



**DFROBOT**  
DRIVE THE FUTURE

# FIRST-AID MANUAL

## For the Boson Starter Kit

```
on start
  set strip to NeoPixel at pin P0 with 7 leds as RGB (GRB format)
  set colour to 0

forever
  while colour > 1
    do
      set colour to colour - 1
      strip show rainbow from colour to 1
      pause (ms) 10
```

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# Table of contents

Lead-in	3
Briefly explore new tools	4
<b>Lesson 1</b> Emergency light beacon	7
<b>Lesson 2</b> Button controlled beacon	23
<b>Lesson 3</b> Automatic light beacon	34
<b>Lesson 4</b> Fan	39
<b>Lesson 5</b> Smart fan	46
<b>Lesson 6</b> Servo fire generator	53
<b>Lesson 7</b> Motion detection trap	63
<b>Lesson 8</b> Sound language translator	72
<b>Lesson 9</b> Radio station	79
<b>Lesson 10</b> Disco light	87
<b>Lesson 11</b> Earthquake detector	97
<b>Lesson 12</b> Rescue boat-Final project	103
Epilogue	118



# Lead-in

Nice to meet you dear reader. You are reading the “First-aid manual for the Boson Starter Kit”.

I want to answer the introduction question, “For whom is considered this book?”.

This book I wrote for those who want to learn programming and electronics with the help of our Boson Starter Kit for the micro:bit.

This book will be a great assistant for teachers in schools to develop their own curriculum for the micro:bit board. Also this book can help make first steps young DIY makers or enthusiasts to the electronics world with help of DFRobot products.



After reading this manual, you will understand how to program micro:bit board and create electronics projects based on it using DFRobot sensors. Sometimes you will encounter difficulties, but never give up. Even the man who wrote this manual faced with difficulties during study of the new knowledge. Only perseverance and patience helped him to become an expert. I know that it's hard for a beginner to start learning new things and dive into the unknown.



In this book I made everything possible to simplify the path to the knowledge. The book is intended for all of those who are not afraid to learn new things and obtain modern knowledge! For those who are not afraid of difficulties and don't like to give up!

Throughout the book I will tell and show you what exactly should be done, how to create and program electronic circuits and deal with tasks.

This book is divided into 12 Lessons and each lesson has a number of programs to do. I made an interesting topic to attract your attention or attention of your students. After reading this book you can use it like a manual for students in school or, if you are not a teacher, you can continue create great projects based on micro:bit, which later can become a successful startups.

# Briefly explore new tools

Before this amazing journey I will briefly introduce the micro:bit board, DFRobot Boson Starter Kit and MakeCode program editor.

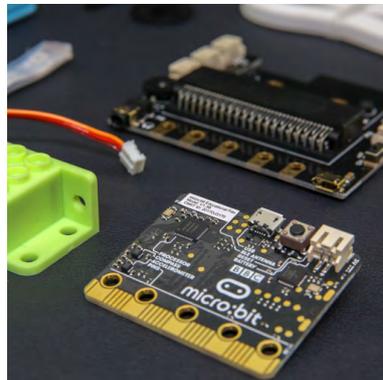
**The micro:bit** is a portable programmable computer designed to involve children to learn programming in easy and fun way!

For teachers the micro:bit board is a great way to inspire their students and give them an opportunity to develop their talents. The micro:bit can be programmed using Python, Javascript, MakeCode and Scratch.

The micro:bit has a built-in lights, buttons, accelerometer and compass to let kids invent programs for a real life applications. The micro:bit supports connections of other sensors and devices to extend a capabilities of this board. Children even can build an autonomous robotic car or smart home device!

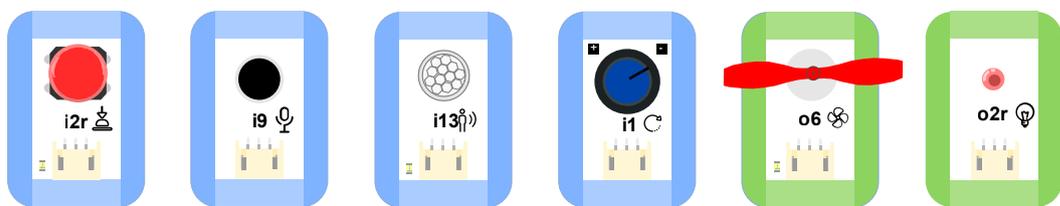
You can read more about the micro:bit board, explore projects and lessons on the official web-page [www.microbit.org](http://www.microbit.org) and on the DFRobot web-page <http://www.dfrobot.com/blog-tag-microbit.html>

Below I can also call micro:bit using a simple word “board”.



**The Boson Starter Kit** is a special kit designed to extend capabilities of the micro:bit board. This kit makes teaching and studying of the STEM and programming disciplines complete and more challenging. Boson Starter Kit has a lot of components, so you or your students can create various electronics projects!

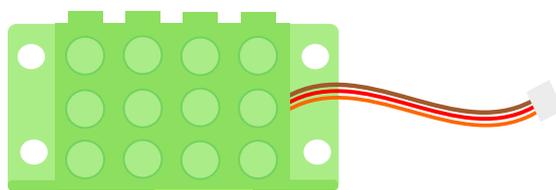
Boson Starter Kit sensors and motors are compatible with the popular building bricks educational platform. If you use it in your school, you can easily add Boson Starter Kit into your curriculum.



Red Push Button   Sound Sensor   Motion Sensor   Rotation Sensor   Fan Module   Red LED Module



RGB LED strip



Mini Servo



# Briefly explore your new tools

**MakeCode** is a software to write programs for the micro:bit. Using MakeCode you can program the micro:bit board two ways. First way is a graphical programming and second way is a Javascript language.

In this manual all programs will be created in blocks view. Virtual blocks make programming for micro:bit like creation of models using building bricks!

**The MakeCode editor has online and PC version.  
For this manual use the MakeCode online-editor (A).**

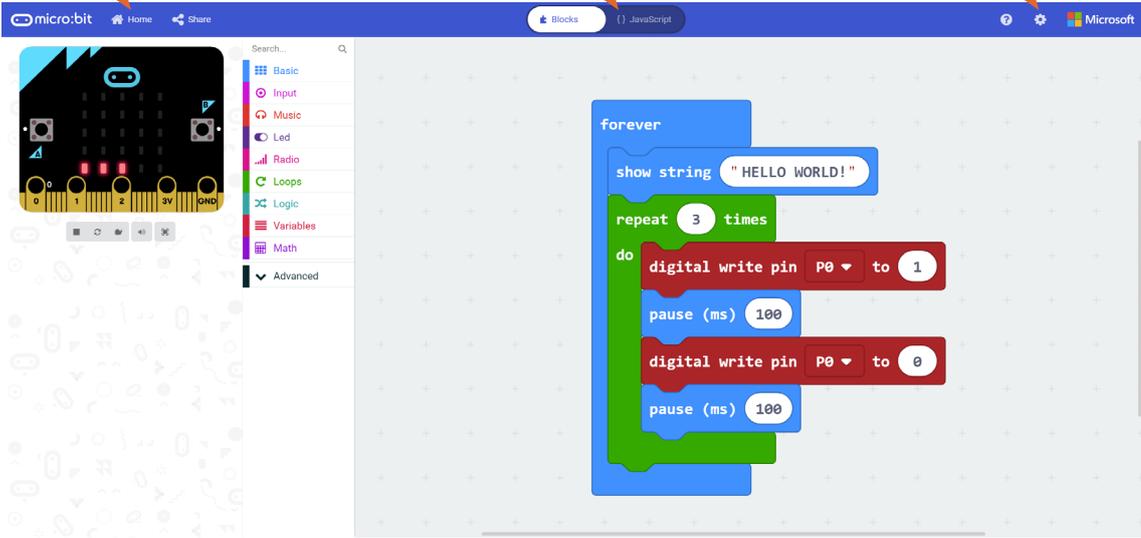
**A.** MakeCode online-editor. To create programs open web-page:  
<https://makecode.microbit.org/#editor>

**B.** MakeCode PC app for Windows 10.

In Microsoft Store find application “MakeCode” and install it. MakeCode PC app has easier uploading of program to micro:bit board and it can monitor sensors value from micro:bit in real-time. You also can use PC app instead of the MakeCode online-editor.

**C.** Check other programming software for micro:bit here:  
<https://microbit.org/code/>

Below you can see how programming area looks like in the MakeCode.



The screenshot shows the MakeCode online editor interface. On the left is a sidebar with a micro:bit board image and a category menu (Basic, Input, Music, Led, Radio, Loops, Logic, Variables, Math, Advanced). The main workspace shows a 'forever' loop containing a 'show string' block, a 'repeat 3 times' block, and two 'do' blocks. Each 'do' block contains a 'digital write pin' block and a 'pause (ms)' block. The bottom of the interface has a 'Download' button, a 'Save' button with an input field, and 'Undo/Redo' and 'Zoom In/Zoom out' buttons.

**Home button**  
All your programs and demo-programs you can find here

**Switch**  
Switch between Blocks/Javascript programming

**Settings**  
Extensions, Language, Pair device and etc.

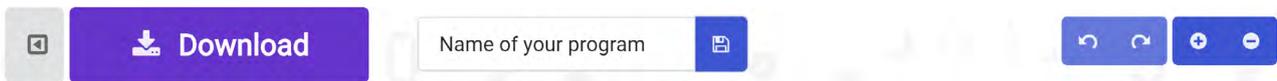
**Download**  
Button to download your program

**Save button**  
Enter name and save program here

**Undo/Redo**  
**Zoom In/ Zoom out**

5

# Briefly explore your new tools



To save program enter name of your program in the box and press icon of the diskette near. To find your saved program, click button Home and here will be a list with your recently created programs and sample programs from the micro:bit's community.

MakeCode editor is easy to understand, so you can very fast explore all its capabilities without any difficulties.

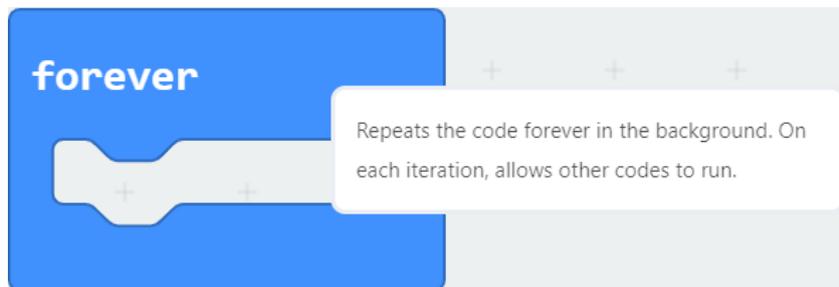
## Reference

Detailed explanation of each block, which you will use during this lessons, you can read here <https://makecode.microbit.org/reference>

Contains lots of useful information, do not forget to look through it from time to time while you are working with that book.

In addition each block in the MakeCode has a small built-in description.

Just point the mouse cursor to the block and wait about 2 seconds. A prompt message will appear near the block.



An example is shown in the picture above.

## Theory

During reading this book you will notice words which are written *italic type*.

Search more about this words on the Internet. When you creating a curriculum for your school or using this book for a teaching in the class, you can give to your students more deep knowledge about each component which is described in this book.

*We are starting our Long, Long Journey!*



# Lesson 1 Emergency light beacon

## A INTRODUCTION



Imagine that you sailed across the ocean and your boat crashed near a small uninhabited island.

In your bag you have only next items: Boson Starter Kit, the micro:bit board, computer and a big power bank battery. You must study programming to survive on this island and be rescued.

### Are you ready to study and save your life?

Your first task is to send a distress signal SOS to be noticed. For this task you must to study how to use lights of the micro:bit board and Boson kit.

### Electronics knowledge:

micro:bit, LED matrix screen of the micro:bit board, №05 “LED Light” of the Boson Starter Kit, №00 “Expansion board Boson”



### Programming knowledge:

Sequential program control of actions

## B1 BRIEF THEORY

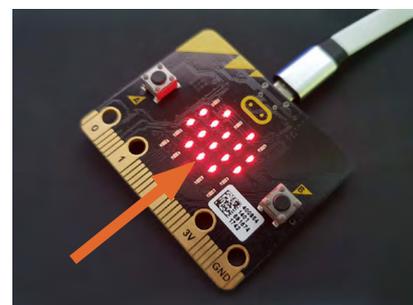
### LED or Light-Emitting Diode



Nobody notice you in the darkness of the island if you don't have any light source.

### Basic idea

Fortunately, your micro:bit board has a built-in light matrix screen. It consists from a 25 tiny lights which are called LED or light-emitting diodes. This screen can show characters, digits or a simple graphics.



### Practical use

Maybe you noticed in the subway or in the bus are installed light screens which can show a name of the station or other information. The micro:bit's light matrix screen uses the same working principle. Manufacturers of modern cars also started to use LED lights due to their light and energy efficiency.



# Lesson 1 Emergency light beacon



This kind of light array are not only using in buses, trains or a cars. They also are installed in skyscrapers to make city bright!

## Working principle

Light matrix consists from a small light bulbs, which are called LED. LED or light-emitting diode is a high-effective semiconductor light emitter.

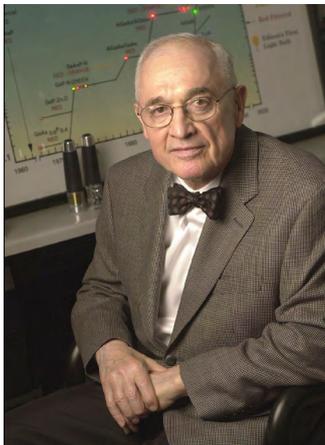
LED is replacing now all other kinds of light sources. LED lights have a different colors and shapes.



## History of the invention

In the next lesson we will discuss more complicated theory about the LED.

Today try to remember that LED is a semiconductor light source which was firstly invented by Nick Holonyak. He came up with the idea of the light-emitting diode in 1962 while he was working for the General Electric Company.



## The largest LED screen in the world

The largest high-resolution LED display in the world is 36 meters high. It is located at the Times Square, Manhattan, New York.

Your LED screen is not so big and it can't show colorful images, but for the studying of programming it is more than enough.



# Lesson 1 Emergency light beacon



## BRIEF THEORY

### Beacon and distress signal SOS



#### Beacon

It is an intentionally noticeable device designed to attract attention to a specific place or location. Mostly beacons are using for navigation. Sea beacon allows captain of the ship see the land or the shallow.

#### Vehicular beacons

They are rotating or flashing lamps mounted to the top of a vehicle to attract the attention of drivers and pedestrians nearby.

Emergency vehicles such as ambulances, fire trucks, police or SWAT cars, tow trucks, construction vehicles and snow-removal vehicles are using vehicular beacons to be noticed and to attract attention.

Turn signals are also vehicular beacons. Each vehicle has turn signals to let other drivers know where vehicle is going.

#### Crash beacon or emergency beacon

There are different types of emergency beacons.

Most of them are using a radio frequency to send a distress signal, but a distress signal also can be send using a light like in your case.



Your emergency light beacon is very close to the light lamp in the airplane life vest. Life vests which are situated in the plane has a special light which automatically turns on, when the life vest touches water surface.

You can call this light beacon a signal light or a semaphore lamp.

# Lesson 1 Emergency light beacon

## What is a distress signal SOS?

SOS (••• — — — •••) is a Morse code. It is used as a distress code to signal about danger or emergency situation. It was introduced by the German government of radio regulations on April 1, 1905.



From the beginning, the SOS distress signal has been a continuous sequence of three-dits/three-dahs/three-dits.

In the International Morse Code three dits mean the letter “S” and three dahs mean the letter “O”, so “SOS” became a simple way to remember the correct order of the dits and dahs.

During the time SOS became connected with phrases like “Save our Ship”, “Save Our Souls” and others.

## C1 WIRING DIAGRAM



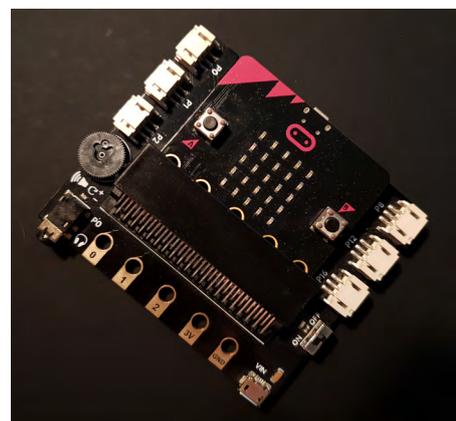
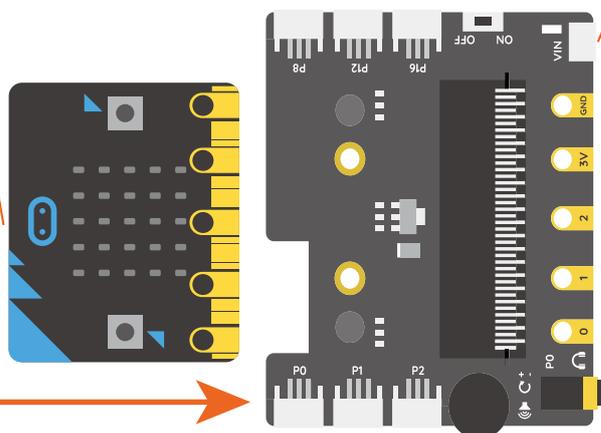
**Connect** the micro:bit board to the DFRobot Boson board. Just insert the micro:bit’s golden color pads into a black connector of the Boson board. Side of the micro:bit with two buttons A,B must be appear upside.

**To upload** program you must connect micro-USB cable to the micro-USB port of the micro:bit board.

**To supply** additional power you must connect a second micro-USB cable to the VIN port of Boson board. VIN port of the Boson board do not support uploading a program to the micro:bit.

Micro-USB port to upload a program to micro:bit

Micro-USB port to supply external power if necessary



CONNECT MICRO:BIT TO BOSON BOARD

# Lesson 1 Emergency light beacon

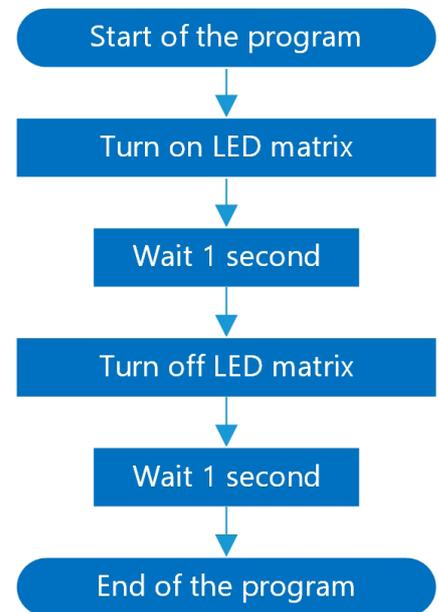
## D1 PROGRAMMING LOGIC Description and flow-diagram



The main idea of the program is described in the flow-diagram.

Turn on all LED lights of the matrix, then wait 1 second. Then turn off all LED lights, wait again 1 second.

Take a look at that flow-diagram of the program sequence.



## E1 PROGRAM IMPLEMENTATION



1. Open MakeCode.

2. When you first open the window of MakeCode editor you will see two blue blocks.

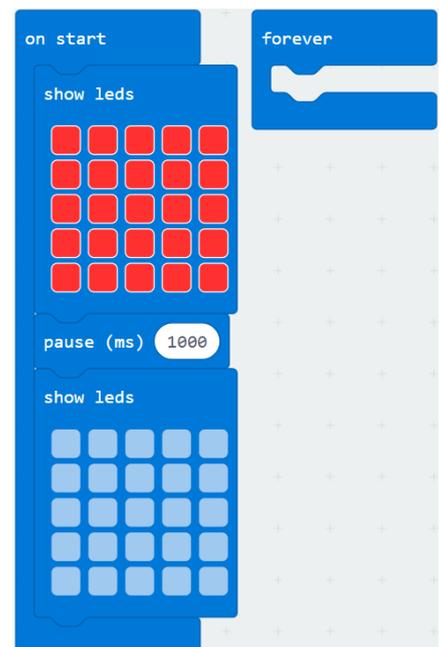
First named “on start” and second is named “forever”. “on start” block will run program inside only one time. “forever” block will run program inside infinitely until you physically turn off power supply of the micro:bit board.

3. This time you need to put your program inside of the “on start” block, leave block “forever” empty or delete it.

4. Take a block “show leds” from the Basic section. Red square or white square means that LED is turned on, empty square means that LED is turned off. Click on the square with a left mouse button to change its state.

5. Take a block “pause” from the Basic section. By default block “pause” has 100 milliseconds pause. 100 milliseconds (ms) equals 0.1 second (s).

To make a pause for a 1 second you must write 1000 milliseconds. Remember  $1s=1000ms$ .



# Lesson 1 Emergency beacon

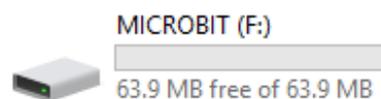
6. Finish the program from the picture above.

## First launch of the micro:bit board

1. Connect the micro:bit board to your computer using a micro-USB cable. Wait 3-5 minutes to complete drivers installation.

2. Open “File explorer”.

Your micro:bit board must be detected in computer with a name “MICROBIT”. The micro:bit’s storage in computer looks like USB flash drive storage when you insert it into computer.



 Download

3. Click on the button “Download” in the left bottom corner of the MakeCode window.

4. A pop-up window will appear. Locate file with completed program to the “MICROBIT” storage and save it there. While uploading a yellow light of the micro:bit board will start blinking fast.

If no pop-up window appeared, check Downloads folder of your browser, copy HEX-file to the micro:bit.

5. If you are using MakeCode PC app, save program and close MakeCode. Connect micro:bit to the computer, only after that open MakeCode PC app again. Click button Download and program will be uploaded to the micro:bit automatically.

## Result

After uploading program to the micro:bit, LED matrix screen will blink for one time. To be noticed at the night on the uninhabited island you must use all 25 LEDs in the micro:bit and blink forever.



## PROGRAMMING LOGIC

### Description and flow-diagram



In the previous program you made an one time blinking LED light.

I think that it is not enough, because if you want to be noticed on this island, you must send this distress signal continuously. Your program must be repeated forever.

Take a look how a new flow-diagram will look like. When the last block is executed, program goes back to the start and all actions repeat again. To do this use a “forever” block.

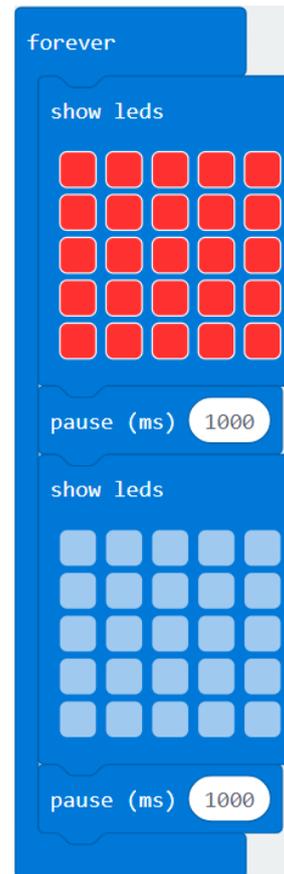
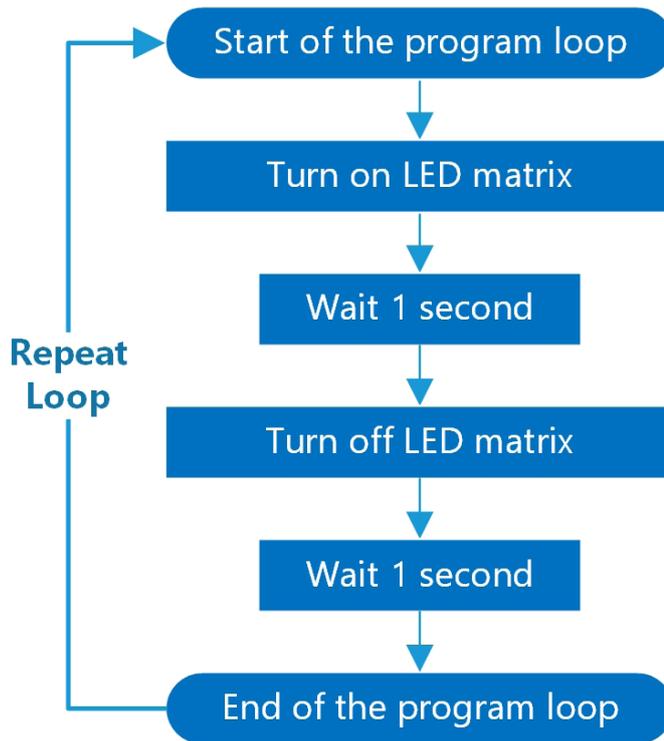


# Lesson 1 Emergency beacon

## E2 PROGRAM IMPLEMENTATION



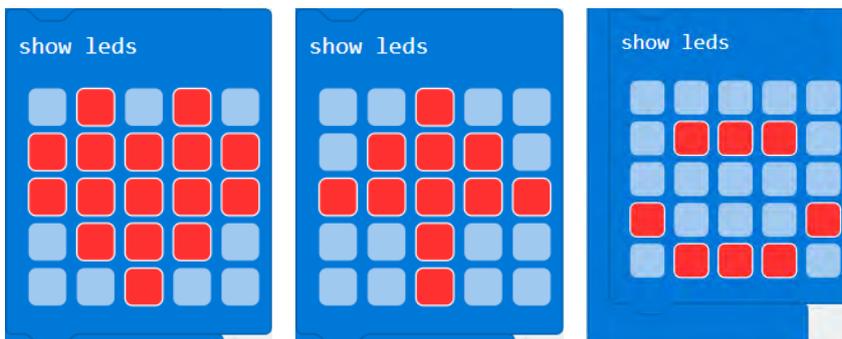
1. Insert all the code from the block “on start” to the block “forever”. Empty “on start” block you can delete.
2. Create program and copy it to the micro:bit.



### Result

After uploading a program to the micro:bit board, LED matrix screen starts blinking continuously. Change time of the pause to make blinking faster or slower.

Try to make pause 10000, 5000, 3000, 500, 100, 10, 1 milliseconds and see what will happen. Change sequence of the LED in array. Create a heart image, arrow image, smile image.

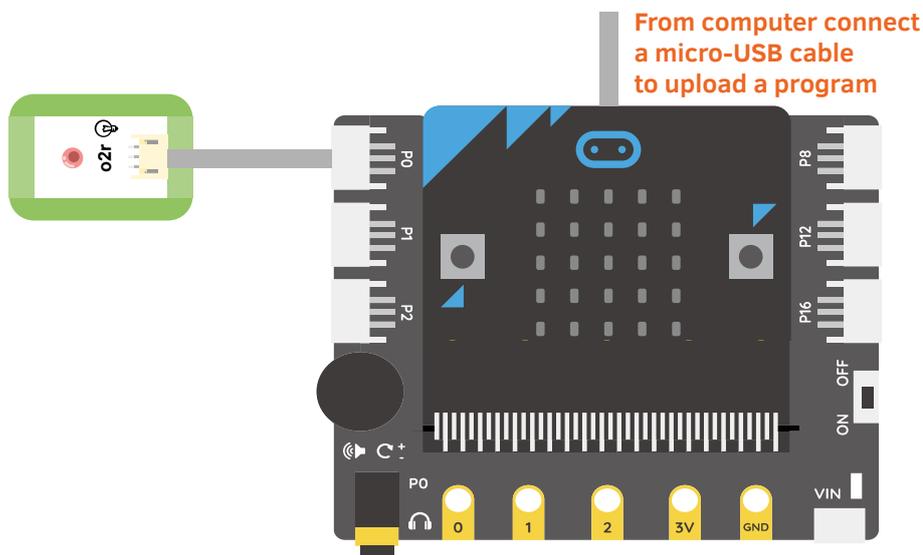


# Lesson 1 Emergency beacon

## C3 WIRING DIAGRAM



Connect the №05“LED Light” to the Boson board, port P0.



## D3 PROGRAMMING LOGIC

### Description and flow-diagram

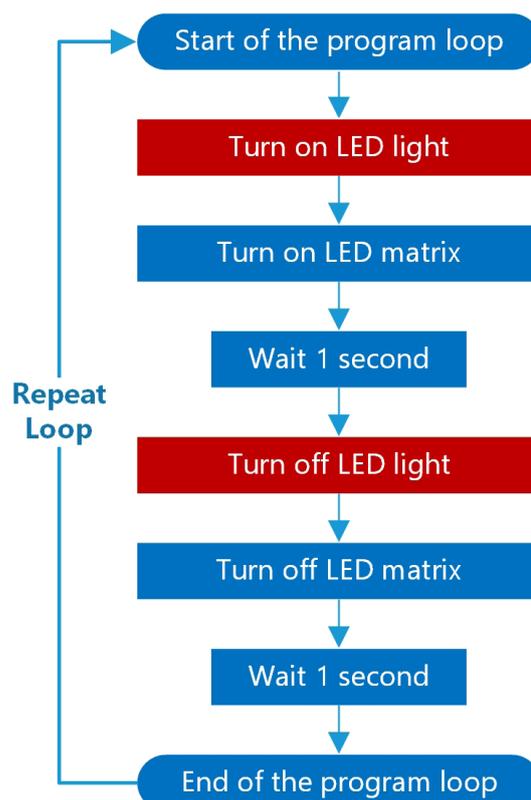


All programming logic will be the same with D2 programming logic.

Except of external LED light which you will add this program to turn on and turn off it.

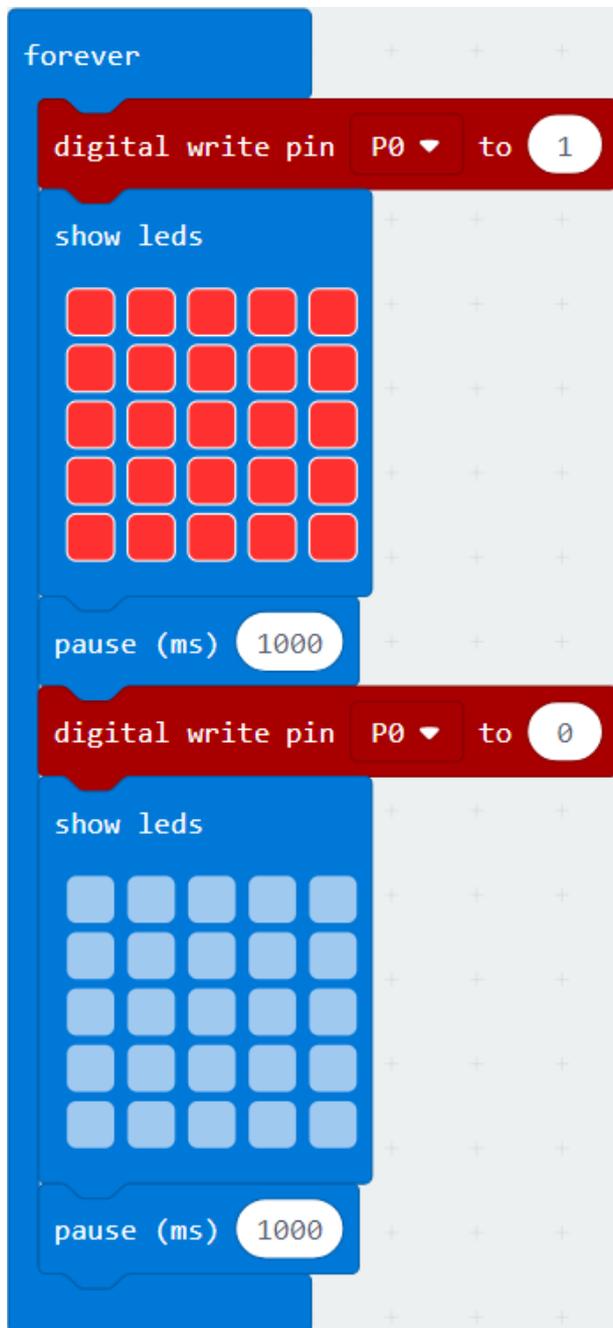
First will turn on an external red LED and then LED matrix, they both will illuminate during 1 second.

You can think than red LED will light up faster than LED matrix. On electronics side answer is, “yes”. But on human perception side they will light up at the same time, because time between turning red LED light and LED matrix screen is nanoseconds, your eye can't notice it.



# Lesson 1 Emergency beacon

## E3 PROGRAM IMPLEMENTATION



1. Please take a notice that to turn on external red LED light use a block “digital write pin” from the Pins section of the Advanced category. Choose the right pin inside of the block, it must be P0.

2. Remember that digit “1” means turn on and digit “0” means turn off.

3. Create program and copy it to the micro:bit.

### Result

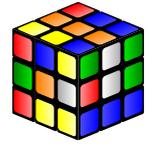
After uploading program to the microbit, LED matrix and red LED are blinking together.

Let's program distress signal SOS using external LED light!



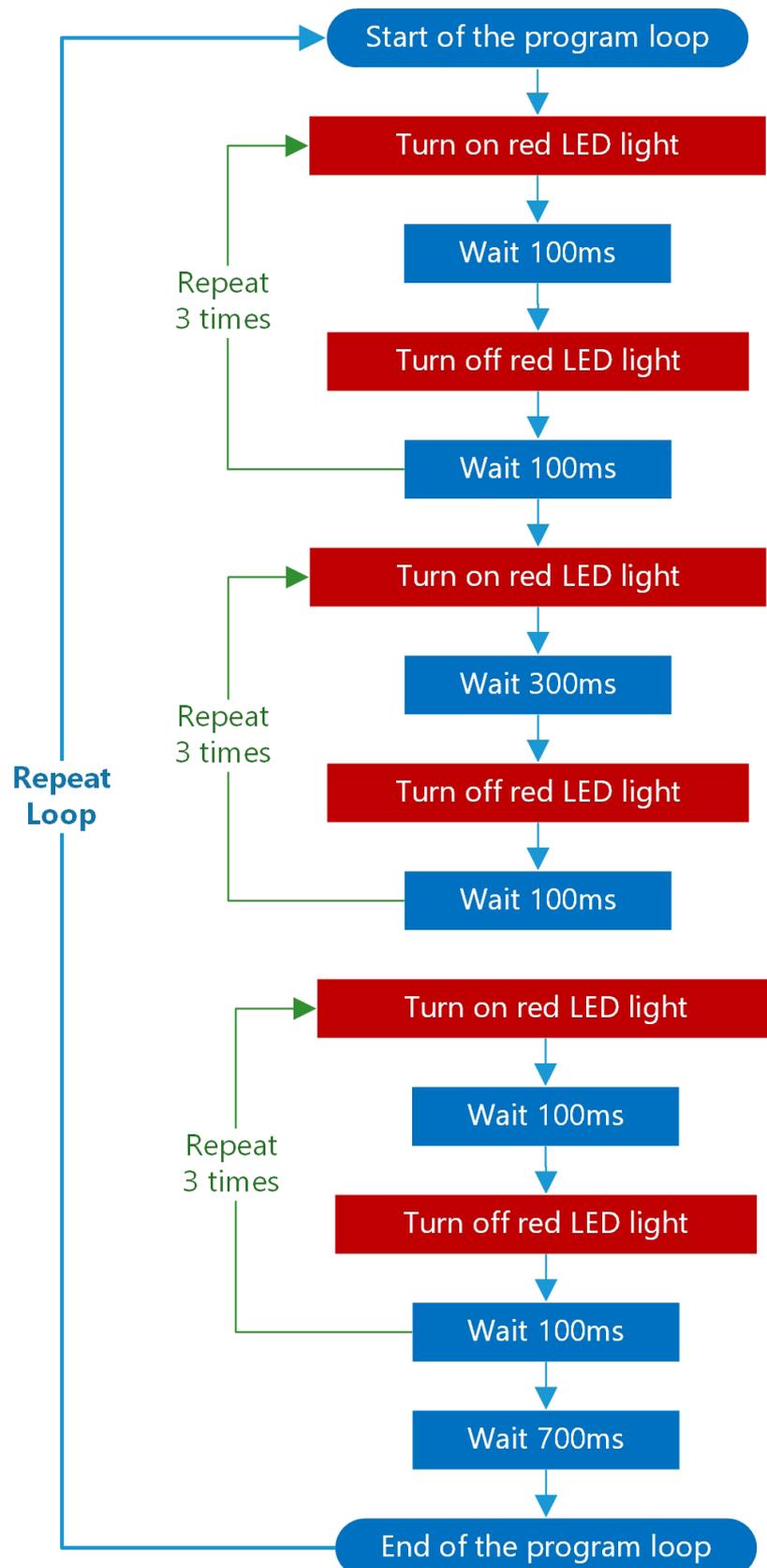
# Lesson 1 Emergency beacon

## D4 PROGRAMMING LOGIC Description and flow-diagram



Program a distress signal SOS using red LED.

Please take a look at the Brief theory section of this lesson to see the SOS signal sequence.



# Lesson 1 Emergency beacon

## E4 PROGRAM IMPLEMENTATION



```
forever
  repeat 3 times
    do
      digital write pin P0 to 1
      pause (ms) 100
      digital write pin P0 to 0
      pause (ms) 100
  repeat 3 times
    do
      digital write pin P0 to 1
      pause (ms) 300
      digital write pin P0 to 0
      pause (ms) 100
  repeat 3 times
    do
      digital write pin P0 to 1
      pause (ms) 100
      digital write pin P0 to 0
      pause (ms) 100
  pause (ms) 700
```

1. You can see a flow-diagram, actions repeating for a several times. As a programmer you must be lazy person to write one block a lot of times.

2. Use a new block which is called “repeat times” from the Loops section.

3. Using this block you can repeat your actions once and again, avoiding writing the same blocks a lot of times, if they are repeating one by one.

4. Create program and copy it to the micro:bit.

### Result

After uploading program to the micro:bit, external red LED is imitating SOS signal sequence.



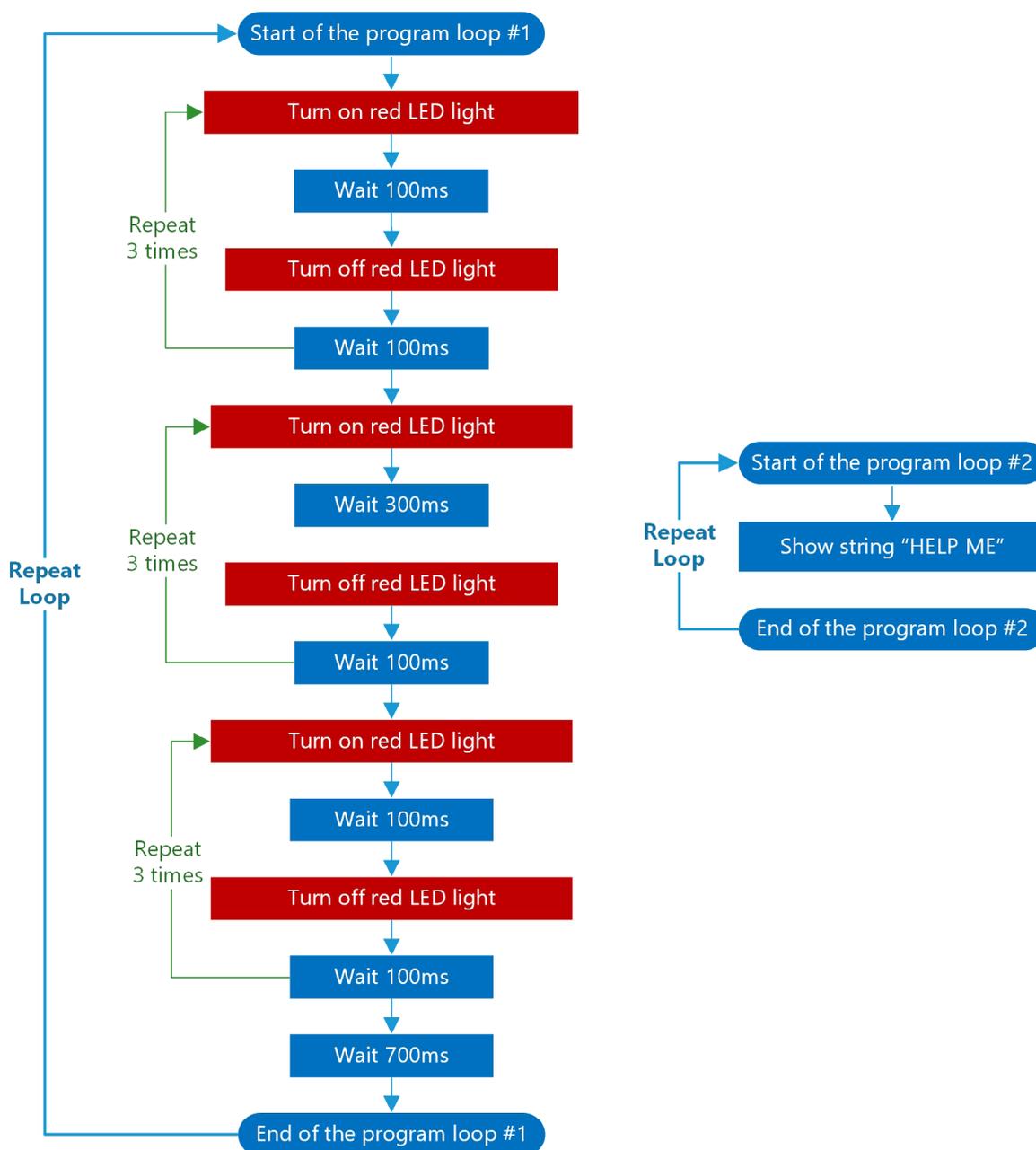
# Lesson 1 Emergency beacon

## D5 PROGRAMMING LOGIC Description and flow-diagram



What to do if you want to use red LED like emergency beacon to send a distress SOS signal and LED matrix screen to show a text message on it? It will increase your chances be noticed.

Parallel programming! Your micro:bit is powerful enough that can execute two programs at the same time. One program will blink external red LED and another program will show a message on the screen.



# Lesson 1 Emergency beacon

## E5 PROGRAM IMPLEMENTATION



1. In the first “forever” block put a program E4.

2. In the second block “forever” insert new block “show string” from the Basic section.

3. The micro:bit’s LED matrix screen can show text. Inside of the block “show string” you can write everything what you want and screen will show this text. To be rescued I recommend you to write “HELP ME”.

4. Create program and copy it to the micro:bit.

```
forever
  repeat 3 times
  do
    digital write pin P0 to 1
    pause (ms) 100
    digital write pin P0 to 0
    pause (ms) 100
  repeat 3 times
  do
    digital write pin P0 to 1
    pause (ms) 300
    digital write pin P0 to 0
    pause (ms) 100
  repeat 3 times
  do
    digital write pin P0 to 1
    pause (ms) 100
    digital write pin P0 to 0
    pause (ms) 100
  pause (ms) 700
show string "HELP ME!"
```

### Result

After uploading program to the micro:bit, red LED is blinking SOS signal sequence and on the screen appeared LED scrolling sign.



# Lesson 1 Emergency beacon

## F ADDITIONAL KNOWLEDGE



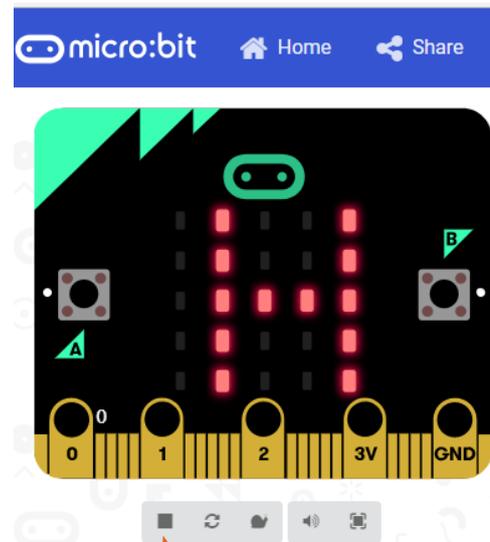
### Simulator of the program

You can see how the new program is running without uploading it to the micro:bit.

In the MakeCode editor on the left side is window with the micro:bit's board image. Click on the triangle button "Play" to start simulator and on the "Rectangle" button to stop it.

Run a simulator of the program E5 and on the screen of your computer will appear the same LED sequence which you are running on the real micro:bit board. Contact pad #0 will blink according to the program for your external red LED.

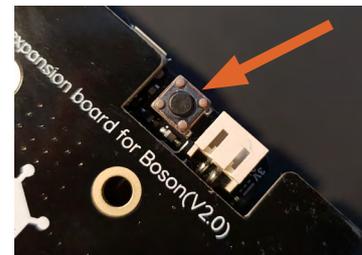
Use this simulator to test programs before you upload them to the micro:bit board.



Control buttons

### Reset button

To run program again or restart it press black button near the micro-USB port of the micro:bit board. This button was made to reset an uploaded program and to start it from the very beginning.



### Mini-game

When you turn on your brand new micro:bit board a small game will launch and you can play in it. When you upload a new programs into your micro:bit this game will be erased.

If you want to play this game again please download it here and upload to the micro:bit board again: <http://bit.ly/micro-bit-demo-program-1>

### Parallel programming

Possibility of writing two parallel mini-programs sometimes is very necessary and useful. Maybe you will not use this function everytime, but just remember that you can do this.

# Lesson 1 Emergency beacon

For example, one mini-program can detect impact using Boson Starter Kit sensors and other mini-program can response at the same time.

## CHECK YOURSELF QUESTIONS



1. What is LED?
2. Who invented it?
3. What are LED applications?
4. What is the sequence of the SOS distress signal?
5. What is the difference between block “on start” and block “forever”?
6. How many milliseconds contains 1 second?
7. How does block “repeat” work?
8. Which block to use to interact with connected external red LED light?

## HOMEWORK AND CHALLENGE



1. Try to find out what is the longest time of pause the micro:bit board can execute. Try to make a program of blinking LED using different pause periods. 10 seconds, 60 seconds, 1000 seconds.
2. Now let's try to make a pause between turning on and turning off LED smaller and smaller. Which pause is necessary to stop seeing a blinking of the LED?
3. What will happen if delete a pause between block “turn on external LED” and block “turn off external LED”.
4. Play with the LED matrix of the micro:bit board. You can draw different images on it and show them. Try to use a new block “show icon” from the Basic section. This block has a lot of sample images. You can use this block to show images on the screen.
5. Can you program moving graphics on the LED matrix? Make a small movie. First, you have a small heart on the screen, after 0.5 second this heart becomes bigger, after 0.5 second it explodes! Use the LED matrix screen to draw a small heart, bigger heart and then explosion of this heart. It will look like a stop-motion animation.

# Lesson 1 Emergency beacon

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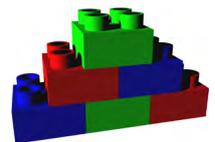
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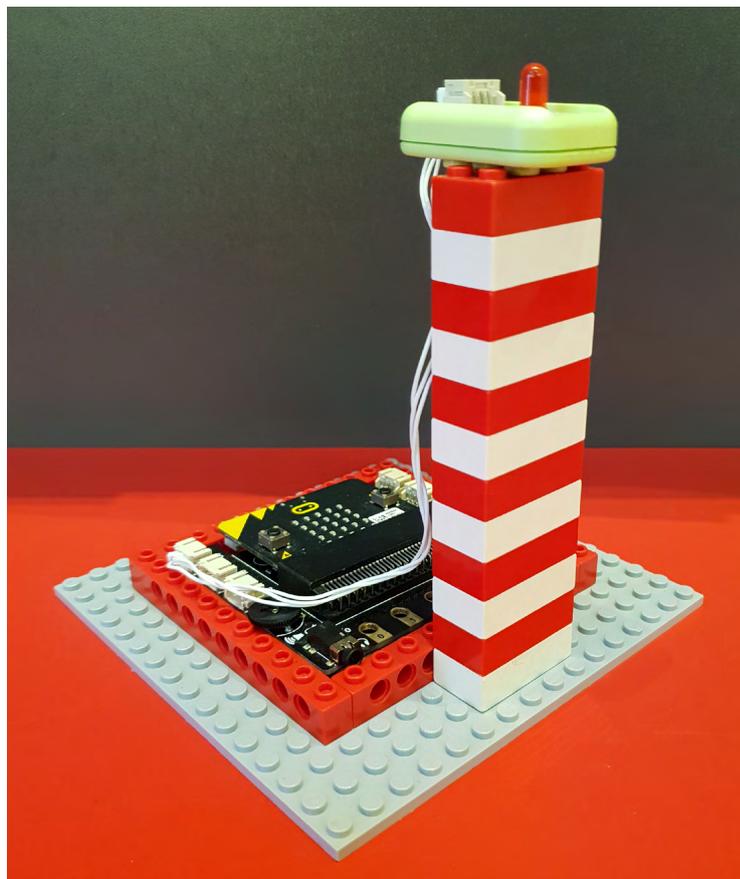
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## **I** MAKE A MODEL



Develop your creativity! Use plastic parts, paper or other DIY materials to make a real model from this lesson.



# Purchase Boson kit with the book

It is a preview of the DFRobot Boson Starter Kit book.

If you are interested to purchase that book, e-book is included with the Boson Starter Kit.