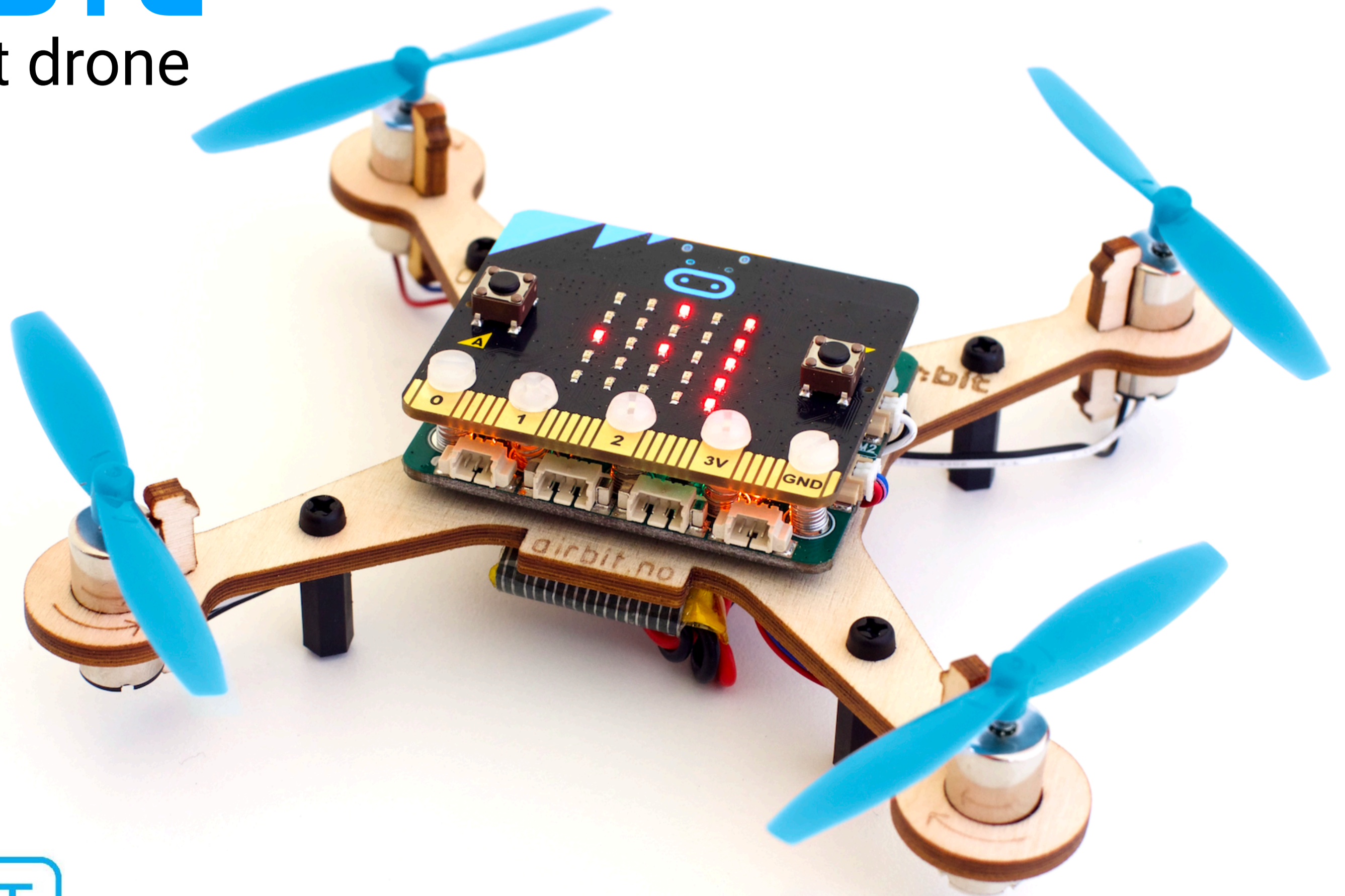


Air:bit

The micro:bit drone



If you experience trouble getting the air:bit to fly, please see page 56.

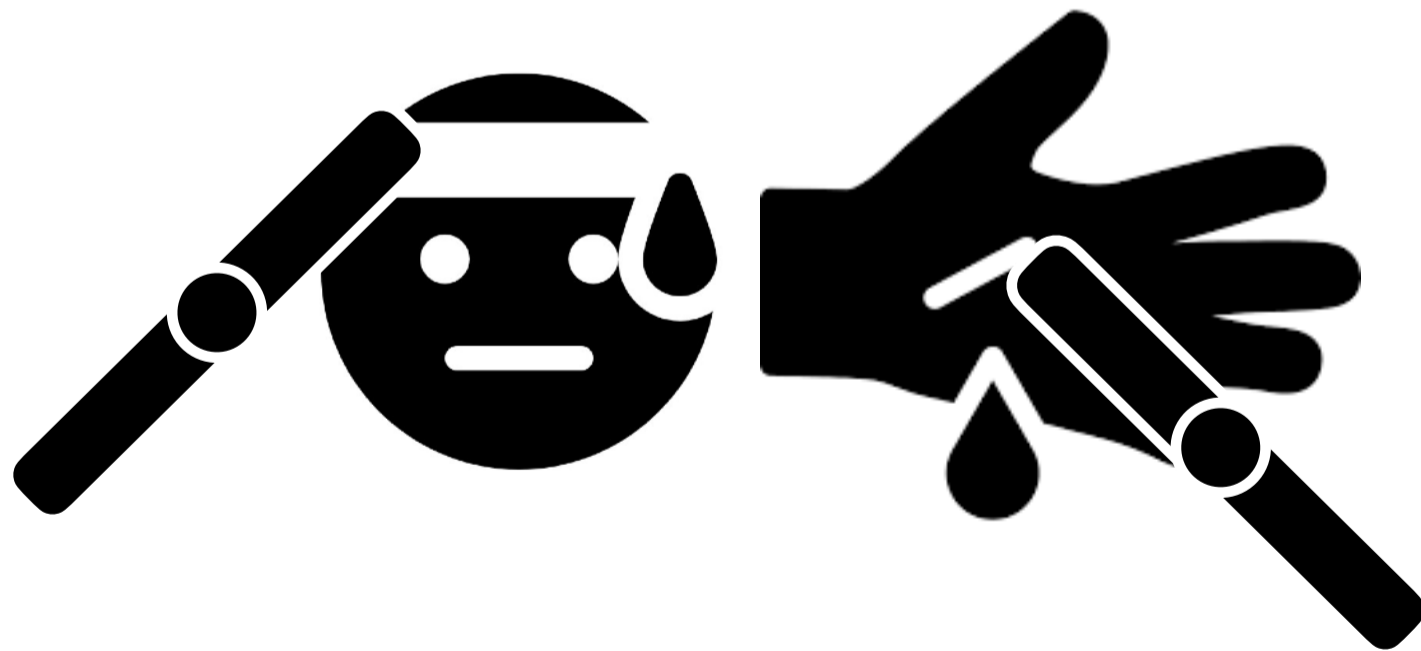


Safety warning

Fast rotation propellers can hurt humans and animals

To prevent injury, do:

- Mount the propellers at after all building and coding is done. Test that you can start and stop motors (shake to stop)
- Keep a distance when arming and flying the drone.
- Children under 8 years and animals must be kept at a safe distance, at least 5 meters away even indoors.
- Use propeller protector if possible
- Follow local FAA regulations



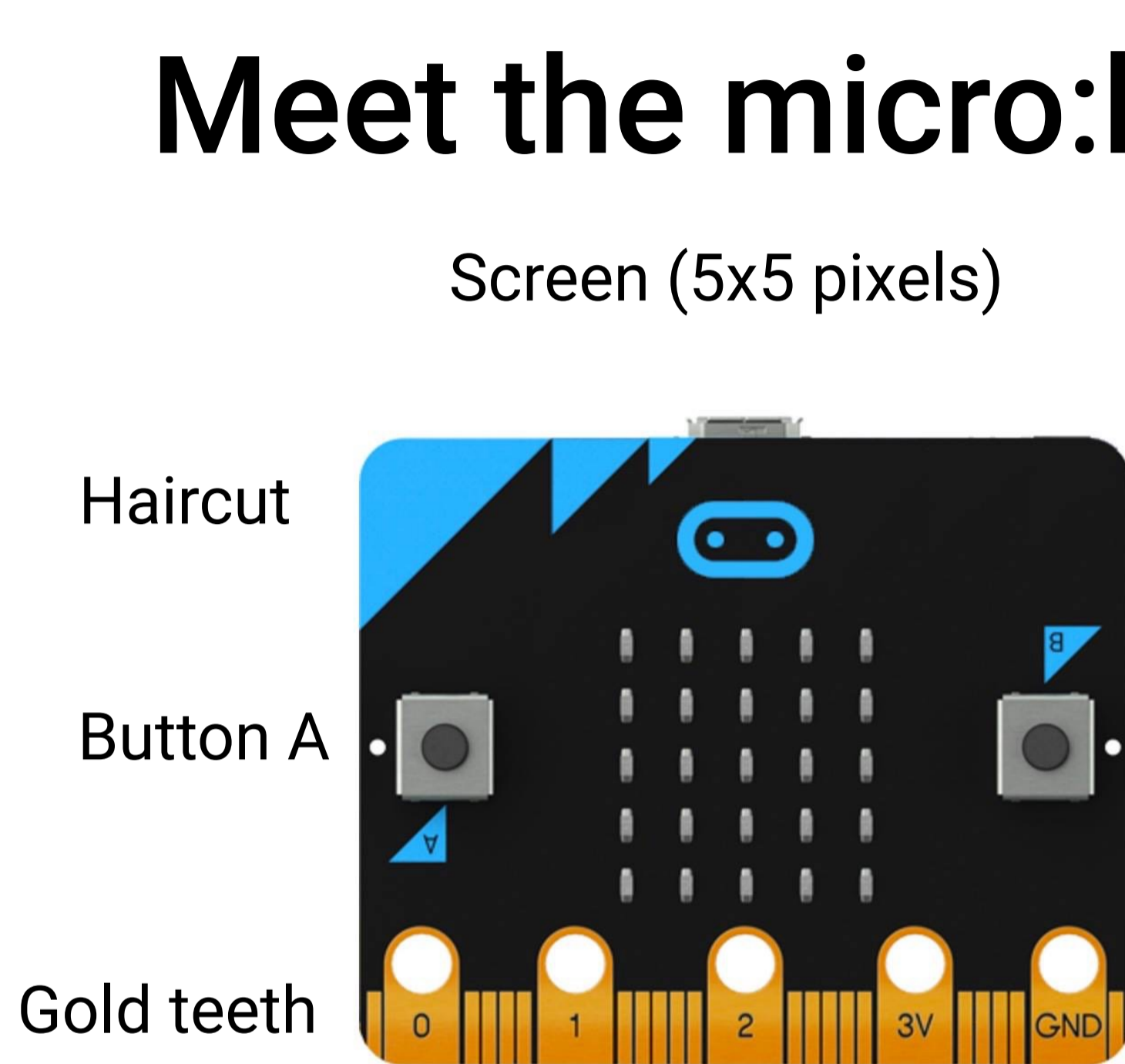
Lithium batteries can release smoke or cause a fire

To prevent damage, do:

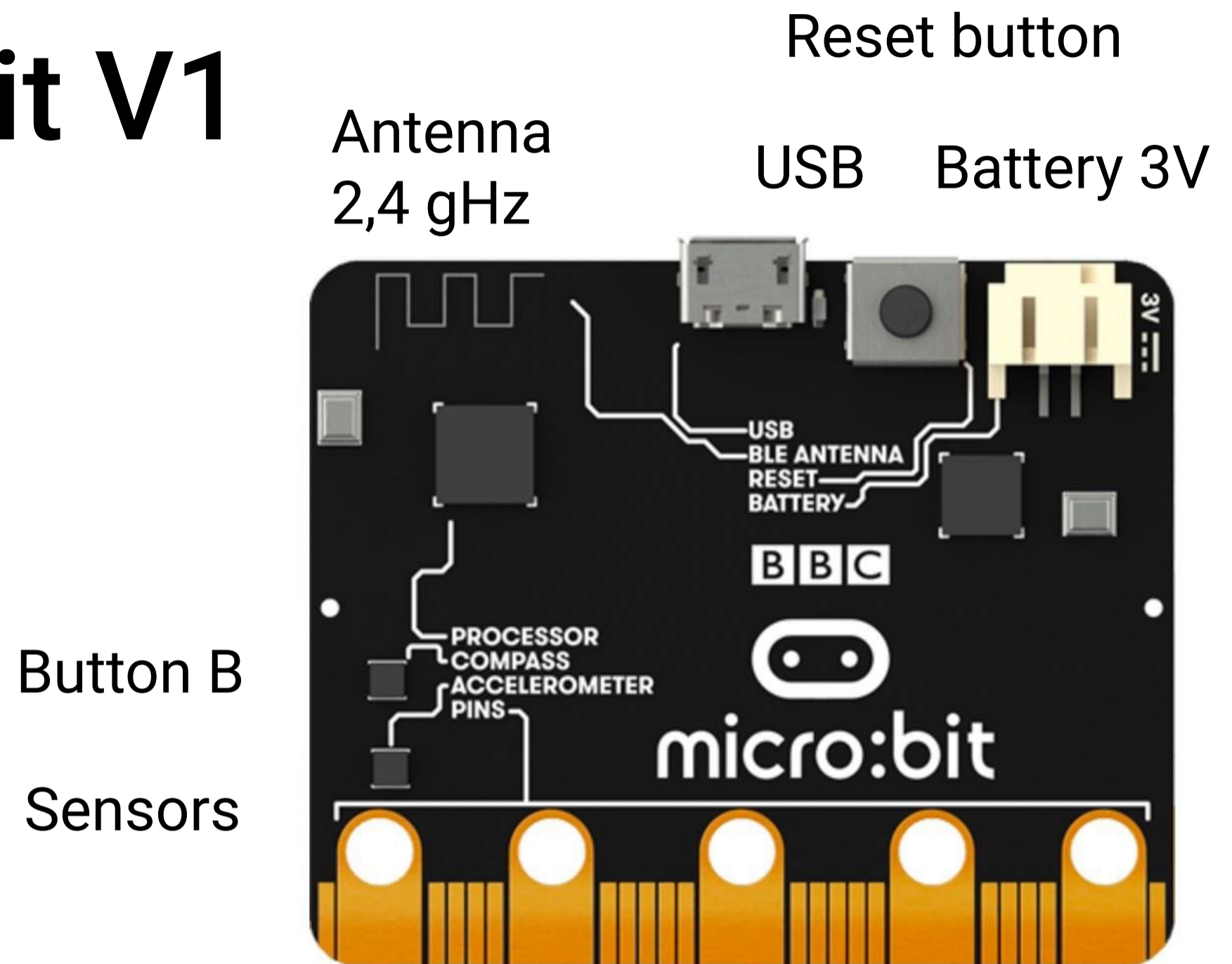
- Don't charge the batteries unattended
- Don't use a damaged or punctured battery
- Do not short circuit the battery
- Avoid temperatures below -10 and above 50 degrees celcius.
- Don't use batteries that are colder than 15 degrees celcius
- Always have a plan for what to do in case of a fire: If you are indoor, open a window and get the battery outside to prevent smoke or fire.
- Do not open or modify the battery in any way.
- For optimal performance, store the battery at around 30% capacity and between 10 and 20 degrees celcius
- Follow airport regulations for carrying lithium batteries on airplanes. (Usually hand luggage only)



Meet the micro:bit V1



Front



Backside

micro:bit is a small computer with processor, sensors, display and radio. It has connection pins for external components like LEDs, speakers or various sensors.

You can learn more at: <https://tech.microbit.org/hardware/>

Air:bit

micro:bit drone

micro:bit with
Microsoft
make:code

Screen showing flight
directions and battery
status

Nylons screws/
spacers M3

6 layers
"unbreakable"
birch plywood

Air:bit control
board with charger

Propeller:
Gemfan 65mm
Polycarbonate

Expansion ports:
Servo, kamera, i2c,
serial (jst picoblade)

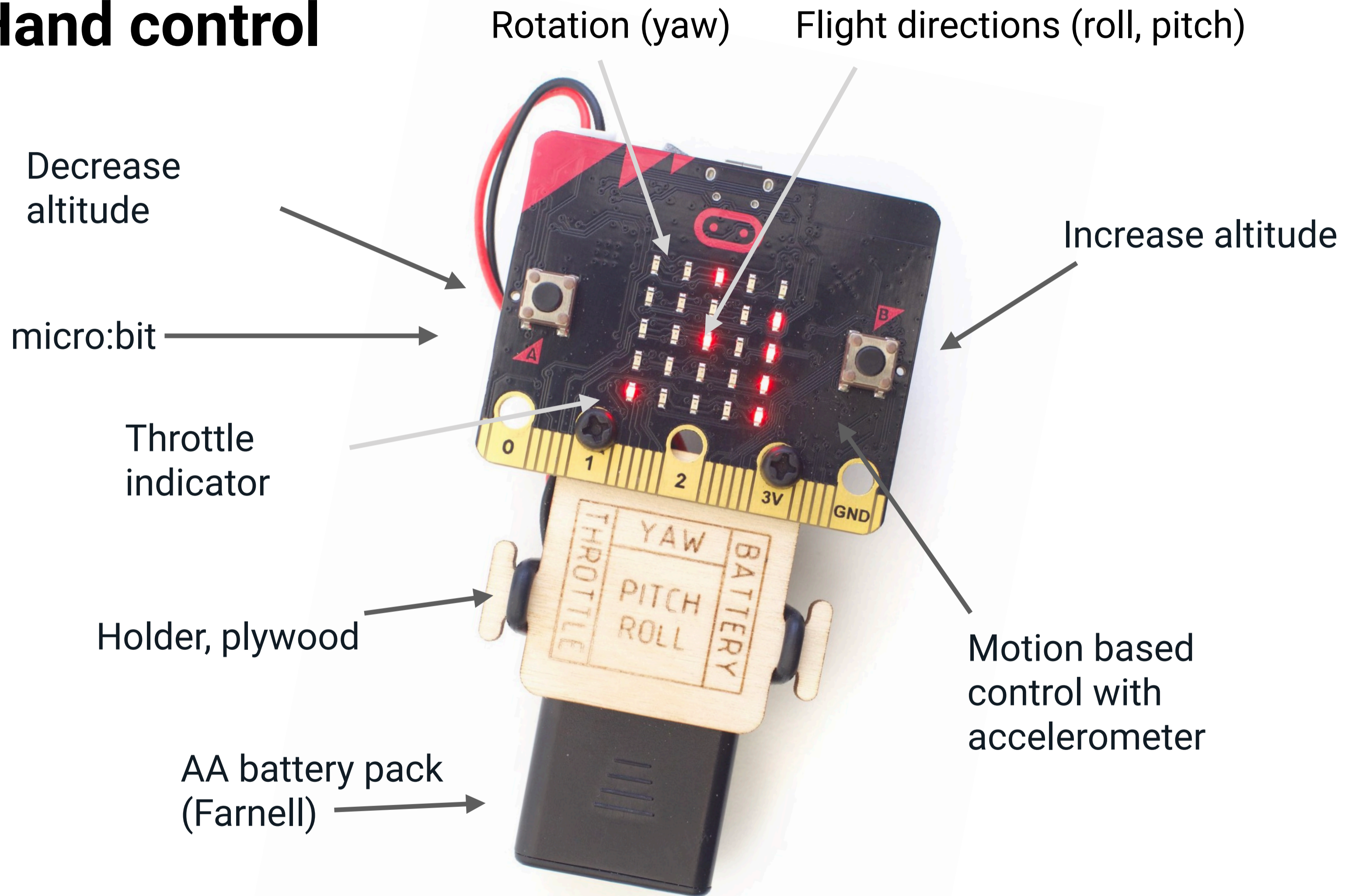
1 cell 3,7v
800 mAh
LiPo-battery

10x20mm
coreless
dc-motors 3.7v
(replacable)

More info: Visit airbit.no



Hand control



Control board

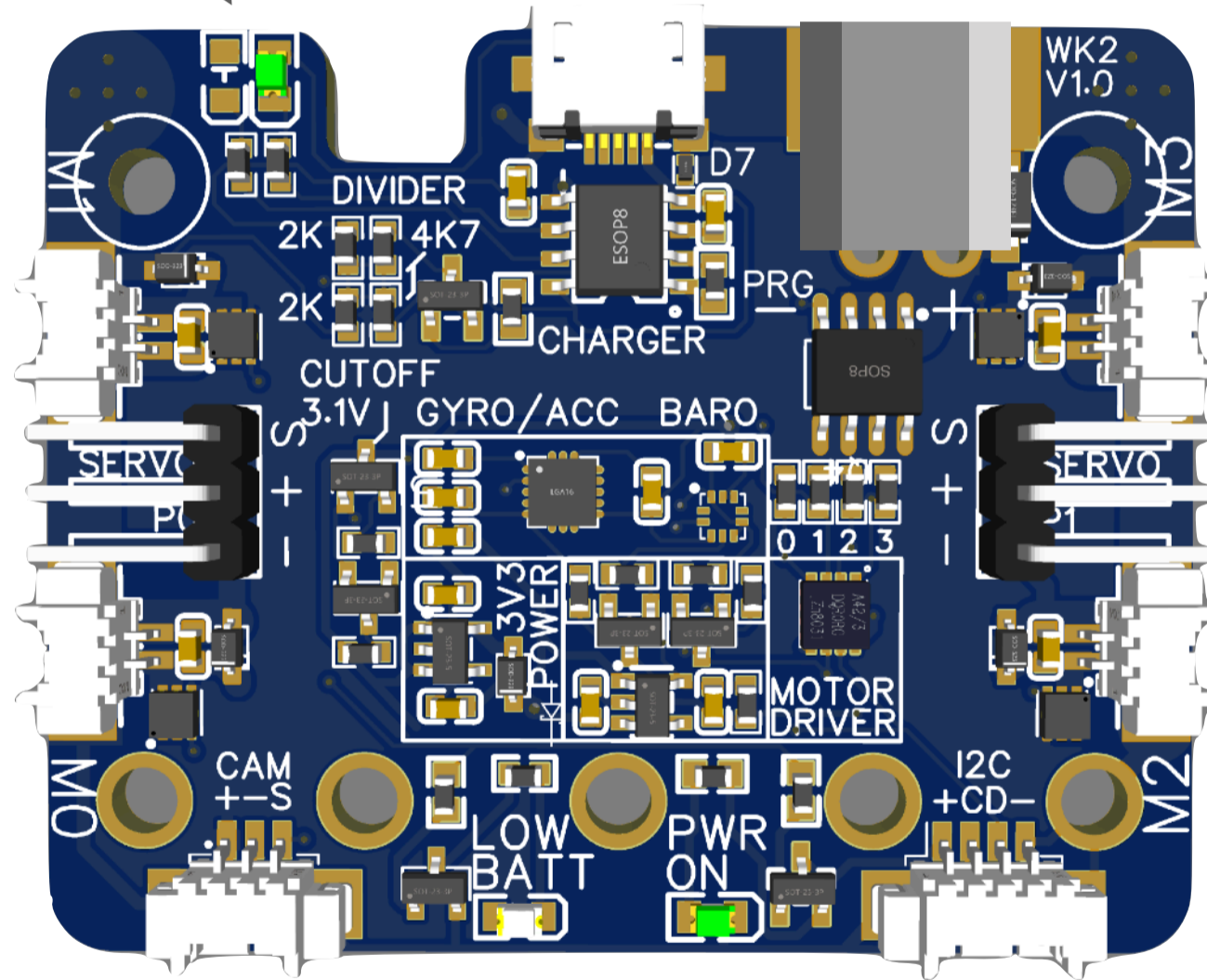
By MakeKit

USB power
(charging)

Red: Charging
Green: Finished

Battery plug

Front-left motor
Servo connector
Back-left motor



Front-right motor
Servo connector
Back-right motor

Micro
servo/
camera

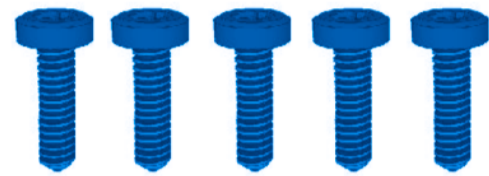
i2c (sensors)

Parts

Note: CW means Clockwise rotation, CCW means counter clock wise



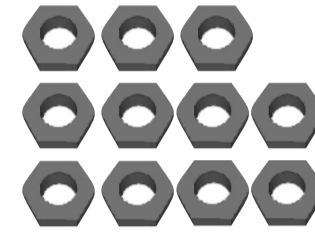
6 nylon screw m3x8



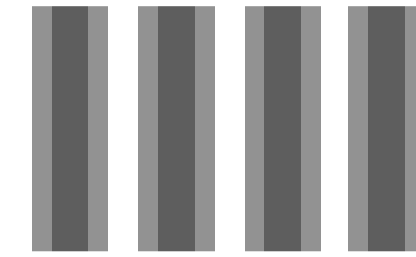
5 nylon screw m3x12



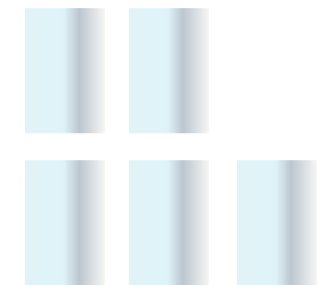
2 nylon screw countersunk



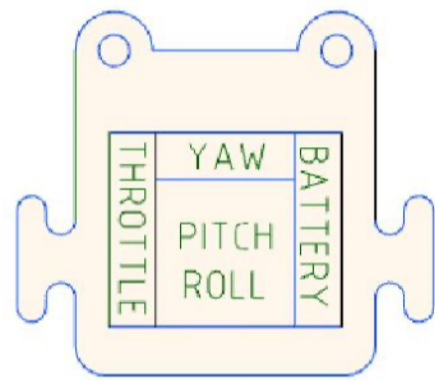
11 nylon nuts



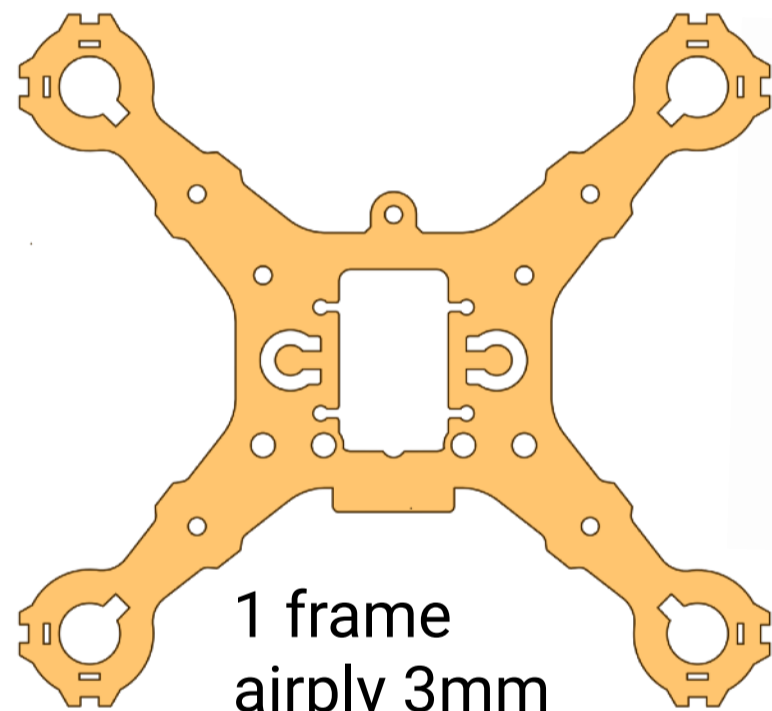
4 spacers m3x20



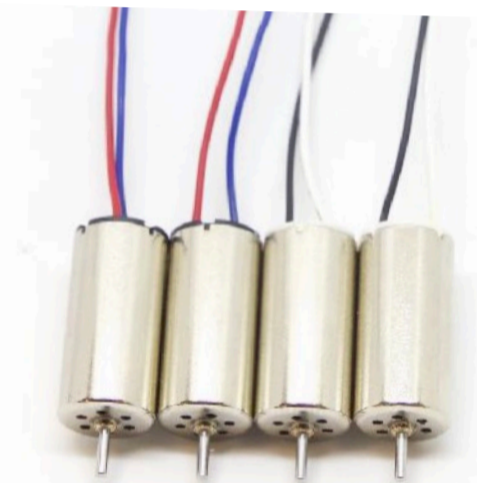
5 aluminium Spacer rings



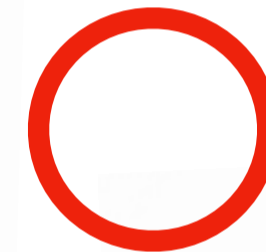
remote-holder



1 frame airply 3mm



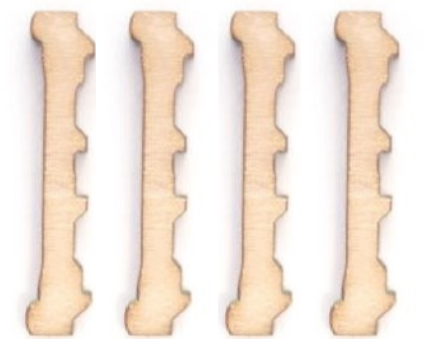
Motors: 4 CW/CCW



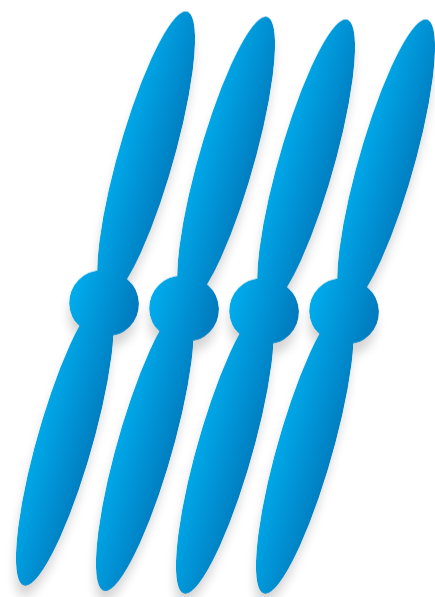
Red silicone ring



Rubber Band



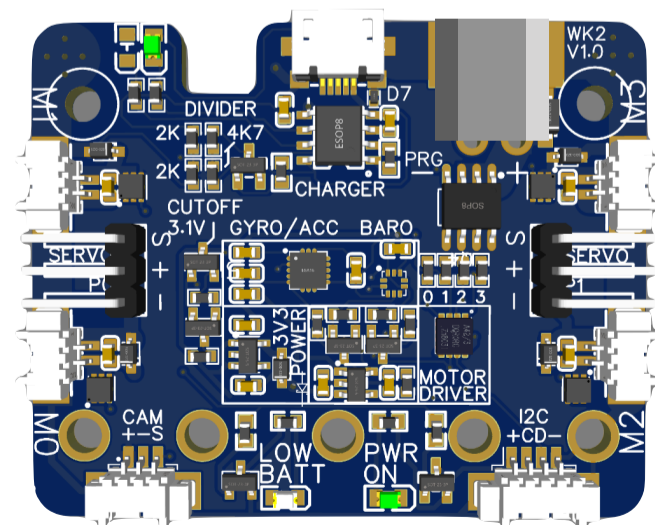
4 wedges



4 propeller (+4 spares)
4 CW, 4 CCW



1 Lithium (LiPo)-battery



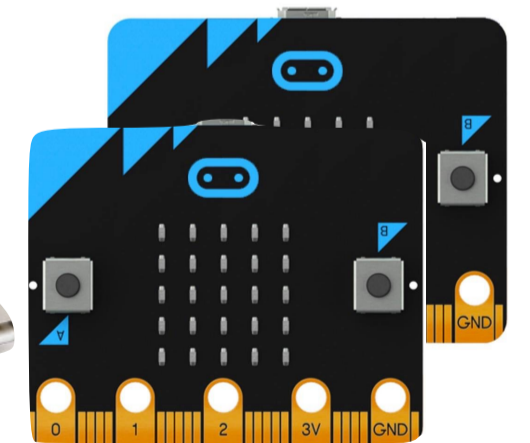
Control board



Micro:bit battery box*



1 micro usb cable*



2 micro:bits*

*the universal microbit parts usually sold separately

Tools

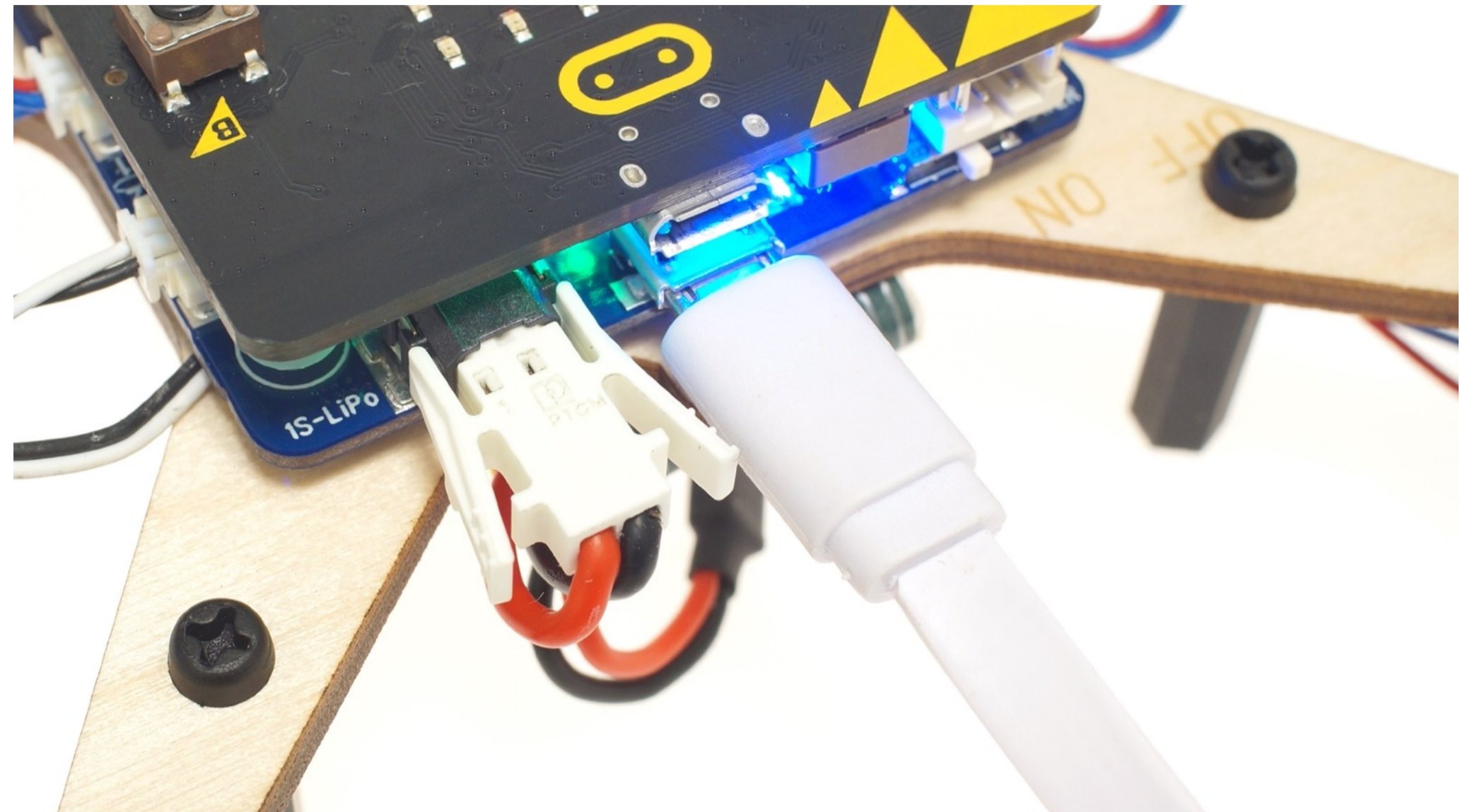
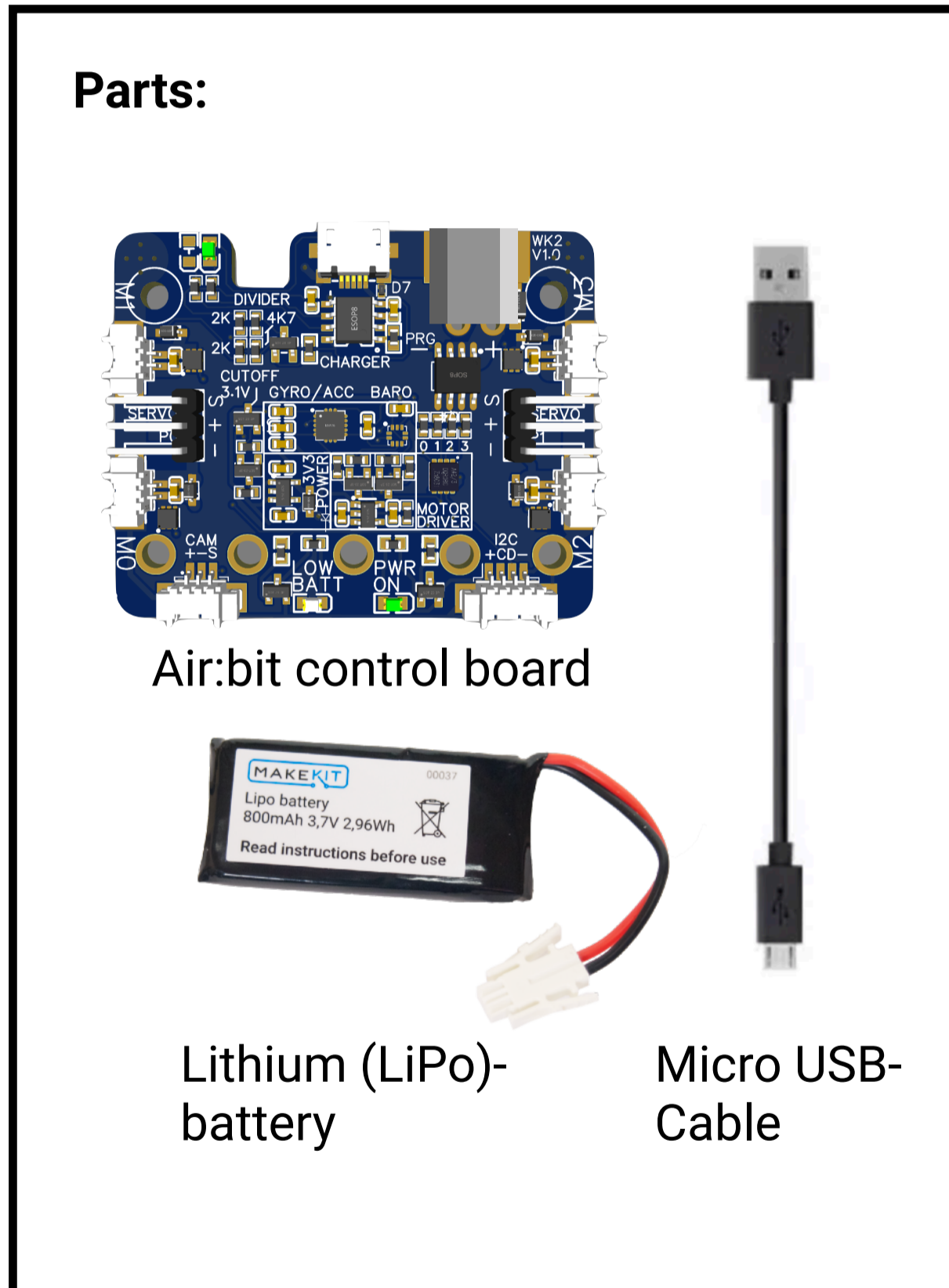


Small philips
screwdriver



Socket wrench
5.5mm (included)

Charging



1. The battery can be charged with or without the micro:bit connected.
2. Plug the big white battery plug into the grey connector
3. Connect the micro USB into the Airbit control board (not the microbit)
4. Connect the other end into a USB charge outlet
5. Red light indicates charging. Green light indicates charging finished. It takes about 1 hour to charge.
6. To prevent battery drain, always unplug battery when not in use!

**Fire hazard:
Never charge a Lithium battery unattended!**



Assembly

Assemble the remote

Tools: Philips Screwdriver

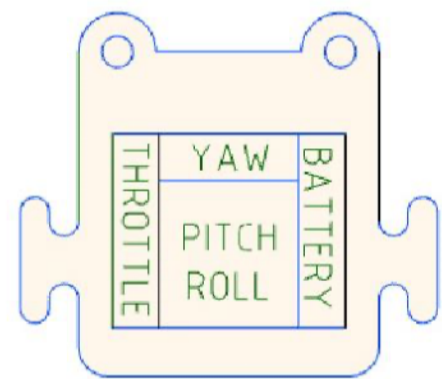
Parts:



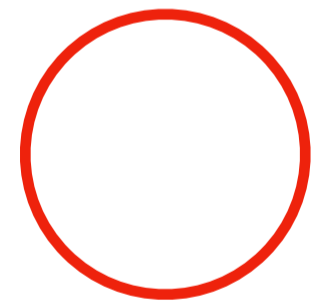
2 nylon screw
m3x8



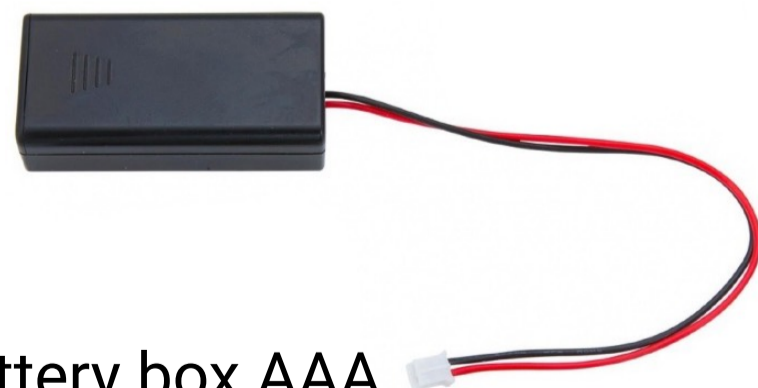
2 nylon
nuts m3



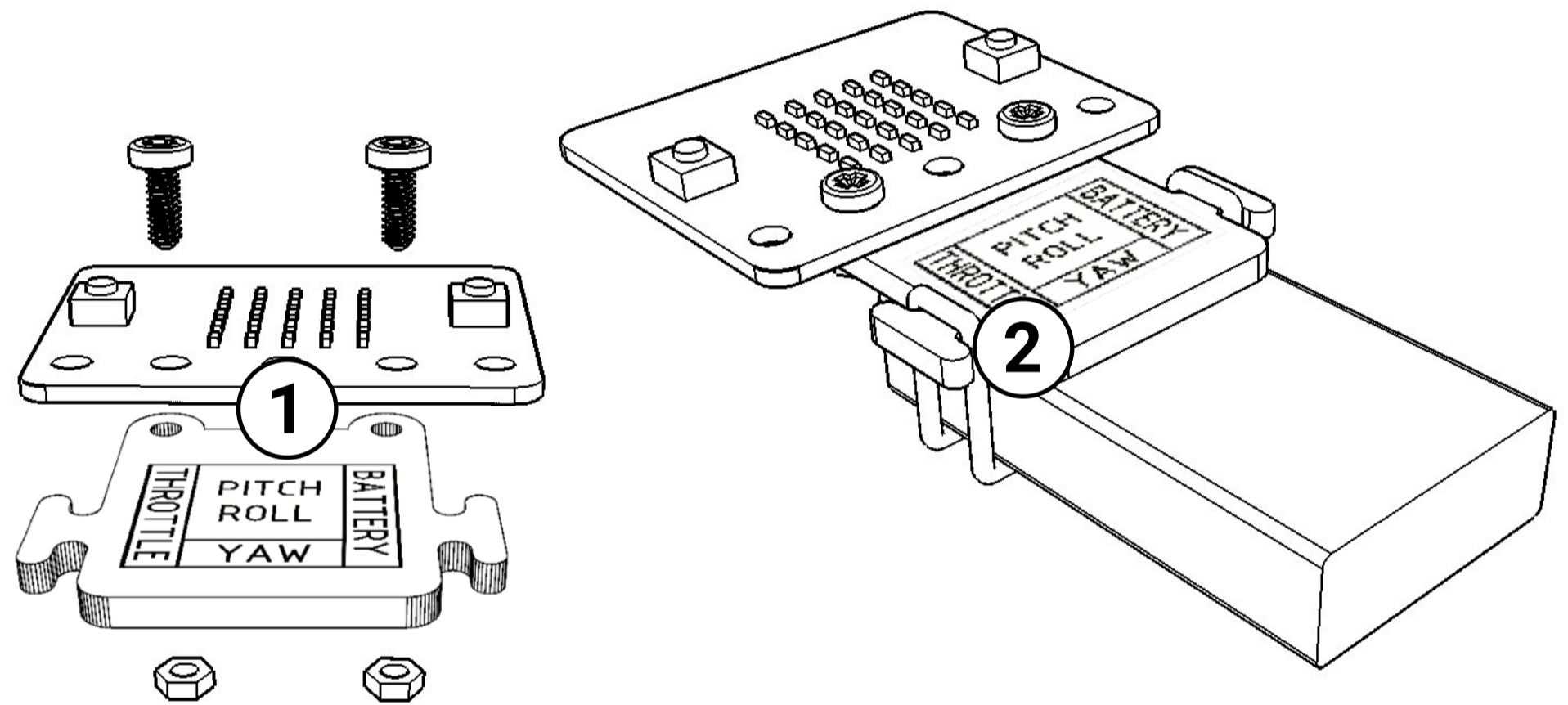
Remote holder



Red silicone ring



Battery box AAA




- Place the micro:bit with screen facing up on top of the holder (1)
- Mount battery box with the silicone ring (2)
- You can use different battery boxes


Mounting the frame

Tools: Philips Screwdriver

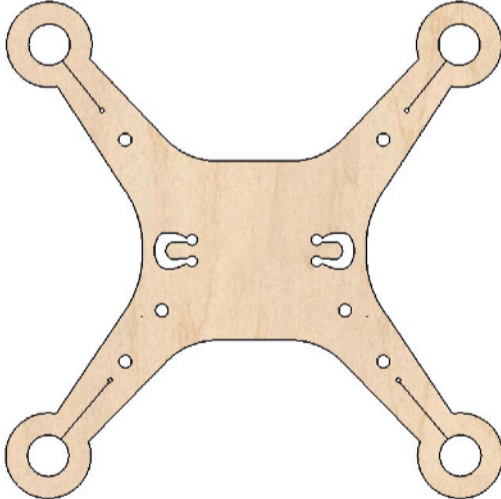
Parts:




4 stk nylon screws m3x8



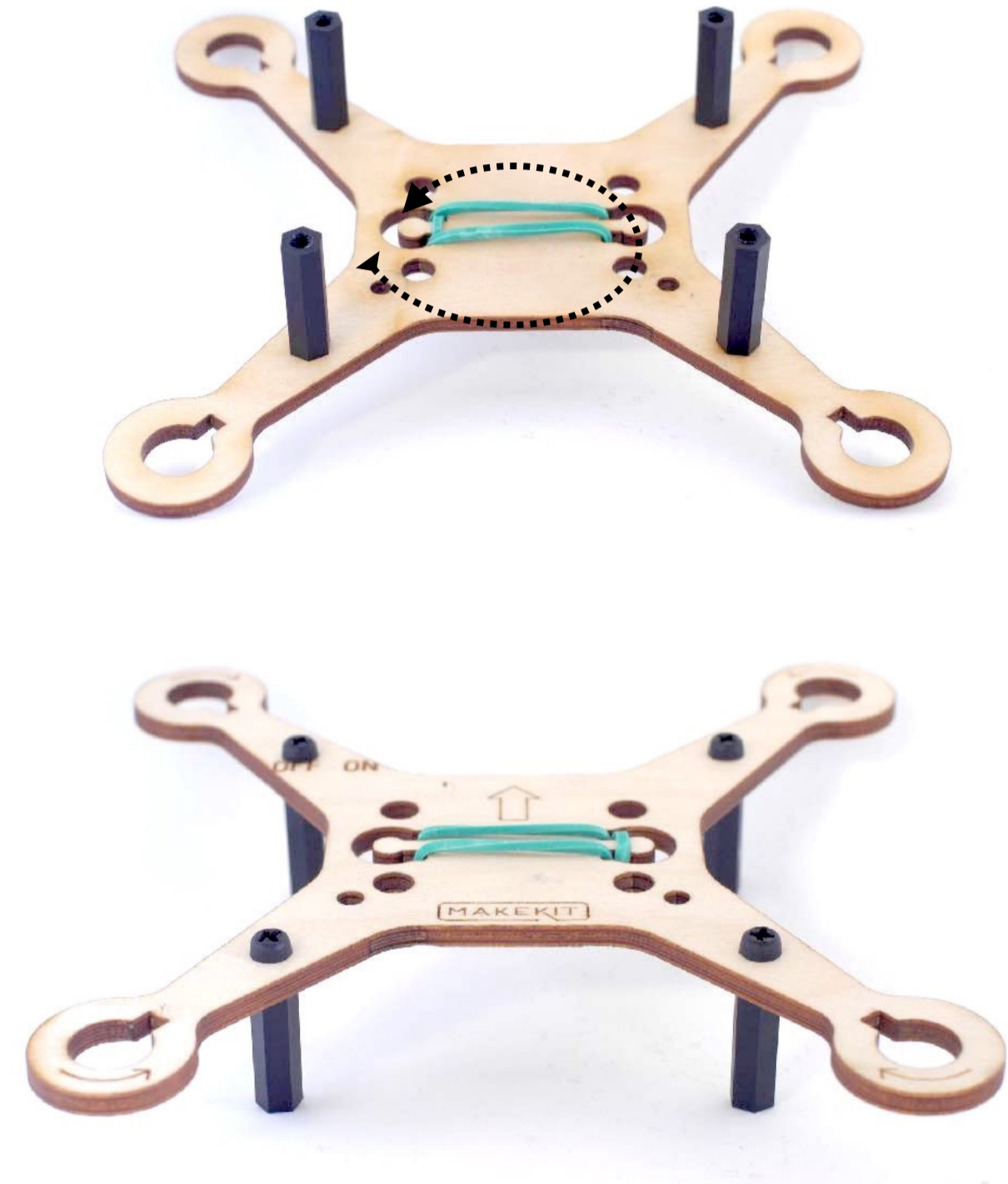
4 spacers m3x20



Center frame

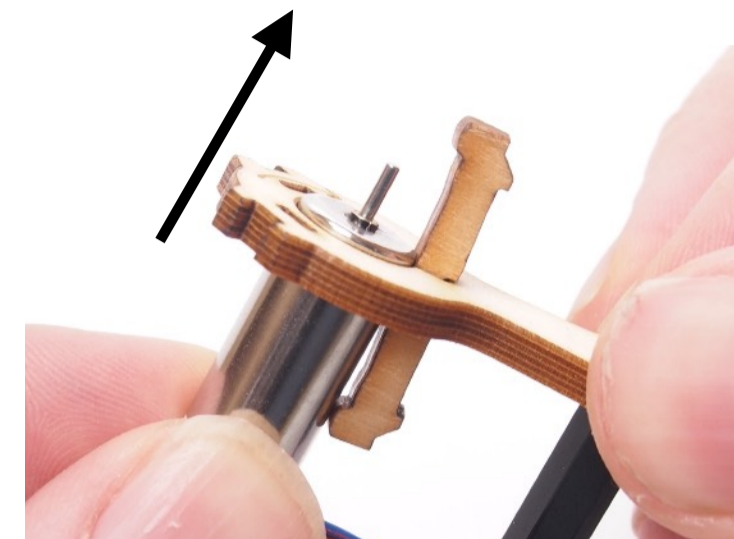


Rubber band

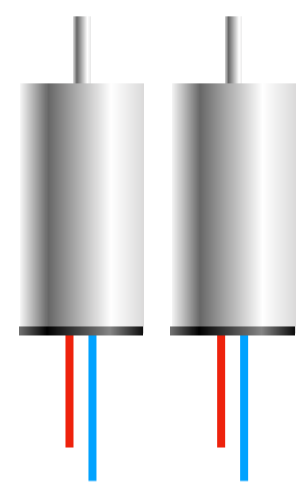


- Hook the rubber band from one knob, under the frame, to the next hook, over the frame, and back.
- Mount the spacers with the screws. Notice, the text should face up while the legs points down.
- The rubber band will be visible on both sides of the frame

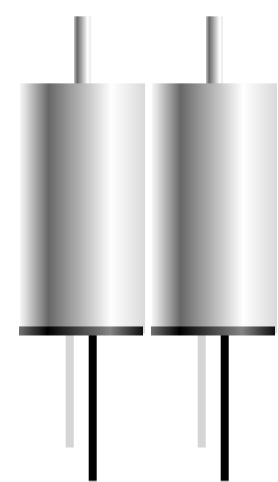
Mounting the motors



Parts:



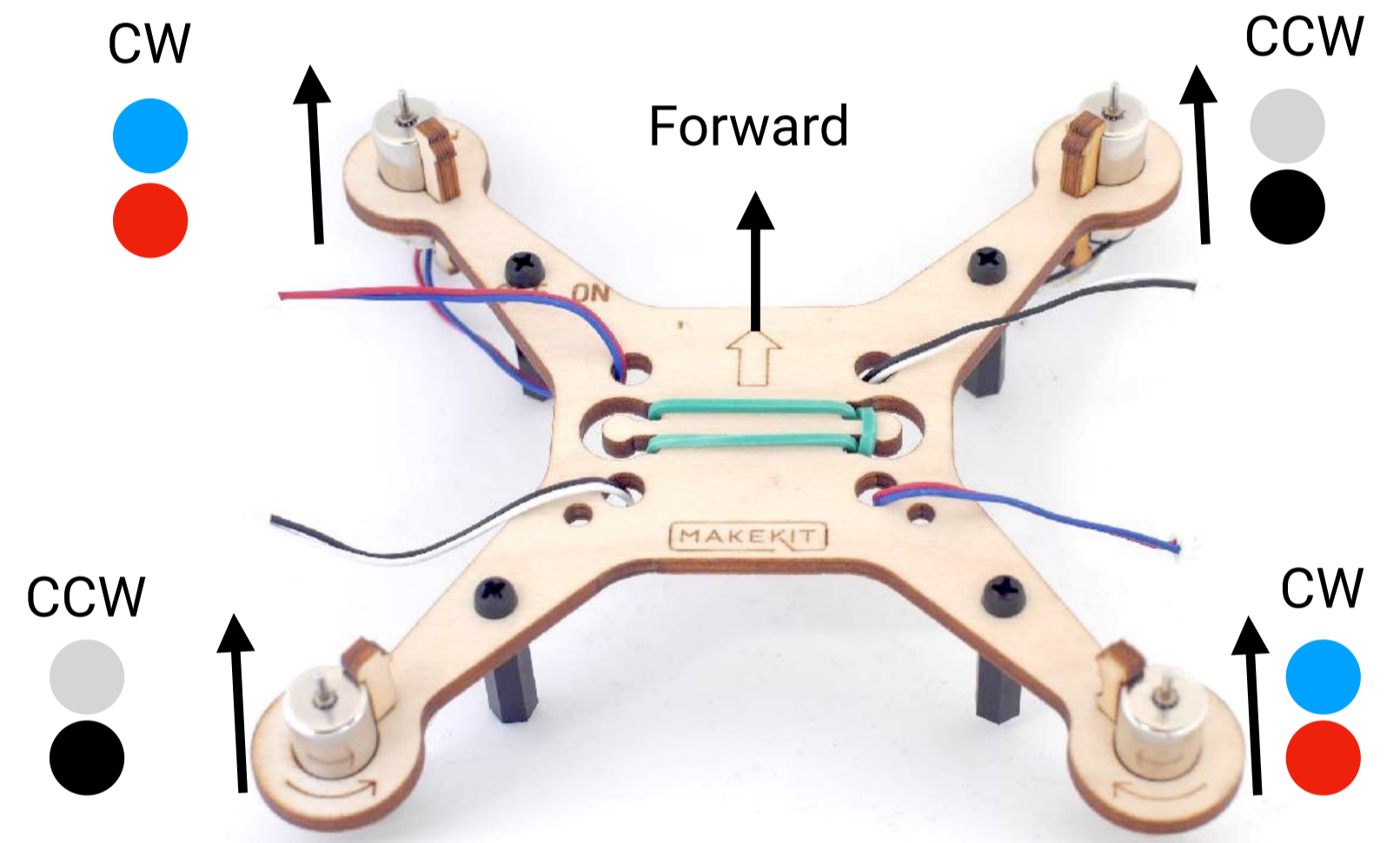
2x CW motors



2x CCW motors



4 wedges



- First insert a wedge onto the frame, then push the motor upwards to click into place. (All 4 motors)
- Then pull the motor cables through each notch to tidy them up a bit.
- Follow the color scheme to make sure the CW motors (blue and red) is placed top left and bottom right, while the CCW motors (black and white) are placed top right and bottom left.

Countersunk screws

Tools: Philips Screwdriver, socket wrench

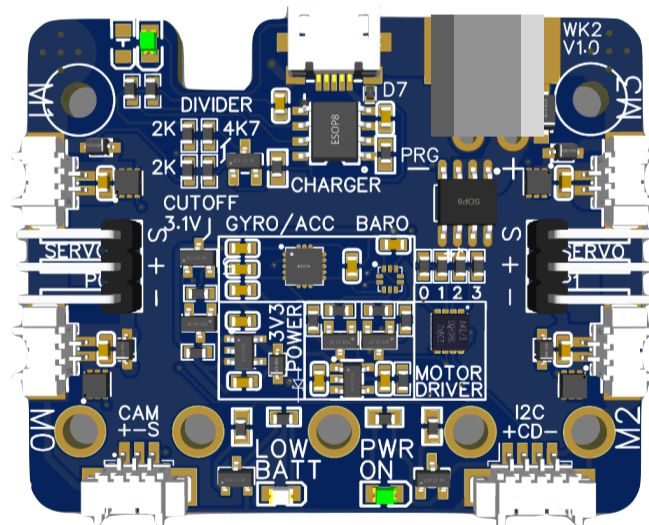
Parts:



2 x
countersunk
screws



2 x
Nylon nuts



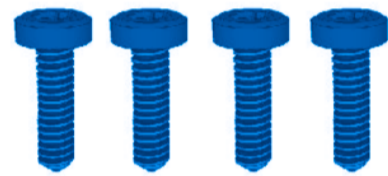
Control board



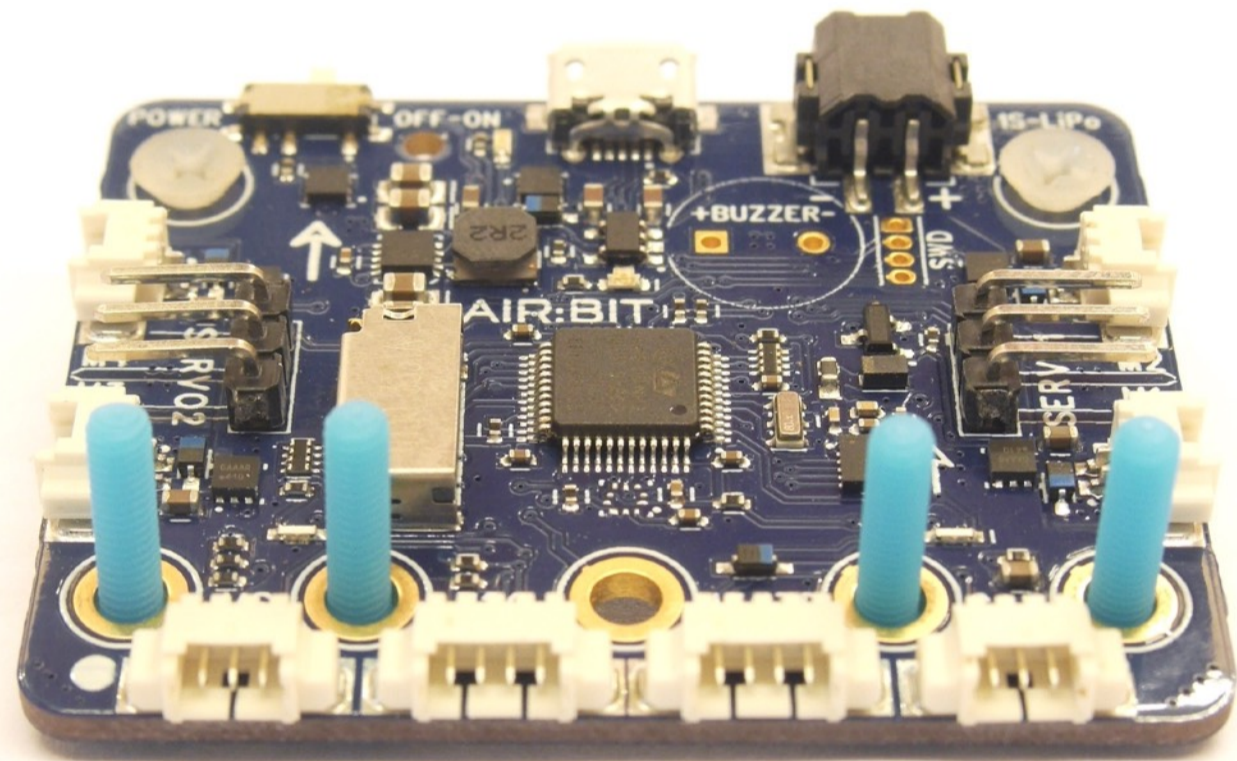
- Pull the screws through and attach the nuts on the back side of the board.
- The back side is the even surface without any components.
- Use the socket wrench to hold the nut.

Control board

Parts:



4 nylon screws m3x12 (blue)



- From the backside of the board, insert the 4 screws.
- Hold the screws with your index finger while you flip the control board.

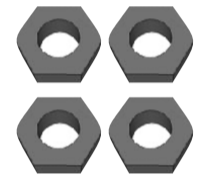
micro:bit

Tools: Philips Screwdriver, pipe wrench 5.5mm

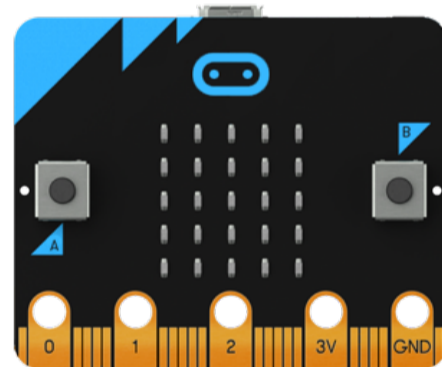
Parts:



4 x aluminium rings



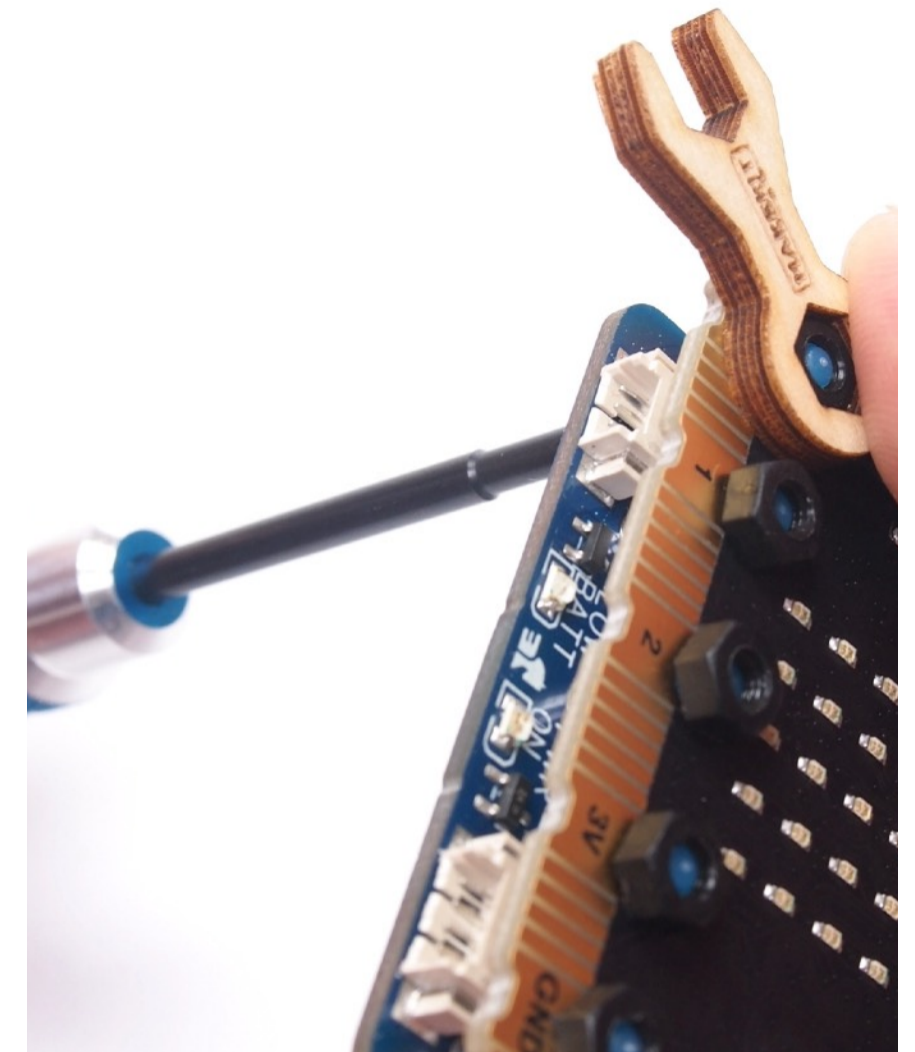
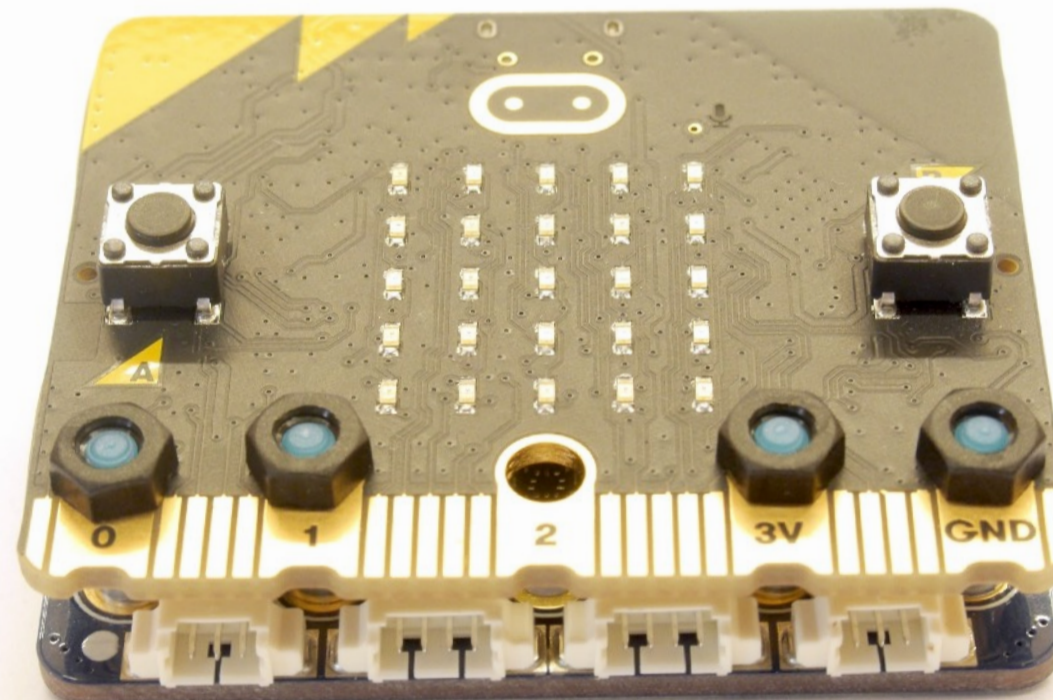
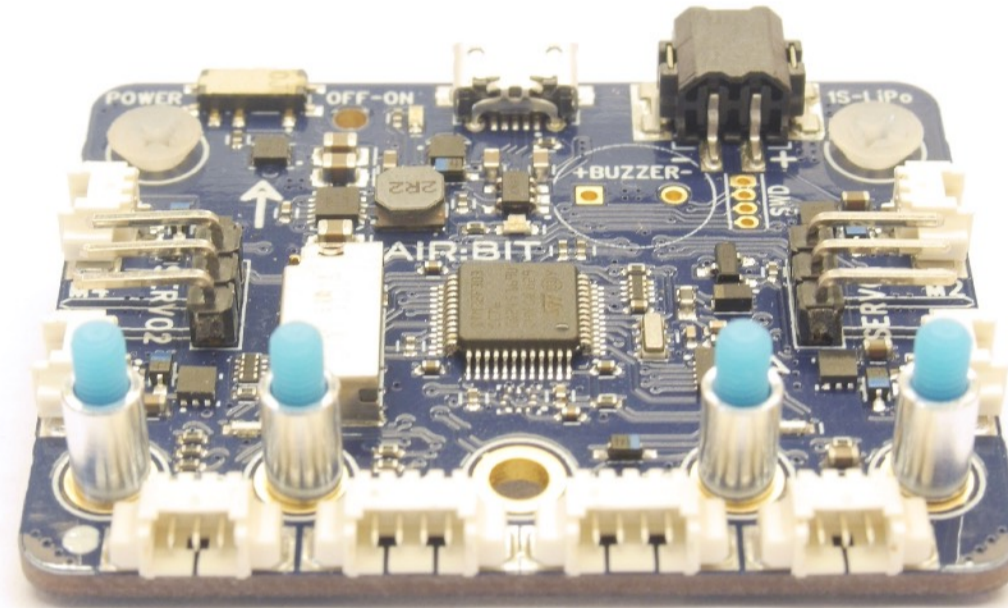
4x nuts



micro:bit



Note! Some kits use brass nuts instead of aluminium spacers. These need to be screwed on and tightened in order to send the signal from micro:bit.



- Insert the 4 spacer rings
- Place the micro:bit on the four screws
- Carefully add the four nuts
- Add some tension using a screwdriver and the socket wrench.
- **They must be slightly tightened for the drone to work as they conduct electric signal between the boards.**

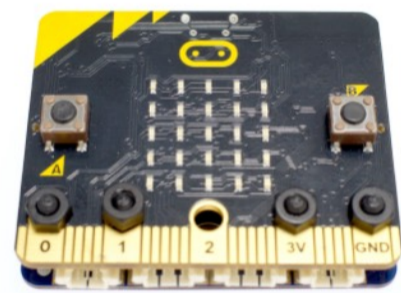
Assembling the drone

Tools: Wrench 5.5mm

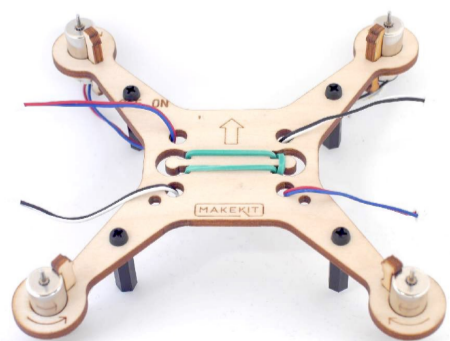
Parts:



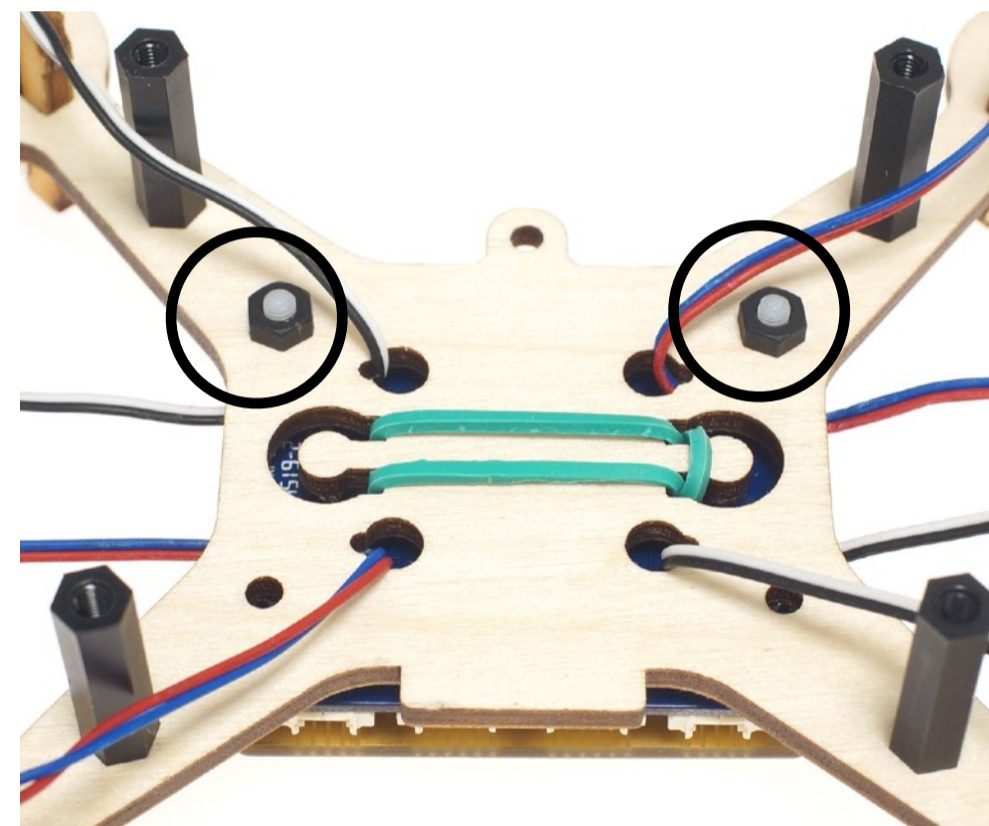
2x nylon nuts



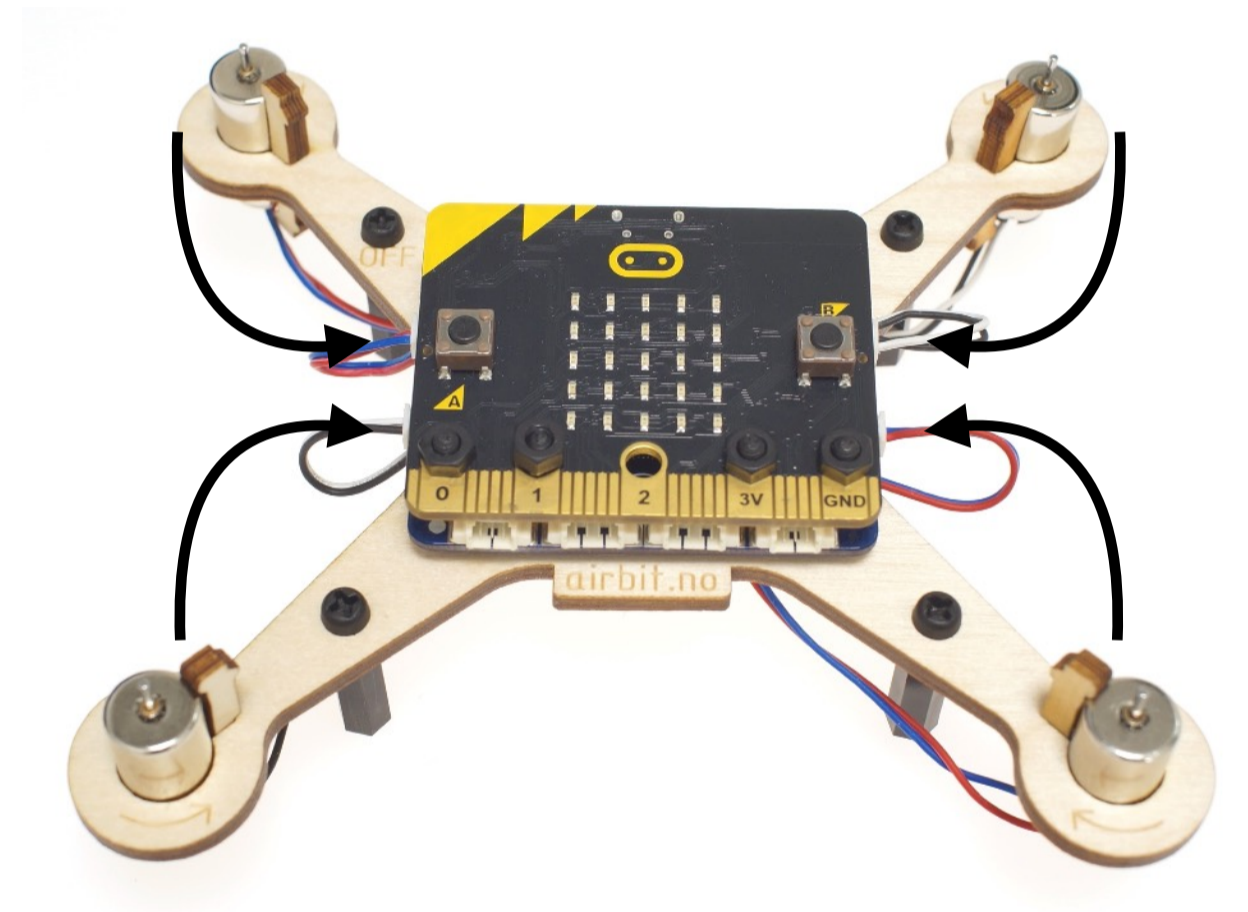
Control board assembly



Frame assembly



- Attach the control board with two nuts underneath the drone.



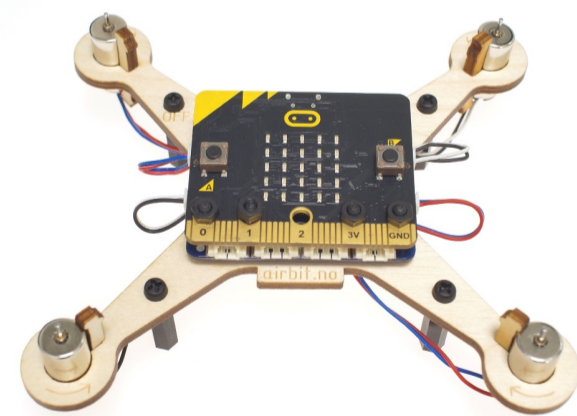
- Flip the drone
- Connect the four motors to each motor's nearest plug

Battery

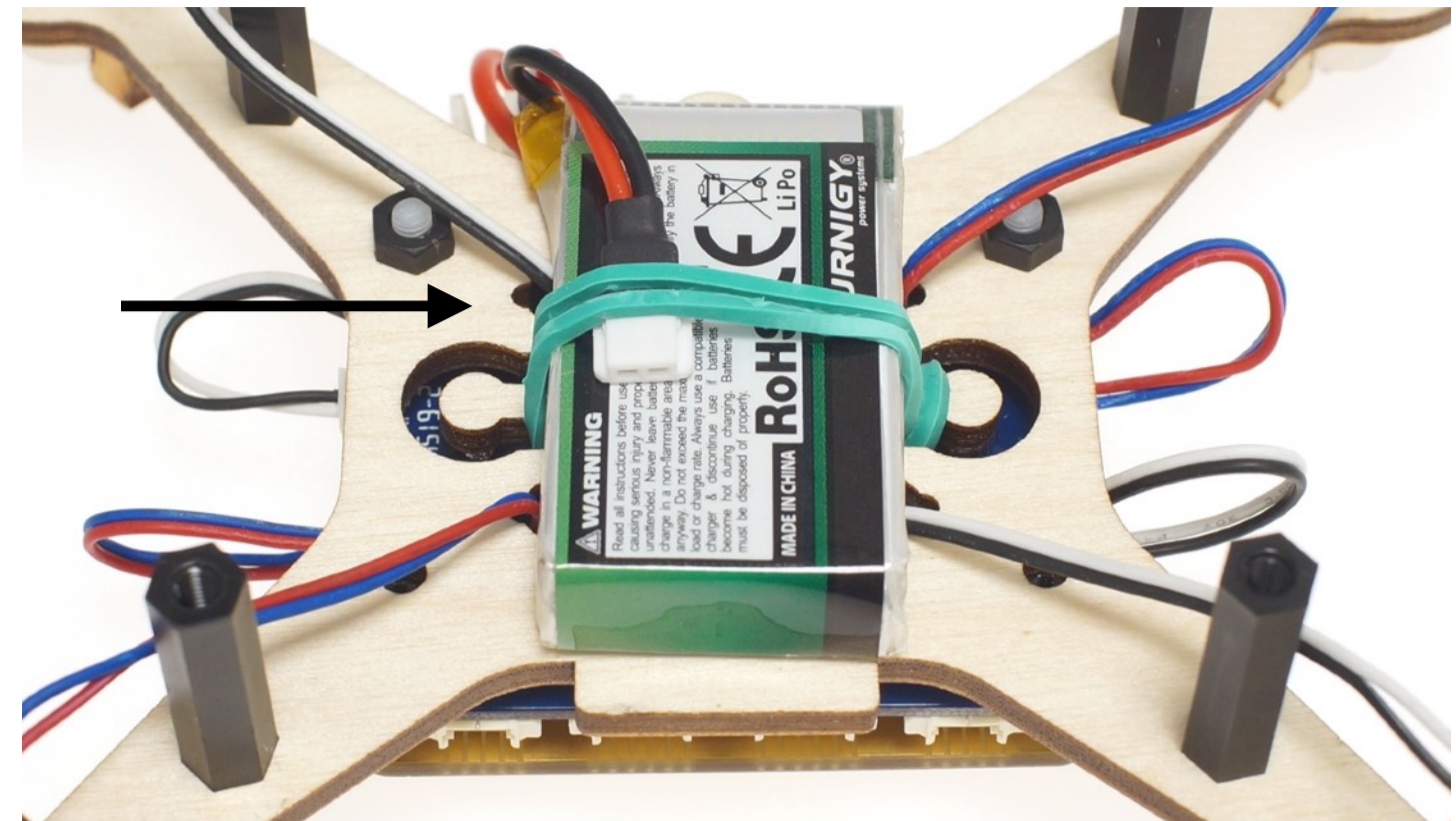
Parts:



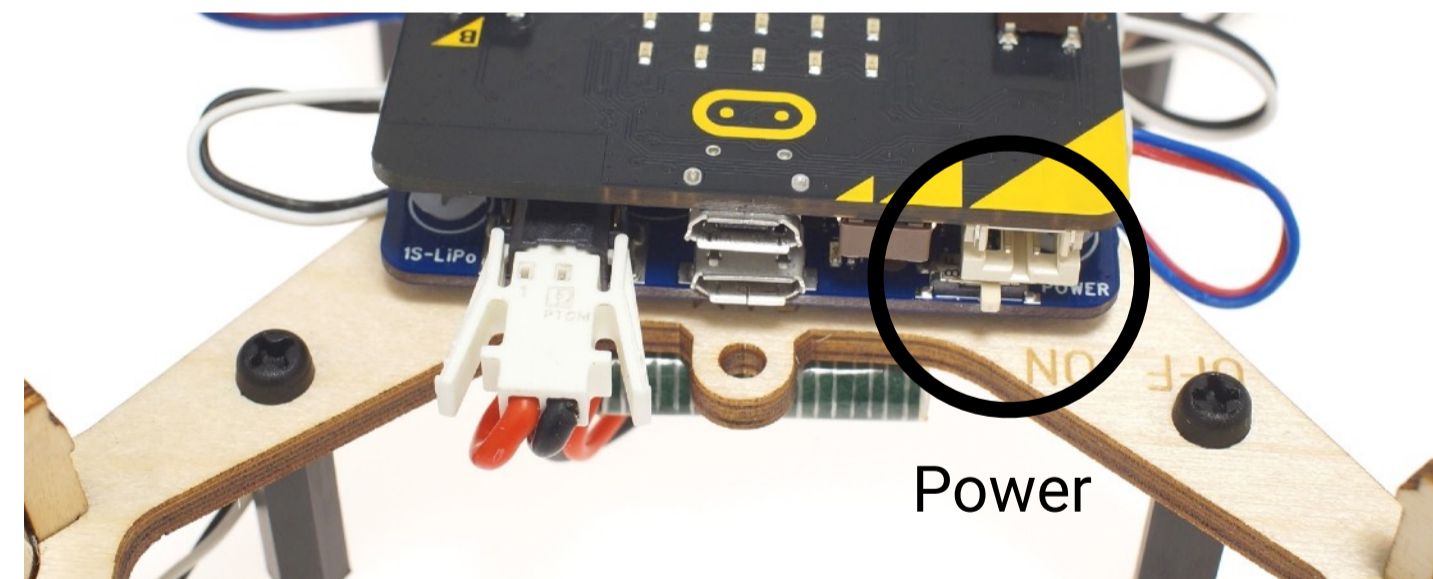
1 Lithium (LiPo)-battery



Air:bit drone



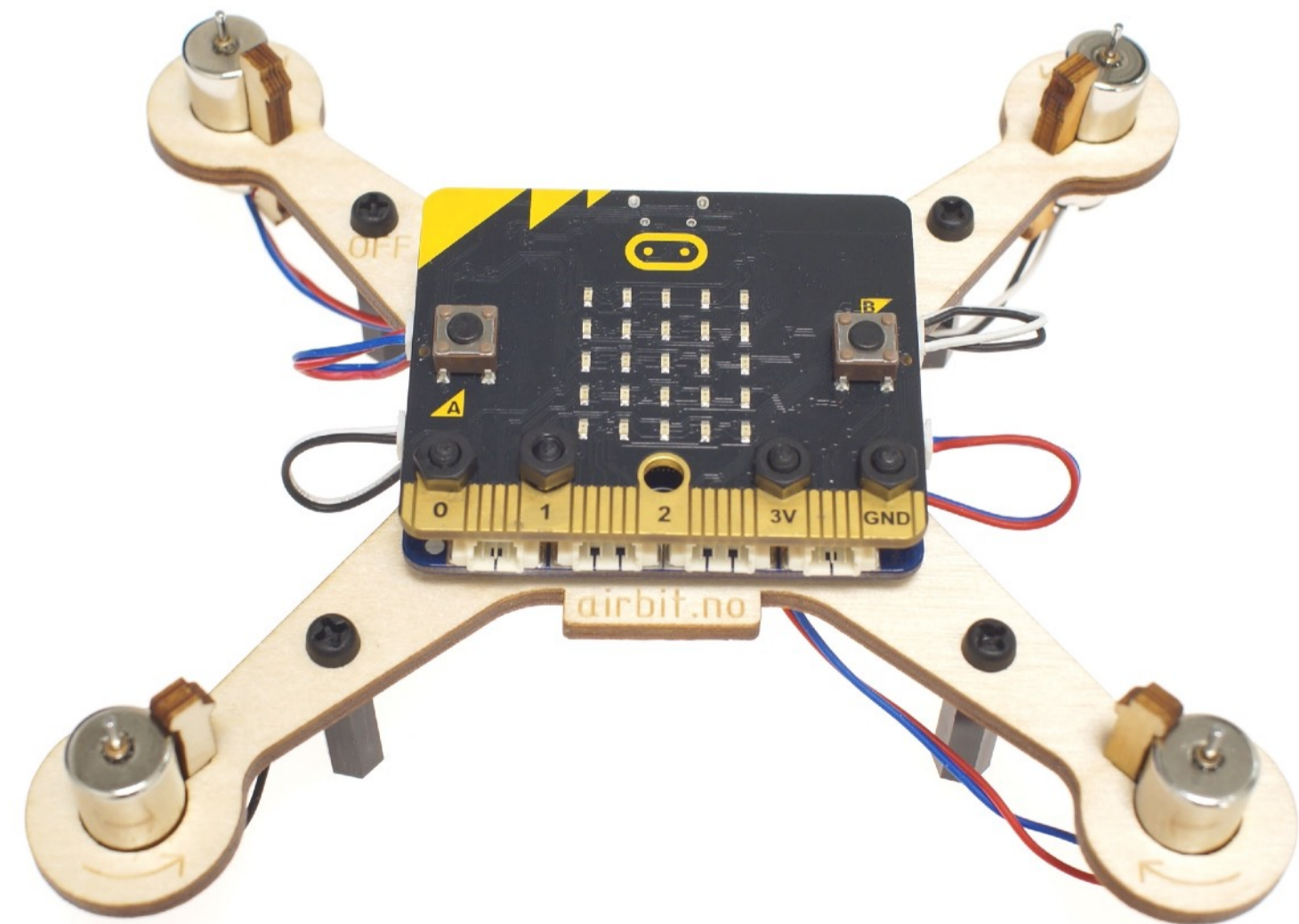
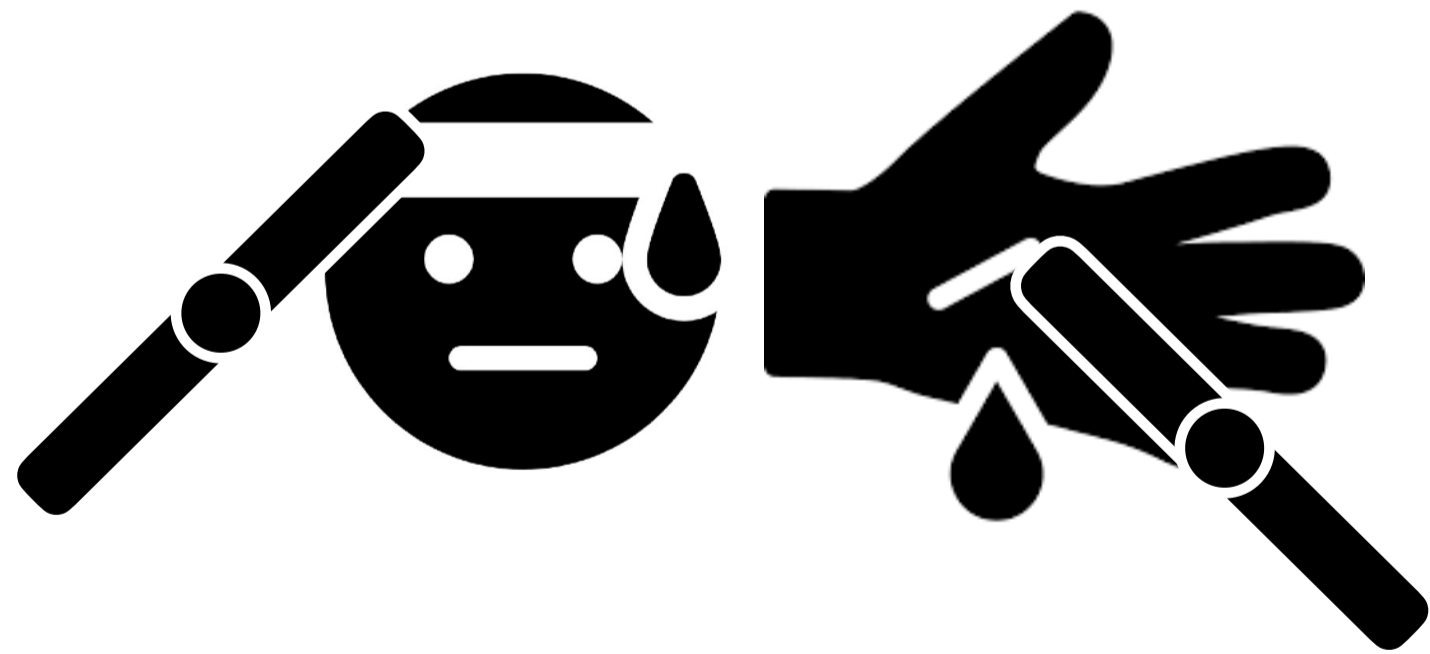
- Turn the drone upside down
- Attach the battery under the rubber band, in the very center of the drone.



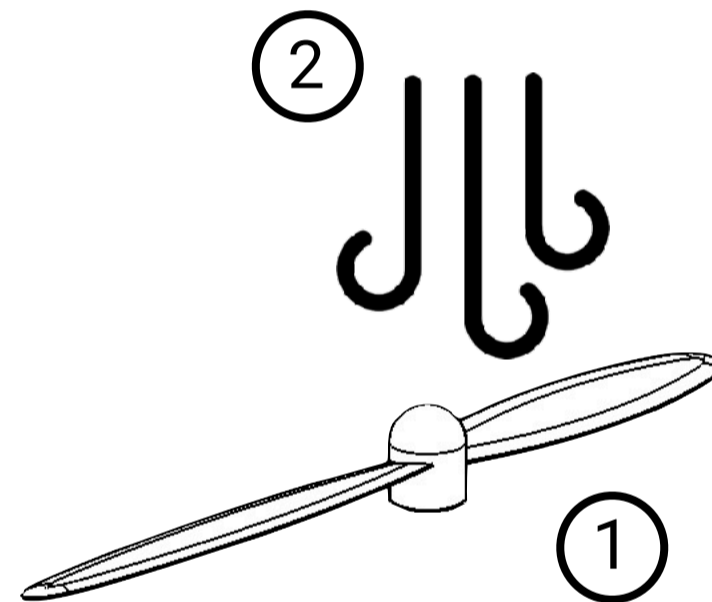
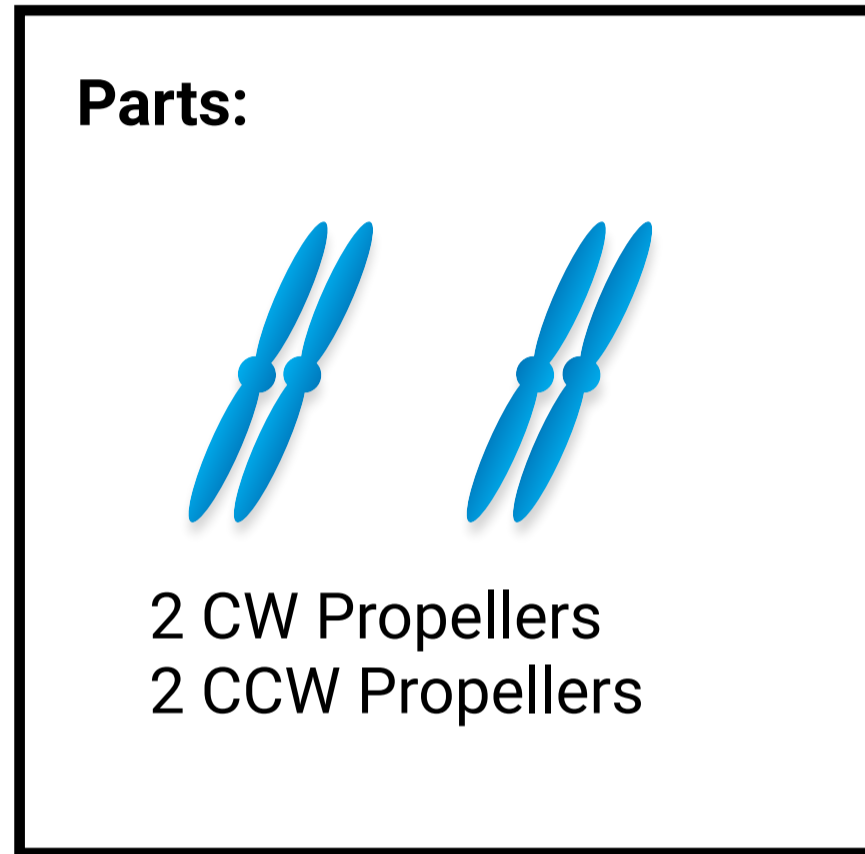
- Plug the big white connector into the control board
- Leave the micro:bit's white connector unplugged
- Notice the power switch on the right hand side

For your safety

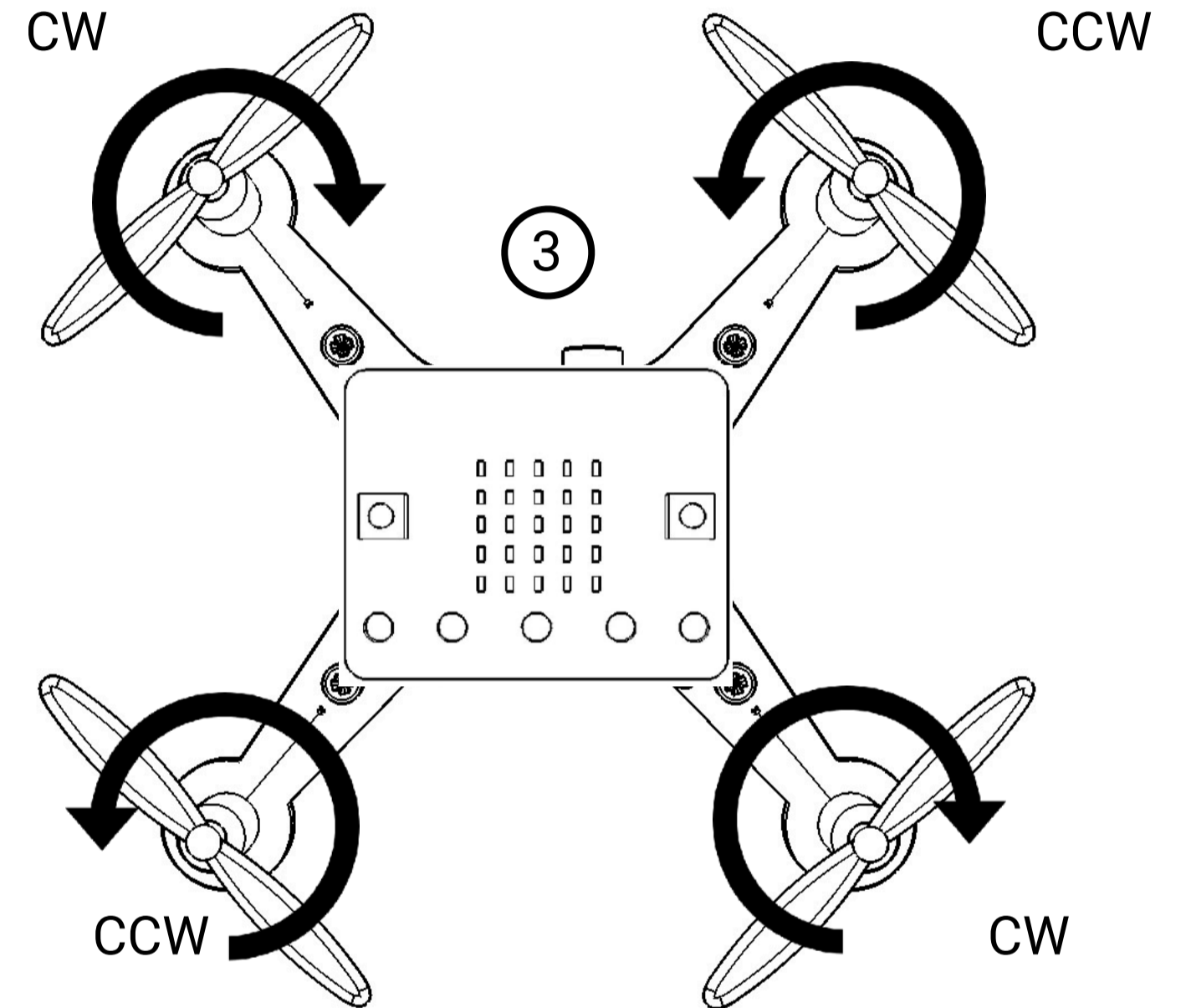
Mount the propellers after testing the drone. Can you start and stop the motors in a controlled manner?



Propellers



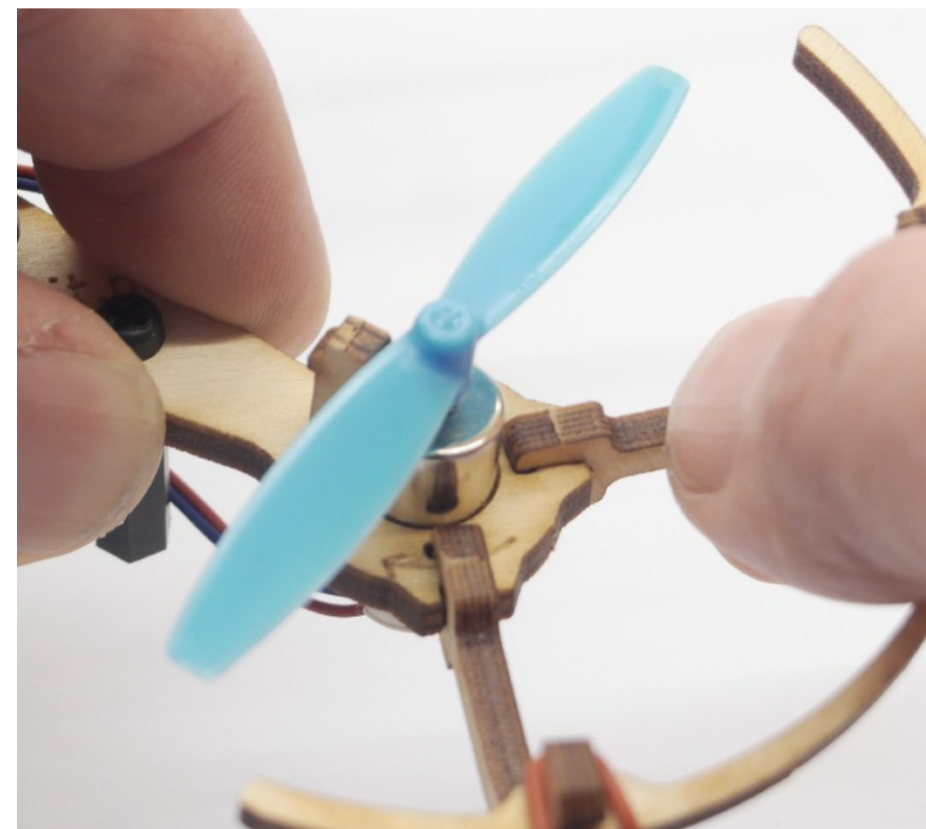
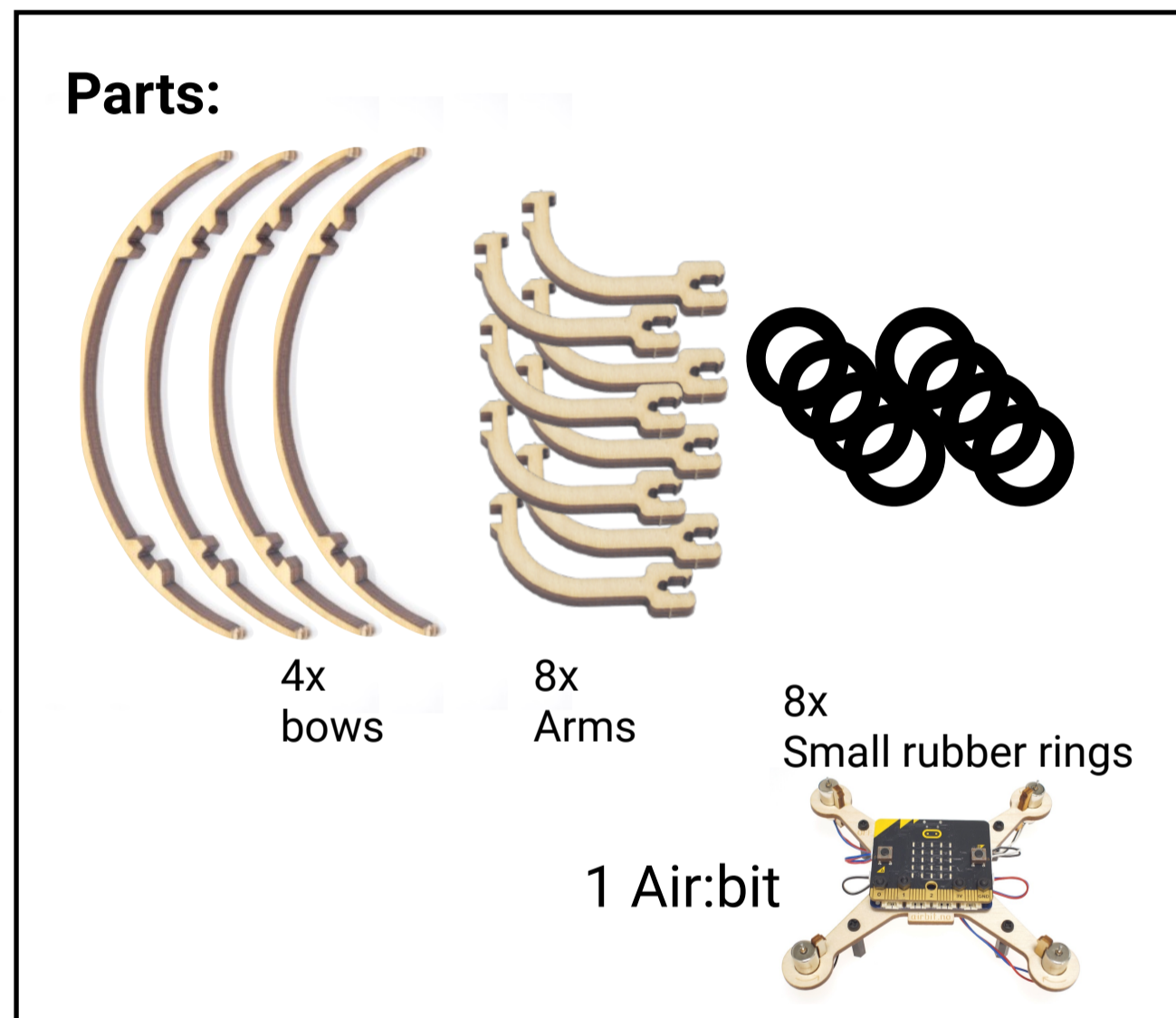
- Switch off the drone
- Identify your propellers between CW (clockwise) and CCW (counter clock wise). Read the small letters, or:
 - Take a random propeller. Place it on a table, able to spin (1)
 - Blow gently straight down above (2)
 - If it rotates with the clock, its a CW propeller
 - If it rotates against the clock, its a CCW propeller
- Place all four propeller on the correct motors



NEVER bend the propeller blades. If you need to remove a propeller, use pliers or a pointy object to release the propeller by the stem only.

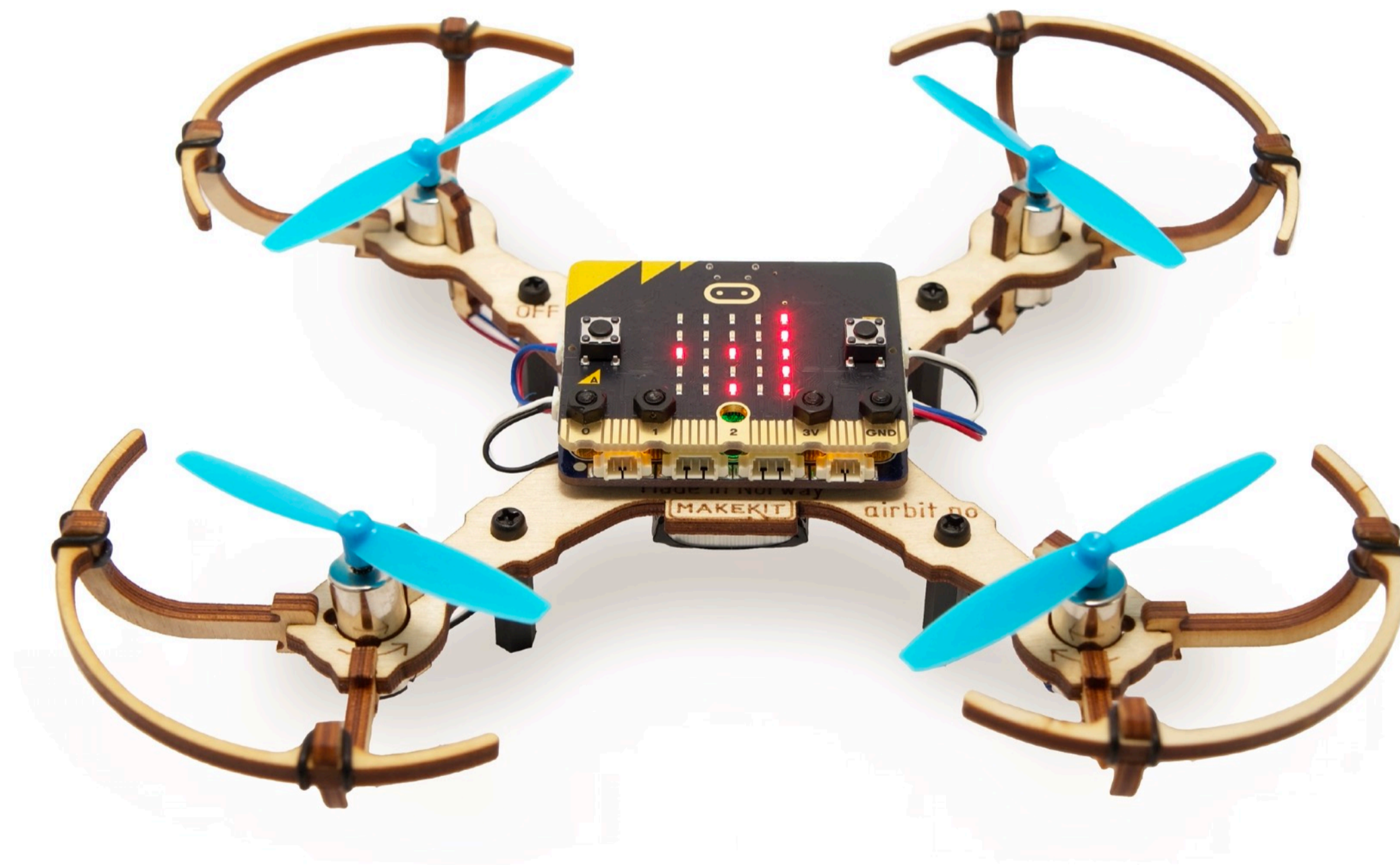


Propeller protectors



- Connect two arms to a bow using two rubber rings.
- Click into place on each arm (x4)
- Make sure they do not obstruct the propeller rotation.

With propeller protection



Feb. 16, 1926.

G. DE BOTHEZAT

1,573,228

HELICOPTER

Filed June 27, 1923

3 Sheets-Sheet 1

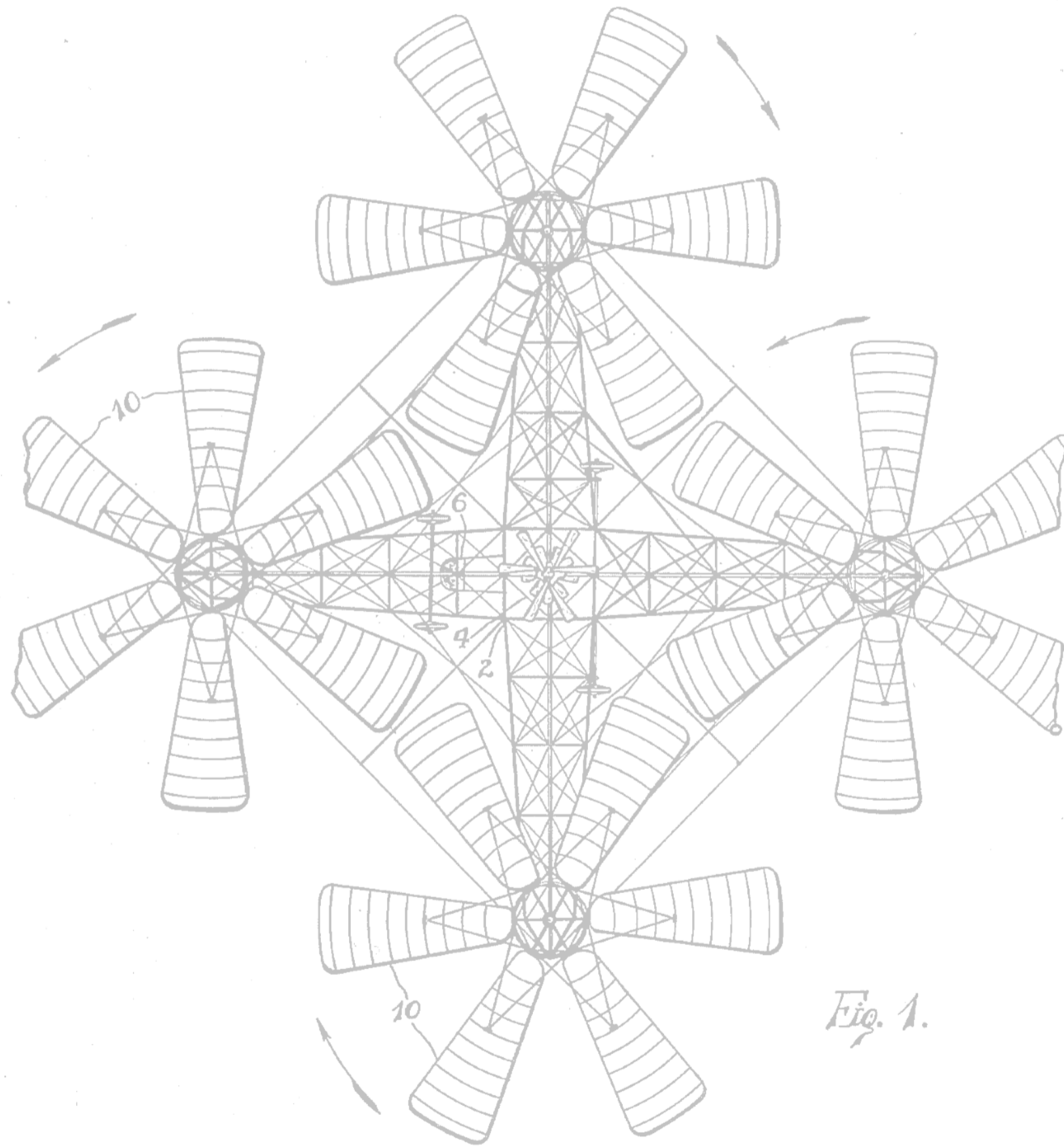


Fig. 1.

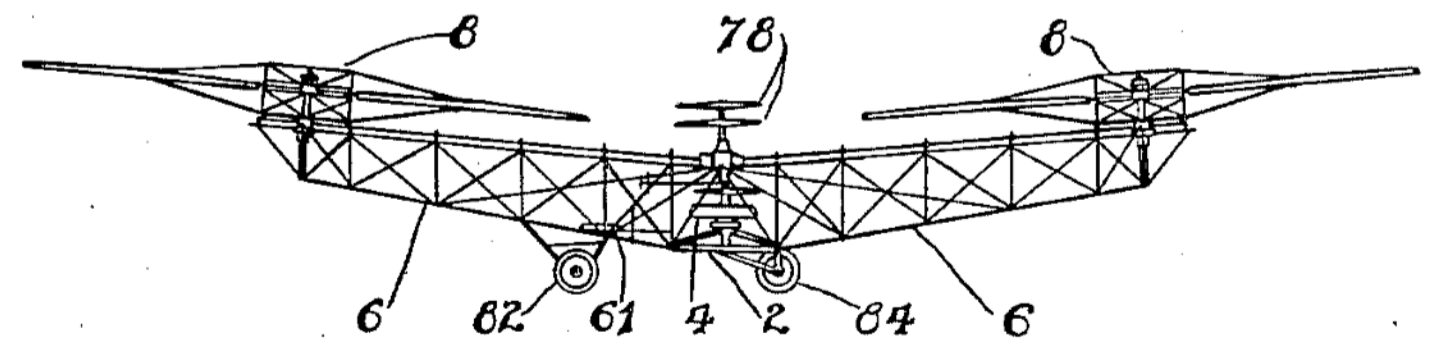


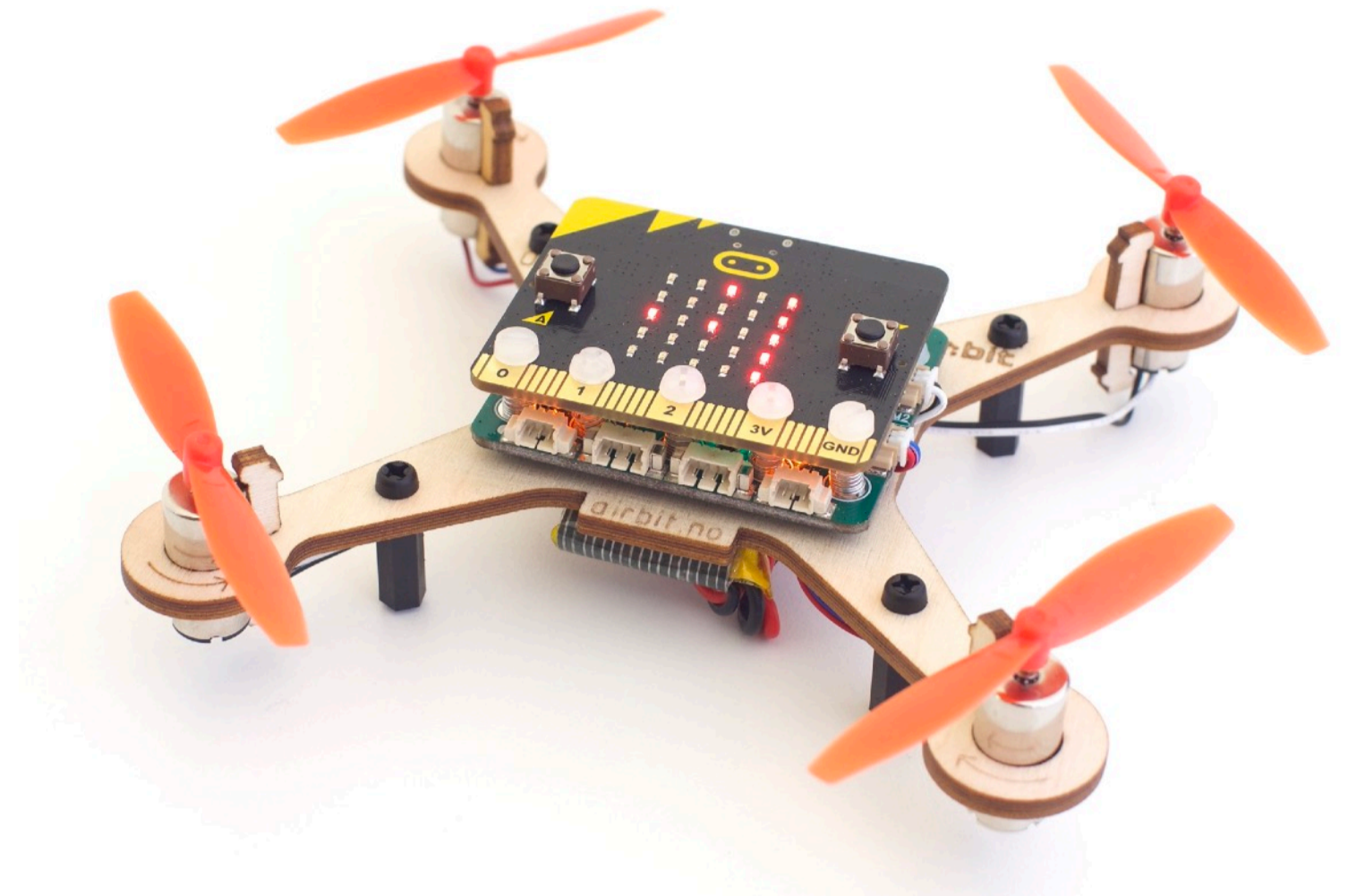
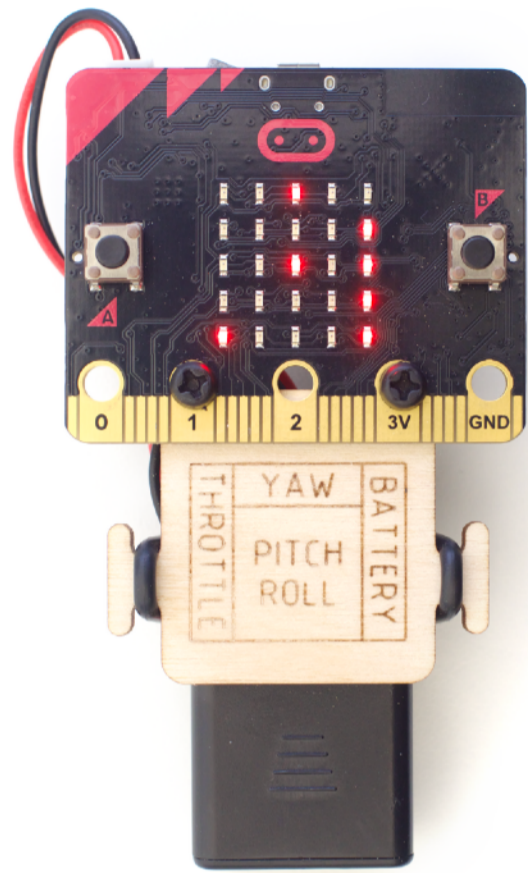
Fig. 2.

Coding

INVENTOR

BY George de Bohezat

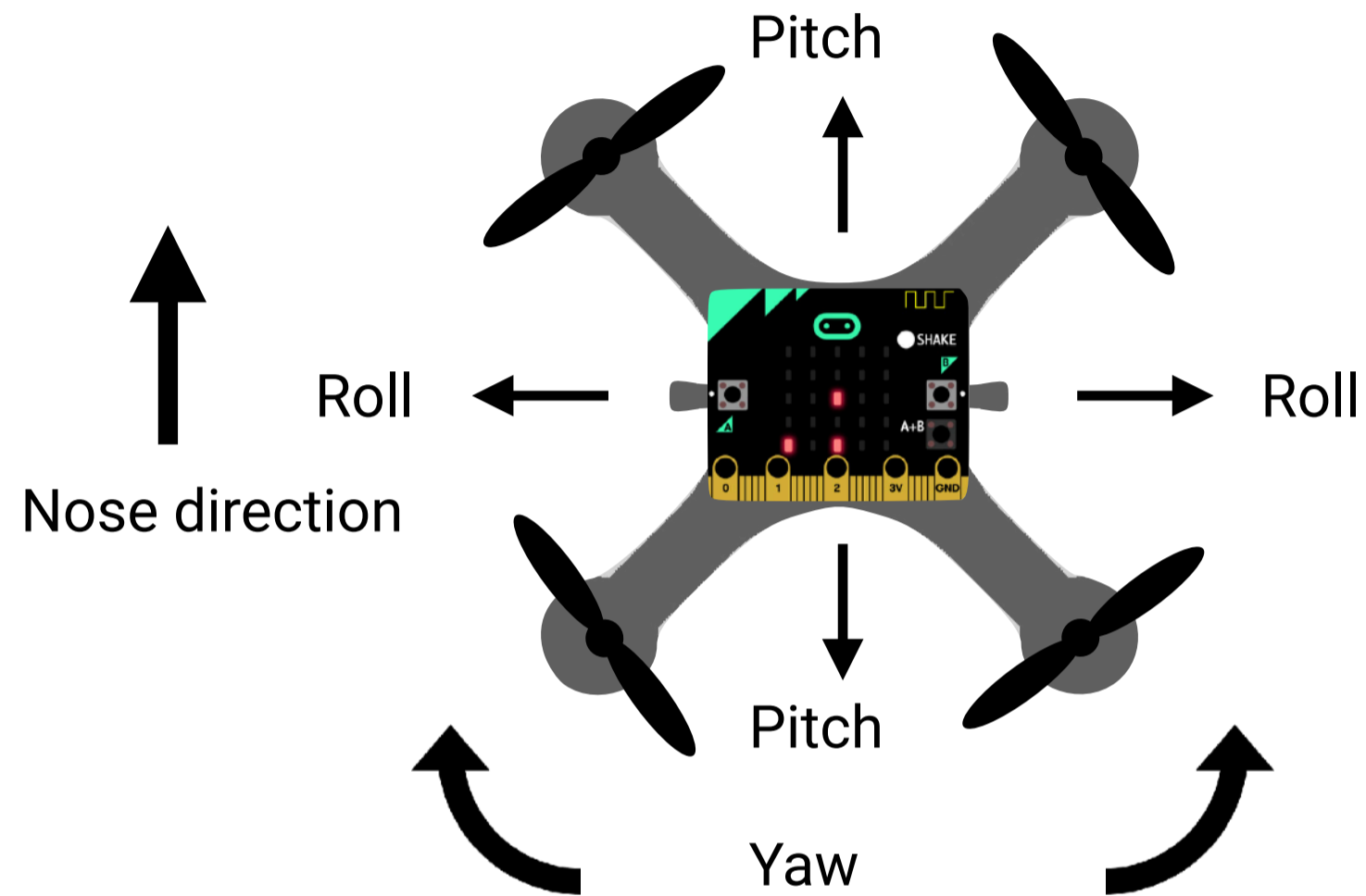
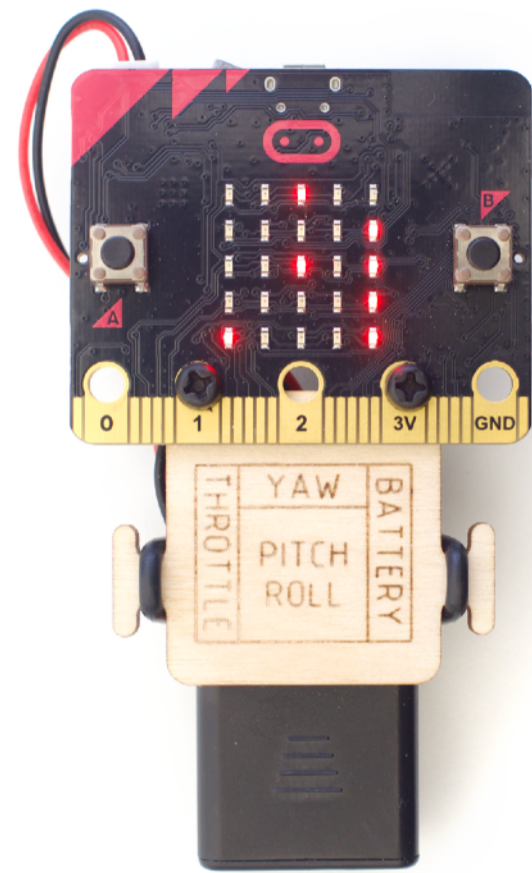
Robert H. Young ATTORNEY



PARTY

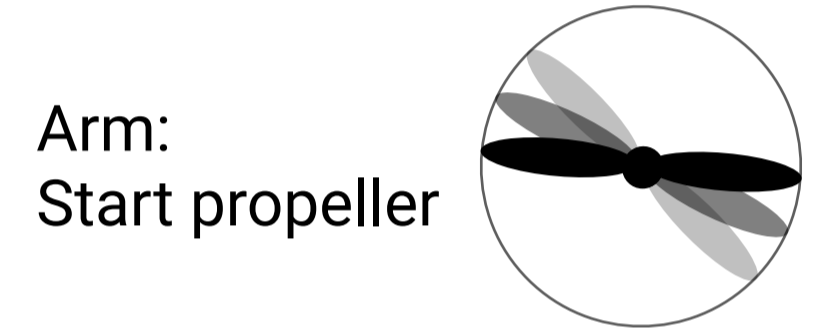
Five values to control the drone

Flight directions



PARTY

pitch, arm, roll, throttle, yaw

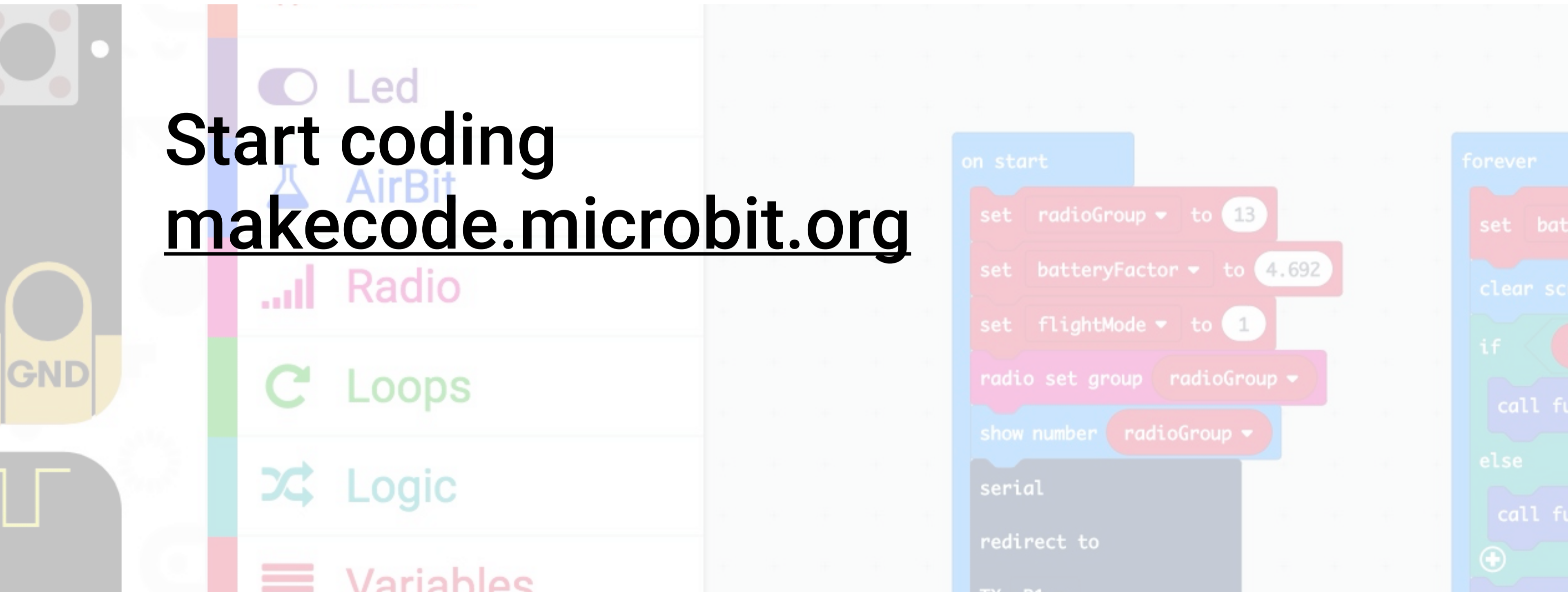


Control the drone using 5 parameters:

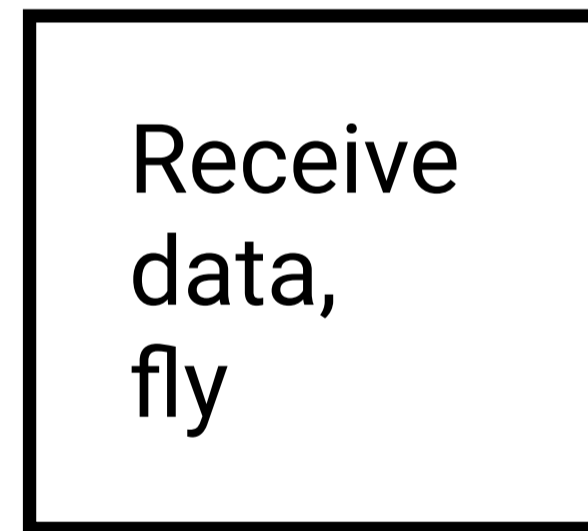
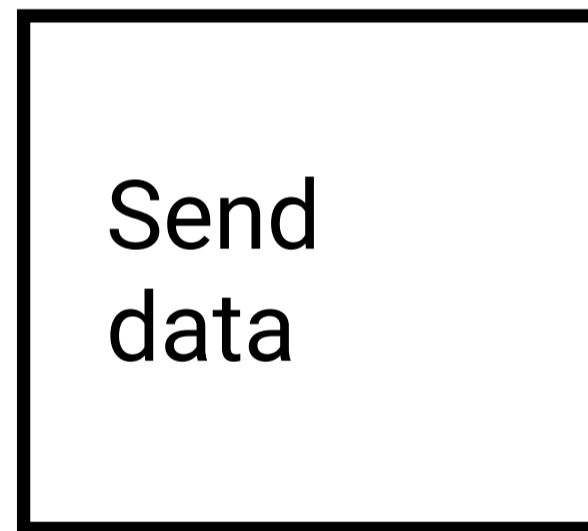
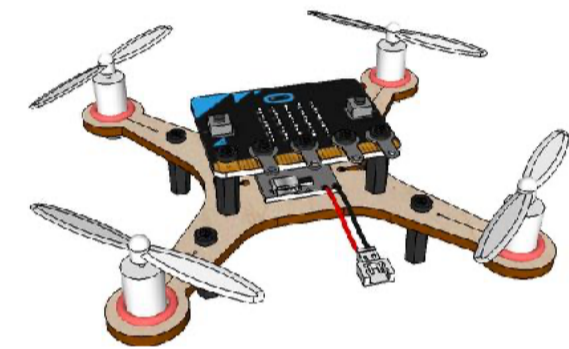
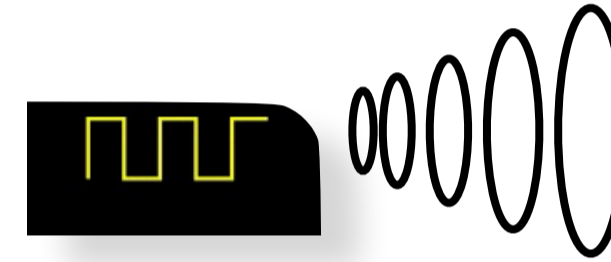
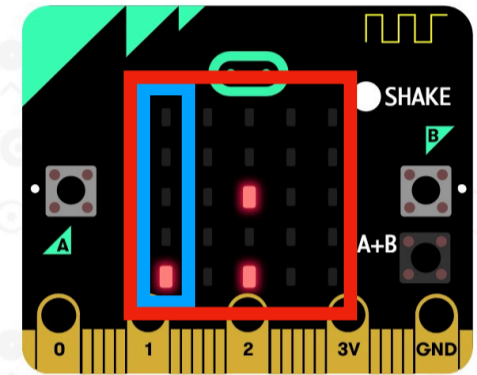
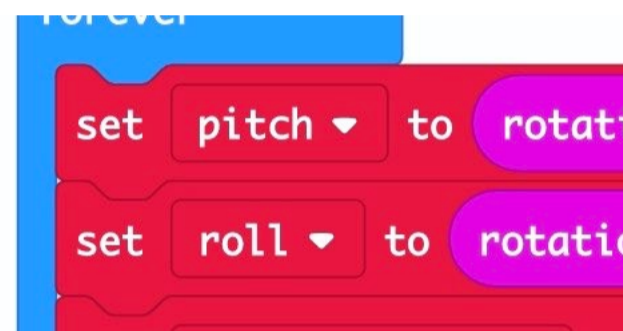
Variable:	Minimum	Neutral	Maximum
Arm	0		1
Throttle	0	50	100
Pitch	-45	0	45
Roll	-45	0	45
Yaw	-30	0	30



Start coding
makecode.microbit.org



Four steps



Collecting data for Pitch, Arm, Roll, Throttle, Yaw

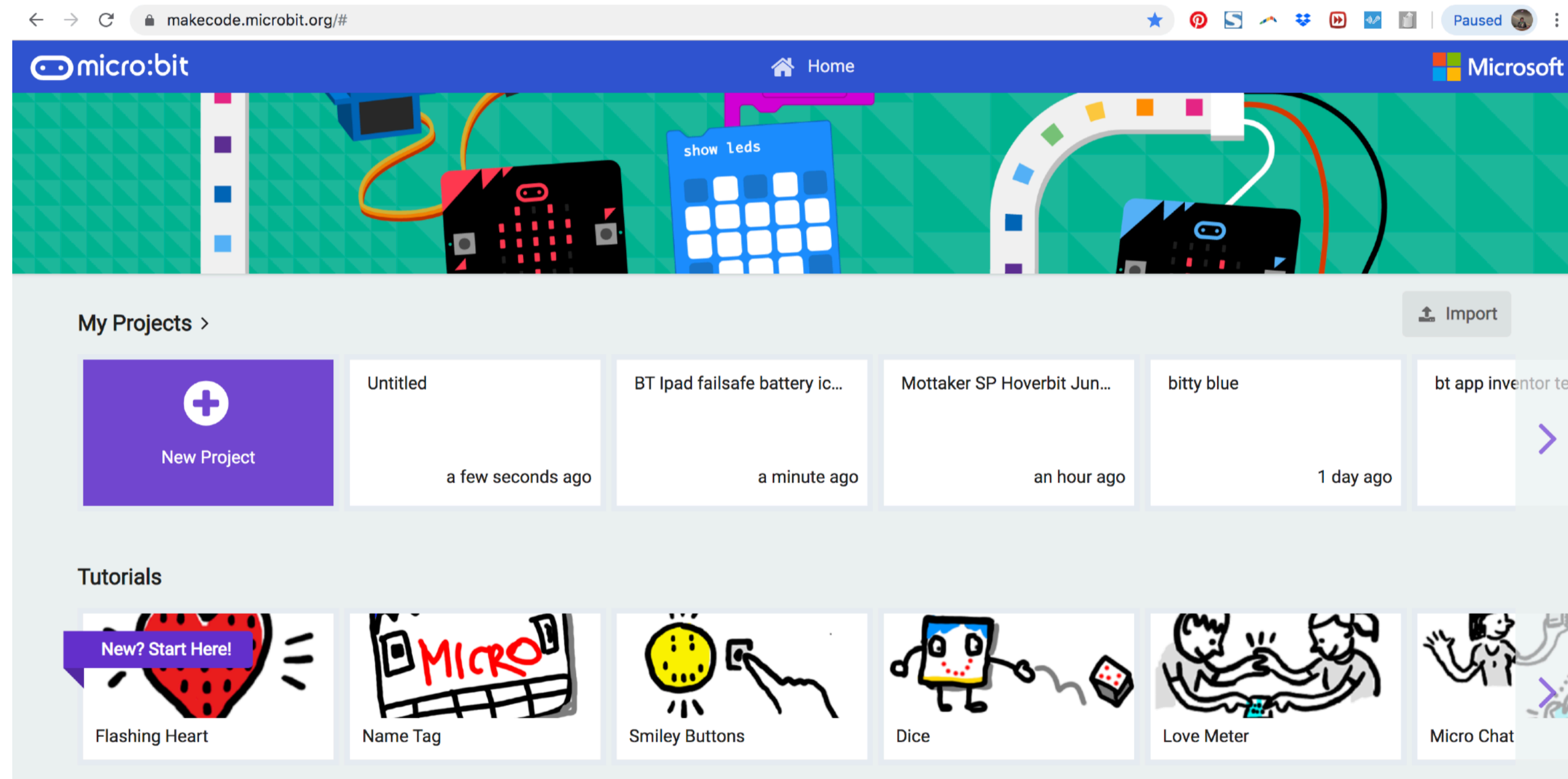
Convert the values to coordinates for the display

Send the value over the radio

Receive the values and turn the into control signal for the Air:bit control board

Start at makecode.microbit.org

Chrome is recommended for better connection with the micro:bit



Select “New project”.

PS. If you’re new to micro:bit you should try one of the tutorials above first.

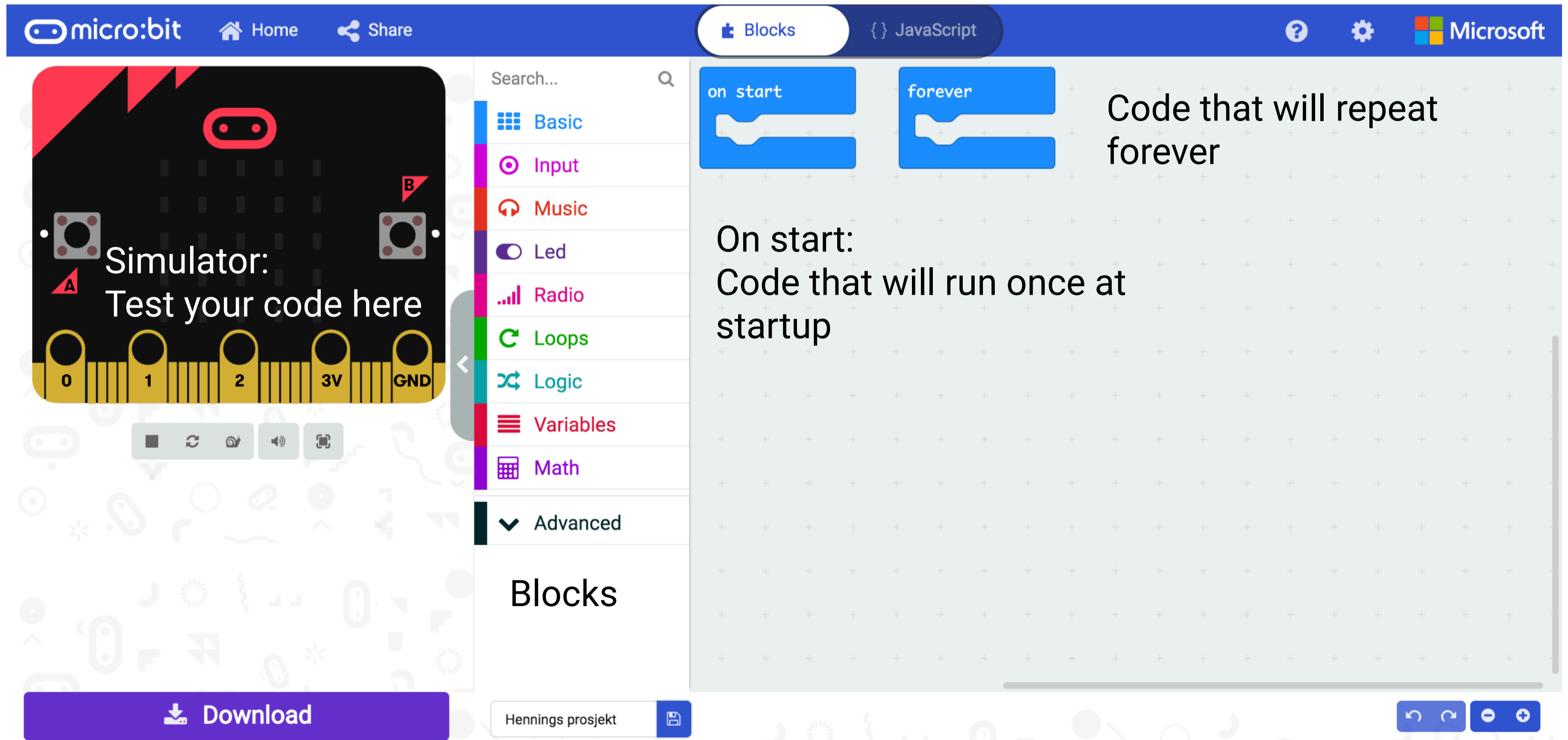
The editor

Main menu

Share your code

Block mode Javascript mode

Settings

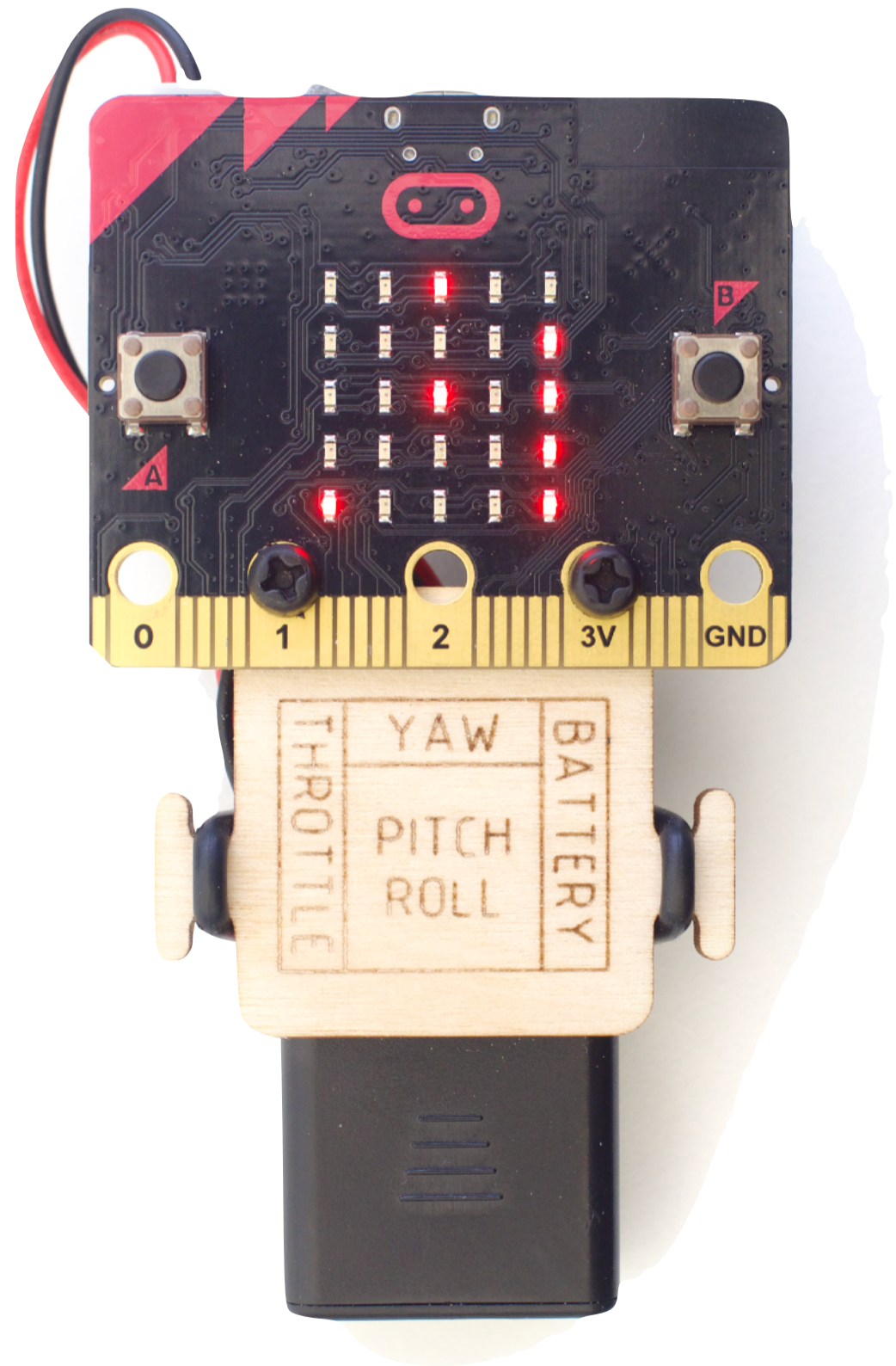


Download to micro:bit

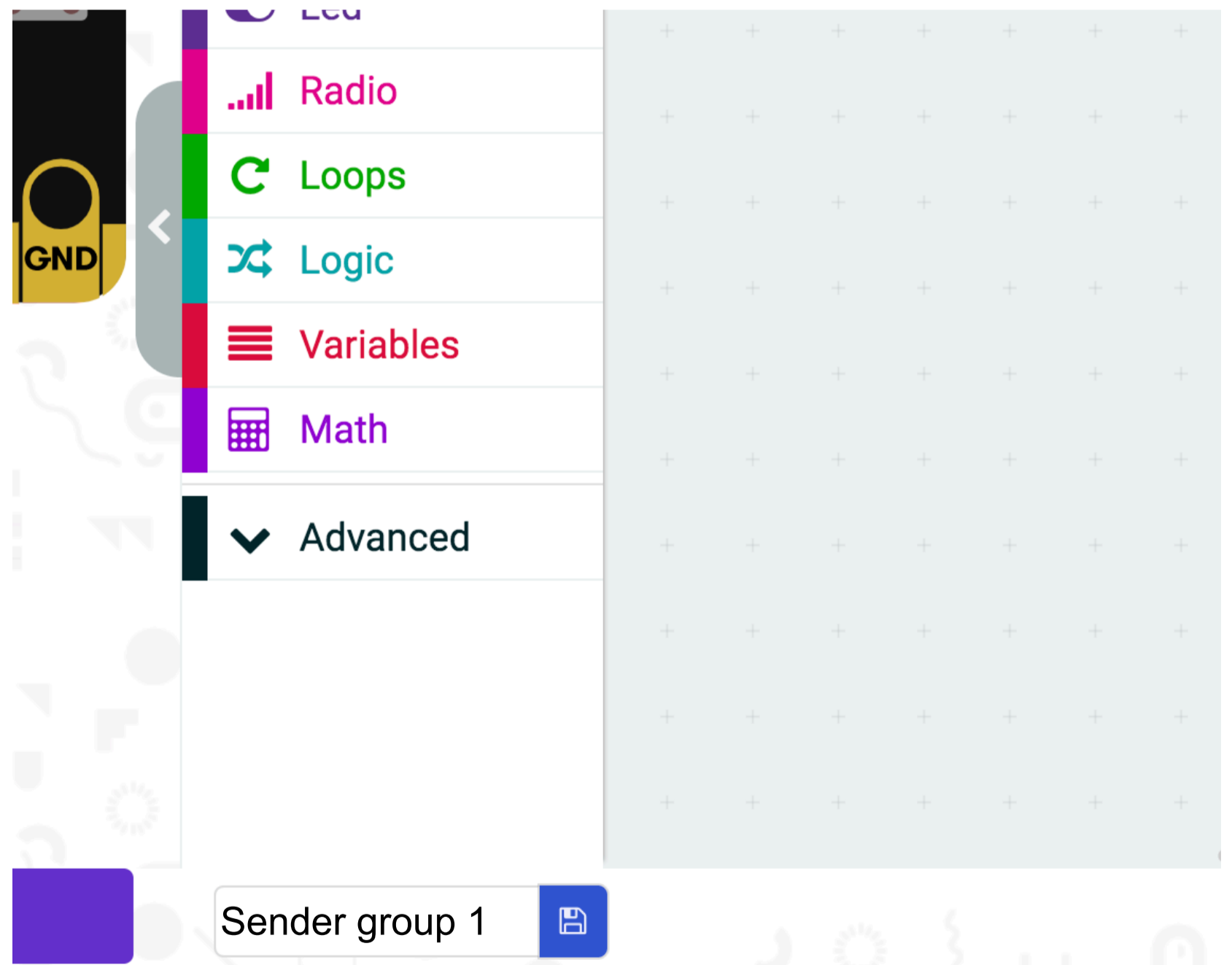
Save a backup
Name your project

Undo zoom

Get the variables and code the remote

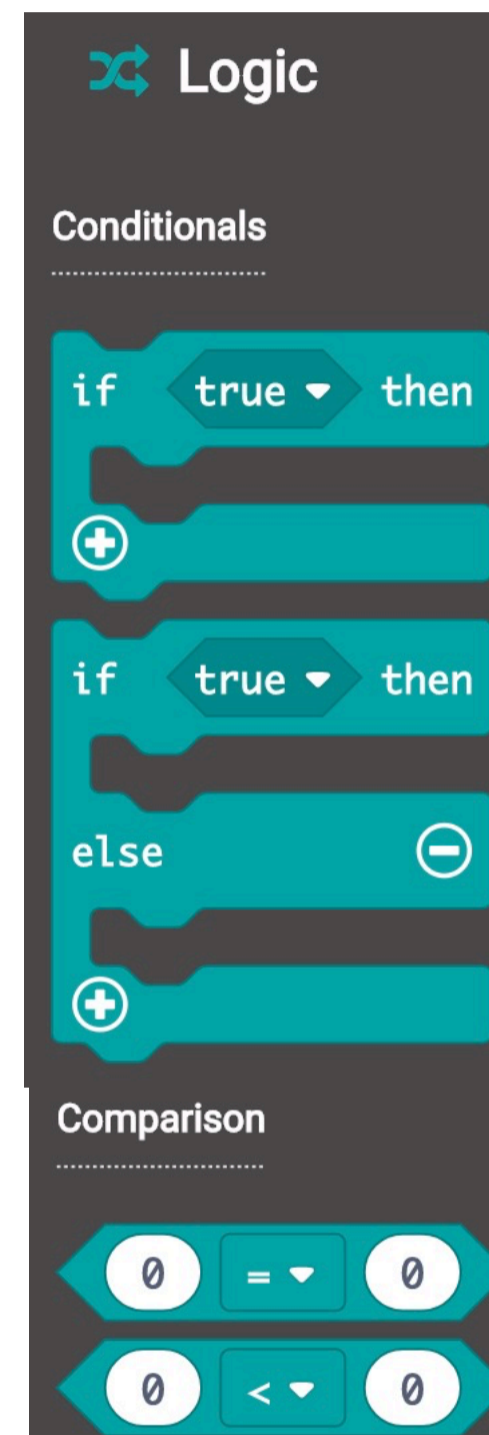
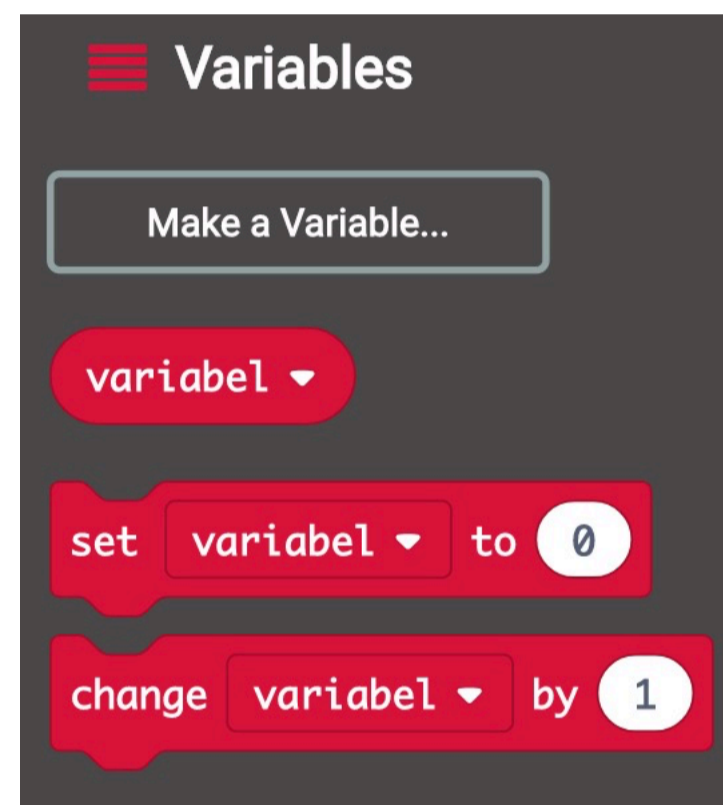
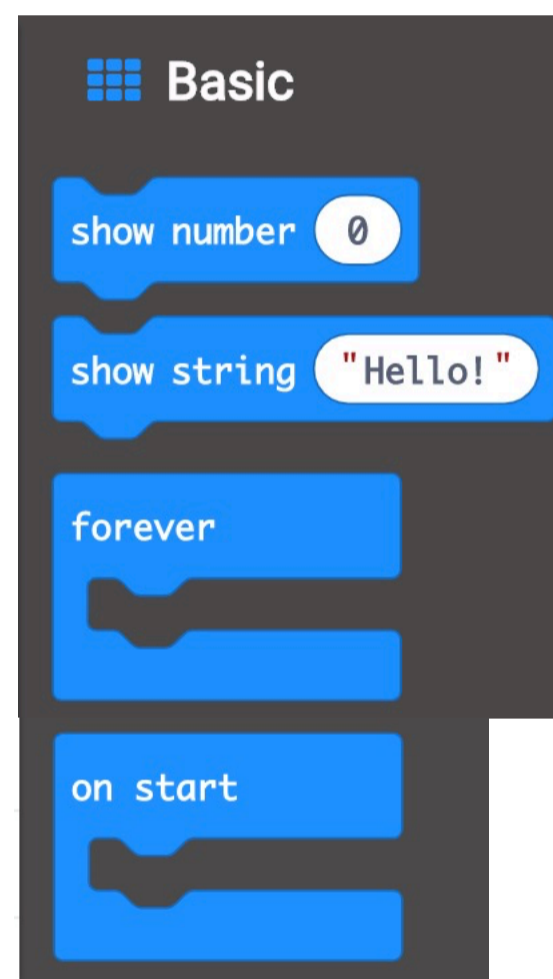


Start by giving your project a name like "Sender group x". This is your unique radio channel. If you are flying alone you can use channel 7



Code blocks

We will be using these blocks



More blocks

Math

0 + 0

0 - 0

0 × 0

0 ÷ 0

constrain 0 between 0 and 0

map 0 from low 0 high 1023 to low 0 high 4

Radio

radio send number 0

radio send value "name" = 0

radio send string ""

radio set transmit power 7

radio set group 1

Pins

analog read pin P0

analog write pin P0 to 1023

PARTY

pitch, arm, **roll**, **throttle**, yaw

Throttle

- Make a variable called Throttle
- Use the buttons A and B to change the throttle. A should reduce it with 5, B should increase it with 5
- Use Show Number (in the forever loop) to verify that throttle is changing correctly
- When above 40, throttle should only change by 1 for better precision when drone is hovering.

Roll og Pitch

- Make a variable called Roll and one called Pitch
- In the forever loop: Set the variables roll and pitch to the input -> more -> rotation.roll and rotation.pitch

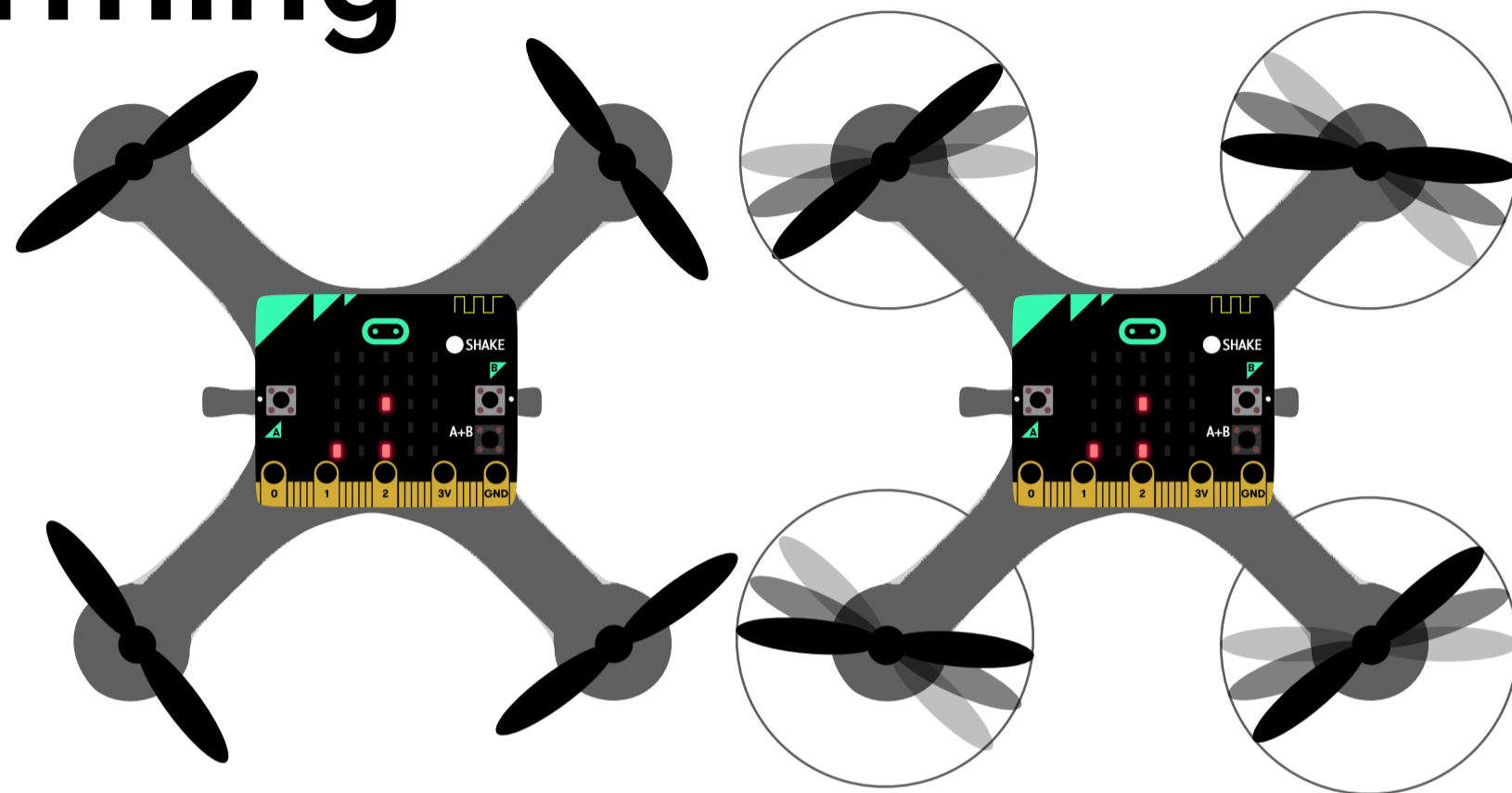
Solution

```
on button A pressed
  if throttle ≤ 40 then
    change throttle by -5
  else
    change throttle by -1
```

```
on button B pressed
  if throttle < 40 then
    change throttle by 5
  else
    change throttle by 1
```

```
forever
  set Roll to rotation (°) roll
  set Pitch to rotation (°) pitch
  clear screen
```

Arming



Disarmed

Armert

Arming

- Arming is a safety switch and the propellers will only spin when arm is set to 1

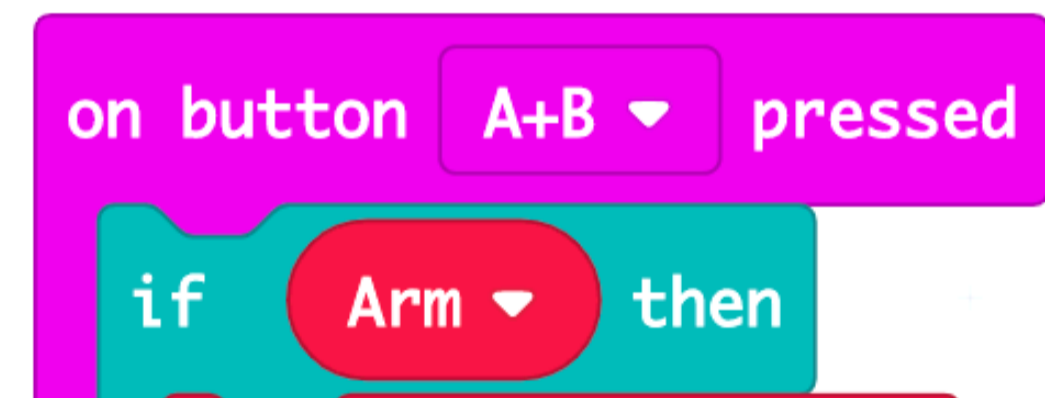
Task:

- Make a variable called Arm
- When pressing A+B, change the Arm between 0 and 1
- If Arm is 1 make it 0 and visa versa
- Use Show Number: Arm to verify
- When pressing A+B also reset throttle to 0

Bryteren setter Arm til 0 og 1 annenhver gang

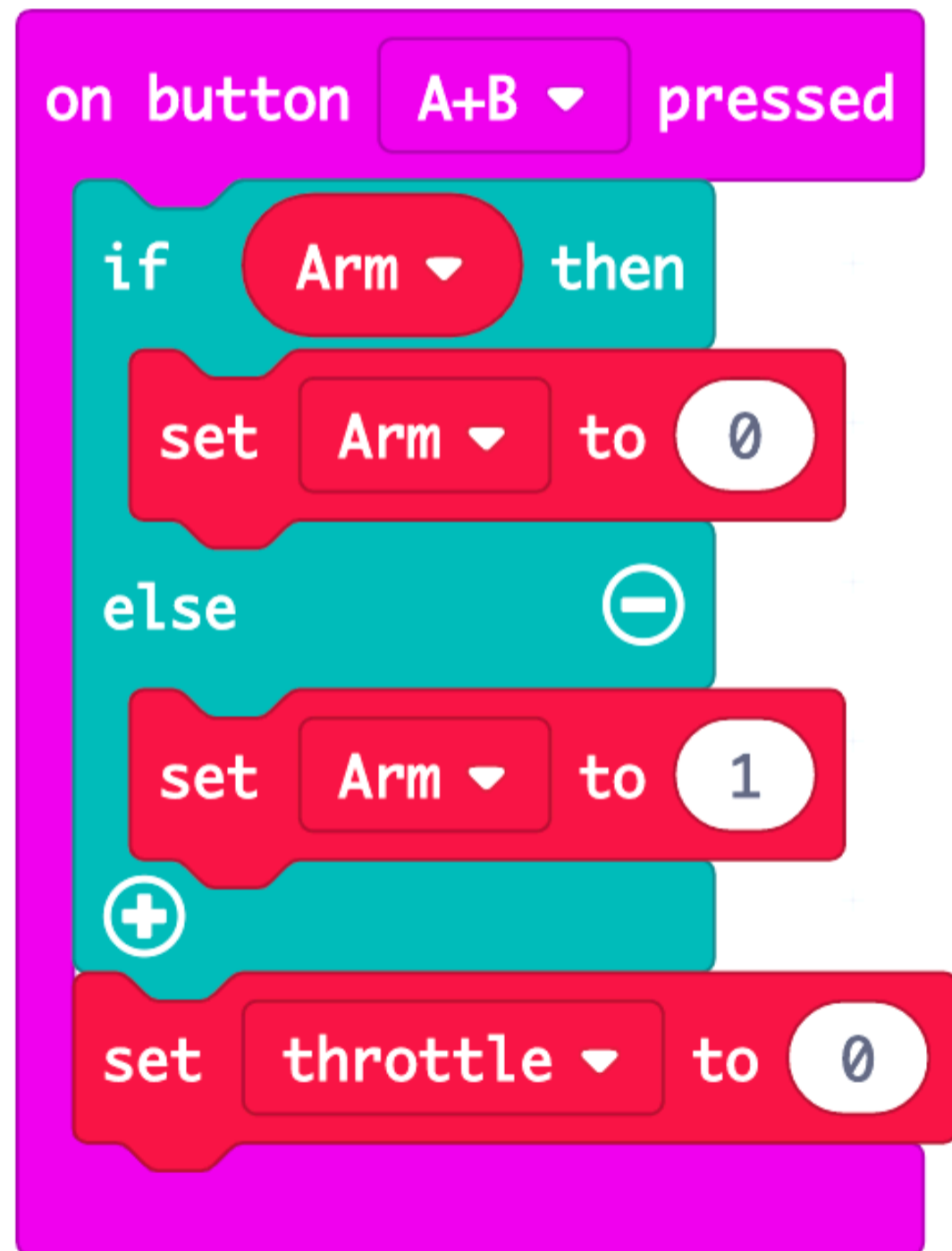


PARTY



Tips! Bruk **If Arm** (betyr "hvis arm ikke er 0")
I praksis betyr dette "hvis dronen er armert"

Solution



```
on button A+B pressed
  if Arm then
    set Arm to 0
  else
    set Arm to 1
  set throttle to 0
```

The code block is a purple 'when green flag clicked' block. It contains an 'if Arm then' block. Inside the 'if' block, there are two 'set Arm to' blocks: one with the value 0 and one with the value 1. Below the 'if' block, there is a 'set throttle to 0' block. The 'if' block has a minus sign in the 'else' section and a plus sign in the 'then' section.



```
on shake
  set Arm to 0
  set throttle to 0
```

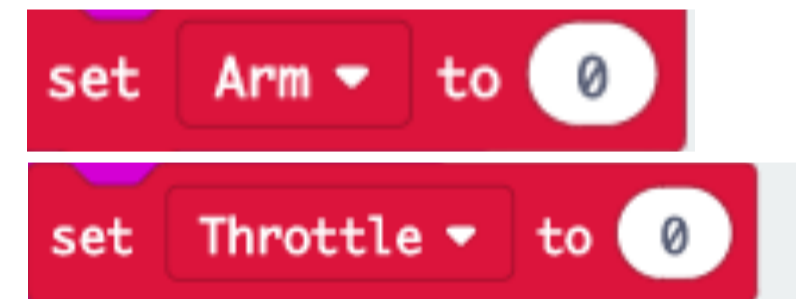
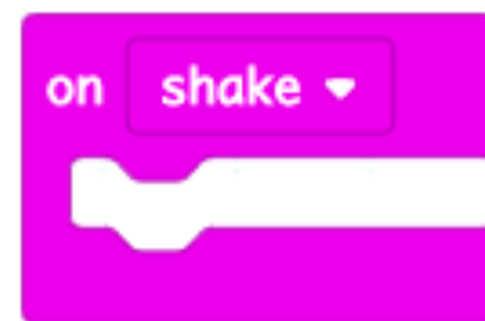
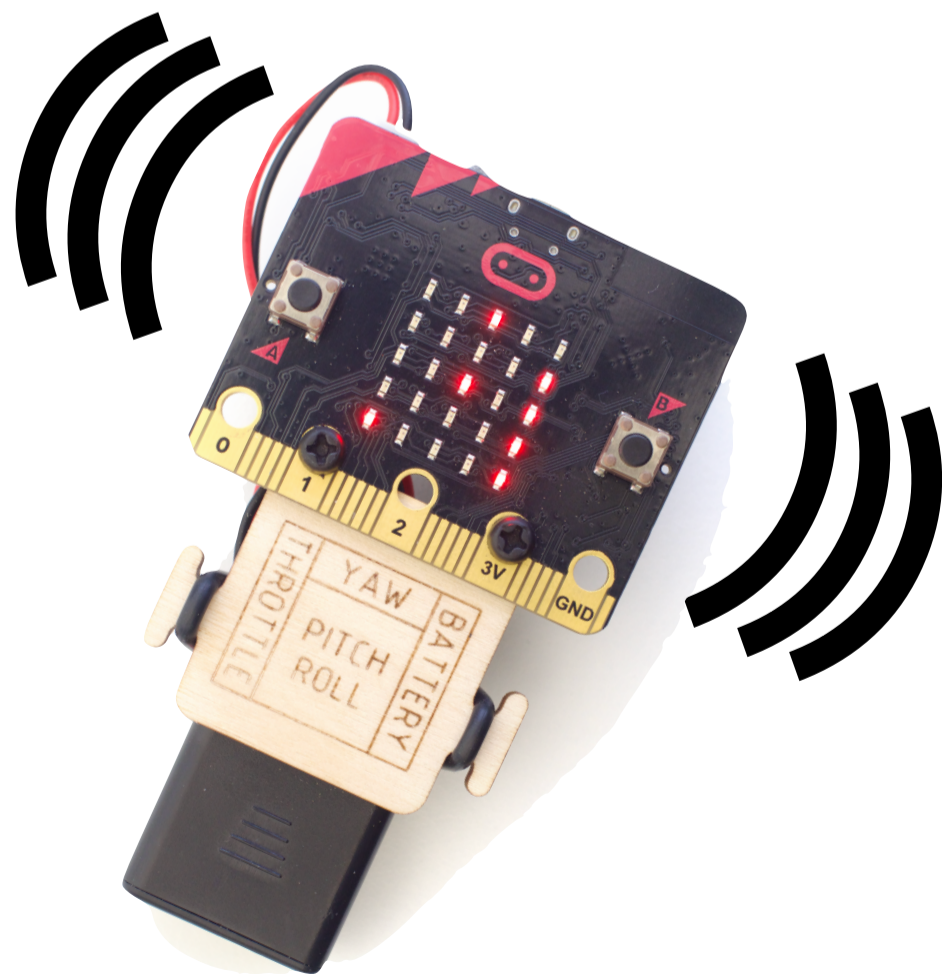
The code block is a purple 'when green flag clicked' block. It contains two 'set' blocks: 'set Arm to 0' and 'set throttle to 0'.

Panic feature

If we lose control of the drone or crash, a panic button will be handy. It will cut off the motors immediately.

Task:

- Use the On Shake feature to disarm the drone. It will detect a shake from the remote control.
- Think twice before using the feature from above 2 meters altitude or the drone can crash and be damaged.



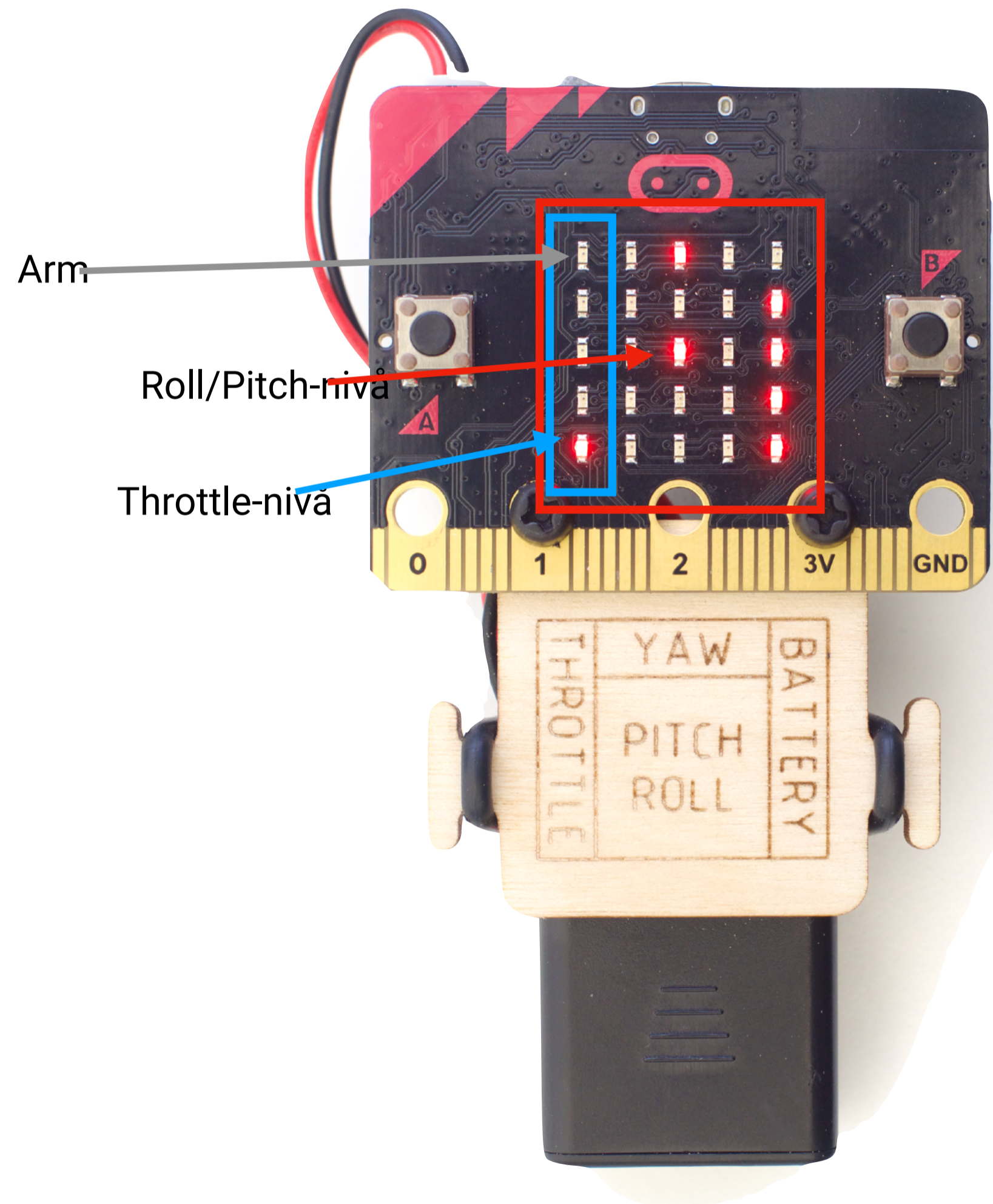
Solution



Visualise the variables

We can use the display to show basic information from our PARTY values.

- Arm-pixel lights when armed
- Throttle-pixel moves upwards when throttle increases (thrust)
- Roll and pitch is the X and Y position of the center dot



Visualise Arming

Arming

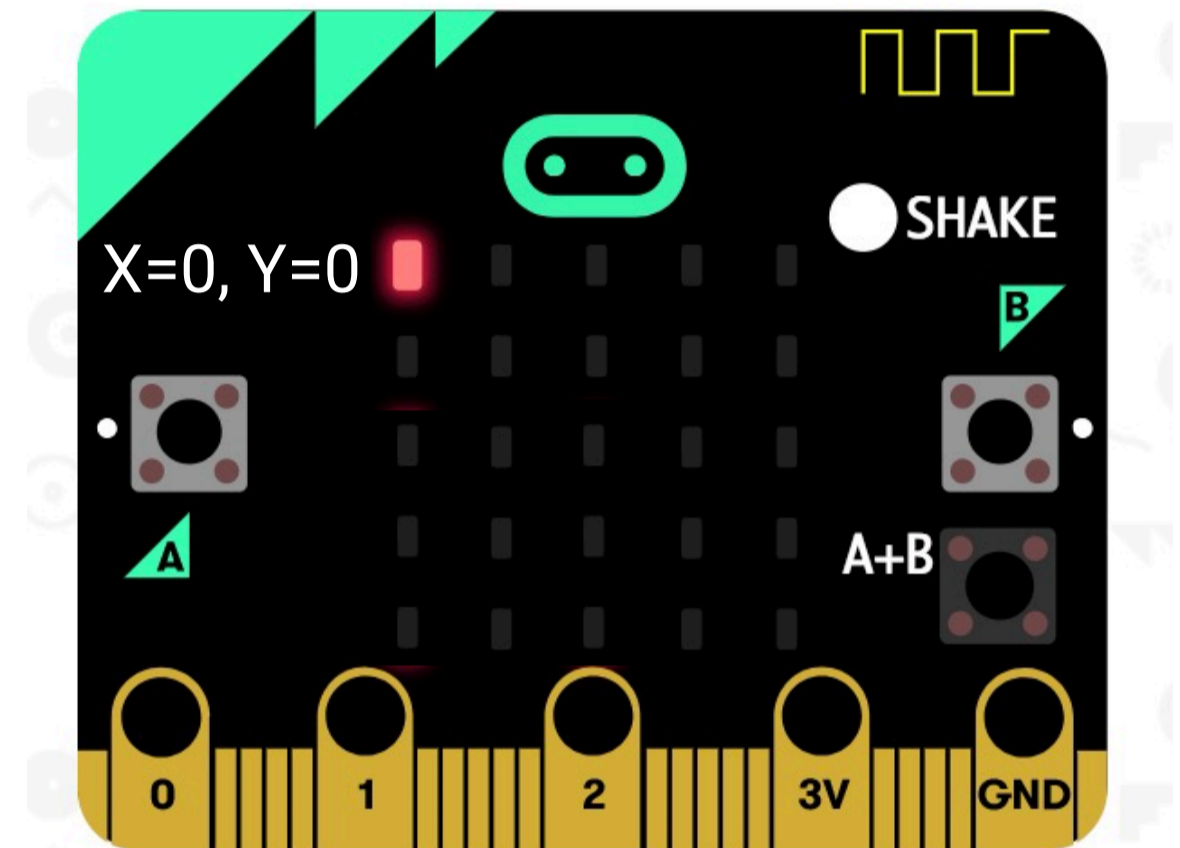
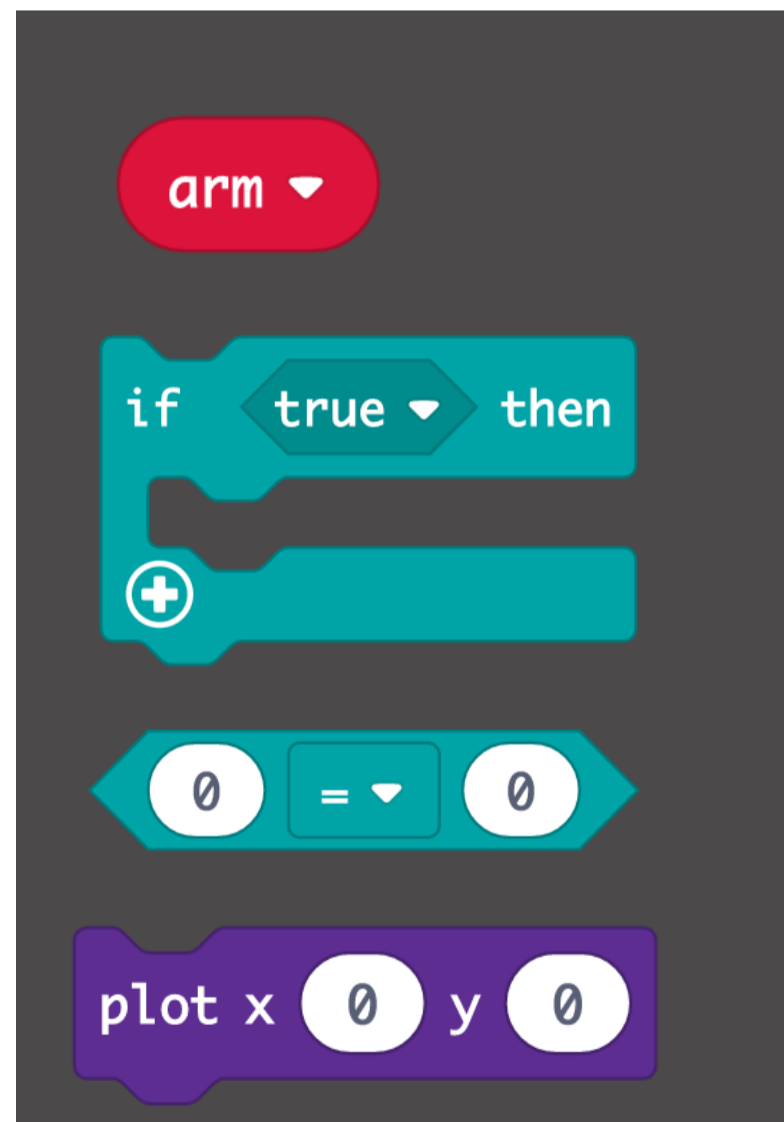
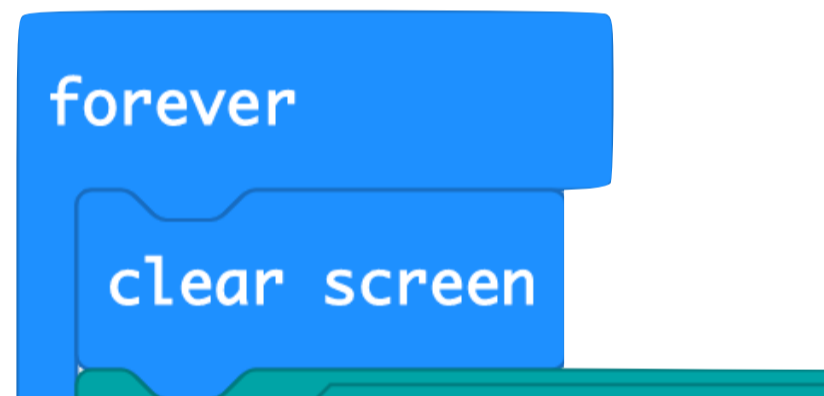
Use the screen to show if the drone is armed.

Find the forever-block.

Insert a clear screen block.

Use the if-block to check if arm is on (armed).

If armed plot at 0,0 (or another place off your choice)



- **Extra challenge:** Make the pixel blink

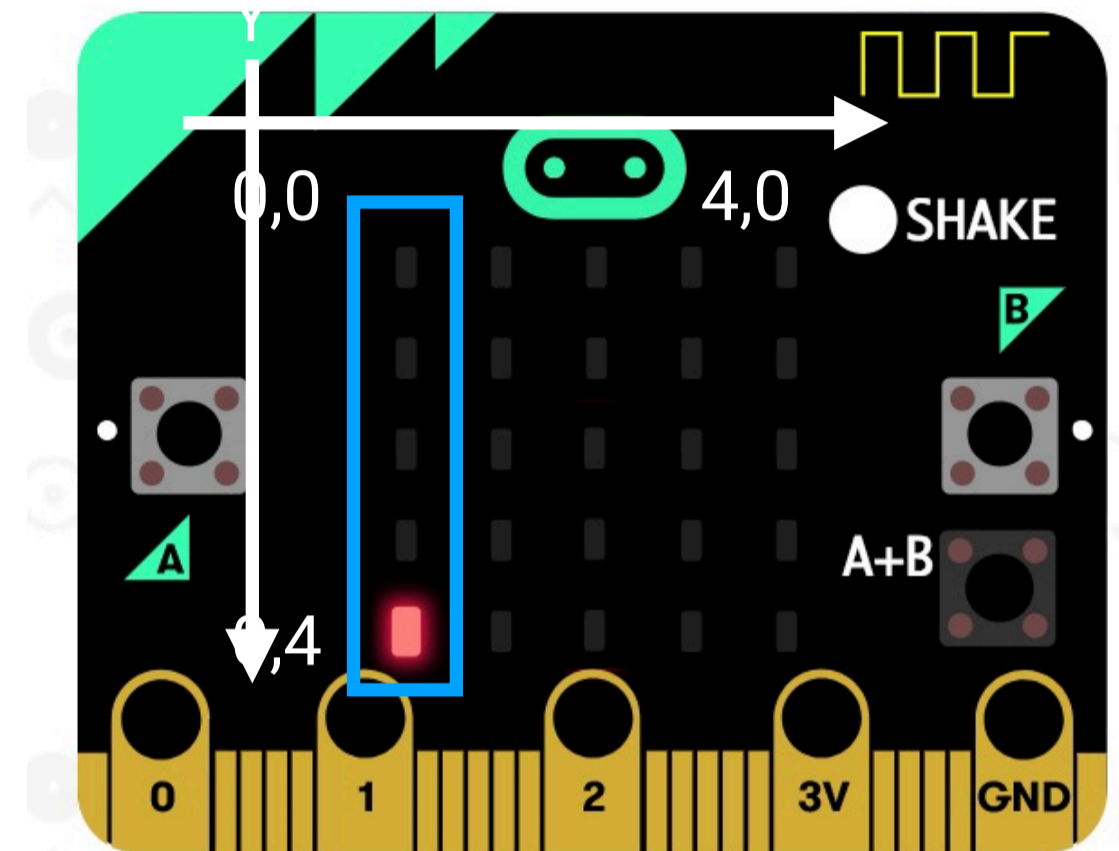
Solution

```
+ clear screen + + + +  
+ if Arm ▼ then + + + +  
+ plot x 0 y 0 + + + +  
+ + + +
```

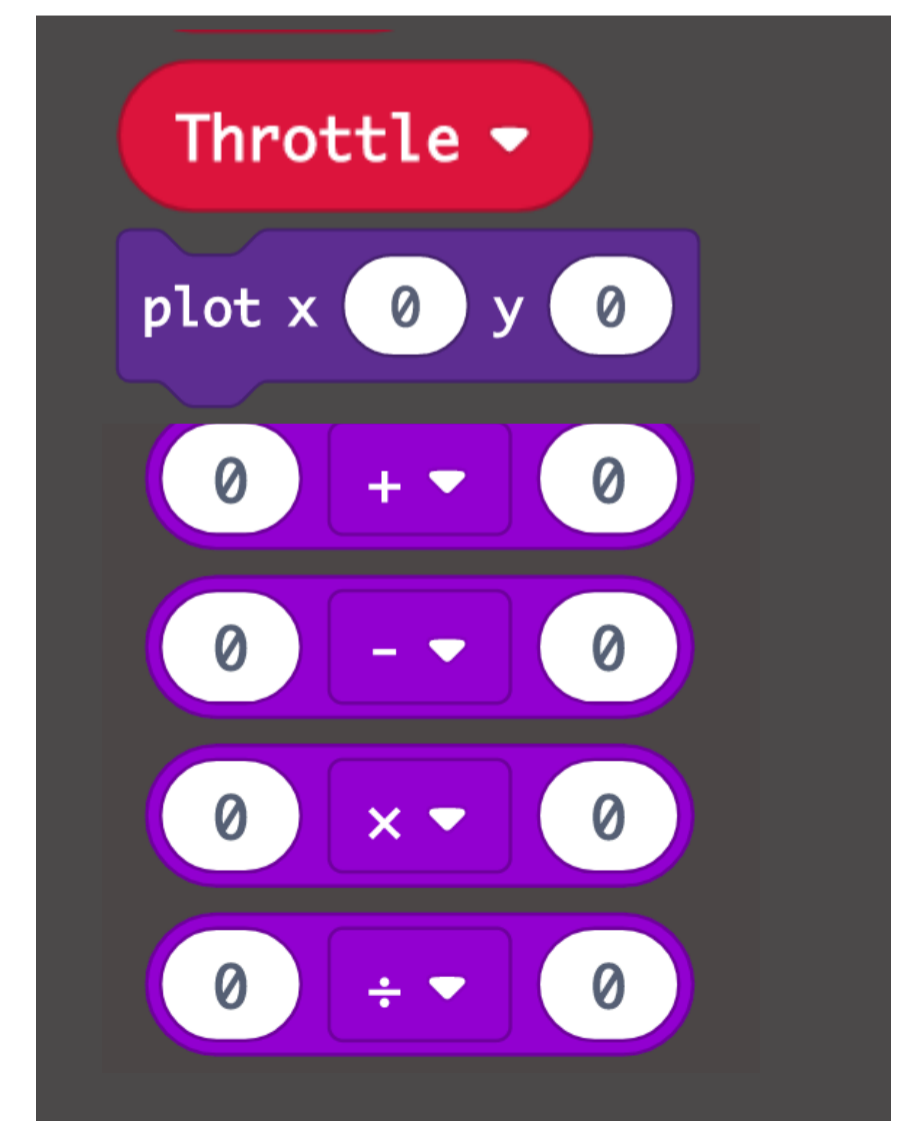

Visualise values: Throttle

Throttle

- We can indicate our throttle using the pixels on the left (blue frame)
- We need to translate our numbers according to the table below so that 0 gives 4, 50 gives 2 and 100 gives 0.
- Can you solve the equations?
- Hint:
 - We need to do a division in the first calculation
 - Then we need to do a subtraction in the second.



Throttle	0	50	100
First calculation	0	2	4
Second calculation	4	2	0



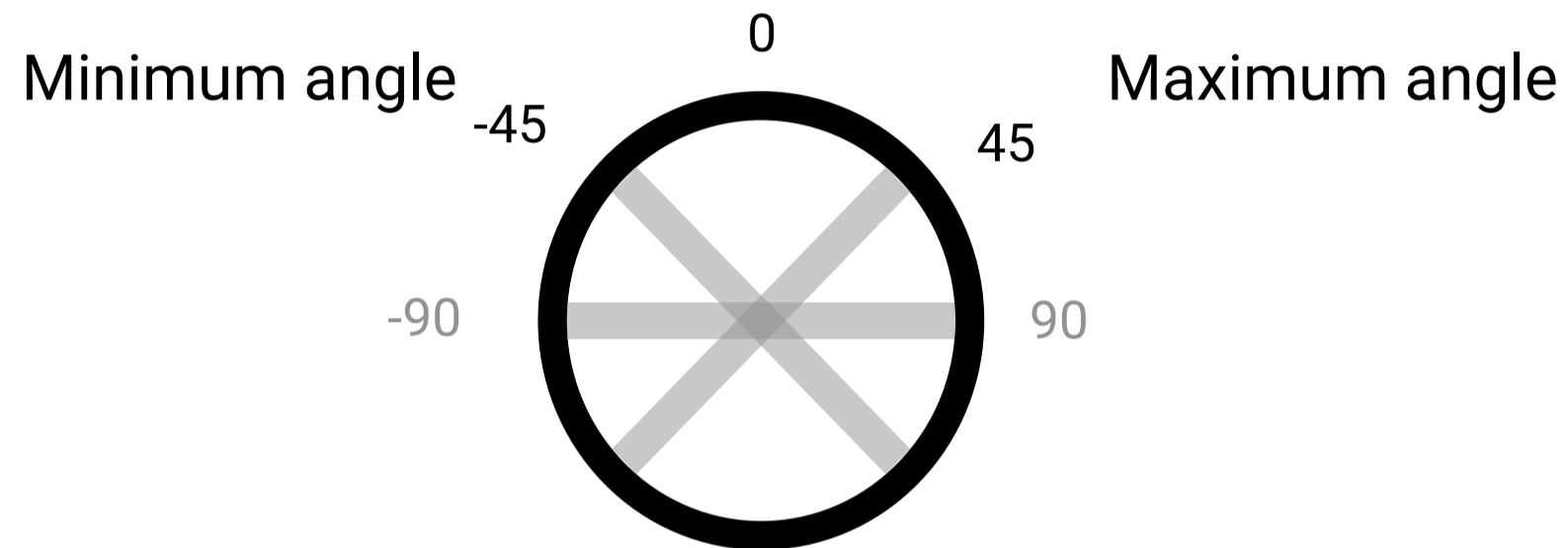
Solution

$$\text{Pixel Y} = 4 - \text{throttle} / 25$$

The image shows a Scratch script on a grid background. It starts with a blue 'forever' loop block. Inside the loop, there are two red 'set' blocks: 'set Roll to rotation (°) roll' and 'set Pitch to rotation (°) pitch'. Below these is a light blue 'clear screen' block. Then there is a teal 'if Arm then' block. Inside the 'if' block, there is a purple 'plot x 0 y 0' block. Below the 'if' block, there is a dark purple 'plot x 0 y 4 - throttle ÷ 25' block. A plus sign icon is visible on the left side of the 'if' block.

Throttle / 25 goes in the inner block

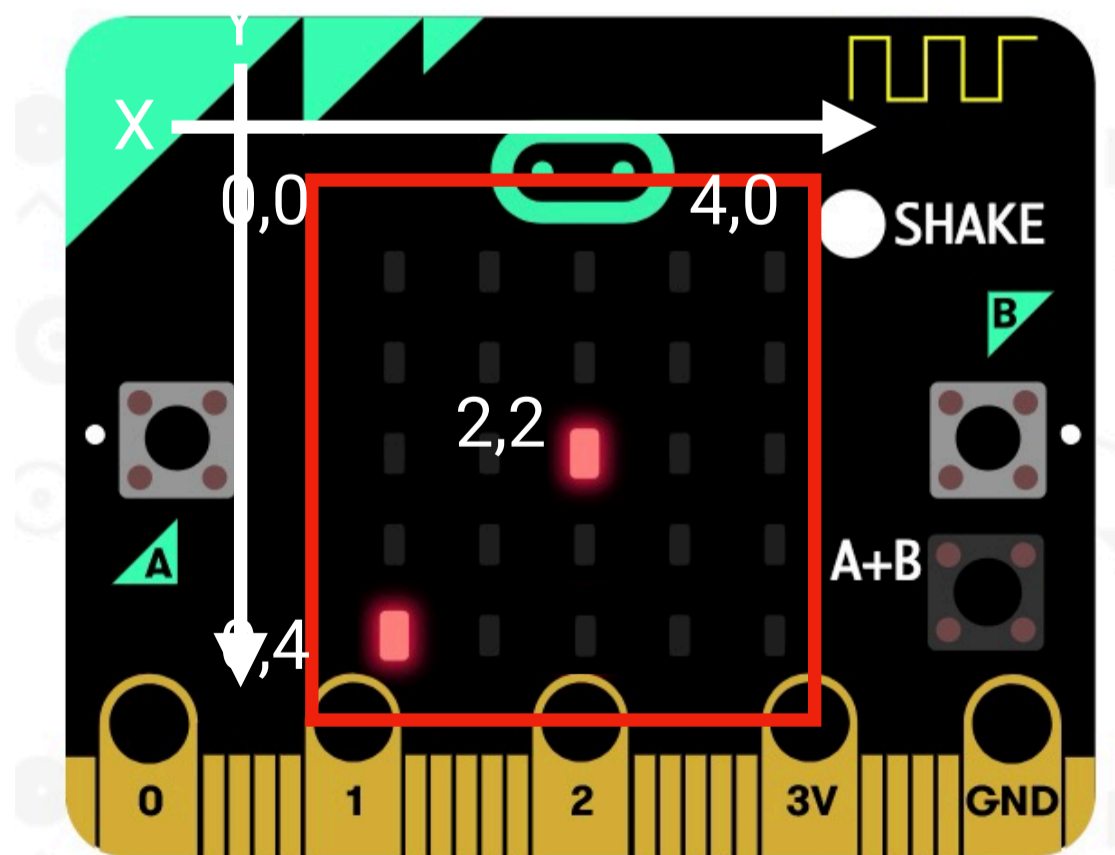
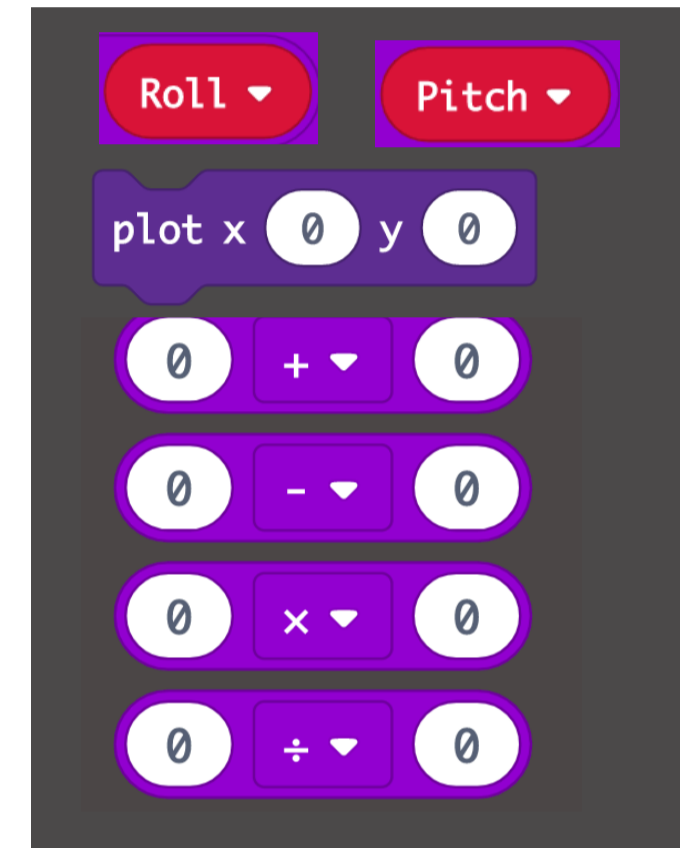
Visualise values: Roll/Pitch



Roll / Pitch

- We can indicate our Roll and Pitch angles using center pixel's X and Y position
- We need to translate our numbers according to the table below so that -45 gives 0, 0 gives 2, and 45 gives 4
- Can you solve the equations?
- Hint:
 - We need to do an addition in the first calculation
 - Then we need to do a division in the second.

Angle	-45	0	45
First calculation	0	45	90
Second calculation	0	2	4



Solution



Roll + 45 in the innermost block

Pitch + 45 i the innermost block



Tip! You can also use javascript. It can be easier to see the whole formula. In code, division and multiplication goes before subtraction and addition automatically. You will need parentheses if you want the + or - to be done first.

Be careful: There is not much room for typing errors in javascript.

```
led.plot(0, 4 - throttle / 25) (Division before subtraction)
```

```
led.plot((Roll + 45) / 22.5, (Pitch + 45) / 22.5) (Addition before division)
```

An easier alternative to functions

We can also map the values using this block



Original value

Lowest expected value

Highest expected value

Lowest output value

Highest output value

Example:



Two solutions

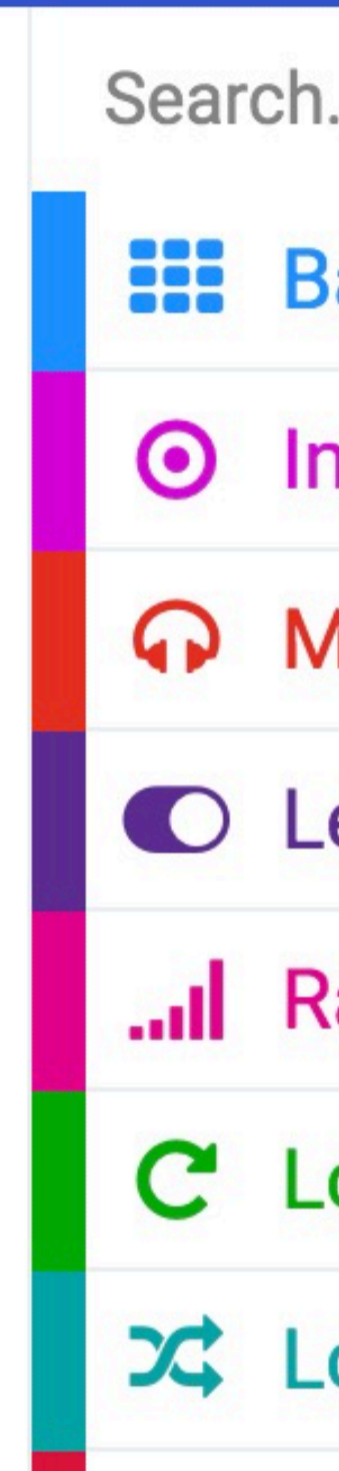
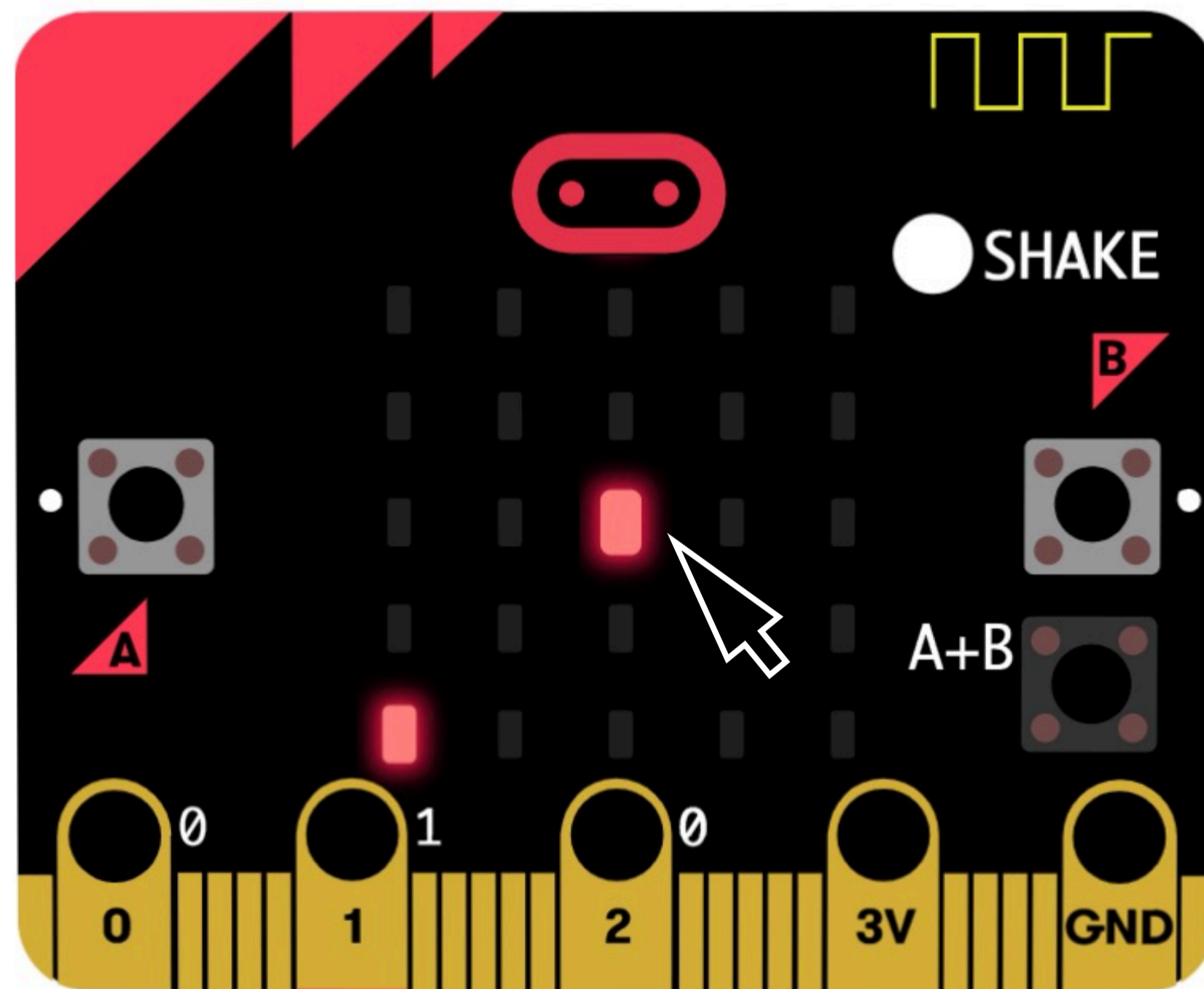
```
if Arm = 1 then
  plot x 0 y 0
  +
  plot x 0 y 4 - Throttle ÷ 25
  plot x 45 + Roll ÷ 18 y 45 + Pitch ÷ 18
```

With functions

```
if Arm = 1 then
  plot x 0 y 0
  +
  plot x 0 y map Throttle from low 0 high 100 to low 4 high 0
  plot x map Roll from low -45 high 45 to low 0 high 4 y map Pitch from low -45 high 45 to low 0 high 4
```

With mapping

Does it work?



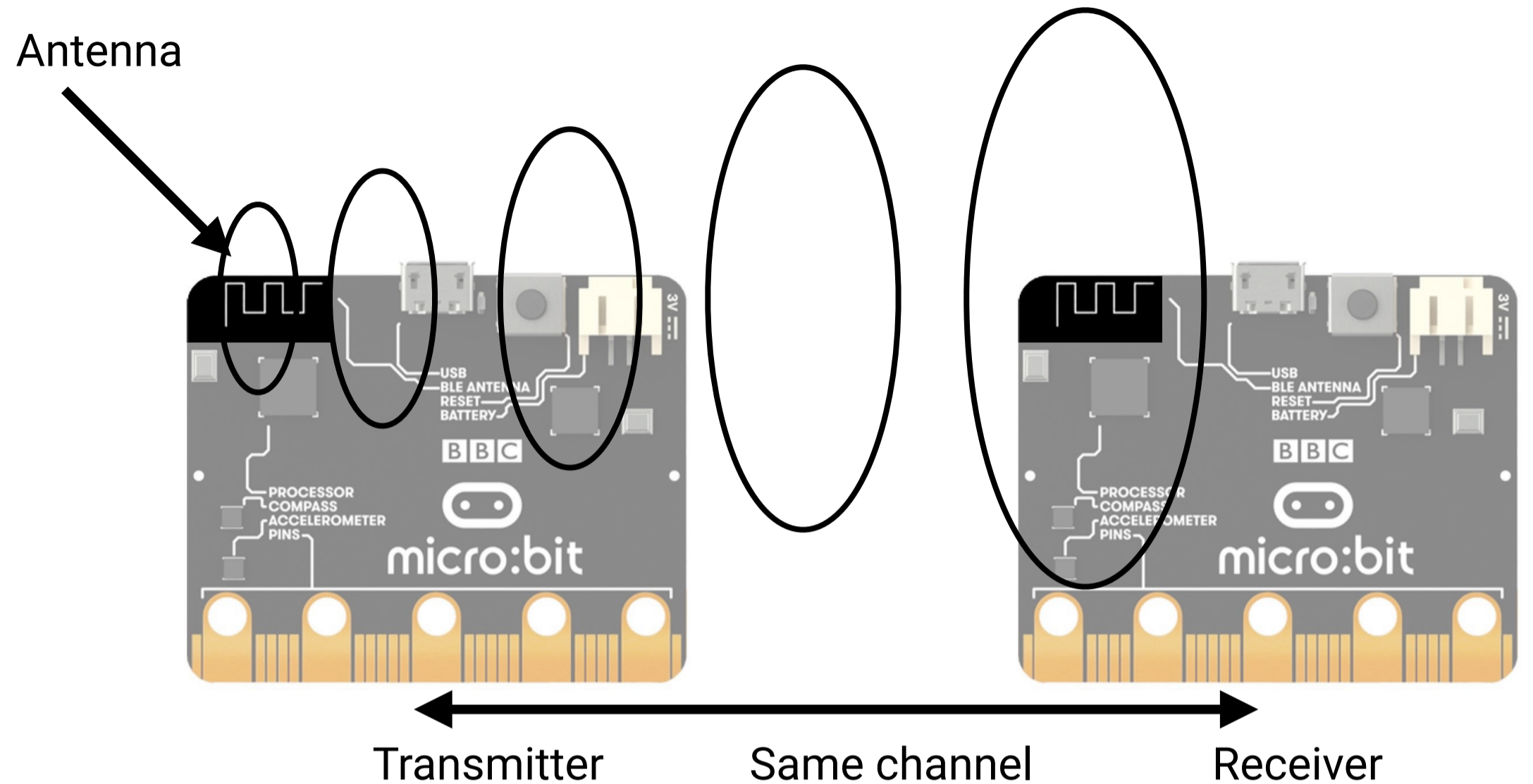
Test it in the simulator:

- The center dot follows the mouse arrow's movement
- The throttle-pixel on the left is rising when pressing B multiple times
- A + B results in a lit ARM-pixel and throttle will go down to lowest position.

Radio

```

radio send value "name" = 0
radio set group 1
    
```



Task:

- In the On Start block:
 - Make a value called radioGroup or similar and set it to your radio channel
 - Show the number
 - Use radio set group to make the channel take effect
- We need to transmit a letter "string" in pair with the number for the receiver to know the number.
- Use a capital letter for each of the 5 PARTY-values.
- Yaw can be skipped

```

on start
  set RadioGruppe to 7
  show number RadioGruppe
  radio set group RadioGruppe
    
```

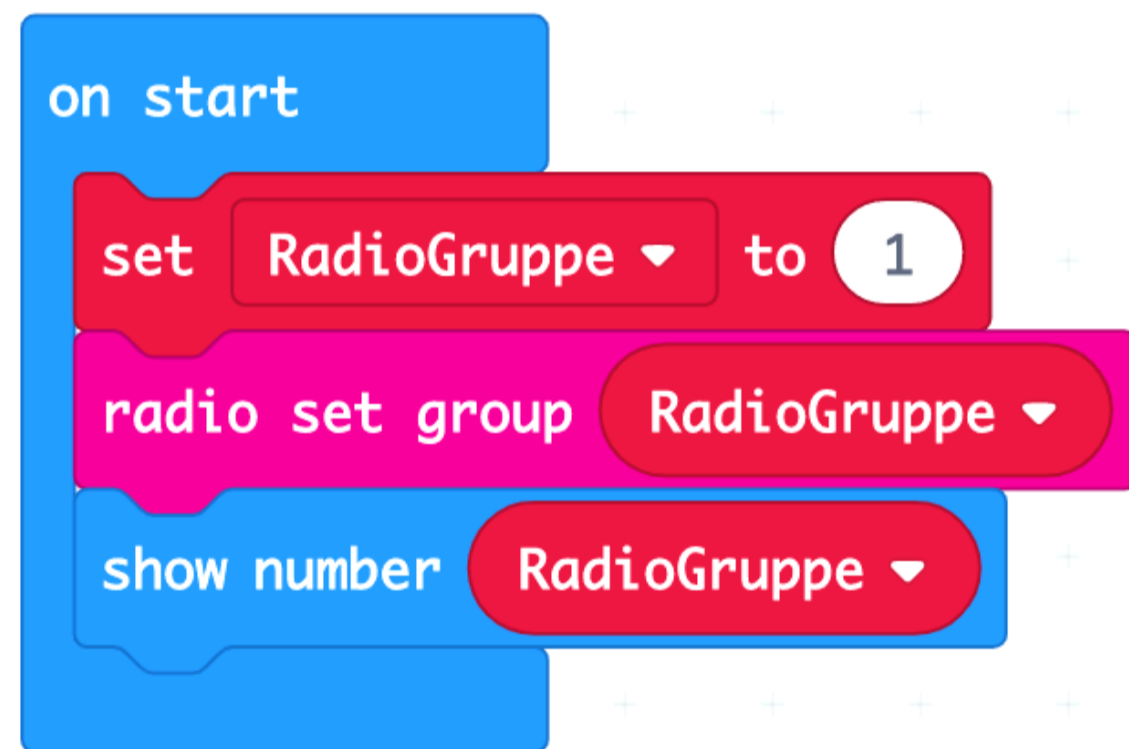
Example:

```

radio send value "P" = Pitch
    
```

Solution

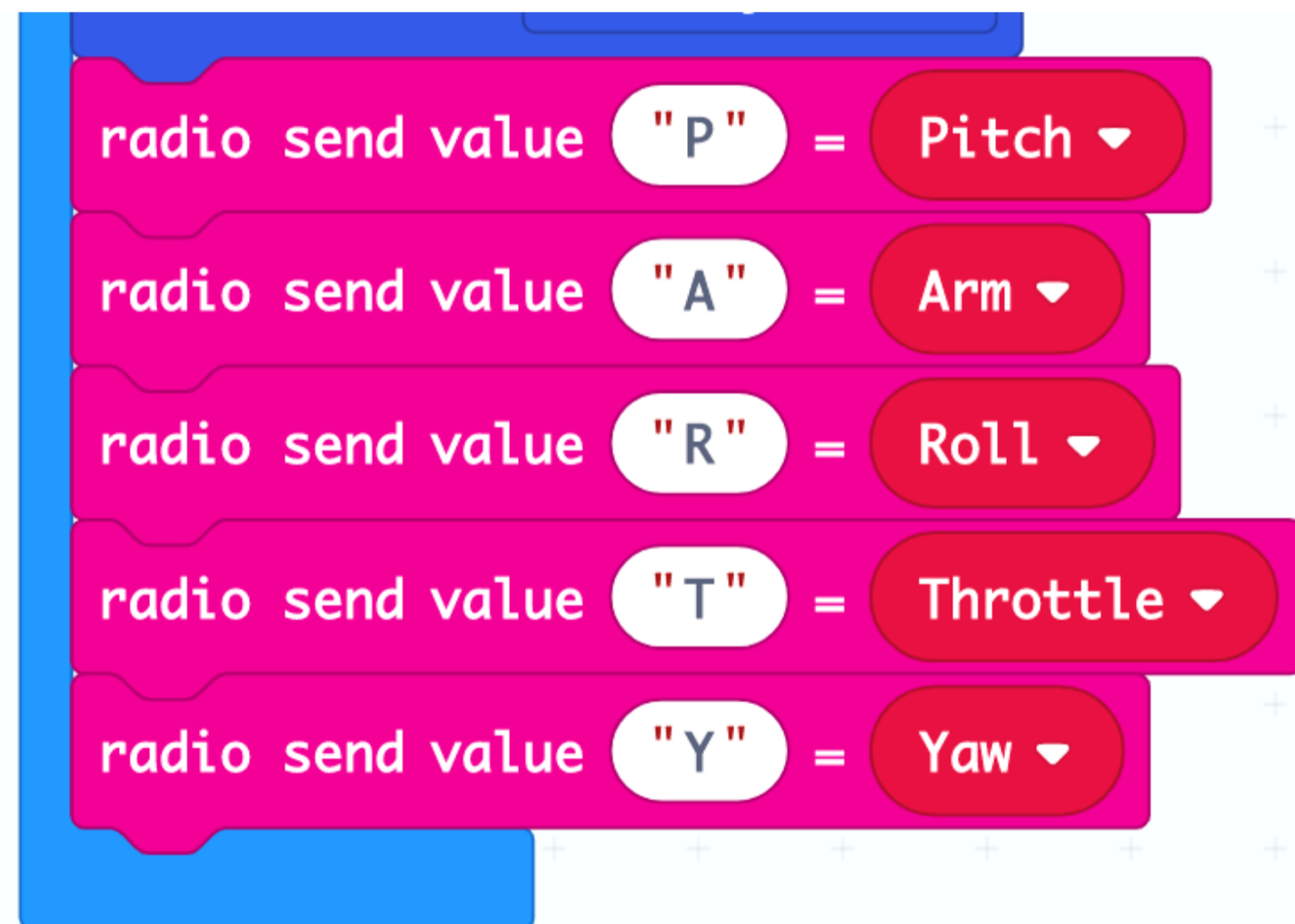
Your unique radio group



```
on start
  set RadioGruppe to 1
  radio set group RadioGruppe
  show number RadioGruppe
```

The image shows a Scratch 'on start' block containing three sub-blocks: 'set RadioGruppe to 1', 'radio set group RadioGruppe', and 'show number RadioGruppe'.

Bottom of forever block



```
radio send value "P" = Pitch
radio send value "A" = Arm
radio send value "R" = Roll
radio send value "T" = Throttle
radio send value "Y" = Yaw
```

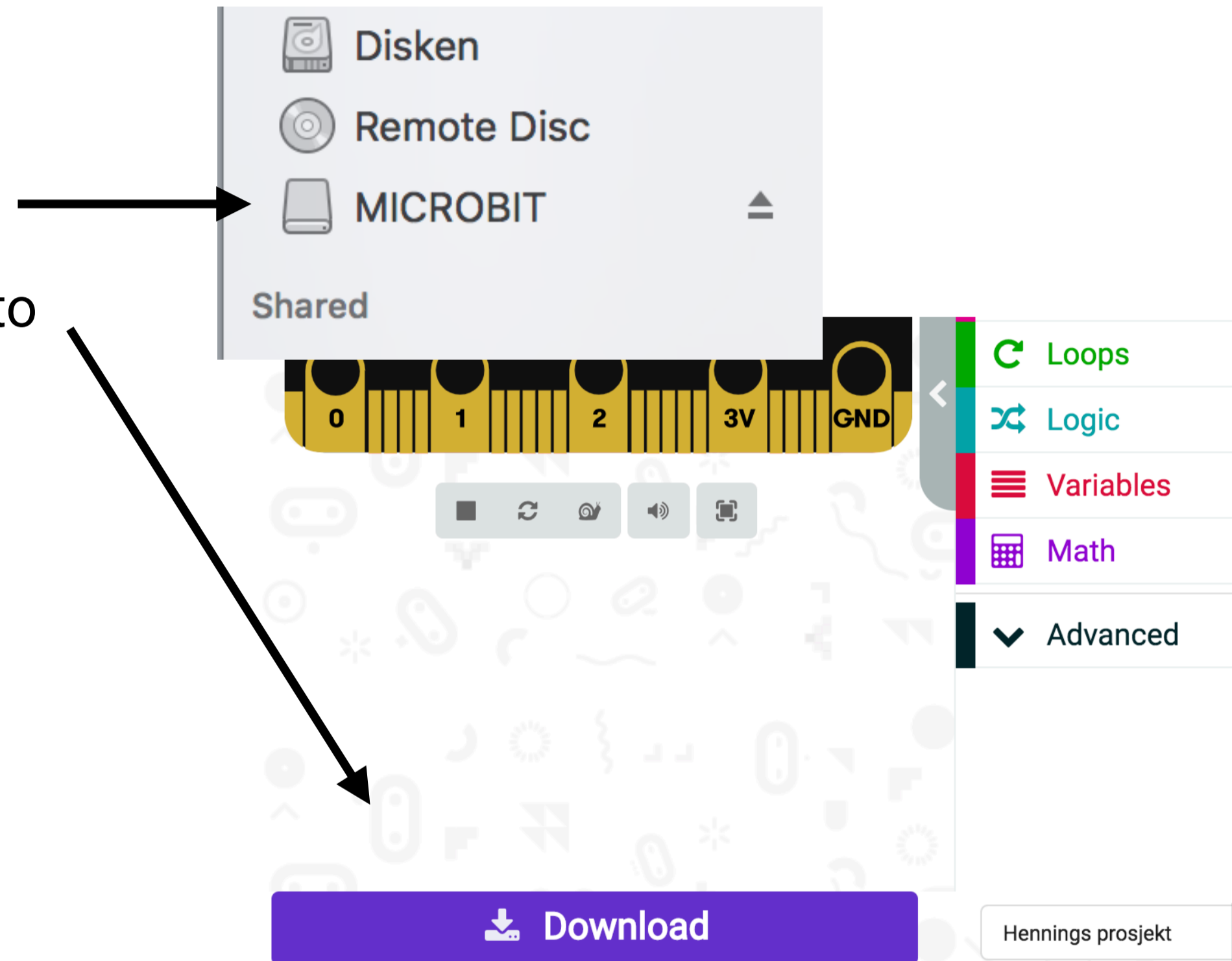
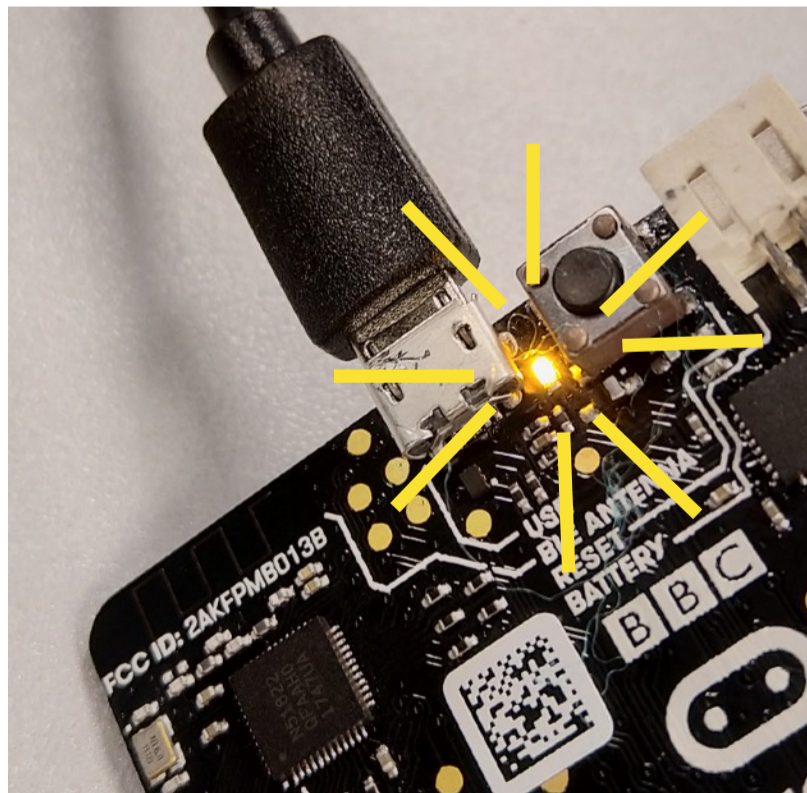
The image shows five 'radio send value' blocks stacked vertically, each with a letter in quotes and a corresponding sensor name: "P" = Pitch, "A" = Arm, "R" = Roll, "T" = Throttle, and "Y" = Yaw.

Remember: capital letters

Yaw can be skipped

Download the code

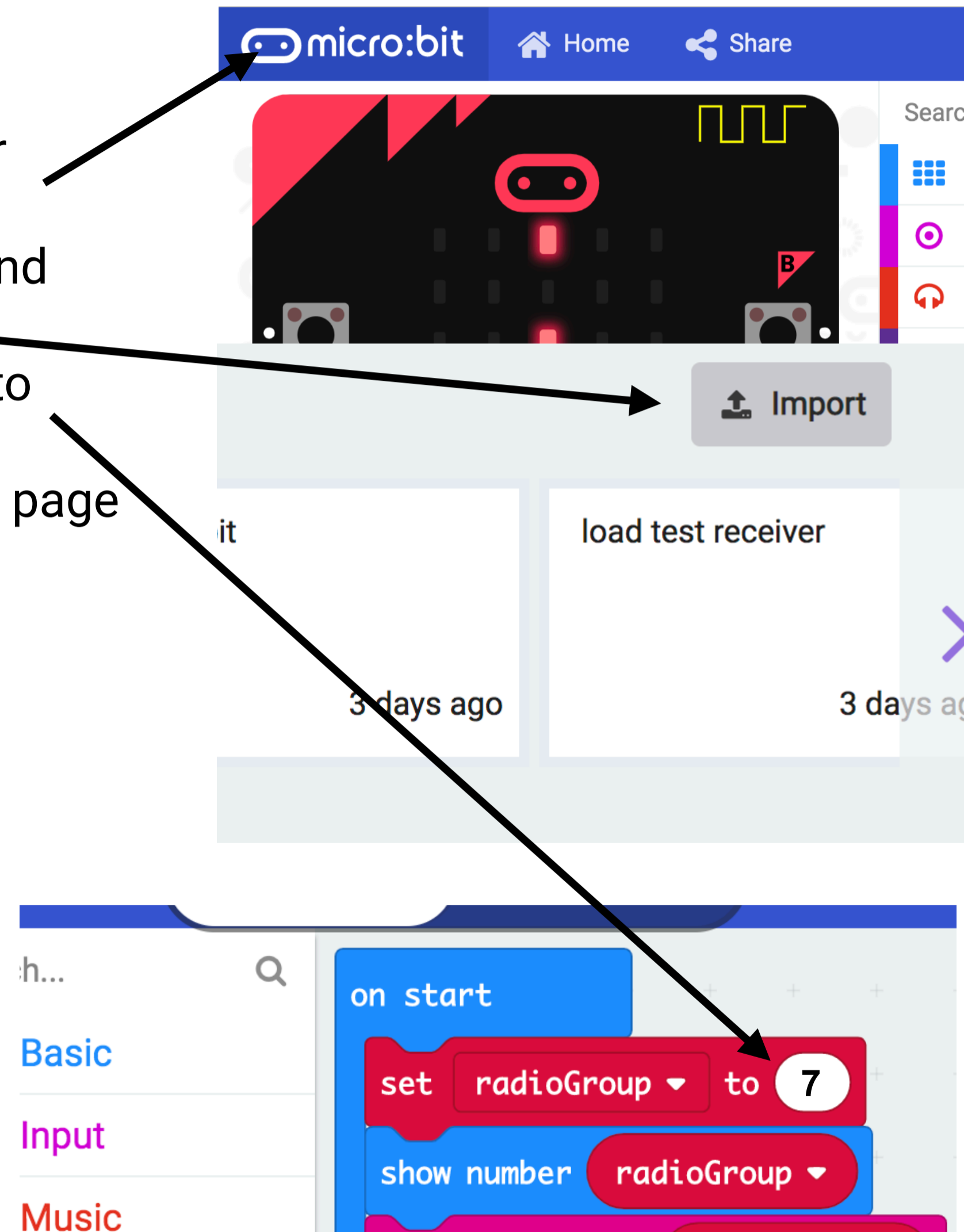
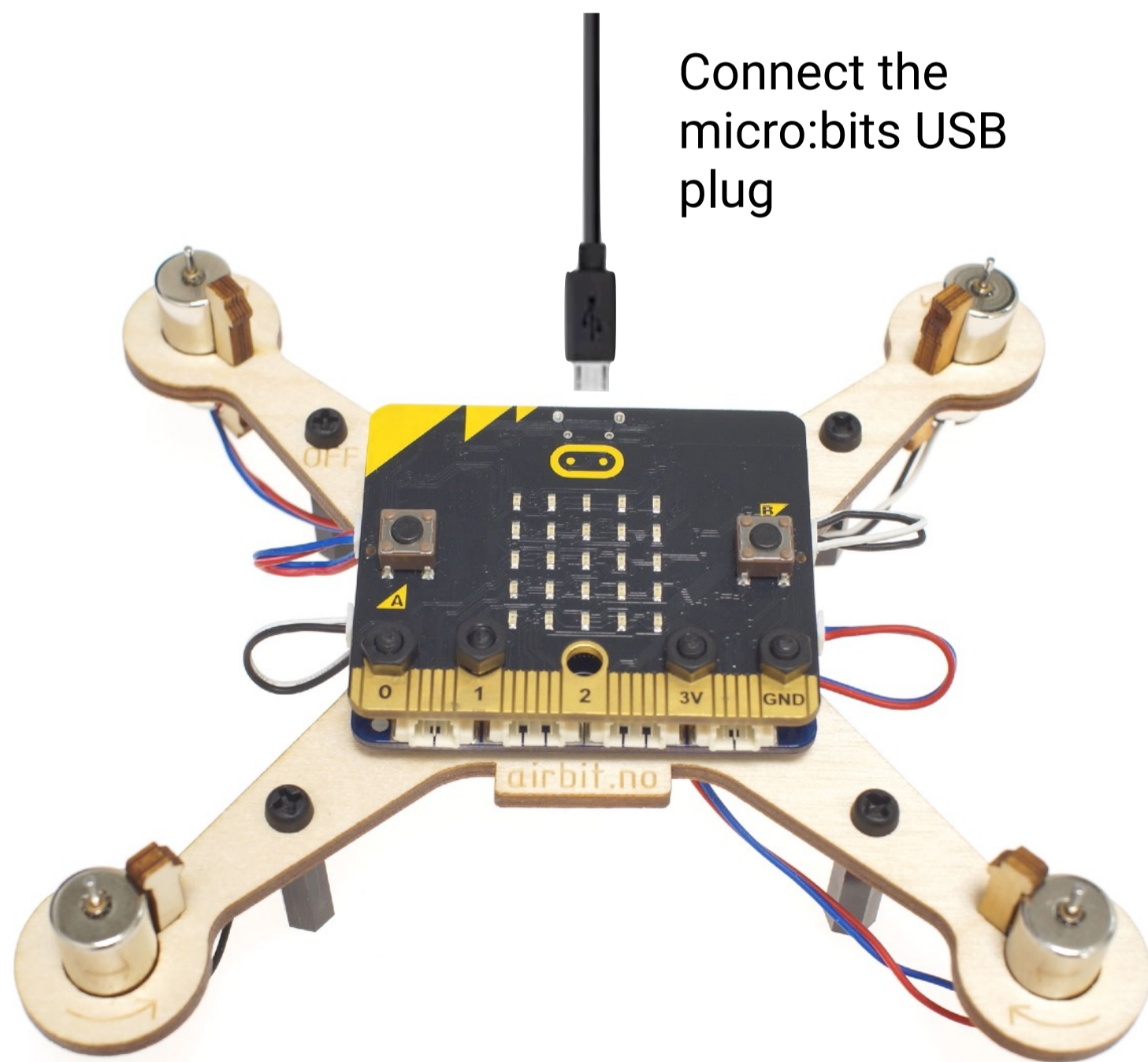
1. Connect your micro:bit to the micro usb
2. Microbit appears as a drive
3. Press "Download" and copy the file to the MICROBIT drive.
4. Watch the orange light on the back and make sure it flashes when code is downloaded



Read more about connecting the micro:bit See the micro:bit introduction at makekit.no/

The drone code

1. Download the drone code called "Airbit" or "Wonderbit Airbit"
2. Open the file in the editor. Click "import" and select the file
3. Make sure you have the right radio group to match your transmitter
4. Download the code as seen on the former page

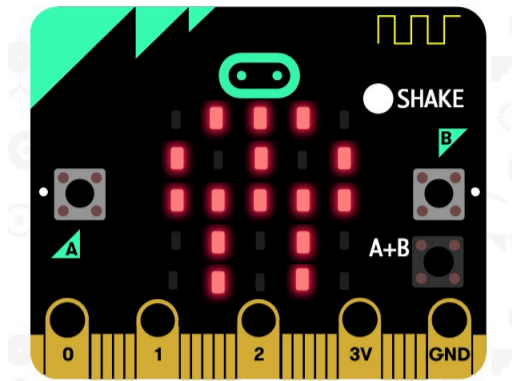


Flying

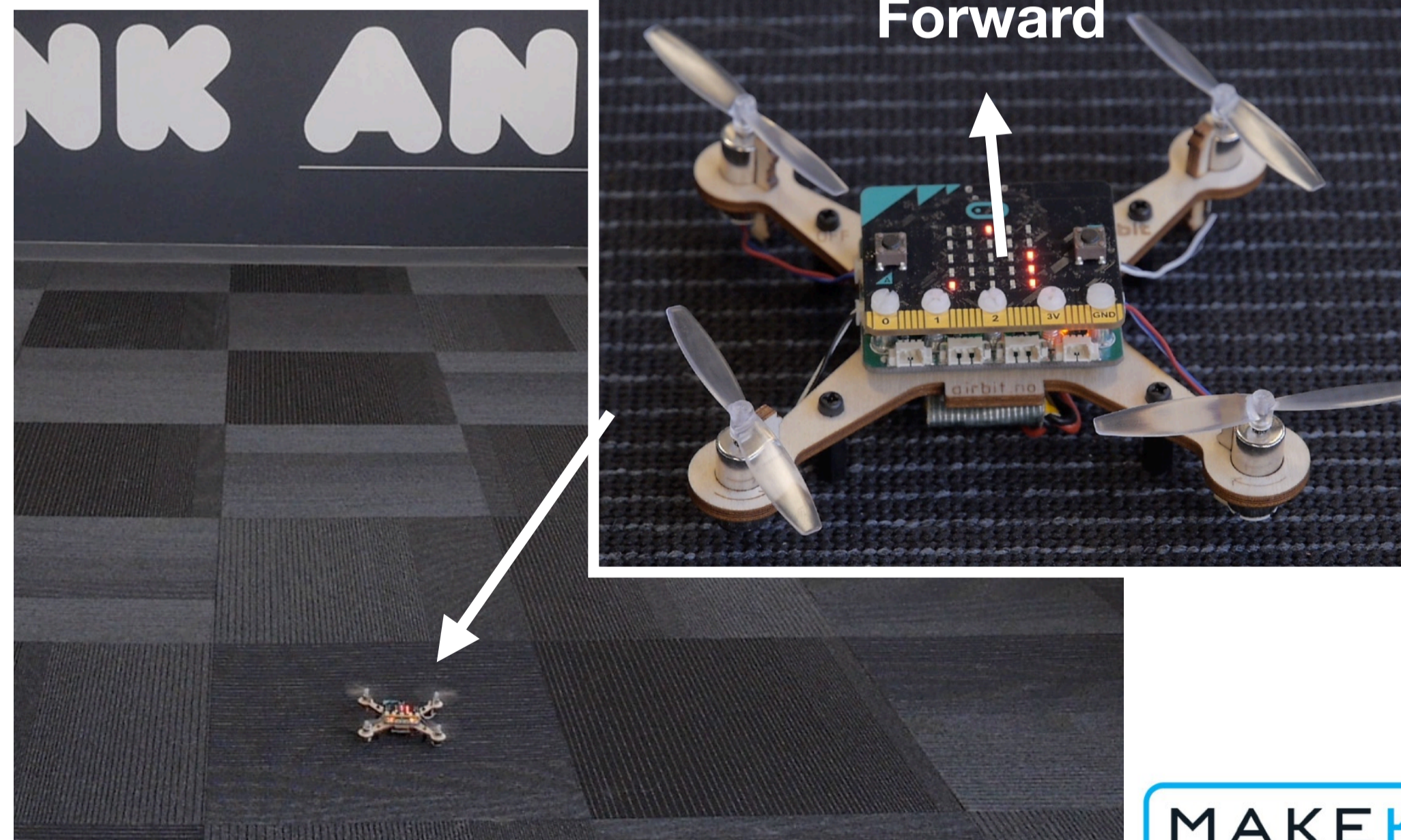
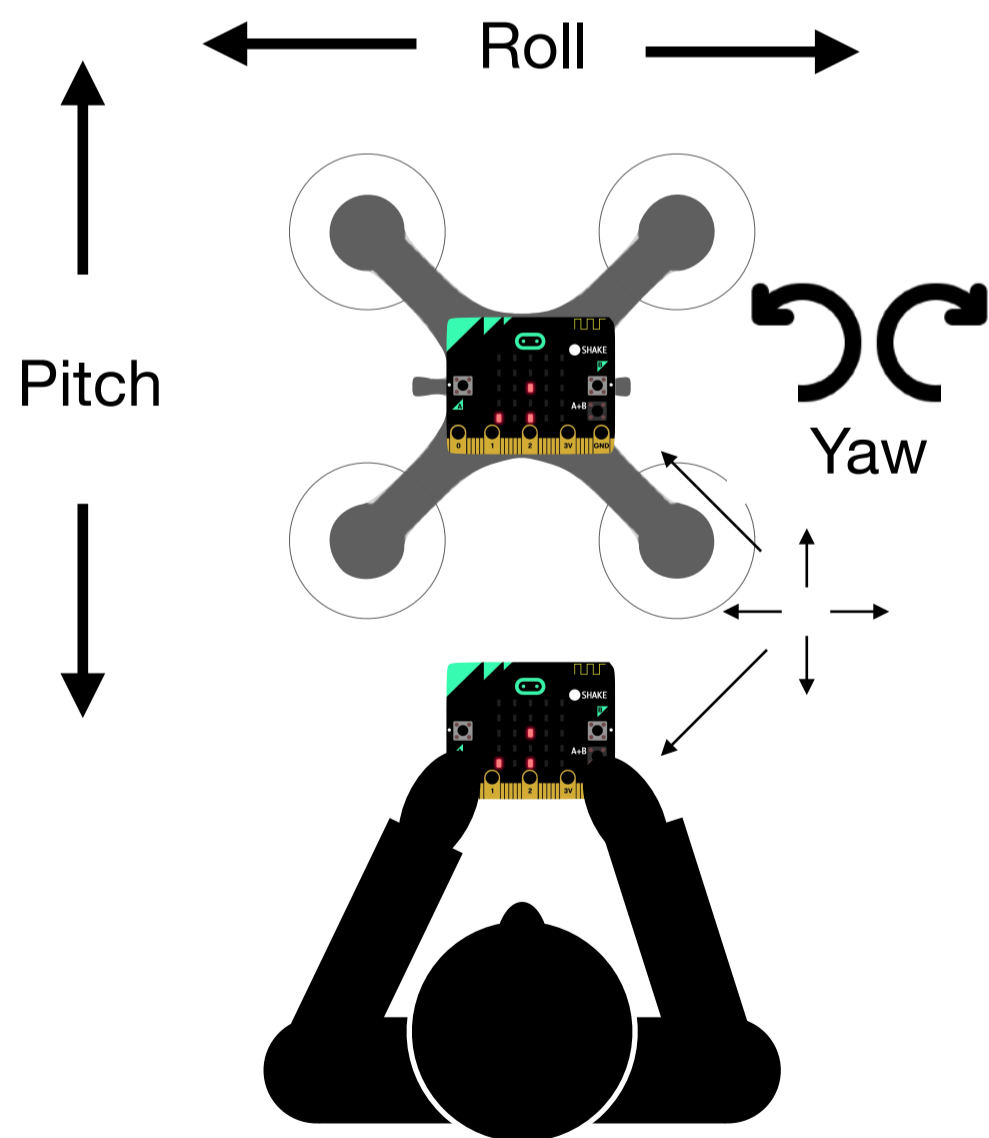


Video: <https://youtu.be/VMF9uehLfg8>

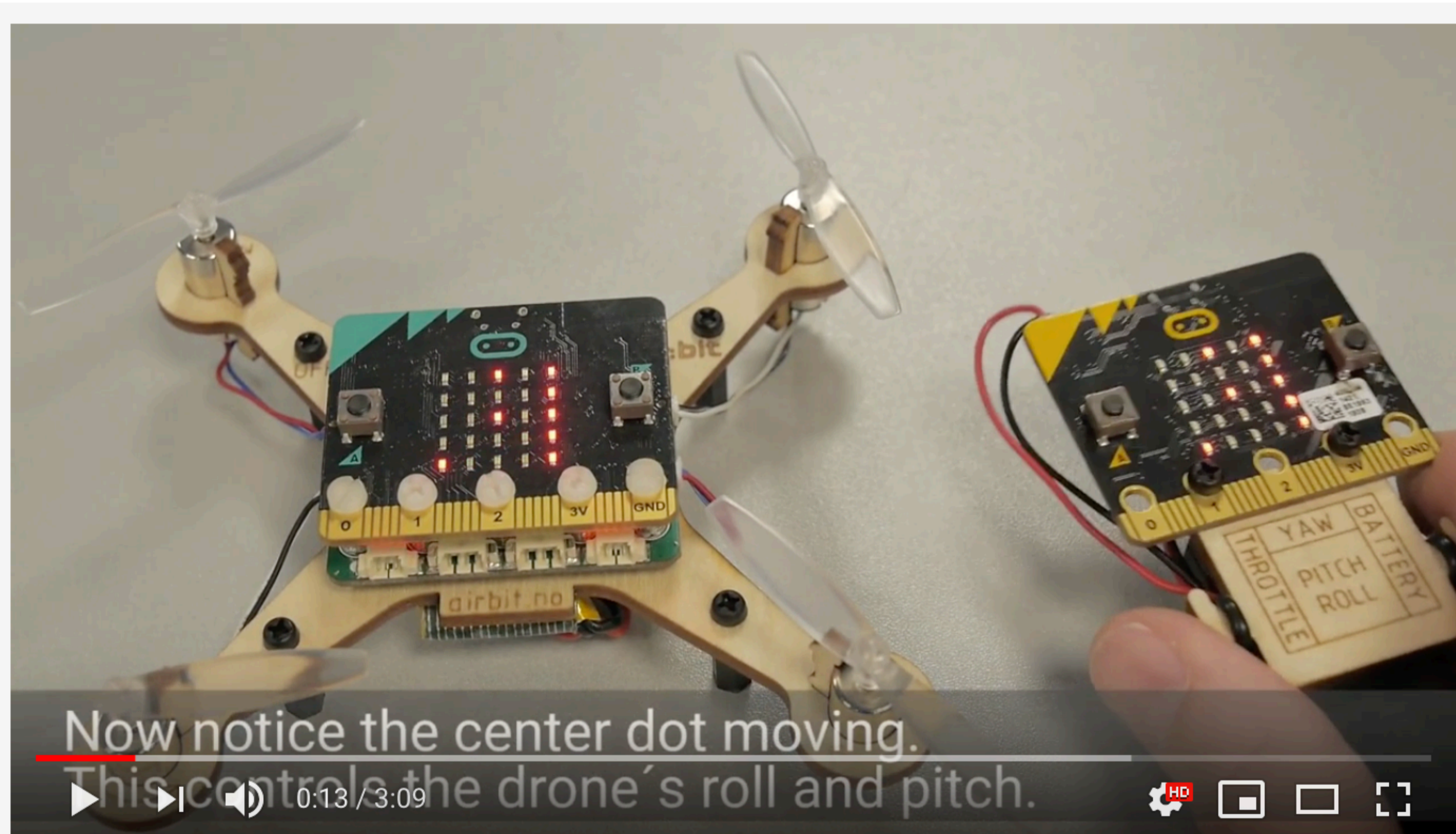
- Find an open room without obstacles, indoor or outside at a grass field or similar
- Carpets and low ceiling lowers the risk of damaging the drone. Fly low and over soft surfaces.
- Keep children under 8 and animals at a safe distance
- Place the drone in the middle of the space, with the microbit's "face" towards you
- Start the propellers by pressing A + B simultaneously
- Increase throttle step by step until the drone is hovering 10-30 cm above the ground
- Move the micro:bit transmitter to steer the drones roll and pitch
- As soon as drone starts to climb, lower throttle a bit to maintain altitude
- If you need to emergency stop: shake the remote
- When the battery is empty, the battery icon will blink, then drone will land and a skull appears
- Follow local drone regulations



Battery empty



See the video: <https://youtu.be/VMF9uehLfg8>



Problems?

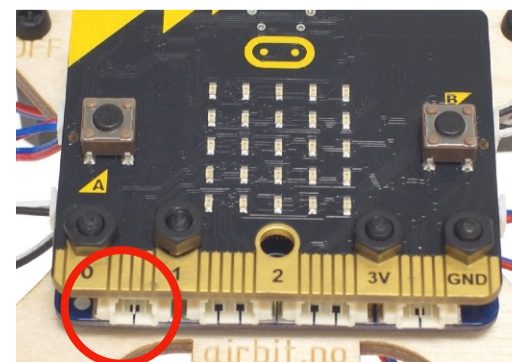
Place drone on ground, wait at least 5 seconds. Press A+B on remote and release quickly. Press a couple of times and watch the propellers closely to see if they starts and stops to spin.

Can't start the motors/propellers

- Is the micro:bit on the drone receiving the radio signal? The dots on the screen should move when you move the remote. Check and re-upload code for transmitter and receiver. Make sure they are on the same radio channel. You can try with ready made code for both transmitter and receiver.

- Are the barrel nuts tightened? On the drone, remove the micro:bit, tighten the barrel nuts, add the micro:bit, tighten the nuts again. Disconnect usb and switch power off and on again.

- If this orange light keeps blinking for a long time, the blue card it doesn't have signal on Pin 1



Motor starts, but can't lift off

Do you have the motors correctly placed and connected correctly? (Page 18)

Have you placed the proper propeller on the right motor? (Page 21)

Are all the motors working and spinning?
Can there be a damaged motor?

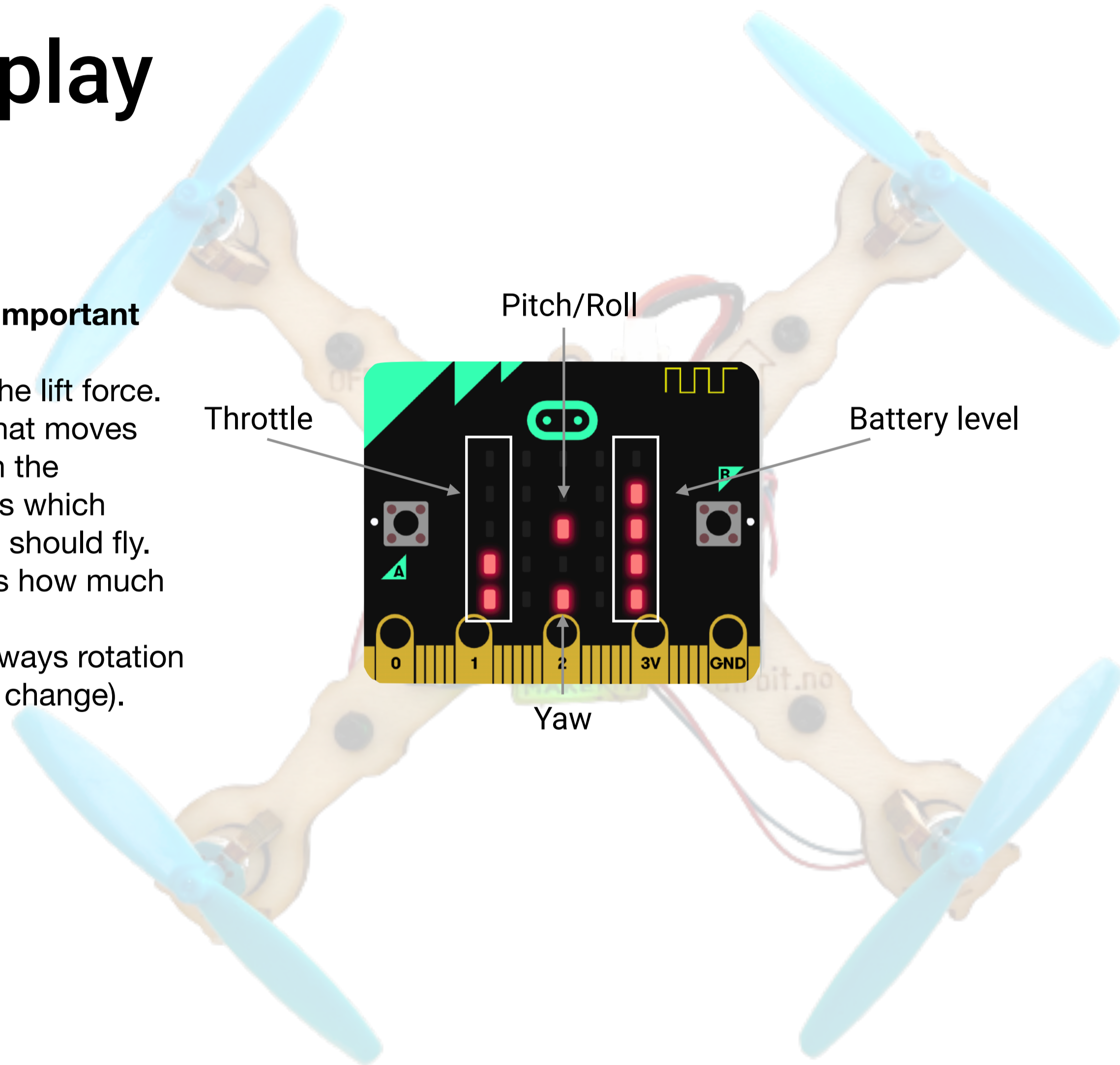
Have you placed the drone the proper way and given enough throttle? Need about 50-60% to lift off. See page 52.

Is the battery charged?

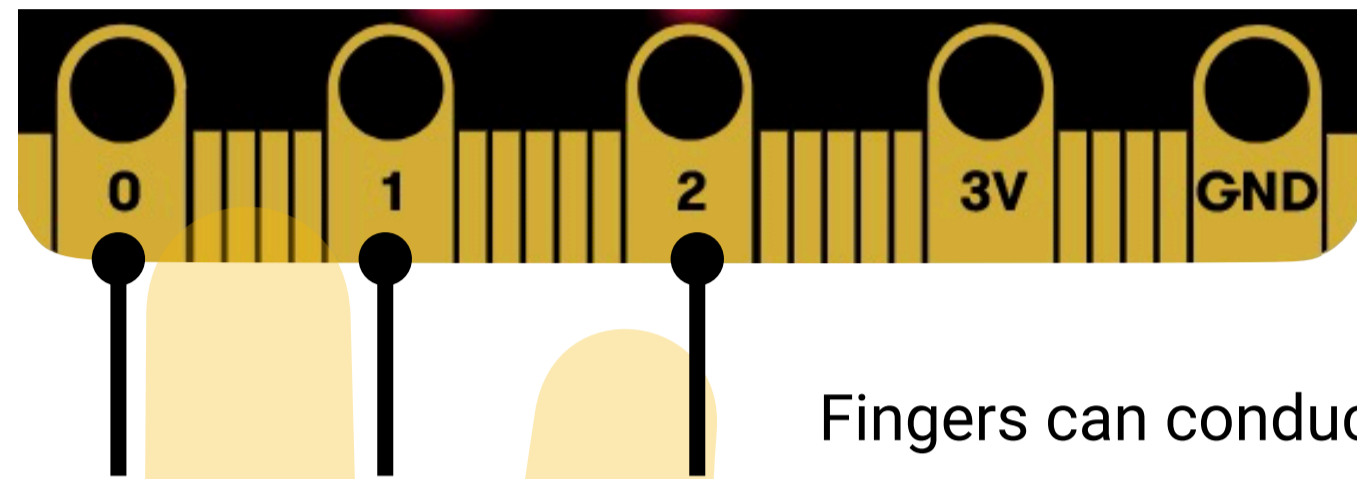
The display

The screen shows important information:

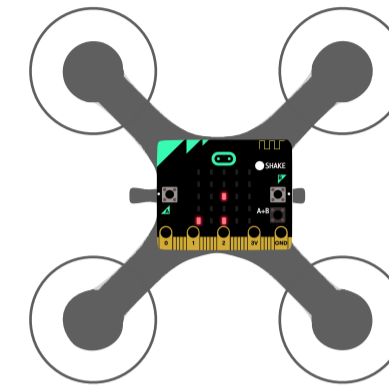
- Throttle indicates the lift force.
- Pitch/roll is a dot that moves synchronously with the transmitter and tells which direction the drone should fly.
- Battery level shows how much power is left.
- Yaw indicates sideways rotation (normally does not change).



Extra task: Yaw



Fingers can conduct electric current



Yaw is a sideways rotation

Yaw

Yaw makes the drone rotate sideways around its center. You can make artificial button and control the yaw.

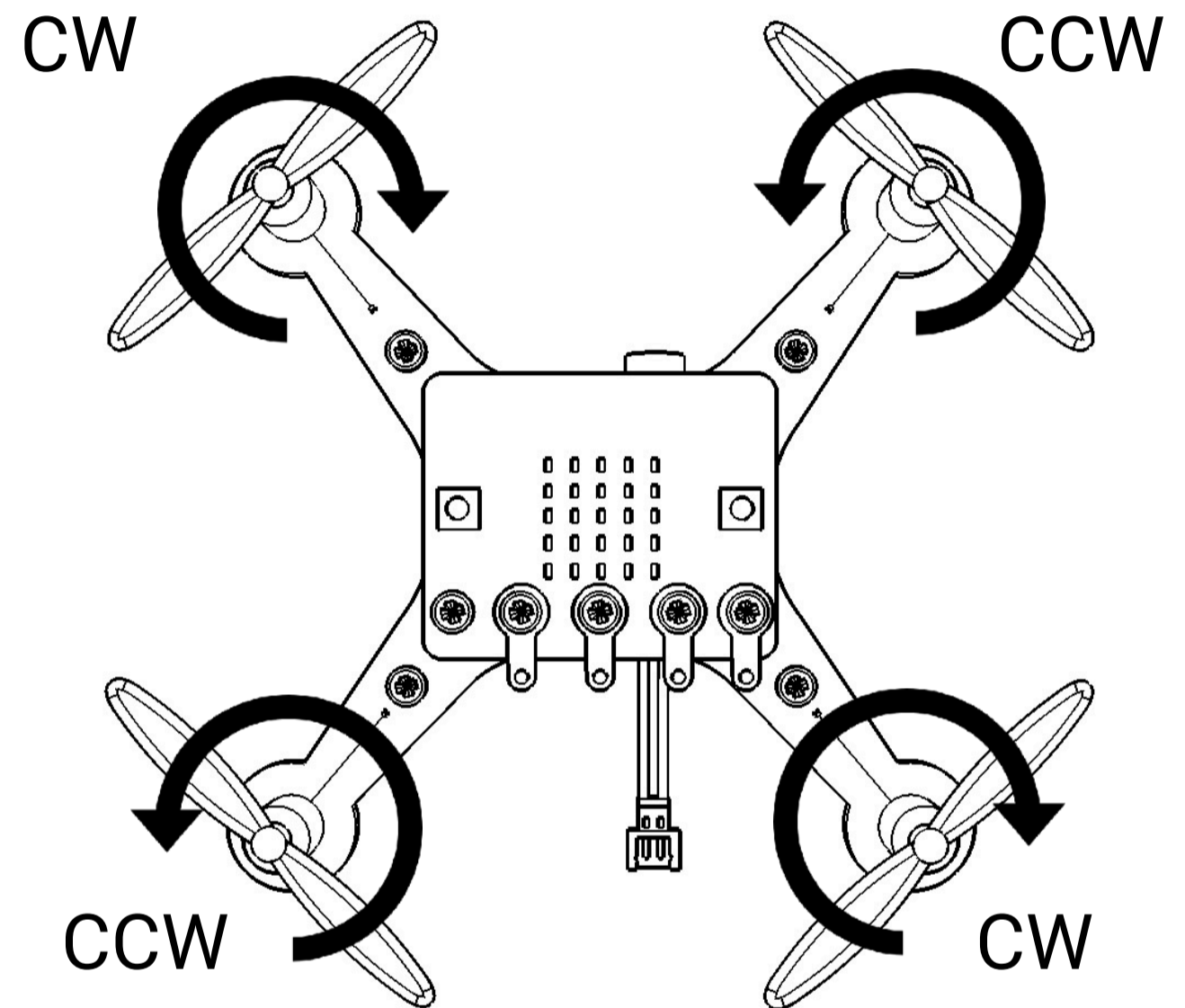
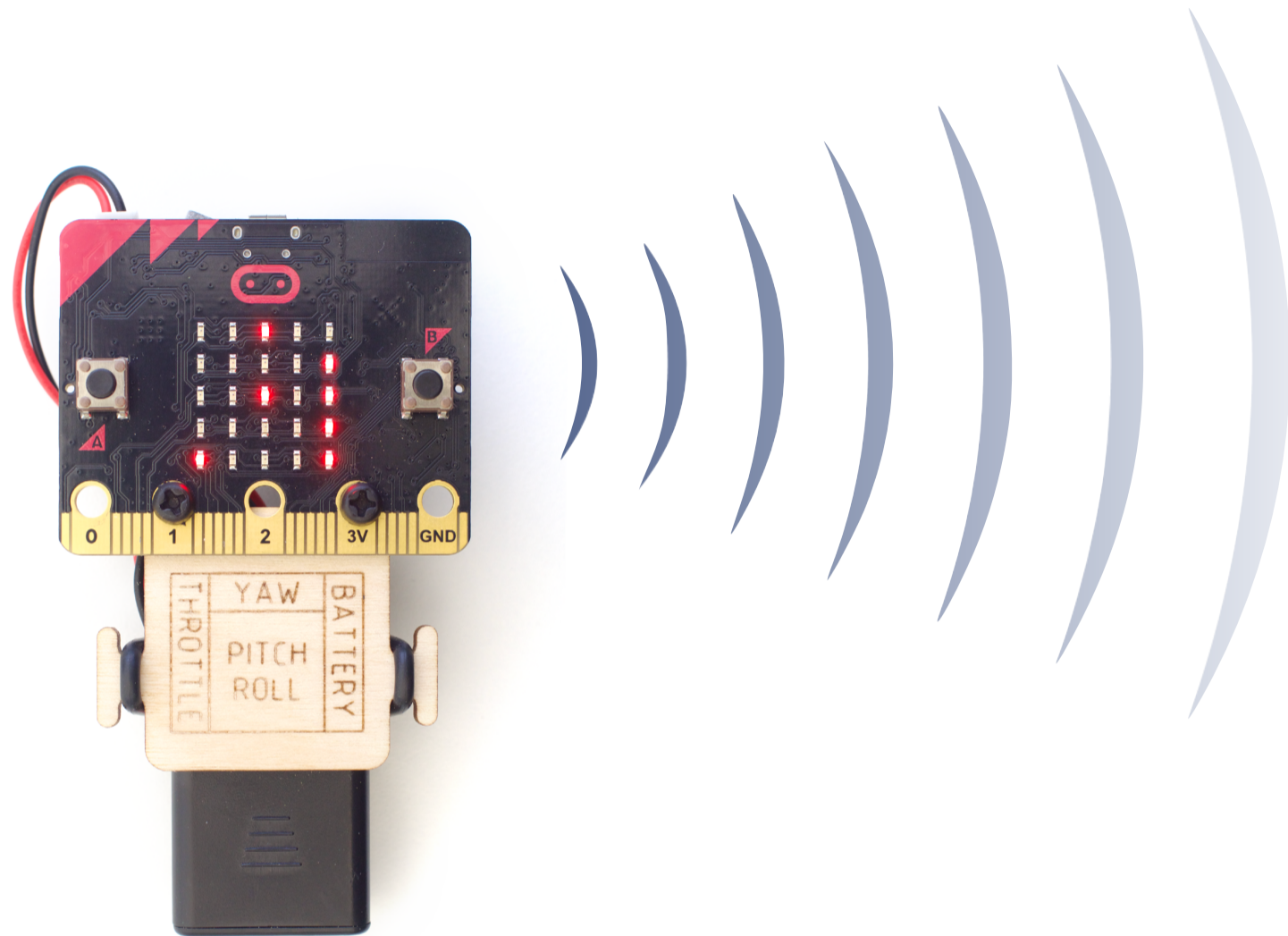
- Use analog write to make P1 send out power
- Use analog read to make P0 and P2 read power that is lead trough your fingers
- When nothing is touching P0 and P2, the analog read will be low (around 200)
- When conducting electricity from your fingers, the analog read can be about 800
- Using a treshold on about 500, you can detect a finger press.
- When a press is detected, change the yaw to a negative number for left rotation, and a positive number for right rotation
- If no button is pressed, the yaw should be 0. The easiest way is to set it to zero before checking if a button is pressed.



Yaw: Solution

```
clear screen
analog write pin P1 to 1023
set Yaw to 0
if analog read pin P2 > 500 then
  set Yaw to 30
  plot x 3 y 0
else if analog read pin P0 > 500 then
  set Yaw to -30
  plot x 1 y 0
else
  plot x 2 y 0
```

How the drone controls its path



- Two motors rotate with the clock (CW) and two rotate against the clock (CCW)
- The counter-rotating setup prevents the drone from spinning around the yaw-axis.
- The drone ascends (**Throttle**) by making all the motors go equally faster
- The drone moves forwards (**Pitch**) by increasing power at the two back motors, while decreasing power to the front motors. This tilts the drone forward.
- Sideways movement is done by speeding up two motors at one side (eg. left) then slowing down two motors at the opposite side (eg. right)
- Drone can rotate around the **Yaw**-axis by speeding up every other motor (eg. every CW motor) while slowing down every CCW motor.
- The flight control board takes all the flight directions (PARTY) and mixes the info onto the four motors.

Contact:

Get tips and help in our Facebook community:
www.facebook.com/groups/goairbit/

