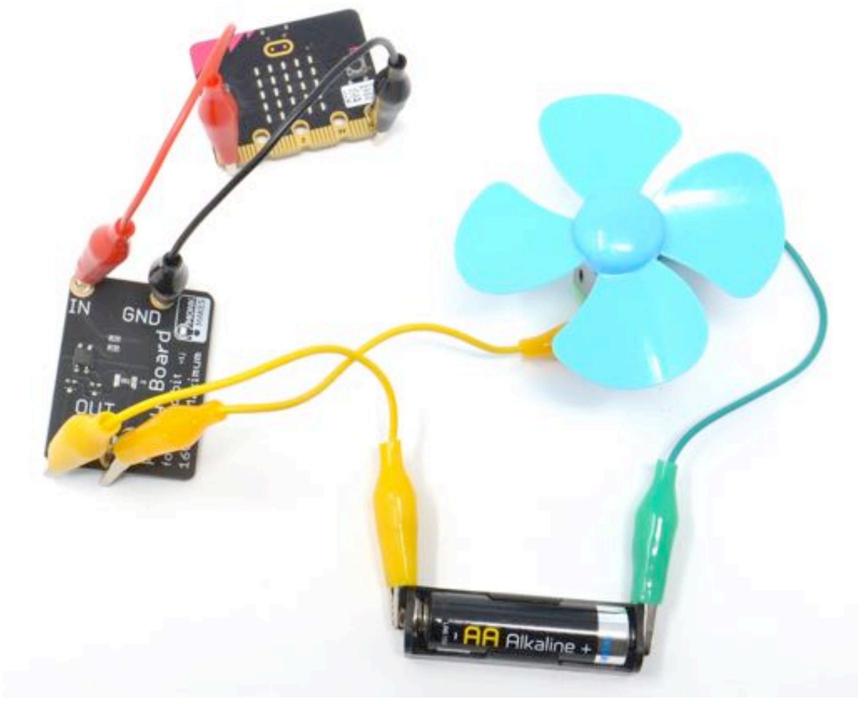
# Instructions:

## Electronics Starter Kit 2 for micro:bit

Works with micro:bit | V2 only



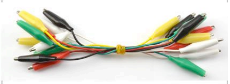
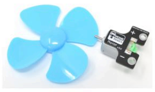
Rev 1a.

# Table of Contents

## PARTS

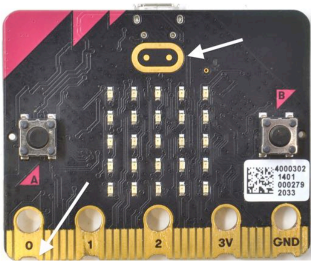
**micro:bit, AA battery and USB lead** are **NOT** included in this kit.

Before you do anything else, check that your kit includes the following items:

| Quantity | | |
|---|---|---|
| 1 | MonkMakes Relay for micro:bit<br><br>(switch things on and off or control the brightness of a light or the speed of a motor) | OUT<br>IN<br>GND<br>Relay Board<br>for micro:bit<br>16V 2A Maximum |
| 1 | MonkMakes RGB LED for micro:bit<br><br>(mix colors) | |
| 1 | Set of alligator clip leads (10 leads) to connect things together |  |
| 1 | Small motor with fan |  |
| 1 | Single AA battery box (battery not included) to power the light bulb and fan | |
| 1 | 1V LED bulb module | |

To make use of this kit, you will also need a BBC micro:bit **VERSION 2**.

This kit is designed for Version 2 of the micro:bit. If the micro:bit logo is gold, and there are indents on alligator clip holes, then it is version 2. Otherwise it's version 1.



# Making the Projects

## Software

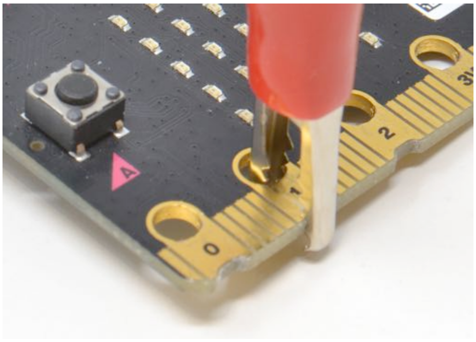
**Before** connecting boards to your micro:bit install the program for the project onto the micro:bit. This makes sure that pins are correctly configured as inputs and outputs before you connect up the electronics.

This code for this kit uses the Makecode blocks editor. As well as programming by plugging together blocks, you can also view and edit the resulting code as Python or Javascript.

The Blocks editor program allows you to program your micro:bit directly from the browser on your computer. Each program has a web address and clicking on the link in these instructions will open it in your browser so that you can then install it on your micro:bit.

## Alligator/Crocodile Clips

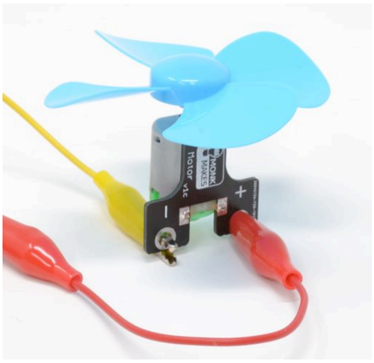
The projects in this kit are assembled by connecting your micro:bit to one or more of the MonkMakes boards using alligator clips. You have to be a bit careful how you connect the clips at the micro:bit end. The correct way is to connect the clips vertically as shown below.



Connecting the alligator clips like this prevents any accidental connections between the large connectors with the holes in and the much smaller connectors (gold lines in the photo above)

## The Motor

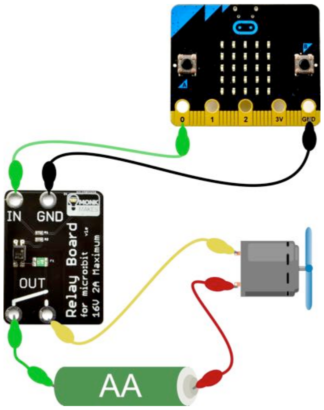
To stop the motor falling over, connect the alligator clips as shown below.



## Building a Project

The micro:bit and the MonkMakes boards are pretty robust when it comes to connecting things up the wrong way around, but it's a good idea to unplug your micro:bit from your computer while you are wiring things up. Then check it over carefully before connecting your micro:bit to your computer.

Each project includes a wiring diagram, like the one below. This shows you what needs to be connected to what. It suggests the colors of lead to be used for each connection. The project will still work just fine, whatever color of lead you use, but it makes it easier to see what's going on if you stick to the color scheme, especially using red for 3V power connections and black for ground connections.



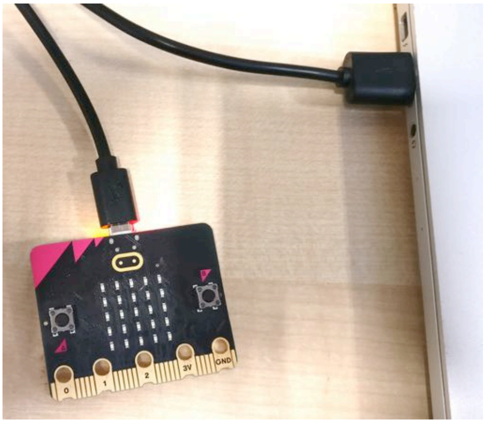
# Getting Started

To get you started with your kit, please follow the steps below. This does not use any of the MonkMakes add-on boards, so for now you don't need the alligator clips.

If you have already used your micro:bit for other things, you can probably skip this section.

## Step 1. Plug your micro:bit into your computer.

Connect your micro:bit to a free USB port on your computer.



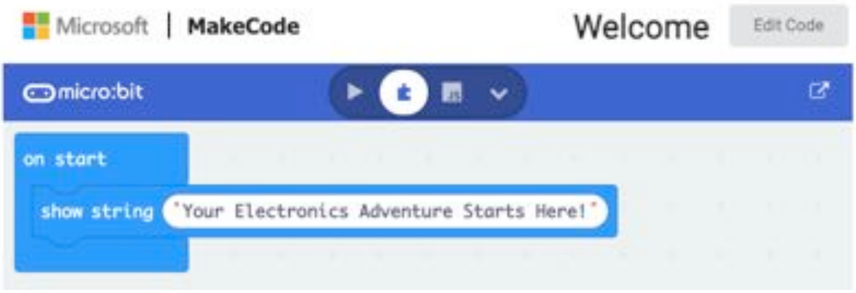
If your micro:bit is new, then its LED display will start displaying messages and showing off various features of the micro:bit. You are going to replace this program currently running on your micro:bit with a new one.

## Step 2. Open The Blocks Editor

To install the new program (incidentally the program is called *welcome*) onto your micro:bit, you first need to open it in the Blocks Editor. You can do this by going to the following page on your computer's web browser by clicking on the link below:

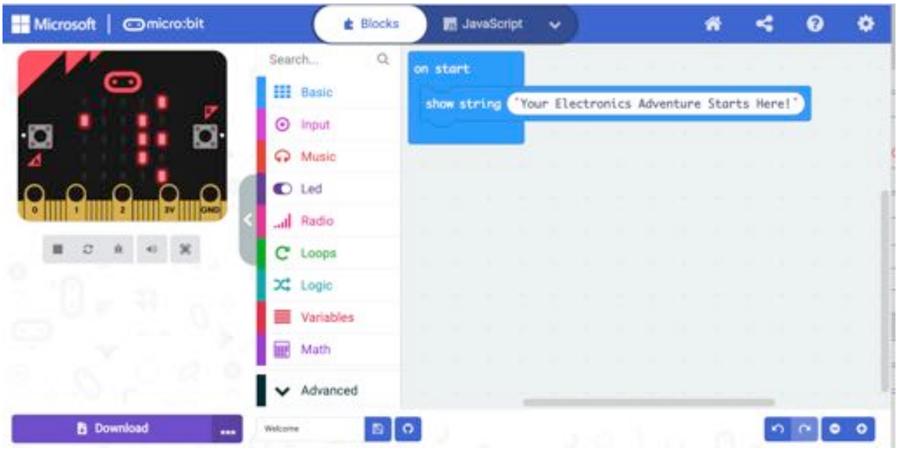
https://makecode.microbit.org/_R0YbTwiDs0pE

This will open a tab that looks like this:



```
on start
  show string "Your Electronics Adventure Starts Here!"
```

Now, click on the Edit Code button (top right) to open the program in the Blocks editor as shown below.

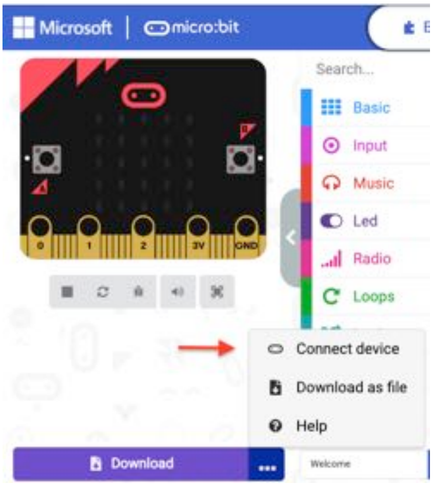


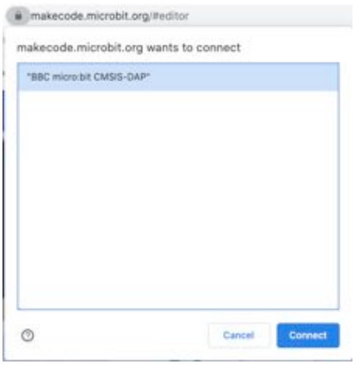
```
on start
  show string "Your Electronics Adventure Starts Here!"
```

## Step 3. Install the Program

Next, you are going to send the *welcome* program to the micro:bit. The easiest way to do that is to pair your micro:bit to your computer. This will only work in the Google Chrome browser. To pair your micro:bit, connect it to your computer and then click on the three dots next to the Download button and then select the option *Connect device*.

This will first pop-up some instructions, telling you to connect your micro:bit. Click on the Next button and this will open some more instructions. Click on Next again and then a pop-up will appear near the address area of your browser as shown on the left of the next page.




makecode.microbit.org/#editor
makecode.microbit.org wants to connect
"BBC micro:bit CMSIS-DAP"
Cancel
Connect

Click on whatever your micro:bit is called in the list that appears (something like BBC micro:bit CMSIS-DAP) and then click Connect.

From now on, all you have to do to put a new program onto your micro:bit is to click on the big Download button in the editor.

Now click on that Download button to install the Welcome program.

Once you click on the Download button, a yellow LED on the back of your micro:bit will start to flicker furiously as the program is *flashed* onto the micro:bit. As soon as the flashing has finished, the welcome program will start and display the message: *Your Electronics Adventure Starts Here!*.

Congratulations, you are now ready to move on to Project 1!

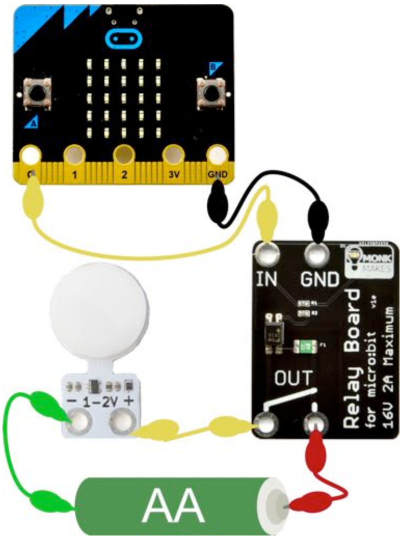
If you want to learn more about getting programs onto the micro:bit including options if you are not using the Chrome web browser, see:

https://microbit.org/get-started/first-steps/set-up/

# Project 1. Lighthouse

## You will need:

- micro:bit
- MonkMakes Relay for micro:bit
- MonkMakes 1V Bulb
- Single AA battery holder and battery
- Program: *P1 Lighthouse*

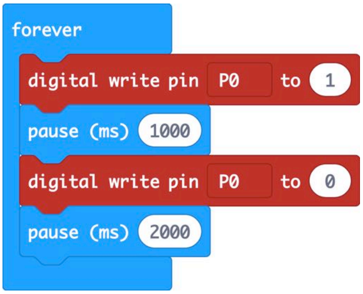


Flash the program *P1 Light House* onto your micro:bit from the following address:

https://makecode.microbit.org/_ft57YJYd7Ky5

Then connect the Relay, battery and light-bulb as shown to the right. This project will make the light bulb blink on and off. You might like to make yourself a cardboard structure as the lighthouse and fix the light bulb on top.

## How it Works



```
forever
    digital write pin P0 to 1
    pause (ms) 1000
    digital write pin P0 to 0
    pause (ms) 2000
```

The MonkMakes Relay for micro:bit is a kind of electronic switch that can use a tiny current provided by the micro:bit's Pin 0 to control a much higher current circuit formed by the battery and bulb.

Here is the code for the project.

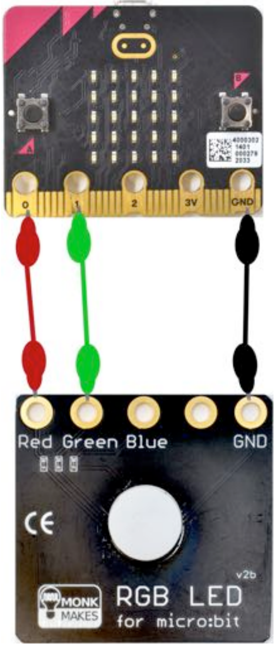
First Pin P0 is turned on using a digital write pin block. The pause block then ensures that it stays on for 1000 milliseconds (1 second) before it is turned off. There then follows another pause of 2 seconds before the cycle repeats itself.

Turning the pin P0 on turns the Relay on that completes the circuit, allowing electricity to flow from the battery through the light bulb, making it light up.

# Project 2. Movement Alarm

## You will need:

- micro:bit
- MonkMakes RGB LED for micro:bit
- Program: *P2 Movement Alarm*



Flash the program *P2 Movement Alarm* onto your micro:bit from the following address:

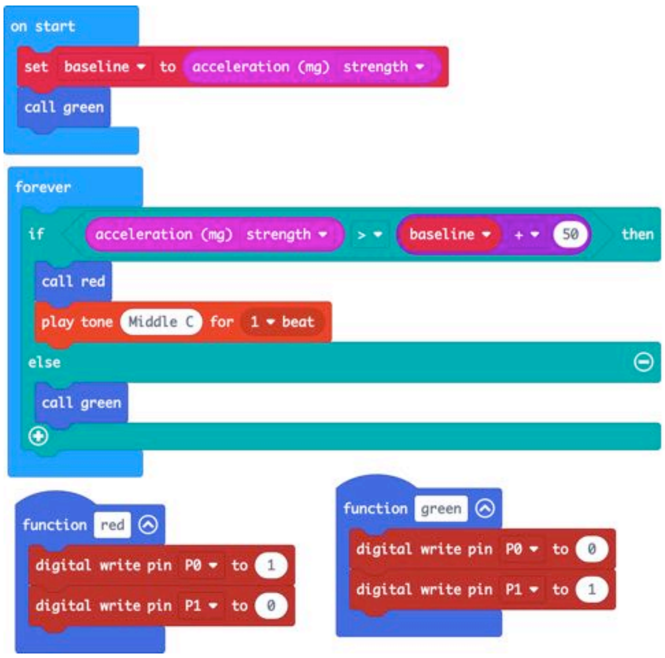
https://makecode.microbit.org/_4Ej08FdLFfku

Then connect the RGB LED as shown to the right.

Try moving your micro:bit. As soon as you do, you should hear a tune start to play to indicate that the alarm has been triggered and the RGB LED color will change from Green to Red.

## How it Works

The program uses the micro:bit's built in accelerometer to measure any force acting on it as a result of it moving. When the micro:bit starts running the program, the micro:bit is assumed to be completely still and an initial reading is taken (baseline) but when the micro:bit is picked up, the accelerometer reading will change.



```
on start
    set baseline to acceleration (mg) strength
    call green

forever
    if acceleration (mg) strength > baseline + 50 then
        call red
        play tone Middle C for 1 beat
    else
        call green

function red
    digital write pin P0 to 1
    digital write pin P1 to 0

function green
    digital write pin P0 to 0
    digital write pin P1 to 1
```

The forever loop repeatedly reads the accelerometer strength and if it exceeds the baseline reading by 50, the alarm is sounded.

The functions red and green set the RGB LED color to red or green, by writing a 1 or a 0 to the appropriate pins controlling the RGB LED red and green channels.

Try tweaking the number 50 in the if block, to alter how sensitive the alarm is.

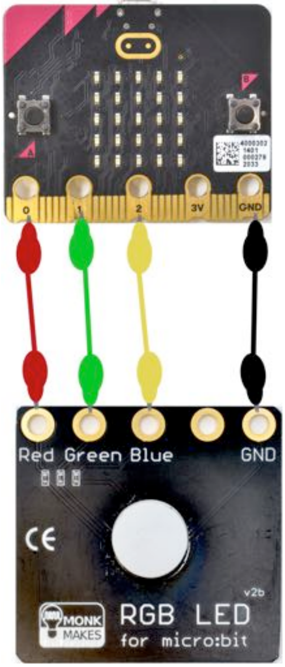
## Project 3. Color Mixer

### You will need:

- micro:bit
- MonkMakes RGB LED for micro:bit
- Program: *P3 Color Mixer*

This project uses the same connections as Project 2, plus one extra wire from Pin 2 of the micro:bit to Blue on the RGB LED. So, if you have just done Project 2, you just need to add the extra wire.

This extra wire is needed because Project 2 only used the red and green channels of the RGB LED, whereas this project uses the red, green and blue.



Flash the program *P3 Color Mixer* onto your micro:bit from the link below. When you tilt the micro:bit, the color of the RGB LED will change.

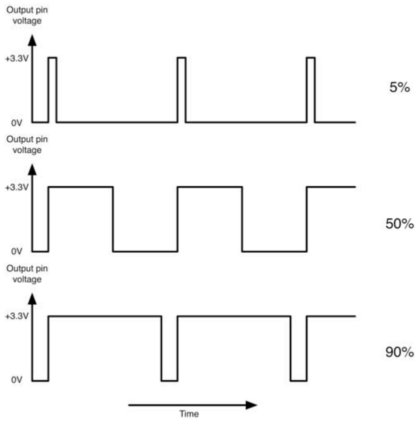
https://makecode.microbit.org/_WyXhYDXe7h6r

### How it Works

In this project, RGB (Red, Green, Blue) LED is used to display different colors by varying the brightness of the red, green and blue channels of the LED. It does this using the three pins of the micro:bit as PWM (Pulse Width Modulation) outputs.

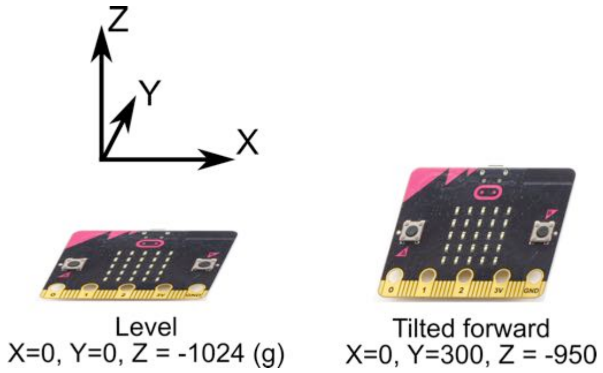
It works by varying the duration of a series of pulses sent the red green and blue channels.

If the pulse is only high for a very short time (say 5% of the time) then only a small amount of power is delivered to that



LED color, so it will be dim. The more time the pulse is high, the more power is delivered to the LED color and the brighter it will be.

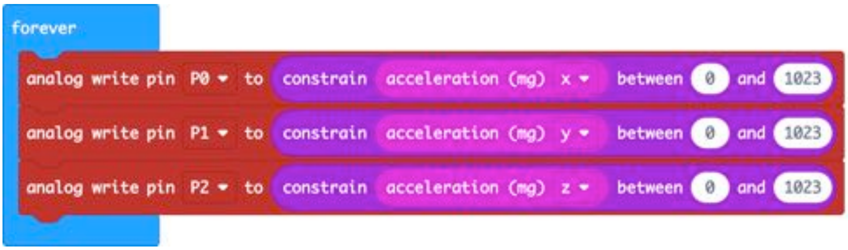
The accelerometer measures forces acting on the micro:bit in the x, y and z dimensions.



Because gravity is acting on the micro:bit then if the micro:bit is completely flat, then the there will be the gravitational force on the Z dimension (up/down) but no forces in the X (left/right) or Y (front/back). However, as soon as you tilt the micro:bit, some of the gravitational pull will be felt on the Y and Y dimensions too.

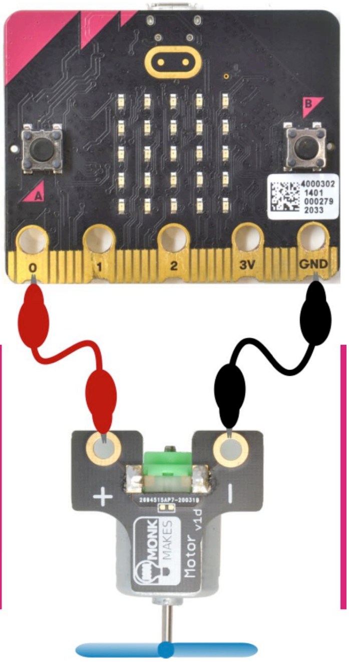
The code reads the X, Y and Z forces separately and uses them to control the brightness of the red, green and blue channels respectively.

The constrain block ensures that if the output brightness of each channel does not exceed the maximum value of 1023, or go negative.



```
forever
    analog write pin P0 ▾ to constrain acceleration (mg) x ▾ between 0 and 1023
    analog write pin P1 ▾ to constrain acceleration (mg) y ▾ between 0 and 1023
    analog write pin P2 ▾ to constrain acceleration (mg) z ▾ between 0 and 1023
```

# Project 4. Anemometer



## You will need:

- micro:bit
- Motor and Fan
- Program: *P4 Amenometer*

An anenometer is an instrument for measuring wind speed. In this case, it's going to measure how hard we can blow onto the fan blades.

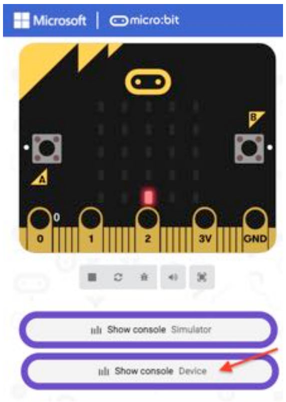
WARNING: Flash the program *P4 Anenometer* onto your micro:bit **BEFORE** connecting up the motor. Failure to do so could damage your micro:bit. Also make sure that you connect the motor as show, with the motor's + connection to micro:bit pin 0.

Also, this project if fine for lung power, but a very high speed of rotation could damage your micro:bit.

The program for this project is here:

https://makecode.microbit.org/_5KA4KjFhE6z4

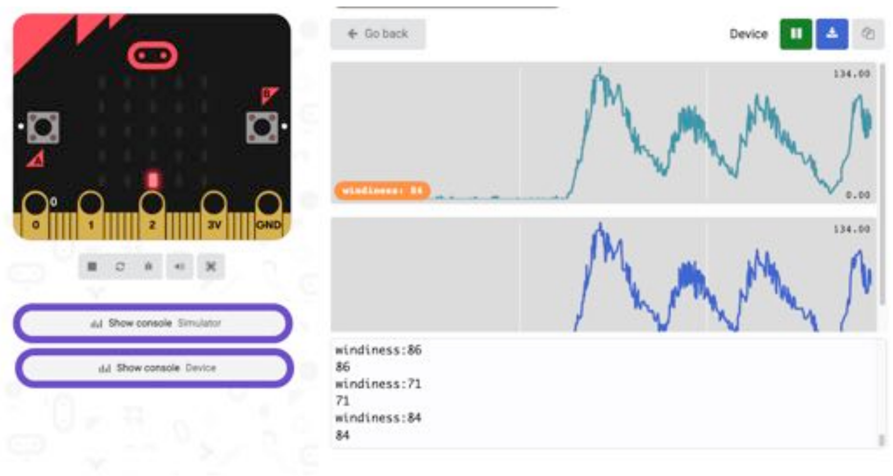
Blow hard on the fan blade so that they rotate and you should see the micro:bit's display lighting up more, the harder you blow.



You can also see a graph of the air speed by clicking on the Show console Device button.

This button only appears if you have paired your micro:bit with your computer (see Page 7).

When you click on the *Show console Device* button, you will see a live chart showing the wind speed readings.

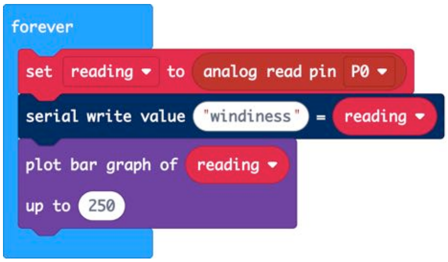


```
windiness:86
86
windiness:71
71
windiness:84
84
```

Each set of peeks corresponds to a strong blow onto the fan blade. You could use this to measure the maximum speed to see who can blow the hardest.

## How it Works

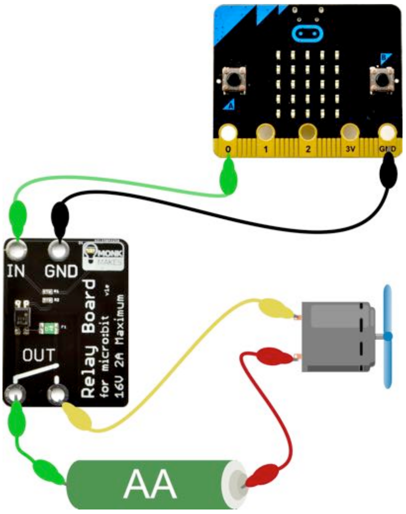
D.C. Motors like the one in this kit, can act as both motors and generators. They are not very efficient and only generate a small amount of power. The voltage that the motor generates will be higher, the faster the fan blades spin.



```
forever
    set reading to analog read pin P0
    serial write value "windiness" = reading
    plot bar graph of reading
    up to 250
```

The forever block uses analog read pin P0 to measure the voltage on pin 0. This number is theoretically (between 0 and 1023), but in practice, unless the fan blade is exposed to hurricane force winds, the maximum reading will be around 250. This number is then sent to your computer over USB using the serial write value block and then a bar graph of the value is shown on the micro:bit display.

# PROJECT 5. FAN SPEED CONTROLLER



## You will need:

- micro:bit
- MonkMakes Relay for micro:bit
- AA Battery holder and battery
- Motor with fan attached
- Program: *P5 Fan Speed*

In this project you will use the motor again, but this time as a motor rather than a generator.

Flash the program *P5 Fan Speed* onto your micro:bit from the web address below:

https://makecode.microbit.org/_UeML9o6bTWhV

Connect up the components as shown to the right. Note it doesn't really matter which way around the motor leads are connected. Reverse them and the motor direction will reverse.

The micro:bit display will show a number between 0 and 9 indicating the fan's speed. Use button B (on the micro:bit) to increase the speed and button A to decrease the speed.

## How it Works

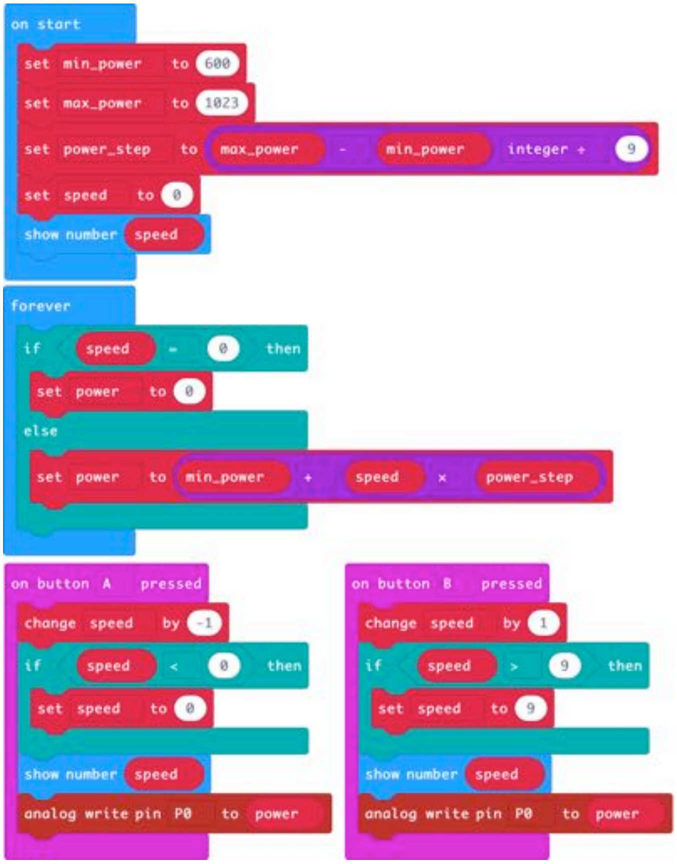
This project uses the MonkMakes Relay to provide pulses of power of varying length to the motor using PWM (see Project 3).

The code is the most complicated so far. It uses quite a few variables that are defined in the *on start* block.

- min_power – This should be set to the minimum power output value that makes the motor just start to turn. This varies a bit between motors. Try the default value of 600, but if the motor doesn't turn when you press button B to set the speed to 1, you may need to increase this value to perhaps 700 or more.

- max_power – This is the maximum power, you can leave this as 1023
- power_step – This is the power range divided by 9 and will be the amount of power change that results from one step more of speed.
- Speed – The speed from 0 (off) to 9 (maximum)

The forever loop is used to continuously set the power level to match the speed. The case of the speed being 0 is treated as a special case, to set the power to 0, otherwise the motor may buzz without actually turning when the speed is 0.



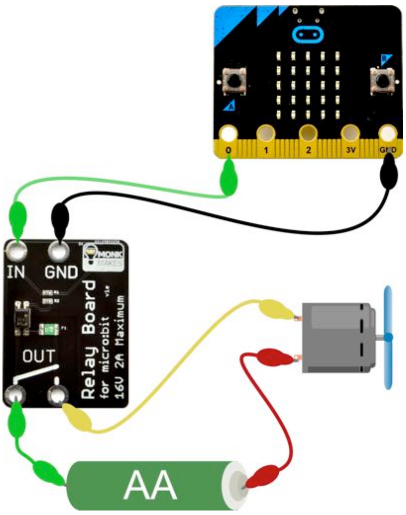
```
on start
    set min_power to 600
    set max_power to 1023
    set power_step to max_power - min_power integer ÷ 9
    set speed to 0
    show number speed

forever
    if speed = 0 then
        set power to 0
    else
        set power to min_power + speed × power_step

on button A pressed
    change speed by -1
    if speed < 0 then
        set speed to 0
    show number speed
    analog write pin P0 to power

on button B pressed
    change speed by 1
    if speed > 9 then
        set speed to 9
    show number speed
    analog write pin P0 to power
```

The on button pressed blocks are very similar to each other. The block for button A subtracts 1 from *speed* while making sure that *speed* does not fall below zero and then displays the new *speed* and uses analog write to set the power output of pin 0. The on button pressed for B does the same kind of thing, but adding 1 to speed.

## Project 6. Clap Controlled Fan

### You will need:

- micro:bit
- MonkMakes Relay for micro:bit
- AA Battery holder and battery
- Motor with fan attached
- Program: *P6 Clap Controlled Fan*



This project uses exactly the same wiring as Project 5, but uses the micro:bit 2's built-in microphone to toggle the motor on and off when a loud noise such as a clap is detected.

Clap once to start the fan and then clap again to turn it off.

Follow this link for the code for this project:

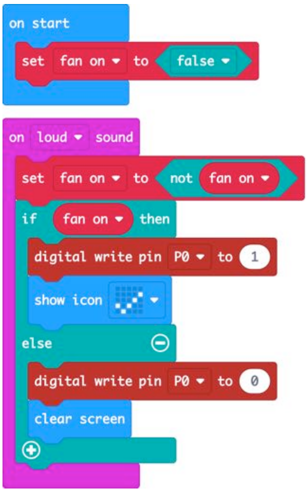
https://makecode.microbit.org/_LszHsFf37P0u

### How it Works

The Relay controls the separate circuit of the battery and fan, just like Project 1. The variable fan on is used to control whether the fan is running or not. Initially, this is set to false.

When a loud sound is detected, the on loud sound block is run. This first uses the not block to set fan to true if it is false and false if it is true, the value of fan on  is then used to decide whether to turn the pin 0 (that controls the Relay) on or off (1 or 0).

This project would work just as well with the LED lamp, but make sure the + side of the battery goes to the + of the lamp.

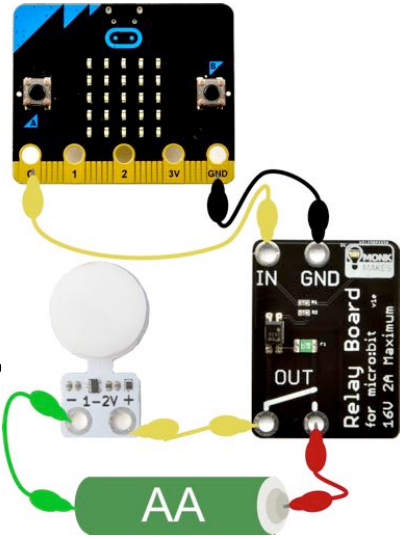


```
on start
    set fan on ▾ to false ▾

on loud ▾ sound
    set fan on ▾ to not fan on ▾
    if fan on ▾ then
        digital write pin P0 ▾ to 1
        show icon ▾
    else
        digital write pin P0 ▾ to 0
        clear screen
```

## Project 7. Nightlight

### You will need:

- micro:bit
- MonkMakes Relay for micro:bit
- AA Battery holder and battery
- MonkMakes LED Bulb
- Program: *P7 Nightlight*



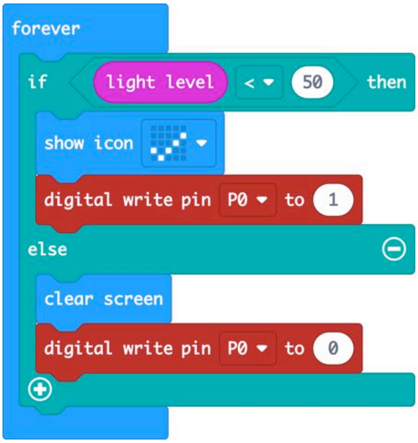
This project uses the micro:bit's built-in light sensor to measure the level of light and when it falls below a certain level, it activates the Relay and turns on the LED lamp.
Hold your hand over the micro:bit's display to simulate it going dark. This should cause the LED lamp to turn on.

You can find the code for this project here:

https://makecode.microbit.org/_YyF41pLhA7wU

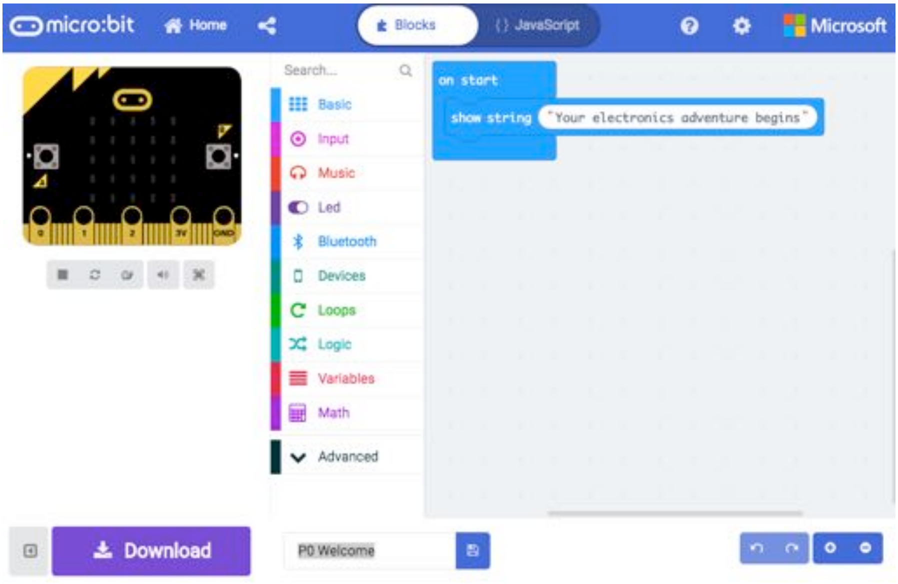
### How it Works

Here's the code for the project. If you want it to be darker before the lamp turns on, then change 50 to a lower number.



```
forever
  if light level < 50 then
    show icon
    digital write pin P0 to 1
  else
    clear screen
    digital write pin P0 to 0
```

# The MakeCode Editor

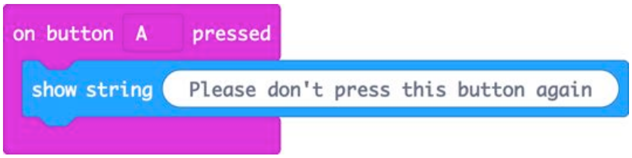


```
on start
    show string "Your electronics adventure begins"
```

One really nice feature of the Blocks editor is that the image of a micro:bit on the left of the screen is a virtual micro:bit that you can run your programs on before flashing them onto the micro:bit. You can press its buttons with your mouse, it will display things and if you used the GPIO pins as digital outputs, it will even highlight them when you write to them. You can also click on GPIO pins to simulate digital and analog inputs. The middle section of the screen has different categories of blocks: Basic, Input, Music etc. where you can find blocks to put onto the right-hand 'canvas' area. You can also use the *Search* box just above the list of block categories if you are not sure where to find the block that you want.

## Events

The JavaScript language that underpins the Block editor uses something called "events". The "on start" block that our welcome message appears in is an example of an "event". The event being that the micro:bit started up, because it was plugged in or its reset button was pressed. Start a new project (by clicking on Projects and then New Project) and delete both the *on start* and *forever* blocks. Add an *on button pressed* (another event) block (in the Input category) and then place a *show string* block inside it and change the text that the *show string* block is to display so that it looks like this.



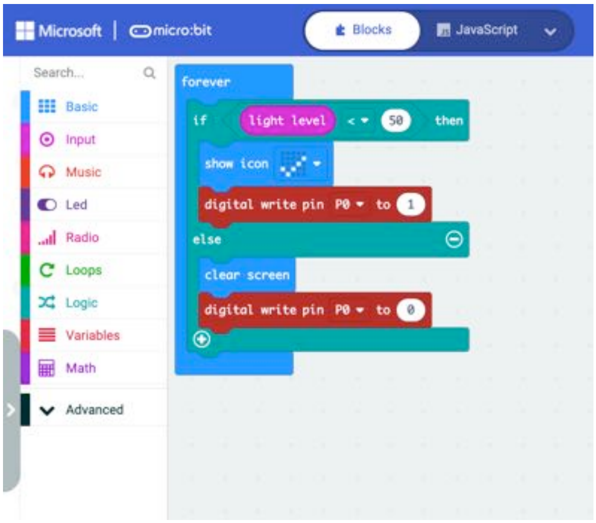
```
on button A pressed
    show string "Please don't press this button again"
```

Now, when you use your mouse to click on button A in the virtual micro:bit it will scroll the message. You could also now try this on a real micro:bit.

## JavaScript and Python

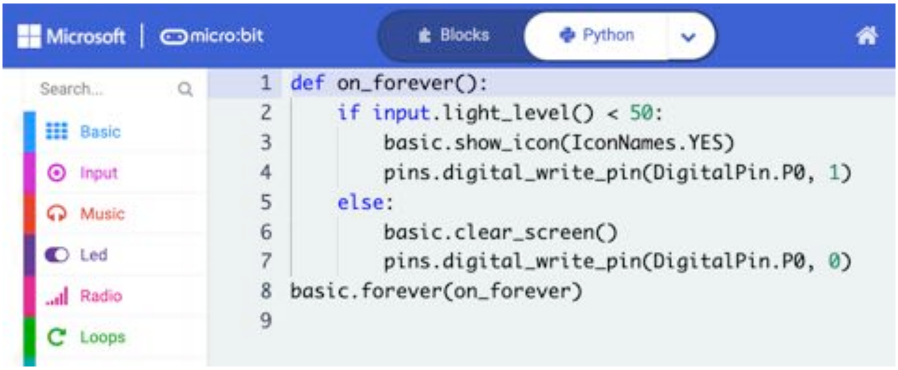
The Blocks editor is primarily for editing your programs as Blocks. But you can also use it to view or edit your programs in JavaScript or Python programming language if you prefer.

To try this out, open the code for Project 7 (Nightlight). Here's the blocks view of the code.



```
forever
    if light level < 50 then
        show icon
        digital write pin P0 to 1
    else
        clear screen
        digital write pin P0 to 0
```

You will notice that at the top of the window, there is a tab button labelled JavaScript. This has a drop-down list that you can set to either JavaScript or Python. If you set the dropdown to Python, the blocks disappear from the editor area and the equivalent Python code will be shown.



```
def on_forever():
    if input.light_level() < 50:
        basic.show_icon(IconNames.YES)
        pins.digital_write_pin(DigitalPin.P0, 1)
    else:
        basic.clear_screen()
        pins.digital_write_pin(DigitalPin.P0, 0)
basic.forever(on_forever)
```

You can if you like edit the code in this Python view and then switch back to the blocks view, and as long as your code is correct, the change you made in Python will appear in the blocks version. For example try changing 50 in the Python code to 40 and then switch back to the blocks view.

You could if you prefer simply write all your code in the Python (or JavaScript) versions of the editor, and you can even drag blocks from the palette into your code where they will appear as Python code.

## Troubleshooting

**Problem**: I can't flash a program onto my micro:bit

**Solution:** First check that the micro:bit's power LED is lit. If it isn't try a different USB port or USB lead. If the micro:bit is receiving power, but you can't see the micro:bit drive on your computer, then you may be using a 'power only' USB cable. Try a different cable.

**Problem**: The LED isn't lit on the MonkMakes Relay for micro:bit even though I think it's connected correctly.

**Solution:** This is normal. The LED on the Relay will only light when the relay is activated.

**Problem**: The project doesn't work, but I'm pretty sure I have the right program uploaded and all the wiring looks good. What can I do?

**Solution:** If you have checked everything and can't find a problem, then it is possible that one of the alligator leads is broken – this can happen if they are over-flexed. Try and think about which lead might be faulty. For example if the LED in the MonkMakes logo for the Sensor or Speaker are not lit, then try swapping out the power leads (3V and GND) from the micro:bit.

**Problem**: The LED bulb does not light. Make sure that you have the polarity correct, using the wiring diagram and if that does not work, try a fresh AA cell.

For other support questions, please check out the product's web page (http://monkmakes.com/mb_kit_2) and you can send support questions to support@monkmakes.com

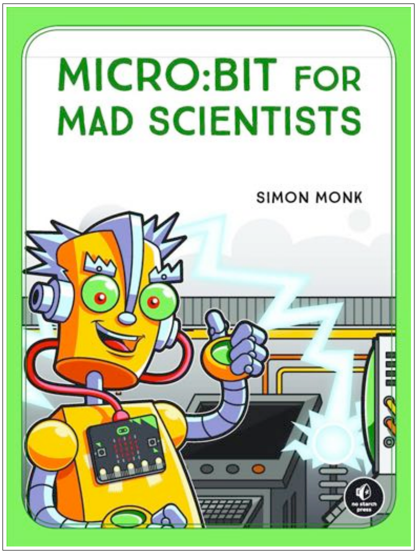
## What Next?

### micro:bit Programming

If you want to learn more about programming the micro:bit in Python, then you should consider buying Simon Monk's book 'Programming micro:bit: Getting Started with MicroPython', which is available from all major book sellers.

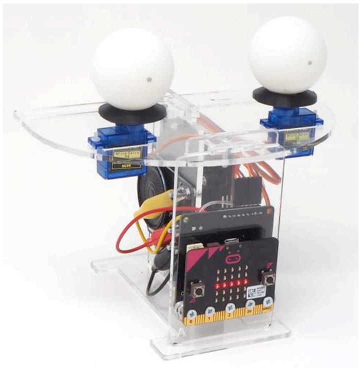
For a micro:bit project book, take a look at micro:bit for Mad Scientists.Both books are available from Amazon and all good book stores.

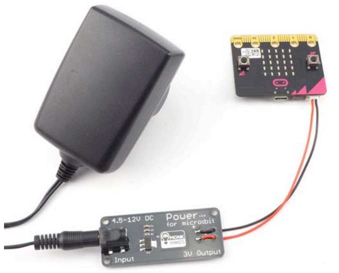
You can find out more about this and other books by Simon Monk (the designer of this kit) at: http://simonmonk.org or follow him on Twitter where he is @simonmonk2

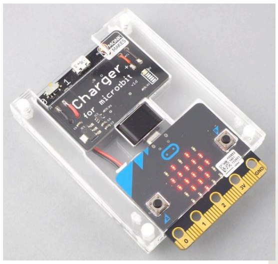


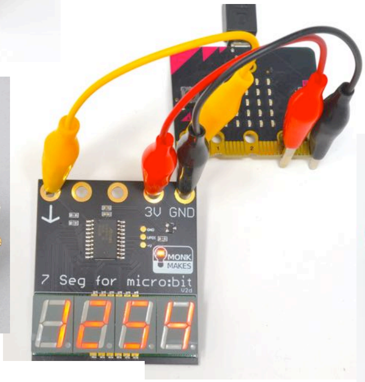
# MonkMakes

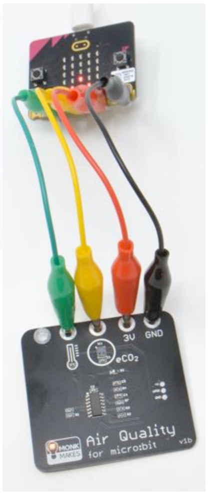
For more information on this kit, the product's home page is here:
https://monkmakes.com/mb_kit_2

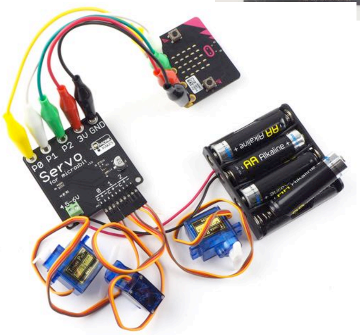












As well as this kit, MonkMakes makes all sorts of kits and gadgets to help with your micro:bit and Raspberry Pi projects. Find out more, as well as where to buy here: https://monkmakes.com you can also follow MonkMakes on Twitter @monkmakes.