senseBox:home

Dokumentation

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senseBox:home

The senseBox:home is a citizen science DIY-toolkit for lowcost measurement of environmental data like temperature, air humidity, air pressure and (UV-) light intensity. It is based on the arduino/genuino platform and is easily integrated into our sensorweb-platform openSenseMap.

On these pages you will find the documentation and building instructions for the senseBox:home (also available as PDF).

> senseBox is an open source project and constantly under development. This means, that these pages are to some extent a work in progress. If you find wrong information or want to contribute other improvements, just contact us via email or open an issue on github!

Building instructions for your senseBox:home

Once assembled, programmed and synchronized with the openSenseMap, a senseBox:home reports location-aware measurements of the phenomena temperature, relative air humidity, air pressure and (UV-) light intensity.

This manual is divided into the following sections:

1. Inventory
2. Software installation and sensor testing
3. Registration on the openSenseMap
4. Exemplary setup

If you have questions about the assembly, which are not answered in this manual, please contact us.

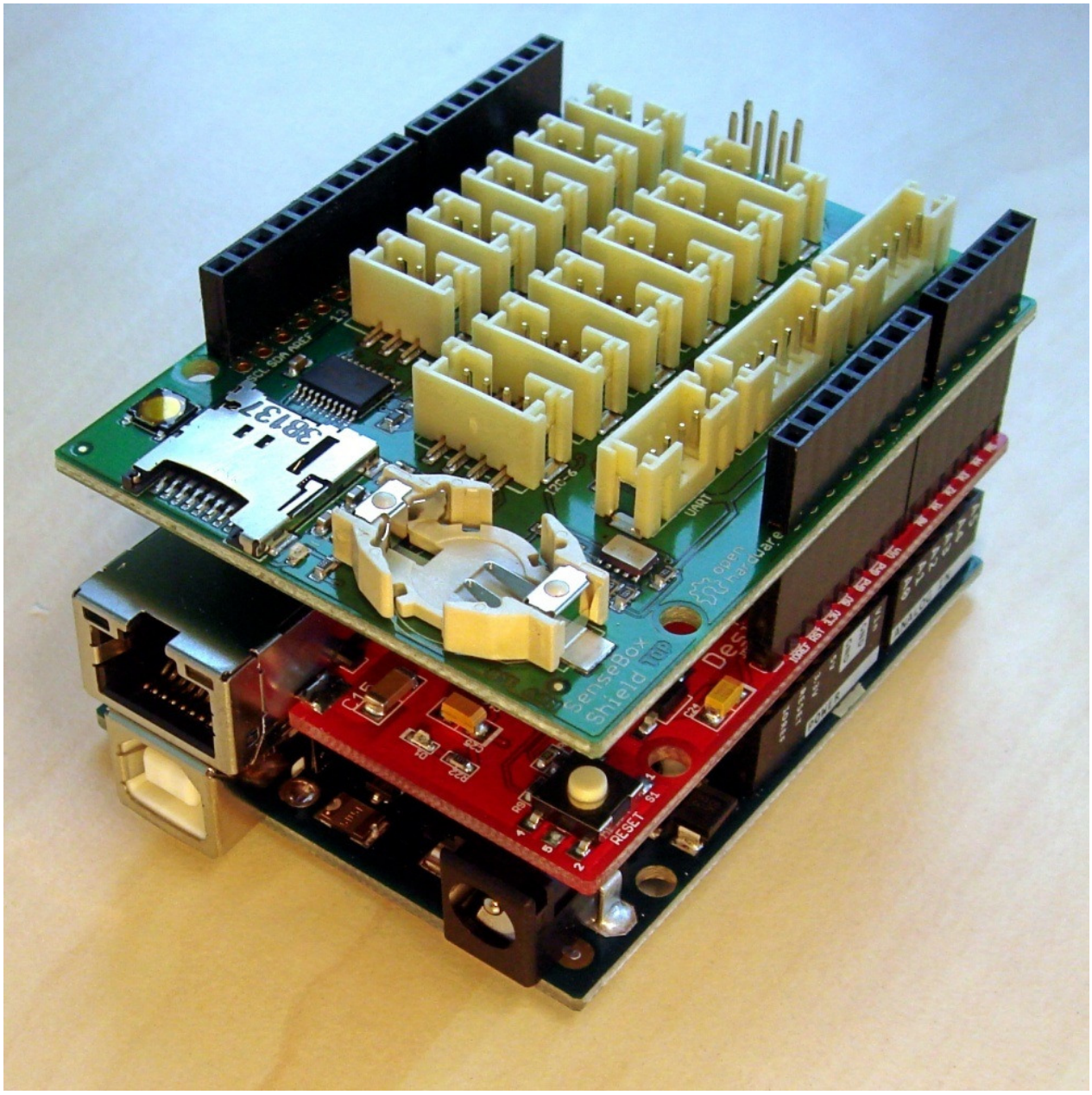
The senseBox team wishes you fun and success with your new Do-It-Yourself sensor station!

> warning:
>
> - Electrostatic discharges may damage or destroy the electronic components. Before touching the components, please ground yourself by touching a radiator or similar.
> - Circuit boards and other electronic components may contain toxic chemicals. Please wash your hands after the assembly of your senseBox.
> - Please dispose the electronic components eco-friendly, if available at your local collection point for electrical waste.

Contents of your senseBox:home

Before starting out, you should check whether your box contains all components. See below for a complete inventory list.

Inventory list



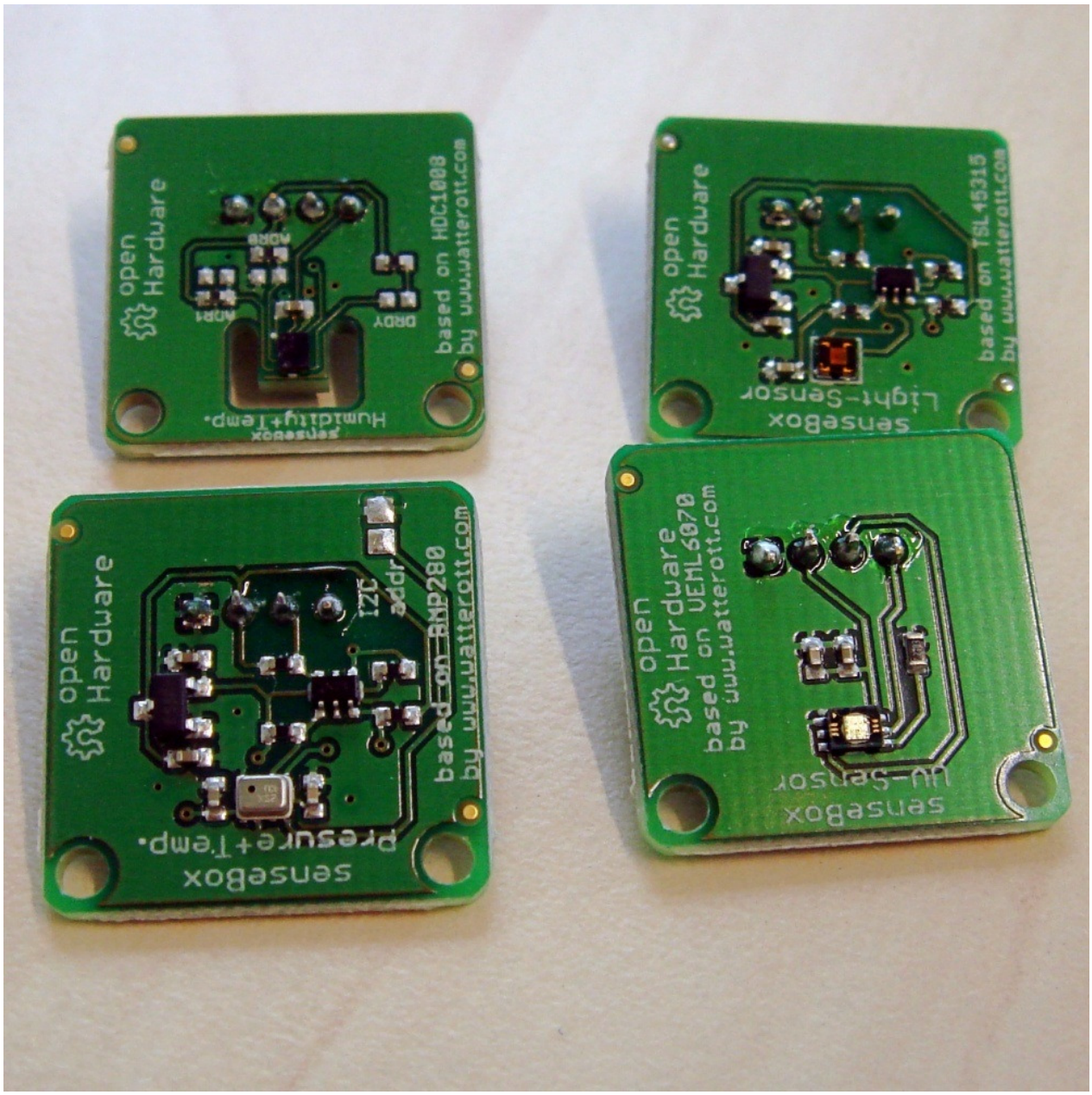
Main board consisting of 3 circuit boards

The senseBox:home is available in two editions: It comes either with an ethernet- or WLAN-shield for the connection to the internet.

The three boards are stacked on top of each other:

- bottom: microcontroller `Wattuino Uno R3`, contains the main computing and IO unit.
- mid: ethernet shield `W5500` or Watterott WiFi-shield, provides the board with an internet connection.
- top: custom `senseBox Shield`, provides an real time clock (`RV-8523-C3 RTC`), microSD-slot, and connectors for the sensors.

Basic configuration with 4 sensors



- `HDC1008` -- thermometer and hygrometer, measuring temperature (°C) and relative air humidity (%)
- `BMP280` -- barometer, measuring air pressure (hPa)
- `TSL45315` -- luxmeter, measuring intensity of the visible light spectrum (Lux)
- `VEML6070` -- UV-light sensor, measuring intensity of UV-light radiation (µW/cm²)

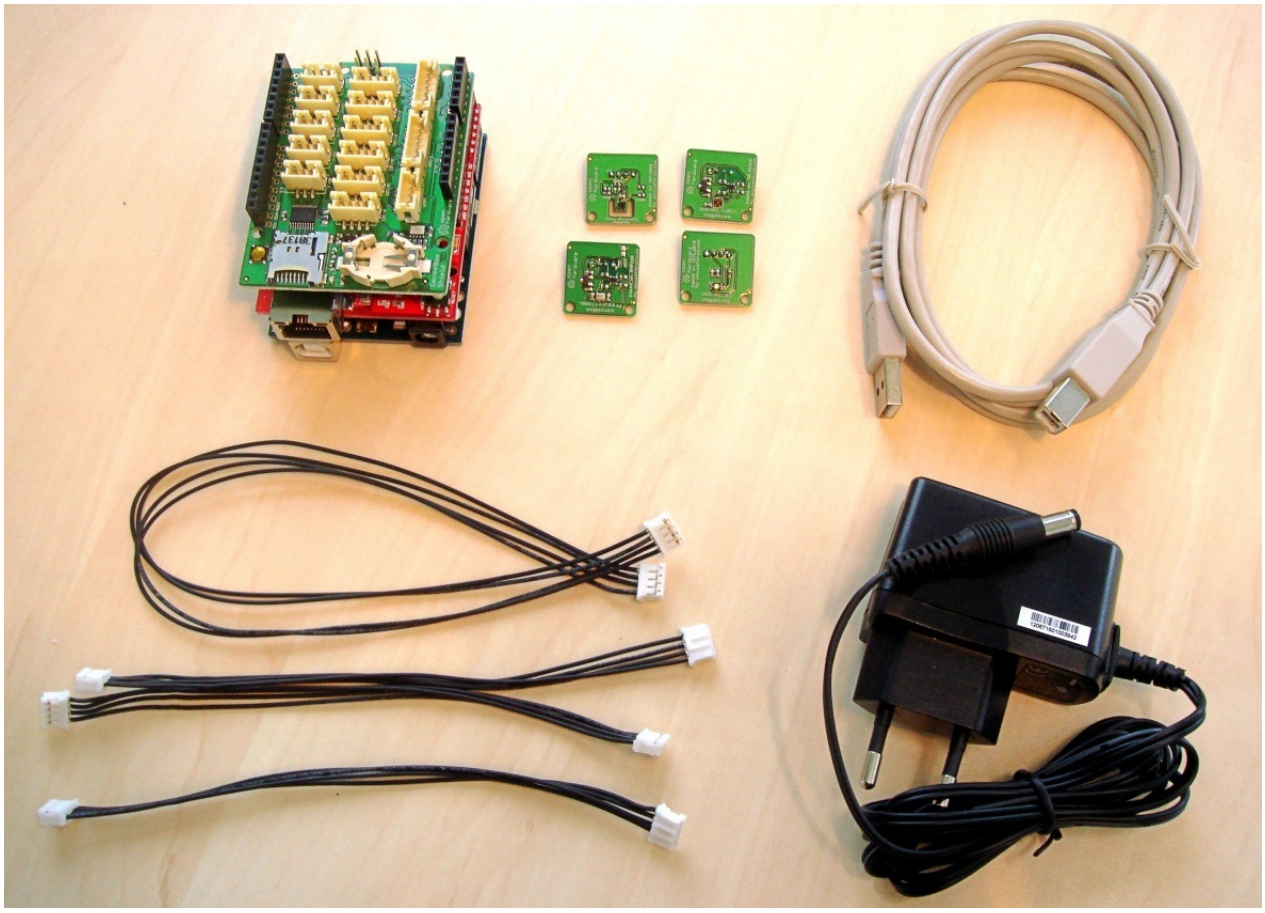
Connection cables for sensors & USB

- 1x USB Type B cable: for the connection between the Wattuino and your computer
- 3x short connection cable: for three of the sensors
- 1x long connection cable: for flexible positioning of the `HDC1008`

Power supply

- 9V DC (670mA)

Overview



Additional accessories (NOT included with your senseBox:home)

To set up your senseBox outdoors, you need additional components, which are not included with your box.

- ethernet cable, for internet connection to your router (if you have the ethernet edition)
- casing, for a weatherproof outdoor installation of the device
- tools for the assembly (e.g. hot glue, drill, ...)

The casing has to meet some requirements to ensure a minimal impact on the measurements. It has to have...

- a transparent top cover, without a filtering effect (G-UVT plexiglass normally does the job). This ensures proper light measurements.
- a white colored material, so it reflects most of the longwave radiation, allowing proper temperature measurements.
- some holes for proper airflow (while keeping it waterproof).

The material cost for such a case total at around 20 - 30 €. Building instructions are not contained in this tutorial, you may get creative yourself! At the end of this tutorial an exemplary assembly is described.

Assembly of your senseBox

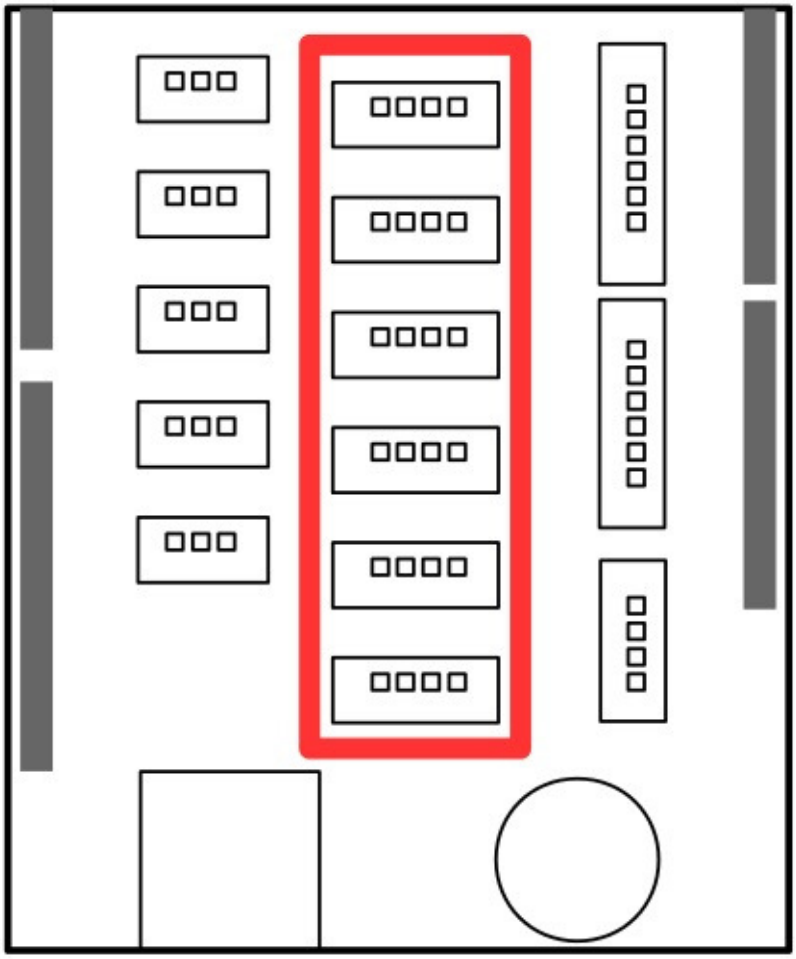
Learn how to assemble your measuring station in few steps.

> The senseBox may be powered via USB or the power supply; you only need to connect the power supply after loading the software onto the senseBox.

Connect the sensors

You will find four small circuit boards shipped with your senseBox; those are the sensors. The actual sensors are only a few millimeters big, and are placed on the topside of the board. To prevent damage to the board avoid touching the sensitive sensors, but grab the board on its sides.

Connecting the sensors is quite simple: Just use the connection cables to connect the sensors to the board. The order of the sensors does not matter. The longer connection cable is meant for the HDC1008.



Driver- & software installation

The senseBox:home is available with different microcontrollers: Older versions come with a Wattuino Uno board (pictured on the left), current versions come with a Genuino Uno board (pictured on the right).

> only windows users with a Wattuino Uno have to do a manual installation of the FTDI drivers (see below)

Preparation

Before activating your senseBox, installation of drivers and additional software on your computer is required. Also a test run is recommended to verify the proper operation of sensors and internet connection. This setup guide is written for Windows 7, but other operating systems like Linux and OSX are supported as well, and are set up similarly.

If something goes wrong, just contact our support team!

Arduino IDE software download

> Please use Arduino IDE v1.6.5 or higher!

The senseBox uses a modified version of the Arduino Uno microcontroller. To load a program onto the board, you need the integrated development environment (IDE) by Arduino. Download the latest version from the Arduino homepage and unpack the downloaded zip-file (see images below).

Arduino is an open source project and is funded through donations. Thus you are asked for a contribution, but you may skip this by clicking "just download".

Create a new folder on your harddrive and unpack the downloaded zip-File there. To launch the IDE, click on `arduino.exe`.

Linux users may check this page for installation instructions.

Installation of Arduino libraries

To be able to control the sensors and ethernet-shield, additional libraries are required. As we are using a custom ethernet shield, the default `ethernet` libary won't work. You can download all required libraries here. Download the archive and unpack it in your arduino-folder.

In case of file conflicts, always overwrite the old files.

Driver installation

> You can skip the installation of FTDI drivers with the Genuino Uno board, as well as on UNIX based operating systems.

In the last step of the software installation drivers for the microcontroller need to be installed. On Windows 7 and newer the installation should be started automatically, given a working internet connection. Just plug in the microcontroller via USB and wait until the installation is completed (see notification below).

Sensor testing

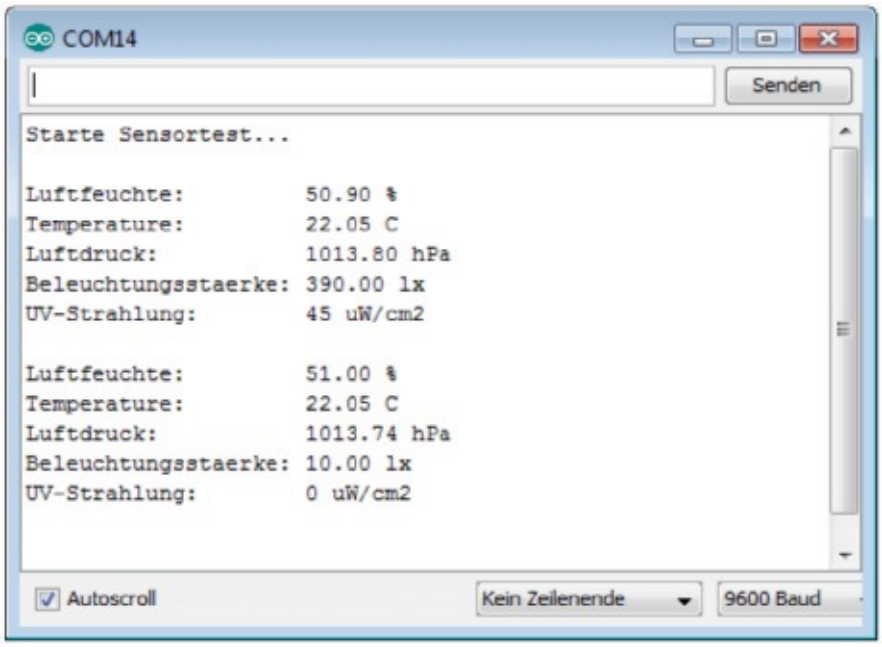
Next we check, if all sensors operate correctly. To do that

1. start the Arduino IDE
2. select `Arduino Uno` in the topbar menu `Tools` → `Board`
3. select the correct device in the topbar menu `Tools` → `COM-port`
    - In case multiple options are displayed, the correct port may be found in the windows device manager or by trial & error.

Now we load a sensor testing program onto the microcontroller, which we previously downloaded with the senseBox libraries:

1. open the sketch: select in the topbar `File` → `Examples` → `senseBox` → `_01_sensor_test`
2. upload the sketch: select in the topbar `Sketch` → `Upload` , or click the arrow icon in the toolbar
3. open the serial monitor: select in the topbar `Tools` → `Serial Monitor` or click the magnifiyng glass in the toolbar

Now the current measurements of the connected sensors should be printed in the serial monitor. You may check the correctness of the temperature-, humidity- and light intensity-values by experimenting. Air pressure and UV energy can hardly be tested directly, but the values should be around 600 - 1000 hPa and below 50 µW/cm² (indoors) respectively.

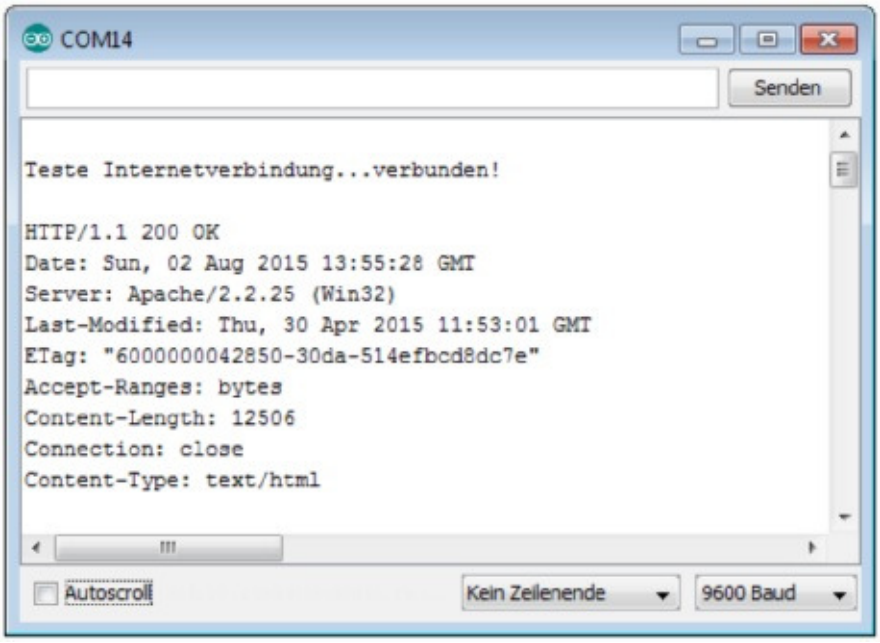


Test the internet connection

Finally we check the internet connection to the openSenseMap (OSeM) server:

1. close the serial monitor window
2. connect an ethernet cable from your home network to the sensebox
   - you may also connect it to another computer and share it's WiFi as described here
3. load the `_02_network_test` sketch: `File` → `Examples` → `senseBox`
4. reopen the serial monitor

If the connection was successful, an according message is displayed in the serial monitor.



> Due to legacy reasons port 8000 and 9000 must be opened on your router for a successful connection to the OSeM server. This should normally be the case without configuration

openSenseMap registration

Here the integration of your senseBox:home in our sensor network openSenseMap is described. On this platform a registration is required, where you specify the exact setup of your box.

> hint: you may change the OSeM website-language in the navbar!

Register your senseBox by filling out the form here. In step 2 of the registration you are asked for a hardware setup specification. Choose senseBox:home and tick the senseBox:home with (Ethernet) or senseBox:home (WiFi) checkbox, depending on your edition.

Once the registration is completed, you will receive an email containing keys for your senseBox and sensors, as well as an custom arduino-sketch (see the file extension `.ino`) which you'll need to upload onto the microcontroller.

Upload the sketch

Once you've downloaded the `sensebox.ino` attachment from the email, you need to upload the sketch onto the microcontroller, as was already described in section 2. Here's a brief summary of the steps:

1. open the Arduino IDE
2. in the toolbar select `File` → `Open` and choose the downloaded `sensebox.ino` sketch
3. confirm the dialog with "yes"
4. upload the sketch onto the microcontroller using the arrow button

If nothing went wrong, you can now view your station on the openSenseMap (use the link in the email) and view your uploaded measurements!

> Information: A custom casing for the senseBox:home is currently in development, but not yet available. The setup shown here thus is just an examplary assembly. With a bit of creativity, you can design a decent casing for your specific installation site!

Exemplary setup

This hardware setup requires that the previous steps are completed, and the station is registered on the openSenseMap.

To set up the senseBox outdoors, a long ethernet cable, a Power-on-LAN (POE) adapter, and a weatherproof case is required. Additionally the following tools are needed:

- hot glue
- drill
- screw-driver
- cable ties

Casing

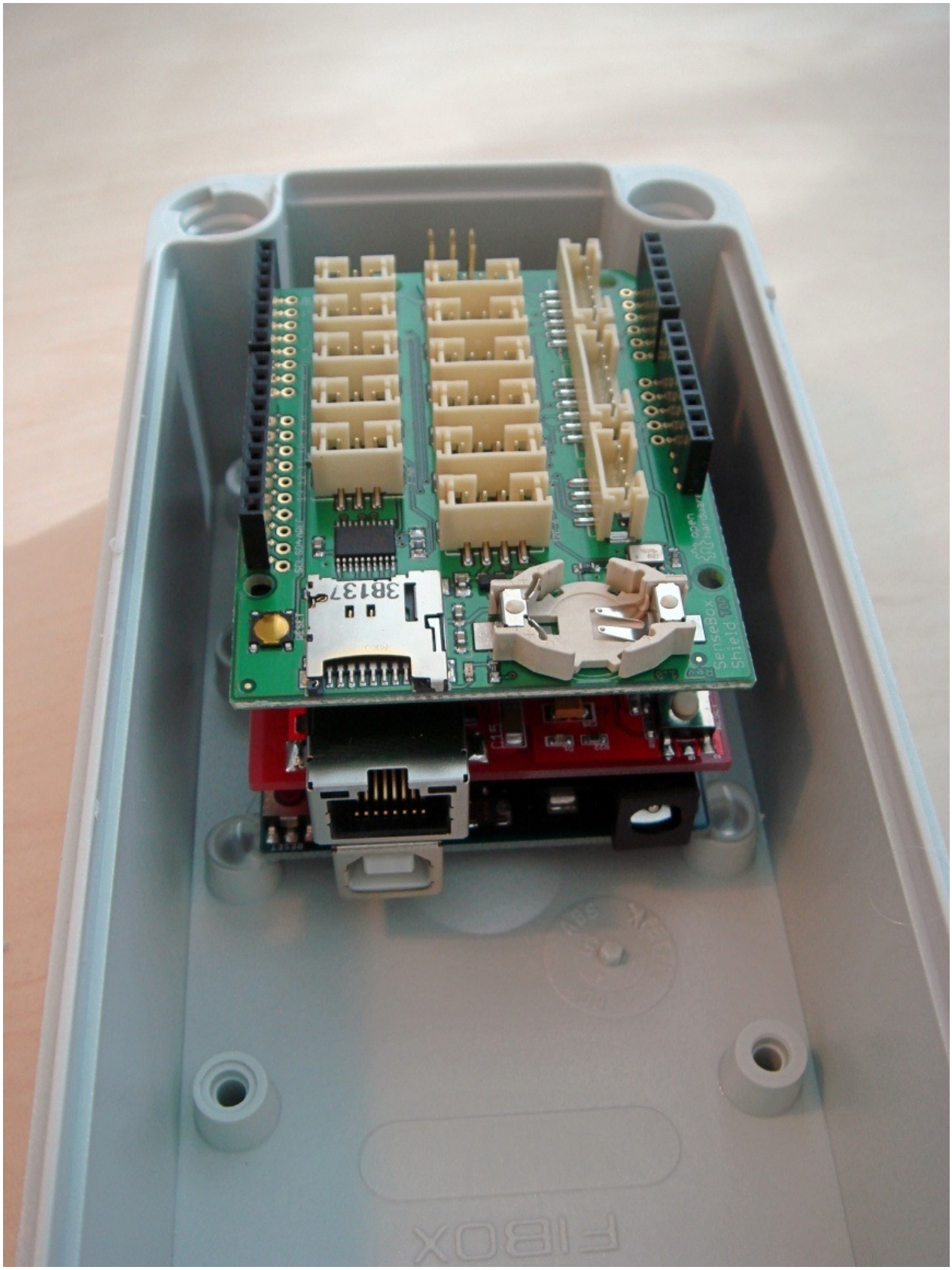
For requirements on the casing see the first section of this guide. We use this case, which is available for order on the manufacturer's webshop.

Cable routing

The combined power- and ethernet cable, as well as the long connection cable to the `HDC1008` temperature sensor is run through a 15mm wide hole, which we drill through the side of the case:

Mounting the circuit board

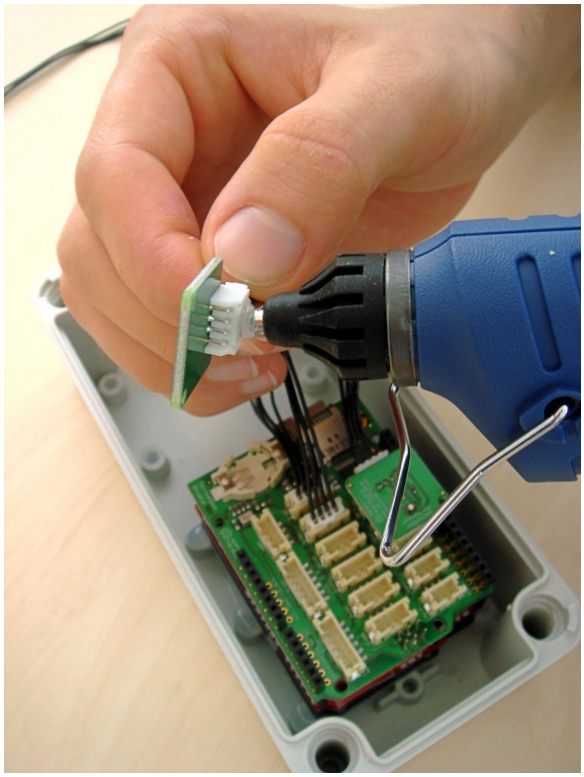
To fix the main board into the casing, simply a few points of hotglue are required. With a bit of pressure it should sit soon well within the case:

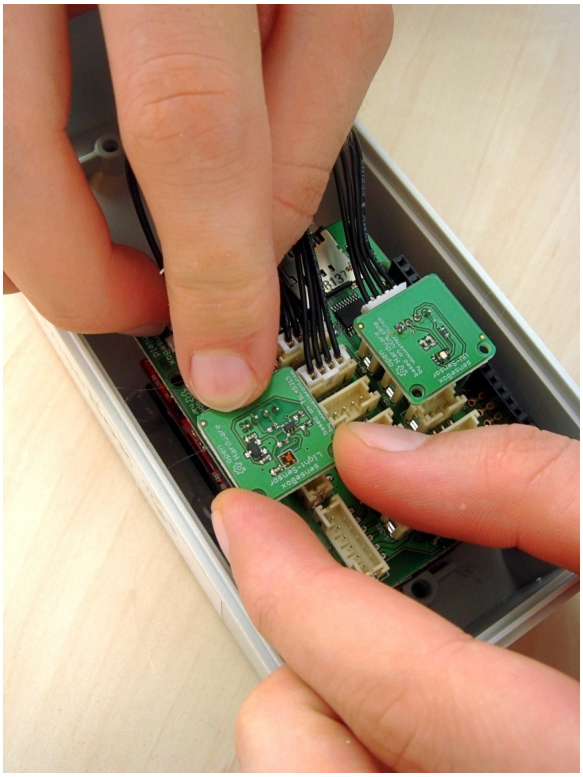


Mounting the sensors

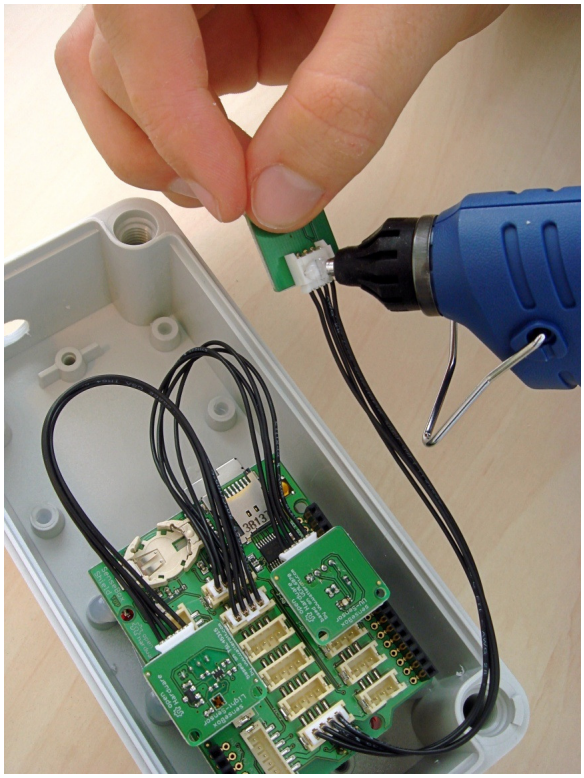
When attaching the sensors, make sure no residues of adhesive get onto the front side of the circuit board!

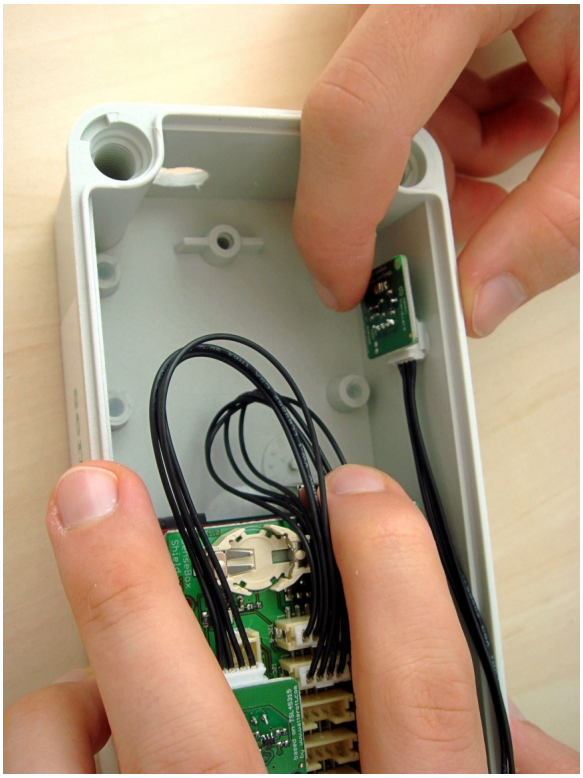
Both light-sensors (`VEML6070` and `TSL45315`) are placed on top of the senseBox shield, as they require an unobstructed view to the transparent case-top. Make sure they are not covered by cables later on!





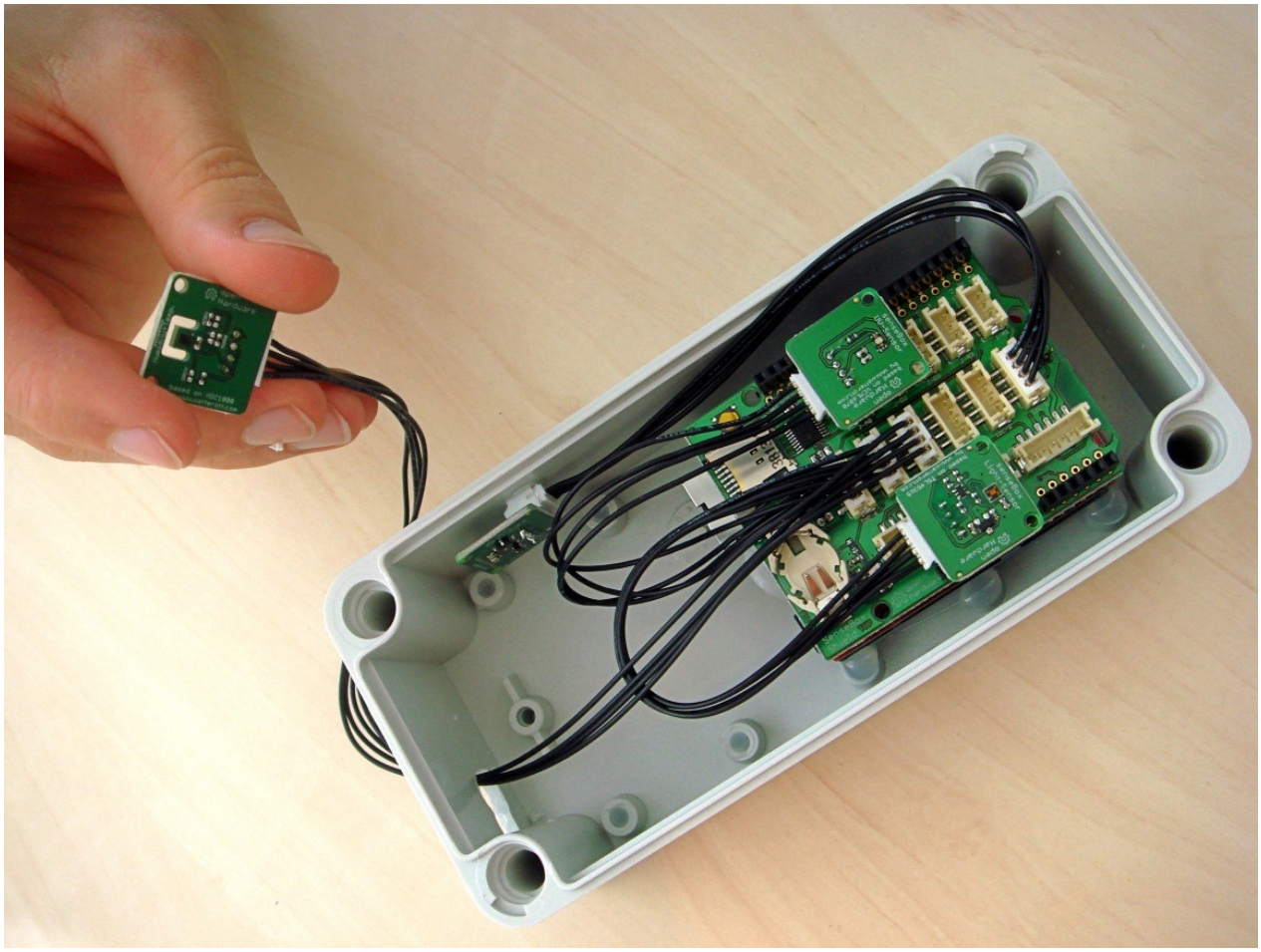
The air-pressure sensor (`BMP280`) is placed on the side of the case:





Mounting the temperature sensor

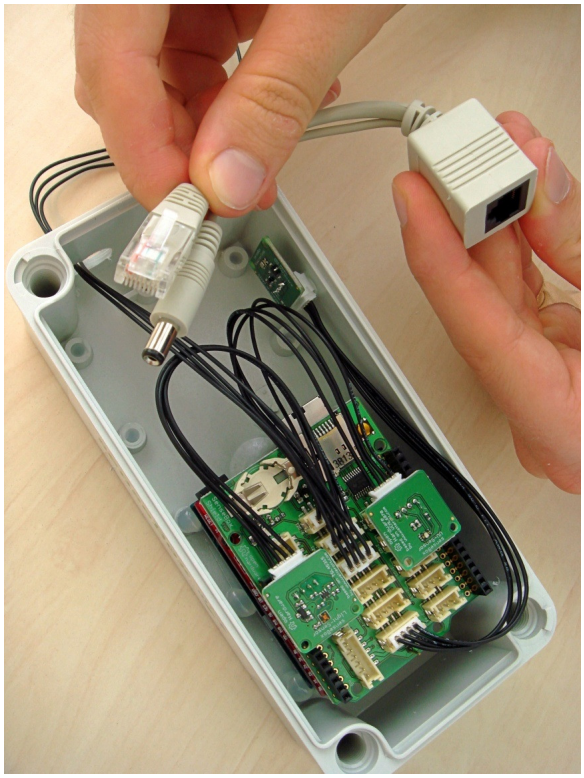
Air-pressure and -temperature are affected by the wasteheat of the microcontroller. Thus a separate housing (see below) for the `HDC1008` is required, that has a better airflow, but still protects the sensor from rainwater. We use the long connection cable for this sensor and route it through the drilled hole:

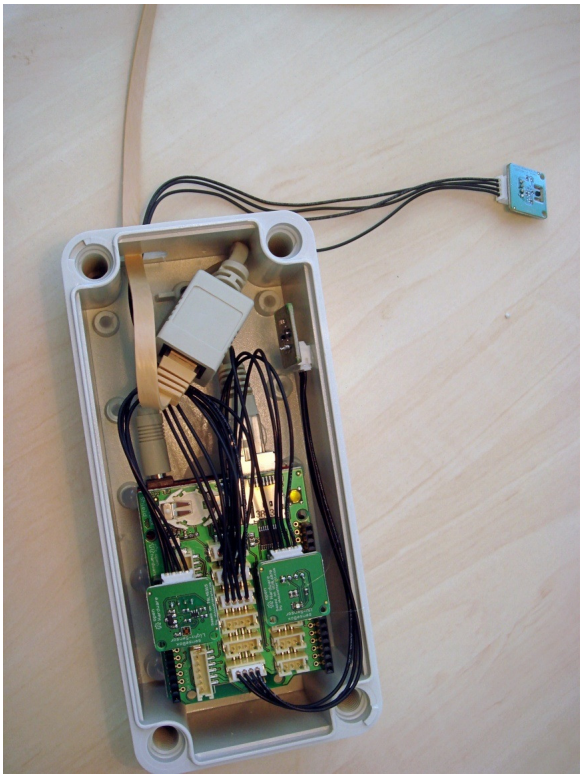


Power and network connection

To provide the station with power, we use a POE-adapter as it uses up less space in the drilling hole. The usual power connection may be used instead of course.

The adapter is connected to the respective connections on the main boards. Afterwards we route an ethernet cable into the case and connect it to the adapter:

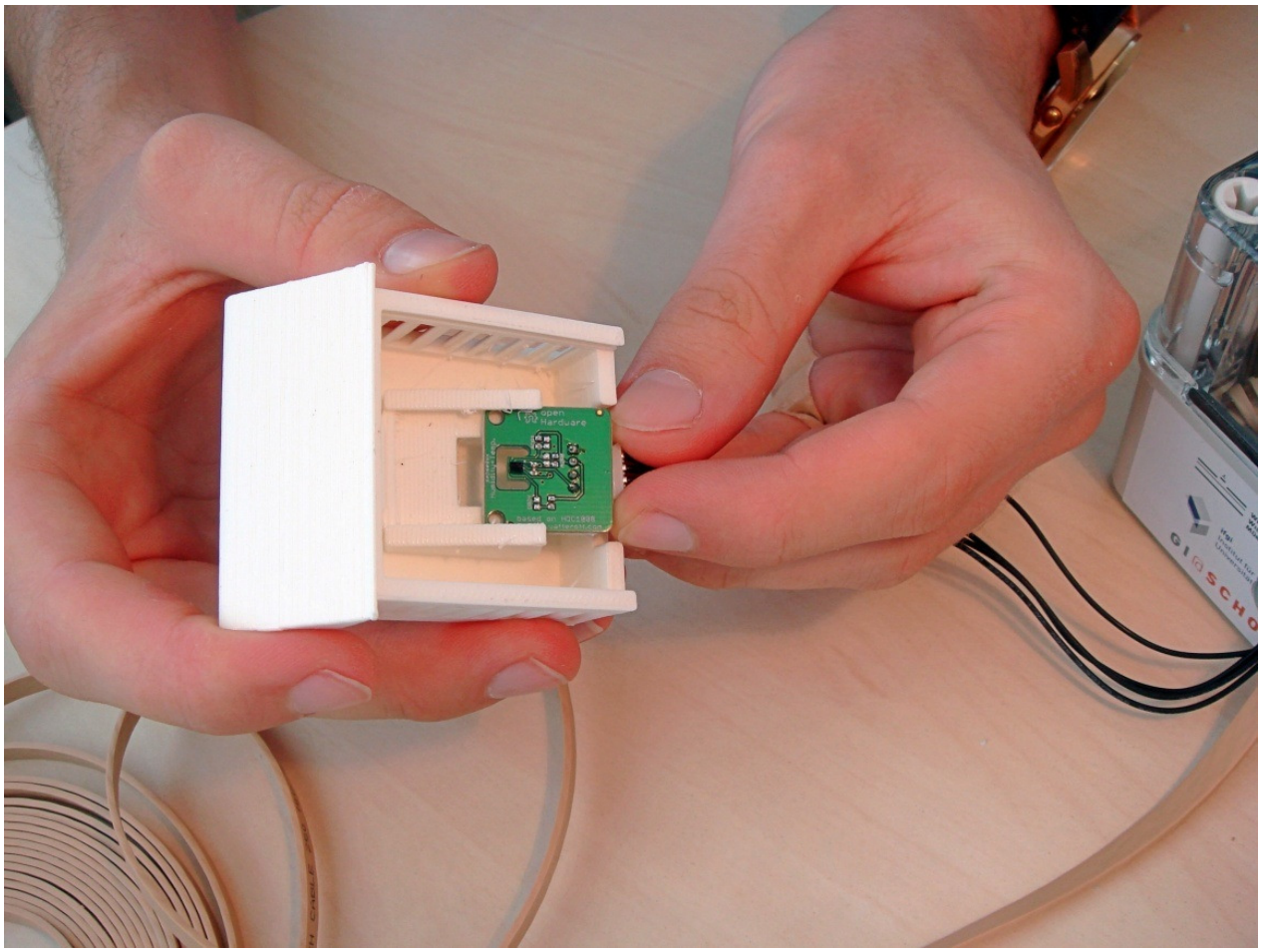




Now we are done with the casing and it may be closed!

Casing for the `HDC1008`

To make the placement of the temperature sensor weatherproof, we 3D-printed a small separate casing:



After sliding the sensor board in and closing the lid, we attach the case onto the main FIBOX case with hotglue.

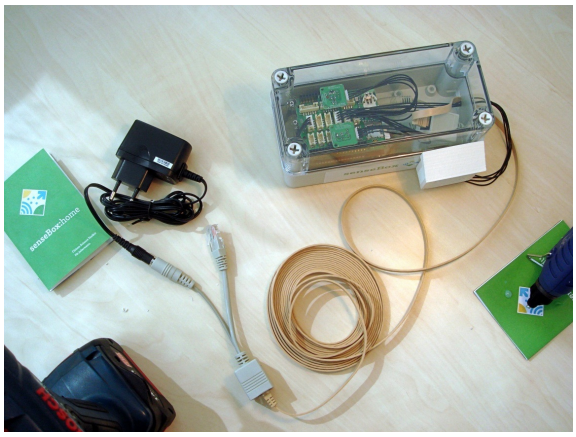
Seal the case

At last we need to make sure that no water gets into the case. Once again we use our hot glue, and seal the drilled hole:

Final result

For the installation we attach the second piece of the POE-adapter to the ethernet cable, and connect the senseBox to the network and power supply.

done!

> hint: Look for a location for the station, which ideally is directly exposed to the sky and is unobstructed in its surroundings
>
> warning! you need to place the power plug outdoors, absolutely use a weatherproof junction box!