waag society

institute for art, science and technology

BioHack Academy
Incubator Design

Picture by Bas Uterwijk

Why we need an incubator

- The behaviour of microbes is temperature dependent
- Temperature dependent:
  - Enzyme reactions
  - DNA interactions
  - Cell state

Pixabay - CC0

Industry standard

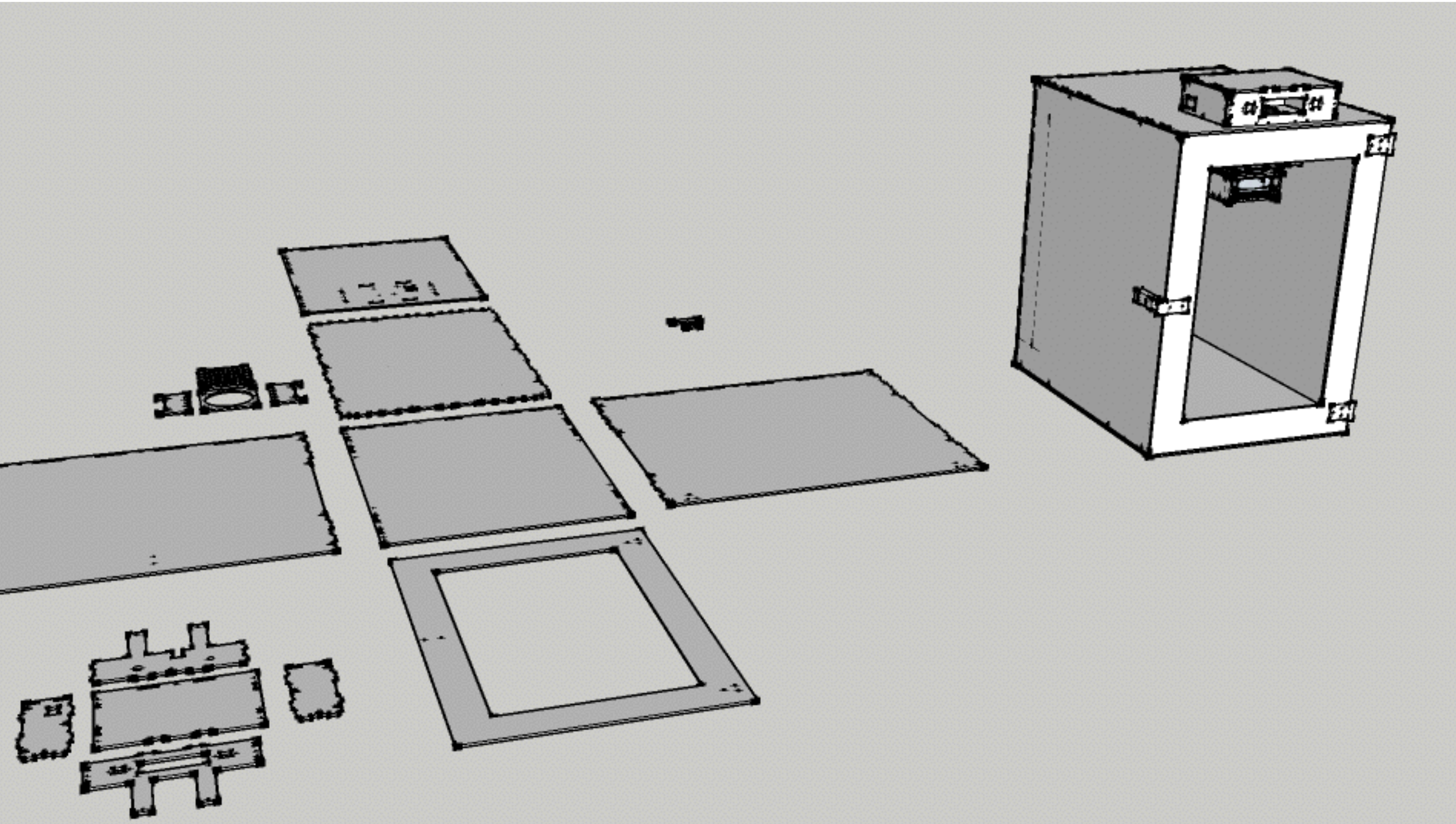
Function

- Heat isolated enclosed cabinet, with see-through window
- Heat source
- Temperature controller
- Temperature indicator
- User interface to set temperature

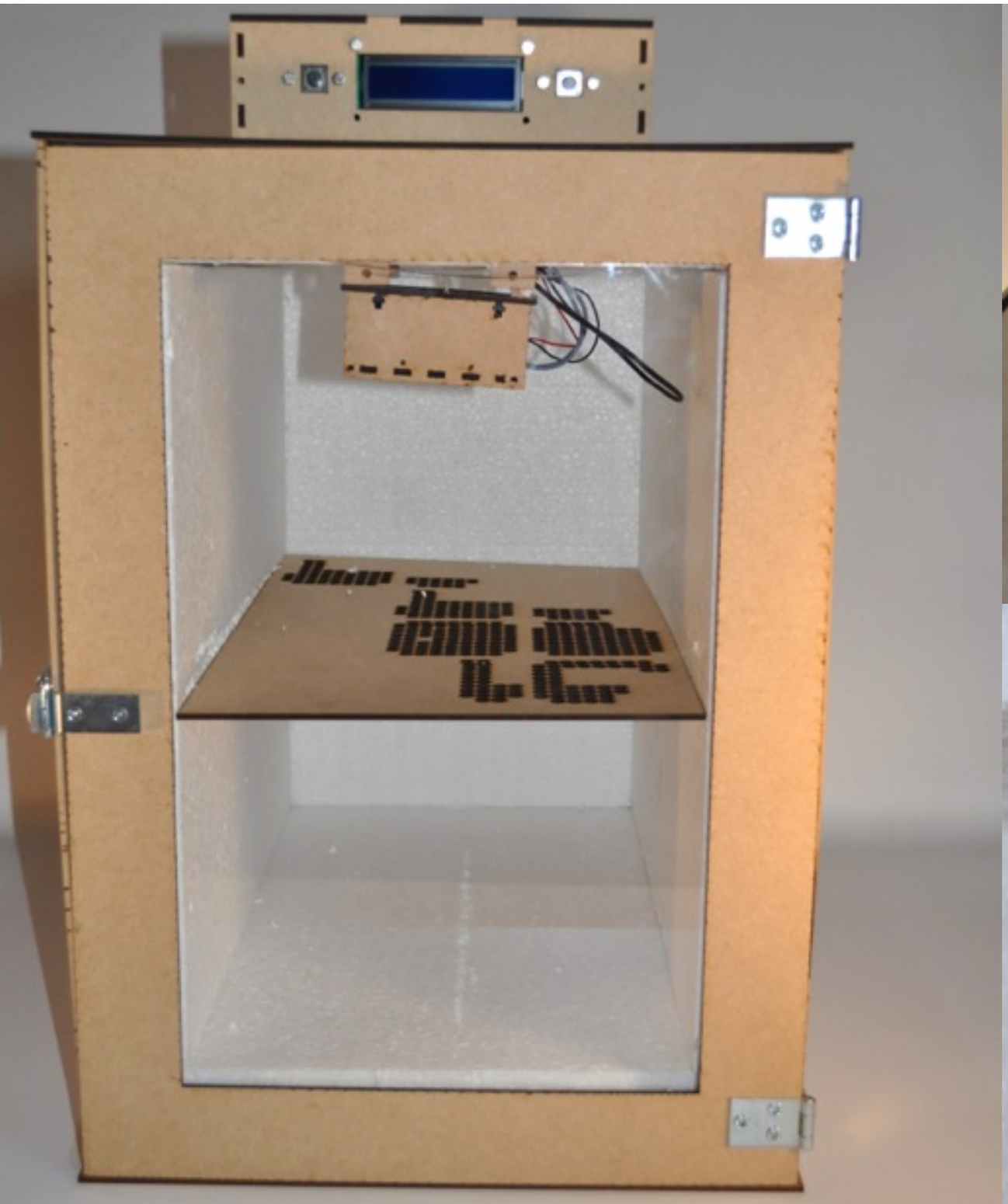
Design constrains:

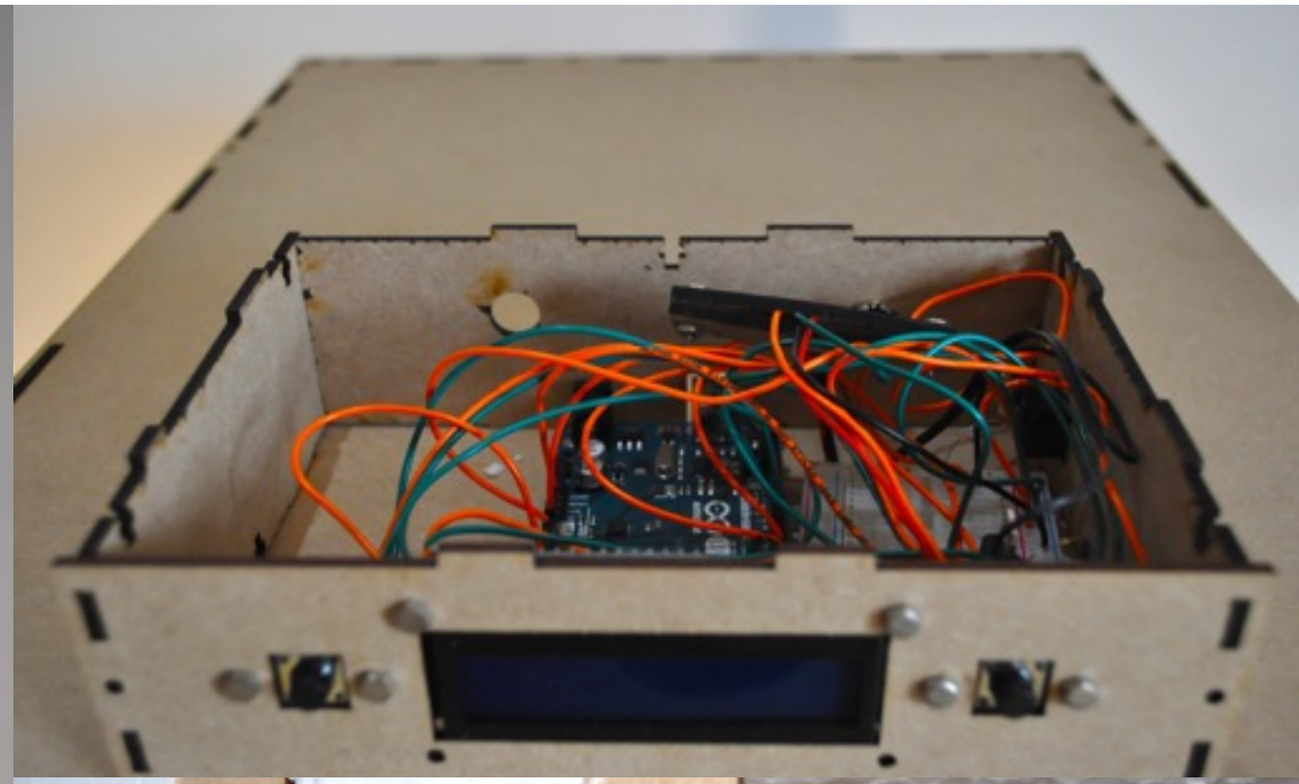
- 9 cm petri dishes

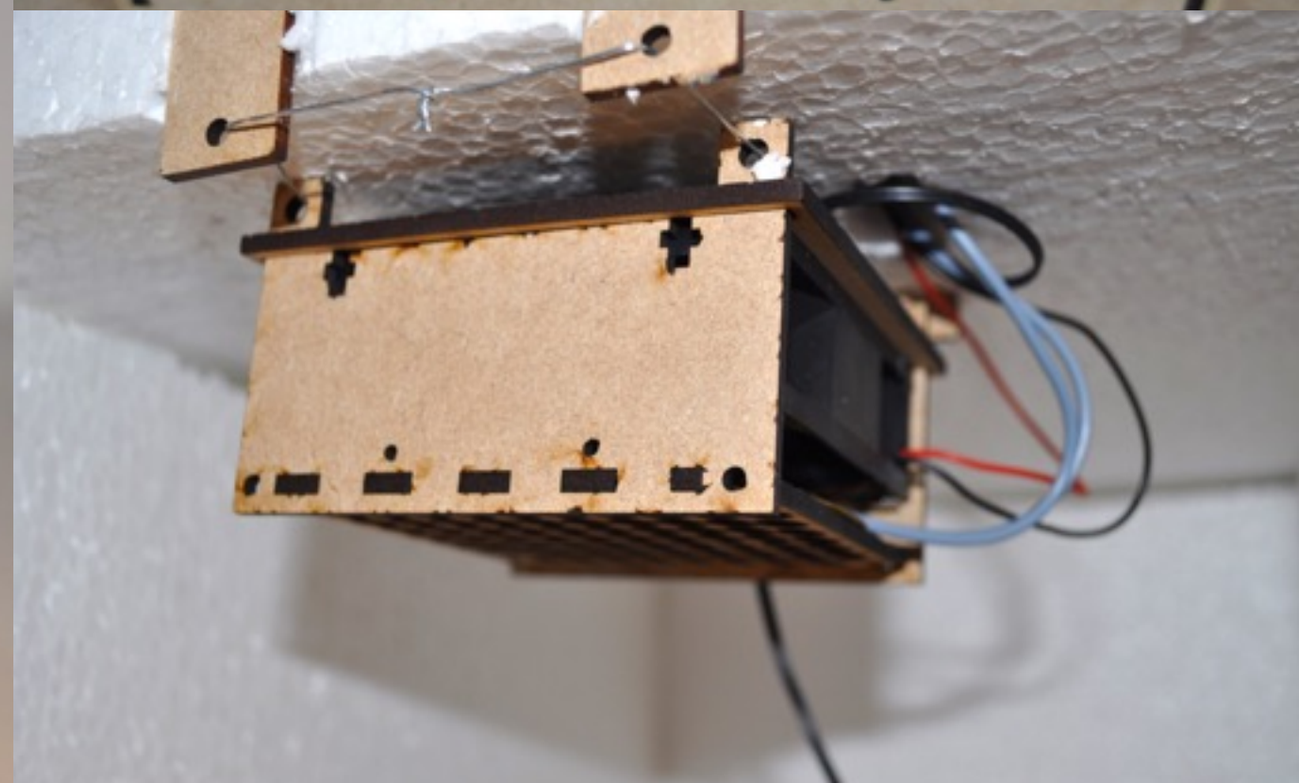
Biohack Academy Incubator



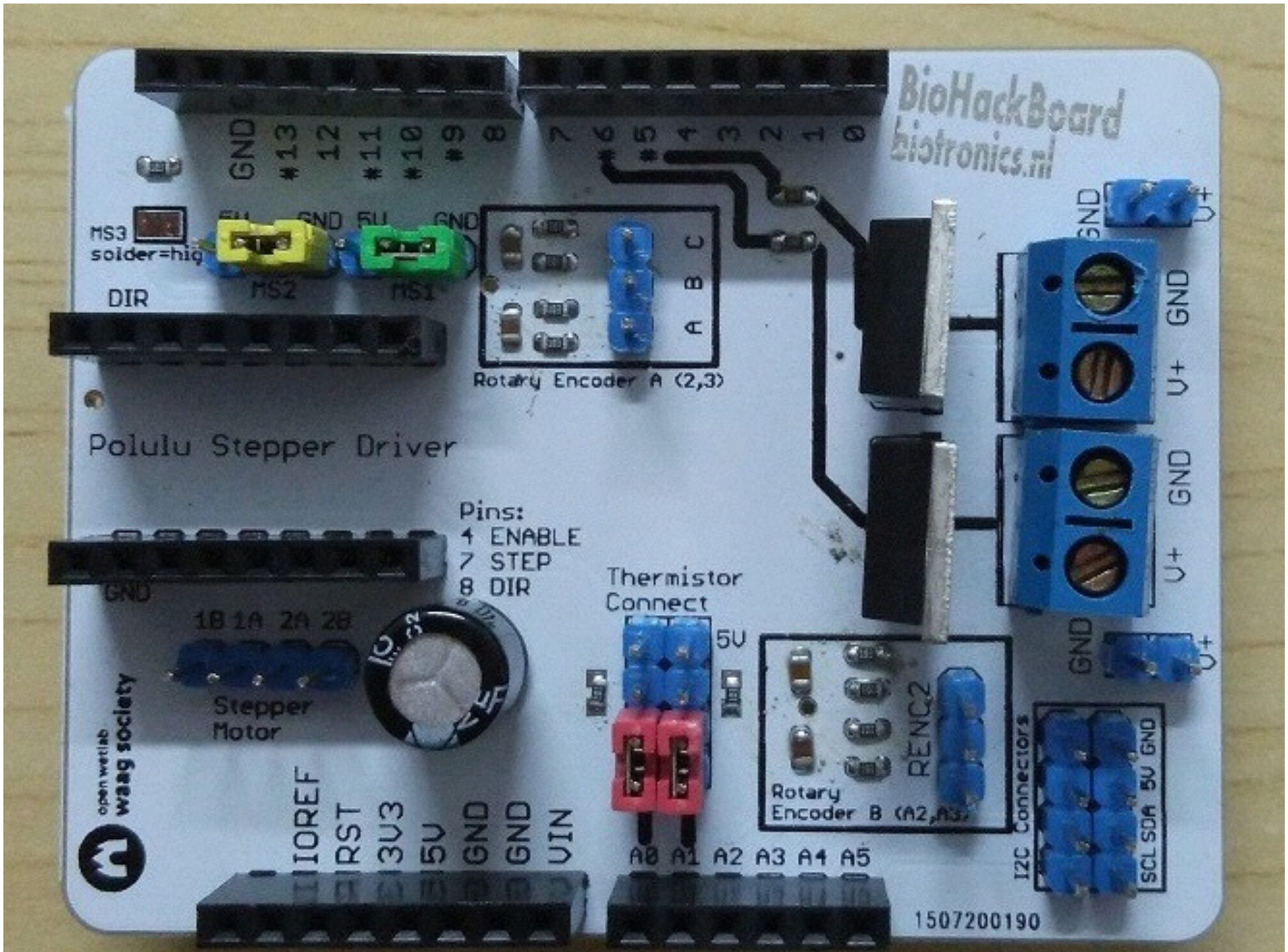
BioHack Academy Incubator







Using the BioHack Board



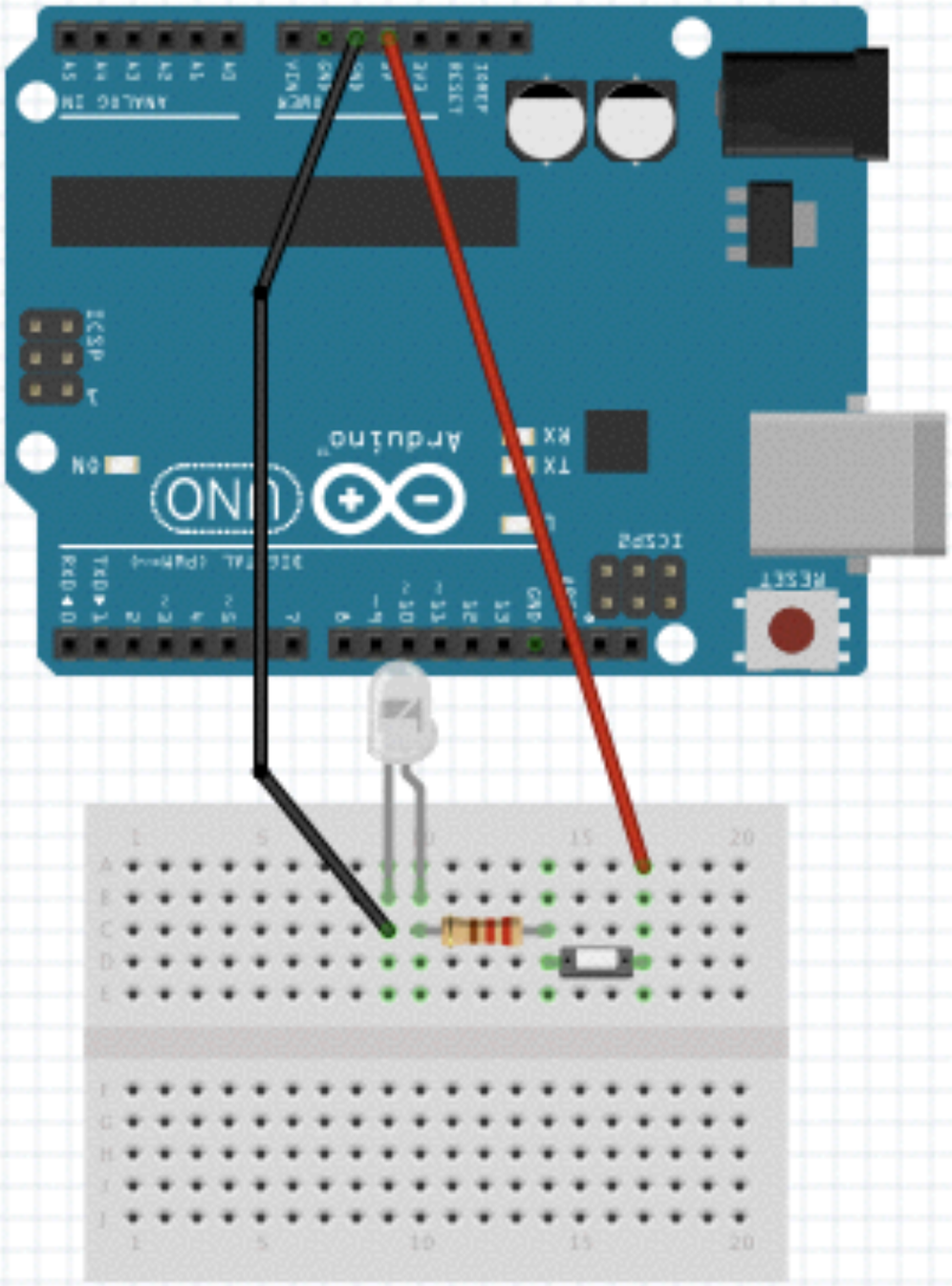
Bill of Materials

= not necessary
when using the BHA Board

No	Amount	Description	Supplier NL	Cost
1	4	3mm MDF 95 x 45 cm	Local wood store, like Houthandel Schmidt	5.00
2	1	Expanded polystyrene (EPS)	Praxis	7.99
3	1	3mm Acrylic sheet 27 x 41 cm	Plexiglas.nl	3.50
4	1	12V 80 mm Axial Fan	EOO, Farnell	8.99
5	1	Power switch	iPrototype	0.95
6	1	Water proof temperature sensor (*1)	HobbyElectronica, iPrototype	2.95
7	1	I2C LCD display	iPrototype, (HobbyElectronica + HobbyElectronica)	16.95
8	2	MOSFET	Farnell, EOO	0.98
9	4	10K resistor	Farnell, EOO	0.06
10	1	Diode	iPrototype, EOO	0.19
11	2	Button	iPrototype	0.55
12	1	White LED	iPrototype, EOO	0.52
13	1	220 Ohm resistor	iPrototype, EOO	0.45
14	1	7.5 W power supply	iPrototype, EOO	13.95
15	1	Jack Adapter	EOO	0.85
16	1	Heating foil	Conrad	20.68

Powering an LED

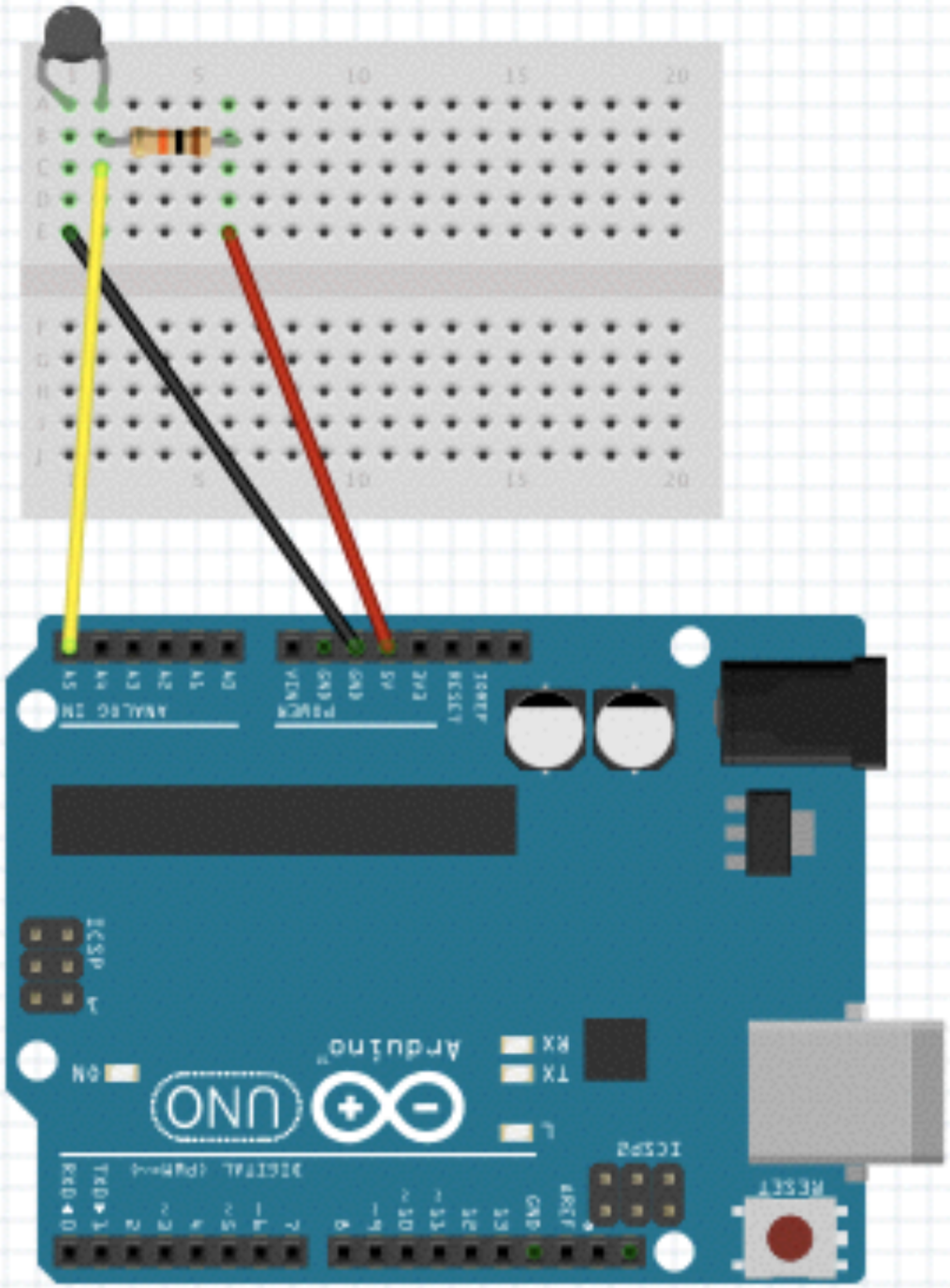
LED circuit



Sensing the temperature

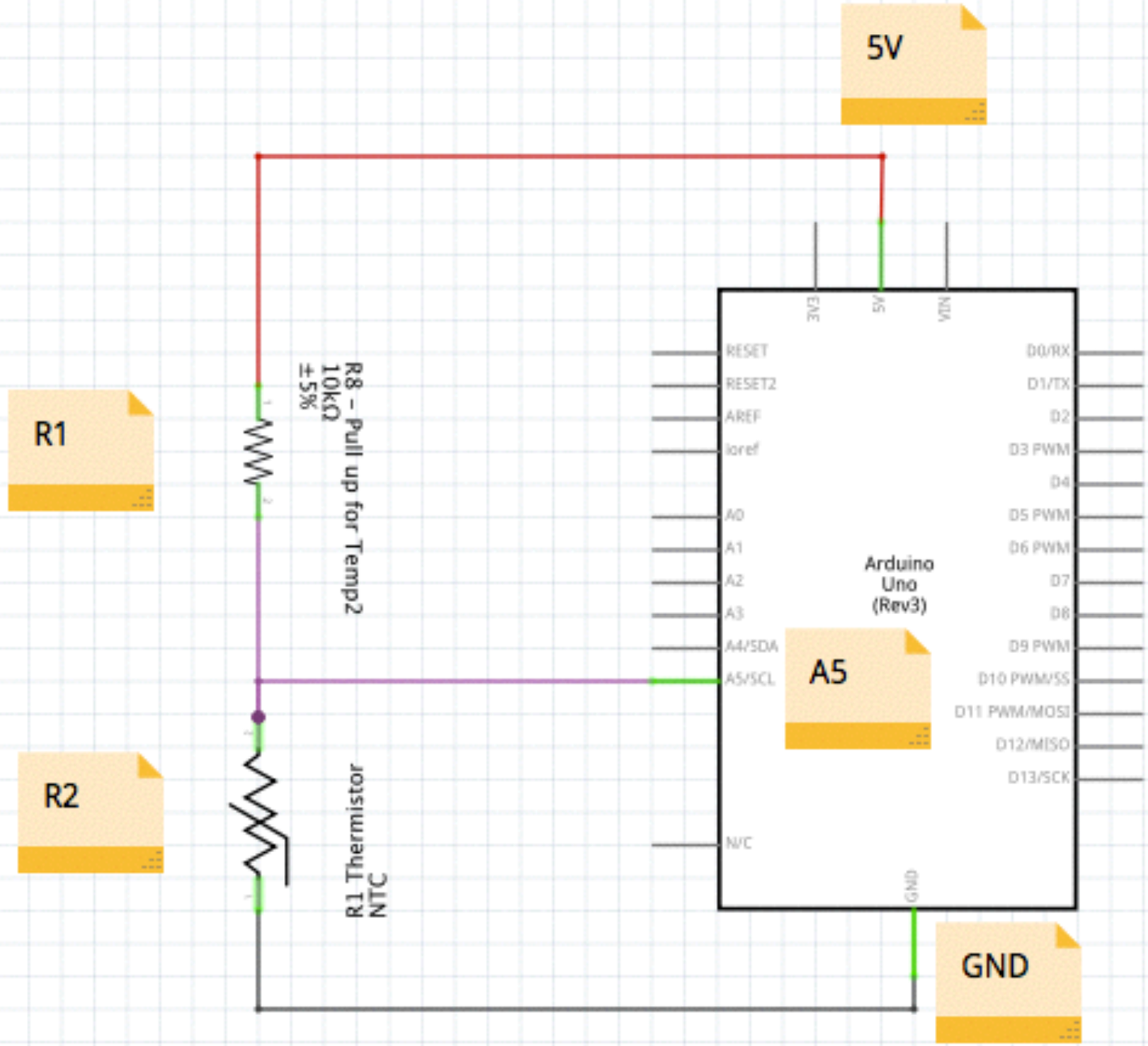
- 10K thermistor

Sensing the temperature



Schematic

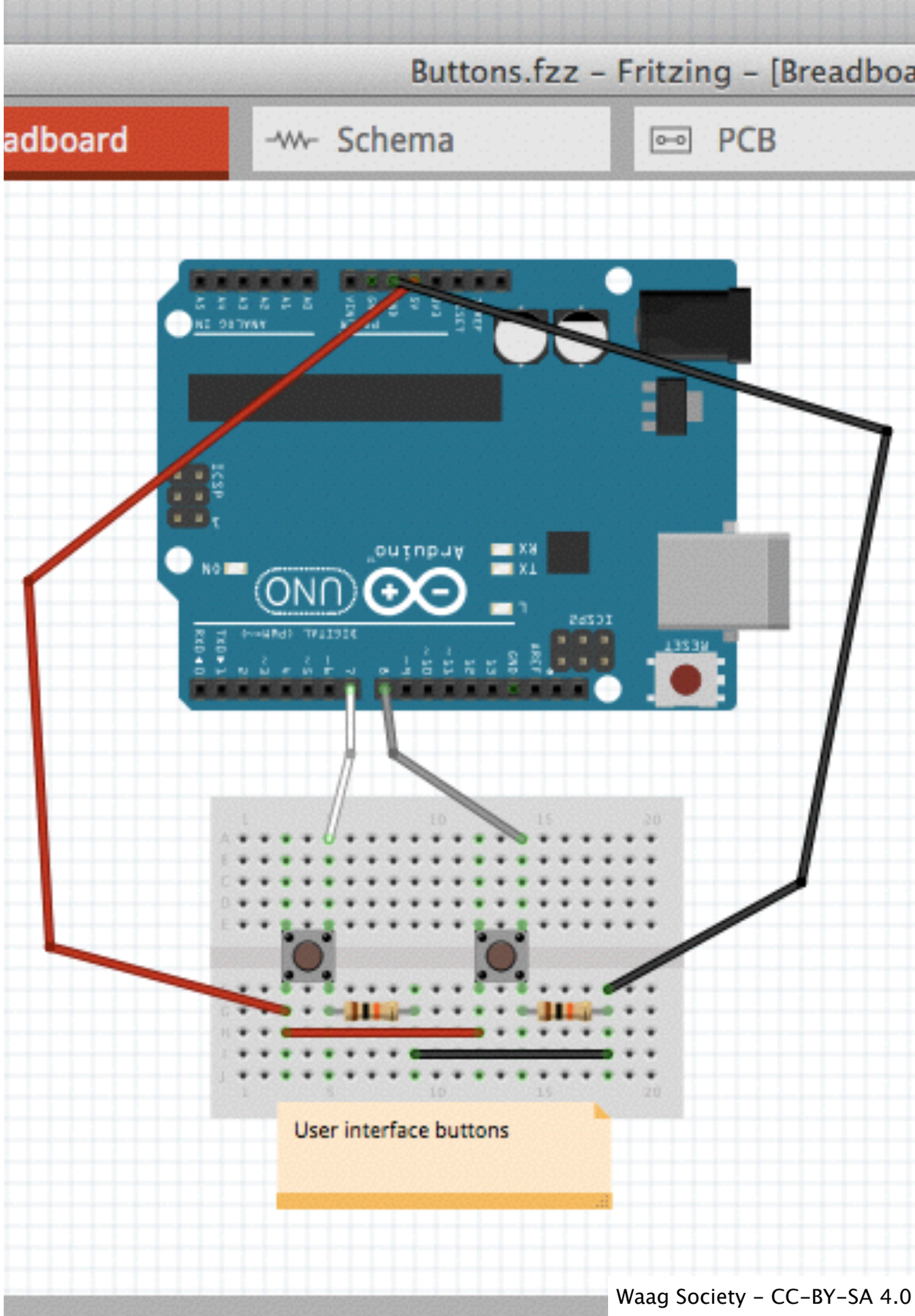
$$Vout = Vin\left(\frac{R2}{R1+R2}\right)$$



Push buttons

Pull down resistors

- 10 K Ohm



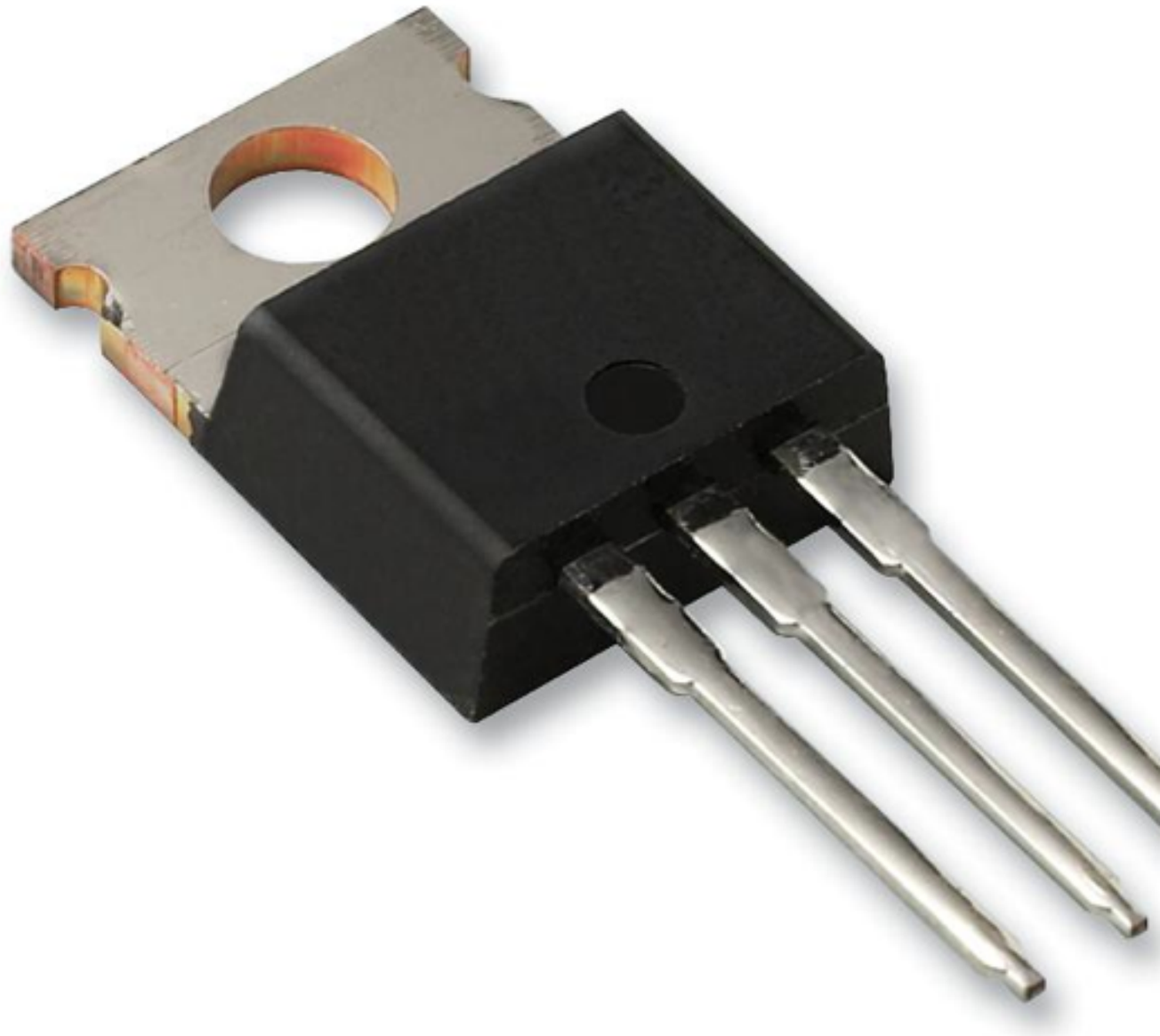
Selecting a heat source

- Lamp
  - Heat as a by product
- Microwave
  - Needs liquid to heat
- Infrared
  - 100W infrared
- Power resistor

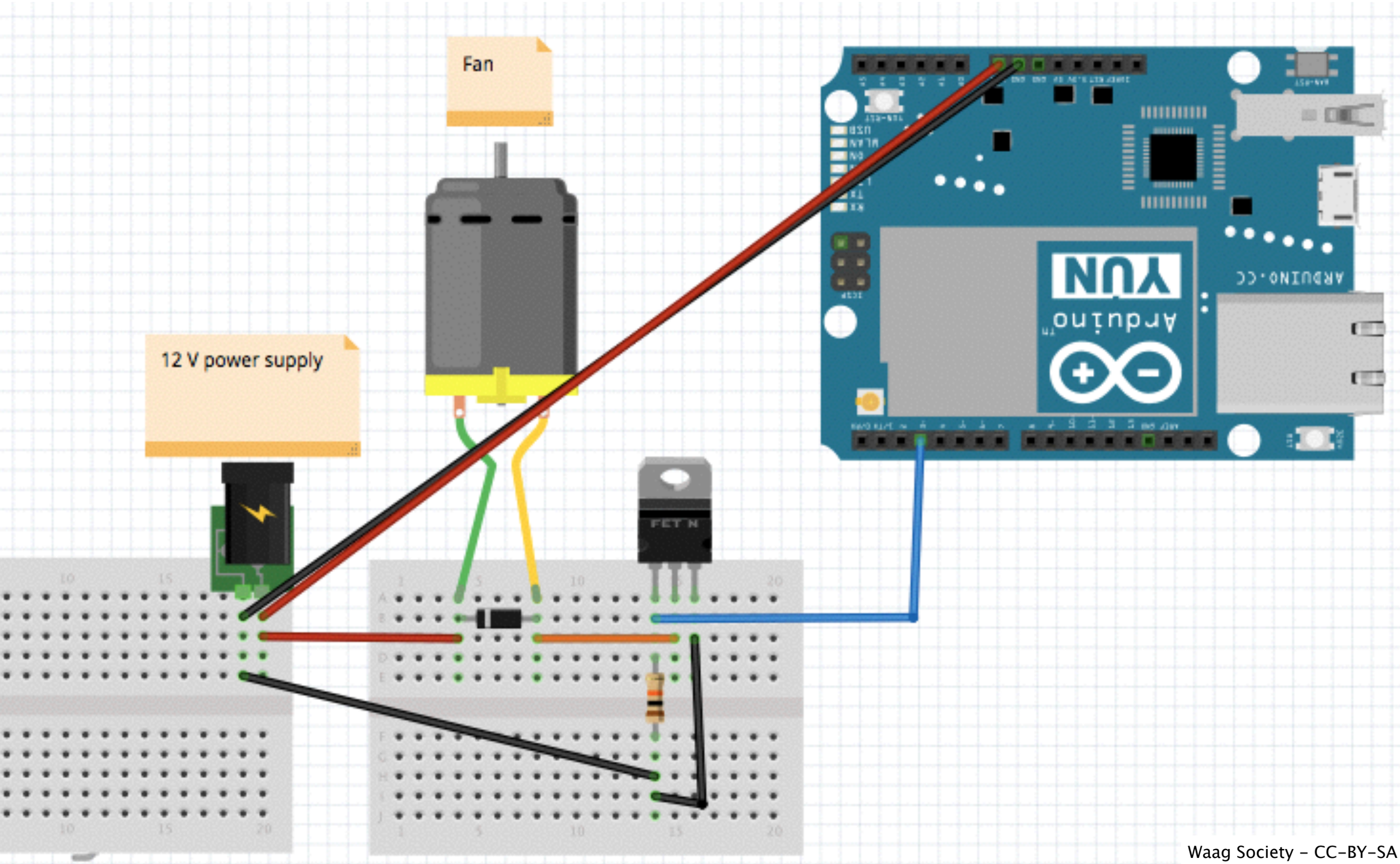
Fan speed controller

- MOSFET
  - Semiconductor

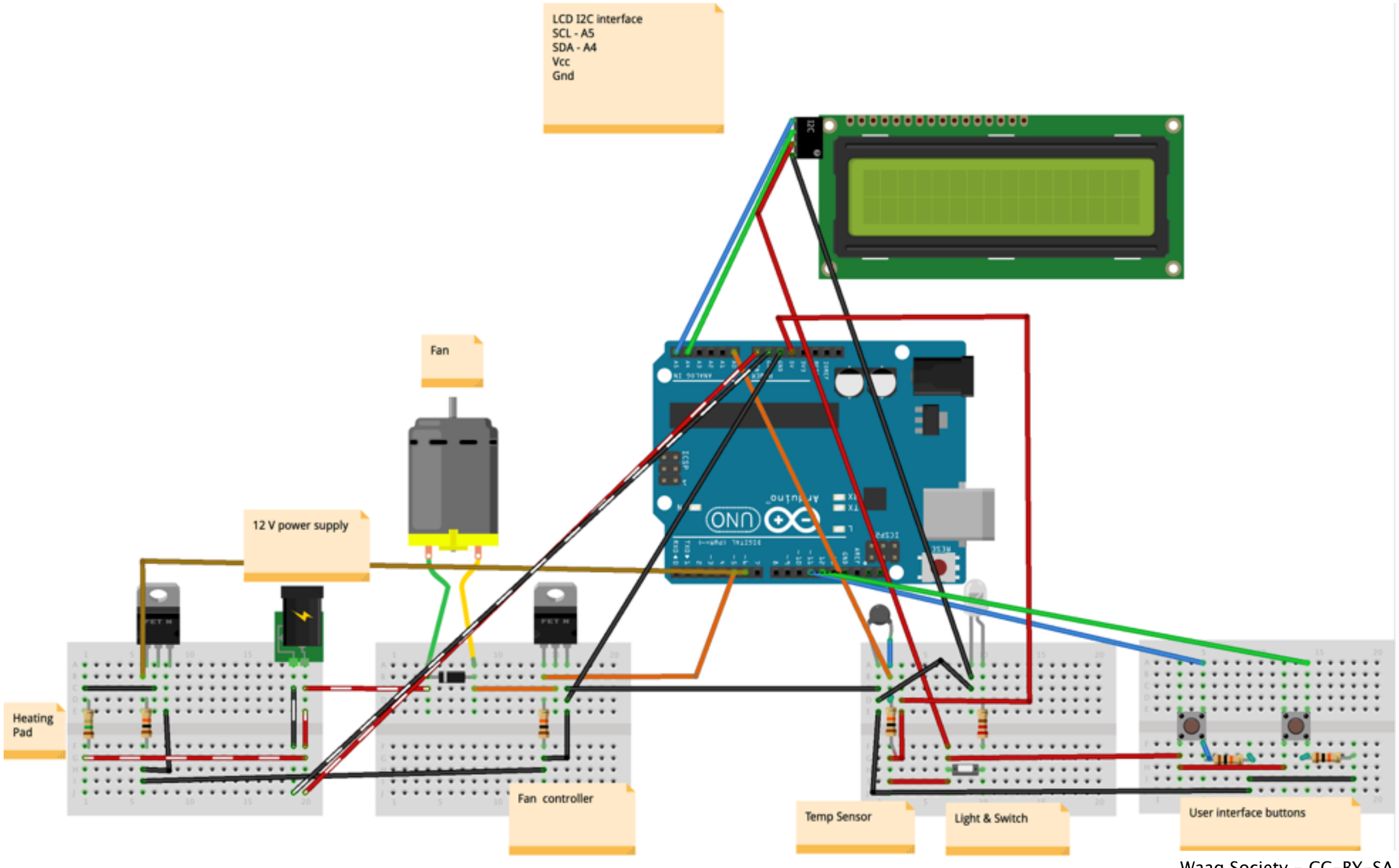
  - N-channel
  - 60V
  - 30A



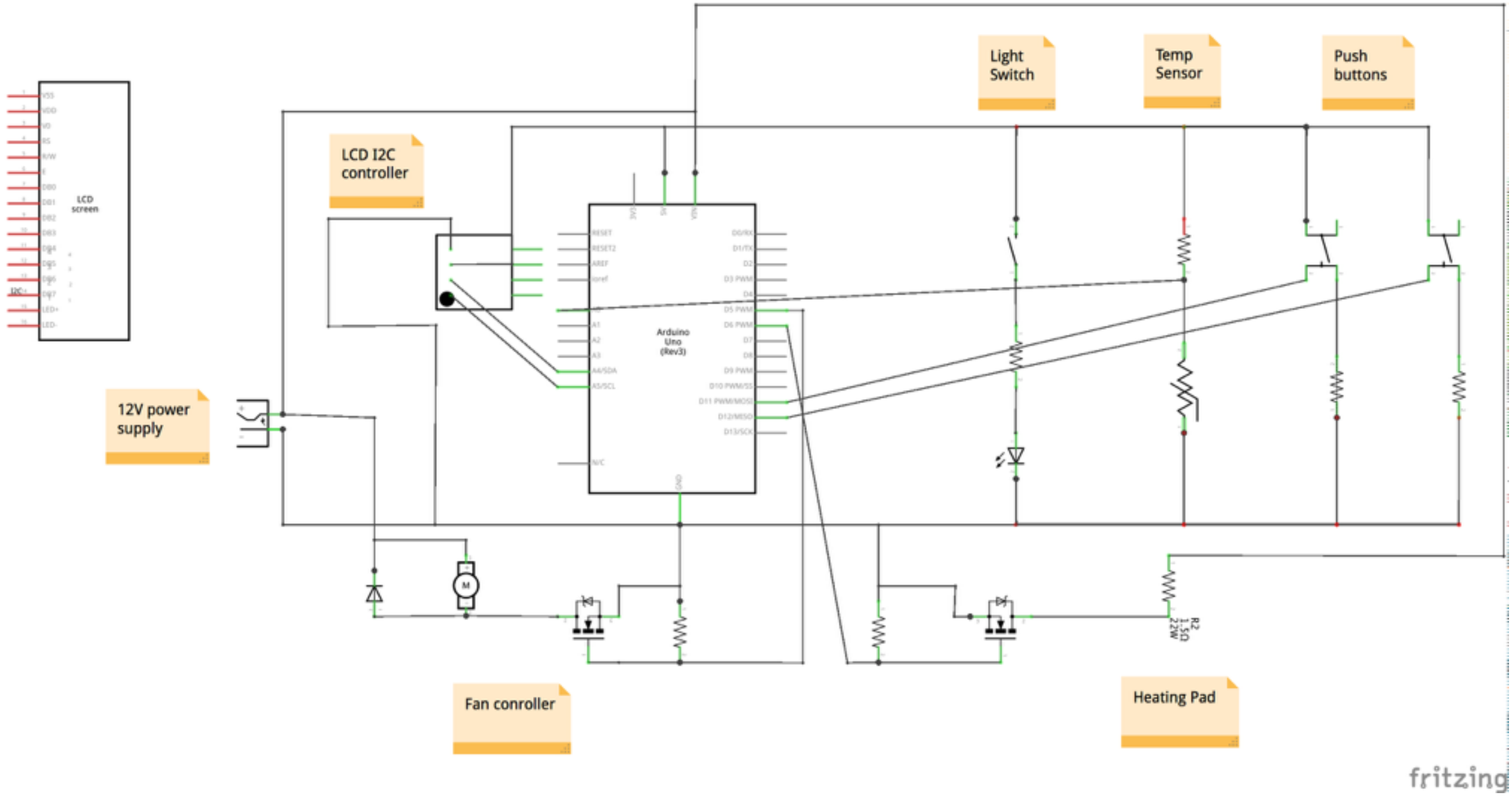
Controlling the fan



All of the electronics together



Schematic



Power Supply

$$P = A \times I$$

$$Power = Current \times Potential$$

$$Watt = Ampere \times Volt$$

- 1 x 30 mA LEDs
- 1 x 250 mA Arduino
- 1 x 400 mA Fan
- 1 x 30 mA 7 segment display
- 1 x 430 mA heating pad

- Total: 1140 mA
- So a 1.5 Amp power supply should be enough

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Arduino tutorial codes

- MOSFET code:
  - http://bildr.org/2012/03/rfp30n06le-arduino/
- Button code:
  - http://arduino.cc/en/tutorial/button
- Thermistor code:
  - http://computers.tutsplus.com/tutorials/how-to-read-temperatures-with-arduino--mac-53714

Code

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PieterVanBoheemen updating pins — Latest commit `eaaeff4` 22 days ago

..		
Incubator.ino	updating pins	22 days ago
LiquidCrystal_I2C.cpp	bha3	a month ago
LiquidCrystal_I2C.h	bha3	a month ago

Code logic

- Measure temperature
  - Turn lamp on when temperature is lower than target
  - Turn lamp off when temperature is higher than target
- Check whether a button is pushed
  - If left button is pushed increase target temperature
  - If right button is pushed decrease target temperature
- Display current temperature
  - In case left or right button is pushed, display target temperature for 5 seconds

Nice to haves

- PID control
- Magnetic door lock
- Lever switch that checks whether door is locked
- Sound alarm in case door is open for too long
- Webcam inside

PID control