

Gardener Programming Set

This set combines simple electronics with programming to convey basic knowledge in a playful way. The instructions are structured chronologically so that all elements of the set can be programmed step by step. The set can also be used for building robotic vehicles and for other projects by OMG Robotics.

Contents

- OMG Robotics expansion board (*without battery)
- Submersible pump
- 7-segment display (TM1637)
- IR sensor
- Photoresistor
- Capacitive sensor
- Temperature sensor (DS18B20)
- 2x Servo motors (360°)
- Programmable LED strip (WS2812)
- MOSFET transistor
- USB data cable
- Connection cables – Dupont F/F
- Robust storage case

Notes on using the set

- Electronic components should always be stored in ESD protective bags (pink bags).
- When connecting modules and electronics with wires or Dupont cables, the micro:bit and the expansion boards must always be disconnected from power. This is done either by switching off the board via the switch (battery power supply) or by unplugging the USB cable.
- When using a battery, care must be taken to ensure that it is not mechanically damaged.

- During charging, the charging status must be monitored. After charging is complete, the MB2 expansion board must be disconnected from the mains by unplugging the USB cable.
- Programs are transferred exclusively via the USB port on the top of the micro:bit, not via the USB port of the expansion board.
- For uploading programs, it is recommended to remove the micro:bit from the expansion board and reinsert it after successful transfer.
- The individual components do not form an independent functional system and may require proper assembly.

LED Display TM1637

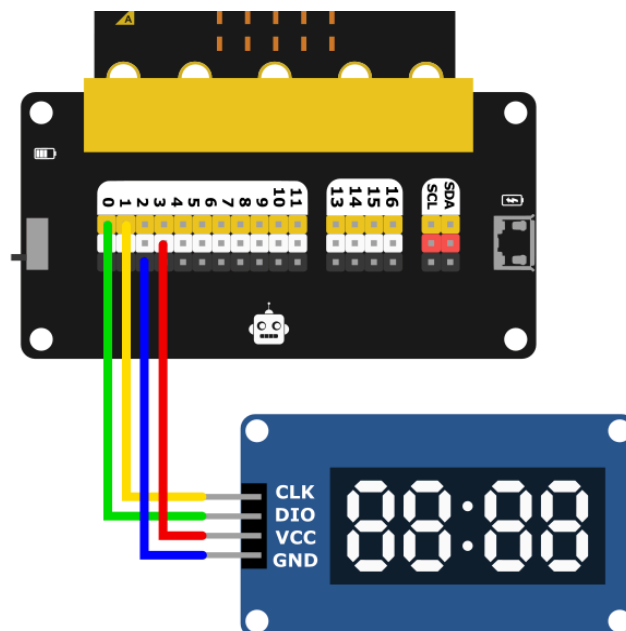
Info

- The seven-segment display is an electronic module for displaying digits. It is suitable for various projects and can show measured values such as time, electrical, or physical quantities. Connection is simple using Dupont wires. Multiple modules can also be connected to display longer numbers. The display is connected to the OMG Robotics expansion boards MB1 or MB2, where the micro:bit is inserted.

Specifications

- Supply voltage: 3–5 V
- Display capability: 4 digits
- Module dimensions: 66 × 27 × 10 mm
- Display dimensions: 50 × 19 × 7 mm
- Backlight: Red
- Weight: 15g

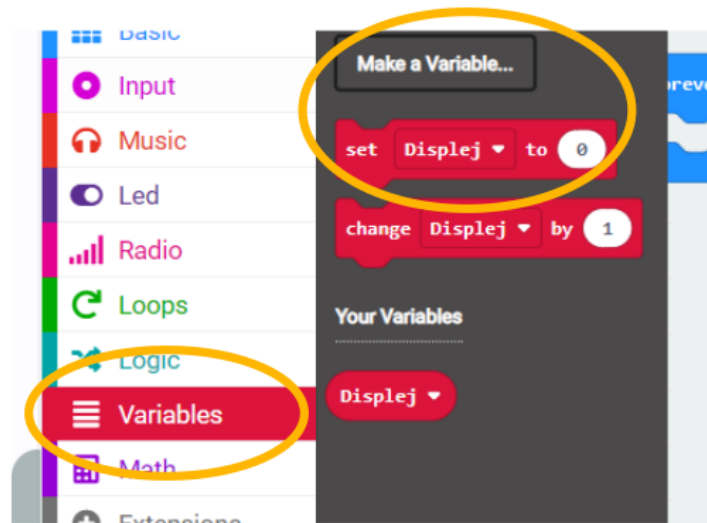
Circuit diagram



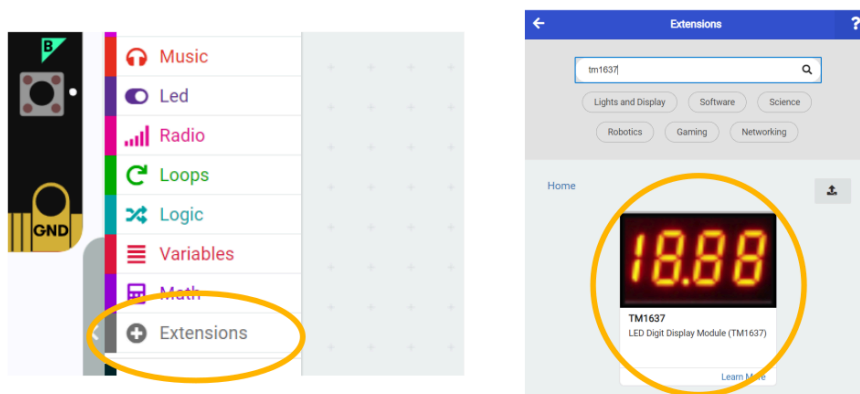
Programming

Note: When opening MakeCode via the instruction page, the TM1637 extension is already installed.

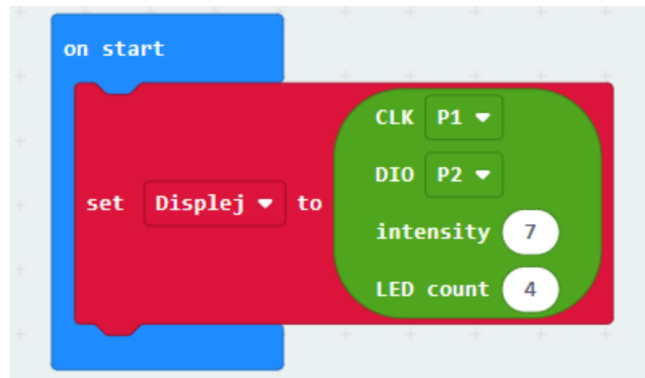
- First, create a new variable named Display.



- Then add the TM1637 extension in MakeCode. After installation, a new block category TM1637 will appear.



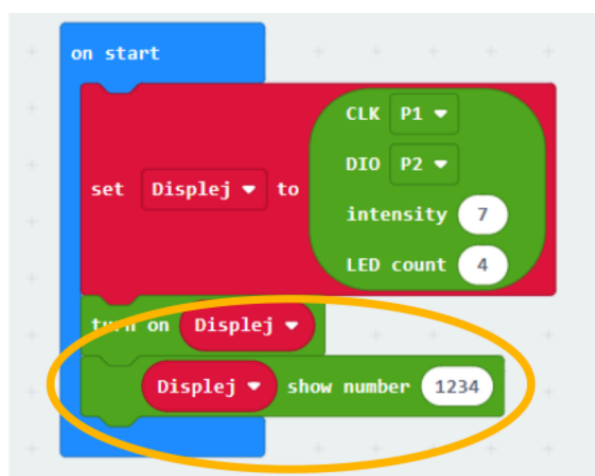
- At program start, the display is initialized with the block set Display to 0. In the TM1637 block, it is also necessary to specify the pins to which the display is connected:
 - CLK – Clock signal, connected to the yellow rail. The selected pin must be defined in the program.
 - DIO – Data signal, connected to the yellow rail. The correct pin must be set in MakeCode.
 - Intensity – Brightness setting from 0 to 8.
 - LED count – Number of used segments.



- The block turn on Display activates the display. Without additional output commands, the display remains blank.



- Numbers can be shown using the block show number. To display multiple values in sequence, combine these blocks with time delays from the Basic category.



- If no output appears, check wiring and selected pins in the program, especially the Dupont cables between display and expansion board.

Tasks

Task 1: Displaying numbers

- Use the blocks from the TM1637 tab. Various numbers can be displayed and updated, for example, every second.

Task 2: Changing brightness

- Adjust the intensity of the LED display to observe the effect. Find and use the corresponding brightness block.
- Determine the minimum and maximum brightness values.
- List situations where brightness adjustment or reduction is required.

Task 3: Simple stopwatch

- Create a new variable, e.g. Number.
- Continuously increase this variable by 1 and display the value.
- The counting is too fast. What adjustment is required to implement an accurate stopwatch?

Task 4: Blinking colon (as in digital clocks)

- Use the block DotPoint from the TM1637 library.
- Test the function of this block, output a time value (digits) and program the colon to blink every second.

Important notes

- Verify correctness of CLK and DIO pins. They must match both the program values and Dupont cable connections at the yellow connector rail.
- Ensure proper connection of supply voltage (+V white rail, -V black rail).
- Check correct Dupont cable connection to the LED display.
- Switch on MB2 expansion board if powered via battery or external USB.
- Program must be uploaded correctly.
- Update the program after every change.
- More information:

<https://omgrobotics.com/projekt/programator-zahradnik-online/>

Temperature Sensor DS18B20

Info

- The digital temperature sensor DS18B20 is ideal for temperature measurement. The waterproof sensor element allows use in liquids. The sensor is resistant to dust, humidity, and contamination, and withstands various environmental influences. Temperature data are transmitted digitally.
- The DS18B20 communicates via the 1-Wire bus, which requires only one data line (plus ground) for connection to the microcontroller.
- The connection is made using three Dupont wires:
 - Yellow – Signal line (yellow connector rail)
 - Red – Supply voltage +V (white connector rail)
 - Blue – Ground –V (black connector rail)

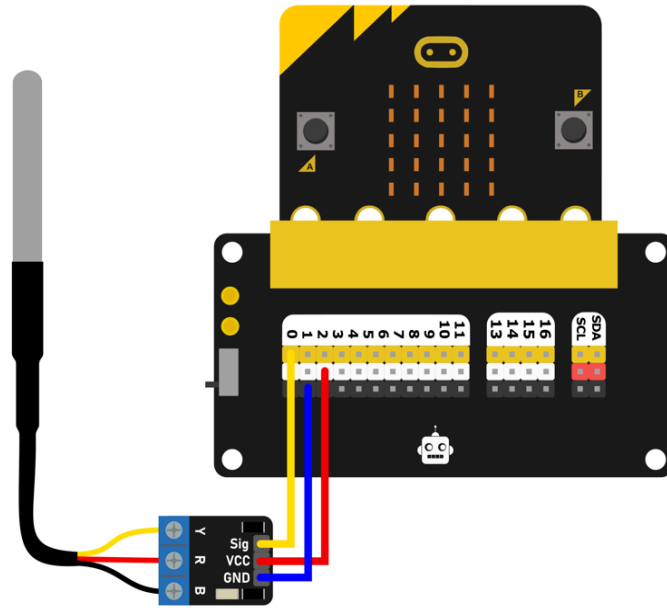
Specifications

- Supply voltage: 3–5.5V
- Temperature range: –55 to +95 °C
- Cable length: 1m
- Stainless steel probe: 6 mm diameter, 50 mm length
- Cable diameter: 4 mm

1. Temperature Display on the micro:bit

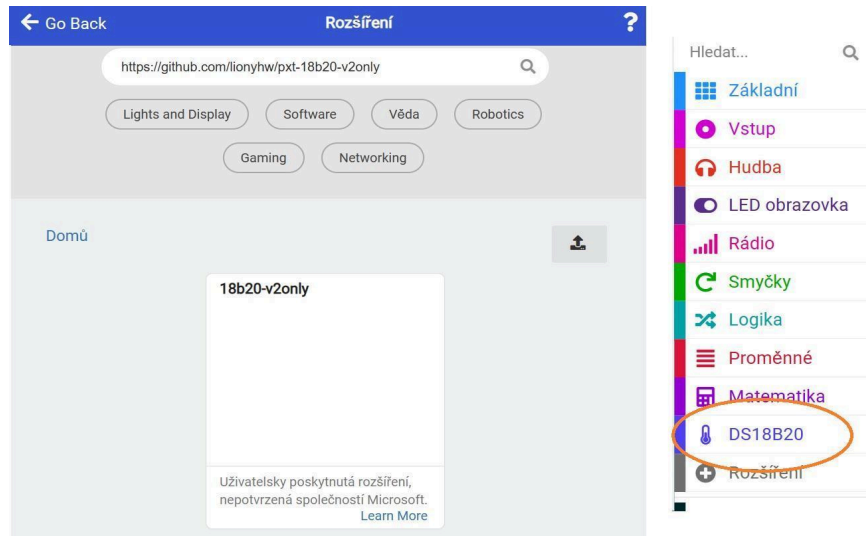
If no external display is available, the temperature can be shown on the LED matrix of the micro:bit. However, multi-digit values are difficult to read, therefore using a 7-segment display or an LCD expansion is recommended.

Circuit Diagram



Programming

- After correct wiring, install the required library. In MakeCode, add the DS18B20 extension via this link: <https://github.com/lionyh/pxt-18b20-v2only>.



- For working with the temperature sensor, use the block from the DS18B20 category.
- Place the block value of DS18B20(°C) at pin P0 inside the forever loop.
- Check that the signal wire (yellow Dupont) is connected to pin P0 on the yellow connector rail. If another pin is used, it must also be set correctly in the program.



- When correctly connected, the temperature will be displayed on the micro:bit LED matrix after program upload.

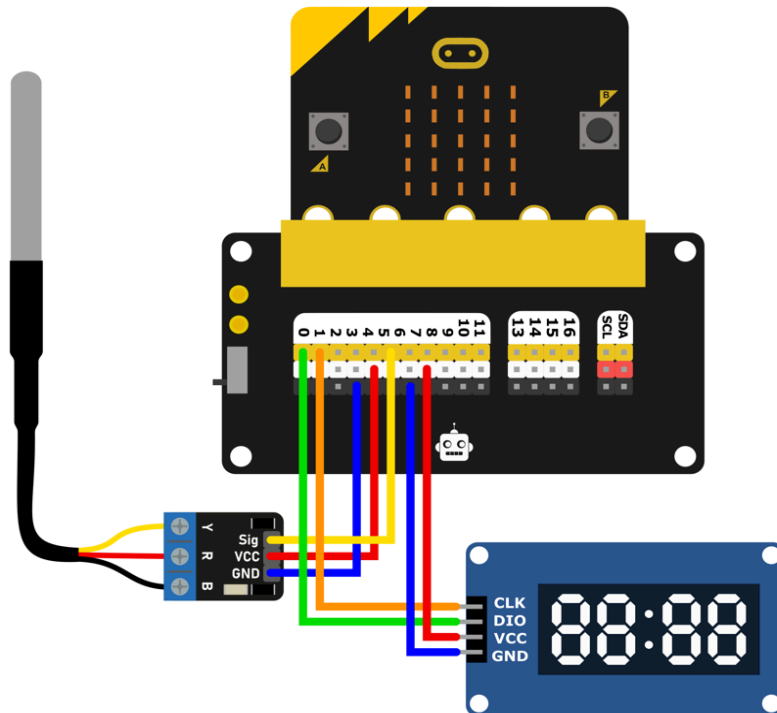
Important Notes

- Signal wire (yellow) must match the pin defined in the program.
- Connect power correctly (+V white rail, -V black rail).
- Turn on the MB2 expansion board if running on battery.
- Program must be uploaded correctly.
- For liquid measurements, always use the full cable length and keep electronics away from water.

- Liquids should only be measured when the MB2 or MB1board is powered via battery.

2. Temperature Display on the LED Module TM1637

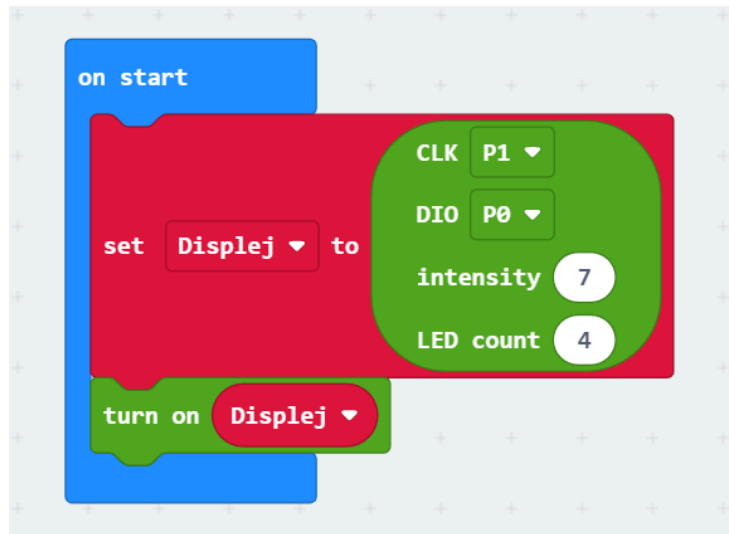
Circuit Diagram



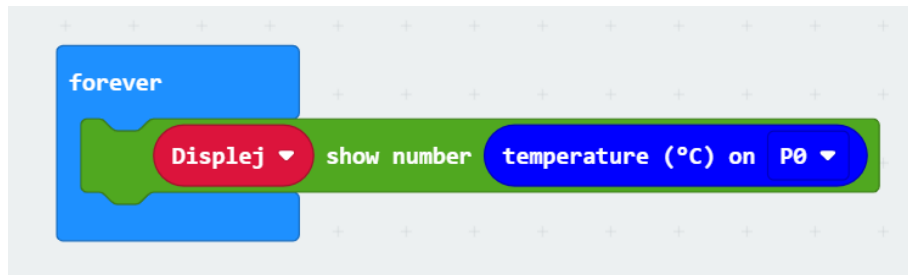
Programming

When accessing MakeCode through the instruction page, a test program can be loaded directly. After downloading, a text appears on the display and the temperature measurement starts. If the wiring is incorrect, an error message is shown on the micro:bit LED matrix.

- Open the MakeCode environment.
- Initialize the LED display according to the section LED Display TM1637.



- Set up the temperature sensor as described in Chapter 1 and display the measured values on the external display.



Tasks

Task 1: Comparison of Temperatures from micro:bit and DS18B20

- Connect the LED display to improve readability.
- Measure the temperature three times at 20-second intervals using the internal micro:bit sensor (basic library). Record the values.
- Measure the temperature three times at 20-second intervals using the DS18B20. Record the values.
- Compare the results.

Task 2: Complete Temperature Measurement System

- Connect the sensor and LED display and verify correct function.
- Warm the sensor in your hand and measure the highest temperature of the palm.

Aufgabe 3: Measuring the Temperature of Liquids

- Prepare two containers with equal amounts of liquid: one with cold water and one with hot water.
- Take three measurements from each container and record the values.
- Mix both liquids and take another three measurements.
- Evaluate the results.

Important Notes

- Verify that the CLK and DIO pins are correct. They must match the program settings and the Dupont cables on the yellow connector strip.
- Connect the power supply correctly (+V white strip, -V black strip).
- Ensure proper connection of the Dupont cables to the LED display and the expansion board.
- Switch on the MB2 expansion board if power is supplied by battery.
- Reload the program after each change.
- The signal wire (yellow Dupont) of the temperature sensor must be connected to the yellow connector strip.

Programmable LED Strip (WS2812)

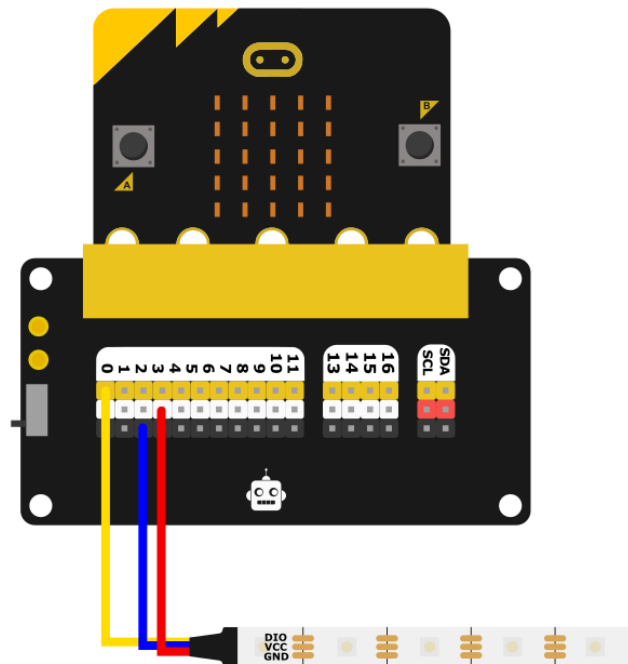
Info

- The LED strip consists of individual LEDs, each equipped with an SMD chip and a control IC. This makes the strip easy to program with the micro:bit. It enables animated light effects and is suitable for projects with colored light decorations. Examples include illuminated tracks for vehicles or experiments on the influence of light colors on plant growth. With the RGB strip, almost the entire visible color spectrum can be generated.
- The LED strip can also be used to demonstrate different color models:
 - RGB – mixing through intensity changes of the primary colors red, green, blue.
 - HSL – similar to RGB, but easier to understand: hue, saturation, lightness.
 - HSV – derived from HSL, more closely aligned with human color perception: hue, saturation, value.
 - CMYK – subtractive model based on color printing: cyan, magenta, yellow, black.

Specification

- Supply voltage: 3 V
- Cable length: 10 cm
- LED strip length: 10 cm
- LED strip width: 1 cm
- Connection via three Dupont wires:
 - Yellow – signal line (yellow connector strip)
 - Red – +V supply (white connector strip)
 - Black – ground –V (black connector strip)

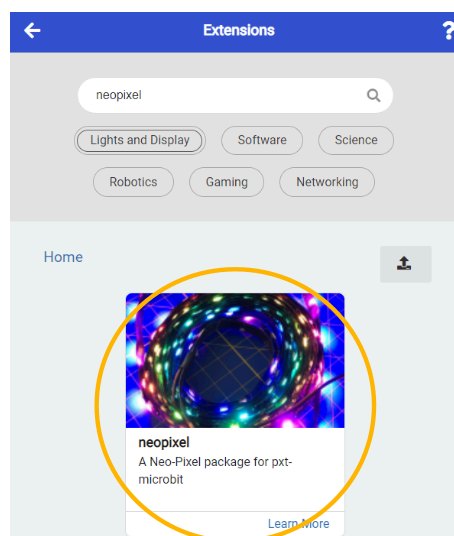
Circuit Diagram



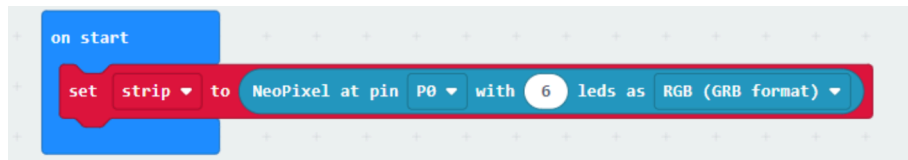
Programming

Note: When opening MakeCode via the instruction page, a test program can be loaded directly. After downloading, a color-changing effect on the LED strip starts automatically.

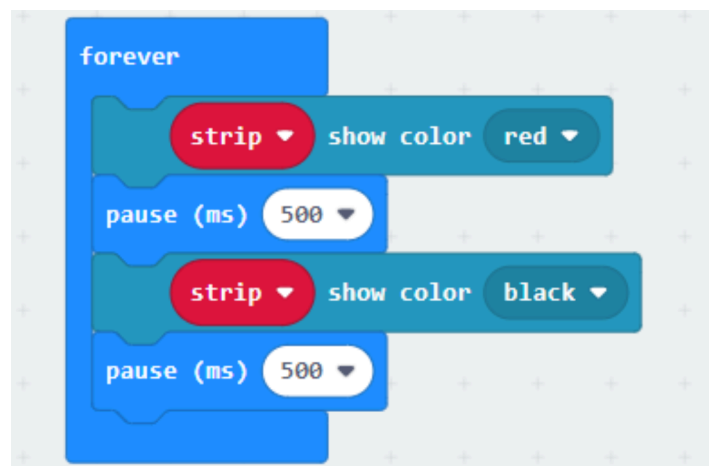
- The LED strip is not included in the standard blocks and must be added via extensions with the keyword `neopixel`. After installation, the blocks appear under the `neopixel` tab.



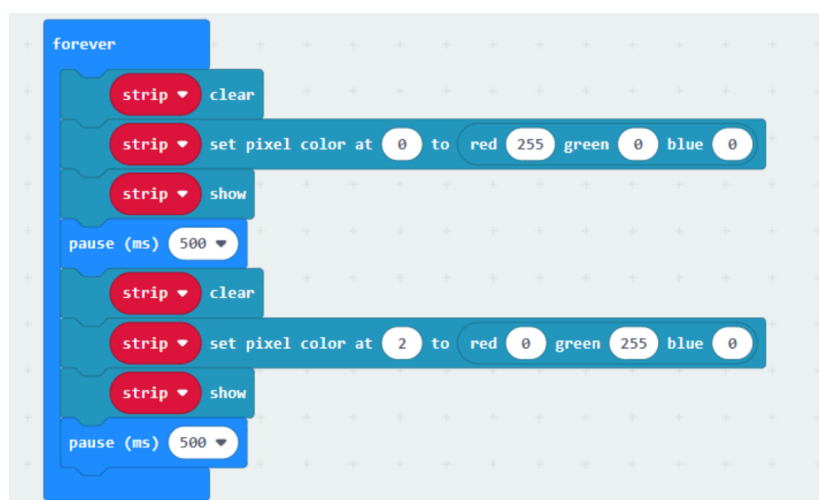
- The strip is initialized with the block set strip to. The used pin (yellow connector strip) and the number of LEDs must be defined. For the included strip, six LEDs are used. Then, the RGB format is selected.



- To program blinking effects, the block show color is used. After outputting the color, add a pause (e.g., 500ms) and then turn off the LEDs.



- To control individual LEDs, use the block set pixel color at. Additional blocks such as clear (reset settings) and show (display current configuration) are required.



Tasks

Task 1: Switch on the RGB strip

- Display LEDs in the primary colors red, green, and blue.

Task 2: Step-by-step blinking and effects

- Program your own light effects. After testing all blocks, create sequential blinking and color changes on the LED strip.

Task 3: RGB and HSL

- Investigate the influence of color components on light intensity.
- Analyze differences between HSL, HSV, and CMYK color models.
- Use the HSL option in the neopixel library and test its functionality.

Task 4: Clap sensor lamp

- Program a bedside lamp with the LED strip and micro:bit that can be turned on and off by clapping. Use blocks from the Logic section.

Important Notes

- Ensure the signal line (yellow Dupont) is correctly connected to the yellow connector strip.
- Connect the power supply correctly (+V white strip, -V black strip).
- Switch on the MB2 expansion board if powered by battery.
- Reload the program after each modification.

Capacitive Sensor

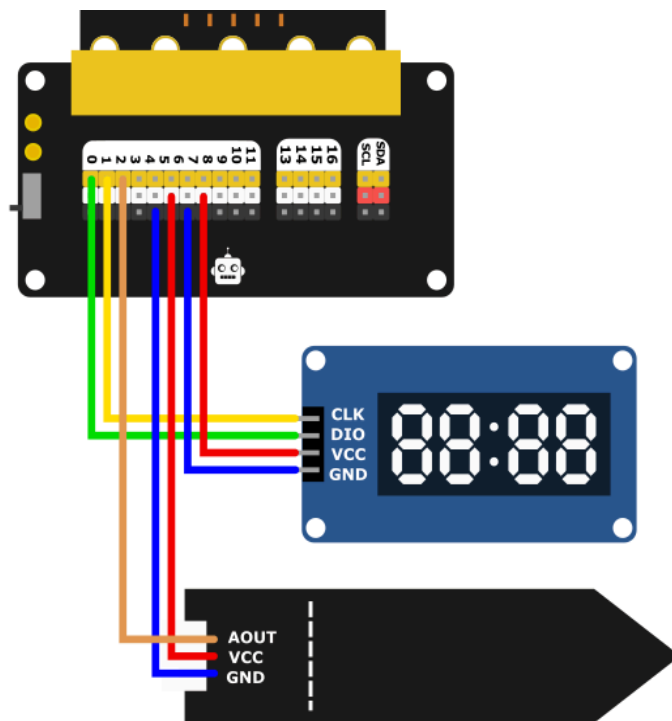
Info

- The capacitive sensor is suitable for measuring the moisture content of substrates or similar materials that can absorb liquids.
- The sensor contains two electrodes between which electrical conductivity is measured. With increasing moisture, conductivity rises.
- The sensor output is an analog signal, which is processed by the micro:bit.

Specification

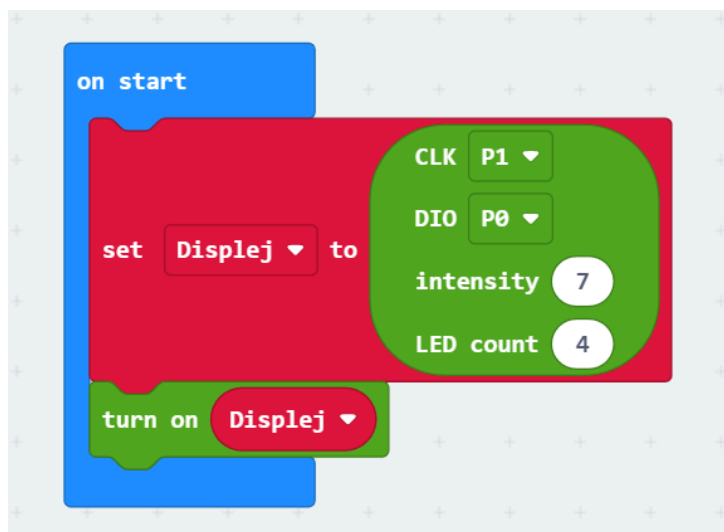
- Supply voltage: 3.3V or 5 V
- Cable length: 20 cm
- Dimensions: 99 × 22 × 1 mm
- Connection via three Dupont wires:
 - Yellow – signal line (yellow connector strip)
 - Red – +V supply (white connector strip)
 - Black – ground –V (black connector strip)

Circuit Diagram

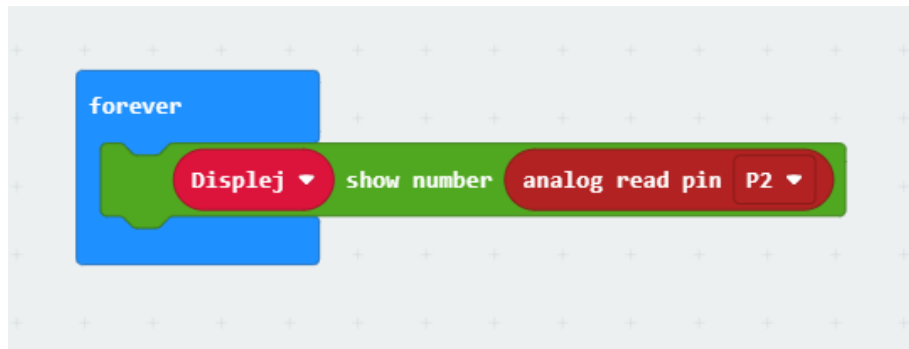


Programming

- Connect the sensor and LED display. The yellow signal wire must be plugged into the yellow connector strip.
- Initialize the LED display at the beginning of the program (see chapter LED Display).



- Values are read using the analog-to-digital converter (ADC) of the micro:bit with the block analog read pin.



- The displayed values depend on the moisture level:
 - Values above 600 → dry substrate
 - Values decrease as moisture increases

Tasks

Task 1: Recording sensor values

- Connect the sensor according to the wiring diagram.
- Observe the readings on the display.
- Touch the sensor with dry fingers and record the values.
- Repeat the test with wet fingers. Ensure that neither electronics nor computer come into contact with liquid.

Task 2: Substrate measurement in a flowerpot

- Carefully insert the sensor into dry soil and record the values.
- Water the plant, measure again, and compare.
- Observe changes over time and record them (e.g., every 10 minutes).
- Determine the highest and lowest measured values.

Task 3: Comparison of different soils

- Prepare different materials (e.g., sand, soil, clay).
- Perform measurements without and with the same amount of water.
- Clean the sensor after each test.
- Evaluate the results and determine which material had the highest moisture initially and after watering.

Task 4: Irrigation indicator for plants

- Combine LED strip, capacitive sensor, and LED display.
- Record the moisture values before and after watering.
- Define a threshold value for irrigation.
- Create a program: when the measured value falls below the threshold, the LED strip lights up.
- Test with plants or substrate.

Important Notes

- Pins CLK and DIO must match the program settings and the Dupont cable connections.
- Connect the power supply correctly (+V white strip, -V black strip).
- Ensure proper wiring of Dupont cables to the LED display.
- Switch on the MB2 expansion board if powered by battery.
- Connect the capacitive sensor correctly using the supplied Dupont cable.

- The program must be reloaded after each modification.
- Avoid any contact of the sensor and electronics with water.
- If no values are displayed, check pin configuration in both the program and the physical connection.

Submersible Pump and MOSFET Module

Info – Submersible Pump

- The submersible pump is used for conveying and distributing liquids. It is mainly intended for water but can also be used with similar liquids. It is not suitable for chemicals as this may cause damage.
- Inside the pump there is a motor with an impeller that draws water through the inlet and discharges it through the outlet. For proper operation, the pump must be fully submerged in the liquid. Dry running is not allowed – the pump must only be switched on once fully submerged. Operation of the pump is prohibited while the battery is charging.

Specification – Submersible Pump

- Supply voltage: 3–6 V
- Current consumption: 1 A at 5 V
- Cable length: 20 cm
- Dimensions: 43 × 33 × 24 mm
- Connection via two Dupont wires:
 - Red – +V supply (white connector strip)
 - Black – ground –V (black connector strip)

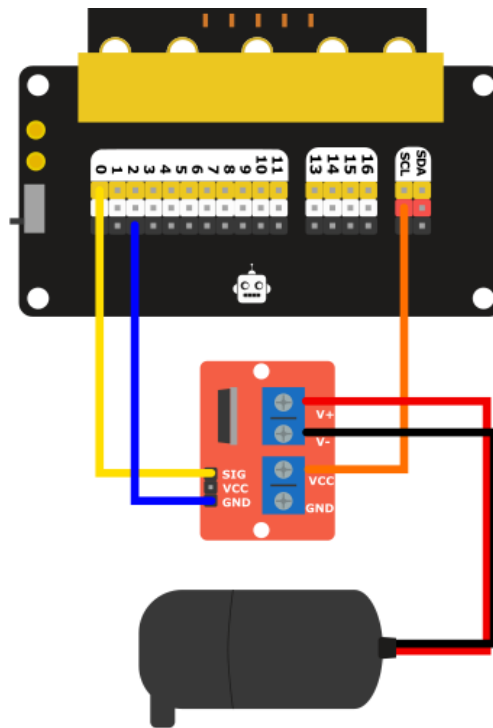
Info – MOSFET Module

- The MOSFET module is required to control the submersible pump. Direct connection to the micro:bit would cause damage. In addition, the pump requires 5–6 V for full performance, which cannot be supplied without an additional module.

Specification – MOSFET Module

- Supply voltage: 0–24 V
- Output current: < 5 A
- Cooling required for loads above 1 A
- Dimensions: 33 × 24 mm
- Weight: 10g
- Connection via two Dupont wires:
 - Red – +V supply (white connector strip)
 - Black – ground –V (black connector strip)

Circuit Diagram



Programming

When opening MakeCode via the instruction page, a test program can be loaded directly. After downloading, a program starts that allows control of the pump using the A and B buttons.

- After successful wiring, the pump can be programmed using blocks from the Advanced section.
- Control is carried out via digital signals on the pin to which the signal line of the MOSFET module is connected.
- In addition, pump power can be regulated using pulse-width modulation (PWM).
- A simple on/off control is also possible: output logic value 1 = on, logic value 0 = off.



Tasks

Task 1: Pump Control

- Check the function of the pump and the MOSFET module.
- Extend the program to switch the pump on and off using the micro:bit buttons.
- Prepare suitable containers (e.g. laboratory containers with a minimum volume of 1 liter).
- Connect a hose to the pump outlet (aquarium hose suitable).

Task 2: Measuring Pump Performance

- Determine the pump flow rate over time intervals of 10, 20, and 30 seconds.
- Create a program so that the pump starts after a button press and stops automatically after the set time.
- Read and record the pumped water volume using a measuring cylinder.

Task 3: Automatic Irrigation

- Create an automatic irrigation system.
- Combine flow rate values from Task 2 with moisture values from the Capacitive Sensor chapter.
- Modify the program so that plants are watered automatically.
- Consider the individual water requirements of each plant.

Important Notes

- Connect the supply voltage correctly (+V red rail, –V black rail).
- Switch on the MB2 expansion board if operating on battery.
- Connect the MOSFET module correctly to the 5V output of the expansion board.
- Upload the program again after each modification.
- Avoid any contact of the electronics with water.

IR Sensor

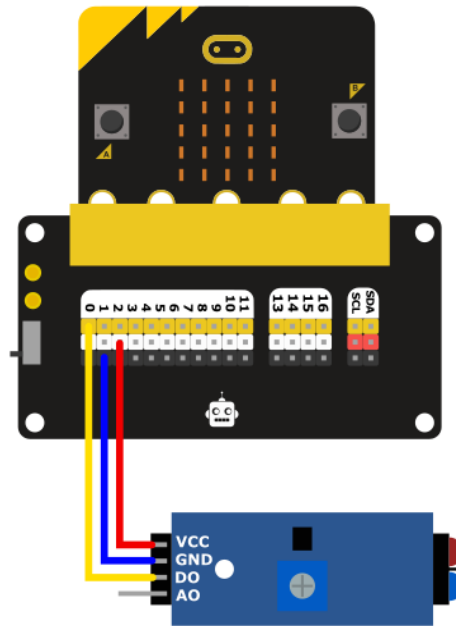
Info

- IR technology is used in everyday life as well as in industrial applications for various purposes. The most common example is television devices, which use IR sensors to process signals from remote controls. In addition, the IR sensor can be used for automatic gates, motion detection, automatic lighting, and many other applications.
- The IR sensor also enables reliable detection of black and white. The detection range is up to 25 mm, with the highest accuracy achieved at approximately 5 mm.
- Connection is made via four Dupont wires:
 - VCC – Supply +V (white rail)
 - GND – Ground –V (black rail)
 - D0 – Digital output, switching threshold adjustable via the blue trimmer
 - A0 – Analog output, wider value range, requires more complex signal processing

Specifications

- Supply voltage: 3.3–5 V
- Detection range: 1–15 mm
- Dimensions: 32 × 14 mm
- Sensor height: 12 mm

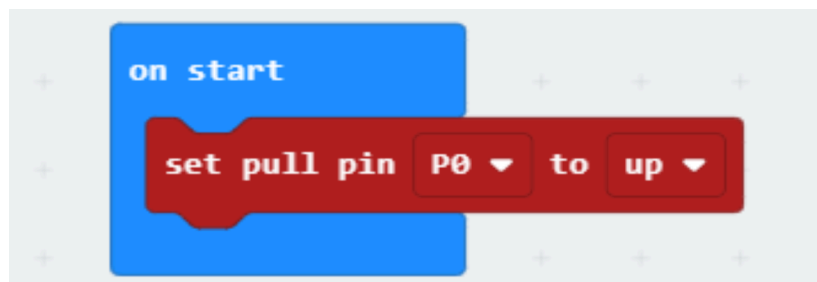
Circuit Diagram



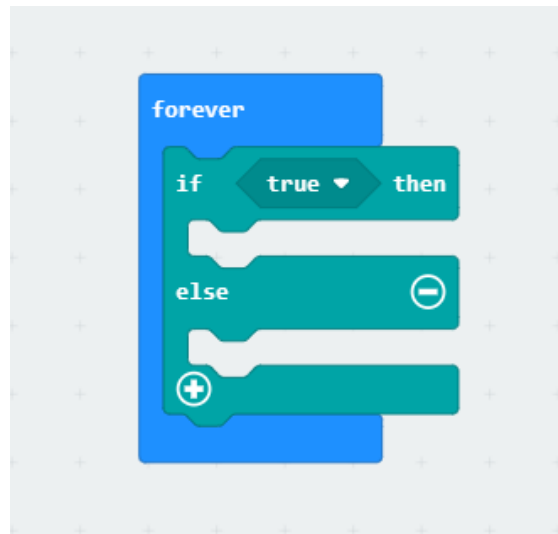
Programming

Note: When opening MakeCode via the instruction page, a test program can be loaded directly. After downloading, the function is verified and the response of the IR sensor to hand movement becomes visible.

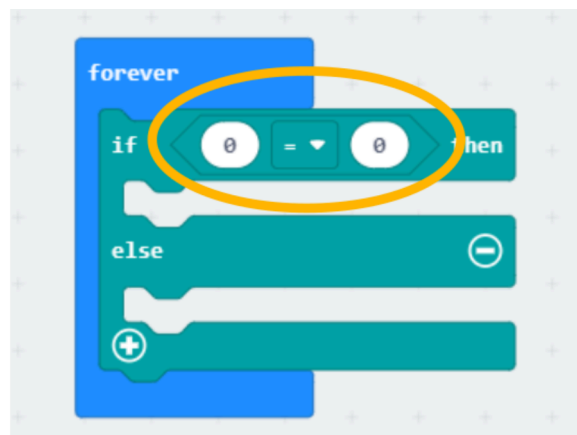
- After successful connection to the expansion board, programming can begin.
- To use the IR sensor, blocks for reading pin values are required. First, the internal resistor must be set to define the logical level in the idle state. Without this setting, no valid values can be read.



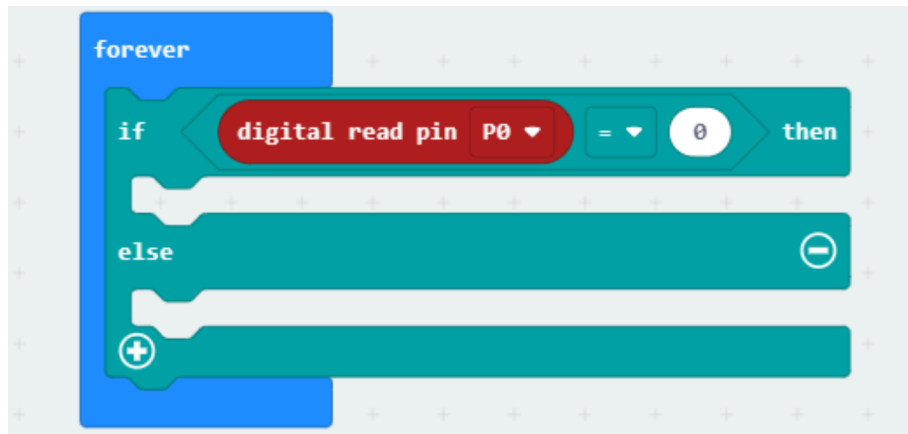
- In the main loop, a condition is created (if block).



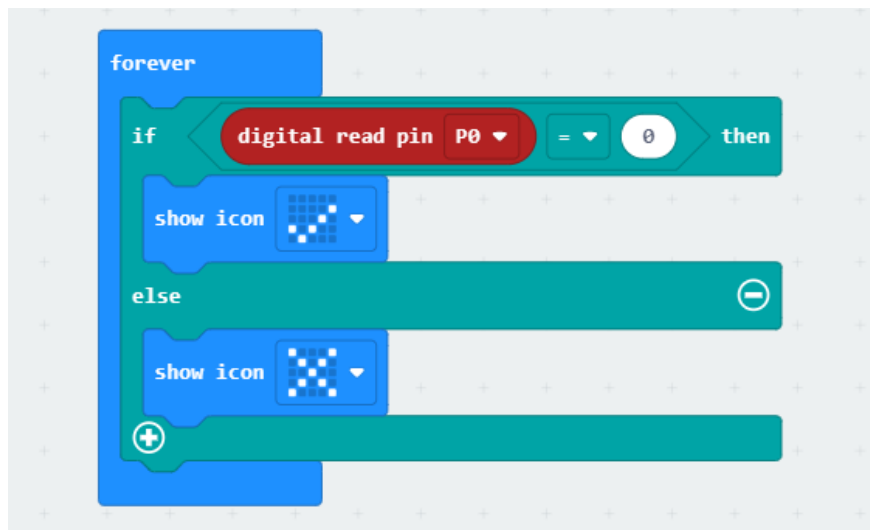
- Replace “true” with a comparison. Use the block digital read and compare it with the value “0”.



- This creates the condition: if the read value = 0, action A is executed. Otherwise, action B is executed.



- For simple visualization, symbols can be displayed on the micro:bit LED matrix. These indicate whether the sensor has detected an object or not.



Tasks

Task 1: Functional Test

- Determine when the output provides value 1 and when it provides value 0.
- Use a hand or object to cover the sensor.

Task 2: Detection Range

- Determine the maximum and minimum distance for object detection.
- Adjust the sensitivity using the blue trimmer and test the extended detection range.

Task 3: Reaction to Black and White

- Use black and white paper to test which color the sensor responds to earlier.
- Measure the distance in both cases.
- Adjust the sensor so that white surfaces are detected at approximately 3 cm, then determine the response to black surfaces.

Task 4: Motion Sensor with LED Strip

- Combine the IR sensor and LED strip.
- Create a program: when motion is detected, the LED strip lights up.

Important Notes

- Verify correct pin assignment for reading values.
- Connect the power supply correctly: VCC to the white rail, GND to the black rail.
- Switch on the MB1 or MB2 expansion board.
- Upload the program to the micro:bit after each modification.

Photoresistor

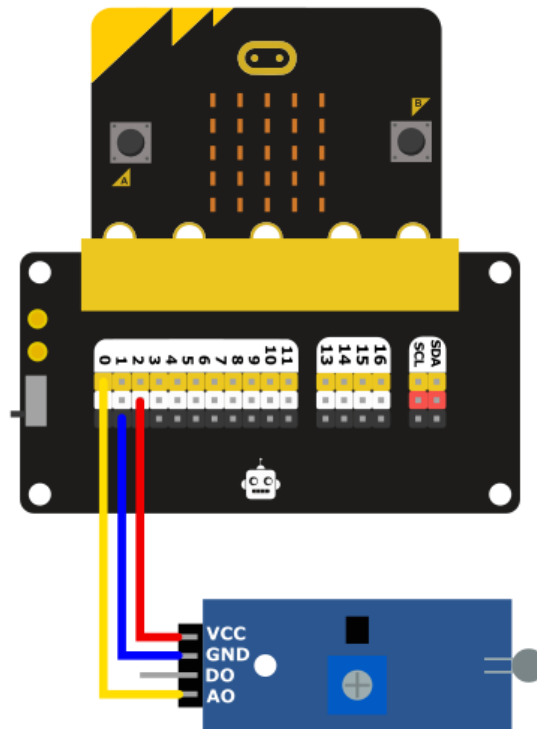
Info

- The photoresistor is a passive electronic component whose resistance decreases as light intensity increases. With the micro:bit, changes in radiation intensity can be analyzed.
- Example applications include automatic chicken coop doors or blinds that close in darkness.
- The photoresistor board contains two indicator LEDs that show the current state:
 - Both LEDs on → output value is 0
 - Only one LED on → low light intensity, output value is 1
- Sensitivity is adjusted using the blue trimmer (potentiometer).
- Connection is made via four Dupont wires:
 - VCC – Supply +V (white rail)
 - GND – Ground –V (black rail)
 - D0 – Digital output, switching threshold adjustable via the trimmer
 - A0 – Analog output, wider value range, requires more complex signal processing

Specifications

- Supply voltage: 3.3–5 V
- Detection range: 1–15 mm
- Dimensions: 32 × 14 mm
- Height with board: 7 mm

Circuit Diagram



Programming

- For working with the digital output, the same program as for the IR sensor can be used.
- For processing analog signals, use the block analog read (as with the capacitive sensor).
- For visualization of values, a bar graph can be displayed. Use the block plot bar graph of from the LED category and place it inside a loop.
- The maximum value must be set to 1023.



Tasks

Task 1: Recording Values

- Determine when the output provides value 1 and when it provides value 0.
- Cover the sensor with a hand and observe its behavior.

Task 2: Displaying Values

- Connect an external LED display and output the sensor values on it.
- Follow the procedure described in the LED Display section.

Task 3: Adjusting Sensitivity

- Adjust the threshold using the blue trimmer so that covering the sensor with a hand is detected.

Task 4: Light in Darkness

- Combine the RGB LED strip and the photoresistor.
- Create a program so that the light switches on automatically in darkness.
- Use blocks for pin reading and blocks from the Adafruit neopixel extension.

Task 5: Automatic Vehicle Lighting

- Mount the LED strip on an OMG Robotics vehicle.
- Build a cardboard tunnel and program the vehicle so that the lighting switches on automatically.
- If an MB1 expansion board is available, the integrated LEDs can be used.

Important Notes

- Verify the correctness of the used pin (must match both the program and the yellow rail).
- Connect the power supply correctly (VCC white rail, GND black rail).
- Switch on the MB1 or MB2 expansion board.
- Upload the program to the micro:bit after each modification.