Photonics workshop template.

Title of the workshop: Heartbeat sensor

Target audience: Young professionals

Time planning: total 1.5h

1. *Introduction: 15 min*
2. *Soldering: 1h*
3. *Assembling the case: 5 min*
4. *Uploading code: 5 min*
5. *Cleanup: 5 min*

Estimated cost: € 10.05 + Arduino Nano + PCB provided by EYEST.

Step 1

Please describe the technology of light behind your workshop in this first step. If possible make explanatory drawings and/or diagrams and foresee a small experiment that the target group can do them theirself.

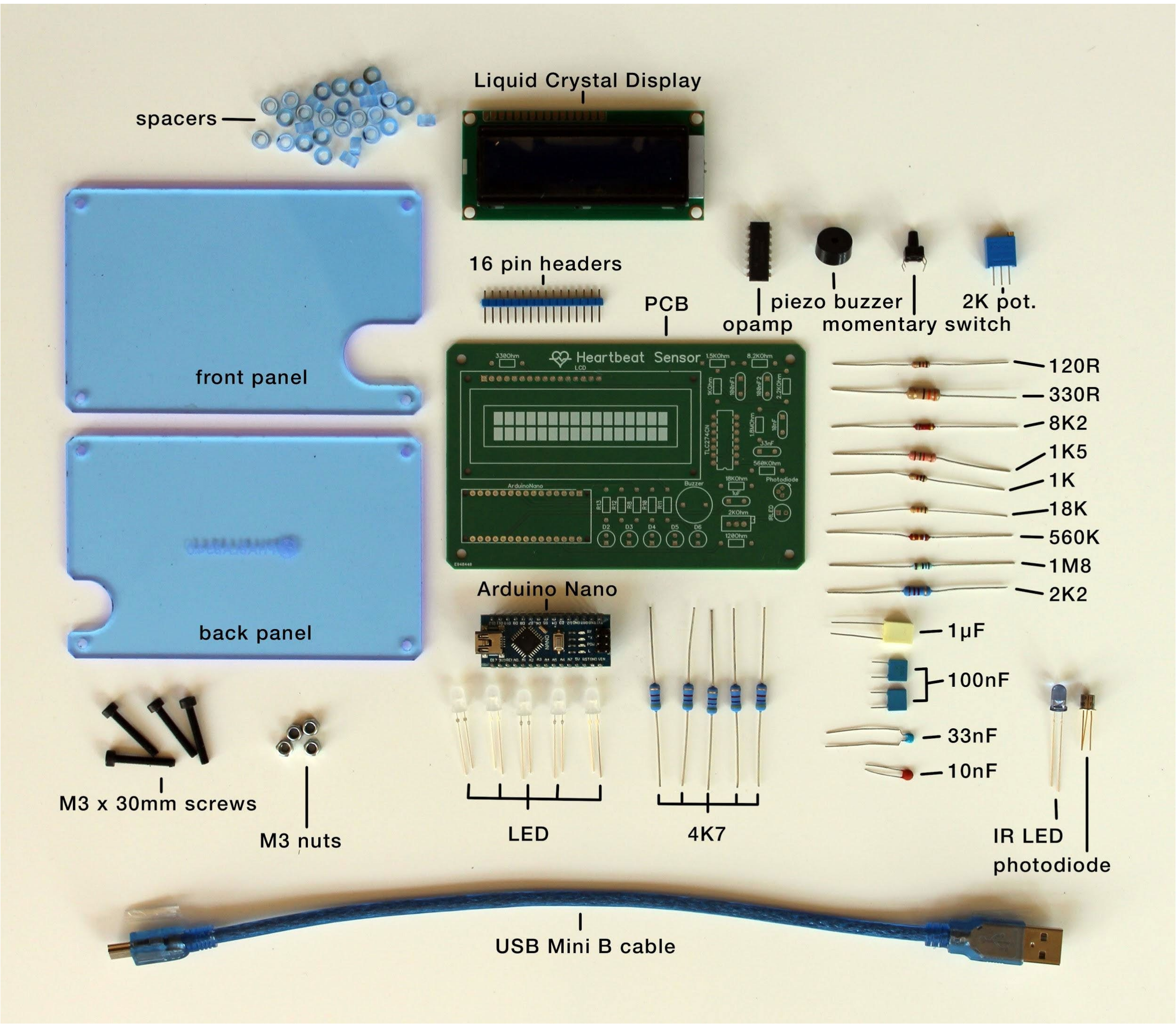
Title:

When light is goes through a finger, it encounters blood vessels. Part of the blood scatters and absorbs the light. When the heart beats, the flow of blood changes and therefore also the amount of light transmitted through the finger. Measuring the variation of light transmitted and converting this in an electric signal enables us to draw the heart beat signal as seen on screen at the hospital. Finding and counting the larger peaks will give us the heart rate and by attaching a sound to each of these peaks, we obtain the famous “beep” signaling that our heat is pumping.

The light used here has a wavelength in the Infrared region (IR), simply because the flesh (muscle) is absorbing most of the visible light and let pass the Infrared. The blood reflects more the IR and therefore we are more sensitive to the blood flow changes.

Step 2: Part list

Parts (see detailed list in Components folder):



Tools:

- Soldering iron + solder
- Flush cutter / wire cutter
- A computer to program the Arduino on the board

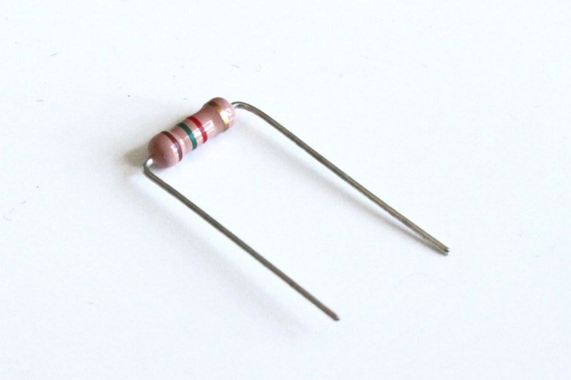
The photonics parts can be bought by EYESTvzw.
The electronic parts can be bought by Fablabfactory.

Step 3

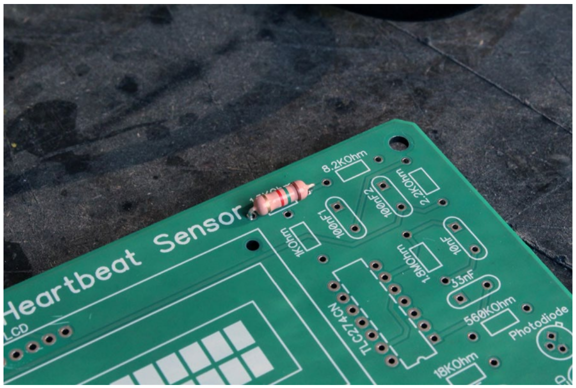
BASIC

Before you start assembling, make sure you have all the parts. You can check with the picture above. Next, we will be soldering all the components to the printed circuit board (PCB).

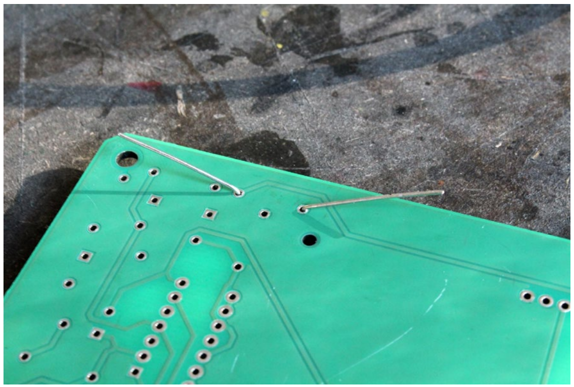
To solder a component, first bend its leads like so if they are not already aligned:



Then, place it in the holes that have the value of the component printed. For these resistors: check the colour codes carefully to make sure it is the right one.

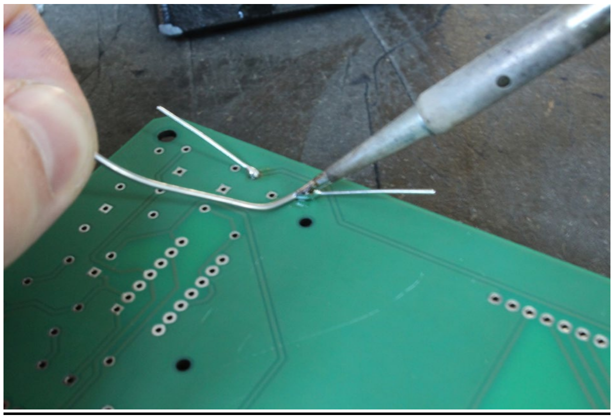


To make your life a lot easier, you can bend the leads over. This makes the component stay in place while soldering.

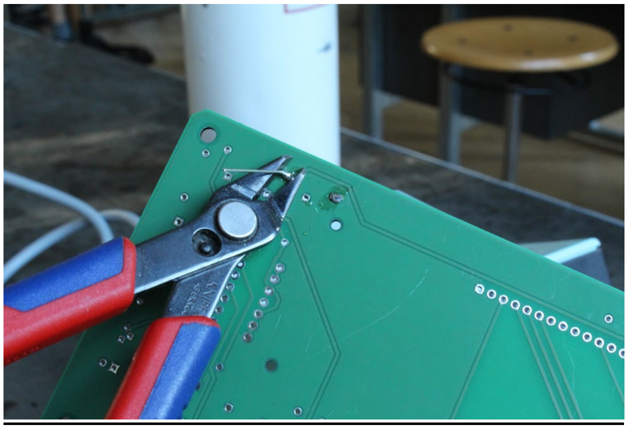


Now, heat up the soldering iron. Apply some solder to the iron (‘wetting’). This will ensure the component is heated well.

Hold the soldering iron to the lead and the PCB so they heat up. Then, apply solder to the components (not the iron).

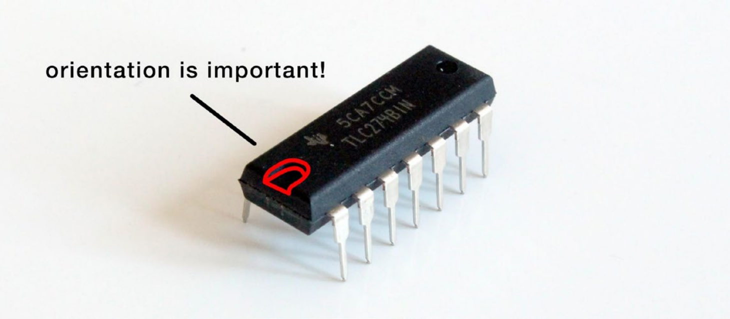


Then, trim the leads.

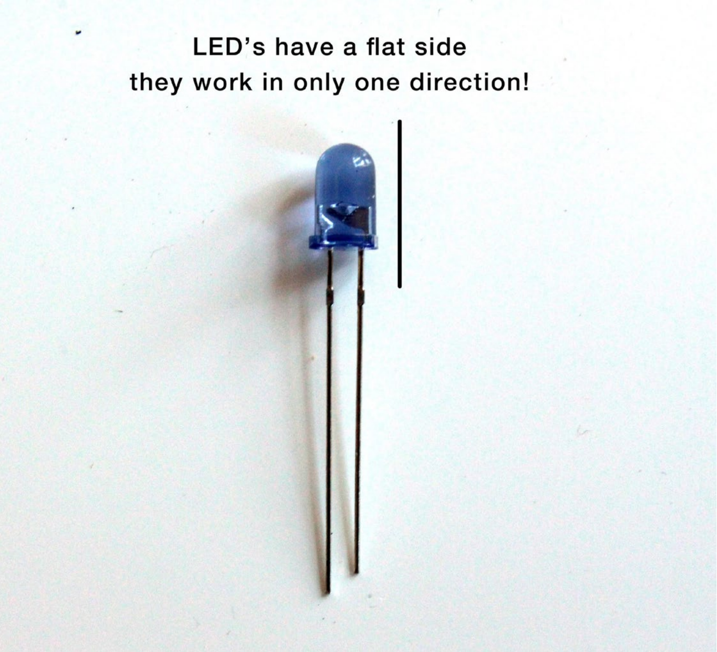


Solder the other components using these steps. Pay attention to a few components though, they have a specific orientation they need to be placed in.

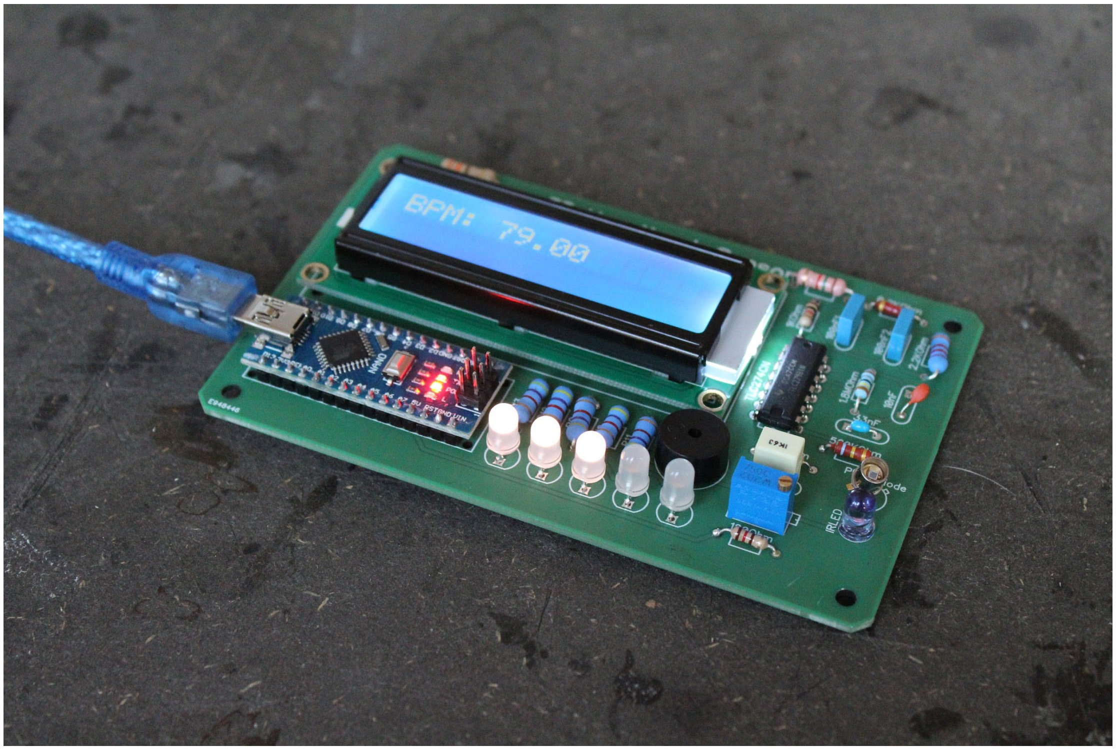
The opamp chip has a notch that is also marked on the PCB.



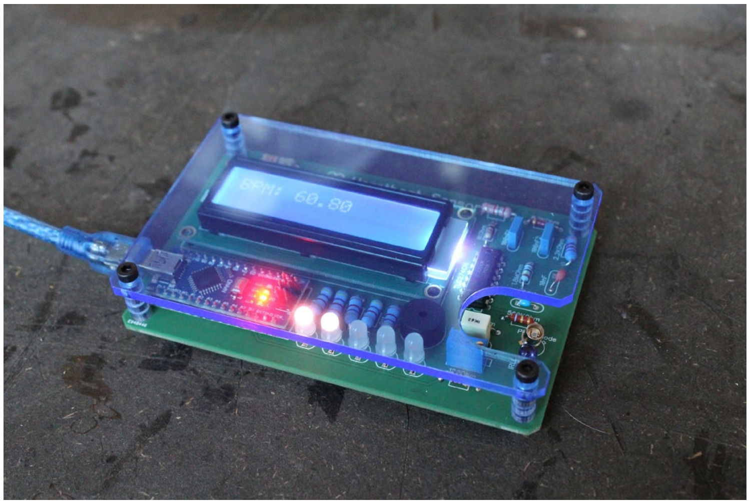
LED’s have a flat side that is also marked on the PCB.



When all components are soldered, the board should look like this:

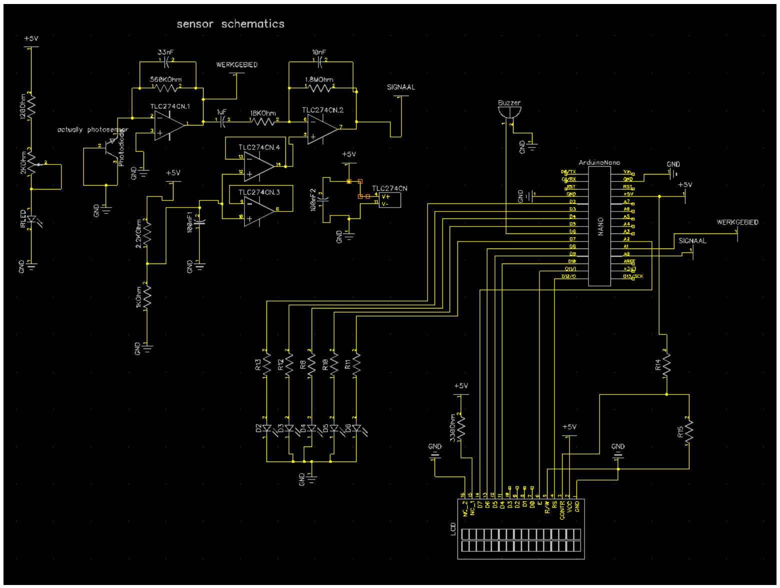


Now, the case can be fitted. Use the spacers to set the front panel at the right height.



EXTENSION

The Heartbeat sensor was built to be hackable! Feel free to take out components, swap them around or add cables to make a remote sensor. Maybe the LED’s should be a different colour… Experiment! The row of breakout holes on the PCB can be used to access unused input and output pins of the Arduino Nano.

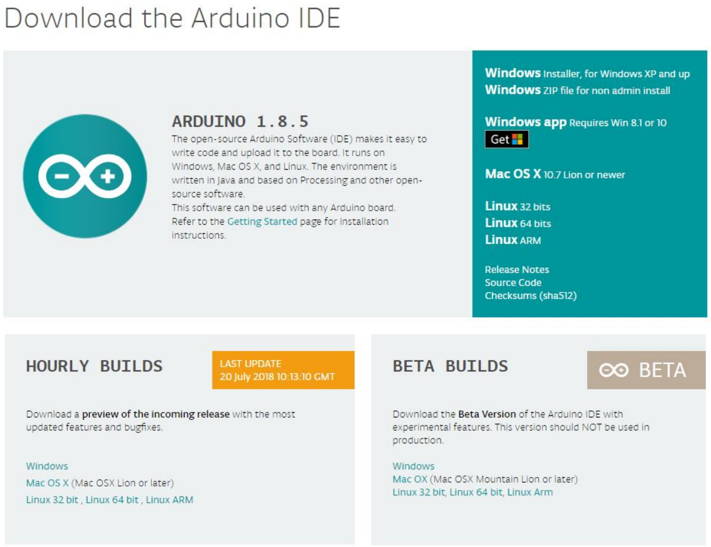

sensor schematics
+5V
120Ohm
2KOhm
IRLED
GND
actually photosensor
Photodiode
33nF
560KOhm
TLC274CN.1
WERKGEBIED
1uF
18KOhm
10nF
1.8MOhm
TLC274CN.2
SIGNAAL
TLC274CN.4
TLC274CN.3
2.2KOhm
1KOhm
100nF1
100nF2
TLC274CN
V+
V-
Buzzer
ArduinoNano
NANO
D0/TX
D1/RX
RST
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11/I
D12/O
Vin
A7
A6
A5
A4
A3
A2
A1
A0
AREF
+3V3
D13/SCK
R13
R12
R8
R10
R11
D2
D3
D4
D5
D6
R14
R15
330Ohm
LCD
NC_2
NC_1
D7
D6
D5
D4
D3
D2
D1
D0
E
R/W
RS
CONTR
VCC
GND

Schematics

Step 4 - ...

BASIC

To make the sensor work, we need to install some software on the Arduino. This is done through the Arduino IDE.



Download the Arduino IDE

ARDUINO 1.8.5

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.
This software can be used with any Arduino board.
Refer to the Getting Started page for Installation instructions.

Windows Installer, for Windows XP and up
Windows ZIP file for non admin install

Windows app Requires Win 8.1 or 10
Get

Mac OS X 10.7 Lion or newer

Linux 32 bits
Linux 64 bits
Linux ARM

Release Notes
Source Code
Checksums (sha512)

HOURLY BUILDS

LAST UPDATE
20 July 2018 10:13:10 GMT

Download a **preview of the incoming release** with the most updated features and bugfixes.

Windows
Mac OS X (Mac OSX Lion or later)
Linux 32 bit , Linux 64 bit , Linux ARM

BETA BUILDS

BETA

Download the **Beta Version** of the Arduino IDE with experimental features. This version should NOT be used in production.

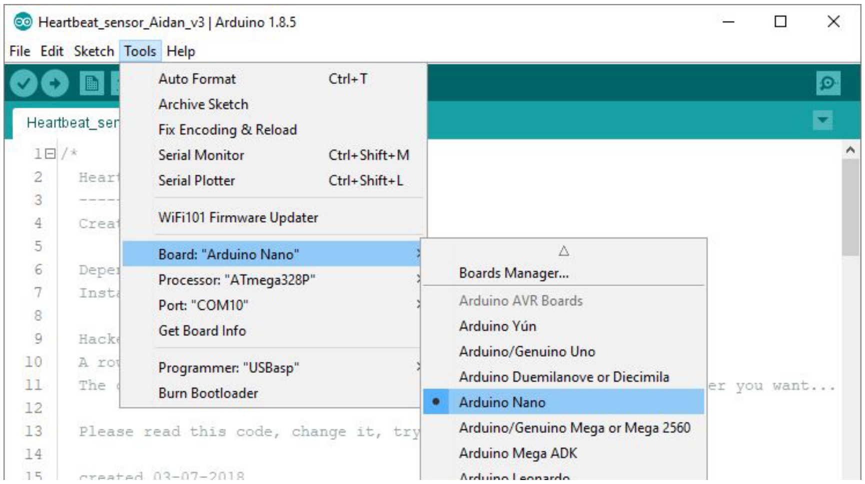
Windows
Mac OX (Mac OSX Mountain Lion or later)
Linux 32 bit, Linux 64 bit, Linux Arm

Get the Arduino IDE at https://www.arduino.cc/en/Main/Software.

Copy the LCD library folder in Documents/Arduino/libraries (see drive).

Now, download the code for this workshop from the @sciencecentredelft Github (or from the PHABLABS Drive):

https://github.com/sciencecentredelft/Heart-beat-sensor
tinyurl.com/phablabsheartbeat also links to this page



Heartbeat_sensor_Aidan_v3 | Arduino 1.8.5

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Hack
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The                                  er you want...

Please read this code, change it, try

created 03-07-2018
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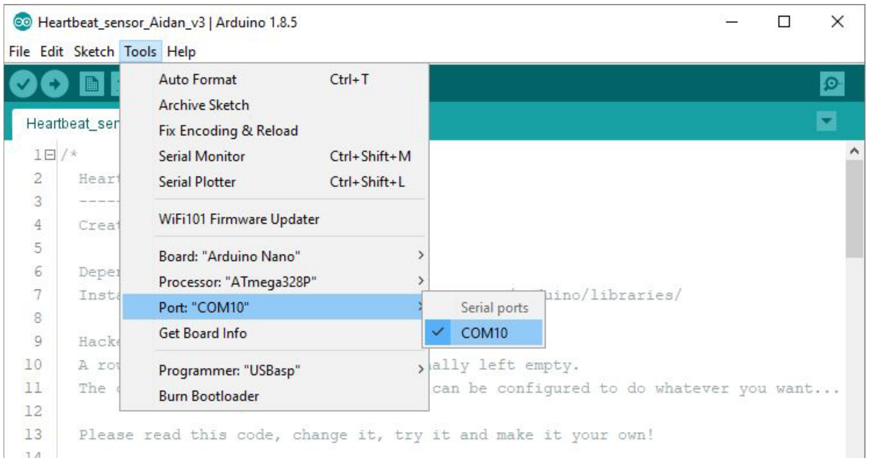
Open the code in the Arduino IDE. Then, go to *Tools* > *Board* and select ‘Arduino Nano’.



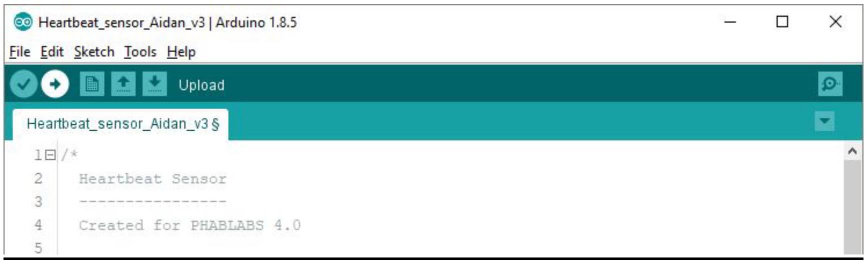
```
/*
  Heart
  ----
  Creat

  Deper
  Insta                                 uino/libraries/

  Hacke
  A rou                   ally left empty.
  The                     can be configured to do whatever you want...

  Please read this code, change it, try it and make it your own!
```

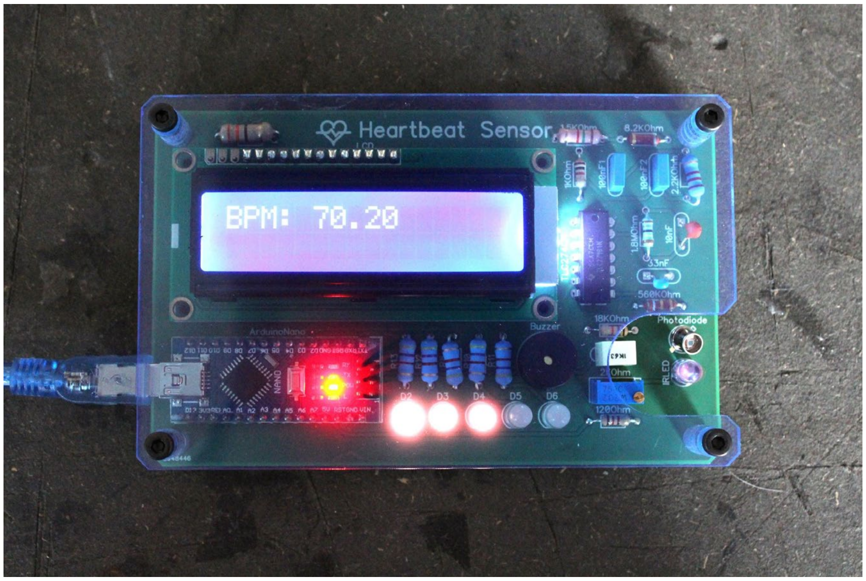
Then plug the Heartbeat sensor in your computer and go to *Tools* > *Port* and select the newly available option (either COMxxx on Windows or /dev/xxxxxx on Mac).


Heartbeat_sensor_Aidan_v3 | Arduino 1.8.5
File Edit Sketch Tools Help
Upload
Heartbeat_sensor_Aidan_v3 §

```
/*
  Heartbeat Sensor
  ----------------
  Created for PHABLABS 4.0

```

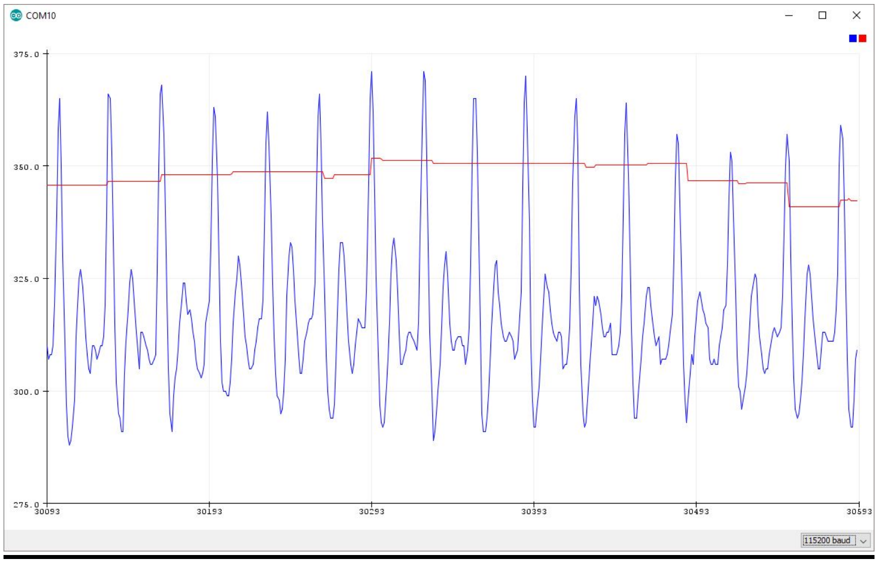
Click the arrow to upload the code to the Arduino on the PCB.



Your sensor should be done! The screen will show you your heart rate in beats per minute (BPM).

EXTENSION

The Hearbeat sensor was built to be hackable! The signal that the Arduino reads can be seen in the Serial plotter (Tools > Serial plotter). Can you figure out what the code does by looking at the two lines? Do other people's heartbeats look different? What else could you do with this signal? Could you detect other things than heart rate?



If you want to learn more about programming Arduino's, have a look at the Arduino Reference page: https://www.arduino.cc/reference/en/.

Last step: End result & conclusions

What we learned?

You learned how optics can be used in sensors, how electronics can make the information useful. You also learned to solder well, a great skill for hacking electronics.

Concluding thoughts

A lot of medical devices use photonic principles: X-ray imaging, ……
What other photonic principles can we use in medicine? Are there any already in use in biology?

In this part you can tell more information about the technology of light used in this workshop.

The following part will always conclude a workshop of PHABLABS 4.0. Please add the names of your institution and that of your pilot fab lab and the logo's.

PHABLABS 4.0 is a European project where **two major trends** are combined into one powerful and ambitious innovation pathway for digitization of European industry:
On the one hand the growing awareness of **photonics** as an important innovation driver and a **key enabling technology towards a better society**, and on the other hand the **exploding network of vibrant Fab Labs** where next-generation **practical skills-based learning** using KETs is core but where photonics is currently lacking.

www.PHABLABS.eu

This workshop was set up by the *(name Photonics Partner's Institution)* in close collaboration with *(name pilot fab lab)*.

Logo's partner + pilot fab lab