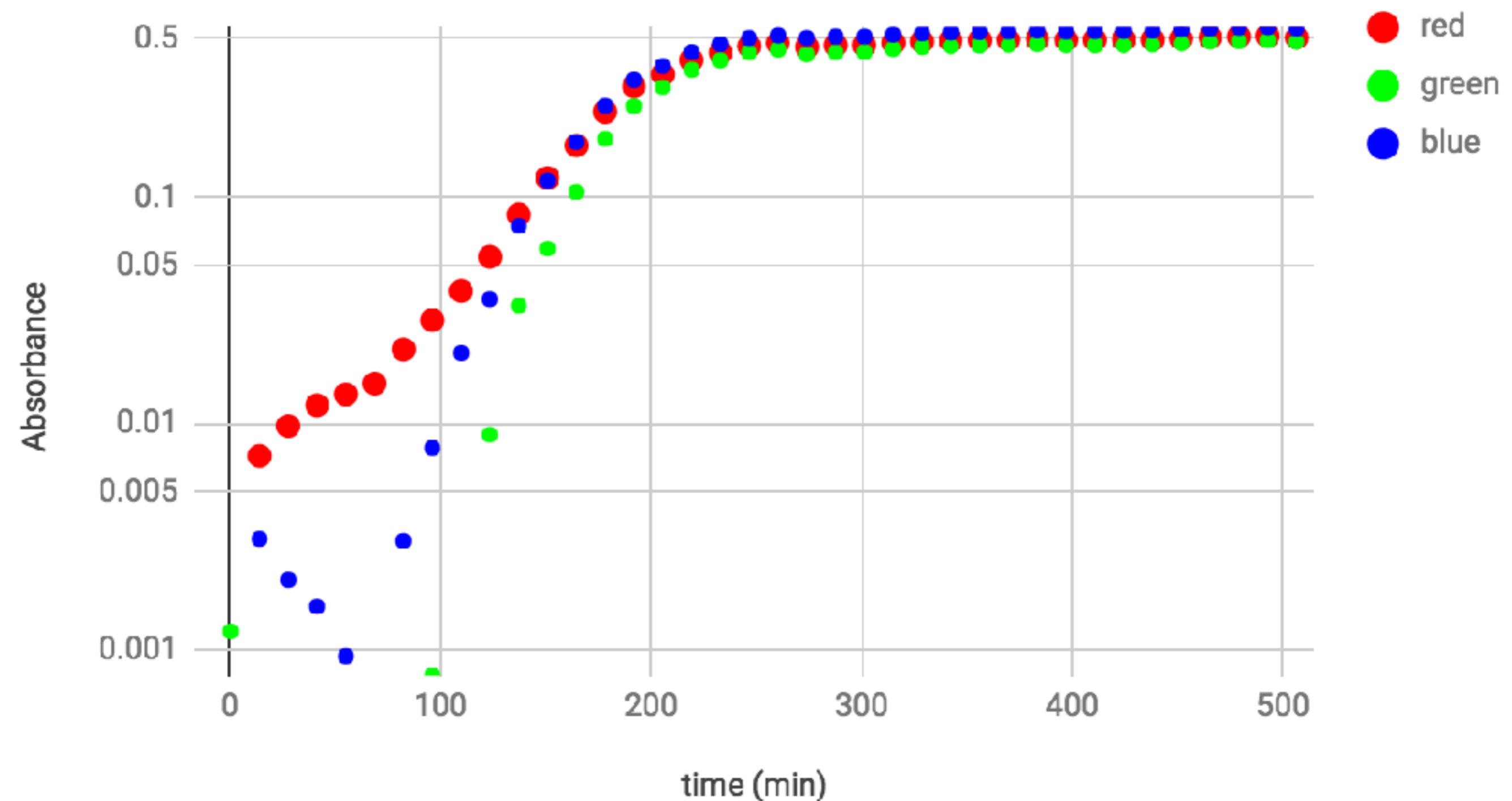
Absorbance versus concentration



OD versus time



OD versus time - log scale



Determine [] of E131

- **Mother solution:**
 - 10mg of E131 in 25mL of water
- **Diluted solutions**
 - 0 mL → 5 mL of mother solution in 20mL of water
 - 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0 mL



Analyse data

What's next ?

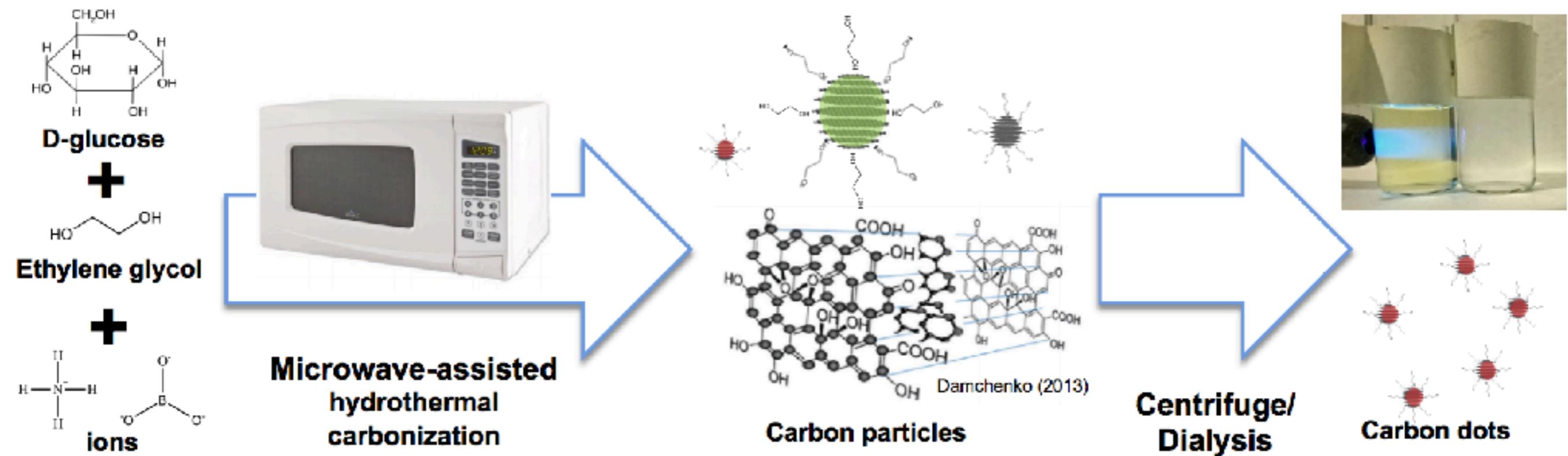
Electronic

- Electronic
 - reduce power consumption
 - hard reset
- Mechanics
 - Good solution for the screen

Applications

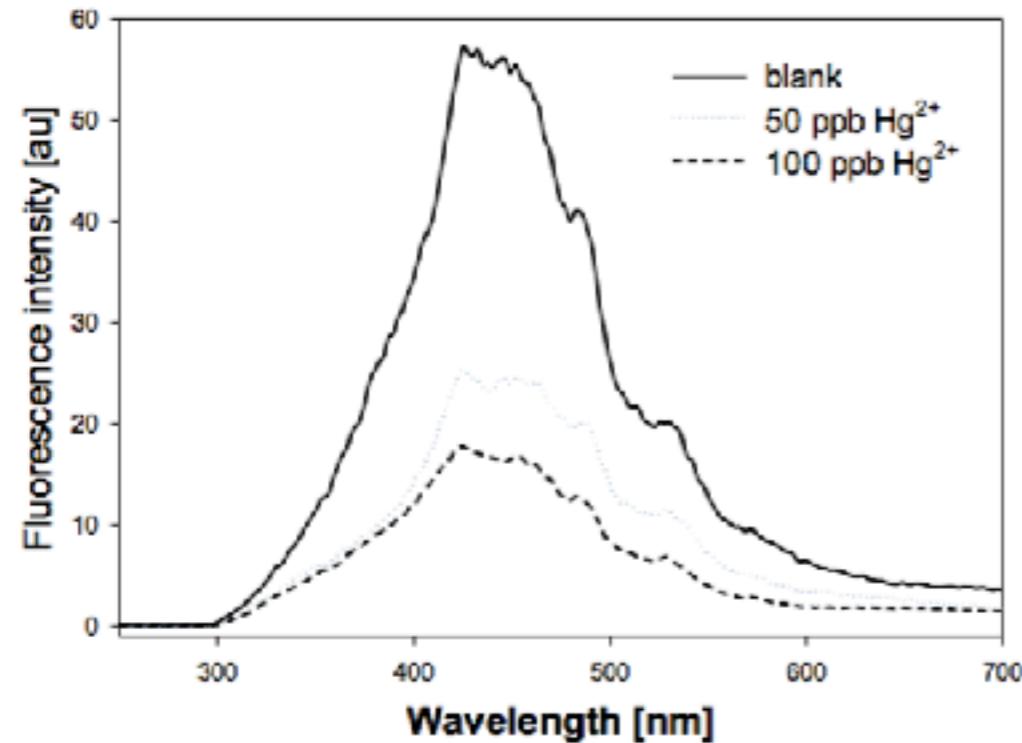
- determination of pH ?
- kinetic reaction
- bacteria growth versus temperature
- various bacteria
- consortium growth
- mercury water contamination using quantum dots

Carbon quantum dots

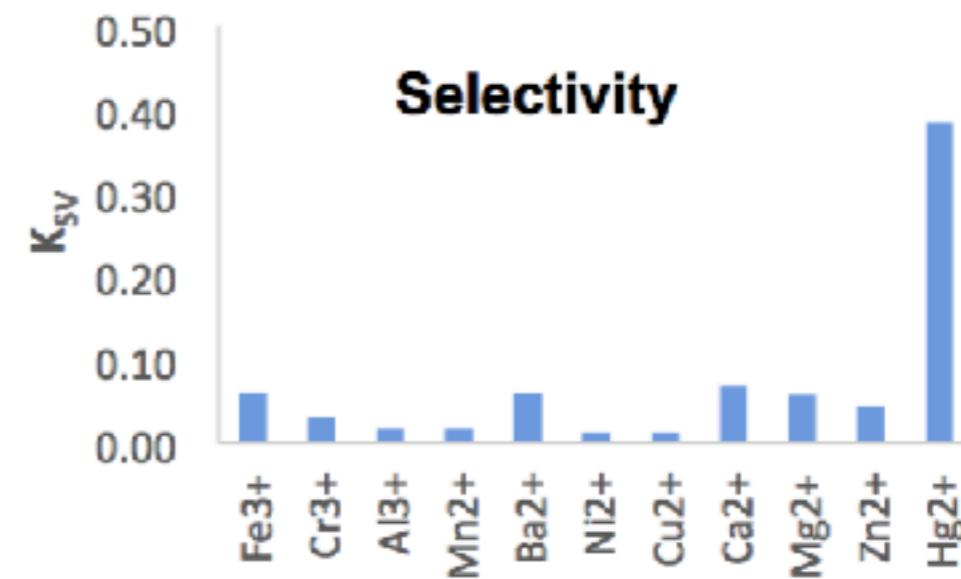
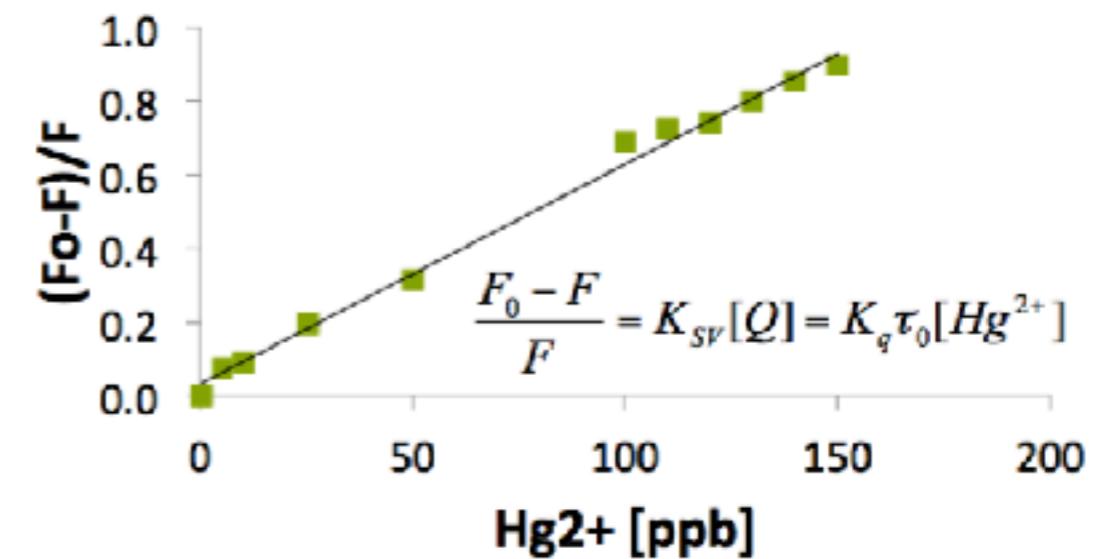


Results

Calibration and selectivity



Limit of Detection: 10.5 ppb
Response time: 5 sec
Selectivity: >98%
Sensitivity: .006/ppb- Hg^{2+}



Currently studying CQD response in mixtures. Early field trials were successful (confirmed by AAS)



