Chapter 9

Line-tracking Robot

Our line-tracking robot is fond of exploring things with a map. No matter how complicated the road is, give him a long enough track, he will trace it to the end of the world. Let's step on an adventure with Maqueen Plus robot!
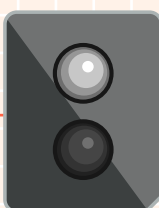
Goal

1. Learn the principle of Grayscale sensor
2. Learn the logic "and"

Electronic Component

Figure of the line-tracking sensor

Grayscale Sensor

Detect the colors of objects and surfaces by aiming directly at close range, which can allow robots to track specified lines.

Command Learning

Block Brief

Line-tracking sensor

read patrol sensor L1 ▼

Measure the intensity of light from black to white; help robot car move along a specified route.

Comparison Operator "="
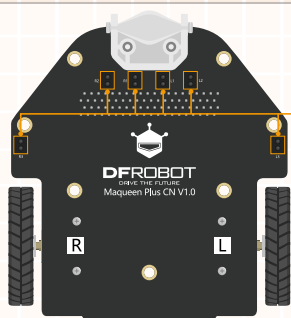
0 = ▼ 0

Return true if both inputs equal to each other.
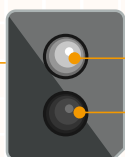
Logic "and"

and ▼

Return true if both inputs are true.

How does a grayscale sensor work?

There are 6 line-tracking sensors integrated on Maqueen Plus board. Each sensor includes an IR transmitter and receiver.
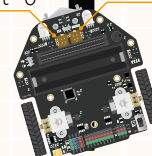
IR Transmitter
IR Receiver

When a line-tracking sensor detected the black line on the map, the indicator turns on, and output "1", otherwise, the indicator turns off, and output "0".

the indicator turns off, and output "0"

the indicator turns on, and output "1"

Note:
1. Since dark colors absorb light(including IR light), when the line-tracking sensor detected black, the IR light emitted by the transmitter cannot be reflected back to the receiver.
2. The output "0" or "1" does not refer to a high/low level, it's just a value obtained by processing the read grayscale.
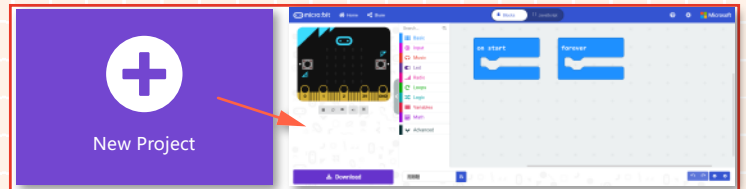
Hands-on Practice

Step 1 Create a New Project

1.Input https://makecode.microbit.org/ into your browser to enter MakeCode editor.
2.Click "new project" to enter MakeCode programming interface.
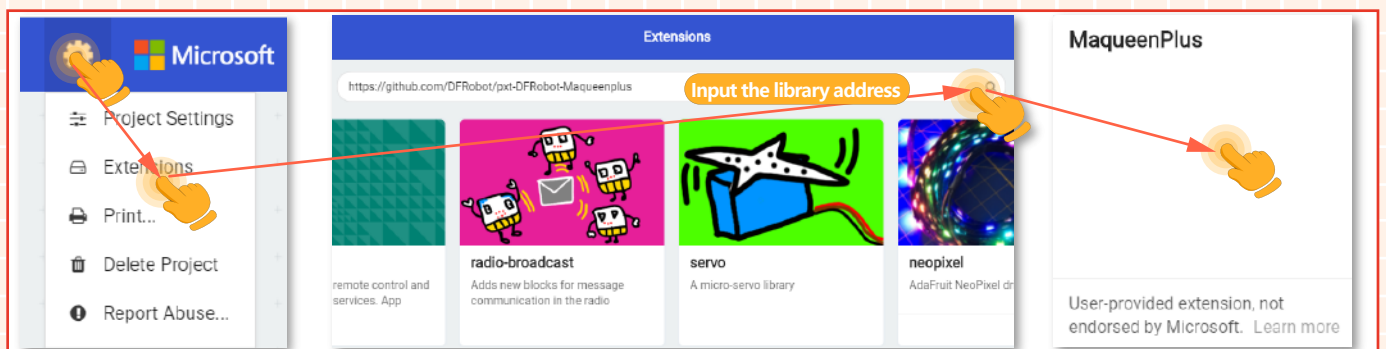3.Add the Maqueen Plus library:https://github.com/DFRobot/pxt-DFRobot-Maqueenplus

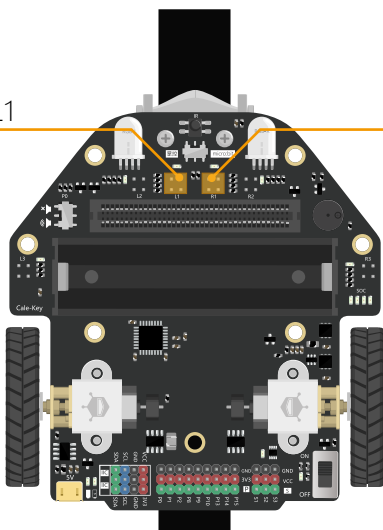1.Enter MakeCode editor

2.Enter programming interface

3.Add the extension library

Step 2 Programming

Maqueen Plus moves along the black line on the map. If you don't have a map, you can make one using adhesive tape. (Sensors R1 and L1 will be used in this project.)

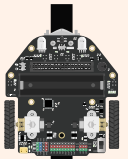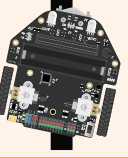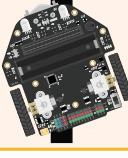### Knowledge Expansion

When you draw your own map, please make sure that both sensors L1 and R1 can be placed on the black line.

1.There are three possibilities when Maqueen Plus drives on the map.

| Status Image	Sensor Status	Detection	Output	Motor Movement
	L1 and R1 are on the black line	Both the left and right sensors detected the black line.	L1 = 1 R1 = 1	Go straight
	L1 is on the black line, R1 is not.	Only the left sensor detected the black line.	L1 = 1 R1 = 0	Turn left
	L1 is not on the black line, R1 is on the line.	Only the right sensor detected the black line	L1 = 0 R1 = 1	Turn right

2.Draw the corresponding program flowchart.
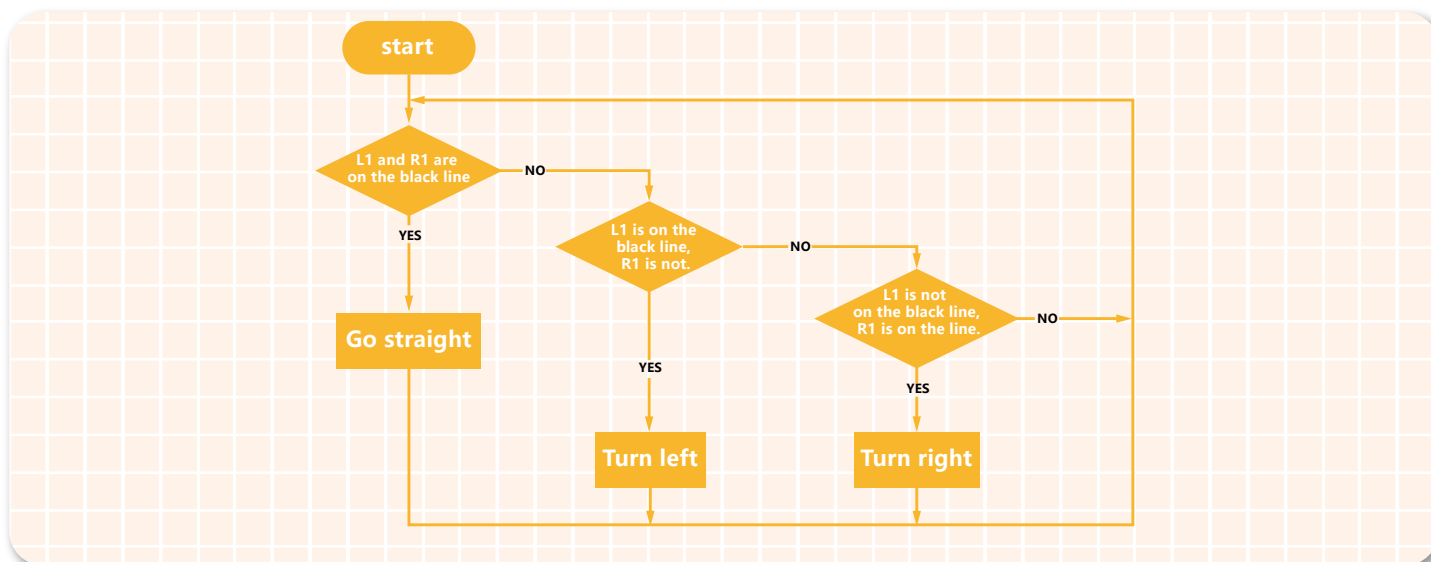
3.Since there are two conditions to judge, the outputs from sensor R1 and L1, we need to use a "and" block to combine them together.
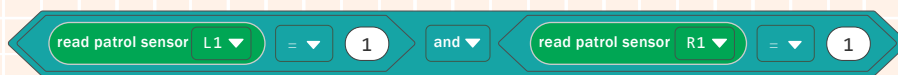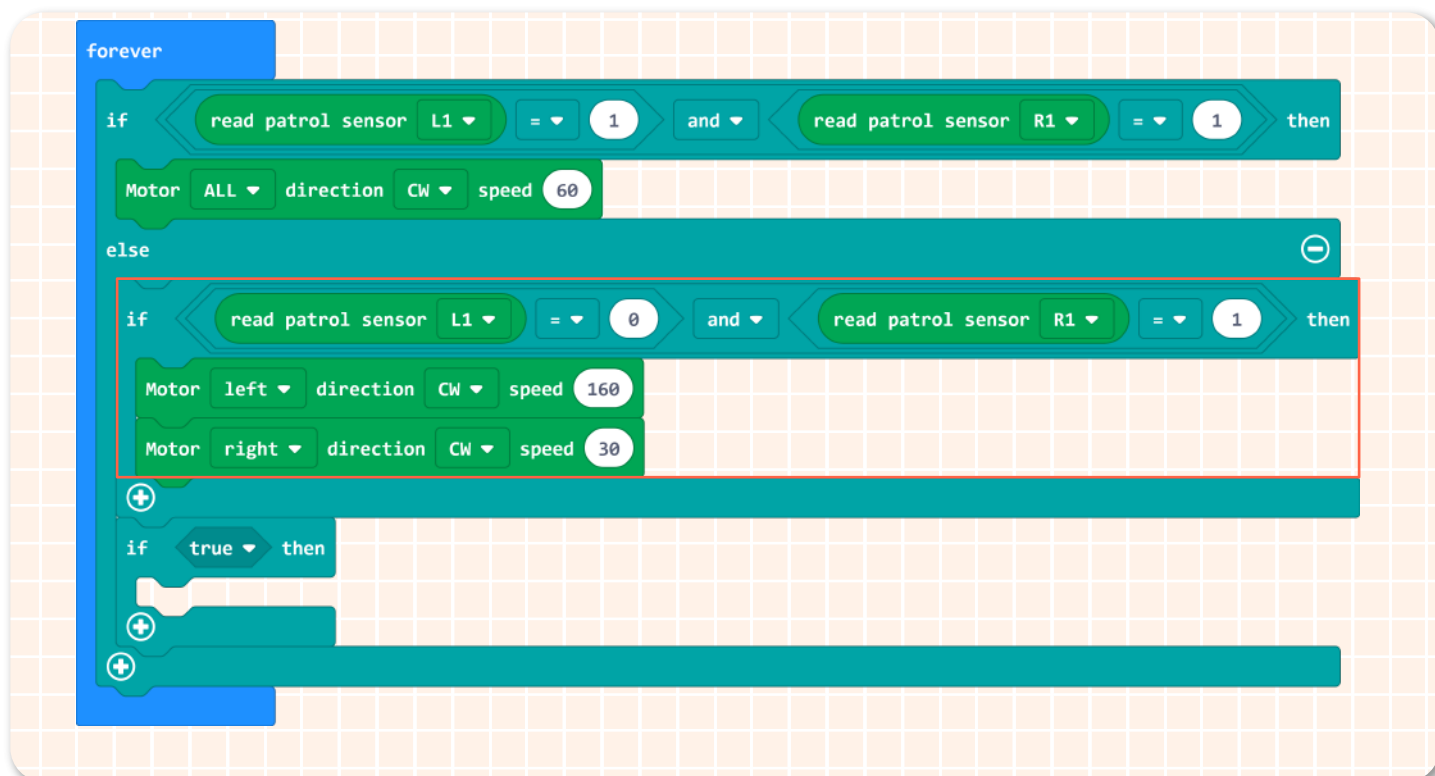

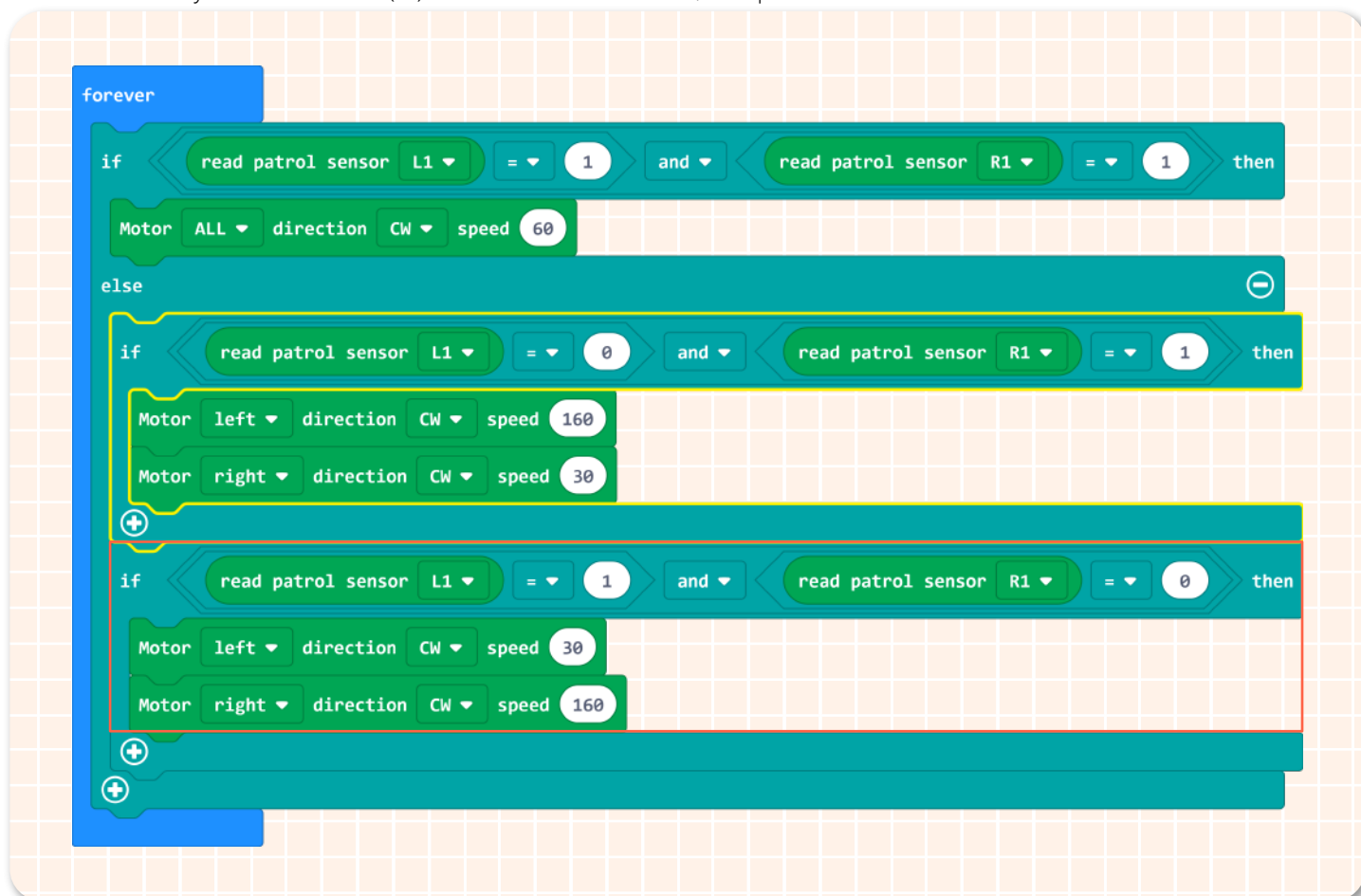Note: the program means that both sensors (L1 and R1) detected the black line.

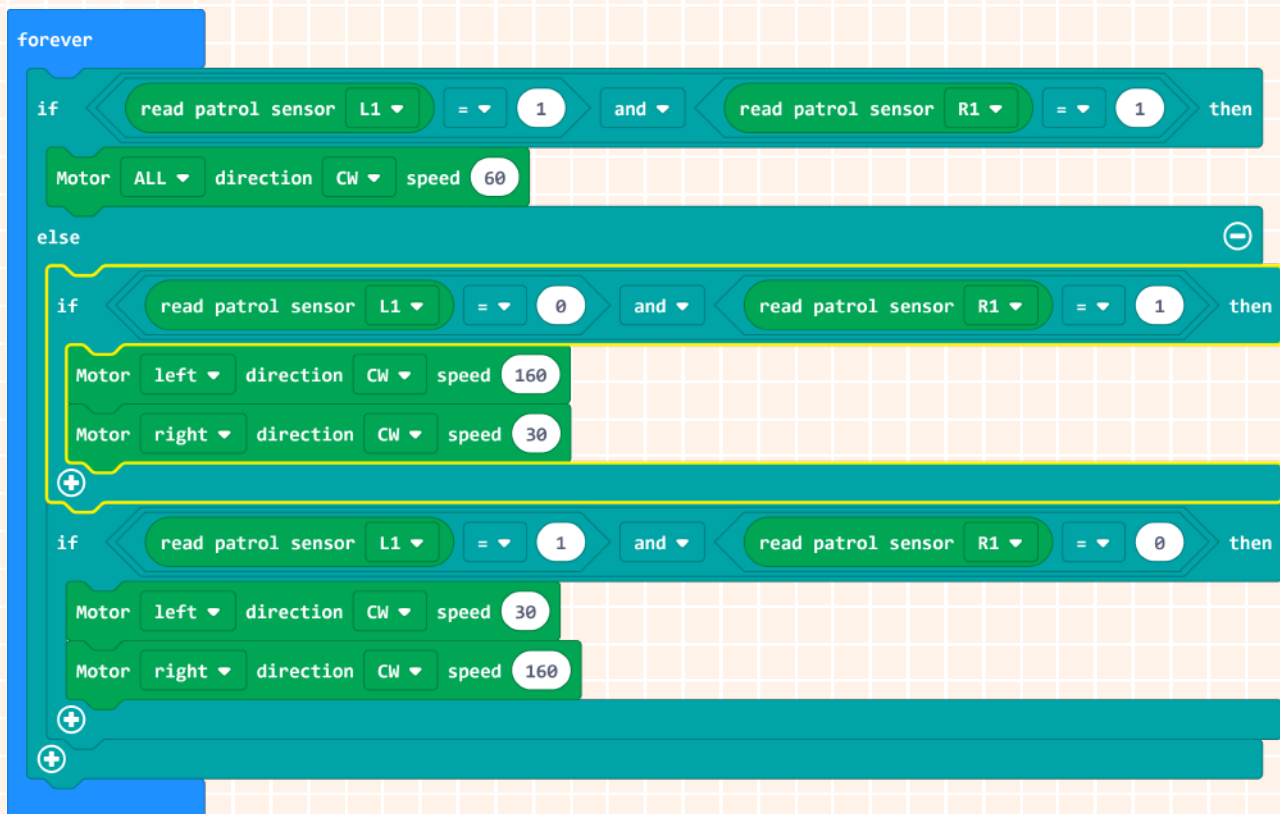4.When the sensor L1 and R1 detected the black line, Maqueen Plus car moves forward.
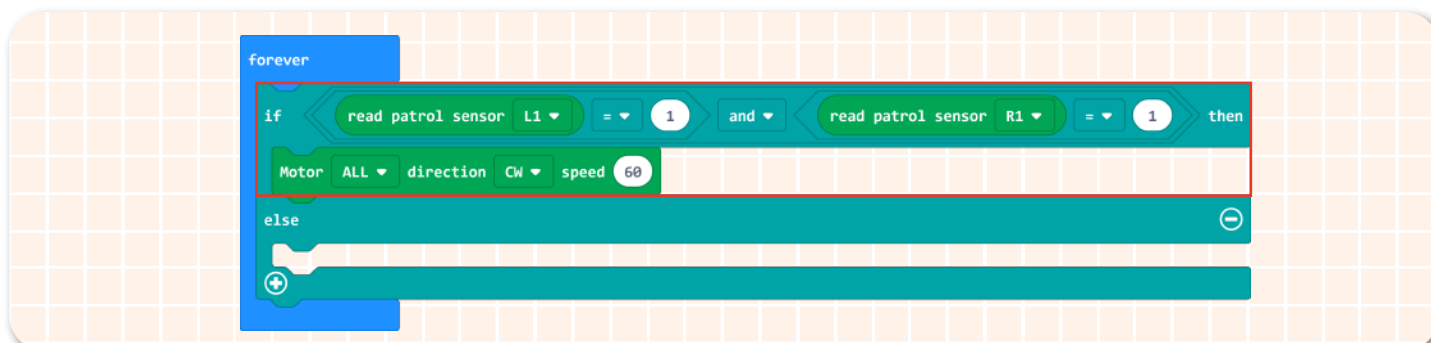
5.When only the right sensor R1 detected the black line, Maqueen Plus car turns right.

```
forever
    if   read patrol sensor  L1 ▼   = ▼  1   and ▼   read patrol sensor  R1 ▼   = ▼  1   then
        Motor  ALL ▼  direction  CW ▼  speed  60
    else
        if   read patrol sensor  L1 ▼   = ▼  0   and ▼   read patrol sensor  R1 ▼   = ▼  1   then
            Motor  left ▼  direction  CW ▼  speed  160
            Motor  right ▼  direction  CW ▼  speed  30
        if   true ▼   then
```

6.When only the left sensor (L1) detected the black line, Maqueen Plus car turns left.

```
forever
    if   read patrol sensor  L1 ▼   = ▼  1   and ▼   read patrol sensor  R1 ▼   = ▼  1   then
        Motor  ALL ▼  direction  CW ▼  speed  60
    else
        if   read patrol sensor  L1 ▼   = ▼  0   and ▼   read patrol sensor  R1 ▼   = ▼  1   then
            Motor  left ▼  direction  CW ▼  speed  160
            Motor  right ▼  direction  CW ▼  speed  30
        if   read patrol sensor  L1 ▼   = ▼  1   and ▼   read patrol sensor  R1 ▼   = ▼  0   then
            Motor  left ▼  direction  CW ▼  speed  30
            Motor  right ▼  direction  CW ▼  speed  160
```
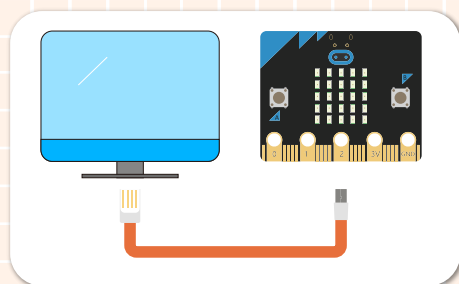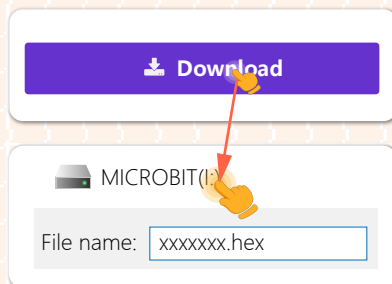
7.The complete program is shown below:

Note: if the Maqueen Plus car turns left or right too much, you can change its motor speed to adjust.

8.Name your project as "Line-tracking Robot " and save it.
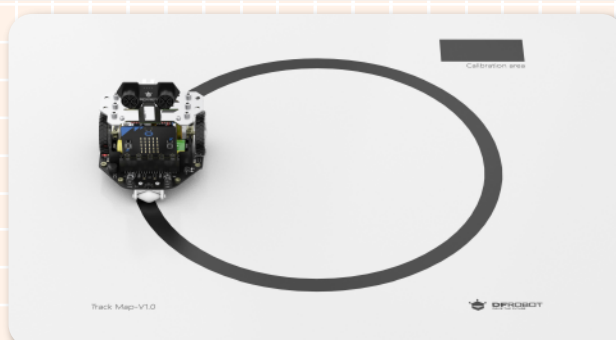
Step 3 Download Program

1.Connect to computer   2.Download program   3.Plug in micro:bit

Step 4 Effect Display

Turn on the power switch after all the above steps done, put Maqueen Plus car on the map, then it will automatically move along the black line, just like a track train!
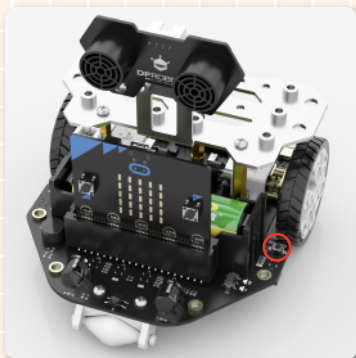
Extension-Sensor Calibration

The grayscale sensors on Maqueen Plus can be directly used since they are factory calibrated. But if you find that your sensors cannot detect black line accurately, you can calibrate them as the way shown below:

The button circled in red is the calibrate button.

Place Maqueen Plus on the black calibrating area of the map, and make sure all the grayscale sensors are within that area. Press down the calibration button, when the two RGB LEDs flashes green light, release the button, then sensor calibration is done.

Note: the black line printed by printer cannot be accurately detected sometimes. You can use black tape or marker to make a map if necessary.
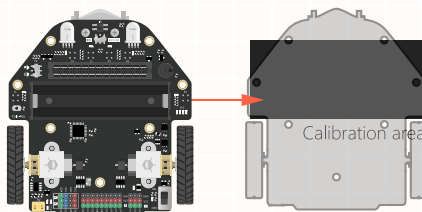
Think & Explore

With the development of technology, sweeping robot is gradually becoming a part of our family life. Simply place it on the floor and turn it on, here it goes !   To prevent the robot from falling off the stairs, the bottom of the robot usually is surrounded by many sensors. Our Maqueen Plus has 6 grayscale sensors, so it can totally meet the requirements. Let's make a sweeping robot with Maqueen Plus. Take the black line on the map as the edge of the stairs, and the robot will be only allowed to move within that area.