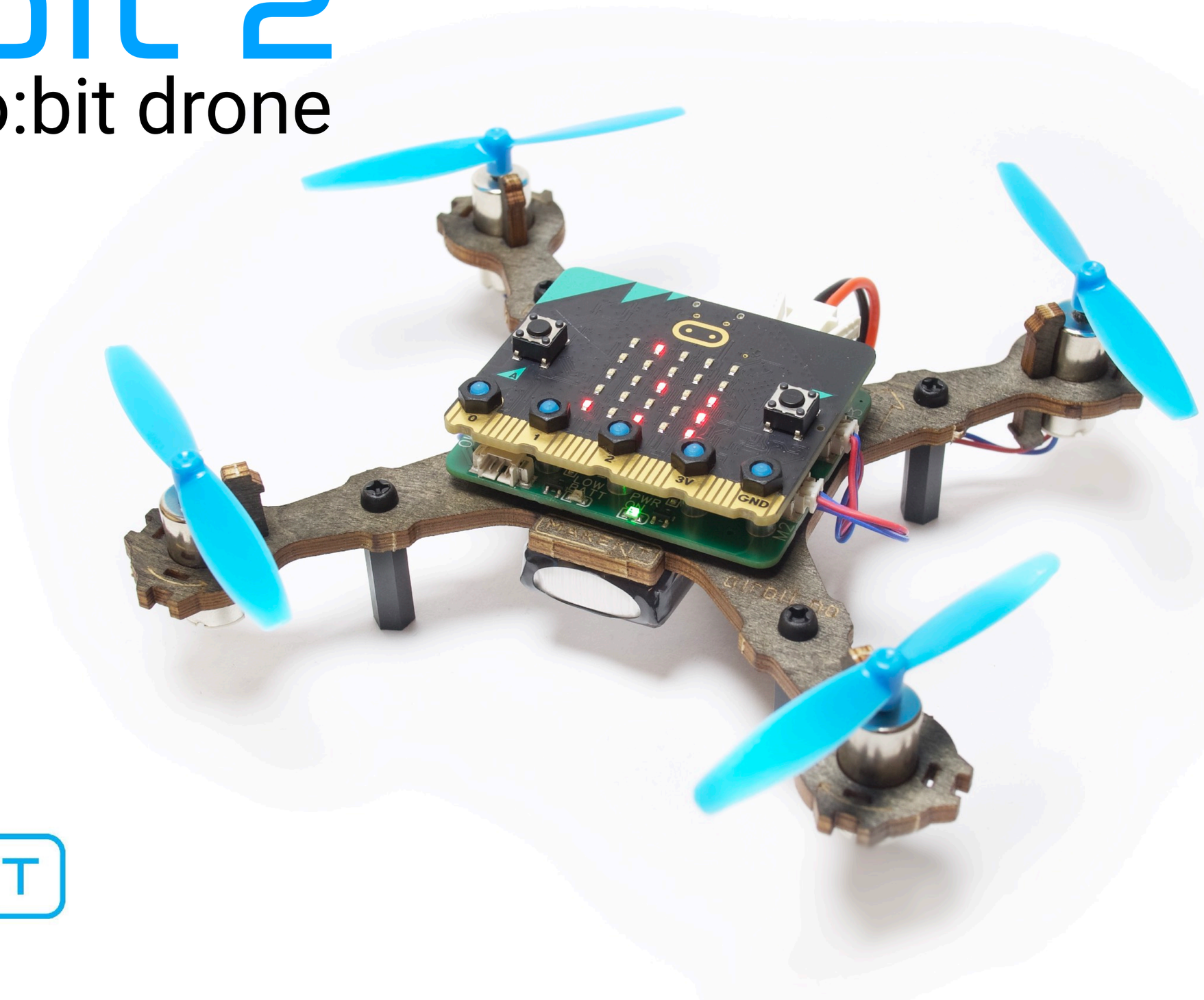
Air:bit 2

The micro:bit drone



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Teachers! Read this

The Air:bit 2 is a great way to engage the students trough cross curriculumn teaching and learning. Here is some useful information.

Time frame
Building takes 2-3 hours
Coding the remote controller takes 3-4 hours or you can download the readymade code.
Flying takes about 30 minutes (flying and adjusting before battery is empty)

We recommend charging the batteries while coding. Charging with Air:bit V2 takes approx. 1 hour.

Micro:bits
We recommend two micro:bits for a drone/transmitter pair. The drone should have micro:bit V2 on board. See the next page.

Radio channels
Each student should select their own radio channel for transmitter and receiver. (0-255). If you use ready made code, make sure to edit the variable called radioGroup in makecode before downloading to micro:bit (both transmitter and receiver)

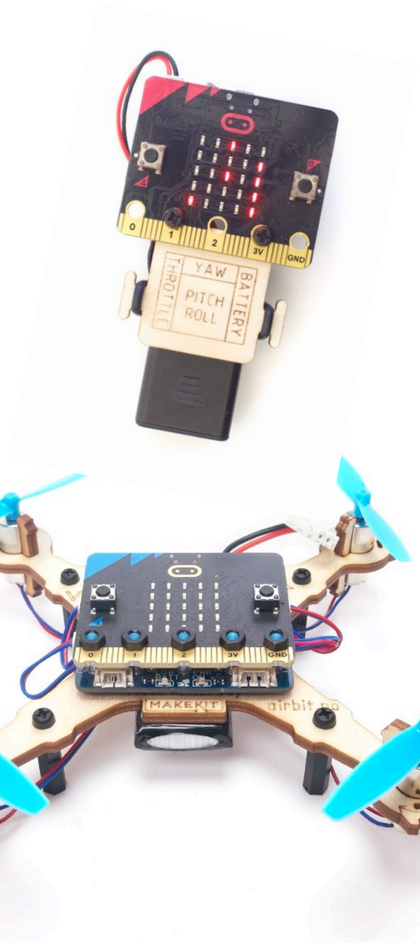
Flying
Use an open space close to where you build the drones. A soft carpet is better than a hard surface in case of crashes. A high ceiling is not needed (in case of crash, high falls are worse)
Read more about flying at the end of the document or see the video at www.makekit.no/docs

Safety
The propellers are small but spins fast and can make small cuts in the skin. Students should be cautious when the propellers and battery are both connected. If you leave the propellers unmounted until the end, you can test run the motors first.

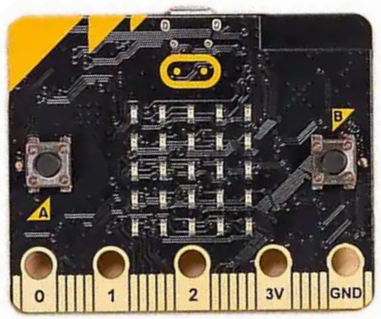
Repairs
All parts can be replaced. The most wear goes to propellers and motors. Keep some spares at hand or order more from your distributors or directly from Makekit (sales@makekit.no)

More activities
Did you know you can 3d-print a frame for Air:bit? Or make a smart glove remote? Check out more projects at www.makekit.no/docs

Micro:bit V1 or V2?

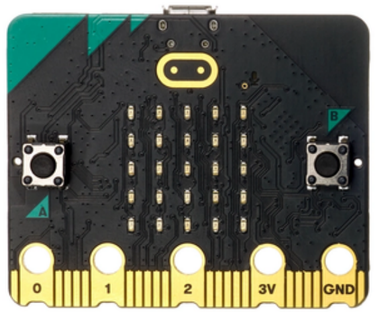


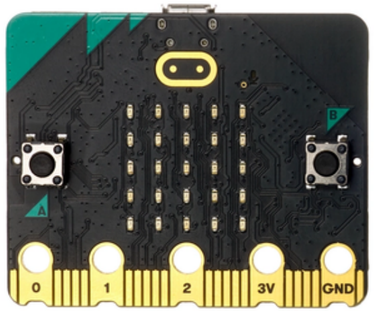
V1



OR

V2





V2

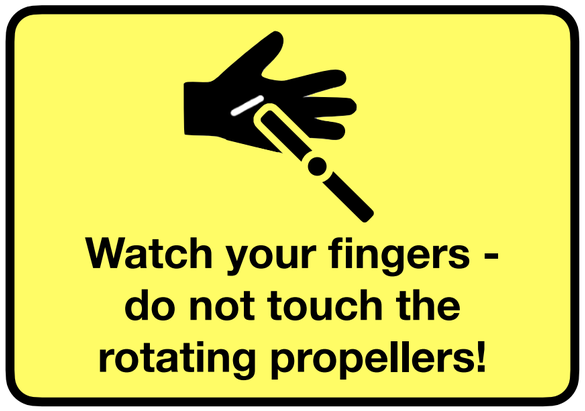
The remote control works great on both micro:bit V1 and V2.
Air:bit 2 relies on the micro:bit for high speed calculations and stabilisation. Therefore, we highly recommend using micro:bit V2 on the drone.

If you experience trouble getting the air:bit to fly, please see page 61.

Safety warning

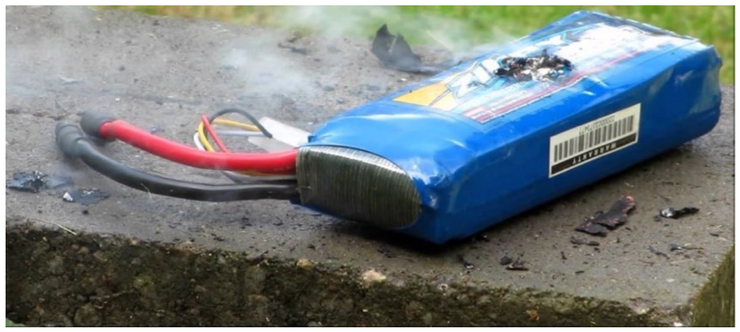
Fast rotation propellers can hurt humans and animals
To prevent injury, do:

- 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 +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 50% capacity and between 10 and 20 degrees celcius
- Follow airport regulations for carrying lithium batteries on airplanes. (Usually hand luggage only)



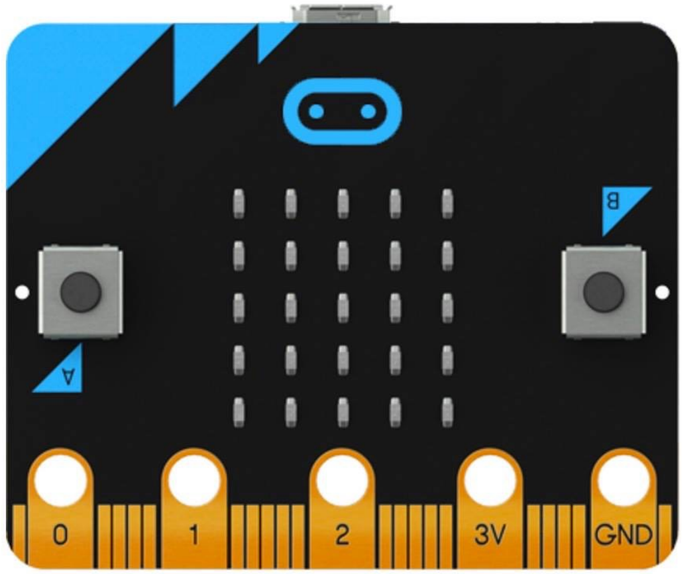
Meet the micro:bit V1

Screen (5x5 pixels)

Haircut

Button A

Gold teeth



Front

Button B

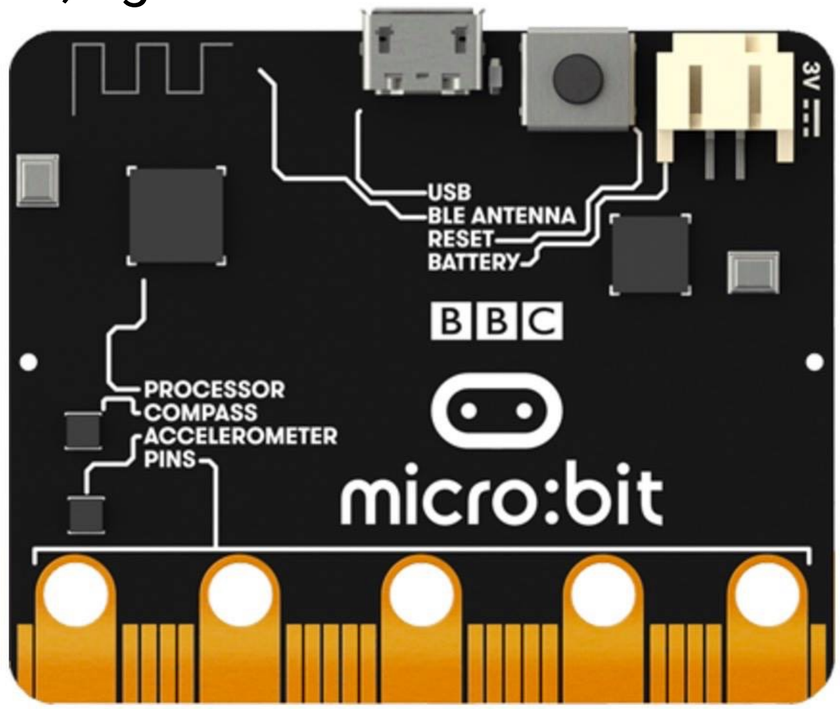
Sensors

Reset button

Antenna
2,4 gHz

USB

Battery 3V



Backside

micro:bit is a small computer with prosessor, 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/

The micro:bit V2

Screen (5x5 pixels)

Microphone

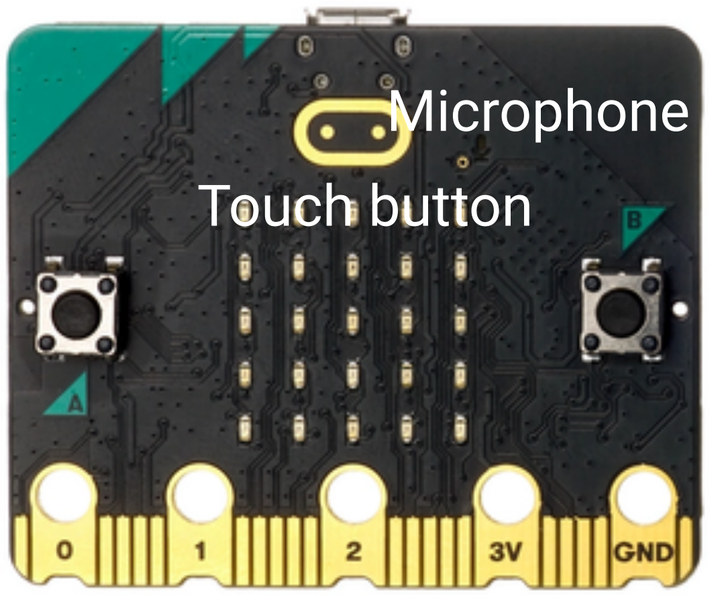
Touch button

Button A

Button B

Sensors

Gold teeth



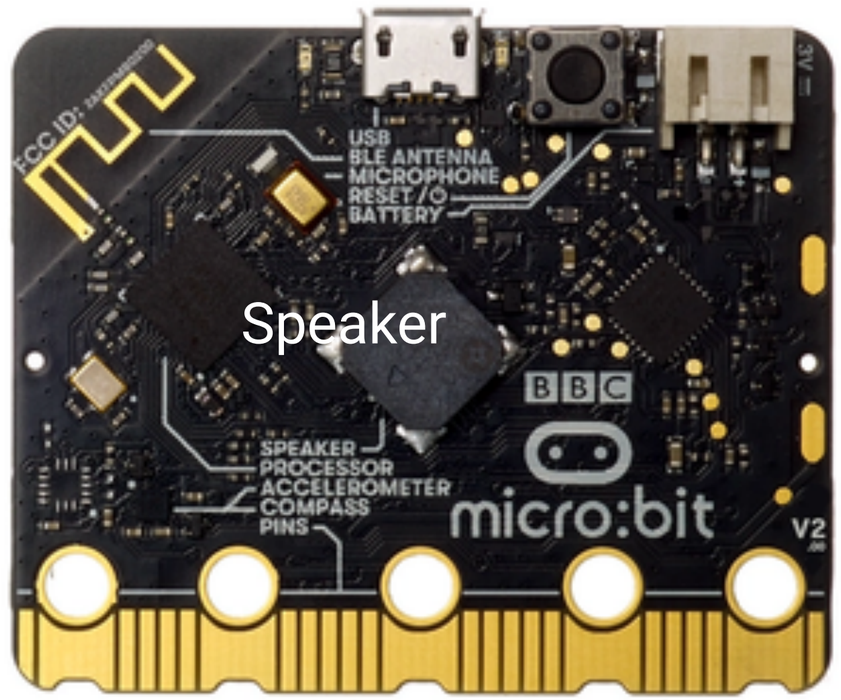
Front

Reset button

Antenna
2,4 gHz

USB

Battery 3V



"V2" mark

Backside

The micro:bit V2 is very similar to V1 but with extra features, like: Microphone, speaker, touch button, faster processor and more memory. The "gold teeth" looks different compared to V1, for better grip with crocodile clips.

Air:bit can work on V1 and V2, but V2 gives more processing power for advanced users.

Air:bit 2

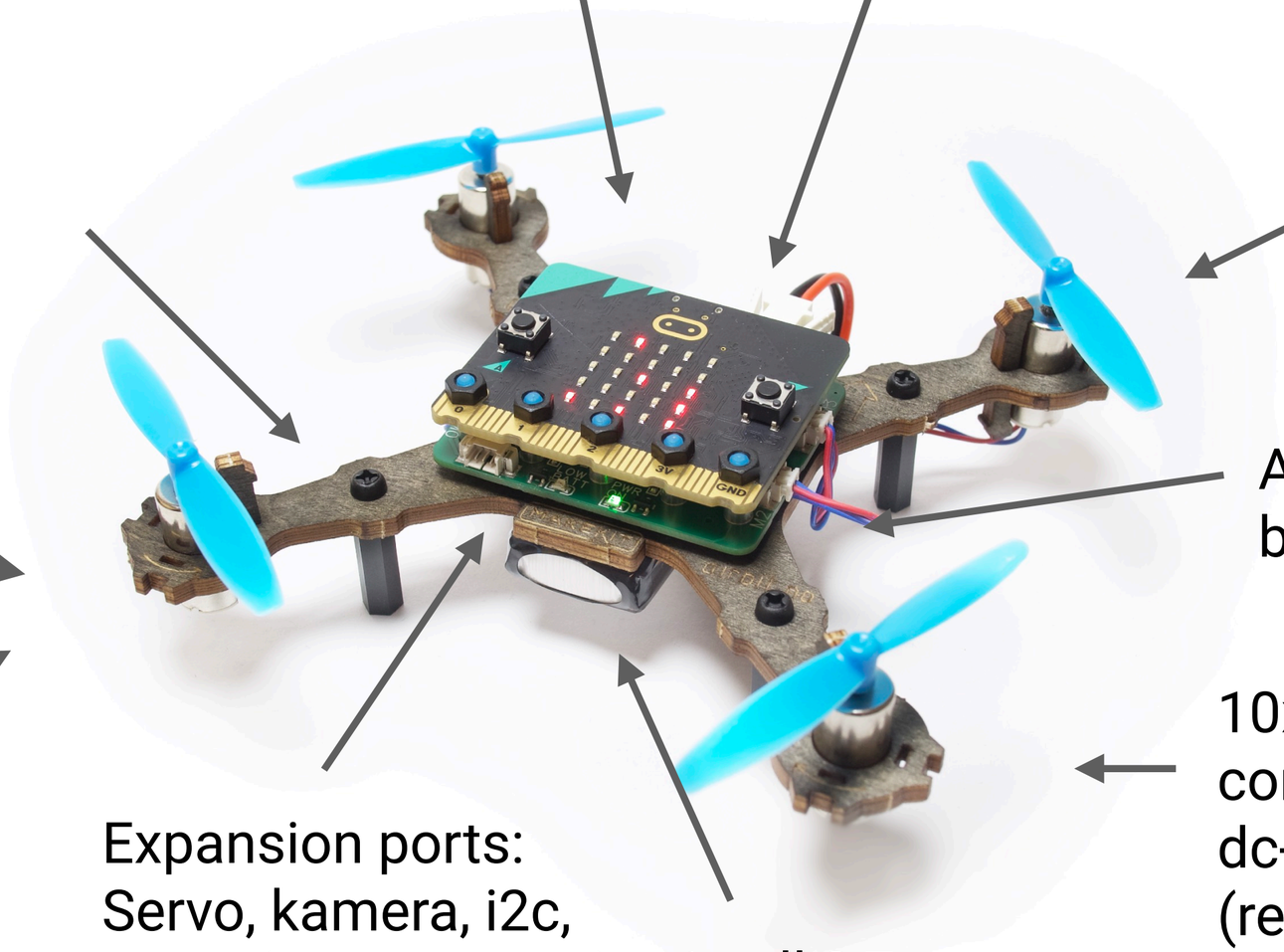
The micro:bit drone

micro:bit with Microsoft make:code

Screen showing flight directions and battery status

Propeller protection mount

Nylons screws/ spacers M3



6 layers “unbreakable” birch plywood

Air:bit control board with charger

10x20mm coreless dc-motores 3.7v (replacable)

Propeller: Gemfan 65mm Polycarbonate

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

1 cell 3,7v 800 mAh LiPo-battery

More info: Visit airbit.no

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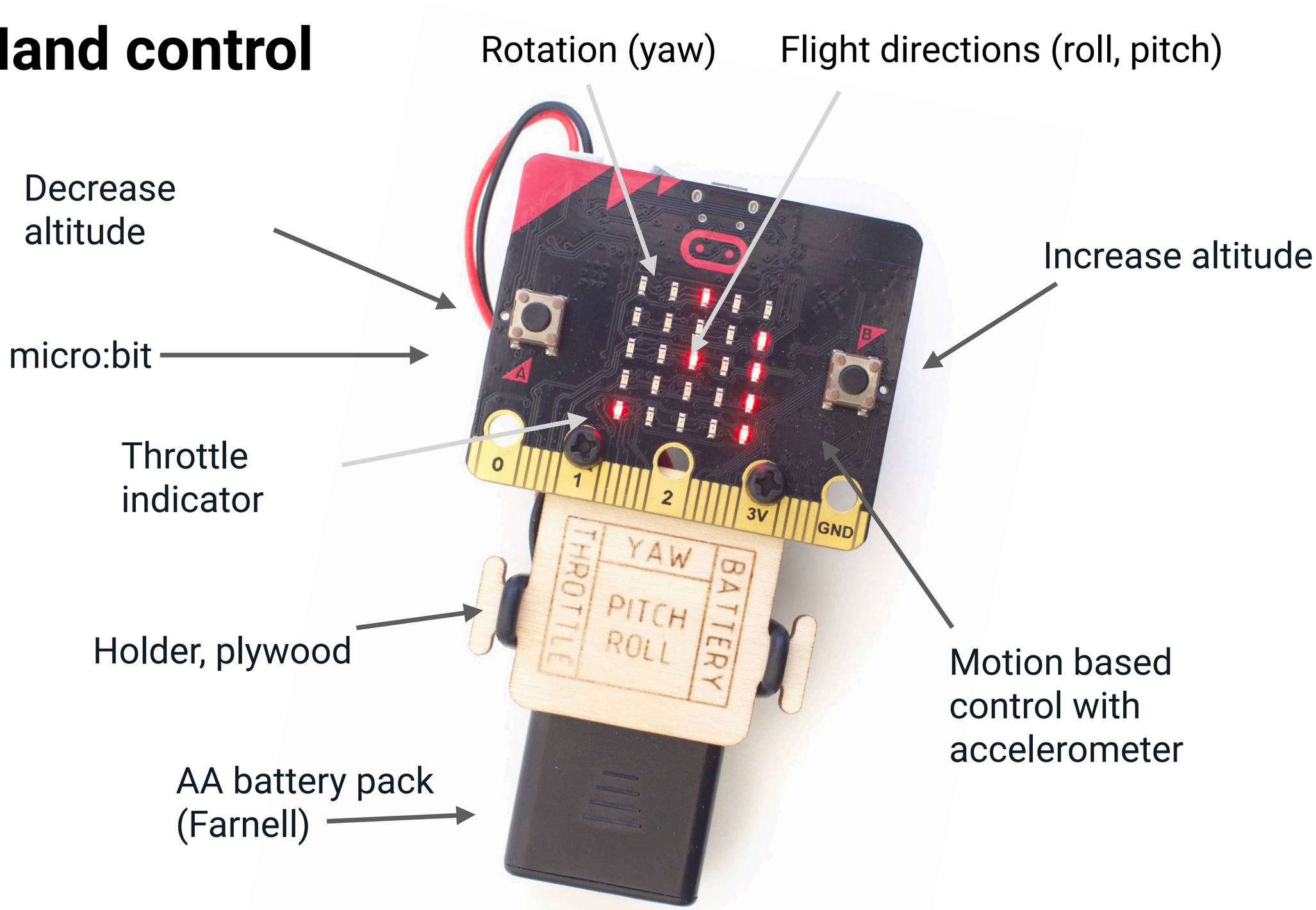
Hand control



MAKEKIT

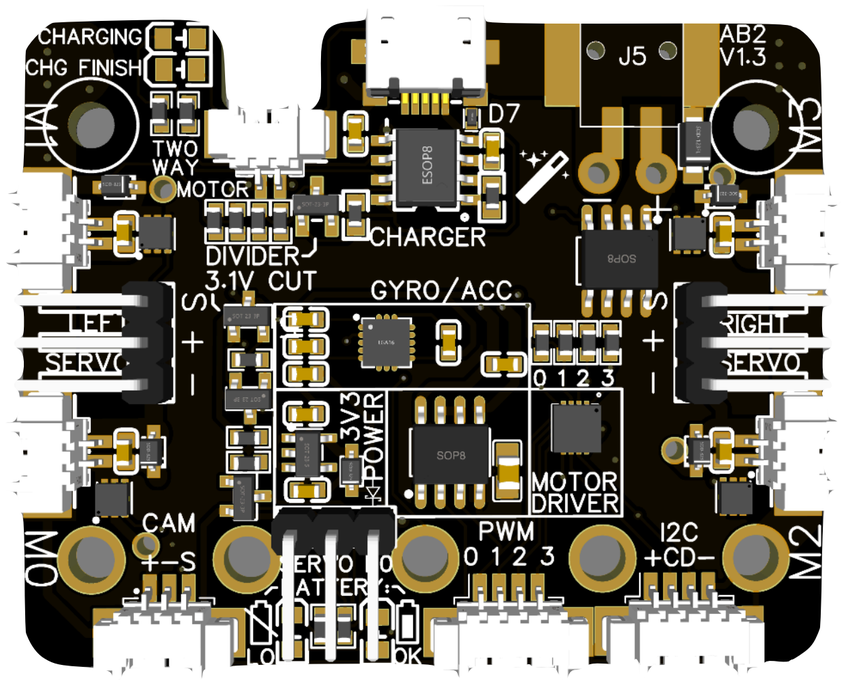
Control board

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

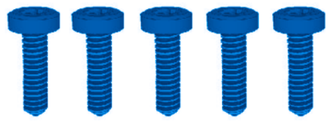
i2c (sensors)

MAKEKIT

Parts

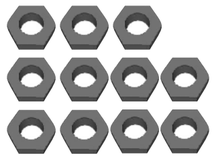
Note: CW means Clockwise rotation, CCW means counter clock wise

6 nylon screw m3x8

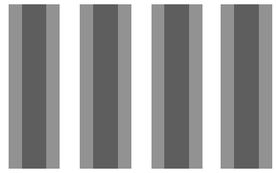


5 nylon screw m3x12

2 nylon screw countersunk

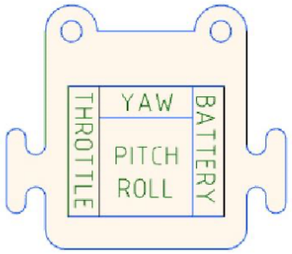


11 nylon nuts

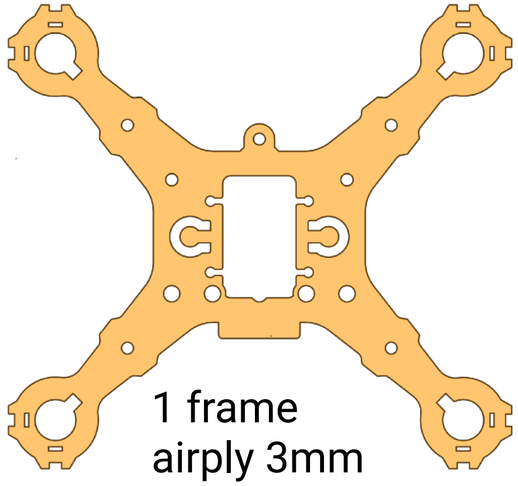


4 spacers m3x20

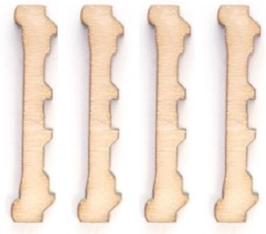
5 aluminium Spacer rings



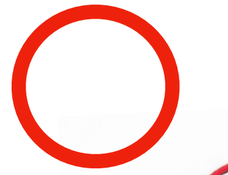
remote - holder



1 frame airply 3mm

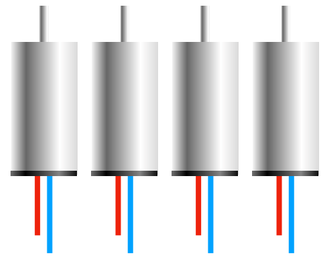


4 wedges

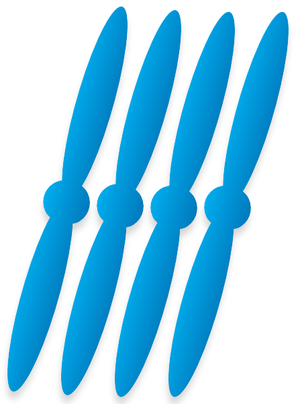


Red silicone ring

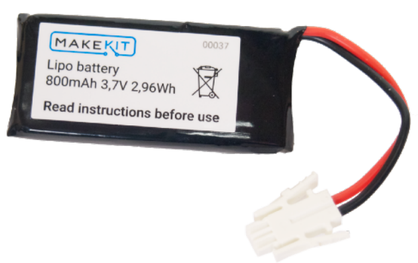
Rubber Band



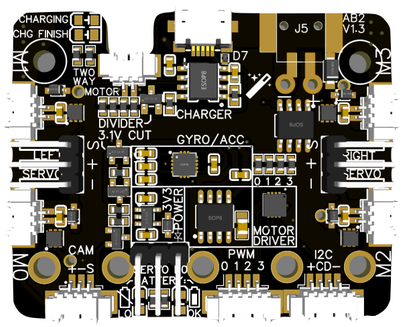
Motors: 4 CW/CCW



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



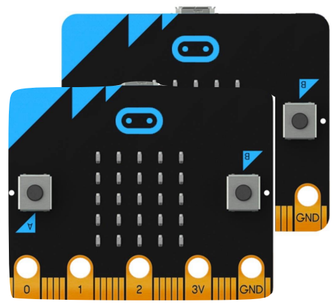
1 Lithium (LiPo)-battery



Control board

Micro:bit battery box*

1 micro usb cable*



2 micro:bits*

*the universal microbit parts usually sold separately

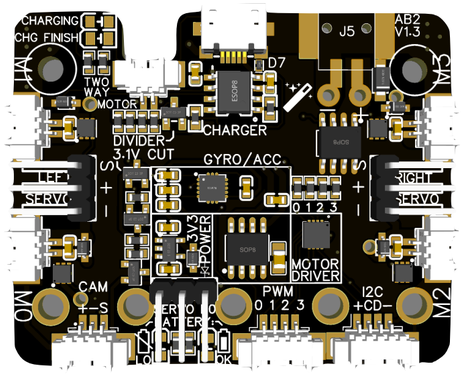
Tools

Small philips
screwdriver

Socket wrenches
5.5mm (included)

Charging

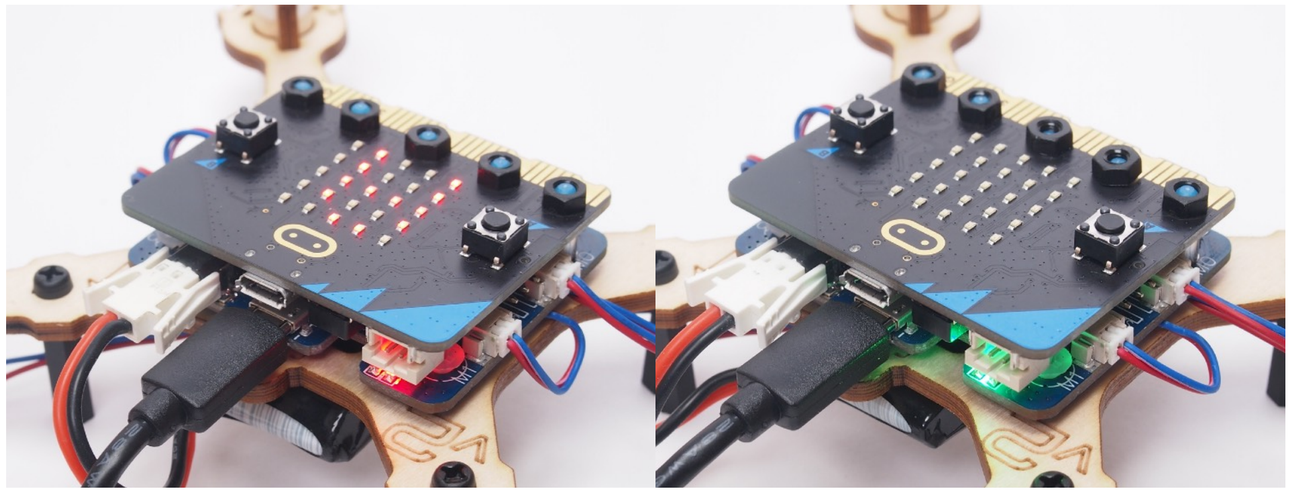
Parts:



Air:bit control board

Lithium (LiPo)-battery

Micro USB-Cable



1. The battery can be charge 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

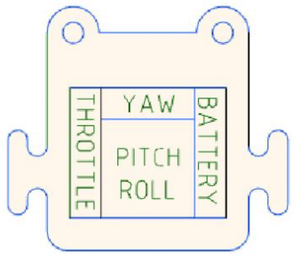
Assemble the remote

Tools: Philips Screwdriver

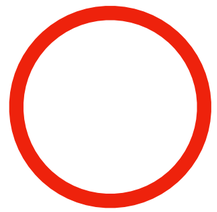
Parts:

2 nylon screws m3x8

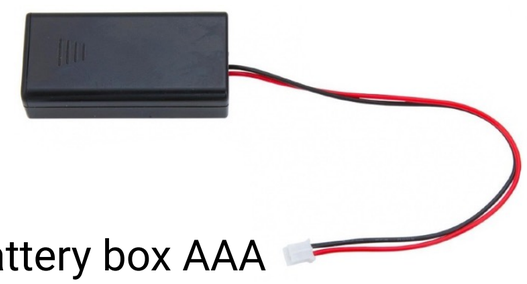
2 nylon nuts m3



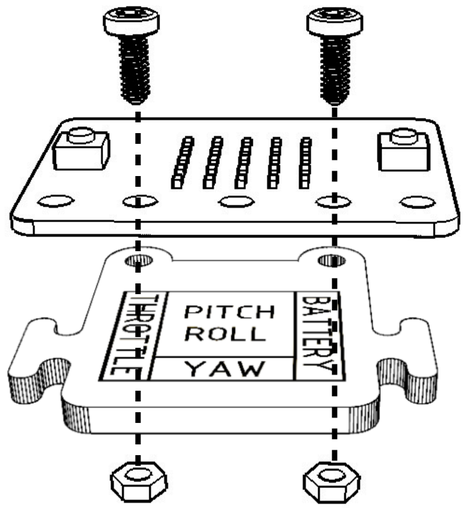
Remote holder

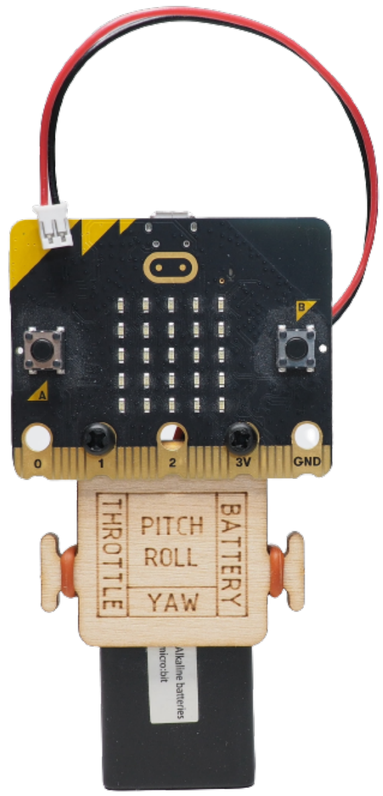


Red silicone ring



Battery box AAA





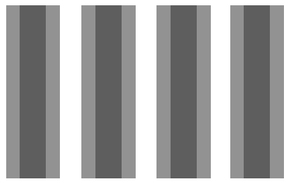
- Place the micro:bit with screen facing up on top of the holder and mount it with the screws somewhat tightened
- Mount battery box with the silicone ring
- You can use different battery boxes

Mounting the frame

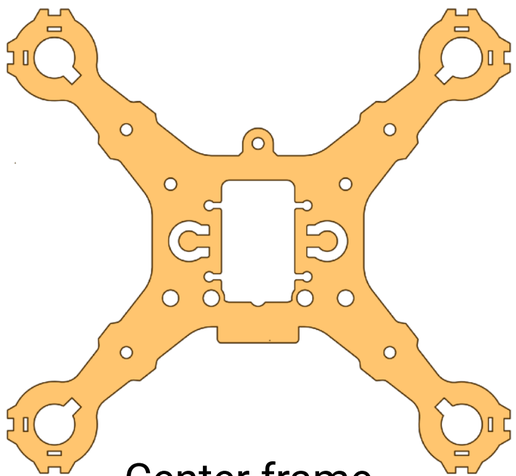
Tools: Philips Screwdriver

Parts:

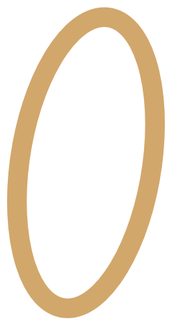
4 stk nylon screws m3x8



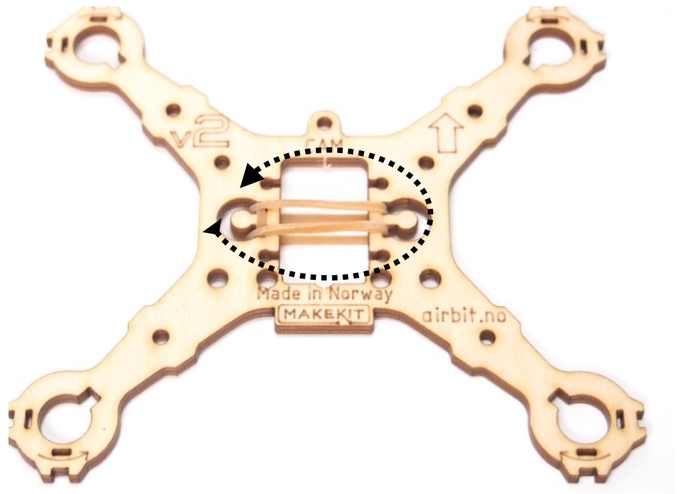
4 spacers m3x20



Center frame



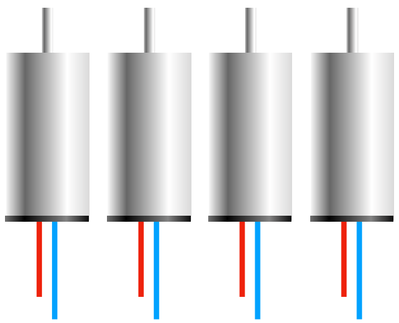
Rubber band



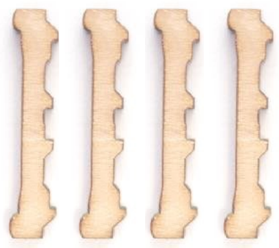
- Hook the rubber band from one knob, under the frame, to the next hook, over the frame, and back.
- Mount the spacers with the screws. Notice, the text should face up while the legs points down.
- The rubber band will be visible on both sides of the frame

Mounting the motors

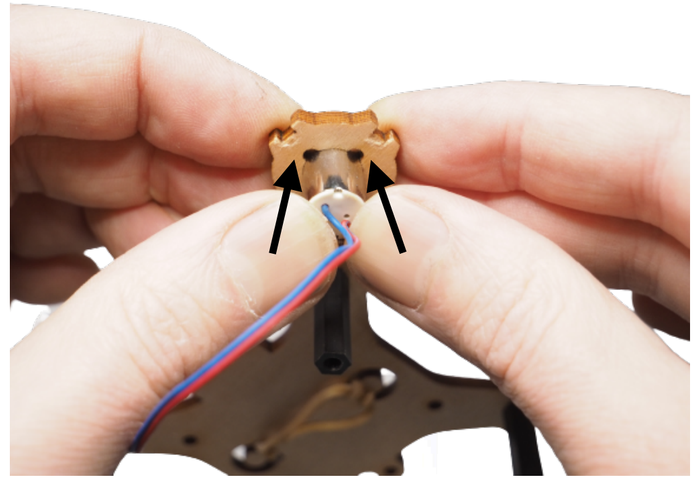
Parts:

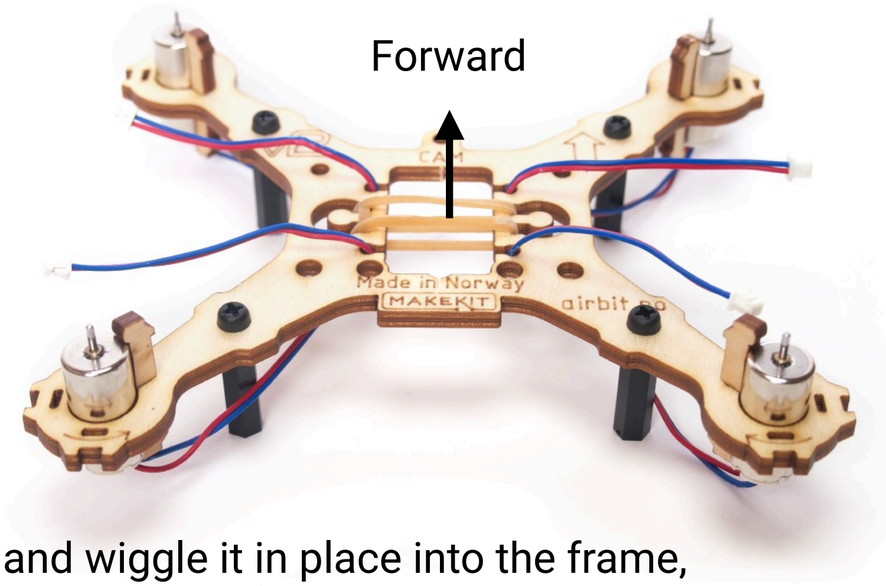


4 motors



4 wedges





- First insert a wedge and wiggle it in place into the frame,
- Then push the motor upwards to click into place. (All 4 motors). Use both hands and both thumbs to push the motor forward.
- Then pull the motor cables trough each notch to tidy them up a bit. Lay the cables to the sides.

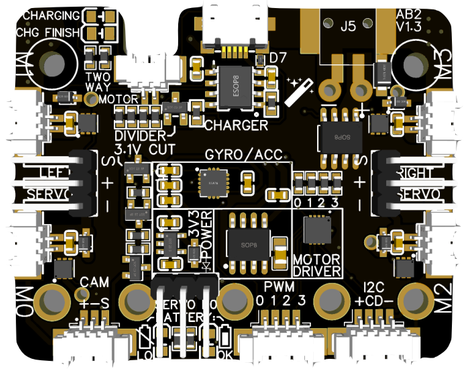
Countersunk screws

Tools: Philips Screwdriver, socket wrench

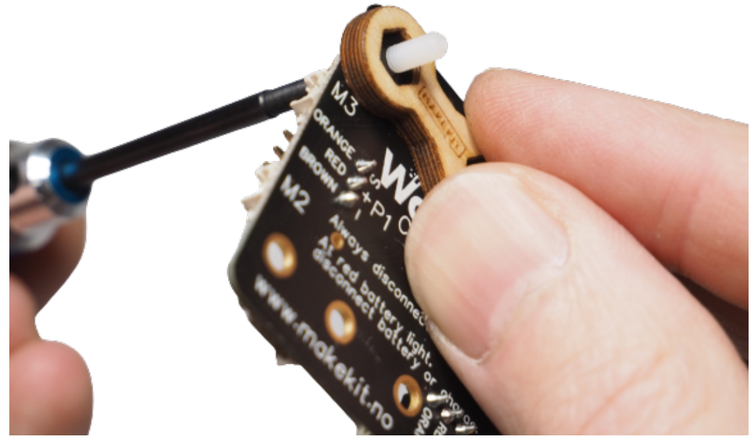
Parts:

2 x countersunk screws

2 x Nylon nuts



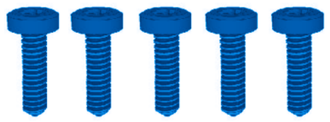
Control board



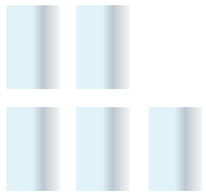
- Pull the screws trough to the back side of the board (where the big letters are)
- Attatch the nuts with a screwdriver and a socket wrench

Control board

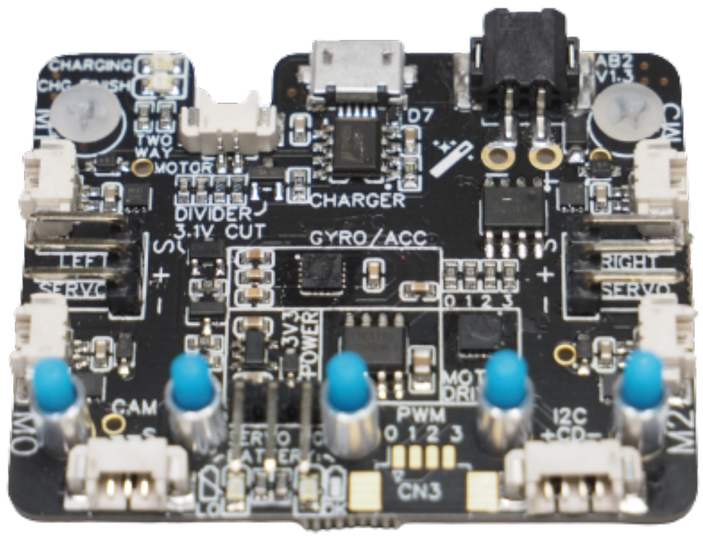
Parts:



5 nylon screws m3x12 (blue)



5 aluminium spacer rings

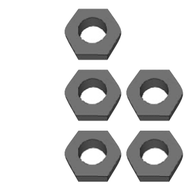


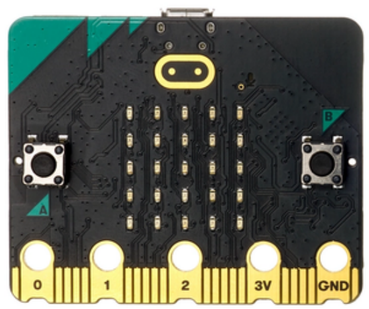
- From the backside of the board, insert the 5 screws.
- Hold the screws with your index finger while you flip the control board.
- Insert the 5 spacer rings.

micro:bit

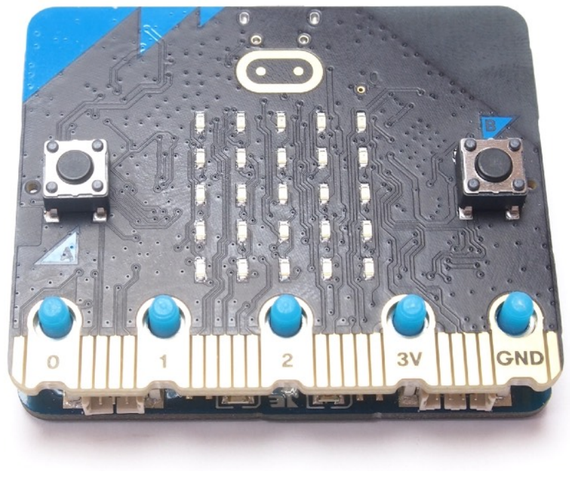
Tools: Philips Screwdriver, wrench 5.5mm

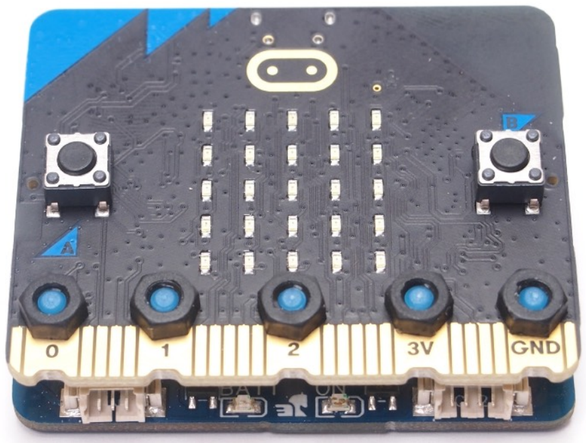
Parts:

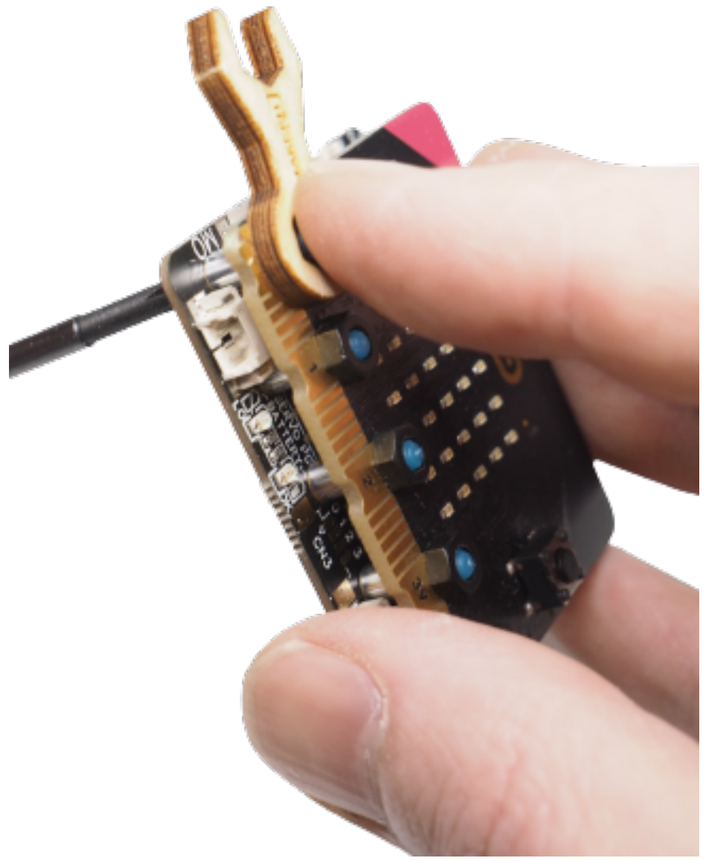




micro:bit







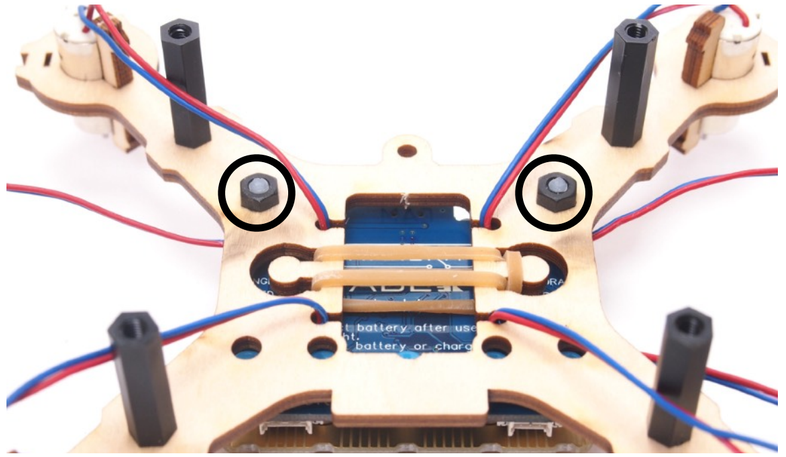
- Place the micro:bit on the five screws
- Carefully add the five nuts and mount them loosely before lifting the unit
- Add some tension using a screwdriver and the socket wrench.
- **The screws must be slightly tightened for the drone to work as they conduct electric signal between the boards.**

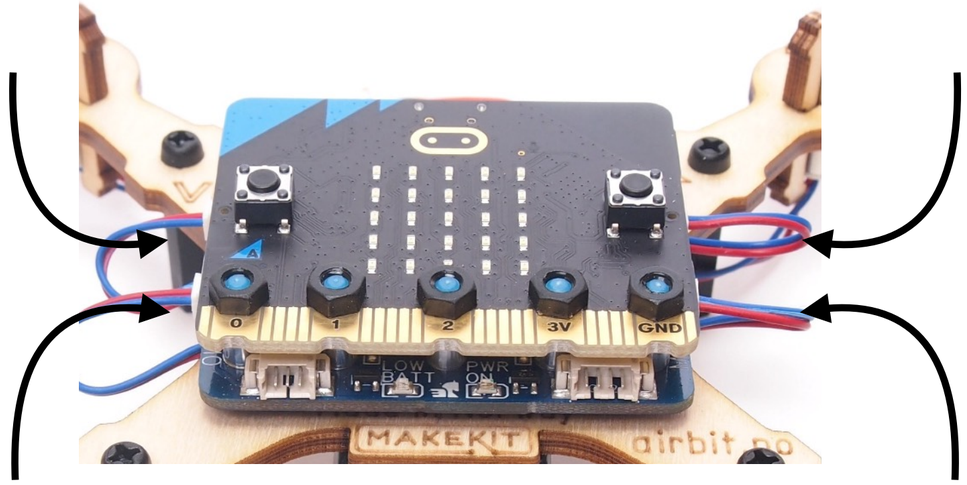
Assembling the drone

Tools: Wrench 5.5mm

Parts:

2x nylon nuts



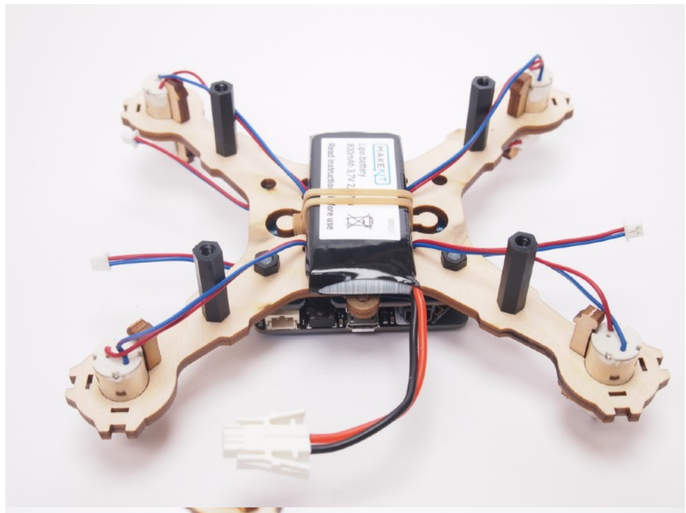


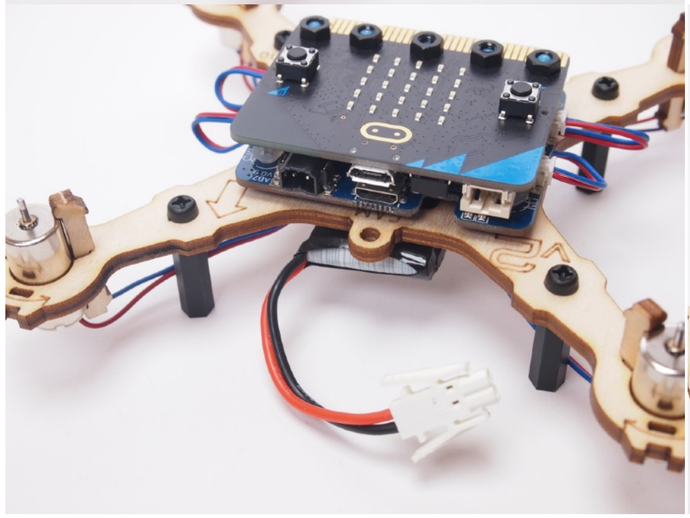
- Flip the drone upside down
- Attach the control board with two nuts underneath the drone. Slightly tighten with the wrench.
- Plug each motor in the nearest connector.

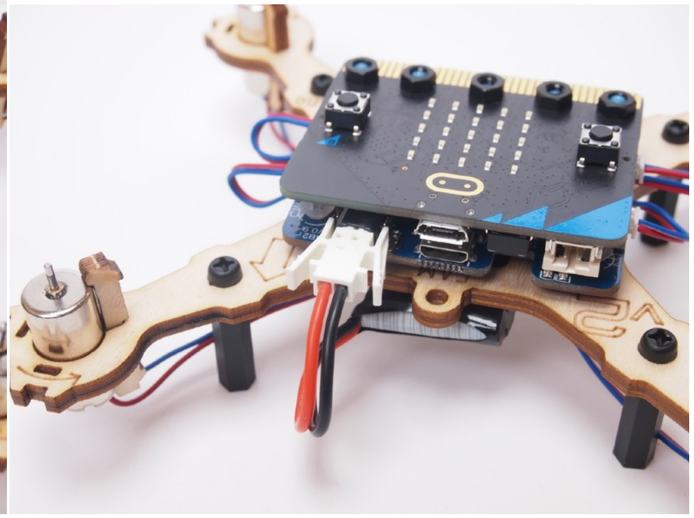
Battery

Parts:

1 Lithium (LiPo)-battery

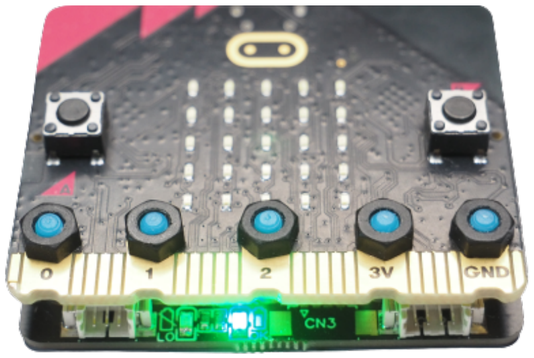




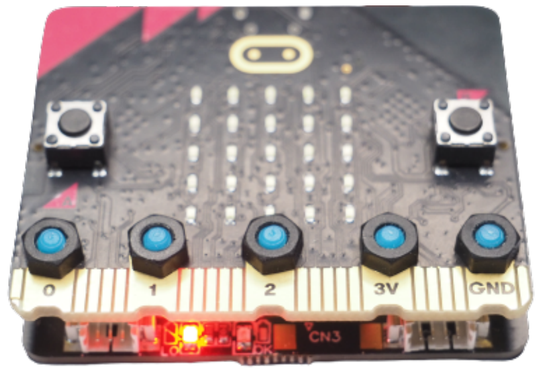


- Turn the drone upside down
- Attach the battery under the rubber band, in the very center of the drone.
- To power the drone, connect the battery to the grey connector.
- Disconnect the battery whenever you are not using or charging the drone. The battery can suffer over discharge if connected for extensive time.

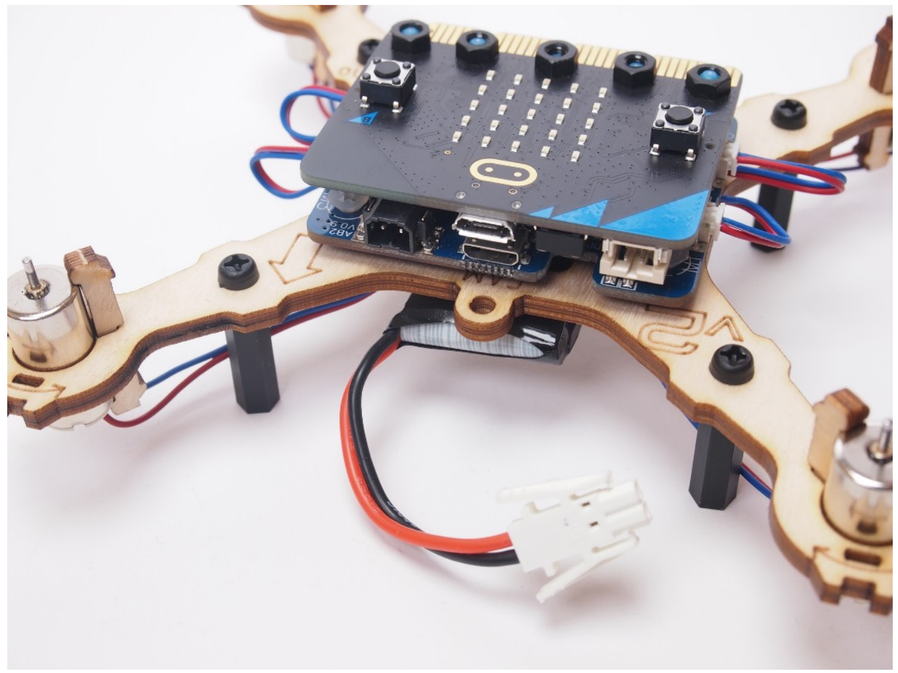
Battery indicator and care



Normal



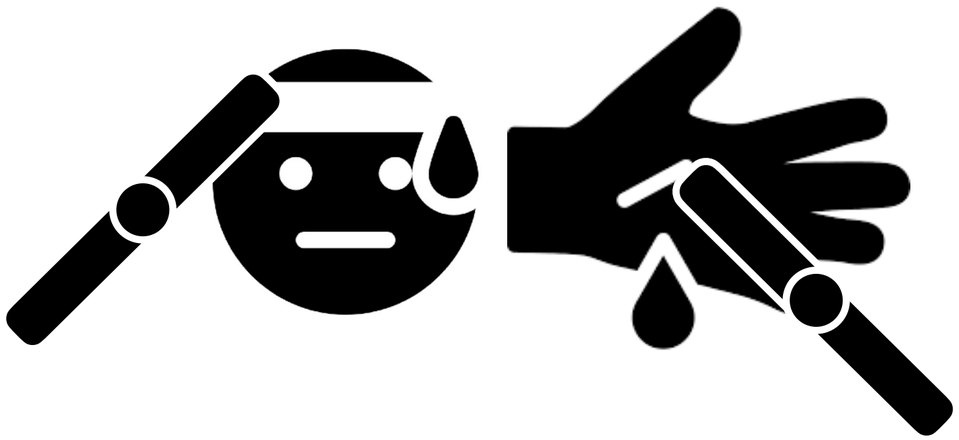
Low battery

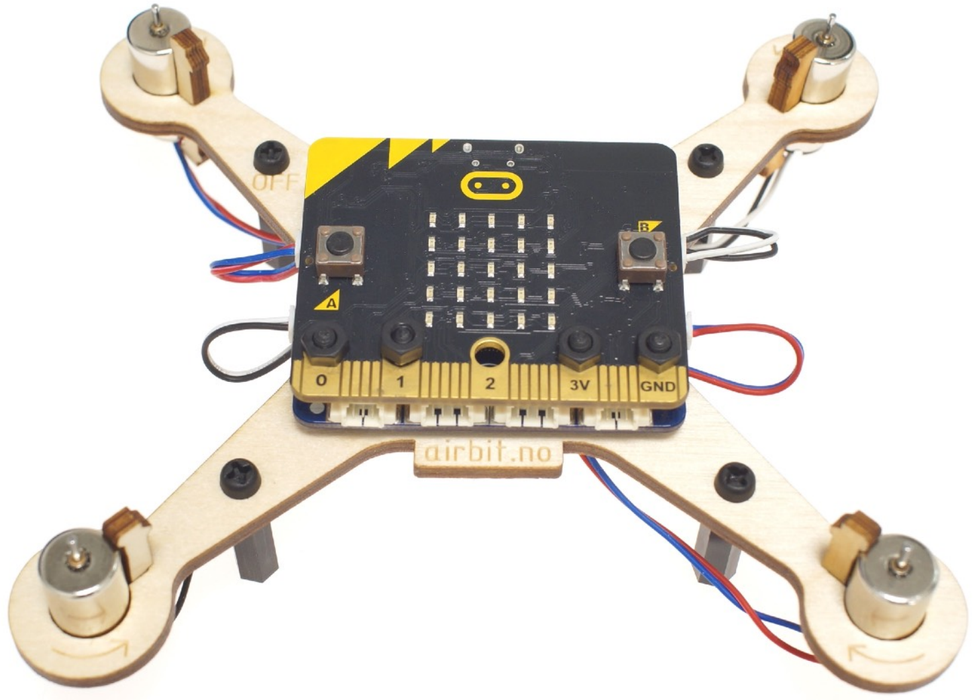


The control board has a battery protection function.
When the green light is lit, battery has sufficent power for flight.
A red light indicates that the battery needs to charge.
Do not attempt to fly the drone after this light has been seen.
Disconnect the battery until you are ready to charge again.

For your safety

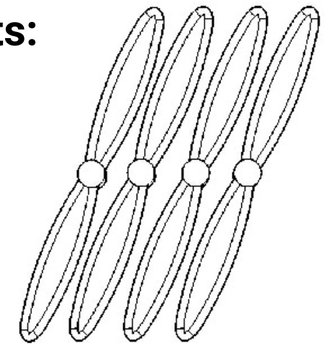
Mount the propellers after testing the drone. Can you start and stop the motors in a controlled manner?



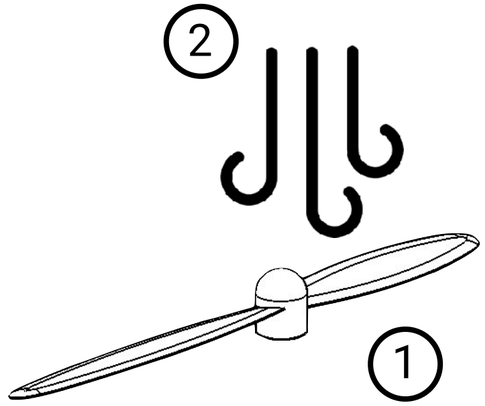


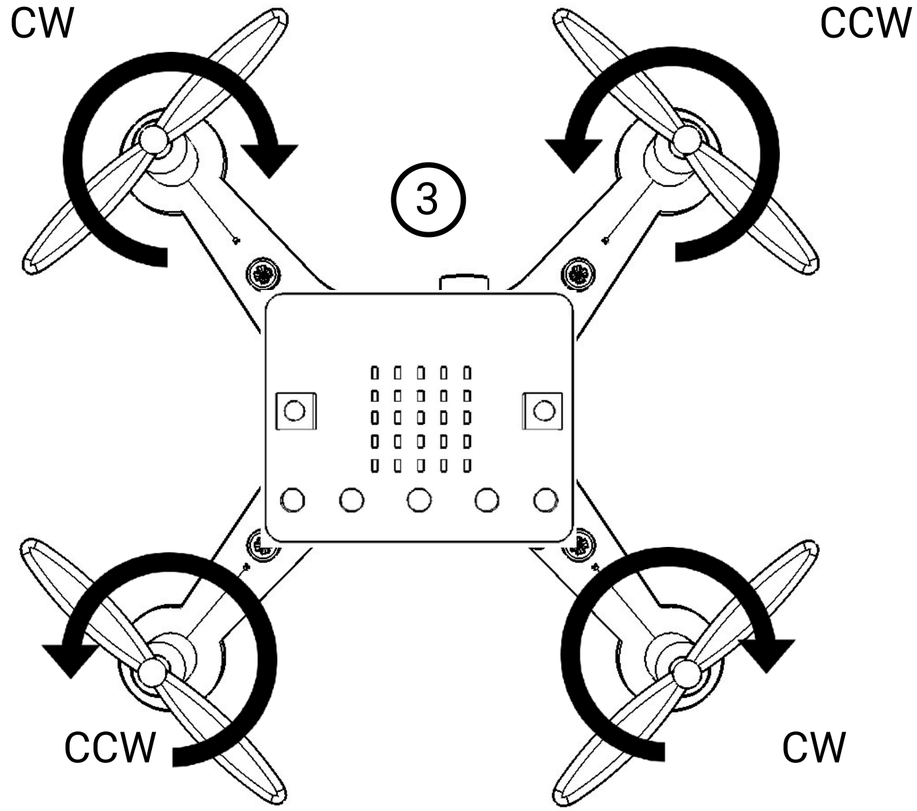
Propellers

Parts:

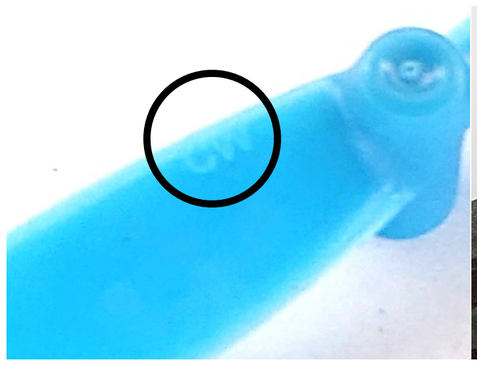


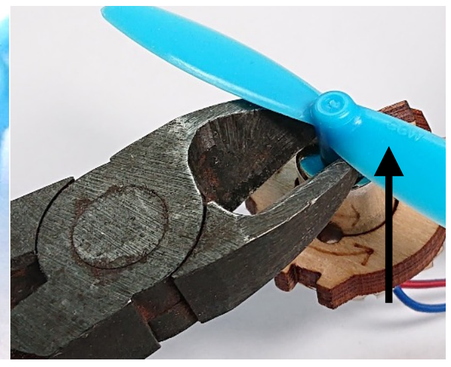
2 CW Propellers
2 CCW Propellers





- Make sure the battery is disconnected
- Identify your propellers between CW (clockwise) and CCW (counter clock wise):
  - 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
- The letters “CW” or “CCW” can also be read on the propeller near the center top.
- If you need to remove a propeller, use some pliers and eject the center of the prop. Do not bend the propeller blades.

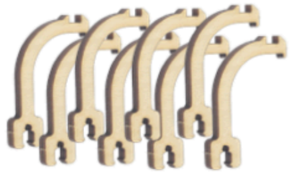




Propeller protection

Parts:

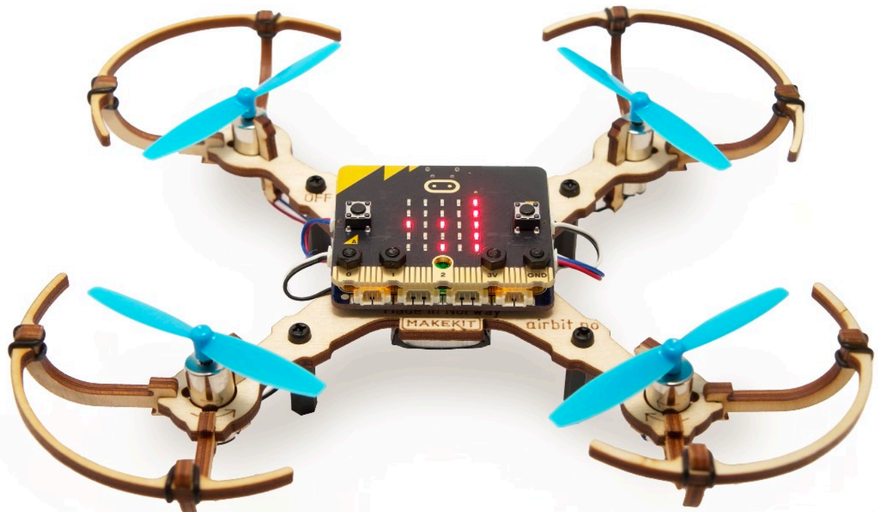
4xBows



8xArms

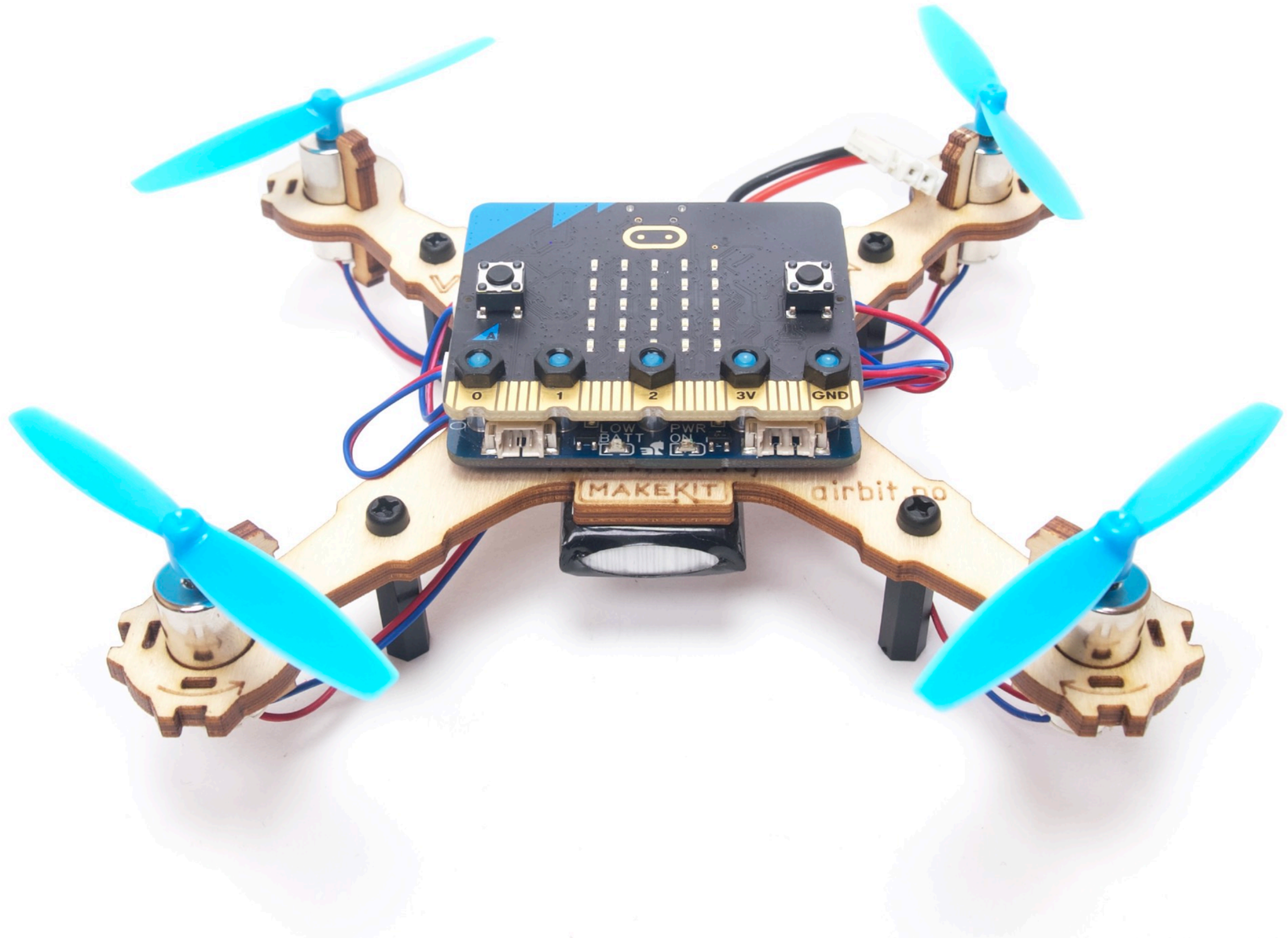
8xSmall rubber rings

Connect the bows and the arms with the rubber rings



On each protector, insert both arms onto the main frame. Adjust so they are straight and do not obstruct the propellers when they rotate.

Ready for coding!



Feb. 16 , 1926.

1,573,228

G. DE BOTHEZAT

HELICOPTER

Filed June 27, 1923

3 Sheets-Sheet 1

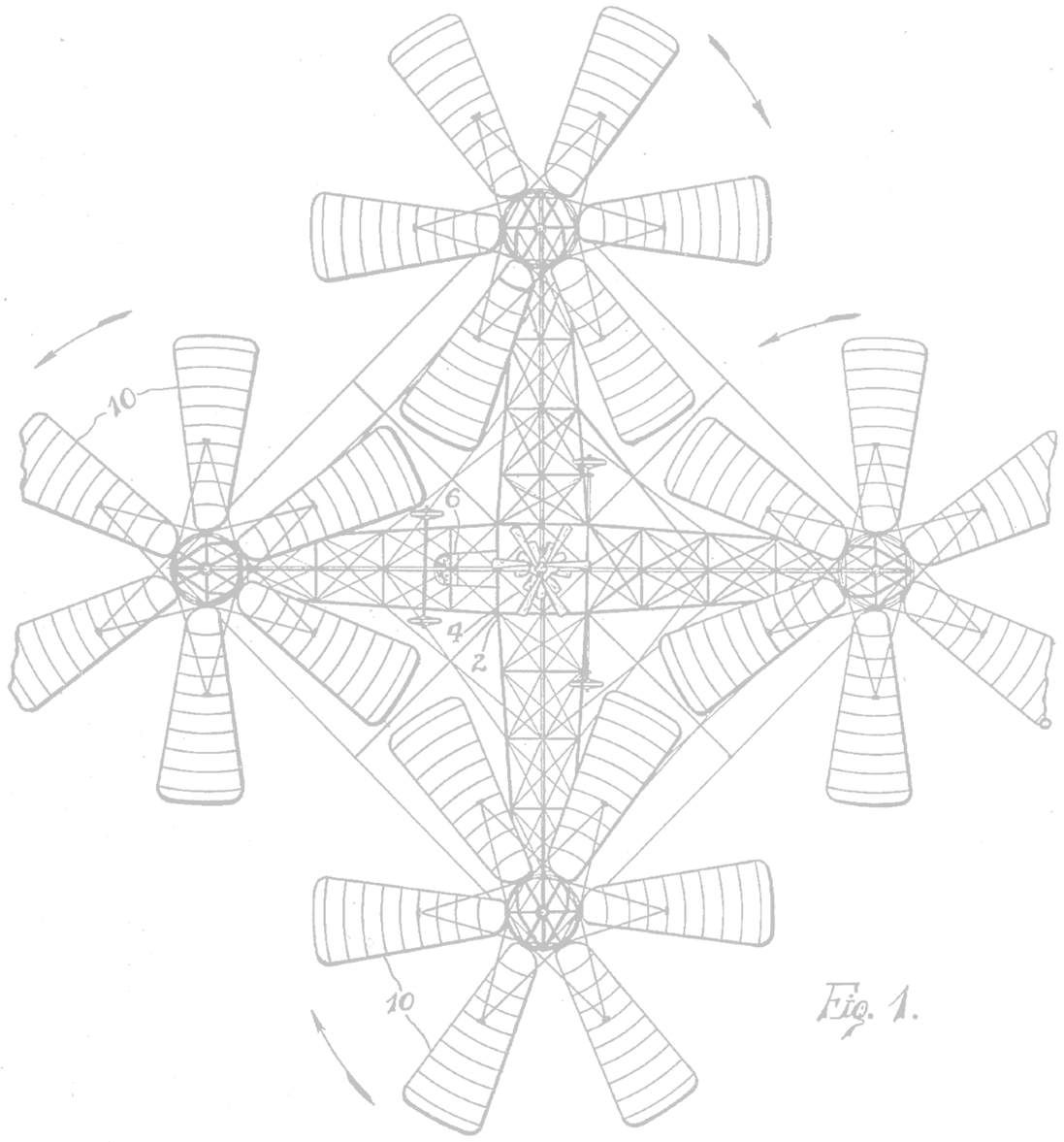


Fig. 1.

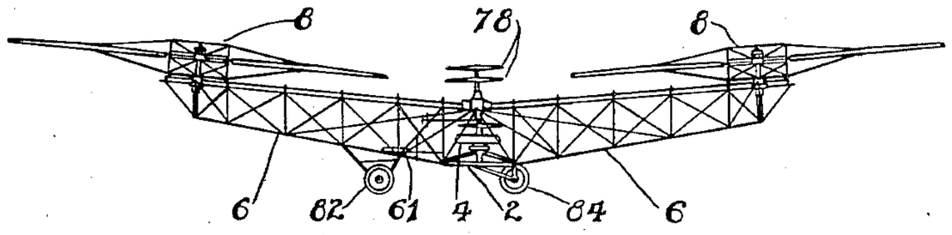


Fig. 2.

INVENTOR

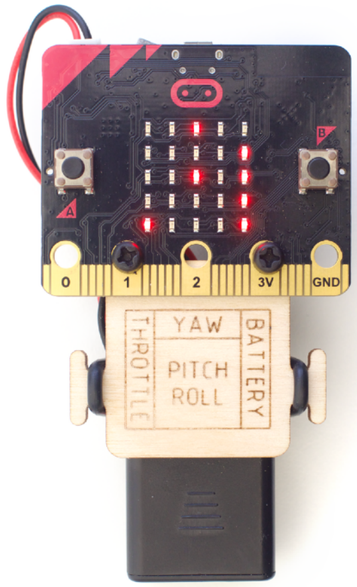
BY George de Bothezat

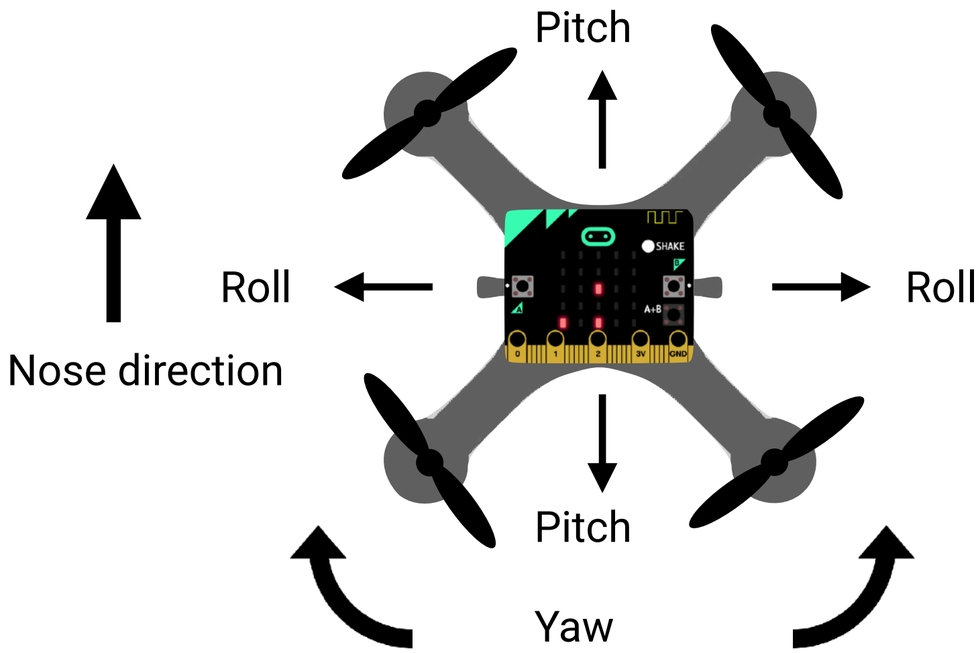
Robert H. Young ATTORNEY

PARTY

Five values to control the drone

Flight directions

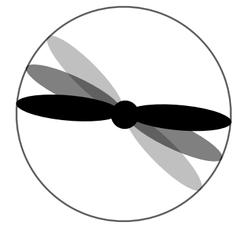




PARTY

pitch, arm, roll, throttle, yaw

Arm:
Start propeller



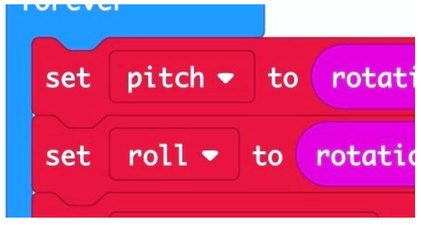
Control the drone using 5 parameters:

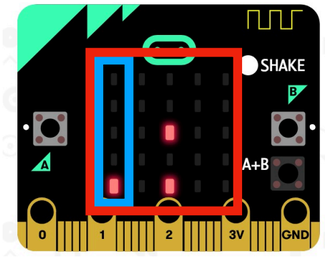
Variable:	Minimum	Neutral	Maximum
Arm	0		1
Throttle	0	50	100
Pitch	-45	0	45
Roll	-45	0	45
Yaw	-30	0	30

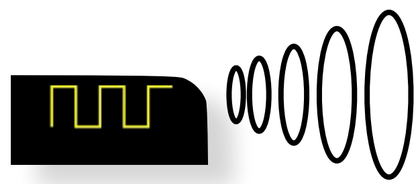
MAKEKIT

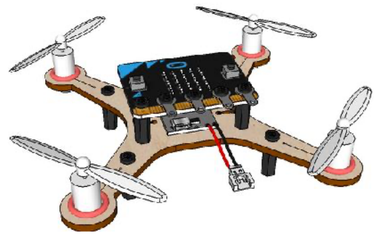
Start coding
makecode.microbit.org

Four steps









Collect data → Visualize data → Send data → Receive data, fly

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

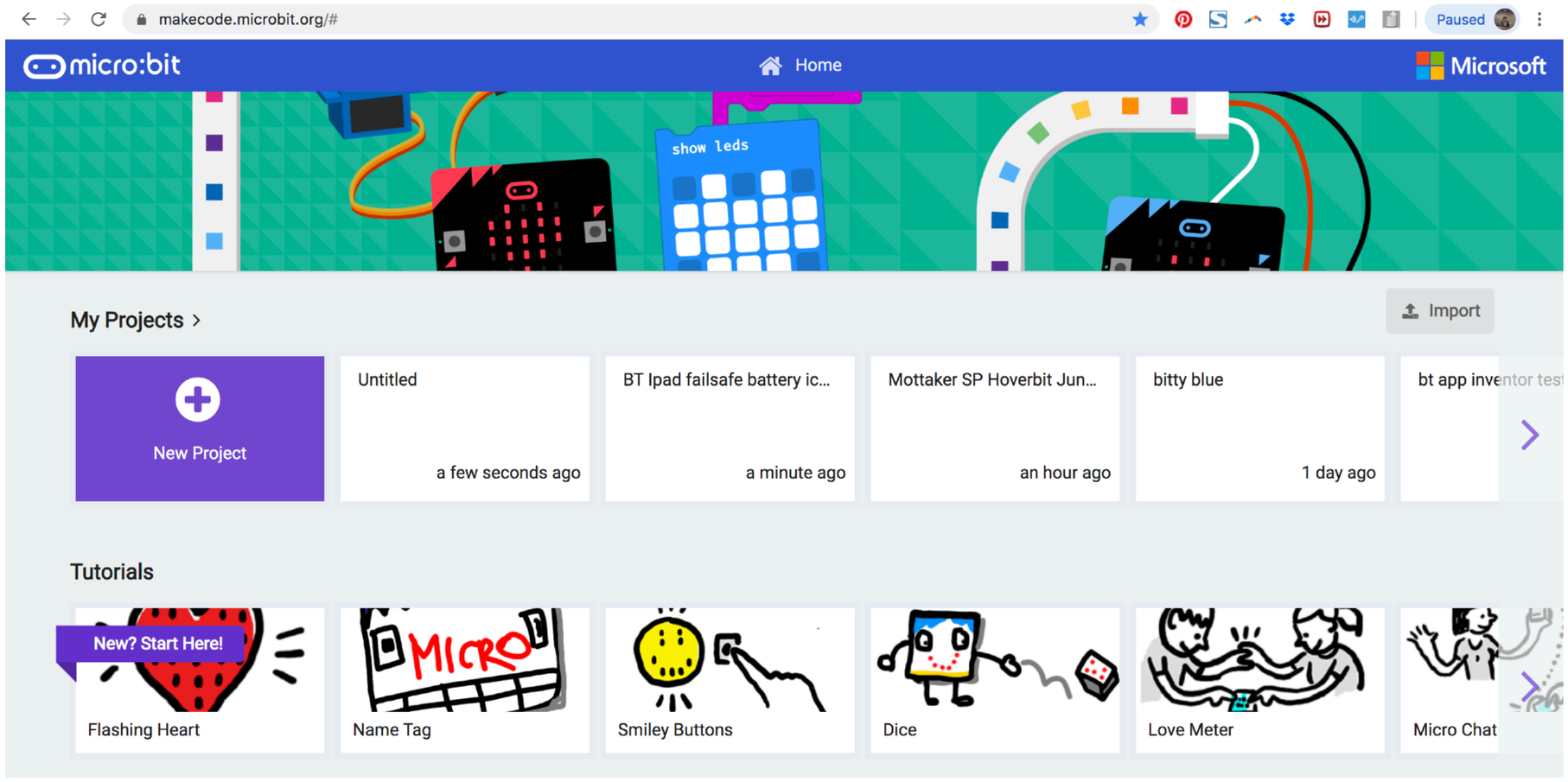
Convert the values to coordinates for the display

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

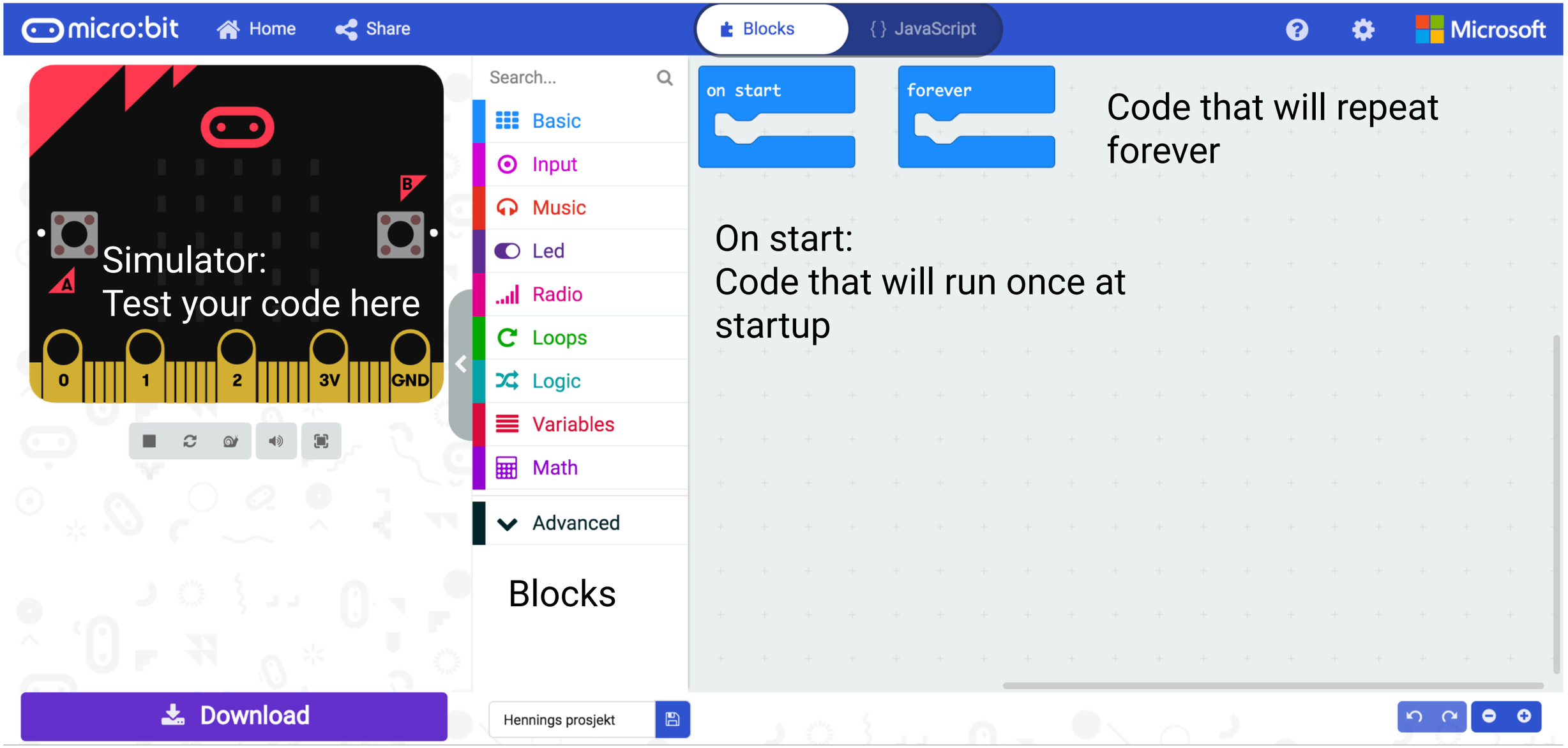
Main menu

Share your code

Block mode

Javascript mode

Settings



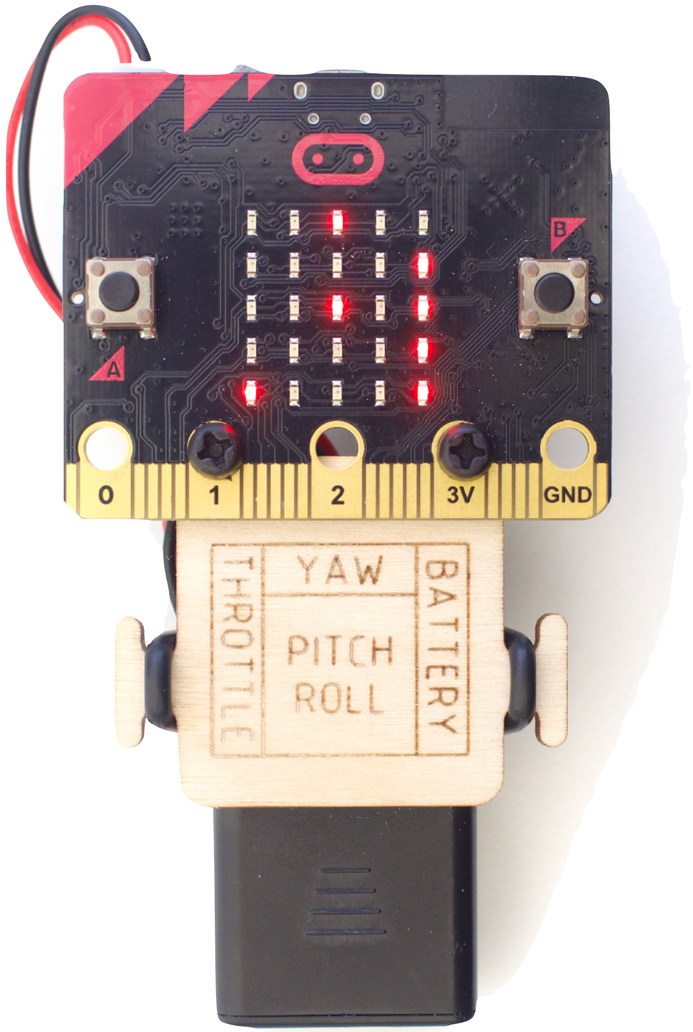
Download to micro:bit

Name your project

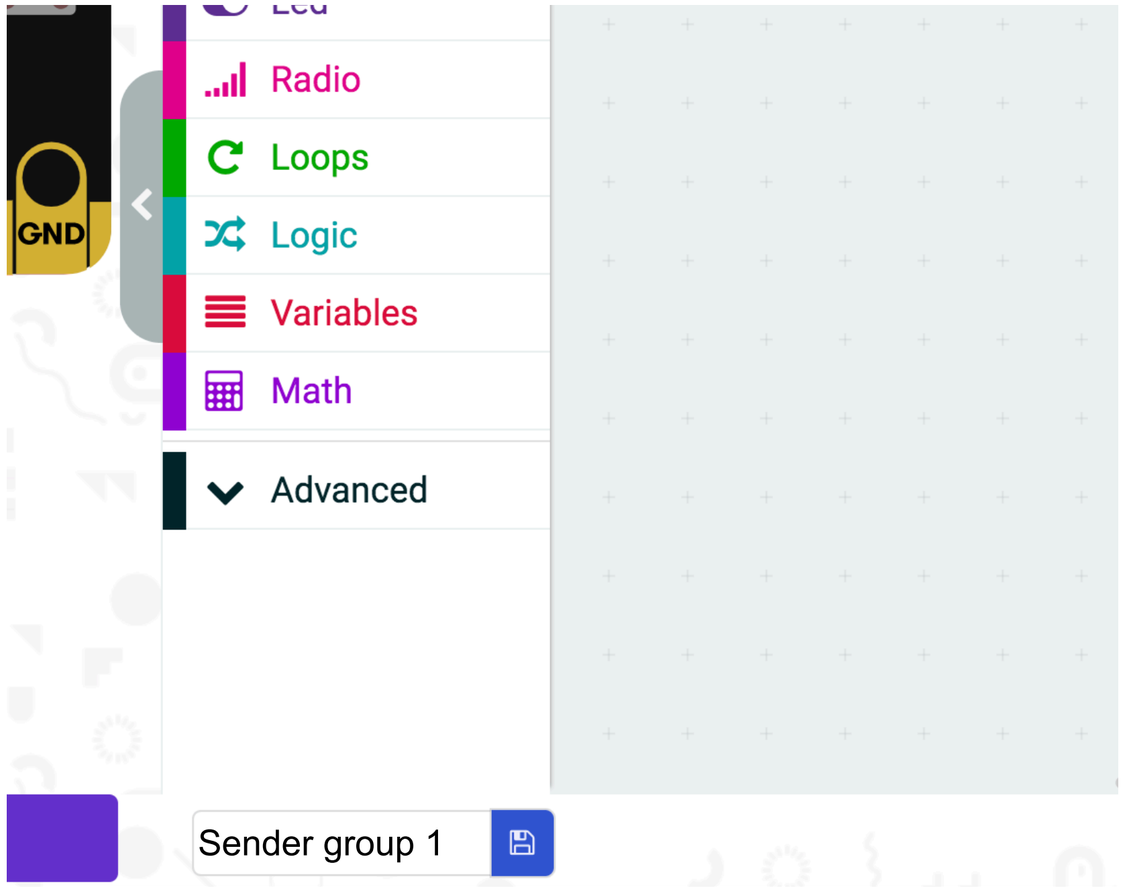
Save a backup

Undo zoom

Get the variables and code the remote

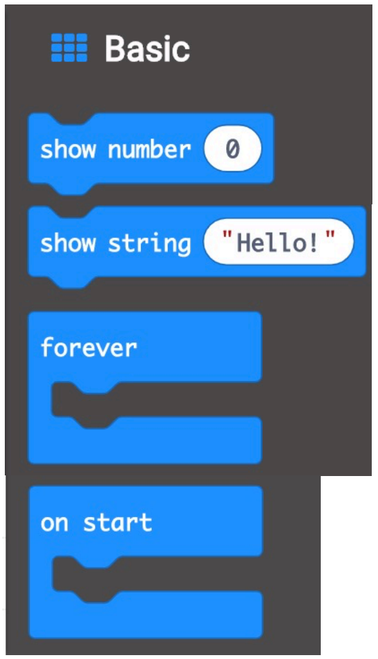


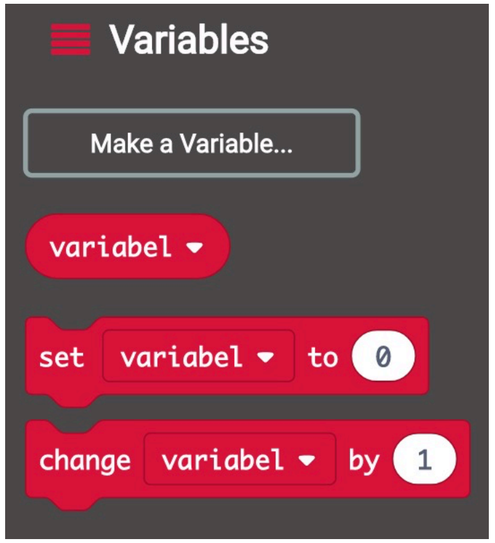
Start by giving your project a name like “Sender group x”. This is your unique radio channel. If you are flying alone you can use channel 7

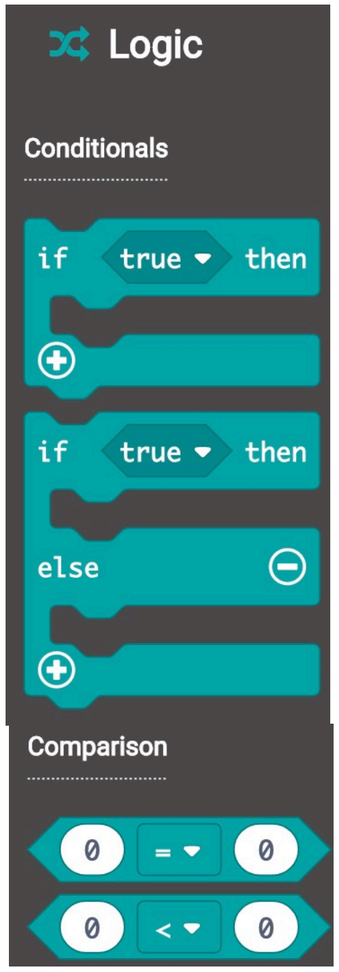


Code blocks

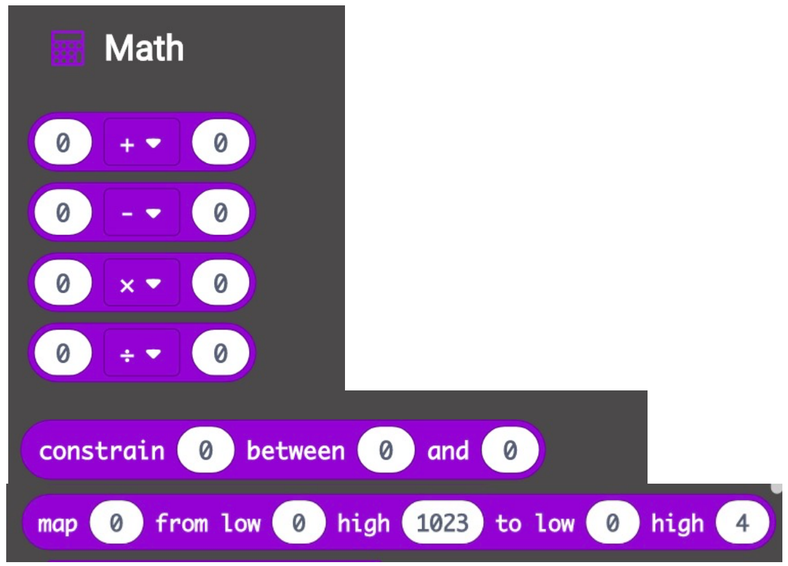
We will be using these blocks

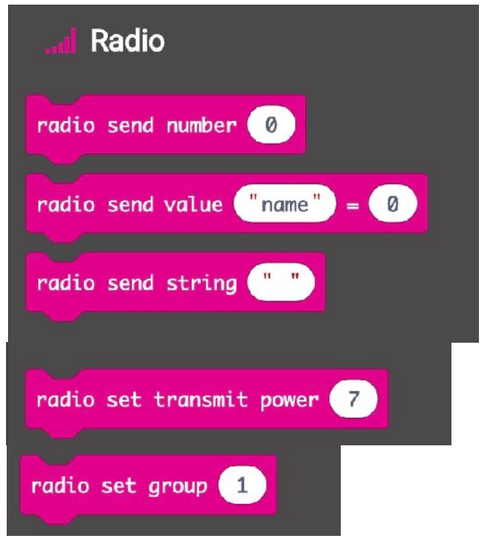






More blocks


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

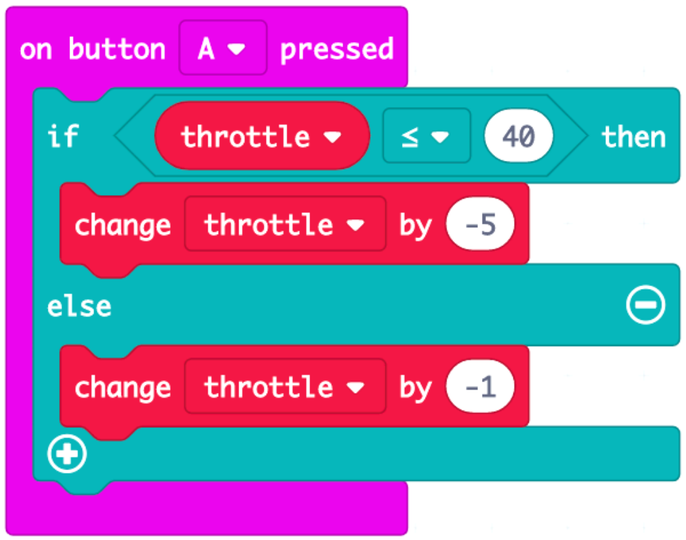
Throttle

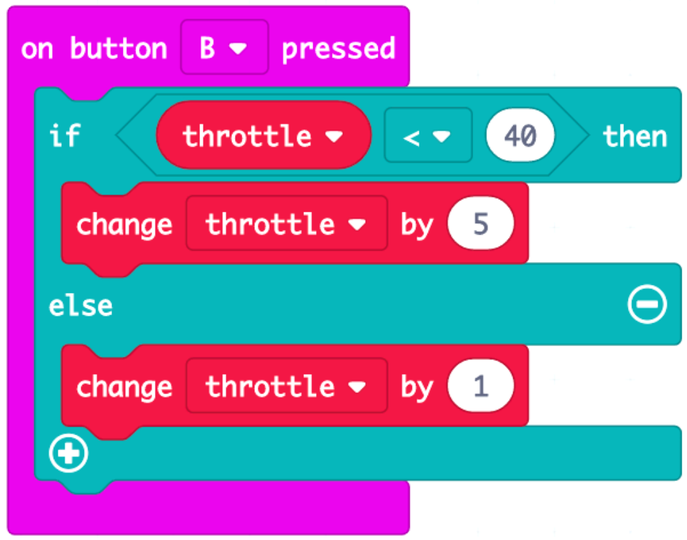
- Make a variable called Throttle
- Use the buttons A and B to change the throttle. A should reduce it with 5, B should increase it with 5
- Use Show Number (in the forever loop) to å verify that throttle is changing correctly
- When above 40, throttle should only change by 1 for better precision when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

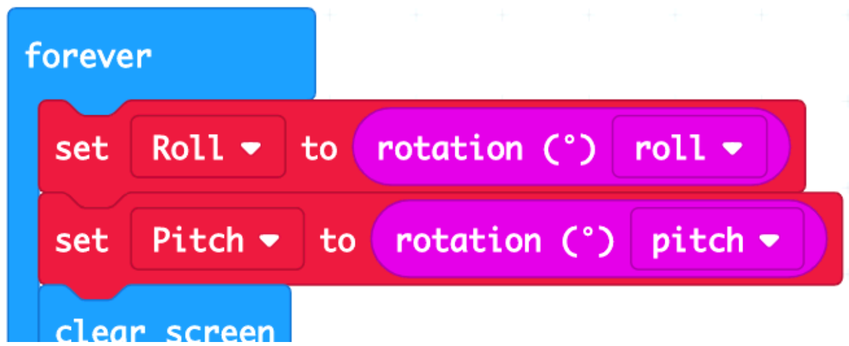
Roll og Pitch

- 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

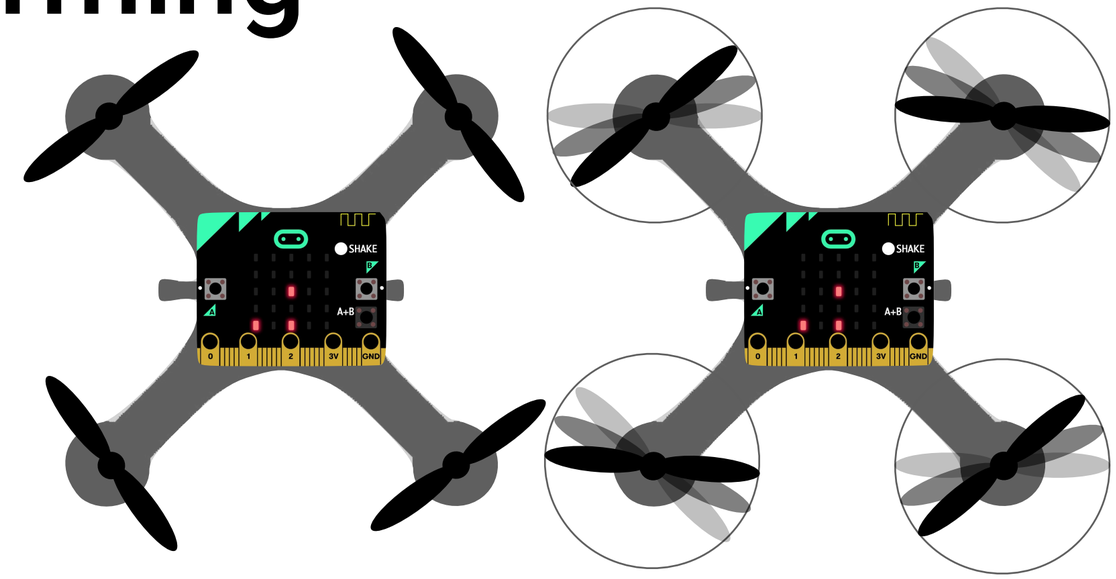
Solution


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

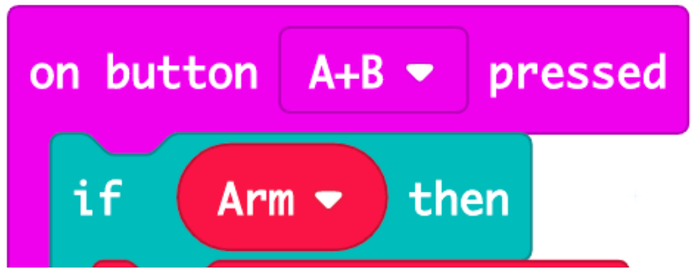
- Arming is a safety switch and the propellers will only spin when arm is set to 1

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

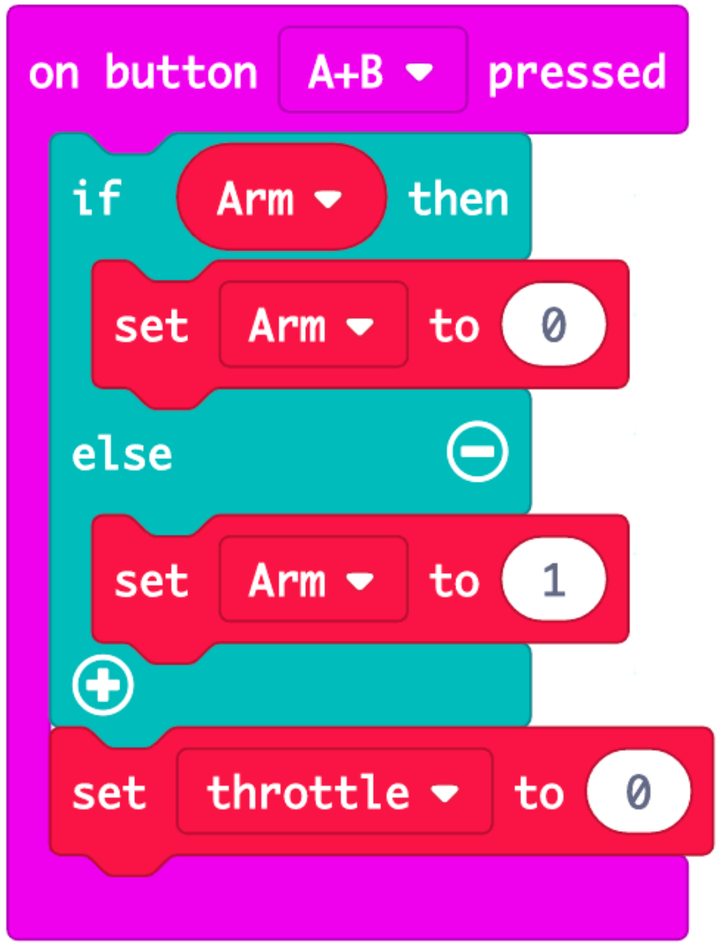
Bryteren setter Arm til 0 og 1 annenhver gang

PARTY



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

Solution

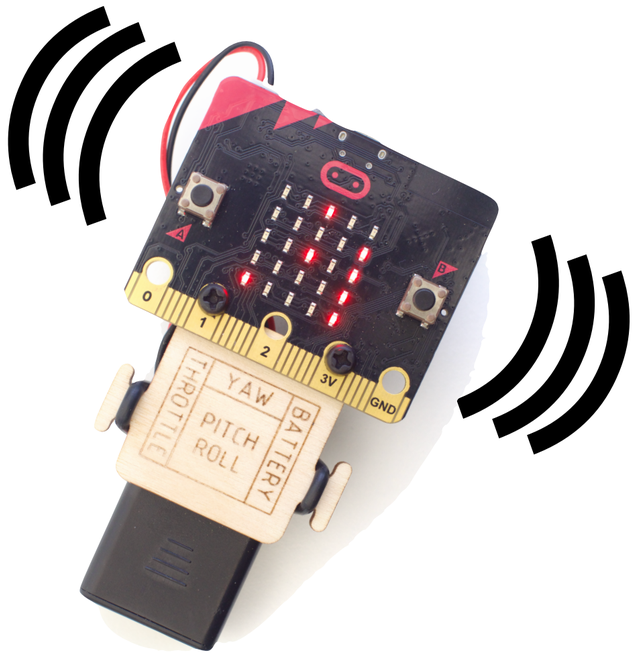

on button A+B pressed
if Arm then
set Arm to 0
else
set Arm to 1
set throttle to 0

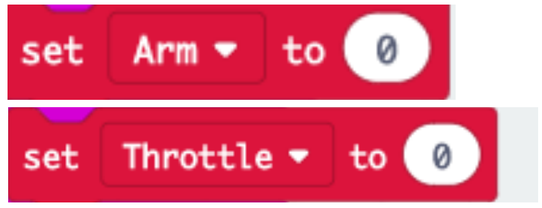

on shake
set Arm to 0
set throttle to 0

Panic feature

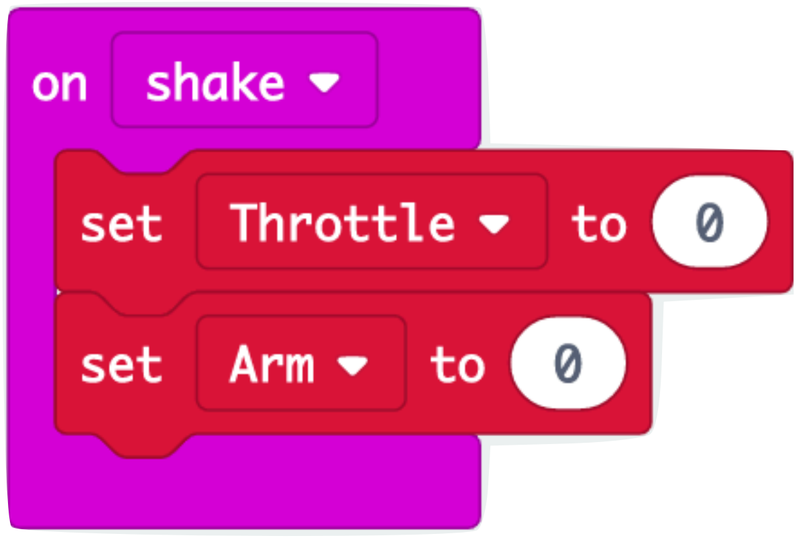
If we loose control of the drone or crash, a panic button will be handy. It will cut off the motors immediately.

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.





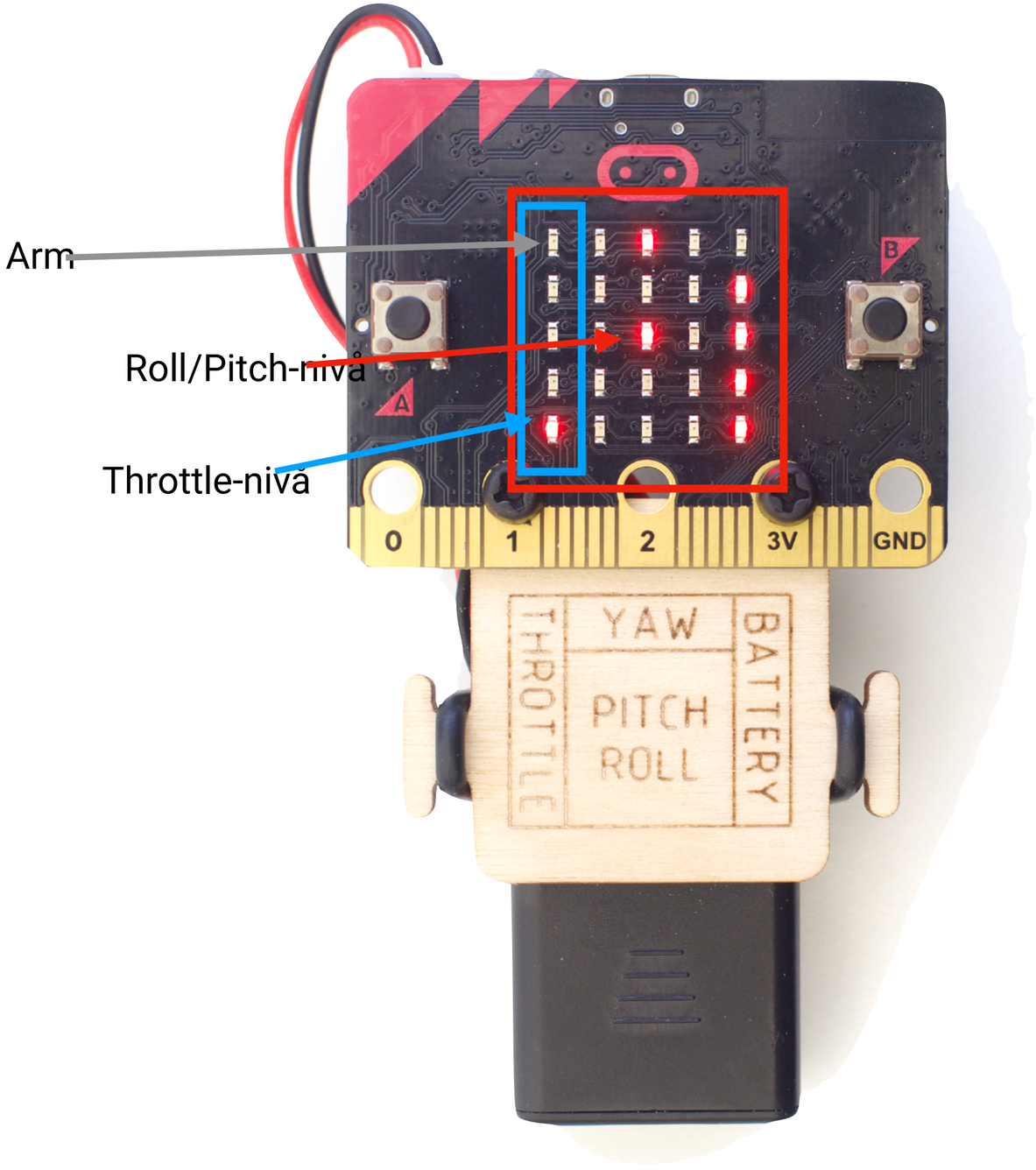
Solution



Visualise the variables

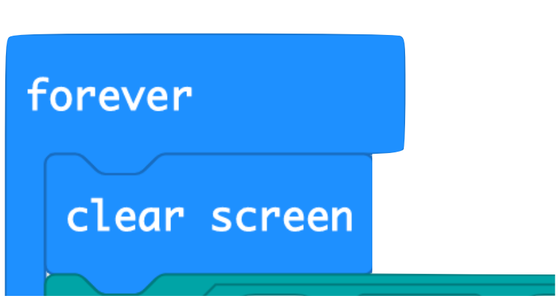
We can use the display to show basic information from our PARTY values.

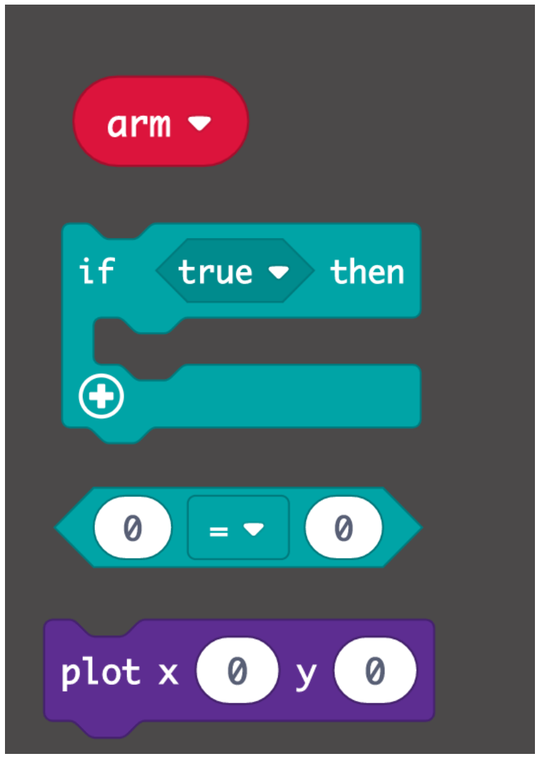
- Arm-pixel lights when armed
- Throttle-pixel moves upwards when throttle increases (thrust)
- Roll and pitch is the X and Y position of the center dot

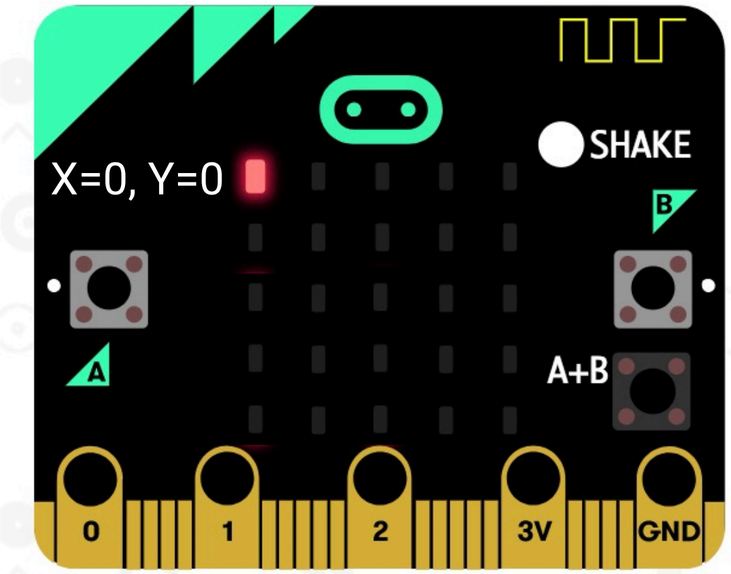


Visualise Arming

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)

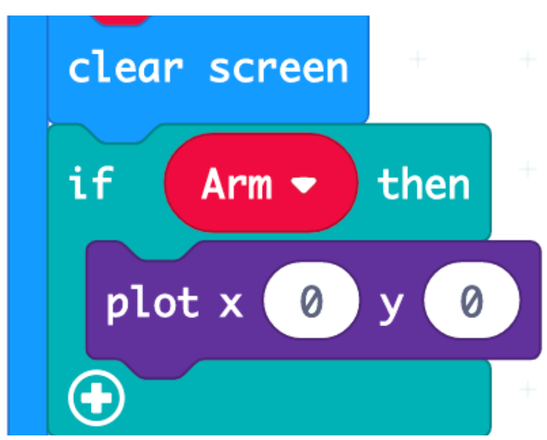






- **Extra challenge:** Make the pixel blink

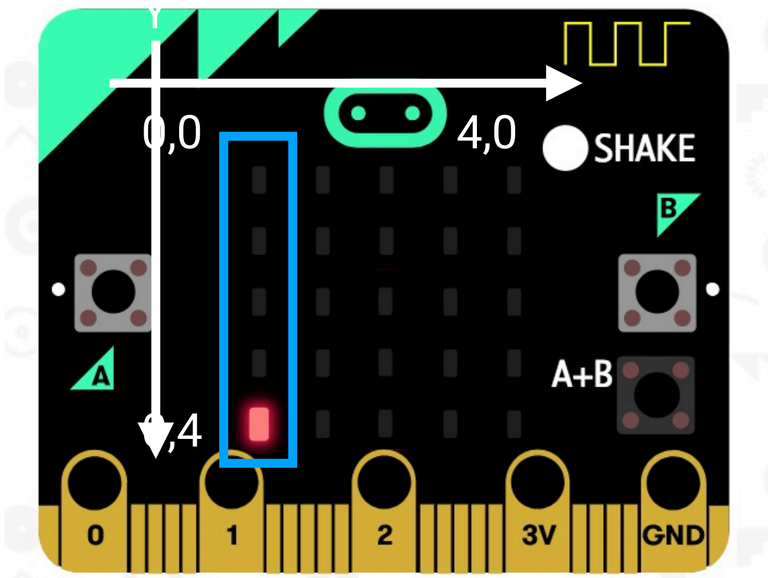
Solution



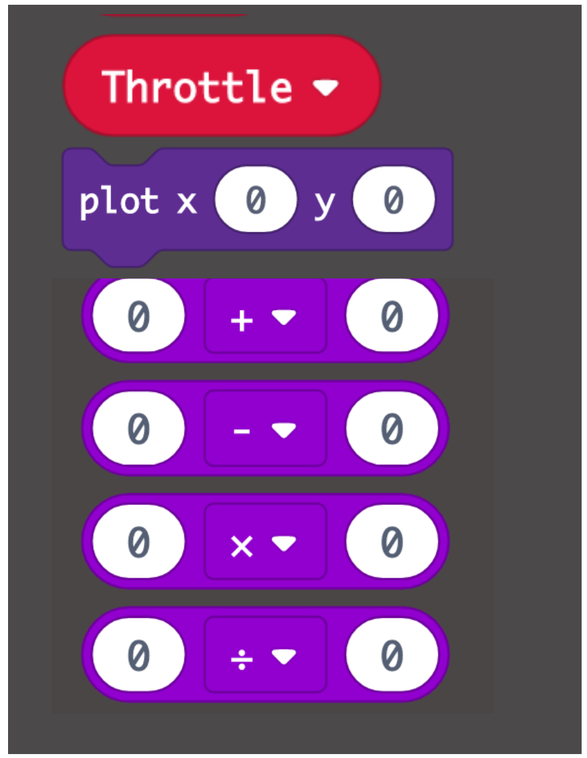
Visualise values: Throttle

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.

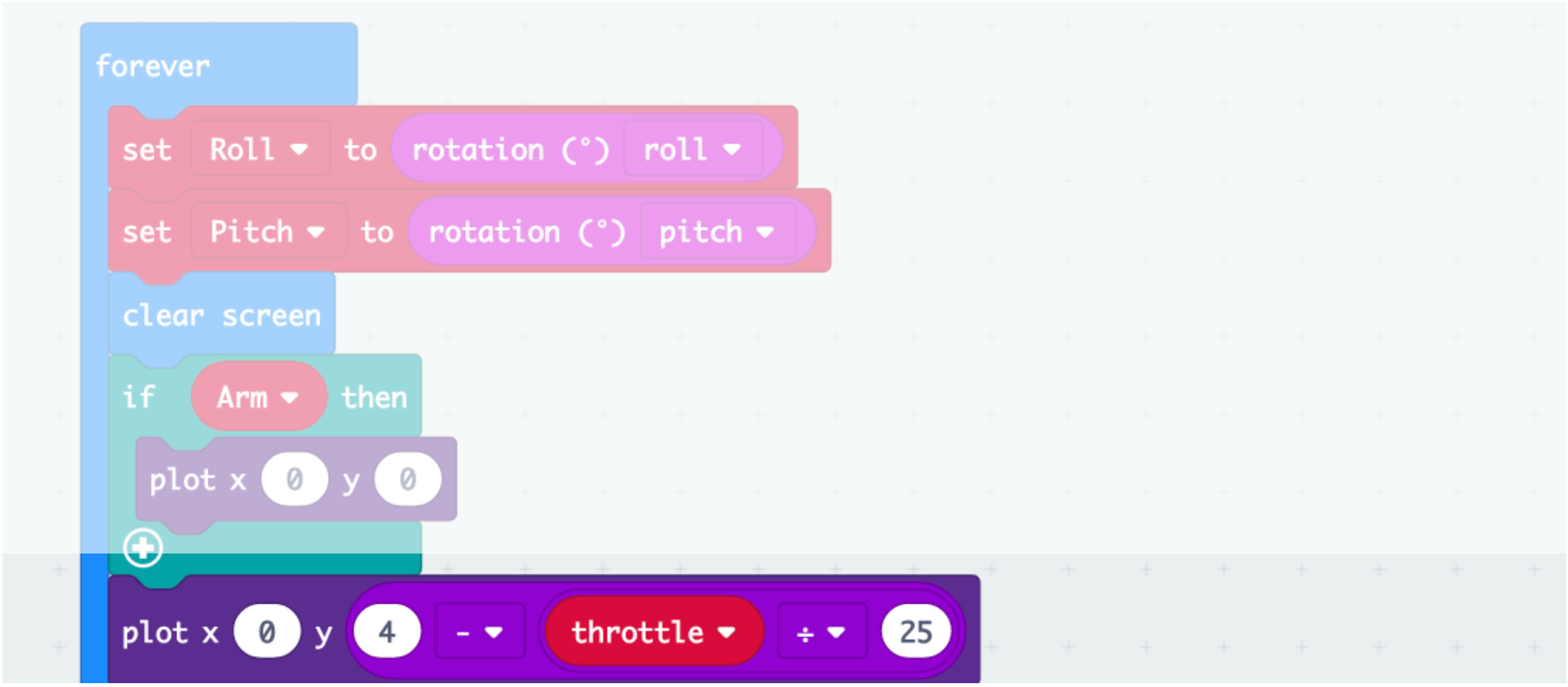


Throttle	0	50	100
First calculation	0	2	4
Second calculation	4	2	0



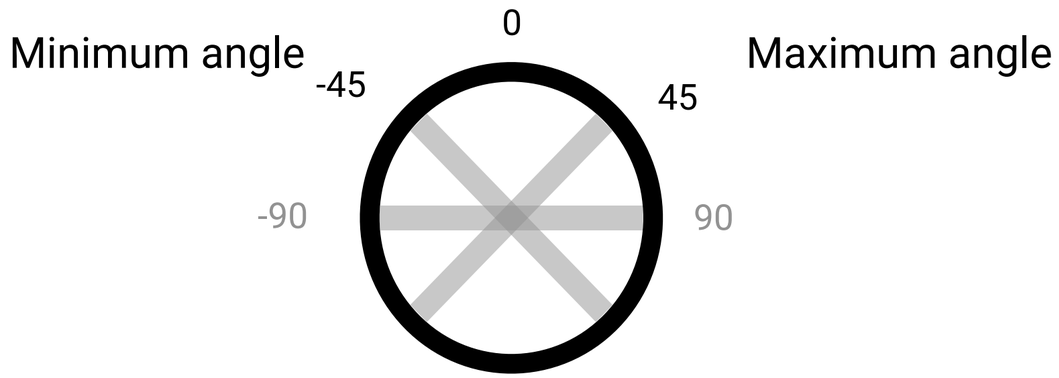
Solution

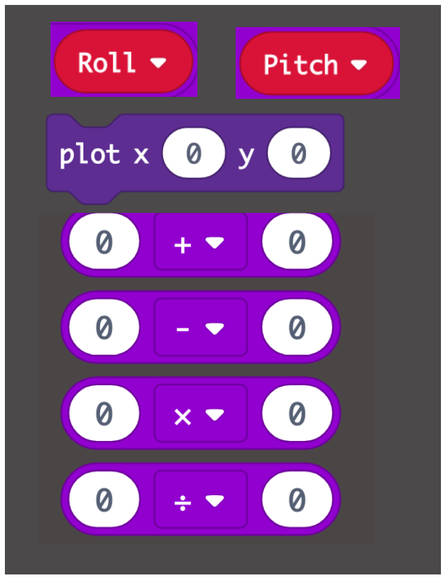
Pixel Y = 4 - throttle / 25



Throttle / 25 goes in the inner block

Visualise values: Roll/Pitch

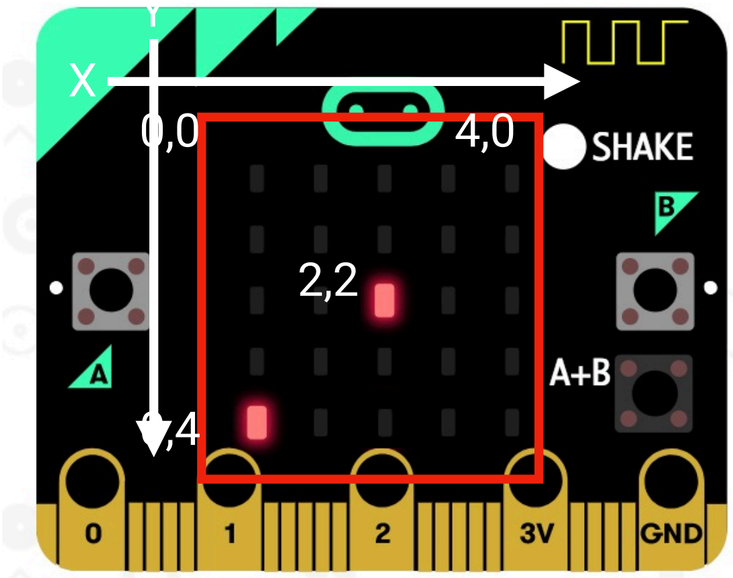




Roll / Pitch

- 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)
```

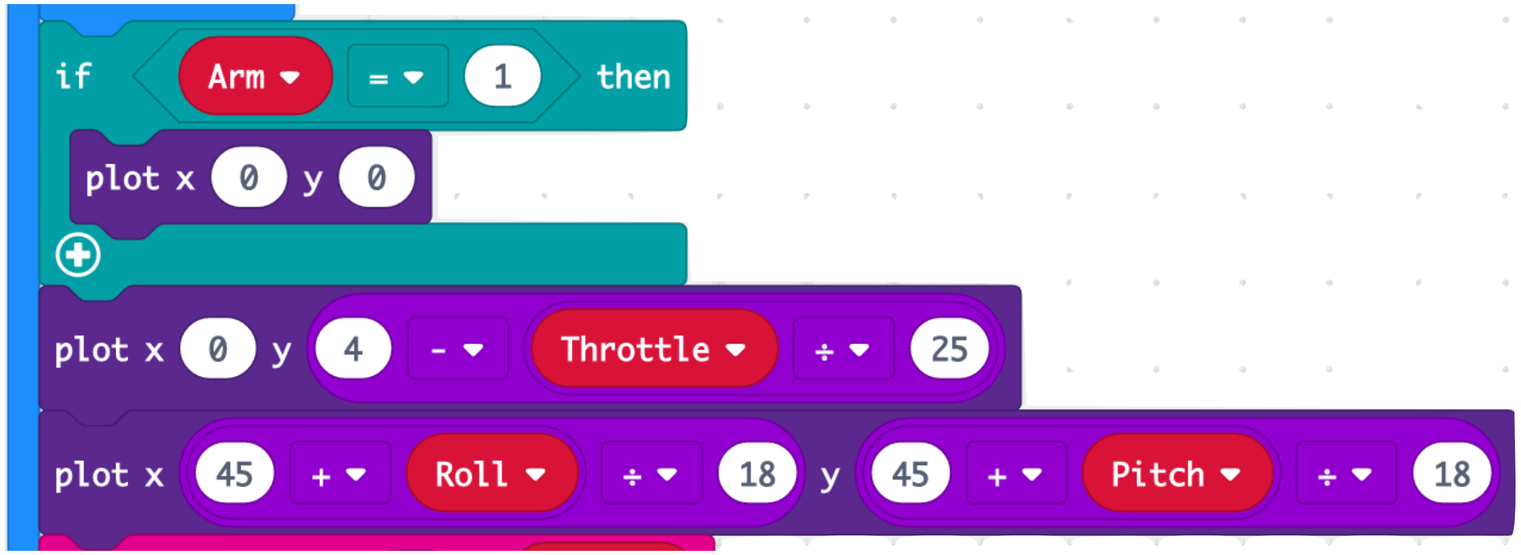
An easier alternative to functions

We can also map the values using this block

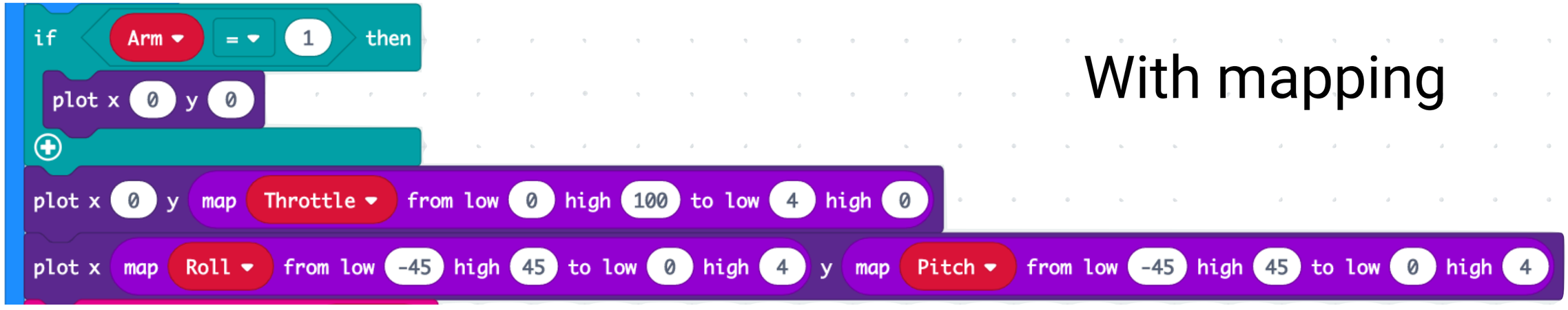
Original value	Lowest expected value	Highest expected value	Lowest output value	Highest output value

Example:

Two solutions

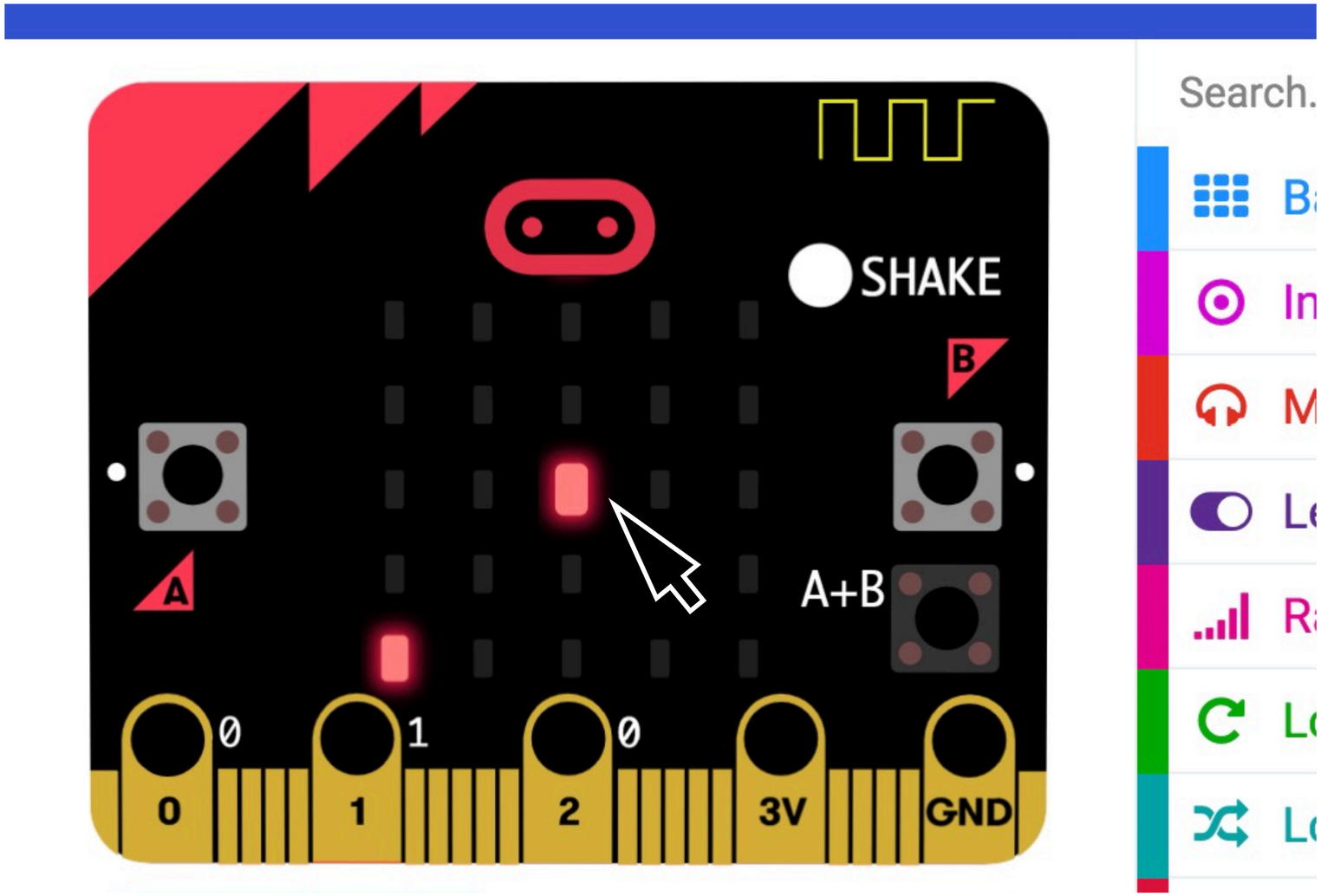


With functions



With mapping

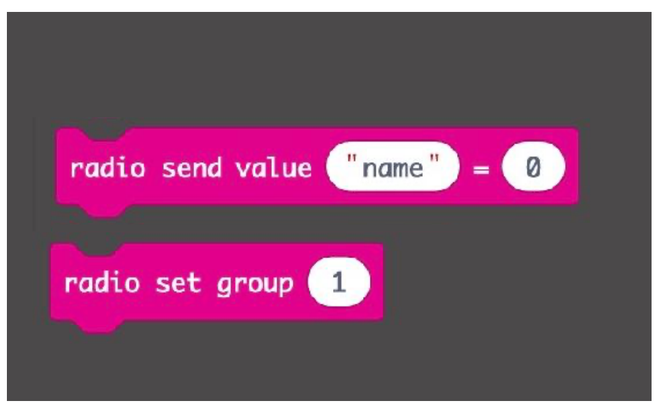
Does it work?

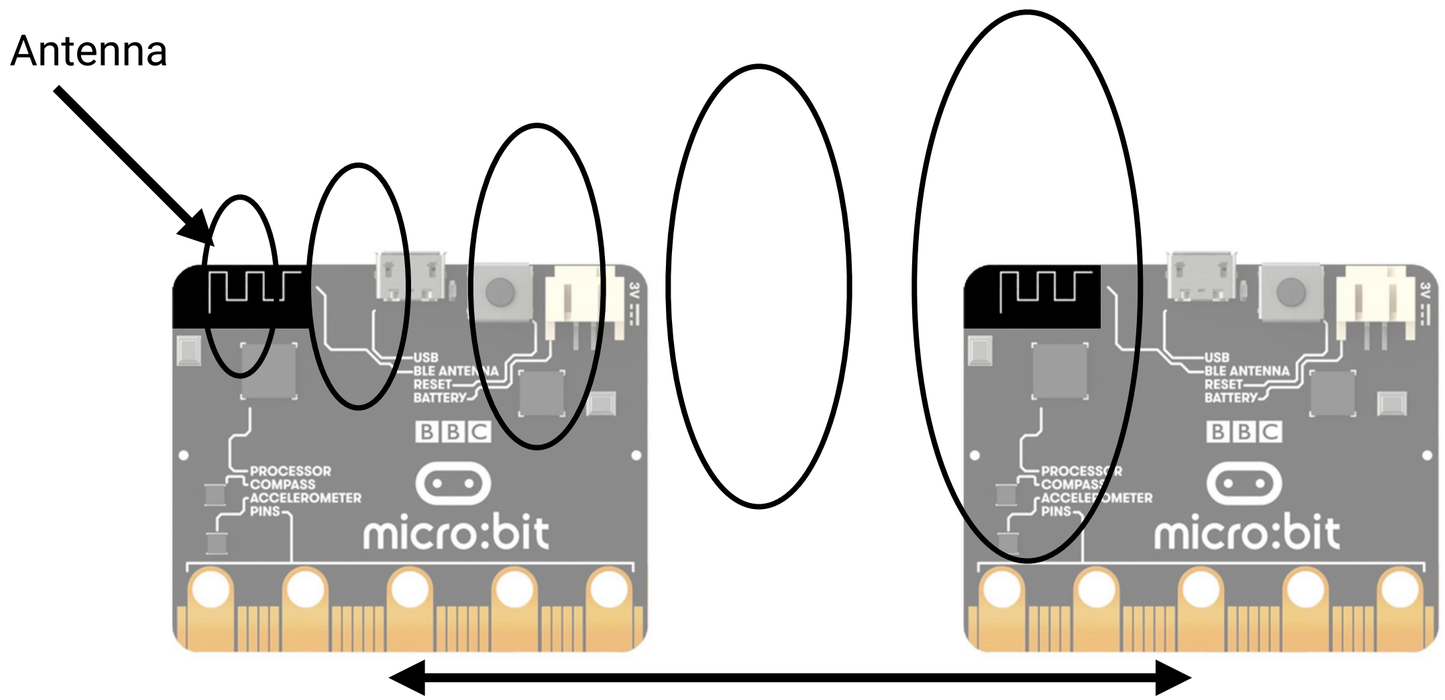


Test it in the simulator:

- 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.

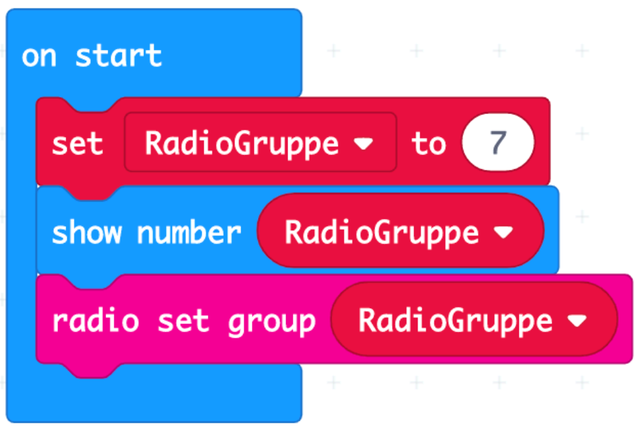
Radio



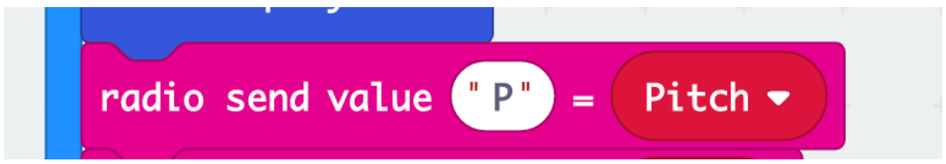


Task:

- 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

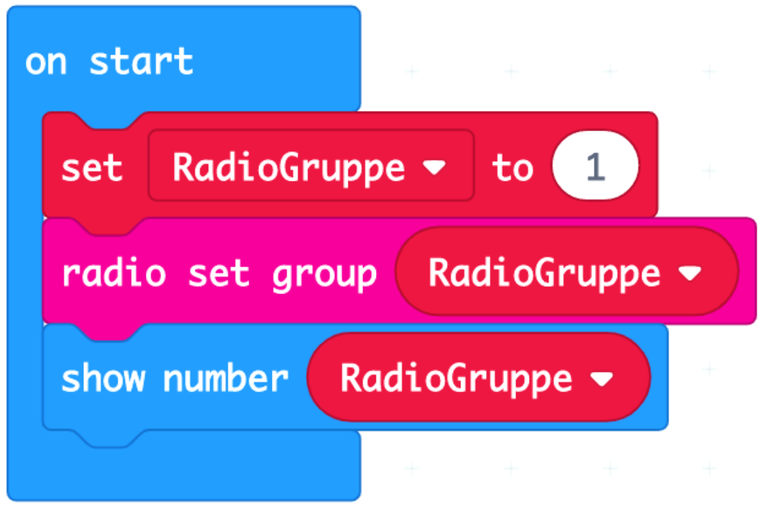


Example:

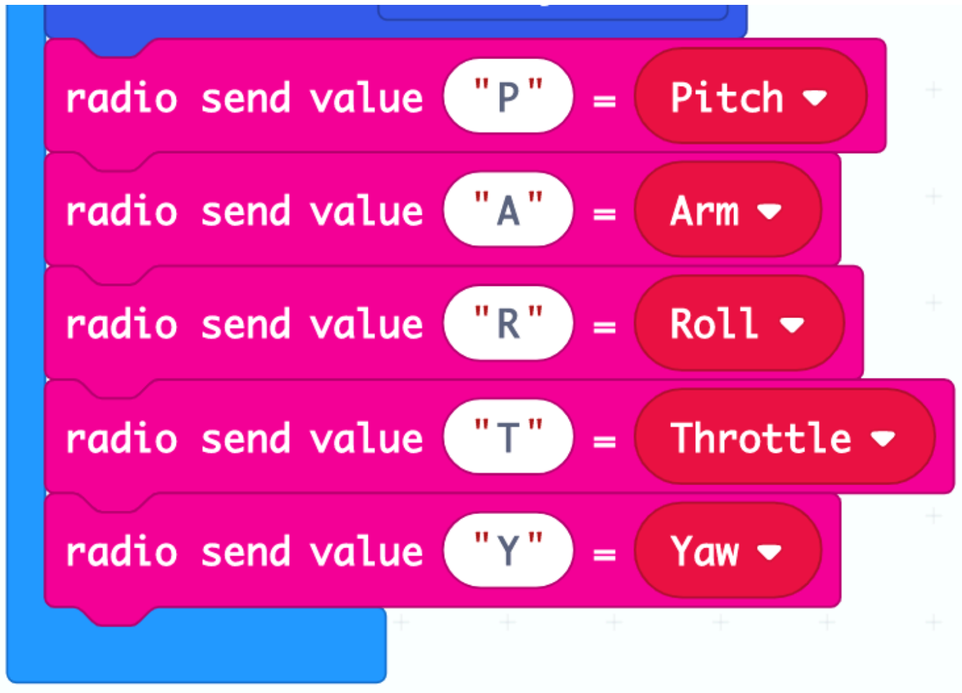


Solution

Your unique radio group



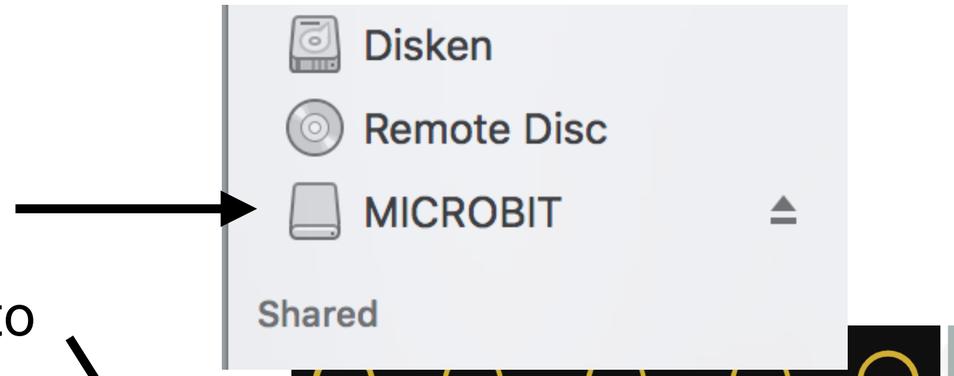
Bottom of forever block

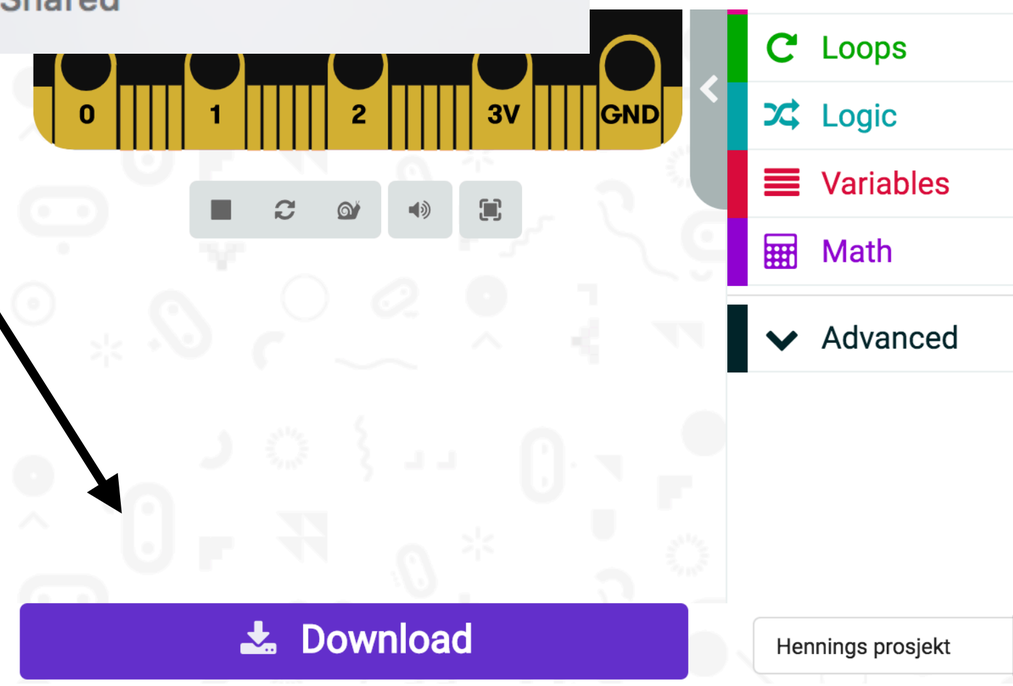


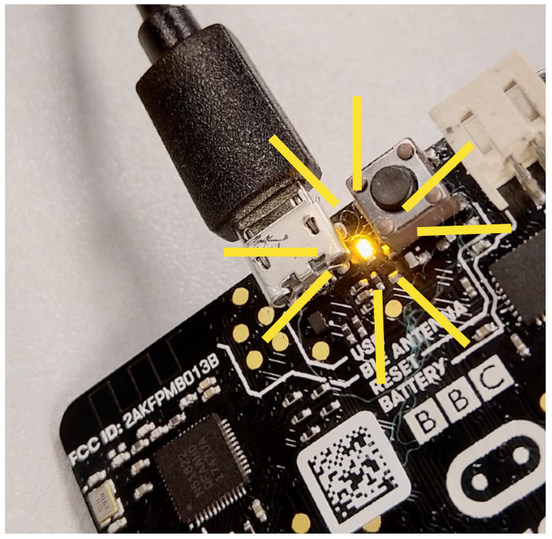
Remember: capital letters
Yaw can be skipped

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



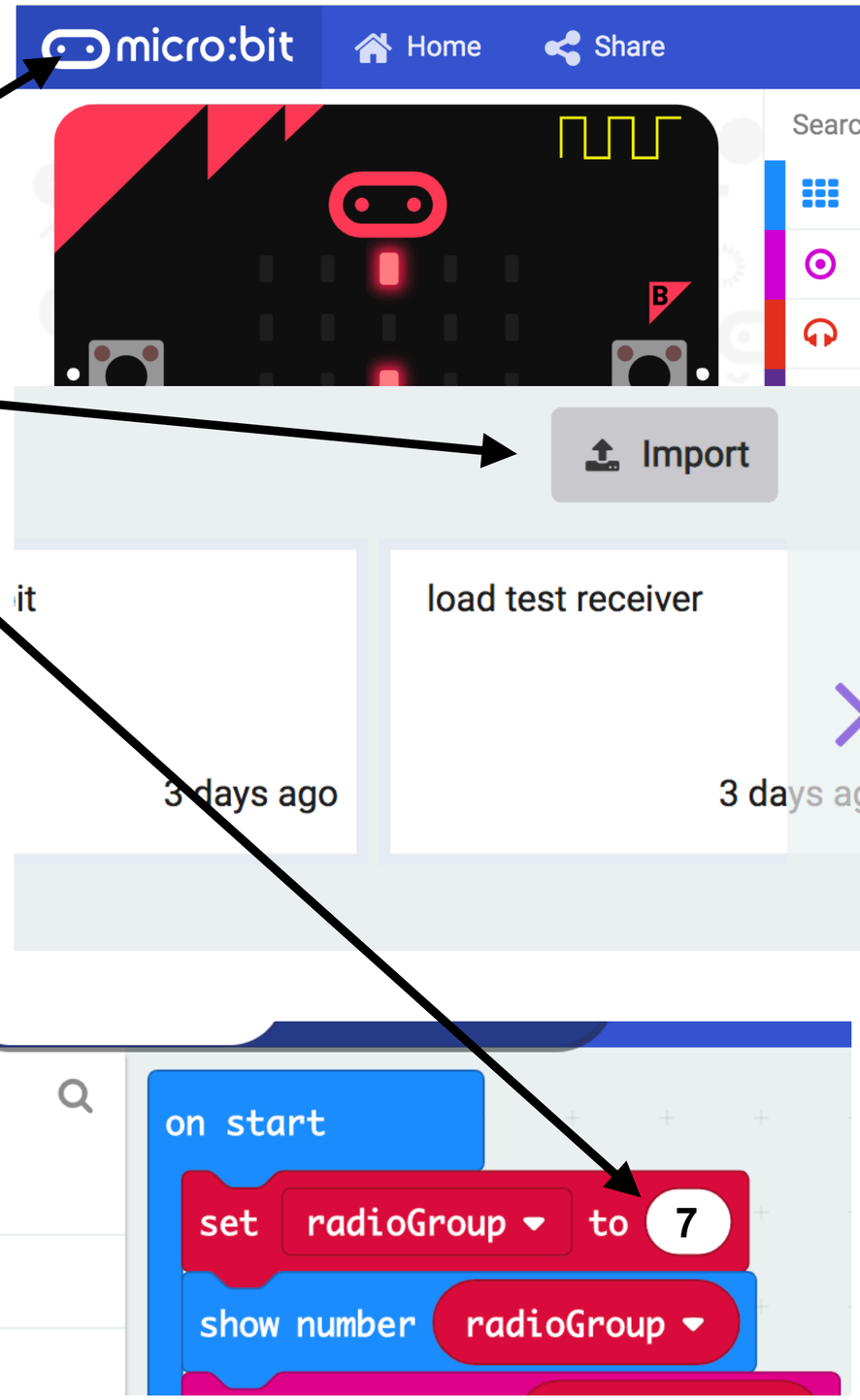


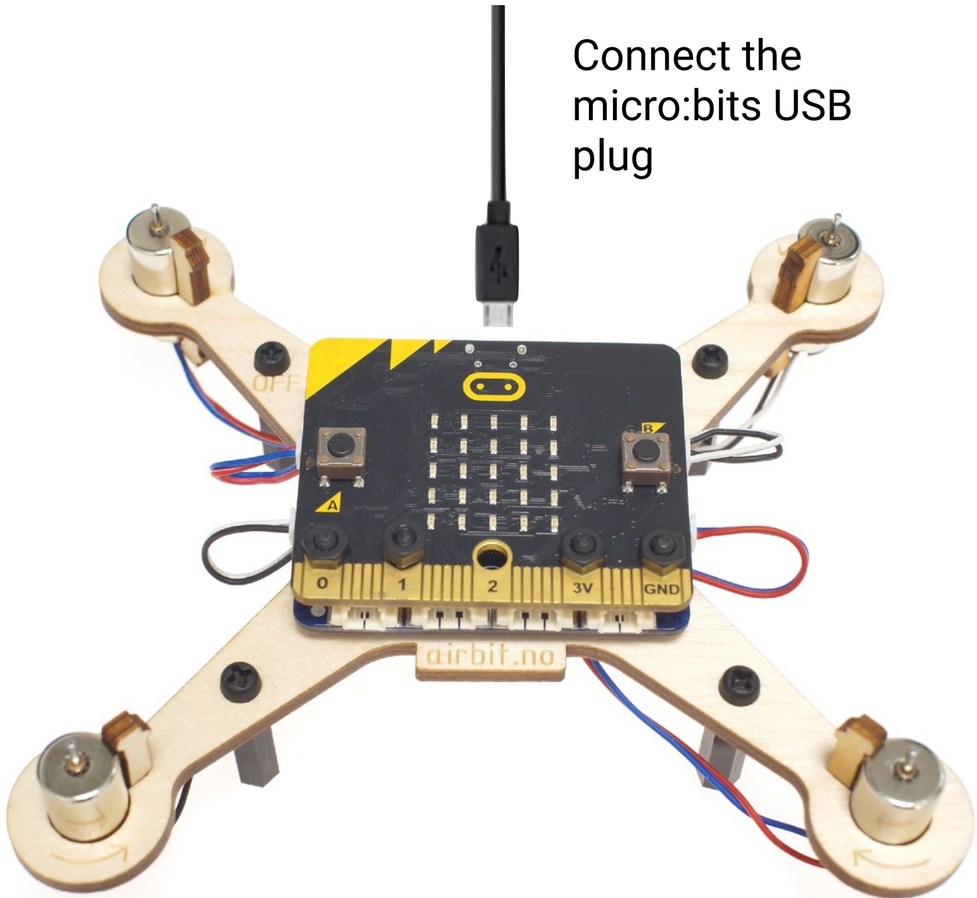


Read more about connecting the micro:bit See the micro:bit introduction at makekit.no/

The drone code

1. Download the drone code called “Airbit 2” 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

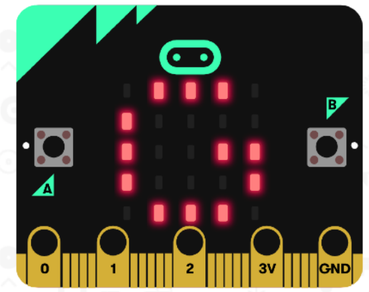




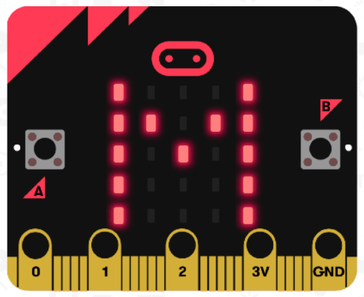
Startup and Calibration

The drone needs to calibrate before flight.
Disconnect any USB power or battery.
Place the drone on a still, level surface and connect the battery. The drone will check for sensors and calibrates.
If you get “no gyro”, check the 5 top screws and reconnect power.
If you get “no pca”, disconnect USB and battery, and connect only battery.

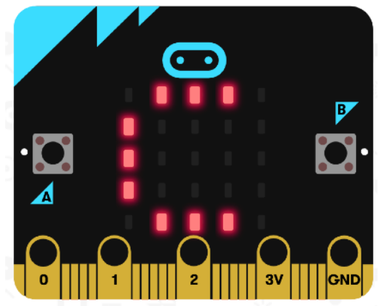
Gyroscope present



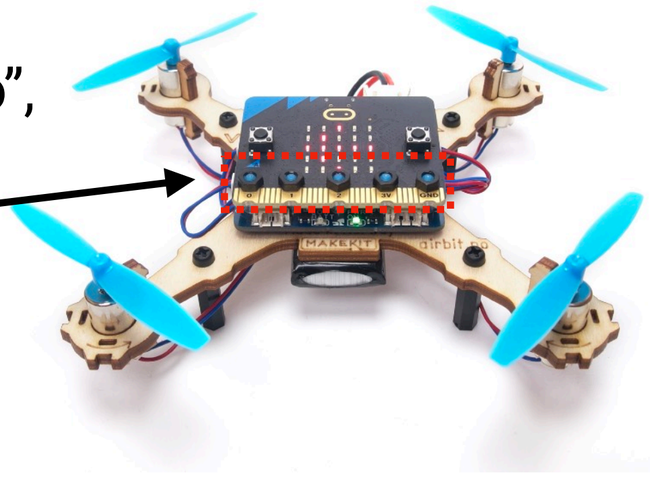
Motor driver present



Calibrating:
When calibrating, the drone needs to be still, on a level surface.



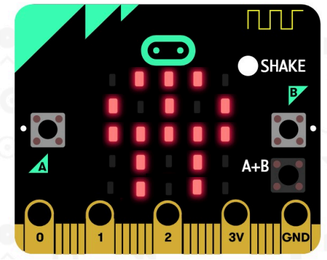
If you get “no gyro”, check /tighten screws



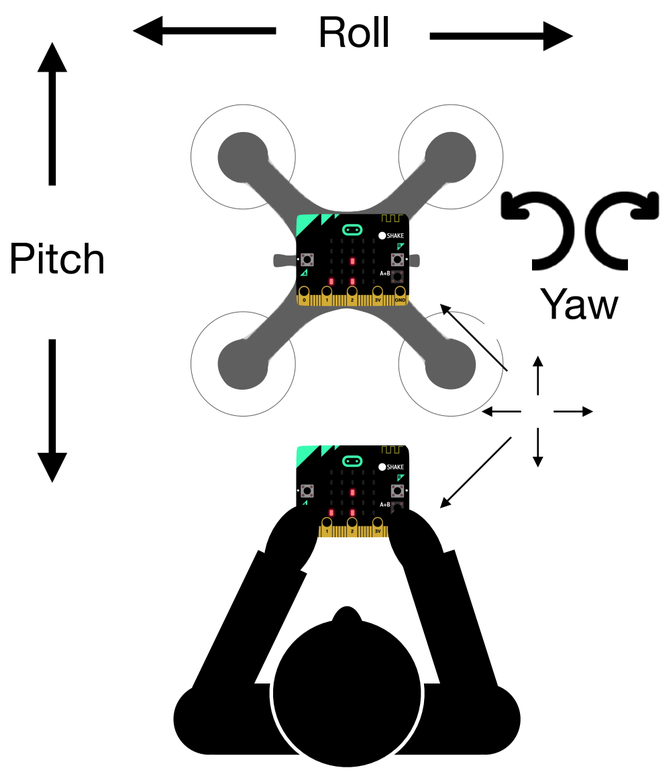
Flying

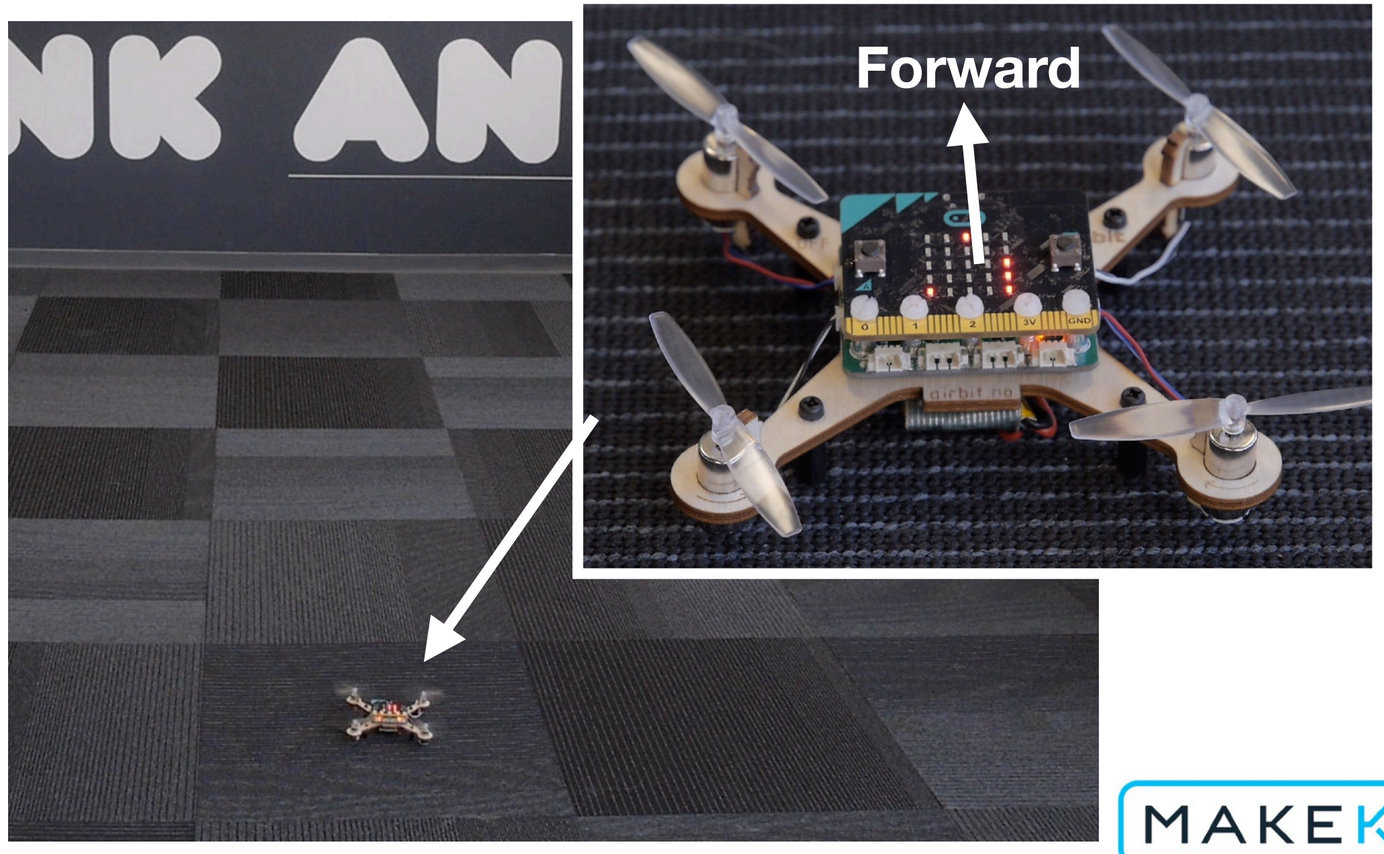
Video: https://youtu.be/VMF9uehLfg8

- [ ] 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. Even small propellers can hurt!
- [ ] 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. Then the battery will be cut off. Do not fly, disconnect battery or charge.
- [ ] Follow local drone regulations.

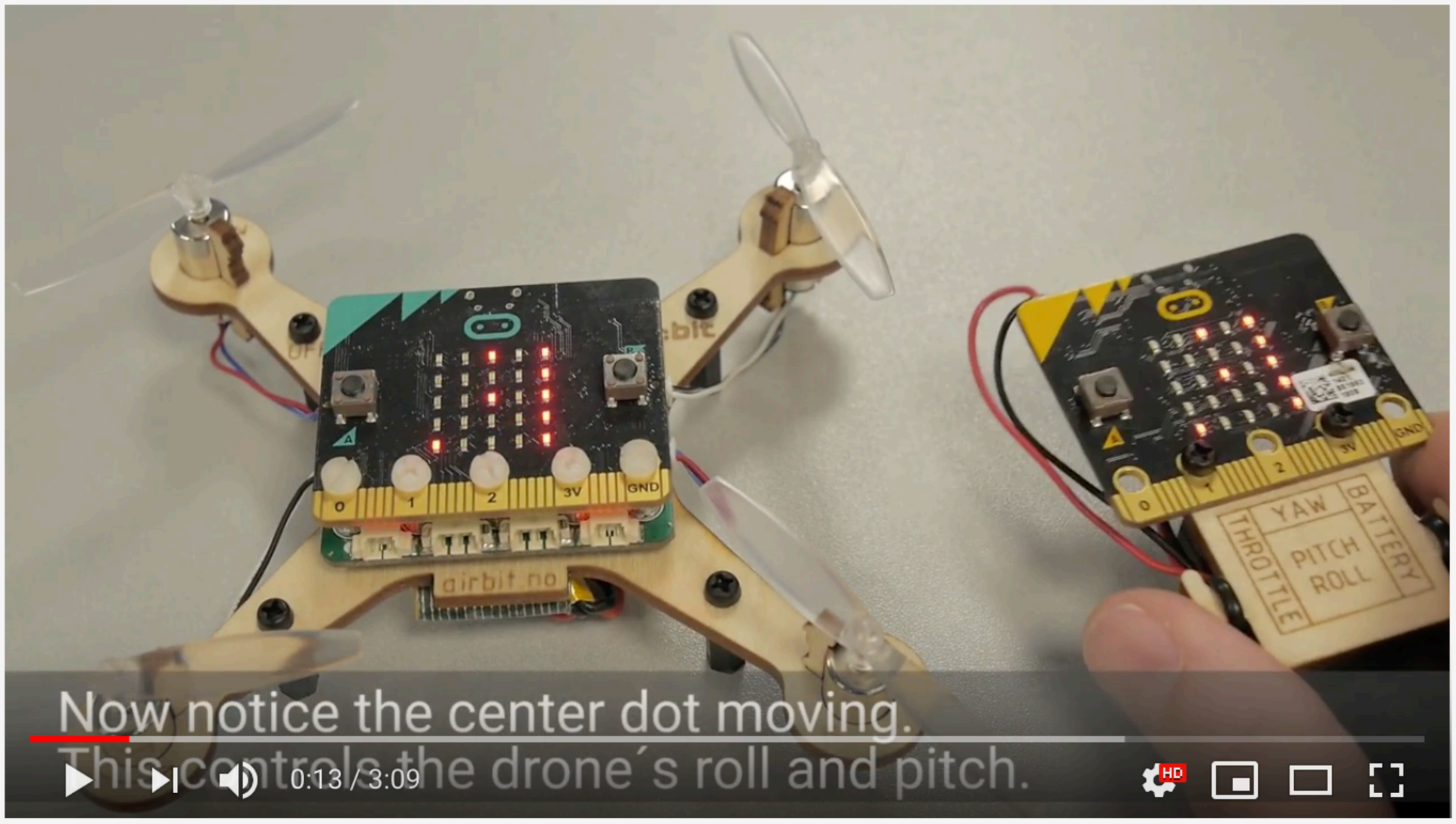


Battery empty





How-to fly video: https://youtu.be/VMF9uehLfg8



Problems?

Place drone flat on ground, connect battery, wait until “C” (calibrating) is done. 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.

- On the drone, is the control board and the microbit connected? If the text say “No Gyro” or “No Motor controller”, the connection is not stable: thighten the nuts. Disconnect / reconnect battery. Look for the letters G and M during startup.

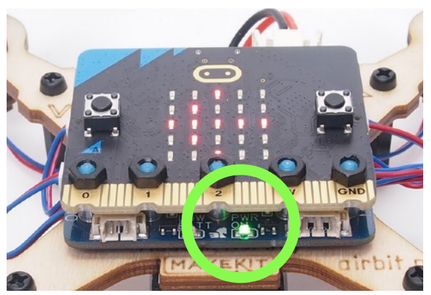
Motor starts, but can´t lift off

Have you placed the correct propeller on the right motor? (Page 23)

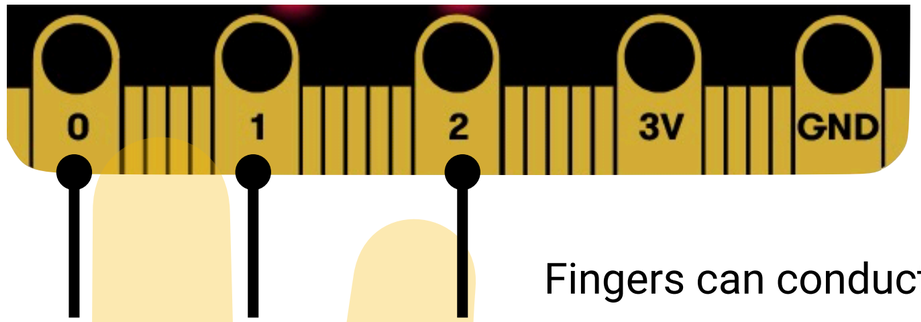
Are all the motors working and spinning? Can there be a damaged motor?

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

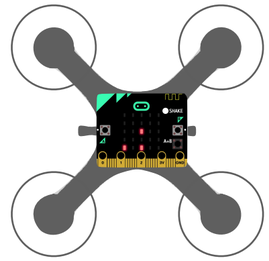
Is the battery charged and is there a green light?



Extra task: Yaw



Fingers can conduct electric current



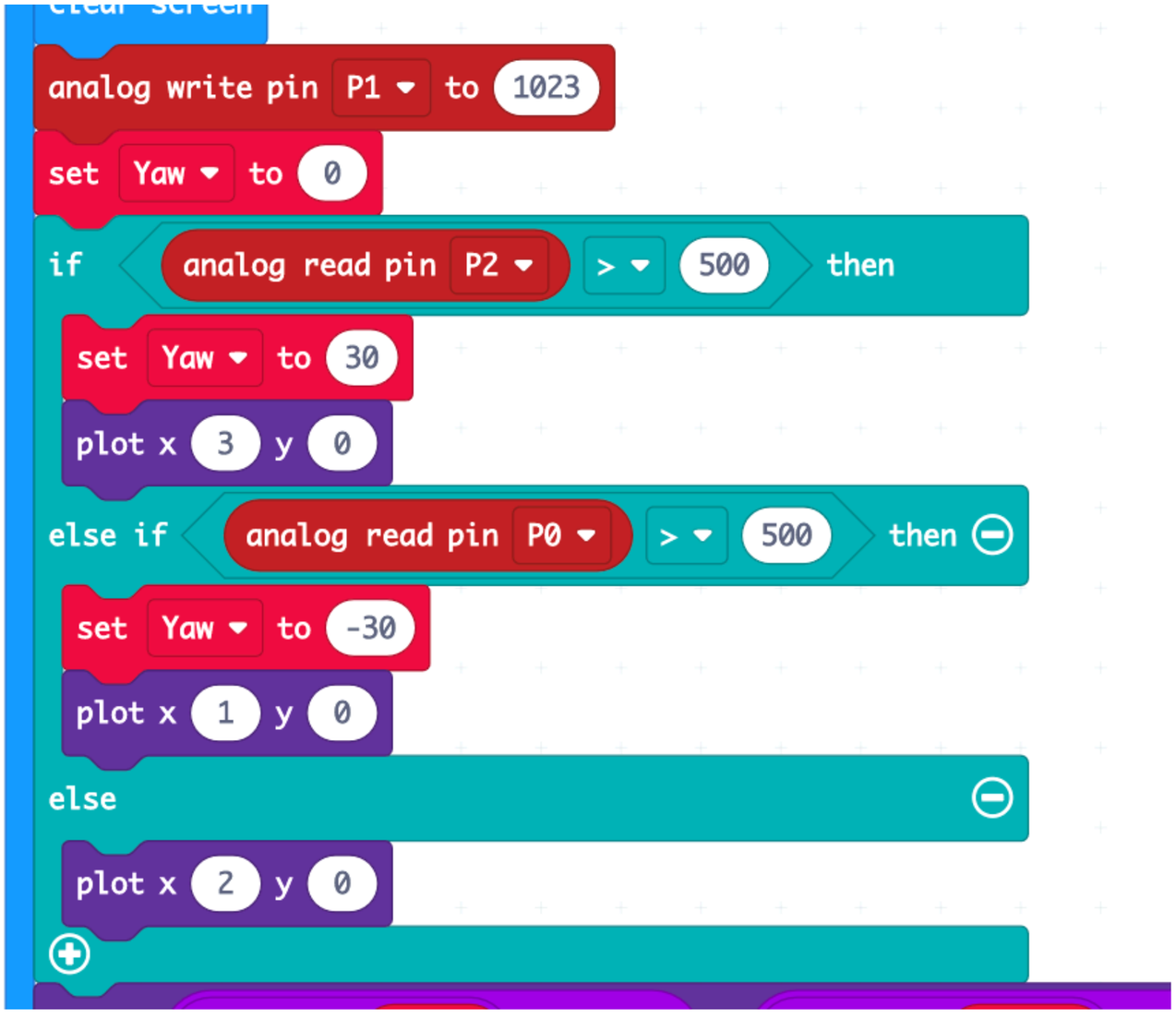
Yaw is a sideways rotation

Yaw

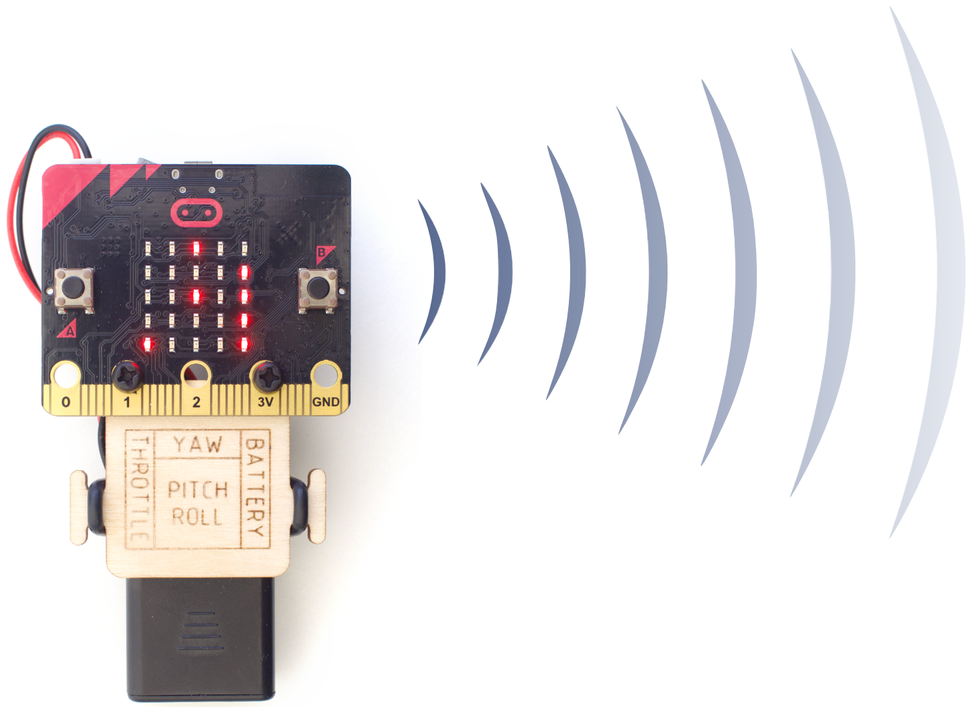
Yaw makes the drone rotate sideways around its center. You can make artificial button and control the yaw.

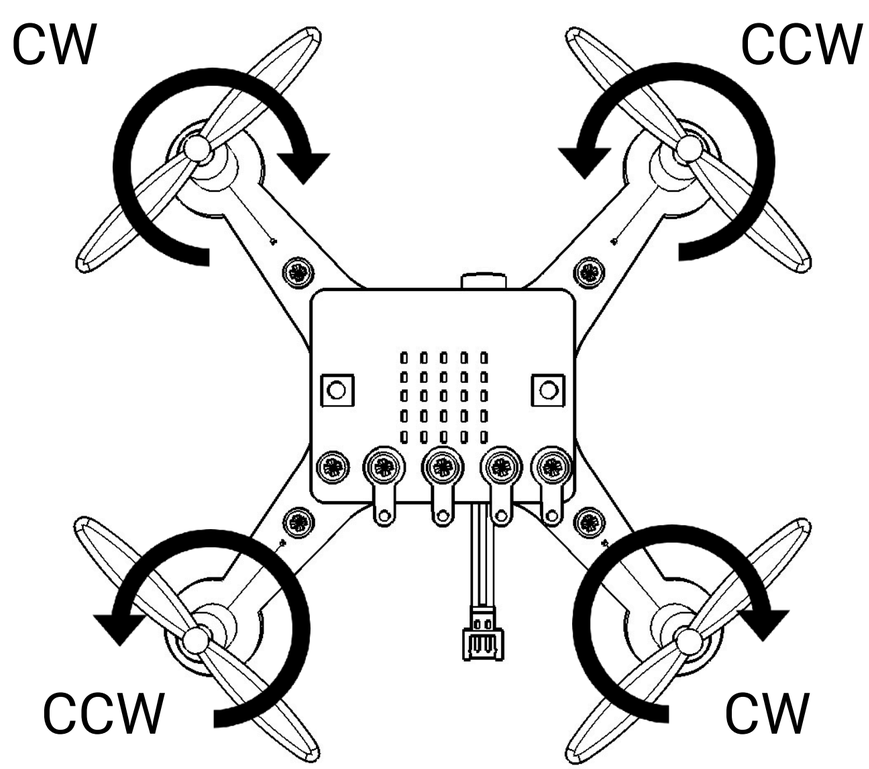
- Use analog write to make P1 send out power
- Use analog read to make P0 and P2 read power that is lead trough your fingers
- When nothing is touching P0 and P2, the analog read will be low (around 200)
- When conducting electricity from your fingers, the analog read can be about 800
- Using a treshold 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.
- The micro:bit V2 is slightly different and might require different values.

Yaw: Solution



How the drone controls its path

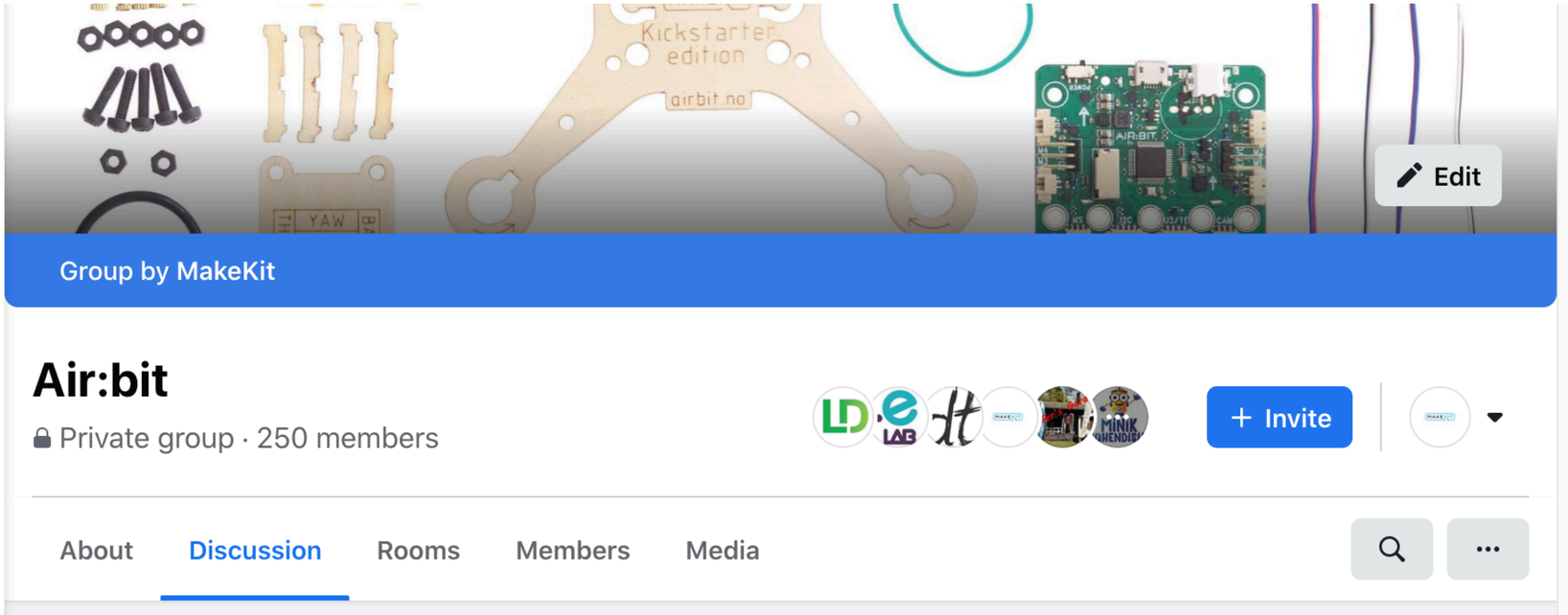




- Two motors rotates with the clock (CW) and two rotates against the clock (CCW)
- The counter rotating setup prevents the drone from spinning around the yaw-axis.
- The drone ascends **(Throttle)** by making all the motors go equally faster
- The drone moves forwards **(Pitch)** by increasing power 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**-aksen 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/



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