senseBox

Flashcards

The senseBox Study cards

The senseBox flashcards help you to experiment with the senseBox. Besides the basics of computer science you get important information on how to use the components of the senseBox.

The flashcards are divided into two categories:

SB	Important components and programming of the senseBox
GI	Basics and concepts from computer science

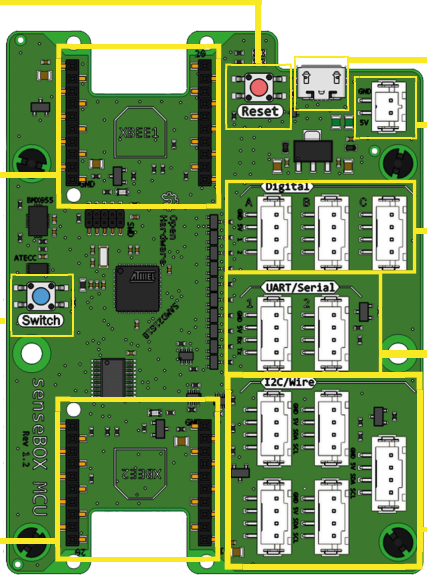
Hints for programming and transferring programs can be found at: www.sensebox.de/en/go-edu

More information, materials and projects at: www.sensebox.de/en/

Mario Pesch & Verena Witte
senseBox, 3. Circulation 2023

senseBox MCU – Ports

SB 01



Reset-Button

XBEE-Plug- in 1

XBEEs are small additional modules with which the senseBox can be expanded with functions such as WiFi or an SD card. Connect the WiFi module here.

Button

XBEE-Plug- in 2

XBEEs are small additional modules with wich the senseBox can be expanded with function such as WiFi or an SD card. Connect the microSD module here.

USB Port

Battery Plug- in

Digital/Analogue-Ports

Sensors and actuators are conntected here via the breadboard.

UART/Serial-Ports

Sensors such as the fine particulate sensor are connected here.

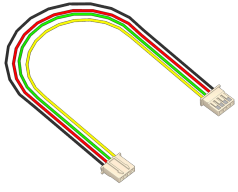
I2C/Wire-Ports

All green enviromental sensors and the display are conntected here.

senseBox Cable

SB
02

There are three different types of senseBox cables:

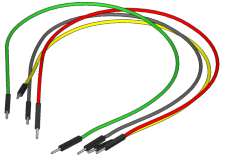


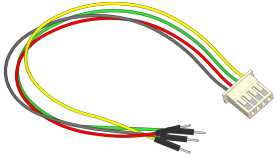
JST-JST cable

These cables are used to connect sensors and actuators directly to the MCU.

Plug- in cable

These cables are used to build circuits on the breadboard.





JST-Adapter cable

These cables are used to connect sensors and actuators via the breadboard.

Digital/ Analog Ports

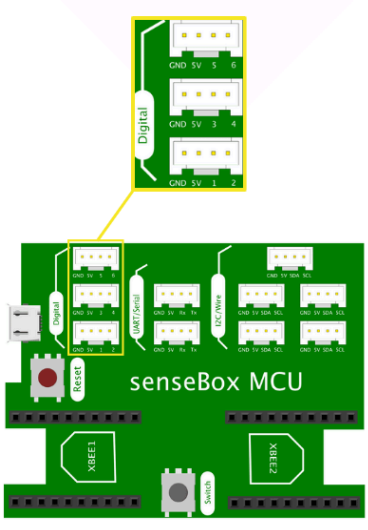
SB 03

With the plug-in cables you can connect sensors or actuators to digital/analog ports.

Each digital/ analog port on the senseBox MCU has four different pins:

- The **GND pin** is the negative terminal and is always connected to the black cable
- The **5V pin** is used for permanent power supply and is connected to the red cable
- The pins labeled **1** and **2** are the digital and analog pins 1 and 2, respectively. This numbering continues up to pin 6 on port Digital C.

So that your programs can work correctly, you must select in some blocks the pin to which your consumer (e.g. an LED) is connected.

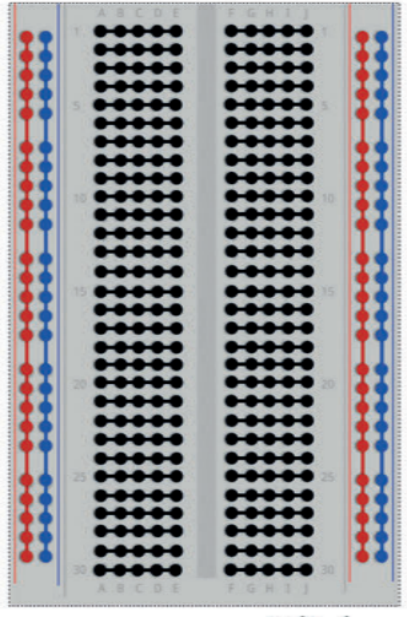


The Breadboard

SB
04

With the breadboard, also called a plug-in board, circuits can be connected very easily without soldering. The electronic components or plugs are simply inserted into the spring contacts.

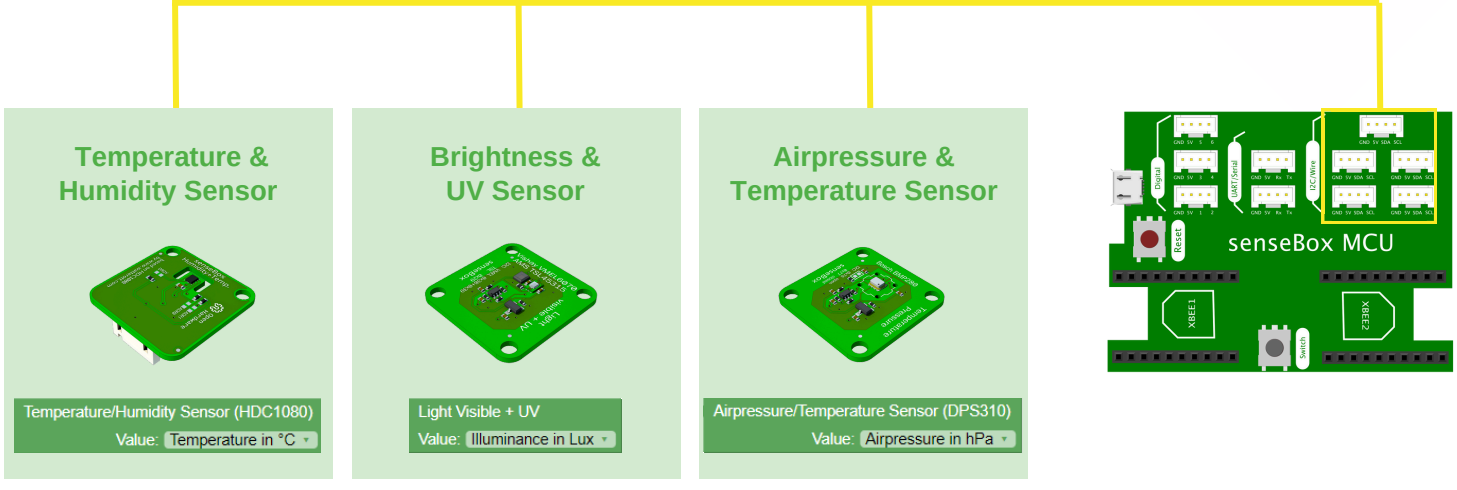
The breadboard consists of two long rows each for the plus and minus connections and two times 30 rows with five contacts each. The contacts are conductively connected as shown in the graphic.



The Green Environmental Sensors

SB 05

The green environmental sensors of the senseBox are connected to the I2C/Wire ports via a JST cable.
The following blocks give you the values for the individual environmental phenomena:

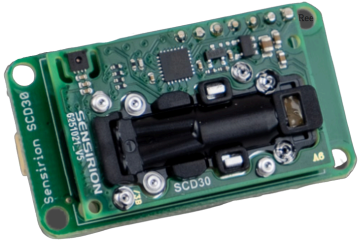


Note: There are two different air pressure sensors: BMP280 and DPS310
Note the label of the sensor and select the corresponding block in Blockly.

The CO2 Sensor

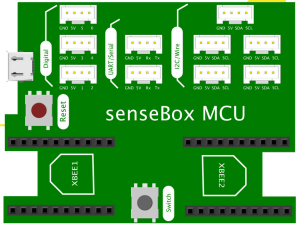
SB 06

With the CO_2 sensor, you can measure the CO_2 concentration in the room air. The measured value is output in parts per million (ppm). In addition to the CO_2 concentration, the temperature and humidity can also be measured. The CO_2 concentration in the air is an important measurement value for indoor air quality. Indoors, the limit value of 1500ppm should not be exceeded for a long period of time.



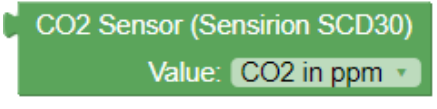
CONNECTION

The CO2 sensor is connected to one of the **I2C/Wire ports**.



PROGRAMMING

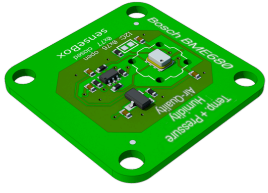
Use this block to read the CO_2 sensor. In the drop-down menu you can select which environmental phenomenon you want to collect. The measured value of the temperature is in this case the temperature in the sensor, which can be higher than the actual ambient temperature.



The Environmental Sensor BME680

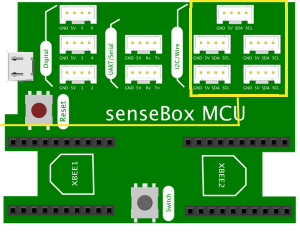
SB 07

With the environmental sensor BME 680 you can measure pressure, humidity, temperature and volatile gases. Note that you do not use the BME680 together with the BMP280 in the setup, because both sensors use the same I2C address, which can lead to conflicts.



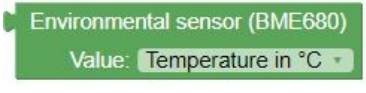
CONNECTION

The environmental sensor is connected to one of the **I2C/Wire ports.**



PROGRAMMING

Use this block to read out the environmental sensor. In the dropdown menu you can select which environmental phenomenon you want to collect.



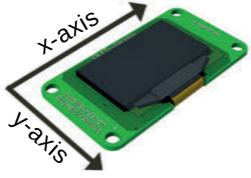
Note: The sensor requires a certain amount of time to calibrate. The status of the calibration can be read from the calibration value. It is either 0 (sensor is stabilized),1 (value is inaccurate), 2 (sensor is calibrated) or 3 (sensor successfully calibrated).

The measured values for temperature, humidity and air pressure can be used directly.

The Display

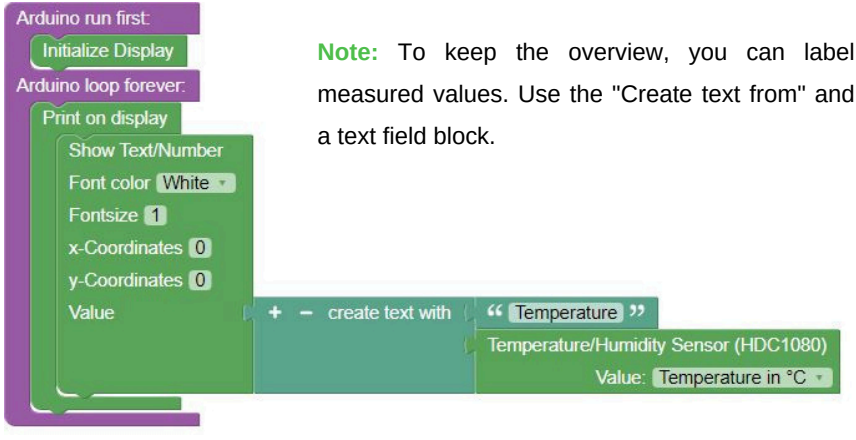
SB 08

The display can show you text, numbers and diagrams. The display has a resolution of 128x64 pixels. With the help of the x- & y-coordinates you can define where to write on the display.

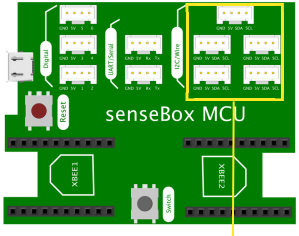


PROGRAMMING

For this, it must be initialized in the setup( ) and programmed in the infinite loop( ).



Note: To keep the overview, you can label measured values. Use the "Create text from" and a text field block.



CONNECTION

The display is connected to one of the **I2C/Wire ports.**

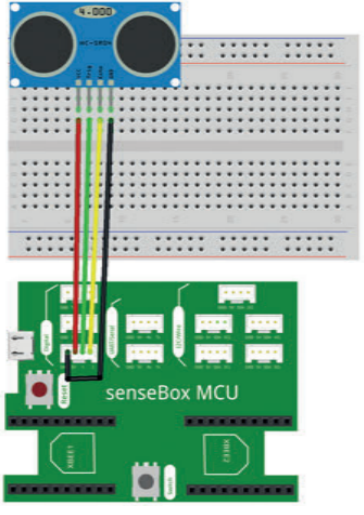
The Ultrasonic Distance Sensor

SB 09

With the ultrasonic distance sensor you can measure distances from 5 to 250 cm.

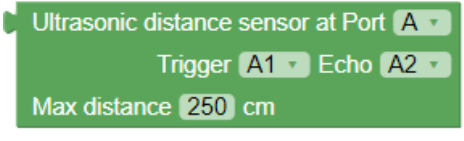
CONNECTION: To connect the ultrasonic distance sensor you need a JST adapter cable. The sensor has four different connections (pins): VCC, GND, Trig and Echo. These four connectors have to be connected to the four cables of the JST adapter cable. be connected:

GND	GND	(black wire)
Echo	2	(Yellow cable)
Trig	1	(green cable)
VCC	5V	(Red cable)



PROGRAMMING

Use this block to read the ultrasonic distance sensor:



Note: If you connect the sensor to a different port, you must also change it in the block.

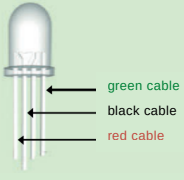
The RGB-LED

SB 10a

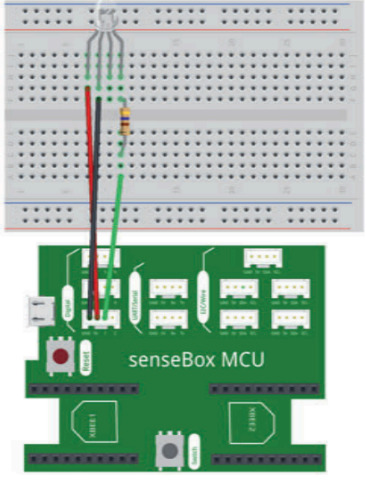
The RGB LED can shine in all colors. RGB stands for red, green and blue. From these three colors you can mix all other colors. The values of the colors can be between 0 and 255.

CONNECTION

To connect the RGB-LED you need a JST-adapter cable. The LED has four pins of different legs (pins). Only three of these four pins have to be connected to the connectors of the JST adapter cable.

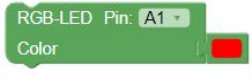


Note: A 470 Ω resistor must be used between the right leg of the LED and the green cable



PROGRAMMING

In the block for the RGB LED you have to select the pin to which it is connected. You can also choose whether you mix the color yourself or define it via the color block.



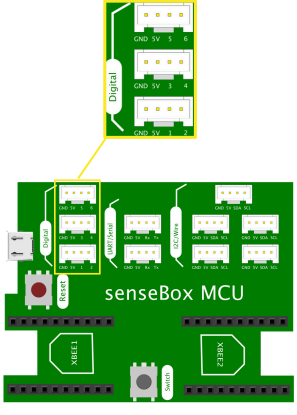
The RGB-LED (WS2812)

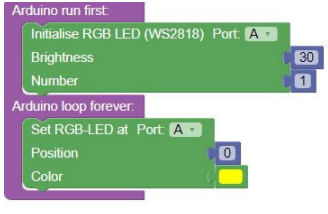
SB 10b

The RGB LED can shine in all colors. RGB stands for red, green and blue. From these three colors you can mix all other colors. The values of the colors can be between 0 and 255.

CONNECTION

To connect the modular RGB LED you need a JST-JST cable. Connect one side to the input of the RGB LED and the other side to one of the three **digital/analog ports**. If several RGB-LEDs are to be daisy-chained together, you can connect them with additional JST-JST cables (output to input). By specifying the position in Blockly you determine which LED is controlled.





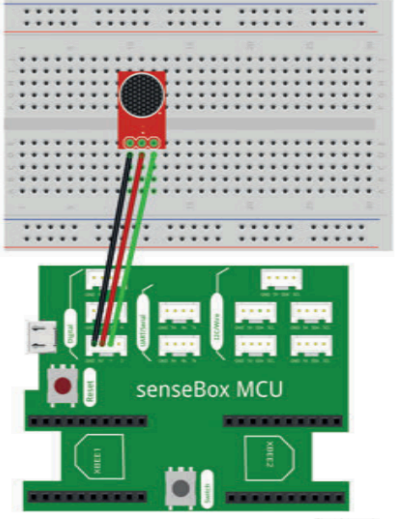
PROGRAMMING

Initialize the RGB LED in Setup() before using it in the infinite loop. Select the port used in the setup. You can select the color of the LED either with the color selector or with the values for the individual color channels.

The Sound Sensor

SB 11

With the noise sensor you can measure the ambient volume. The output measurement values are level from 0V to 5V, where 0V corresponds to the minimum and 5V to the maximum measurable volume. The measured value always represents an average value over 100ms.



CONNECTION

The sound sensor has three legs (pins): GND, VCC and OUT. Each of these legs must be connected to one of the connectors of the JST adapter cable.

GND	GND	(black cable)
VCC	5V	(red cable)
OUT	1	(green cable)

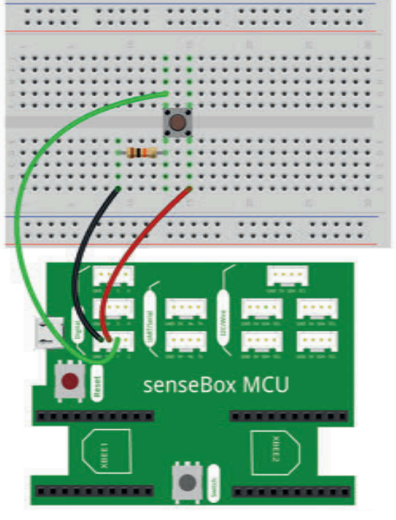
PROGRAMMING

Im block for the sound sensor you have to select the pin where you connected it.

The Button

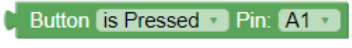
SB 12

CONNECTION: The button is connected together with a 10 kOhm resistor. This circuit is simplified so that the MCU can recognize the state of the button faster. Alternatively, you can also use the button that is directly available on the MCU.

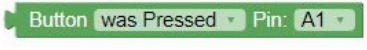


The button can assume different states:

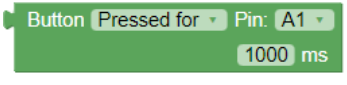
"is pressed": With this block you can query whether the block is currently pressed. You get either the value TRUE or FALSE.



"was pressed": With this block you can query whether the block was pressed. Only if the button was pressed and released again, you get TRUE back.



„pressed for 1000 ms“: With this block you can query whether the block was pressed for a defined time. Only if the block is pressed for the defined time you get TRUE back.

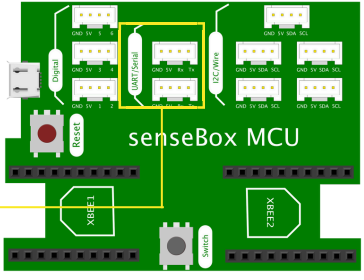


The Fine Particular Sensor (SDS011)

SB 13a

With the fine dust sensor, you can measure the number of minute dust particles in the air in two different particle sizes:

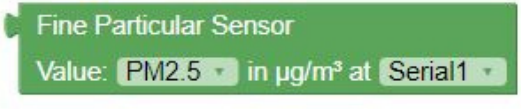
PM2.5: Specifies the amount of fine dust particles <2.5 µm in µg/m3
PM10: Specifies the amount of fine dust particles <10 µm in µg/m3



CONNECTION: The fine dust sensor is connected to one of the two **UART/Serial ports** via the special JST fine dust cable.

PROGRAMMING

In the drop-down menus of the sensor block you can select the desired measured value and the port to which the sensor is connected.

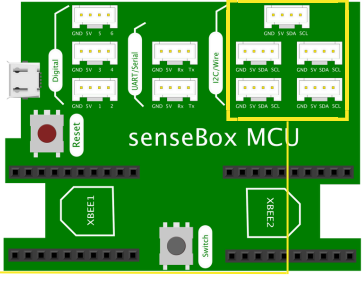


The Particulate Matter Sensor (SPS30)

SB
13b

With the fine dust sensor, you can measure the amount of the smallest dust particles in the air in four different particle sizes:

PM1.0: Specifies the amount of fine dust particles <1 µm in µg/m3
PM2.5: Specifies the amount of fine dust particles <2.5 µm in µg/m3
PM4.0: Specifies the amount of fine dust particles <4.0 µm in µg/m3
PM10: Specifies the amount of fine dust particles <10 µm in µg/m3



CONNECTION

The particulate matter sensor is connected to one of the five **I2C/Wire ports**.

PROGRAMMING

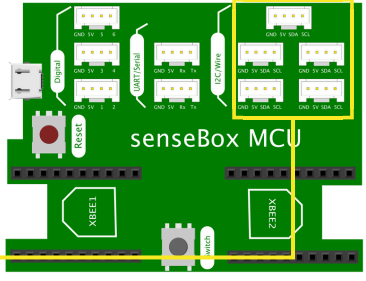
In the drop-down menus of the sensor block, you can select the desired measured value and the port to which the sensor is connected.

The GPS-Module

SB 14

With the GPS module you can get different location information.
It can output six different measured values:

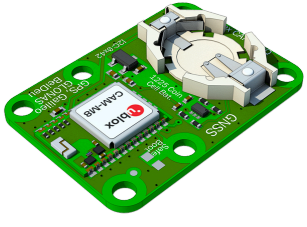
Height above sea level in m	Longitude
Speed in km/h	Date
Latitude	Time



CONNECTION: The GPS module, like all green environmental sensors, is connected to one of the five **I2C/Wire ports.**

PROGRAMMING

Use this block to read the GPS module:



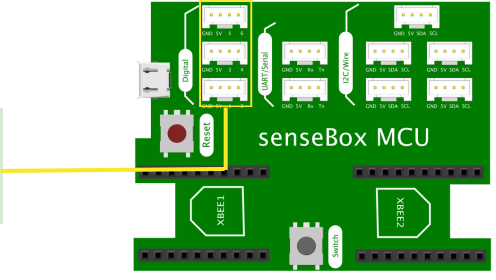
The Ground Sensor

SB 15

With the soil sensor you can measure two different soil parameters:

- Soil temperature in °C
- Soil moisture in %

Soil moisture is expressed in values from 0 to 50% volumetric water content.

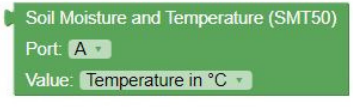


CONNECTION

The floor sensor must be connected to one of the **digital ports**.

PROGRAMMING

Use this block to display the measured values of the soil sensor:



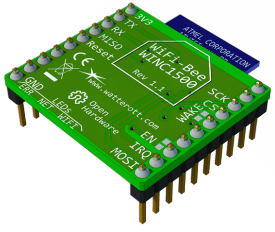
In the dropdown menu you can select the desired measurement value and the port to which the sensor is connected.

Data Transfer to the openSenseMap

SB 16

ESTABLISH WIFI CONNECTION

Plug the WiFi Bee into slot XBEE 1.

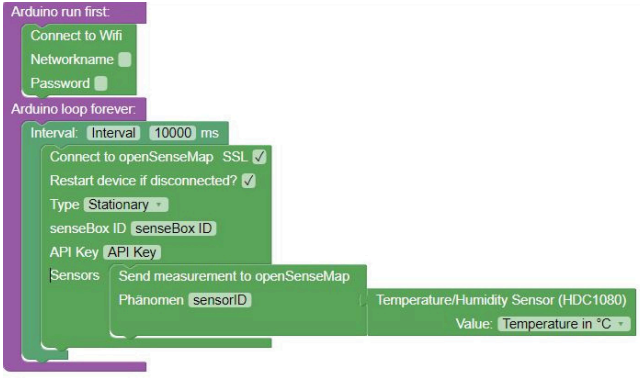


PROGRAMMING

After that, you have to drag the "Connect to WLAN" block into the 'Arduino run first' and enter your network name (SSID) and WLAN password.

SEND TO THE OPENSENSEMAP

After registering your senseBox on the openSenseMap, you will receive a BoxID and a SensorID for each sensor. Now enter the BoxID in the "Connect to openSenseMap" block and the SensorID in the "Send measurement to openSenseMap" block. With the measurement interval, you can define how often measurements should be taken.



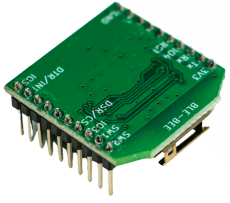
Data Transfer to the Phyphox App

SB 17

ESTABLISH BLUETOOTH CONNECTION

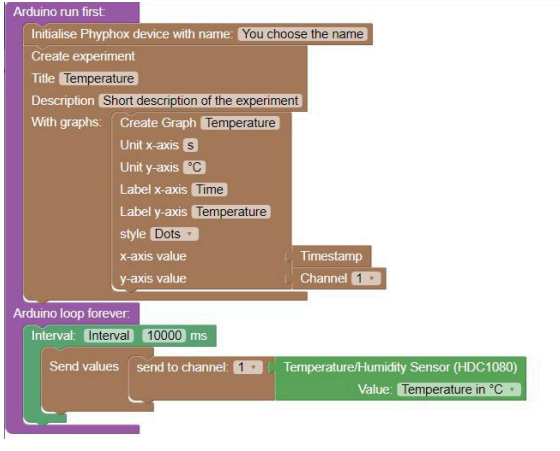
Connect the Bluetooth Bee to the XBee slot 1.

Then download the Phyphox app (https://phyphox.org/download/).



PROGRAMMING

IInitialize the Phyphox device in the 'Arduino run first' and create an experiment. There you can make basic settings for the created graph.



SENDING THE MEASURED VALUES TO THE PHYPHOX APP

Set a measurement interval in the infinite loop and send each environmental phenomenon to a new channel.

PHYPHOX APP

Add a new Bluetooth measuring device in the Phyphox app via the +, activate the automatic timer, and start the measurement. The measured values are now displayed in the app in the form of a diagram.

Data Storage at the SD-Card

SB 18

CREATE A FILE ON THE SD CARD

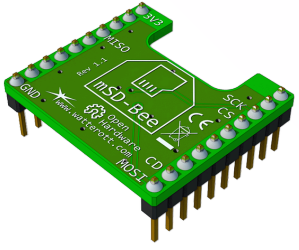
Connect the SD Bee to the XBee slot 2.

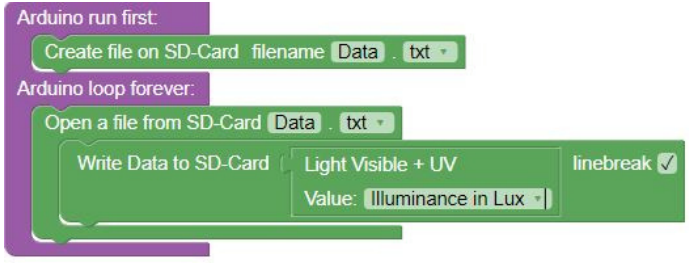
PROGRAMMING

In the 'Arduiono run first', create a new file on you SD-Card with the block "Create a file on SD card".

WRITE MEASURED VALUES TO THE FILE

To save a measured value in the file, you must first open it using the "Open File" block and then write the measured value to the file using the "Write Data" block. The "Open File" block automatically closes the file after writing.

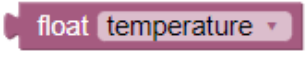




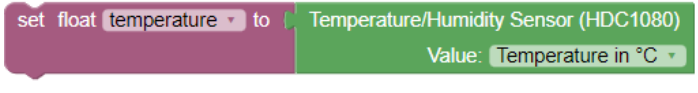
Variables– Placeholder

GI 01

Variables, also called placeholders, are used in computer science for various things. They are a kind of box that is given a name. In this box you can store different things (e.g. numbers and texts) and retrieve them later.



Variables can change their value during the course of the program, so that, for example, you always assign the currently measured temperature value to the variable "Temperature".



DATA TYPES

Depending on what you want to store in a variable, you have to choose the right data type.

Characters (char):	For individual text characters
Text (string):	For whole words or sentences
Number (int):	For numbers from -32768 to +32768
Large number (long):	For numbers from -214748364 to +2147483648
Decimal number (float):	For decimal numbers (e.g. 25,3)
State (boolean):	true or false

If ... then – What?

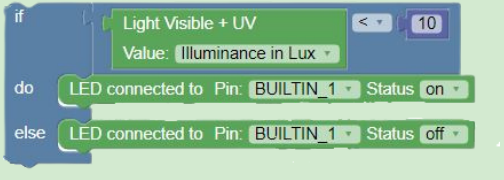
GI 02

The "If-then Condition" is one of the most important control structures in programming. With the help of the "If-Then" condition, the senseBox can perform certain actions when something specific (e.g. a button press) has happened.

With the "Logical comparison," you can compare two values. An explanation of the different symbols in this block can be found on the card GI03 „Operators“.

EXAMPLE

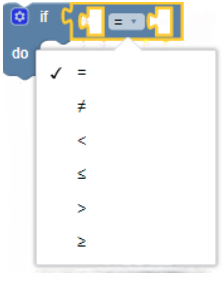
If the temperature is greater than 20°C,
do the built-in LED is to be switched on.
Else, the built-in LED should be switched off.



Operators

GI 03

Operators are needed in many programming situations. With the help of the operators, conditions can be checked or values can be compared.



You can find the following operators in Blockly:

= You can use this character to check whether two values are equal.

≠ You can use this character to check if two values are different.

< With the help of this character you can check if one value is smaller than another.

≤ This character is an extension of the "less than" character and includes values that are the same size.

> You can use this character to check whether one value is greater than another.

≥ This character is an extension of the " greater than" character and also includes values that are equal in size.