waag society

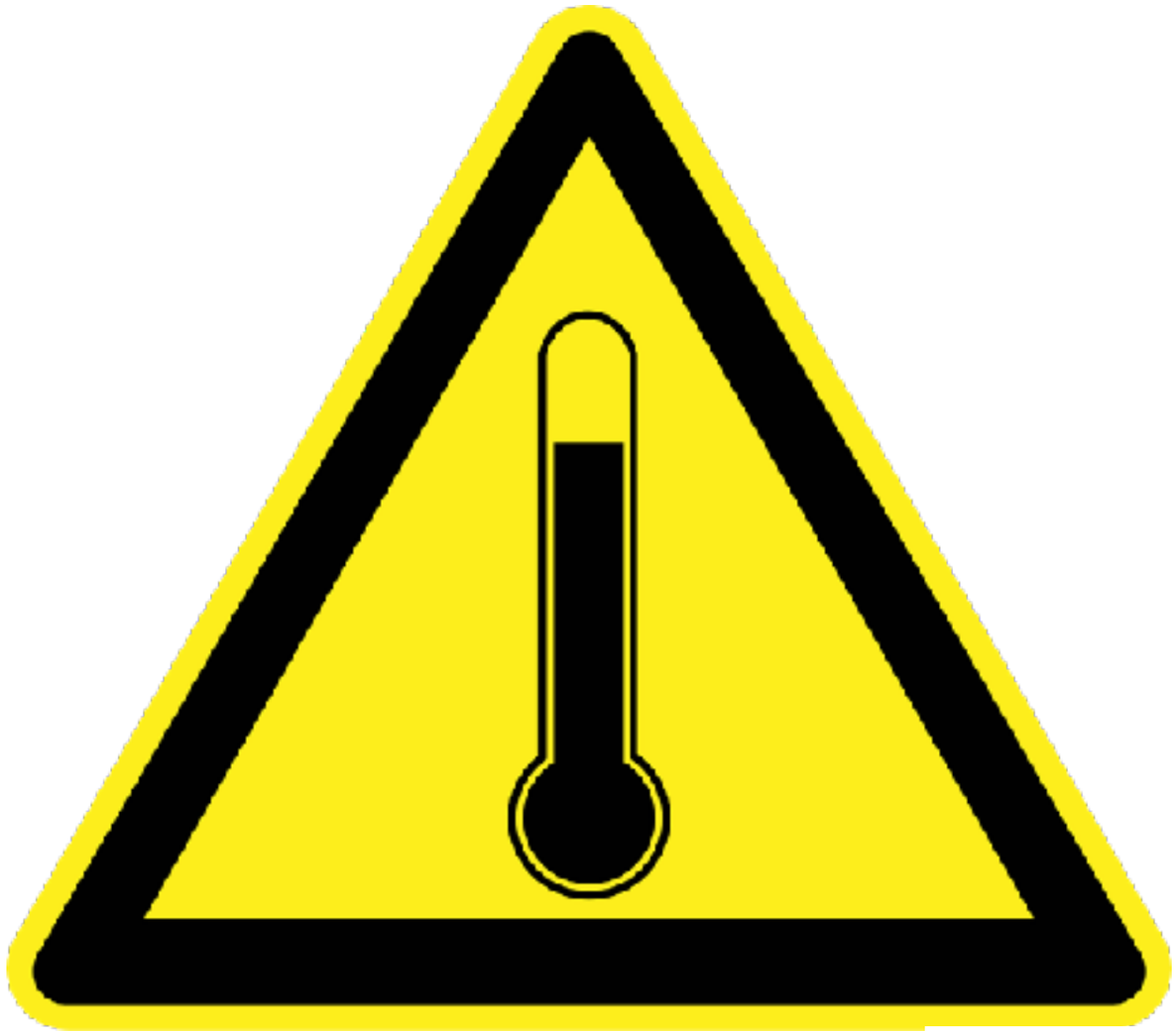
institute for art, science and technology

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

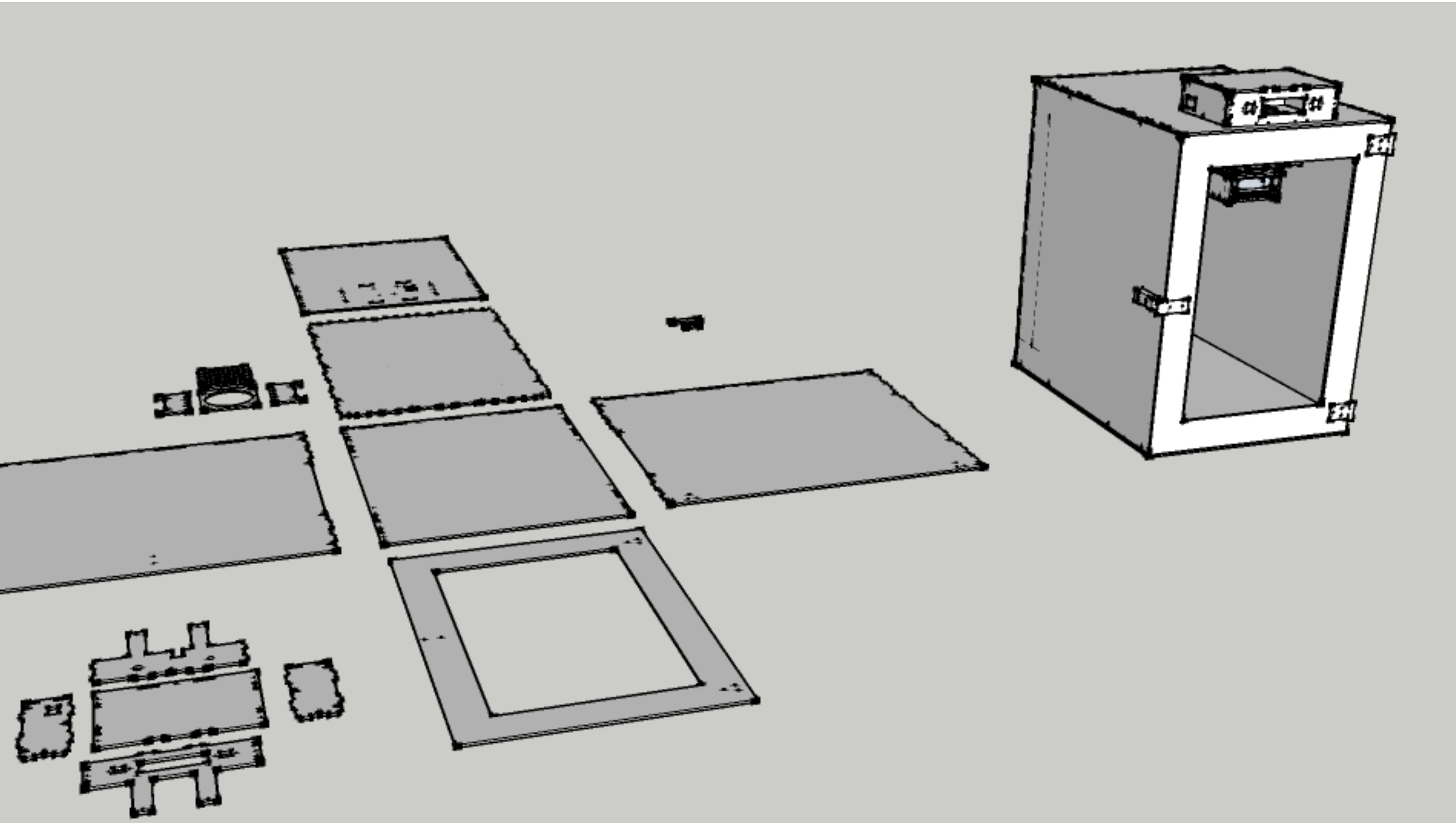
Function

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

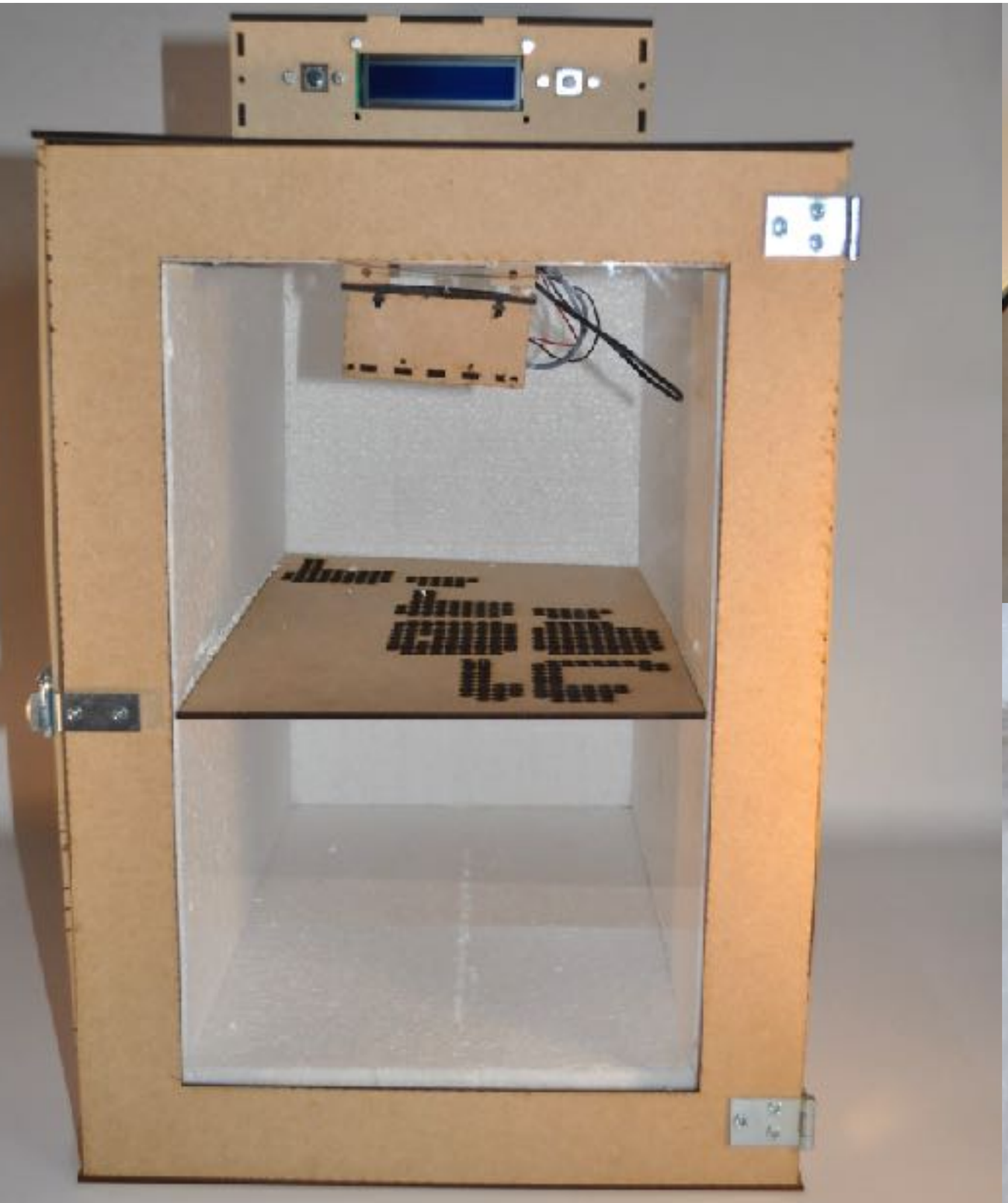
Design constrains:

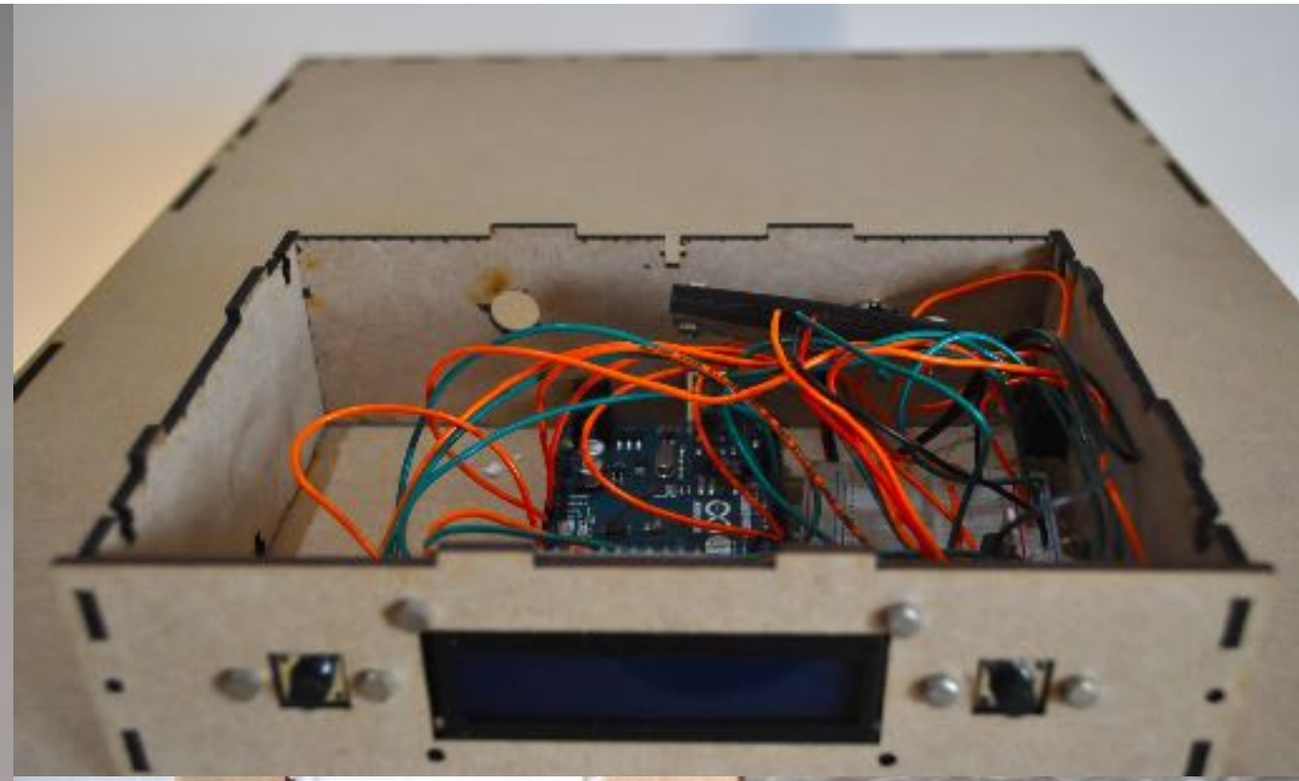
- 9 cm petri dishes

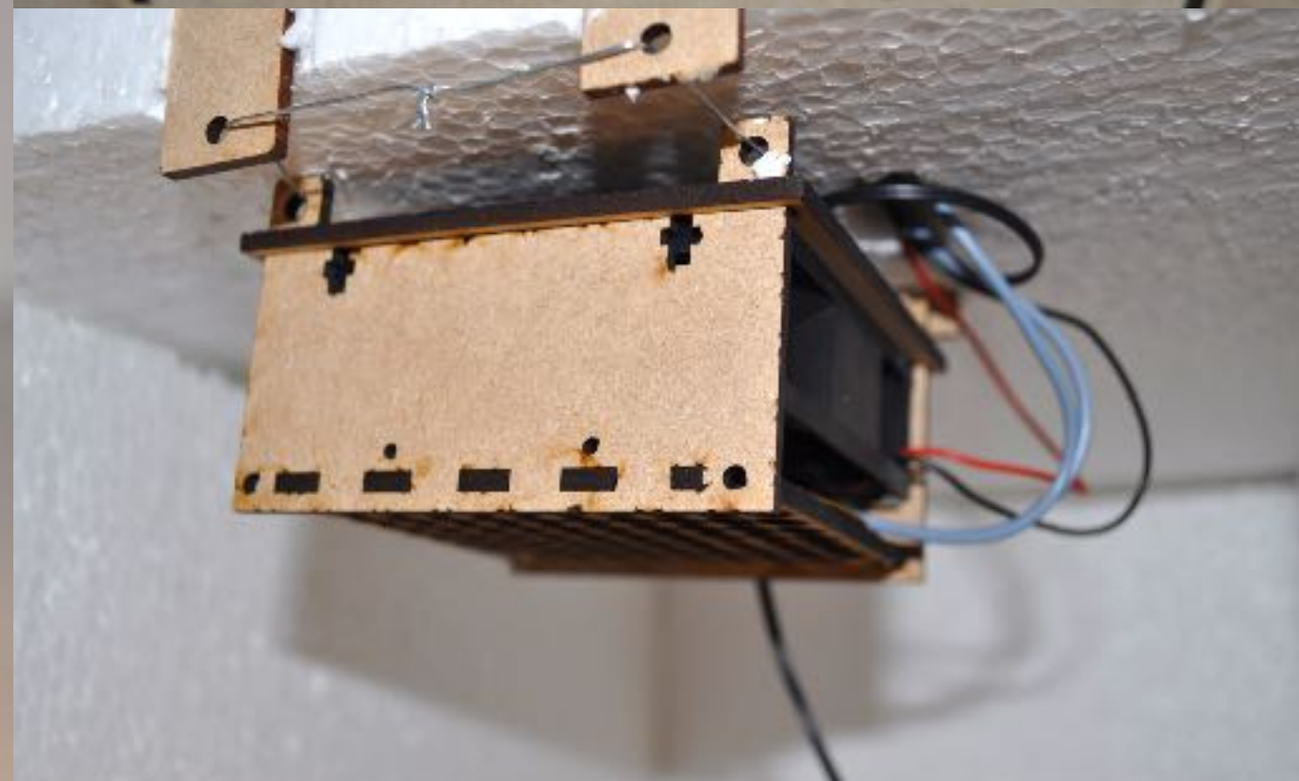
BHA3 Incubator



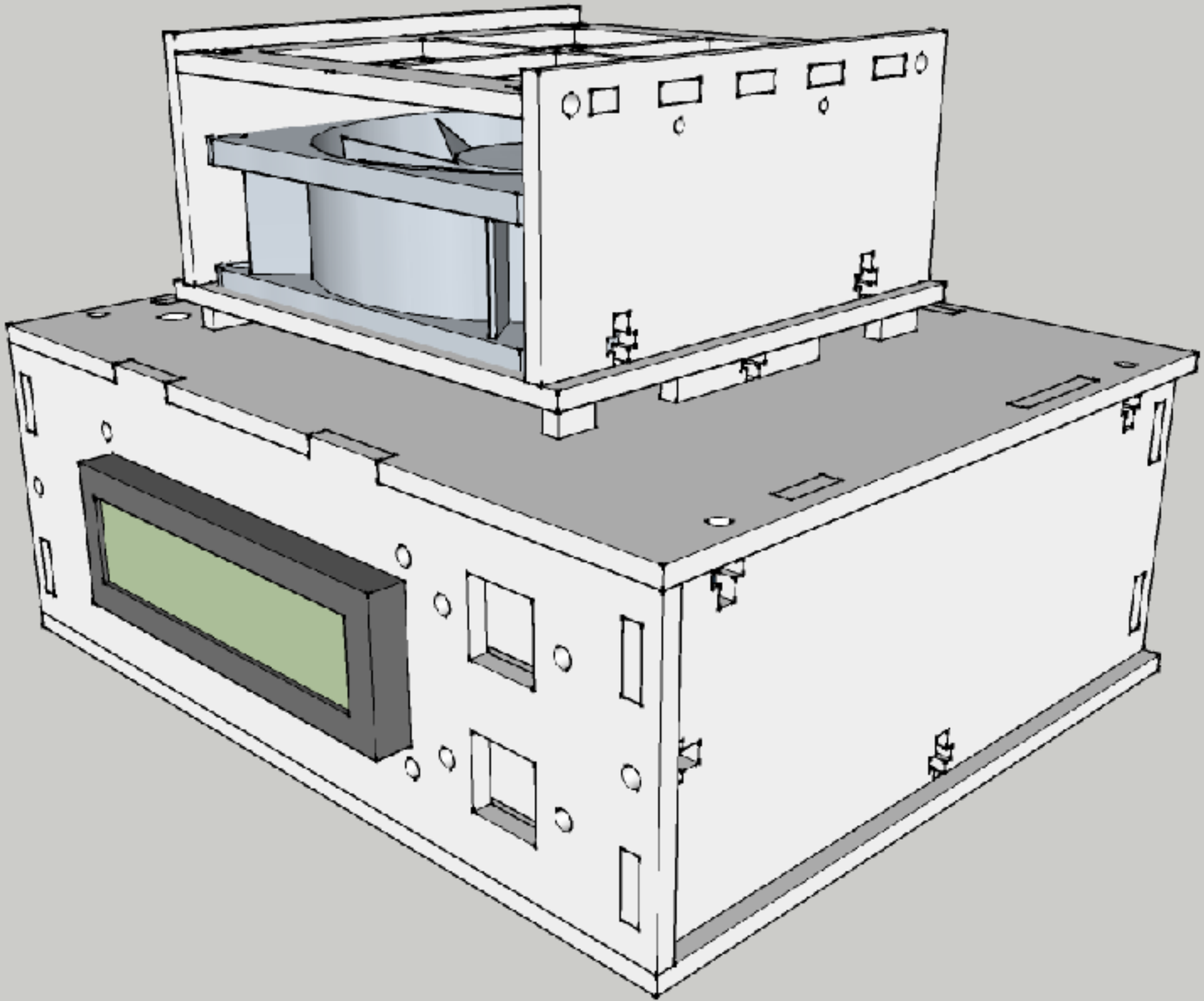
BHA3 Incubator



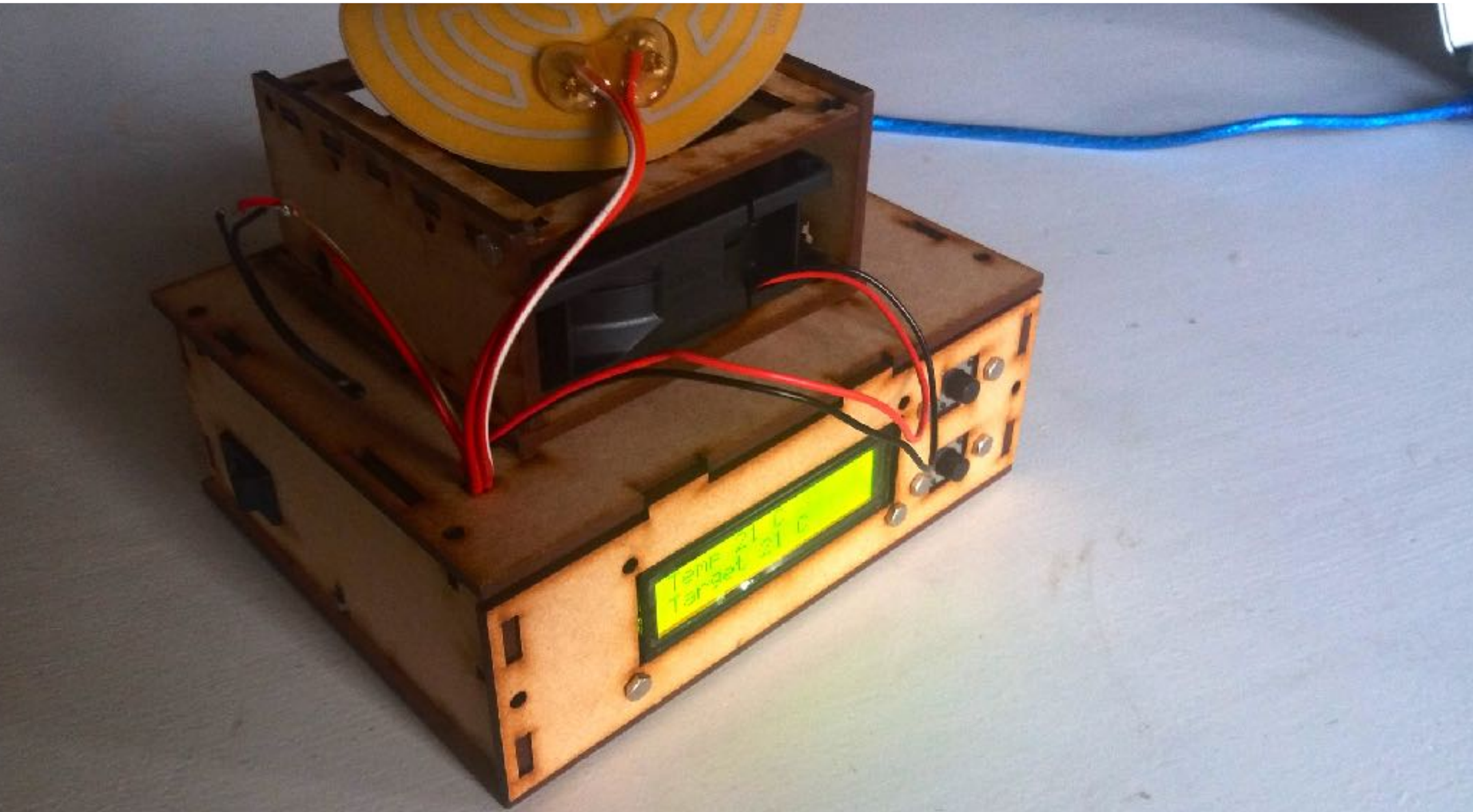




BHA4 incubator



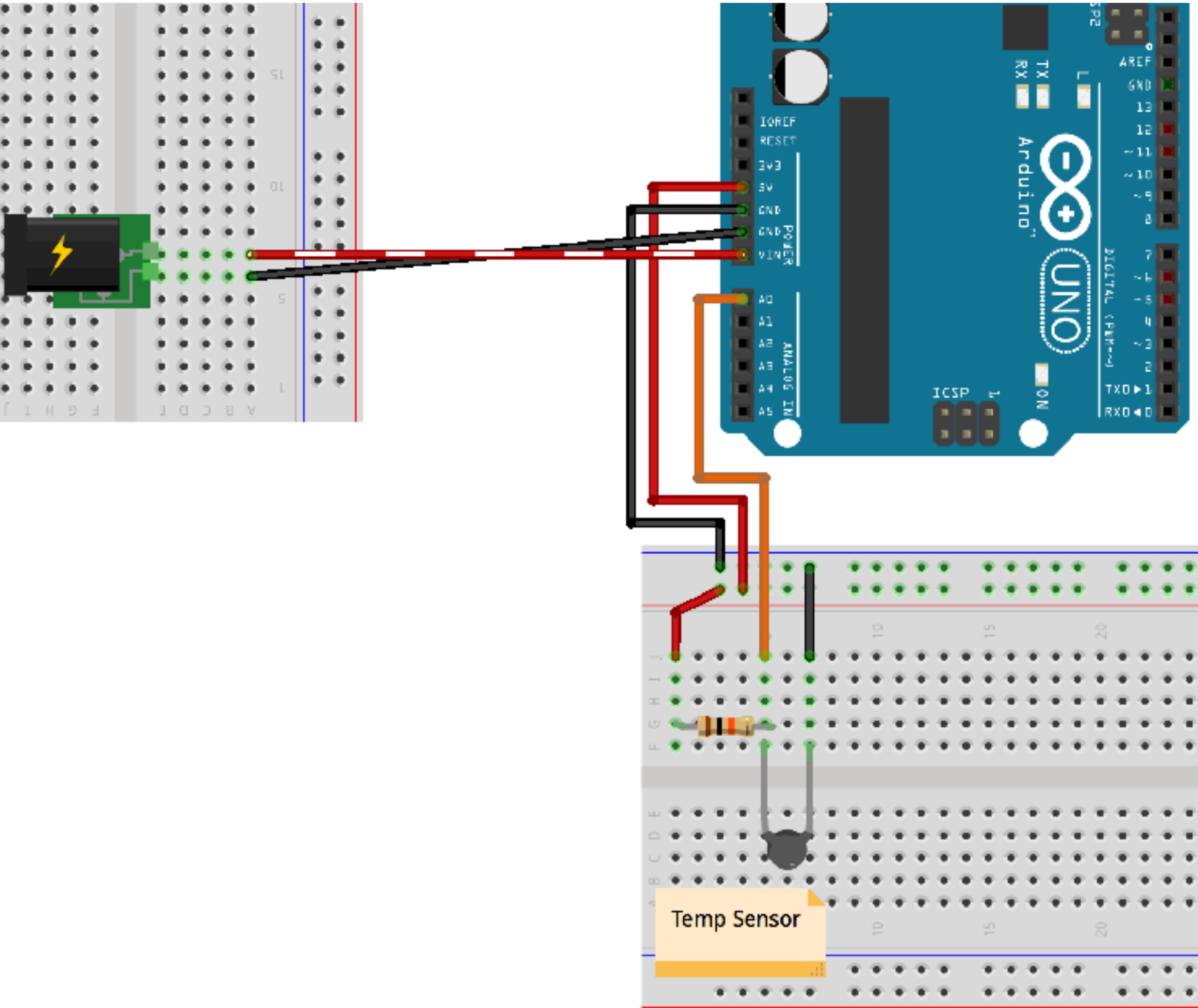
BHA4 incubator



Sensing the temperature

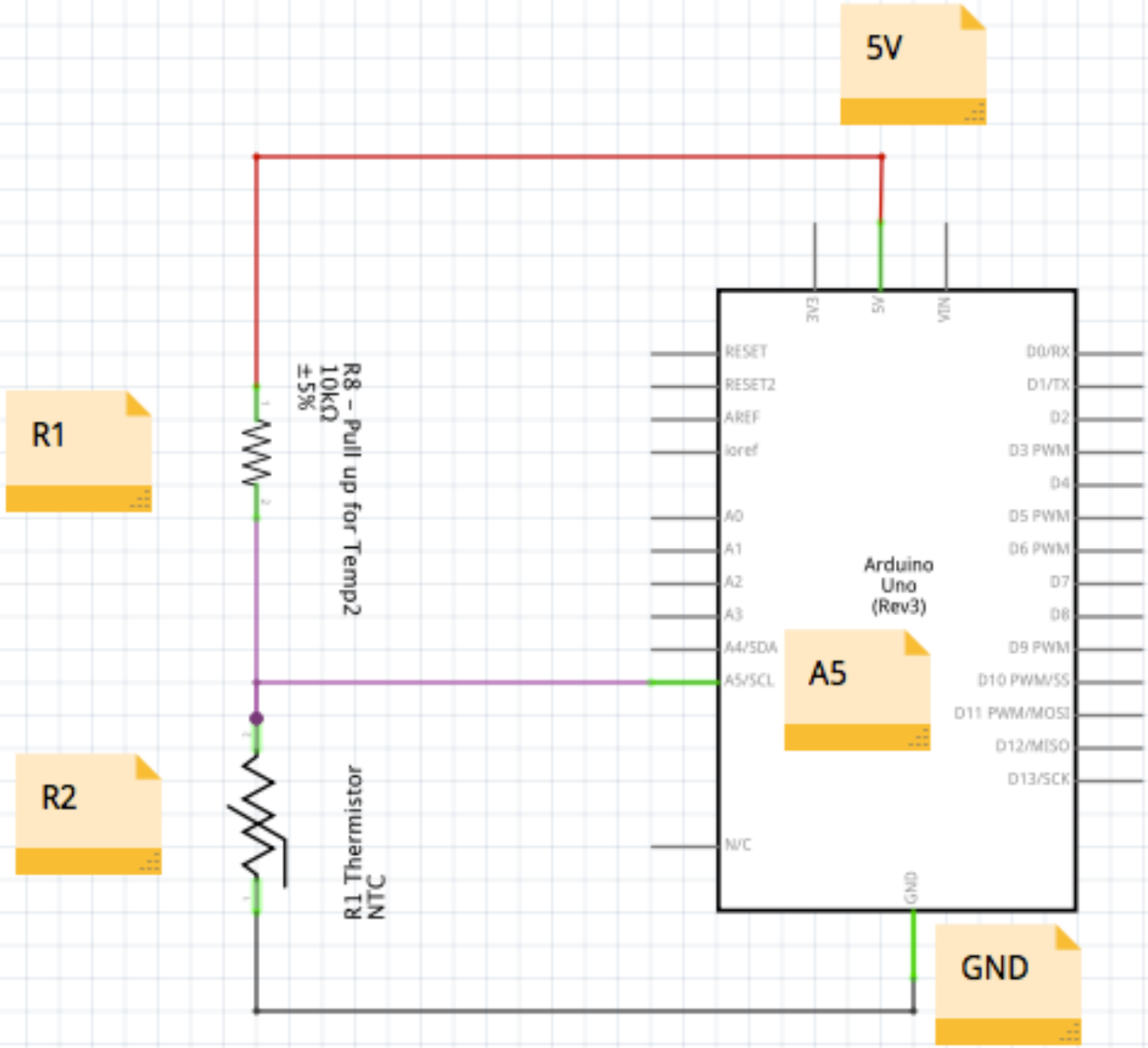
- 10K thermistor

Sensing the temperature



Schematic

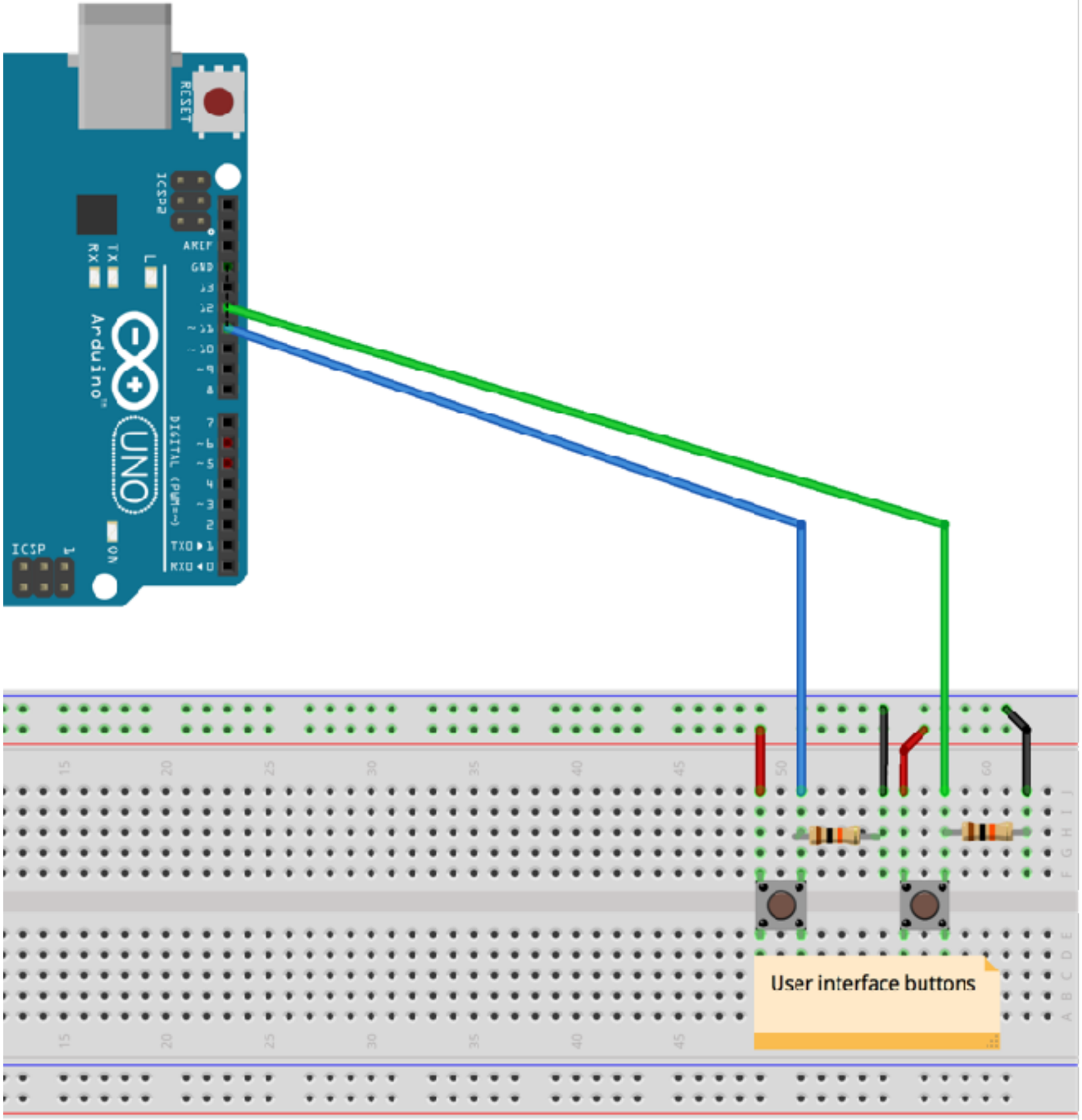
$$Vout = Vin\left(\frac{R2}{R1+R2}\right)$$



Push buttons

Pull down resistors

- 10 K Ohm



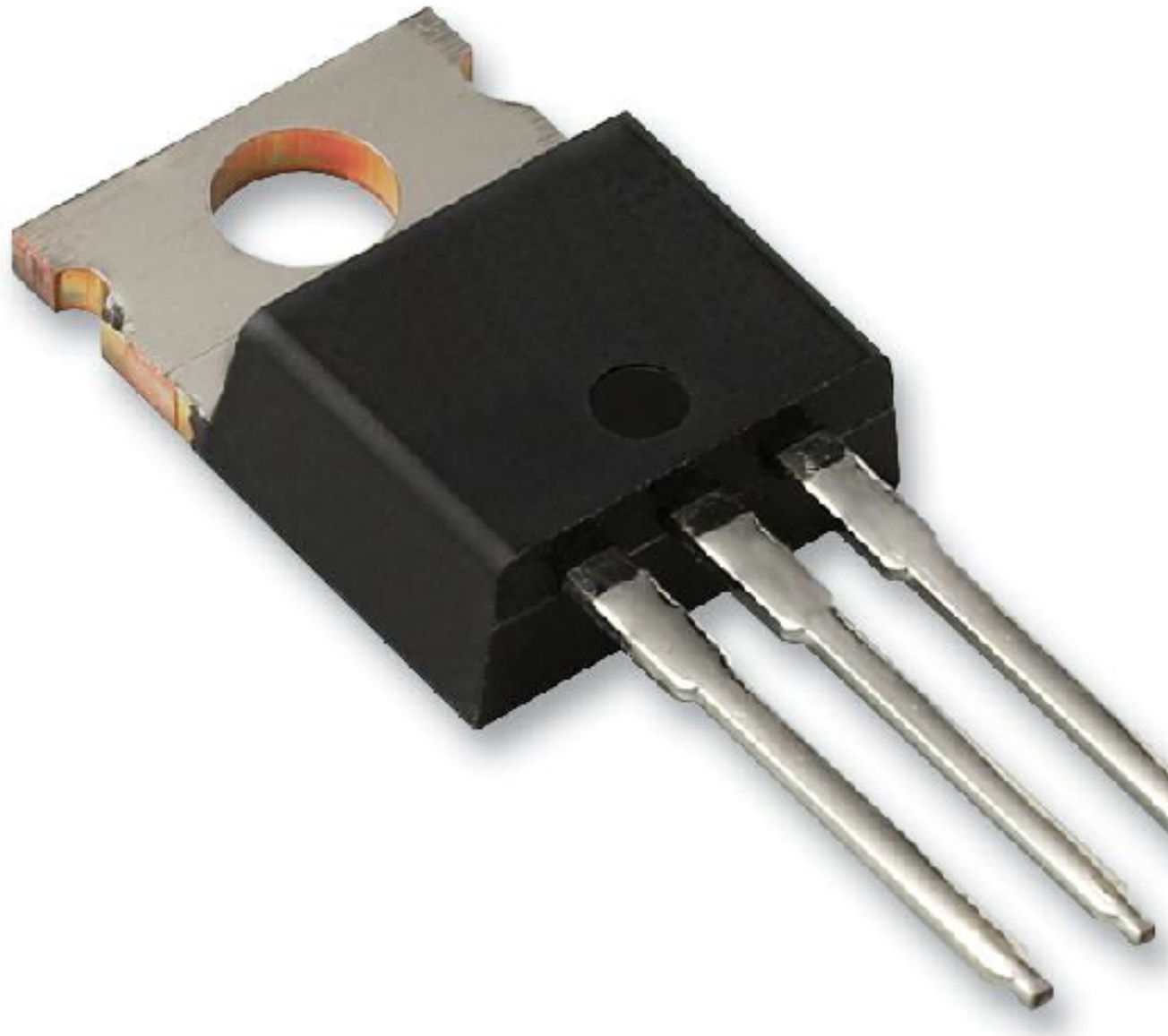
Selecting a heat source

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

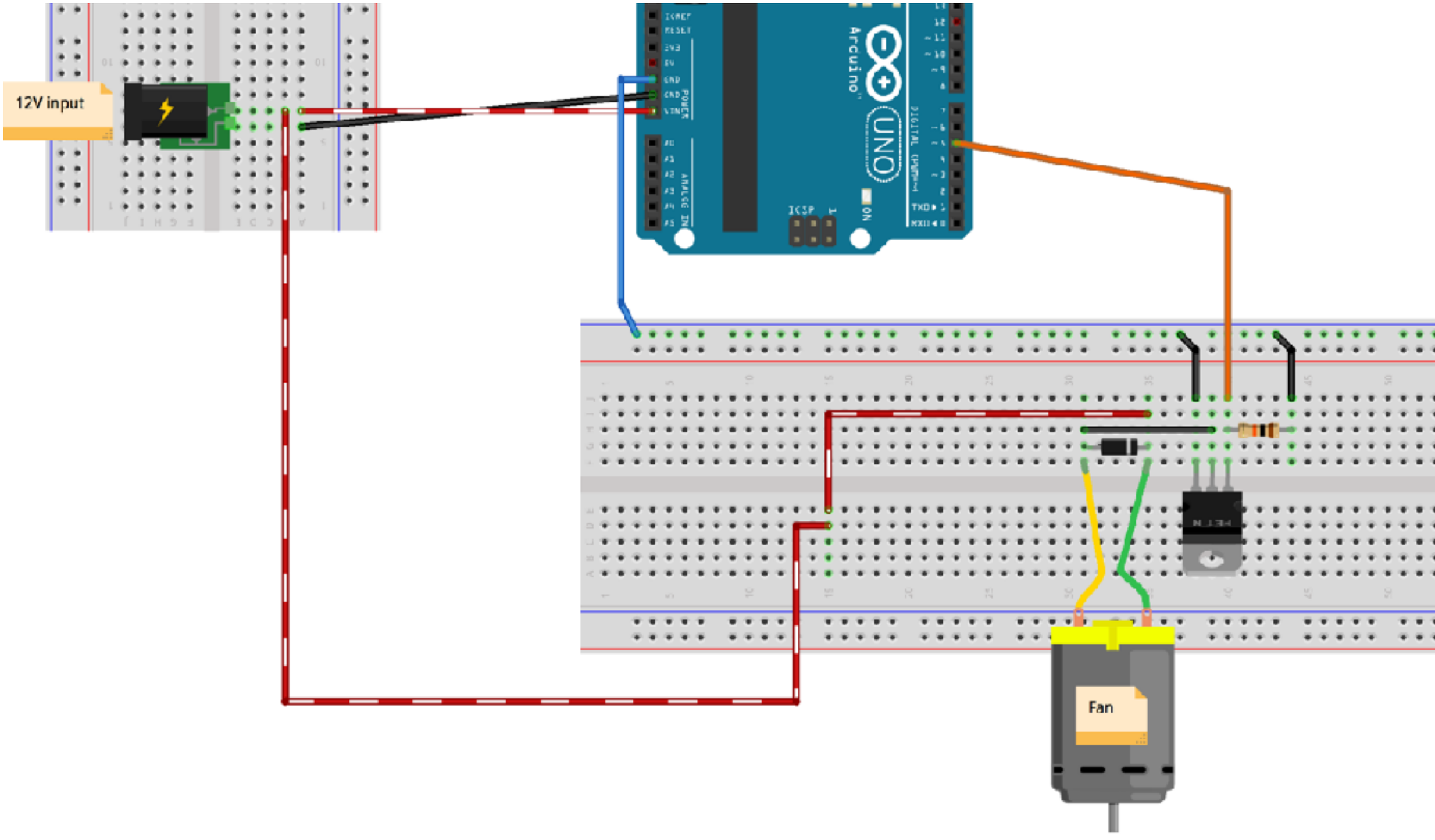
Fan speed controller

- MOSFET
  - Semiconductor

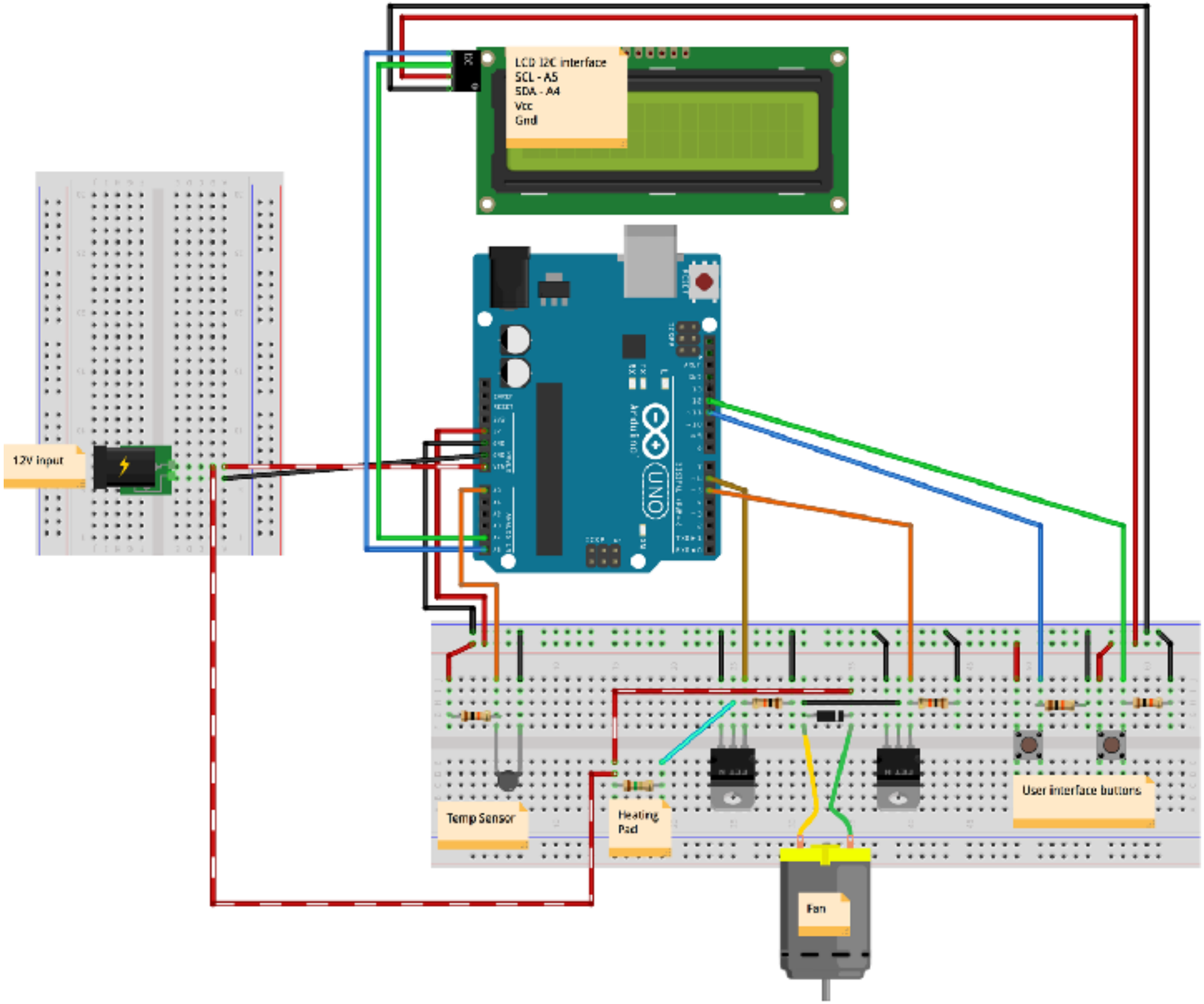
  - N-channel
  - 60V
  - 30A



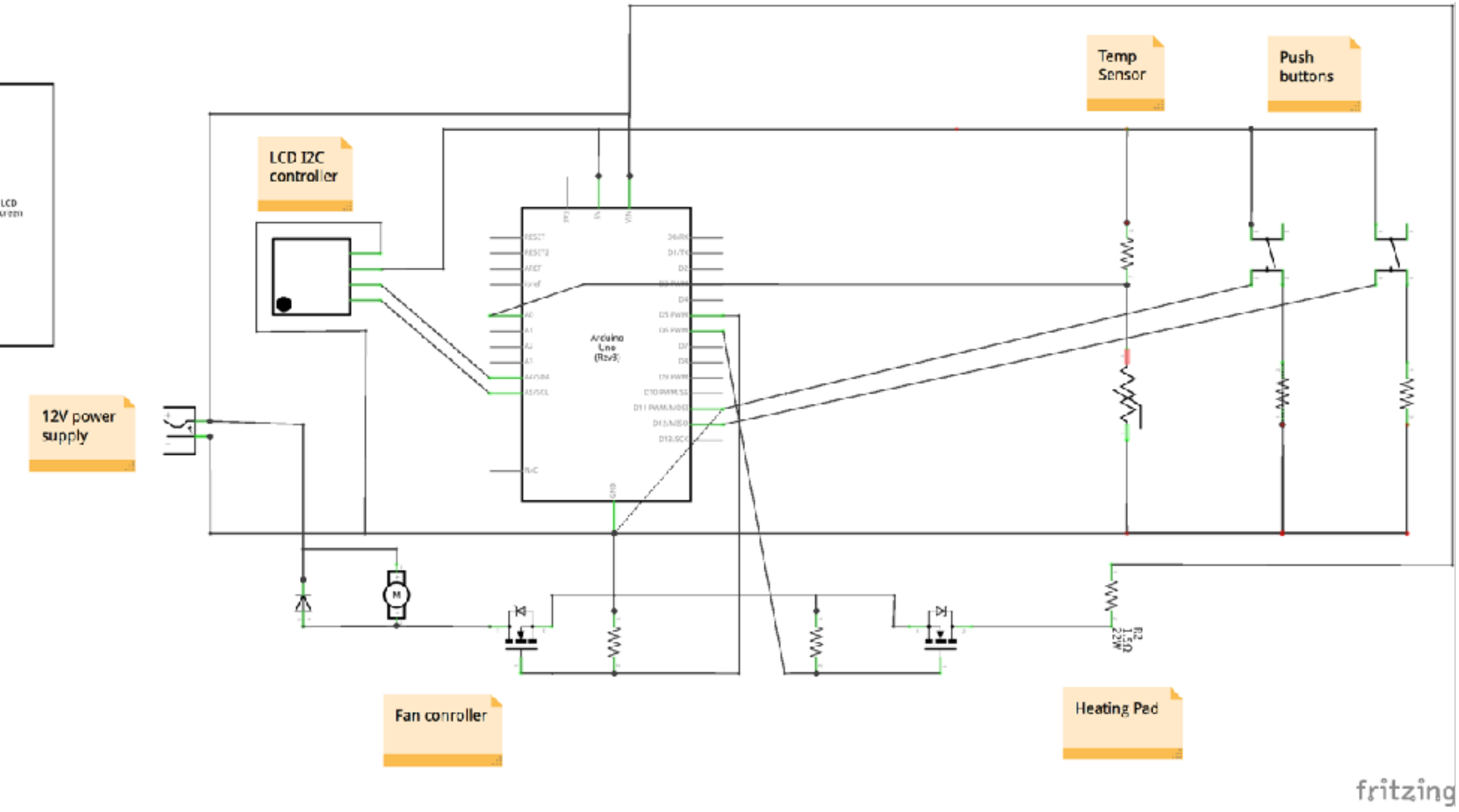
Controlling the fan



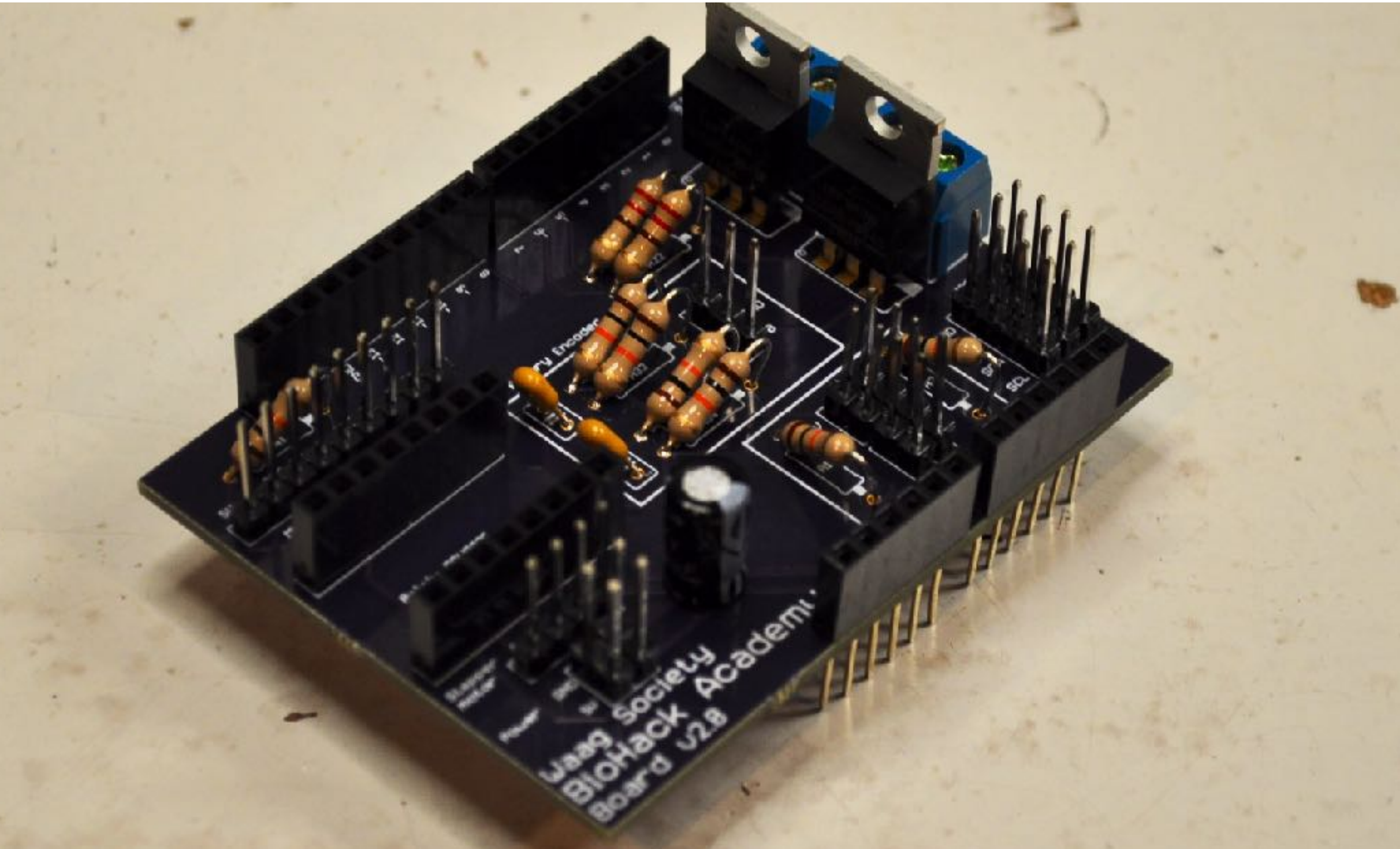
All of the electronics together



Schematic



Using the BioHack Board

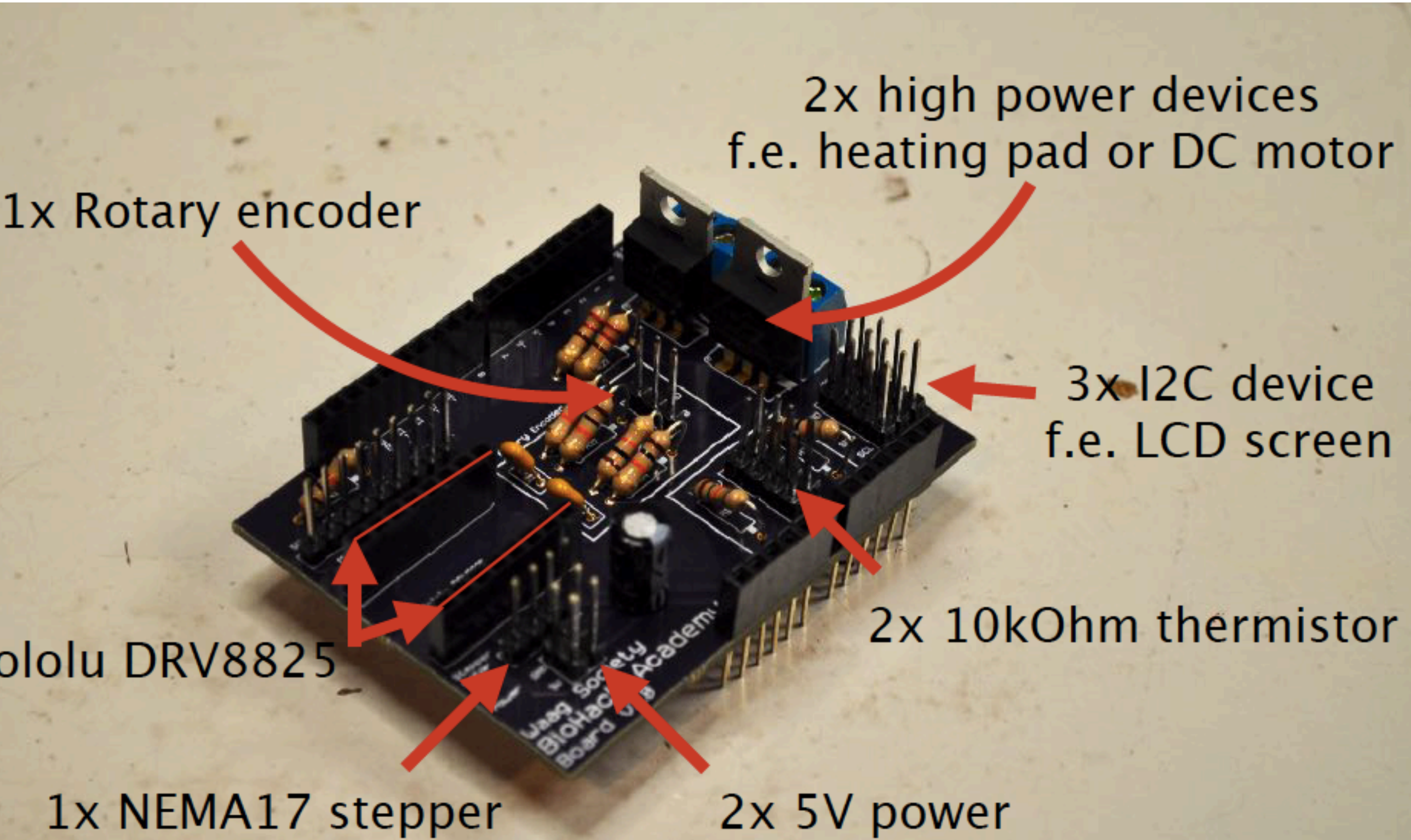


Bill of Materials

= not necessary
when using the BHA Board

No	Amount	Description	Supplier NL	Cost
1	1	12V 80 mm Axial Fan	Farnell, EOO	3.25
2	1	Power switch	Farnell, iPrototype	0.85
3	1	Waterproof 10K NTC thermistor	Hackerstore, Adafruit	2.95
4	1	I2C LCD display	iPrototype, Hackerstore	8.95
5	2	MOSFET	Farnell, EOO	0.60
6	4	10K resistor	Farnell, EOO	0.12
7	1	Diode	Farnell, iPrototype, EOO	0.19
8	2	Button	Farnell, iPrototype, Sparkfun	0.47
9	1	7.5 W power supply	iPrototype, EOO	12.50
10	1	Jack Adapter	Farnell, EOO	0.85
11	1	Heating foil	Floris.cc, Sparkfun, Conrad	4.50
12	1	Breadboard	Farnell. iPrototype	2.56

Connectors


2x high power devices
f.e. heating pad or DC motor
1x Rotary encoder
3x I2C device
f.e. LCD screen
2x 10kOhm thermistor
ololu DRV8825
1x NEMA17 stepper
2x 5V power

Power Supply

$$P = A \times I$$

$$Power = Current \times Potential$$

$$Watt = Ampere \times Volt$$

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

- Total: 1130 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 heating pad on when temperature is lower than target
  - Turn heating pad 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

PID control