senseBox

Researching Particulate Matter (Fine Dust)

Particulate matter (fine dust) consists of tiny particles in the air that can be harmful to health. It comes from many sources, such as road traffic (tire wear and combustion engines), construction sites, and everyday household activities like cooking or using wood-burning stoves. But how much particulate matter is in the air around you—and where are the highest concentrations? With this project, you can find out for yourself.

Step 1: Research Question

What would you like to find out about particulate matter? Choose from the options below or come up with your own question:

☐ Where is particulate matter pollution at its highest? (e.g., street vs. park)

☐ When is the most particulate matter in the air? (e.g., morning vs. noon)

☐ Your own question:

_____
_____
_____

Step 2: Hypothesis

What do you think the answer to your research question is, and why?

I suspect that...
_____
_____
... because ...
_____
_____

Step 3: Plan Measurements

Where and when are you going to measure?

Measurement 1:
Location:_____
Characteristics:_____
Date:_____
Time:_____

Measurement 2:
Location:_____
Characteristics:_____
Date:_____
Time:_____

Step 4: Perform Measurements

Use the back side to set up your measuring station.
Now you can start taking measurements. To do this, follow these instructions:

1. Position sensor 1-2m above ground, sheltered from wind, sensor opening uncovered
2. Take photos of measurement location and position of the sensor.
3. Note values every 5 minutes for 30 minutes (you can use the table).
4. Note special circumstances that could influence the measurement (e.g., "bus passed by").

Measurement 1:

Time in minutes	0	2	4	6	8	10
PM in µg/m3 (PM2,5)						
PM in µg/m3 (PM10)						
Humidity in %						
Special circumstances						

Measurement 2:

Time in minutes	0	2	4	6	8	10
PM in µg/m3 (PM2,5)						
PM in µg/m3 (PM10)						
Humidity in %						
Special cirumstances						

Optional Challenge:

Program your measuring station so that, in addition to the current particulate matter values, the averages from the last two minutes are also displayed. The senseBox should automatically store, for example, the PM2.5 value every second, calculate the average over two minutes, and then display it.

Step 5: Analysis

Calculate the average values for each of your measurements.
Measurement 1:
  ∅ PM2,5: ____ µg/m3
  ∅ PM10: ____ µg/m3
Measurement 2:
  ∅ PM2,5: ____ µg/m3
  ∅ PM10: ____ µg/m3

What factors could have influenced your measurements?

_____
_____
_____

Step 6: Conclusions

Do the results match your hypothesis? Explain.
_____
_____
_____

What new questions have emerged from your findings?
_____
_____
_____

Info: Why measuring humidity?

Humidity can affect your measurements. When humidity is high, dust particles in the air can "swell" (hygroscopic growth) and distort the sensor's measurements.
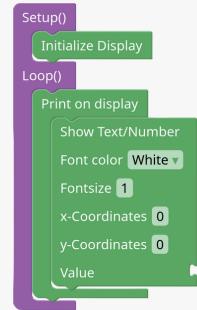This means: When humidity levels vary, your measurements are more difficult to compare.

senseBox

Build a Particulate Matter Measuring Station

Tips for Step 2

1. For programming: blockly.sensebox.de

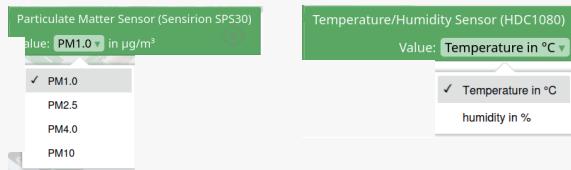2. In Setup, some components need to be activated once at the beginning of the program.

Setup()
Loop()

3. The display has to be initialized in the setup:

Initialize Display

4. To display the measurements on the screen, you need the blocks "Print on Display" and "Show text/number" in the loop.

Setup()
Initialize Display
Loop()
Print on display
Show Text/Number
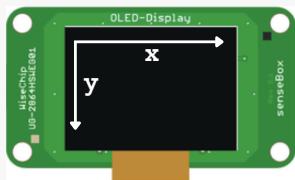Font color White
Fontsize 1
x-Coordinates 0
y-Coordinates 0
Value

5. Under "Value", insert the block for the respective sensor. For sensors that can measure multiple values, you can select the desired value from the drop-down menu.

Particulate Matter Sensor (Sensirion SPS30)
Value: PM1.0 in µg/m³
✓ PM1.0
PM2.5
PM4.0
PM10

Temperature/Humidity Sensor (HDC1080)
Value: Temperature in °C
✓ Temperature in °C
humidity in %

6. To display all three values (PM2.5, PM10, humidity), you need to use the "Show Text/Number" block three times.
You also need to adjust the y-coordinate so that the values are displayed one below the other. The x and y coordinates determine where each value appears on the display. Please note that the display has 128x64 pixels and the origin (0/0) of the display coordinate system is at the top left. The y-values can for example differ in steps of 15.

OLED-Display
x
y

Step 1: Hardware Setup

Connect the OLED display and the sensors to the microcontroller.
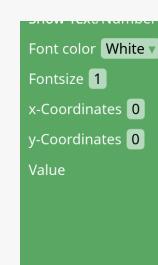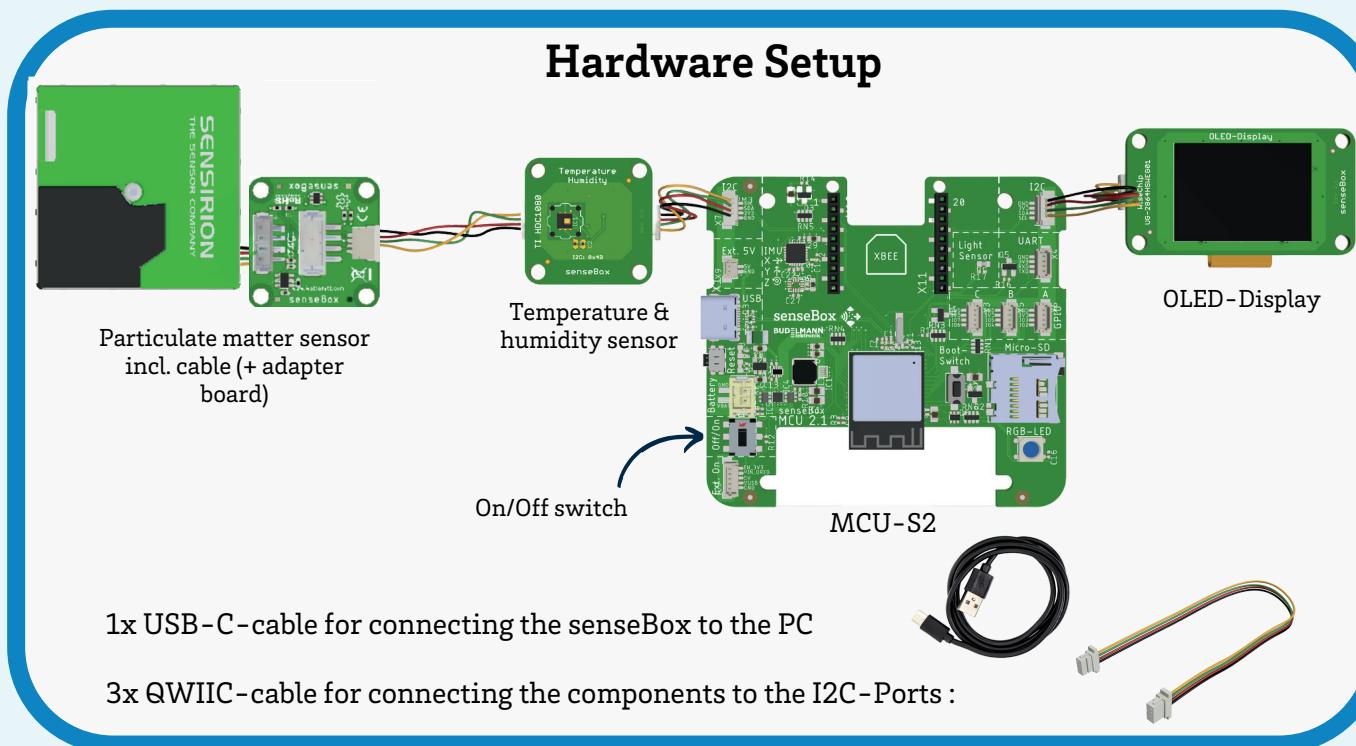
Step 2: Create program code

Create a program so that the measured values of the particulate matter and humidity sensor are shown on the display and constantly updated.

Step 3: Extend program code

Extend your program code so that the measured values, including their names and units, are shown on the display.

Step 4: Transfer program code

Transfer the program code to your senseBox and check whether all values are output and displayed as intended.

Hardware Setup

Particulate matter sensor incl. cable (+ adapter board)

Temperature & humidity sensor

OLED-Display

On/Off switch

MCU-S2

1x USB-C-cable for connecting the senseBox to the PC

3x QWIIC-cable for connecting the components to the I2C-Ports :

Tips for Step 3

To label the measured values, you need the "create text with" block from the 'Text' category. Here you can add another empty space using the "+" sign.

Show Text/Number
Font color White
Fontsize 1
x-Coordinates 0
y-Coordinates 0
Value
+ − create text with " PM 2.5: "
Particulate Matter Sensor (Sensirion SPS30)
Value: PM2.5 in µg/m³
" ug/m3 "

You will also need two empty text blocks where you can enter any text you like, for example the label (PM2.5) and the unit (µg/m³) of the measured value. Repeat this step three times as well.
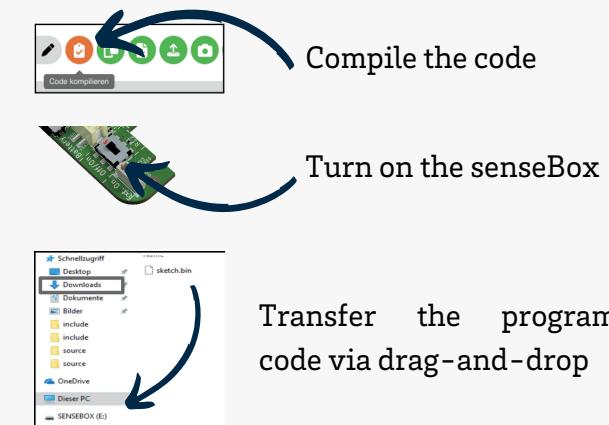
The code isn't working? Troubleshooting tips

- Are your cables plugged in exactly as shown in the illustration?
- Is the microcontroller switched on and connected to the power supply?
- Are your command blocks really connected like small "puzzle pieces"?
- Have you deleted all blocks that are not connected to your main block?
- Have you compiled the latest version of your program code and uploaded it again after making changes in Blockly?

Still having trouble?
Then get in touch with a mentor!

Tips for Step 4

Compile the code

Turn on the senseBox

Transfer the program code via drag-and-drop

Alternative: senseBox Connect App Instructions for transferring the program code using a tablet:

Author: Franziska Franke (translated from German)