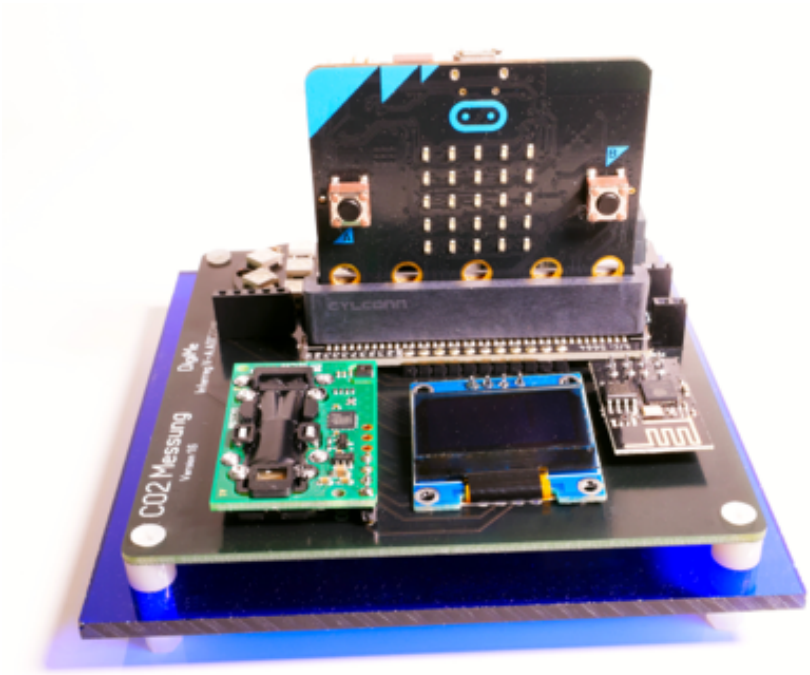
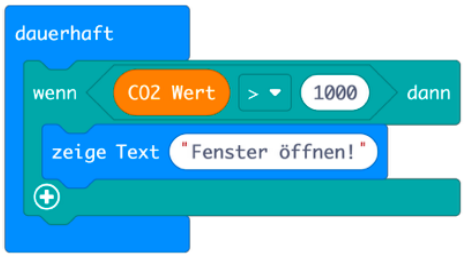




CO2 Warning Device

Programmable with the micro:bit

Interreg

EUROPÄISCHE UNION

Österreich-Tschechische Republik

DigiMe

Europäischer Fonds für regionale Entwicklung

Project co-funded by the European Regional Development Fund (ERDF)

Table of Contents

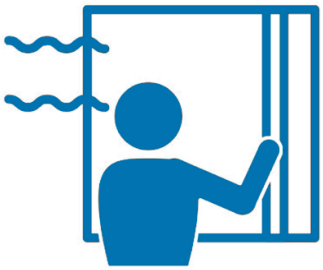
Relationship between Air Quality and CO2

Do you sometimes feel tired or have difficulties concentrating?

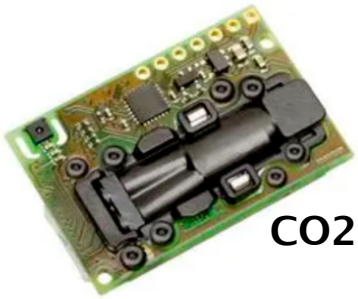
With every breath, you take up oxygen and produce CO2 (carbon dioxide) and other gases.

The exhaled air also contains tiny droplets (aerosols) which float in the air for quite some time and can also contain virus particles (from infected persons, particularly during flu season).

Remedy



Letting fresh air in regularly ensures that the air is circulated and the oxygen in the room is replenished.

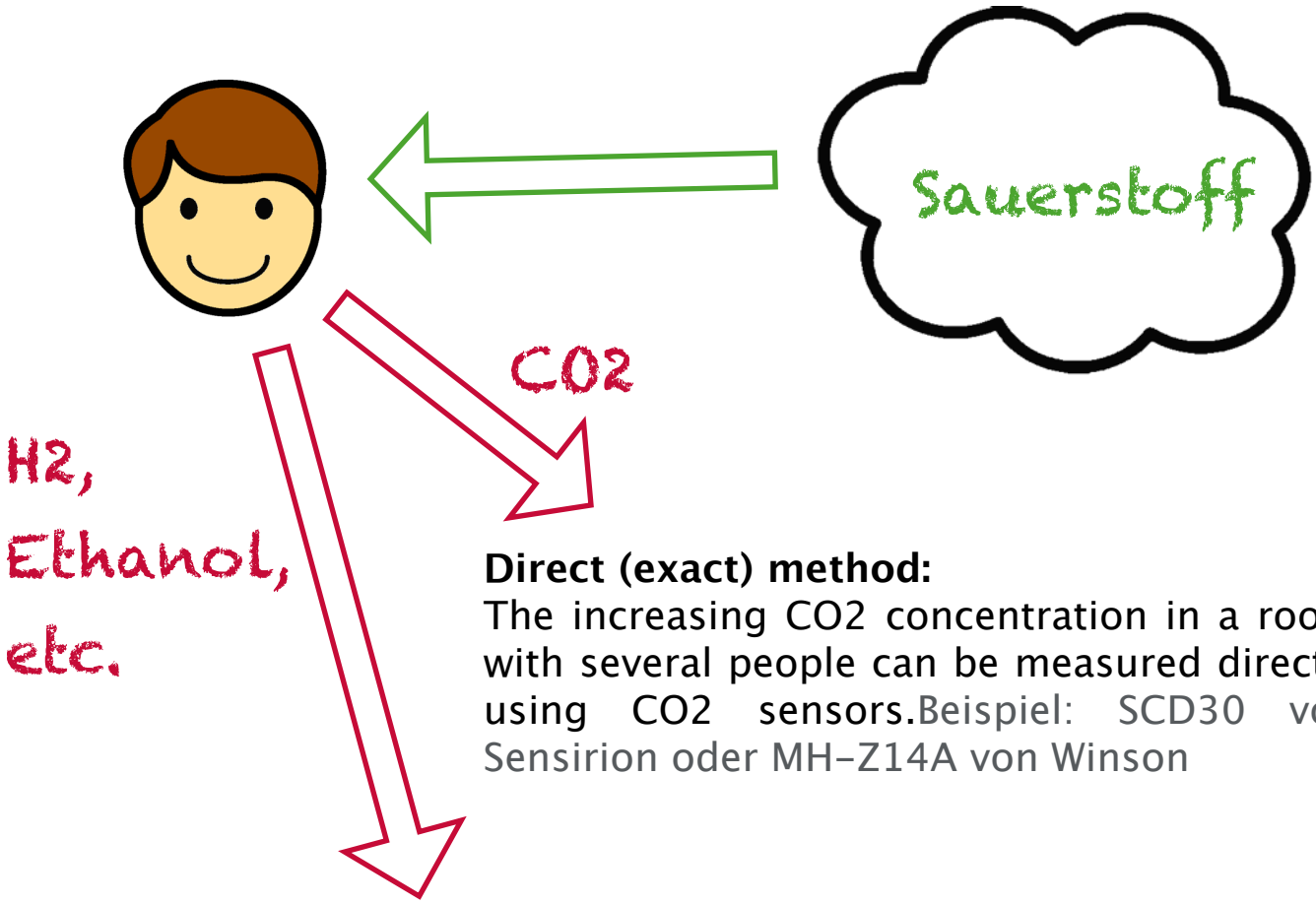


CO2 measuring device as an indicator for “good” room air

By measuring the CO2 content (an increase indirectly indicates that oxygen has been consumed), the air quality in the room is detected and an indication is given when it is time to let some air in to counteract any difficulty concentrating.

Measurement of Air Quality

There are 2 options for measuring the CO2 content in the air.



Direct (exact) method:
The increasing CO2 concentration in a room with several people can be measured directly using CO2 sensors.Beispiel: SCD30 von Sensirion oder MH-Z14A von Winson

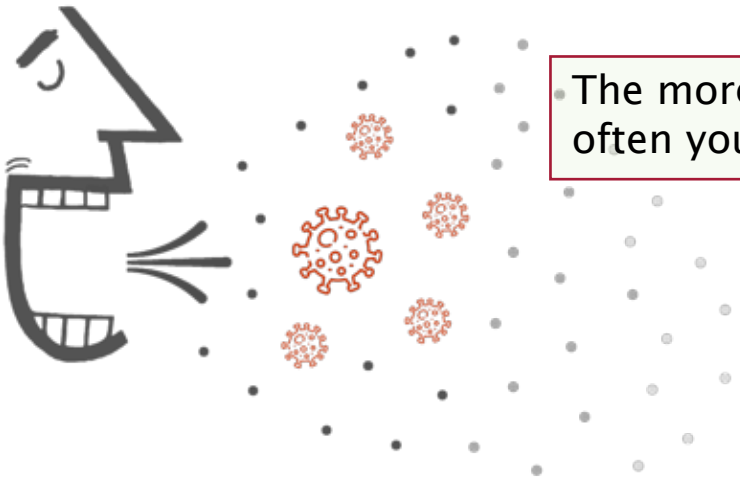
Indirect method (not always reliable):
People continuously release organic substances (H2, ethanol, etc.) into the room air. VOC (volatile organic compound) sensors measure these organic compounds and provide indirect clues about the CO2 content in the air. A derived eCO2 (equivalent CO2) value is shown, which unfortunately will sometimes be distorted due to organic compounds in the air (food smells, disinfectants, alcohol, etc.).
Example: CCS811 or SGP30

Comparison of CO2 sensors vs. VOC sensors

CO2 sensors (e.g. SCD30, MH-Z14A, etc.)	VOC sensors (e.g. CCS881, SGP30, etc.)
Exact values because CO2 is measured directly	CO2 is derived, which can result in outliers and misinterpretations
Commissioning without delay	Long heat-up time during commissioning (15-20 minutes)

Proper Procedure for Letting Fresh Air in

Letting fresh air in ensures that, in the best-case scenario, there is an air exchange, i.e. released harmful substances, increased CO2 levels, bad smells and in part also humidity (e.g. in the bathroom -> mould risk) are removed from the air.



The more people are in a room, the more often you should let fresh air in.

What do we mean by "proper procedure for letting fresh air in"?

In order to enable the air to be exchanged as quickly and as efficiently as possible and at the same time waste as little energy as possible, in particular during the heating season, you need to consider a few things.

Intermittent ventilation and cross-ventilation

Intermittent ventilation with the windows completely open allows the air to be exchanged quickly. This can be further optimised by also opening windows and/or doors on the opposite side, reducing the time required for letting fresh air in to 5 minutes.
In contrast, letting fresh air in by opening the windows a little only takes significantly more time, resulting in energy being wasted and higher heating costs (see chart on the next page for an illustration of this effect).

How often should you let fresh air in?

A rule of thumb is to let fresh air in at least 1x per hour. Since the air quality depends on room size and the number of persons, a CO2 measuring device is which indicates when it is time to let fresh air in.

Visualisation of CO2 Measurement

A great and free-of-charge option to analyse and visualise measured values is the IoT platform ThingSpeak. IoT stands for “Internet of Things” and means devices which are integrated into the Internet.

This can be a beverage vending machine, for example, that notifies its owner when

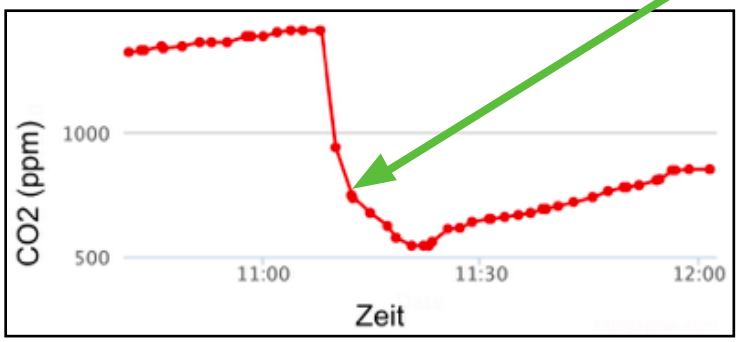
or a weather station supplying measured values to a remote station,

or a heating system that has “smart” remote setup features.

There are countless examples of so-called IoT devices and their number and applications are increasing massively every year.

Analysis of measured data on ThingSpeak

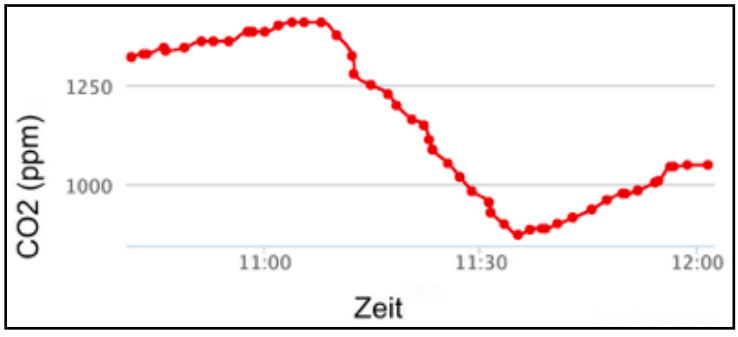
The following measured data highlight that intermittent cross-ventilation for a mere 4 minutes causes the CO2 level to drop by half.



The drop of the curve shows that the CO2 content of the air only drops very slowly in the following 10 minutes.

Let fresh air in for a short

In contrast, the graph below shows the result of letting fresh air in by opening the window only a little.

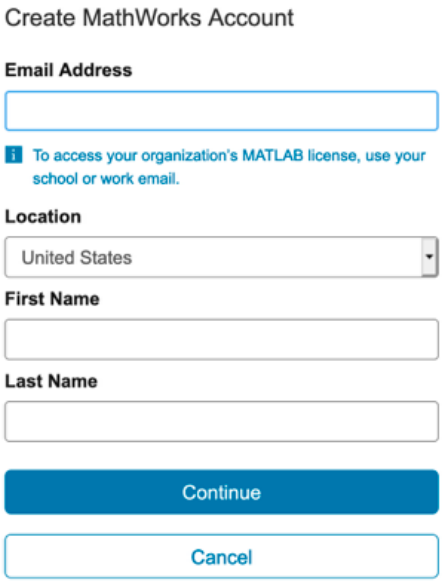


Although fresh air was let in for a longer period, no comparable drop of CO2 content was achieved.

High heating costs (winter season)!

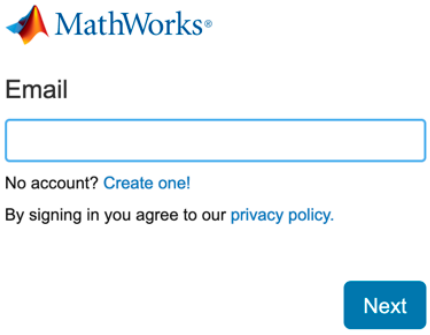
ThingSpeak – Creating an Account

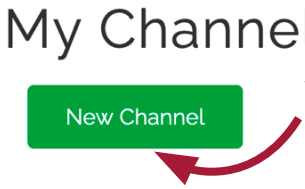
In order to be able to use the ThingSpeak platform, you need to register free of charge at https://thingspeak.com.



In the next step, you need to enter your name, country and email address, and you need to enter a password of your choice.

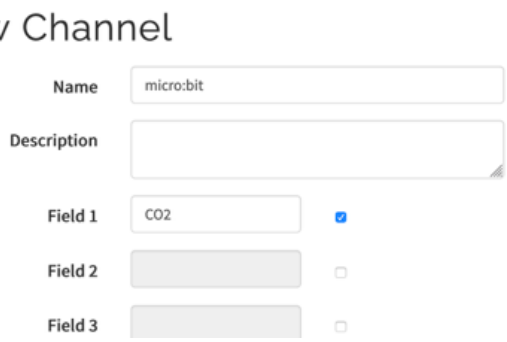
After completing the registration, you can log in at https://thingspeak.com/login.





You now have the option to create a channel (one of 3 in total).

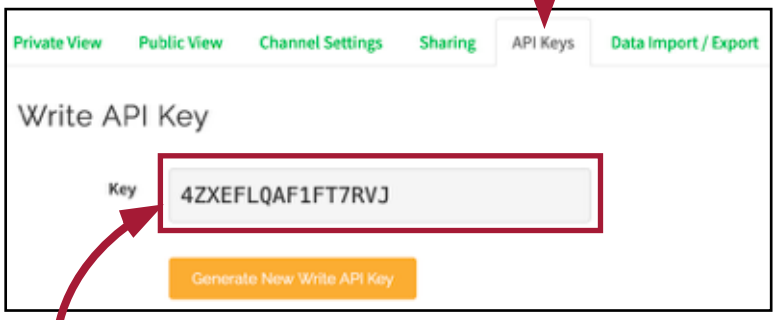
After entering a name for the channel, you can input up to 8 fields for various values under “Channel Settings”.



You then confirm the change by clicking “Save Channel”.

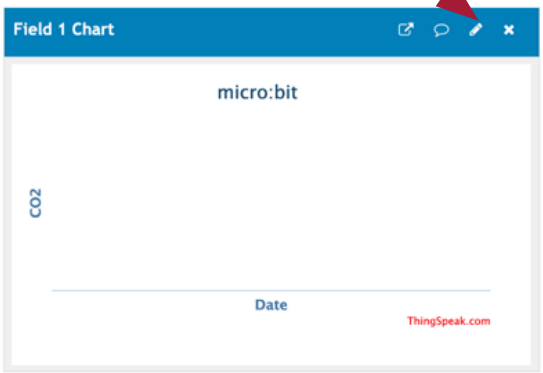
ThingSpeak – Channel Settings

In the “API Keys” panel, you can find the required setting to transfer the data of the micro:bit to your channel.

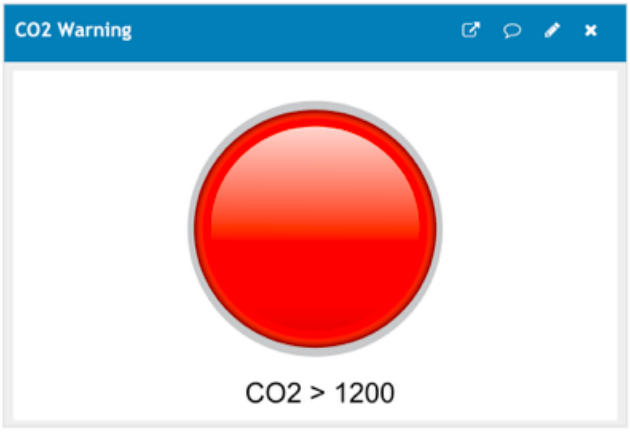


You need this key in the program code in order to transfer data to the ThingSpeak platform.

On the platform, all incoming data is visualised by means of a graph. The graph can be customised (time interval, amount of data, median, etc.) in the “Options” tab.

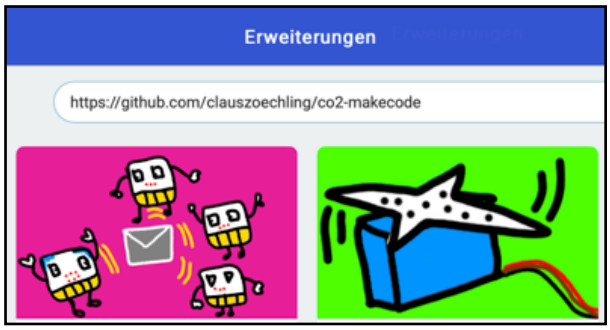


In addition, the category “Add Widgets” features several options for the display of critical measured values.



CO2 – Importing the CO2 Category

To be able to use the CO2 sensor on the Makecode platform (https://makecode.microbit.org), you first need to open the subcategory “Erweiterungen” [Extensions] in the category “Fortgeschritten” [Advanced].

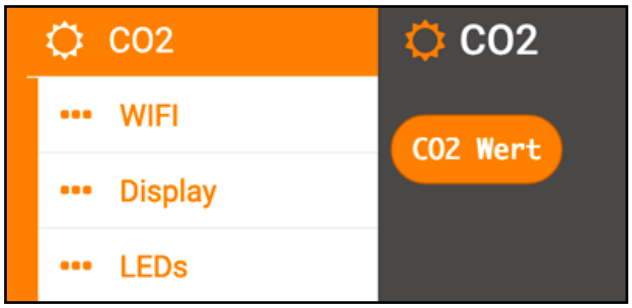


Enter the following link in the search bar and confirm by pressing the Enter key:

https://github.com/clauszoechling/co2-makecode

From this point onward, the additional category “CO2” including subcategories will be available.

You then have access to coding blocks that are tailored specifically to the CO2 set.

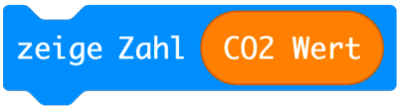


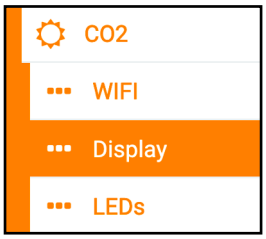
You can use the block `CO2 Wert` to display the CO2 value.

CO2 Blocks – OLED Display

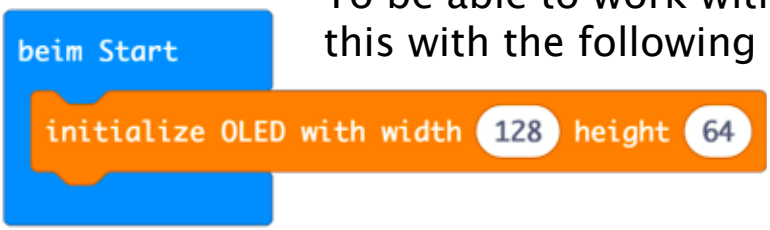
In the category 

, you will find the block “CO2 Wert” [CO2 value]. If you want to show this value on the display of the micro:bit, all you need to do is drag this block into the block “show





To have the values of the CO2 measurement displayed on the OLED display, you go to subcategory “Display”.



To be able to work with the display, you need to update this with the following line.

To do this, drag the complete block into the block “beim Start” [at startup].

You can now use the OLED display.
You can use the orange-coloured blocks “show number” and “show string” from the category “CO2/Display” to show text and/or numbers on the OLED display.

If you want to show text in the same line, i.e. without a line break, you need to use the block “show (without newline) string”.

If you want to force a line break, you can do so by inserting the block “Zeilenumbruch” [new line].

The OLED display can be cleared by using the block “lösche OLED Display” [clear OLED display].

CO2 Blocks – RGB Light-emitting Diodes

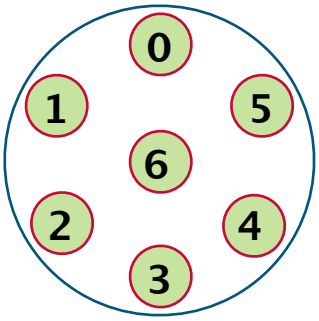
You can find all the blocks you need for programming of the light-emitting diodes (LEDs) in the CO2 subcategory “LEDs”.

To use the LEDs in the program, you need to initialise them. You can do this by simply dragging the following block into the block “beim Start” [at startup].

You can use this block to either set all 7 LEDs to one colour

or specify individual colours for the LEDs. To do this, you need this block:

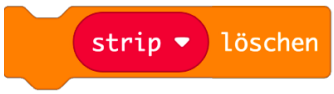
You can use these blocks to define different colours for your 7 LEDs. To have the LEDs light up in the colours chosen by you, you then need to activate the LED ring after defining the colours. You can do this using the following block:



This is what the numbering of the LEDs looks like.

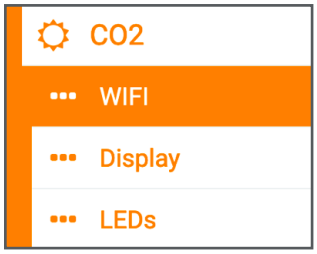
To clear individual LEDs, simply set the respective LED to black (black means that the LED is not lit).

You can switch off all LEDs by simply using the following block:



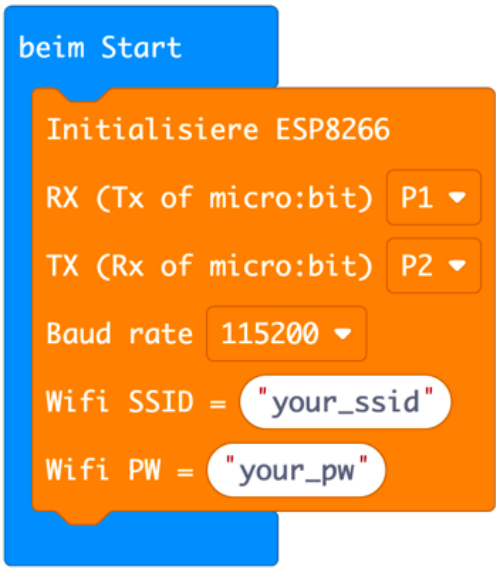
The brightness block indicates how bright the LEDs are (from 0 to 255).

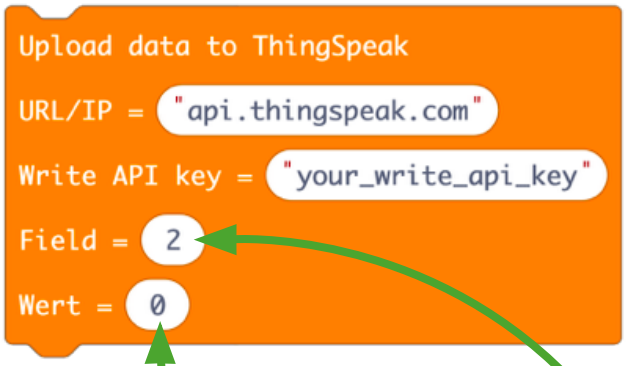
CO2 Blocks – WiFi and ThingSpeak



You can find all blocks concerning the WiFi module in the subcategory “WiFi”.

To be able to transfer data via WiFi, you need to indicate your WiFi settings.
You can do this in the block “beim Start” [at startup]. You can leave all other settings as they are.





To be able to upload data (e.g. our read CO2 values) to the ThingSpeak platform, you need to indicate the “Write API Key”, which can be found in the settings of ThingSpeak.

8 fields per ThingSpeak channel are available that you can enter data into. This means you can install CO2 warning devices in several rooms and upload their values to ThingSpeak.
The CO2 value read in the program is entered into the field “value”.

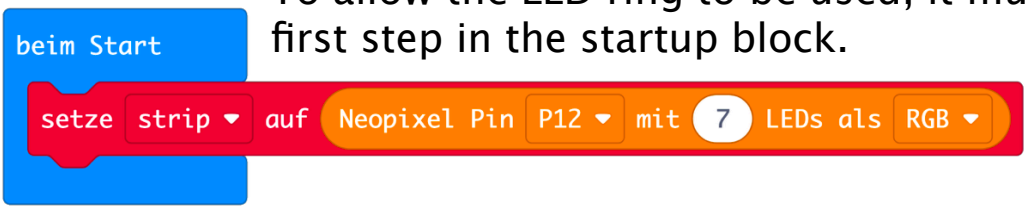
The 2 blocks “WiFi verbunden” [WiFi connected] and “ThingSpeak verbunden” [ThingSpeak connected] can be use in the program to query whether the connection is still active or needs to be re-established.

For more details on this see the section on advanced coding.

CO2 Warning Device – Easy Coding 1

Task
In the “easy” variant, the CO2 value is measured and, depending on this value, different colours are shown on the LED ring.

To allow the LED ring to be used, it must be initialised in a first step in the startup block.



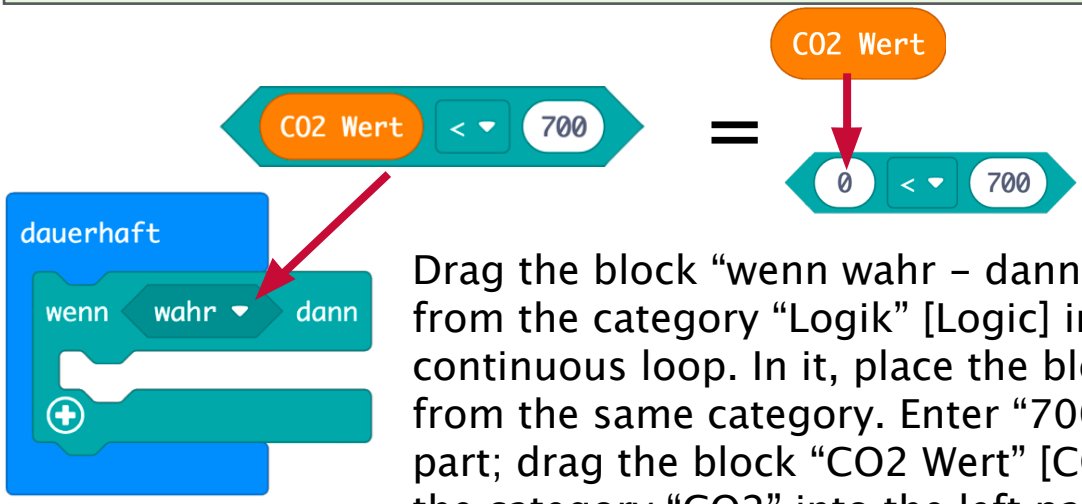
A good guideline value for the thresholds of a CO2 measurement would

CO2 less than 700

CO2 between 700 and 1200

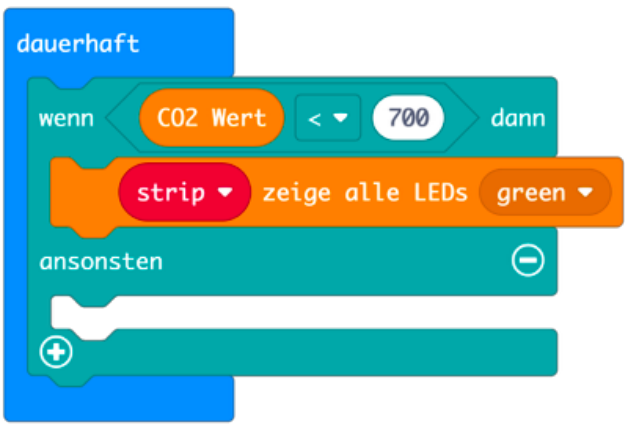
CO2 greater than 1200

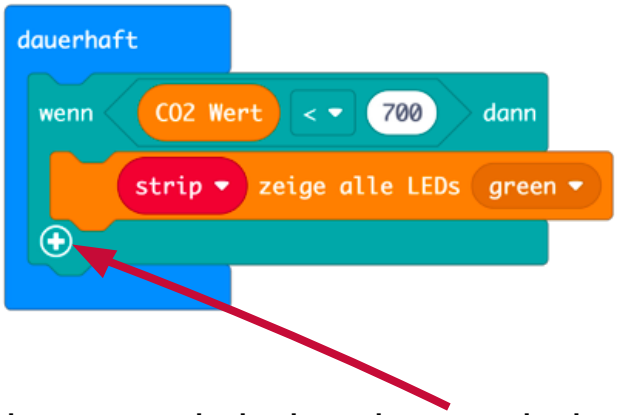
Please note:
“Fresh” outside air has a CO2 value of 400 ppm.



Drag the block “wenn wahr – dann” [if true – then] from the category “Logik” [Logic] into the continuous loop. In it, place the block “less than” from the same category. Enter “700” in the right part; drag the block “CO2 Wert” [CO2 value] from the category “CO2” into the left part.

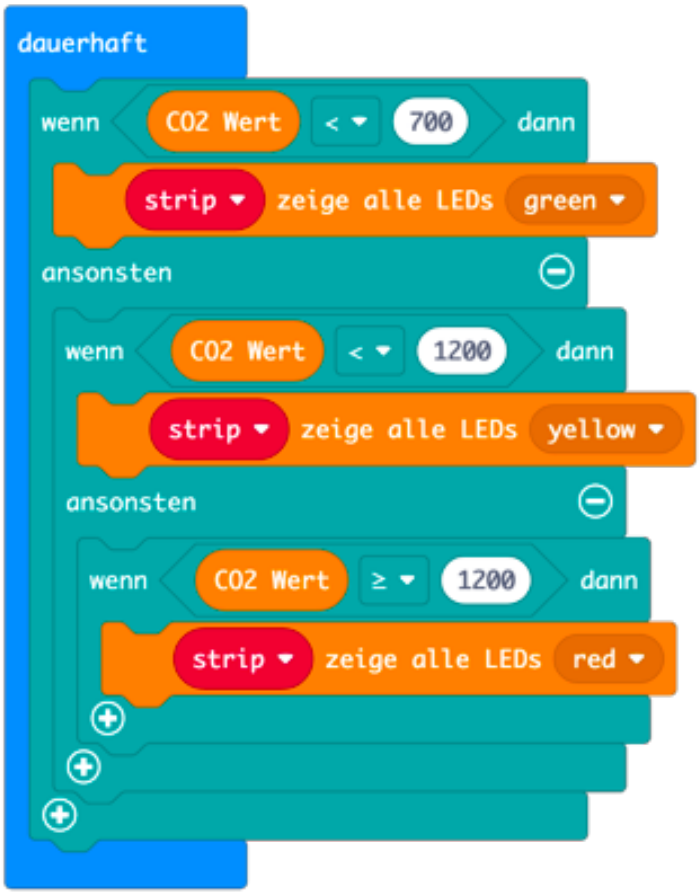
After you have set all LEDs to green in the instruction block, you code will look like this.





When you click the plus symbol, an optional “ansonsten” [else] part will be shown in which you can enter a new instruction in case the first one is not fulfilled.

CO2 Warning Device – Easy Coding 2

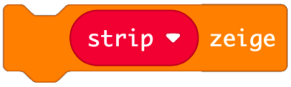


You nest the first query two more times and only change the CO2 threshold and the colour of the LEDs.

You could also leave out the last “wenn” [if] query and simply drag the command “zeige alle LEDs red” [show all LEDs red] into the “ansonsten” [else] part.

Of course, you can also adapt the colours of the LED ring to your requirements, i.e. the 7 LEDs can also be lit in different colours.

To do this, use the block 

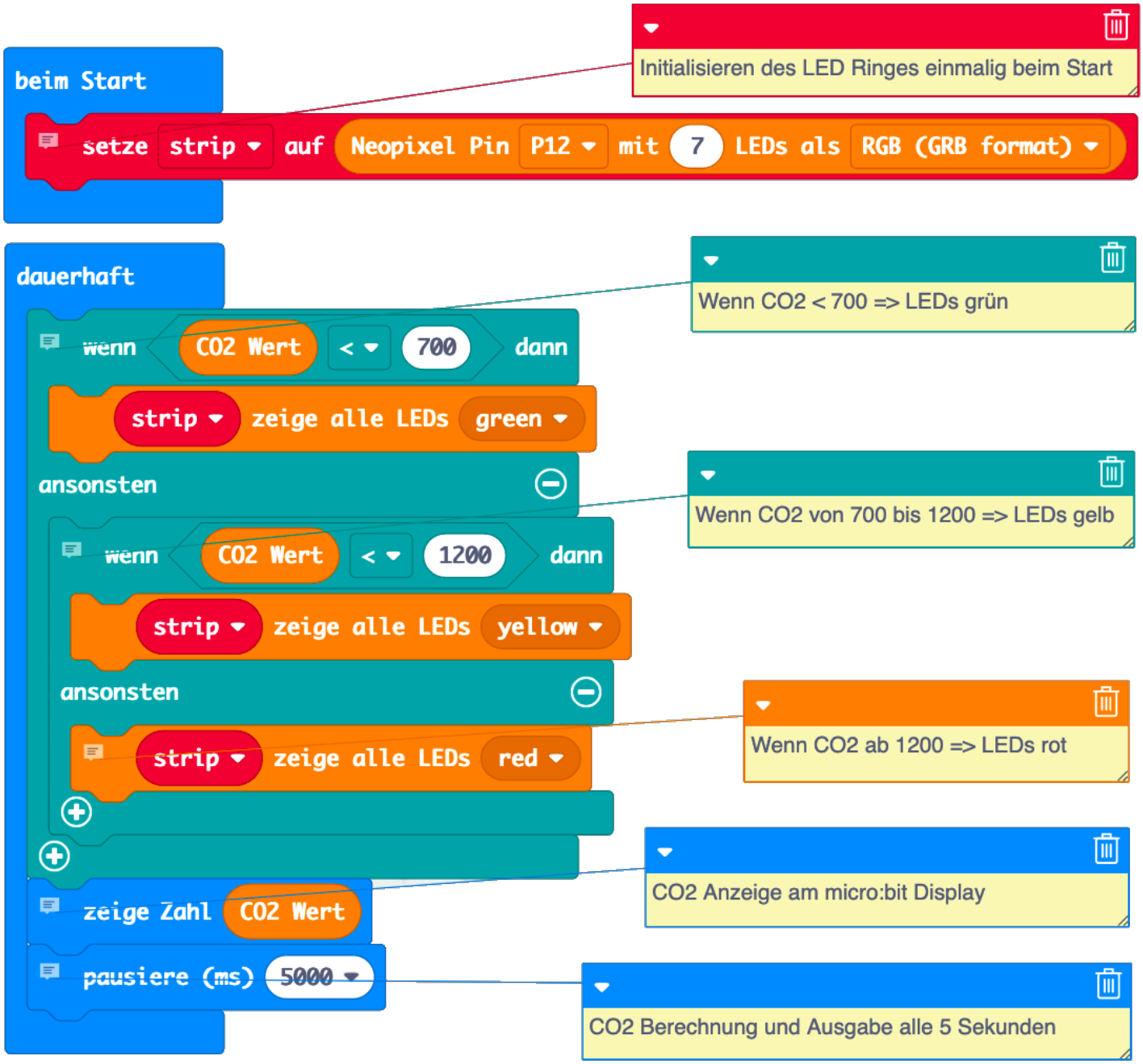
and indicate the desired LED number and colour.
After indicating the colours, remember to have them displayed using the following block: 

You can find an example how to generate a chase light here:

https://makecode.microbit.org/_Ty4d4kLcj0bq

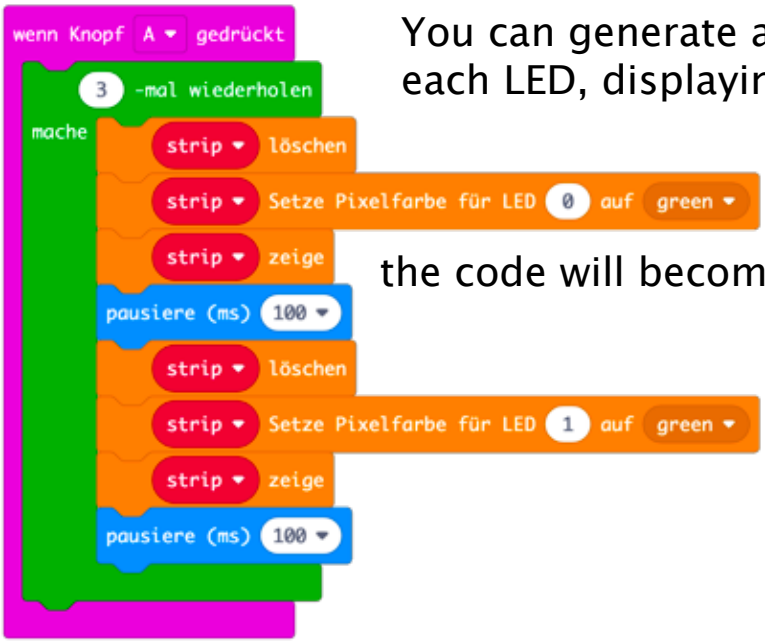
CO2 Warning Device – Easy Coding 3

The following code shows the implementation of the CO2 warning device in a simple variant. Depending on air quality, the LED ring will be lit green, yellow or red. Additionally, the CO2 value is shown on the display of the micro:bit every 5 seconds.



https://makecode.microbit.org/_dReDRdUTMLpX

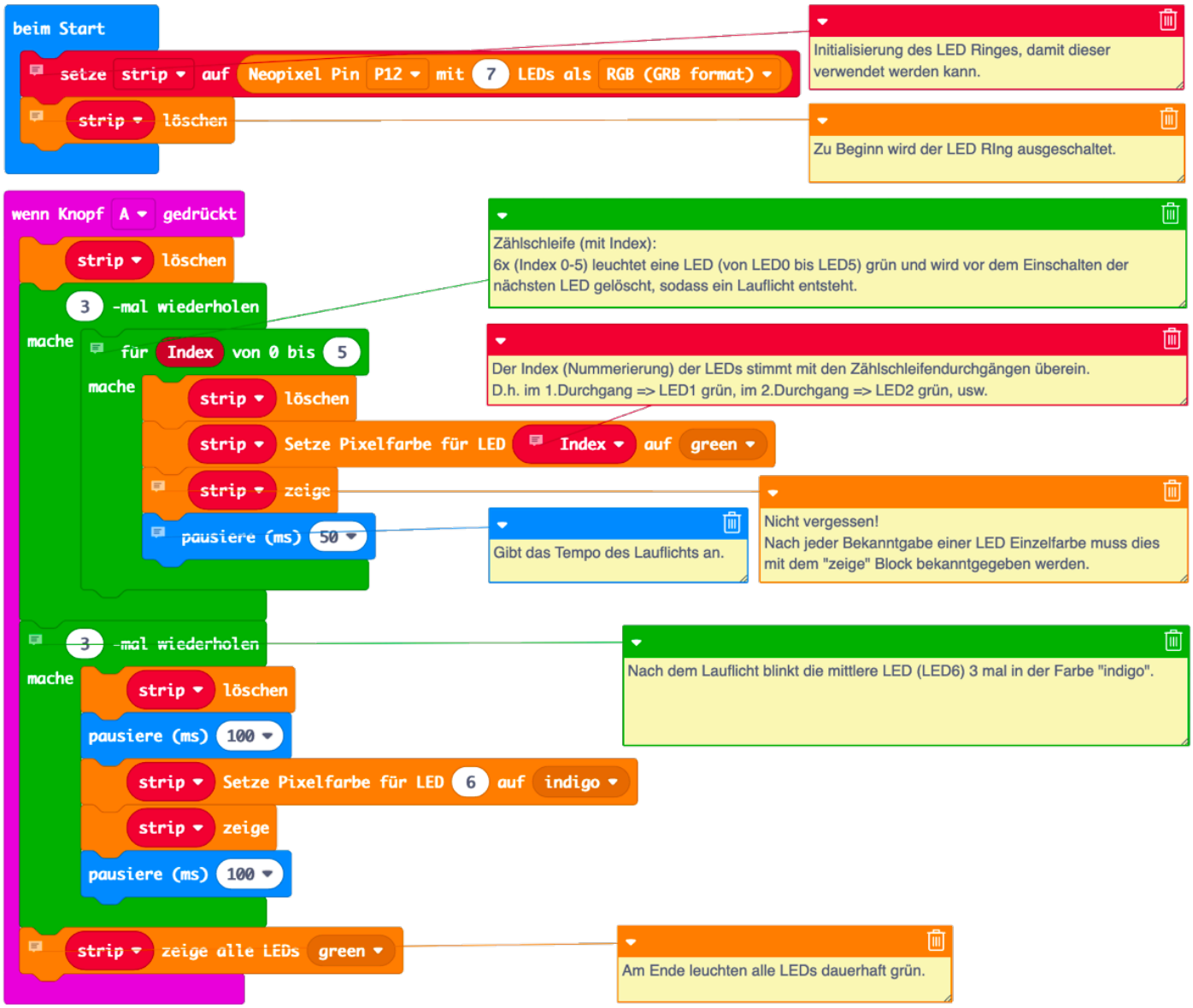
CO2 Warning Device – Chase Light



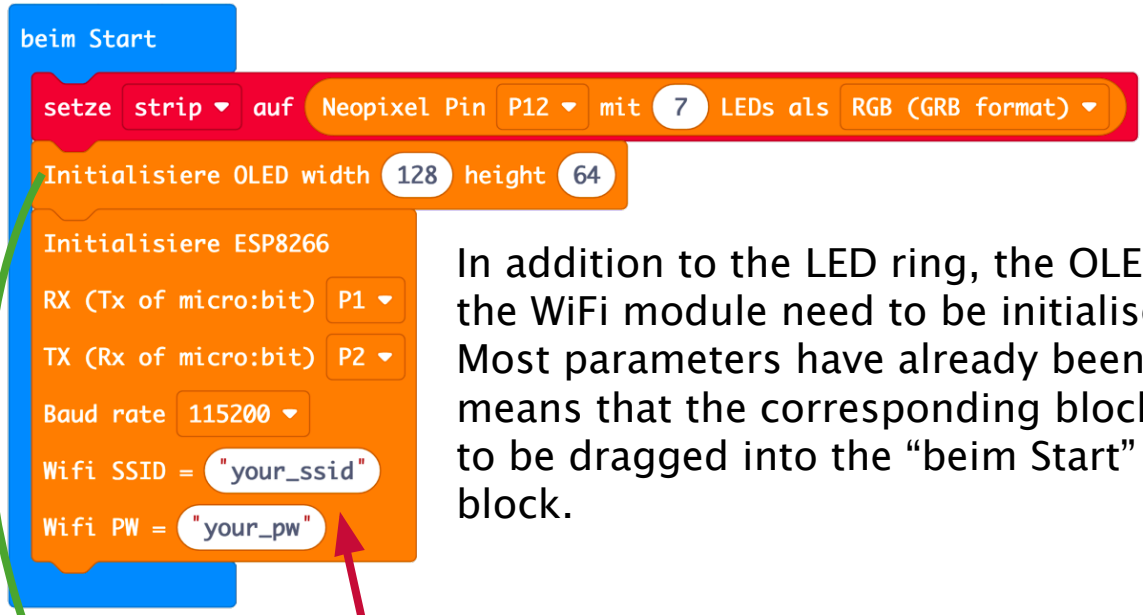
You can generate a chase light by setting a colour for each LED, displaying it and then deleting it again.

Because you need to follow this procedure for all LEDs, however, the code will become very confusing and prone to

Programmers who already have advanced knowledge can apply programming using “for” loops (link on previous page).



CO2 Warning Device – Advanced Coding 1

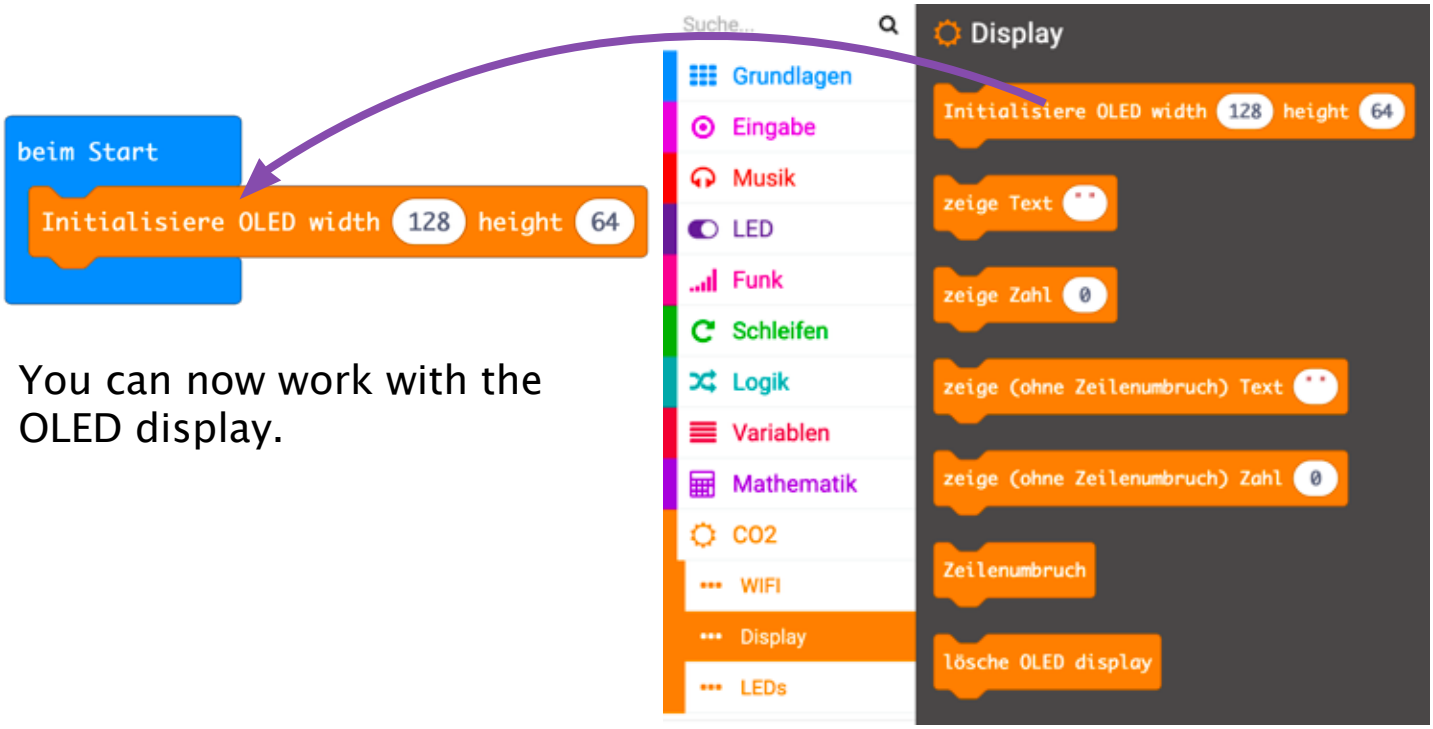


In addition to the LED ring, the OLED display and the WiFi module need to be initialised at startup. Most parameters have already been set, which means that the corresponding blocks simply need to be dragged into the “beim Start” [at startup] block.

You simply need to indicate the SSID and password of your WiFi

For the OLED display to be used, it also must be initialised once at program startup.

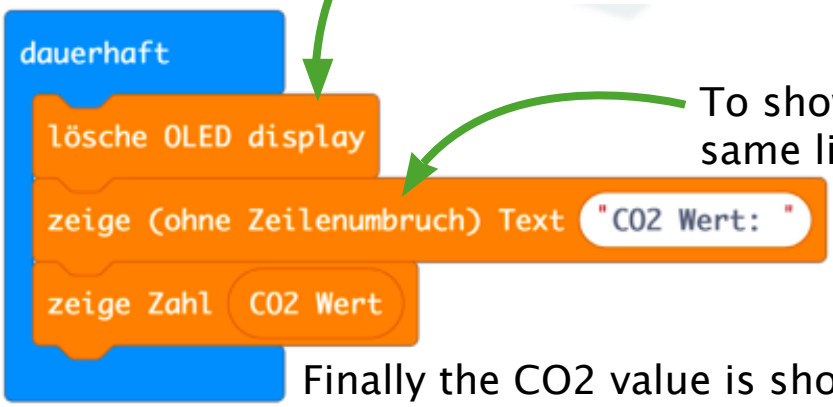
To do this, you only need to drag the already prepared block from the category “Display” into the startup block.



You can now work with the OLED display.

CO2 Warning Device – Advanced Coding 2

Only a few steps are required for output of the CO2 value and other things on the OLED display.

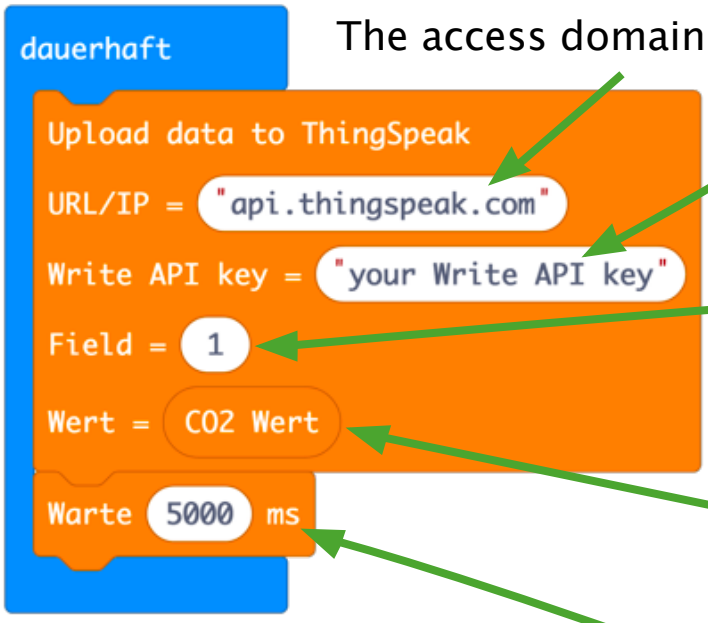


To ensure that what was shown last is cleared and to start in the 1st line, we use the block “lösche OLED display” [clear OLED display].

To show the subsequent text in the same line, you use the block “…ohne Zeilenumbruch…” [without newline

Finally the CO2 value is shown on the OLED display.

For visualisation on the ThingSpeak platform, you need the following block and simply need to enter 3 values.



The access domain has already been entered.

You also need the Write API key from y ThingSpeak credentials.

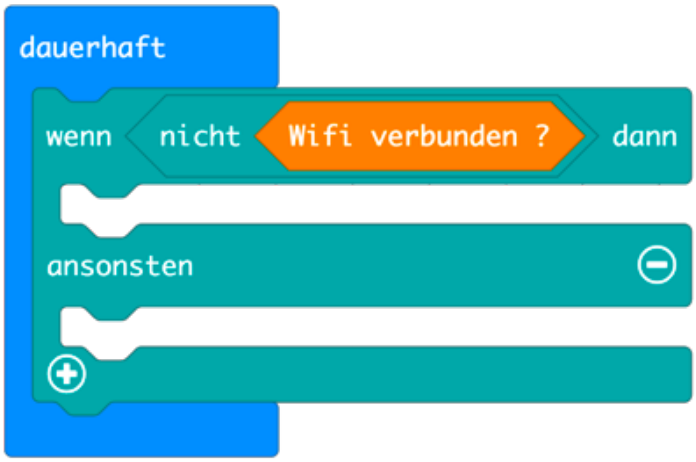
The number indicates to which of the 8 possible channels you want to send your values.

The value to be sent is entered here – in our case, this is the CO2 value.

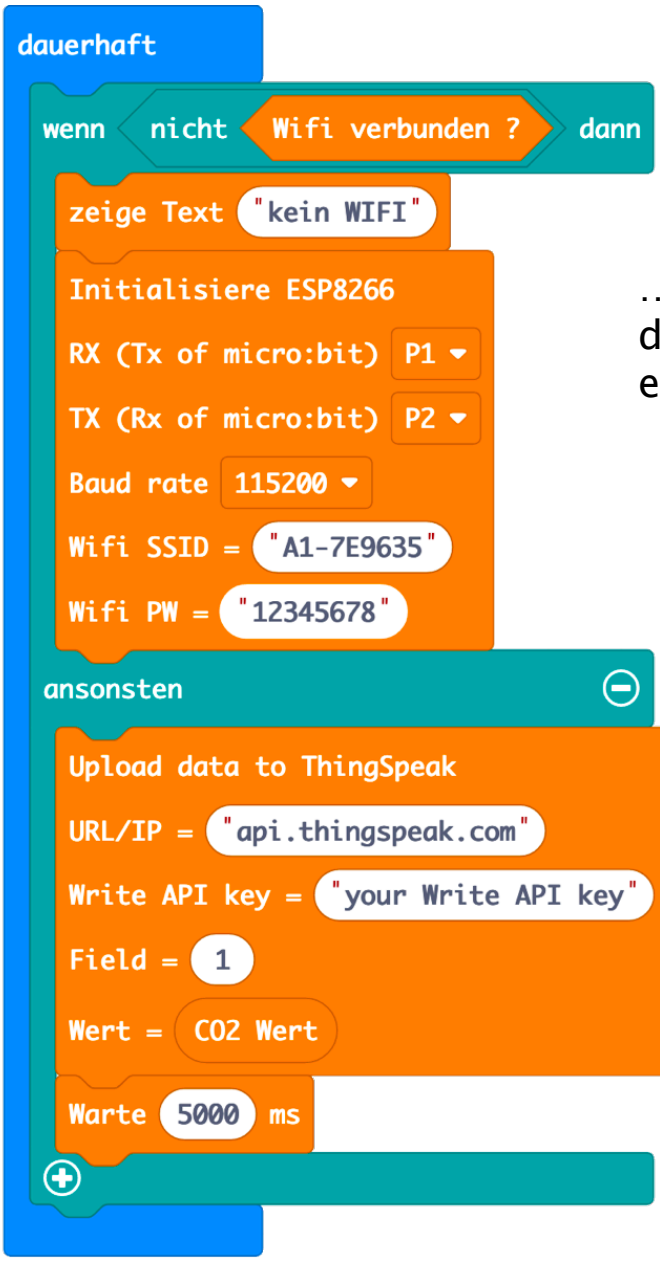
The transmission will take some time. For this reason, use a pause of 5 seconds from the same category to complete the sending process.

CO2 Warning Device – Advanced Coding 3

What happens if the WiFi connection is lost? The block “WiFi verbunden?” [WiFi connected?] is available for this purpose. You can query the existing WiFi connection in the program at any time an re-establish it if necessary.



With a query you check if the WiFi connection is still “active”.
You can find the “nicht” [not] block in the category “Logik” [Logic] and use it to query if the WiFi connection has been interrupted.



If the connection has been interrupted ...

... ”kein WiFi” [no WiFi] is shown on the display and the connection is re-established.

If everything is functioning as intended...

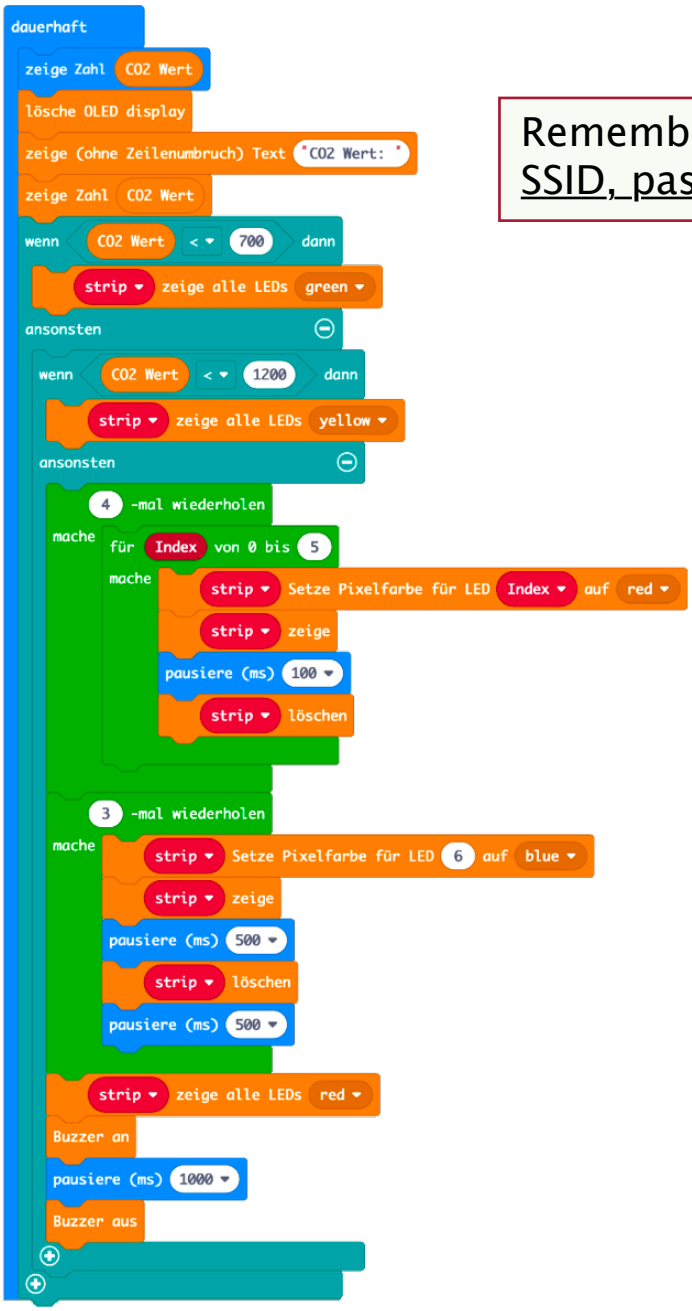
...the CO2 value is transmitted to the ThingSpeak platform as planned.

CO2 Warning Device – Advanced Coding 4

You can find all the code from the last 3 pages here.

You can edit this code on the Makecode platform.

https://makecode.microbit.org/_cHMKDEhHabUd



Remember to use your personal credentials:
SSID, password, ThingSpeak API

... Fortsetzung Dauerhaftschleife