

Assembly Instructions

Parts:

- 28byj-48 stepper motor (2x)
- ULN2003 stepper motor driver board (2x)
- ESP32 - I used Node MCU ESP32, but you can use any variation with wifi. (1x)
- Hall effect sensor - I used S49E, you can use a different one but make sure it's linear (2x)
- Wires
- DuPont connectors
- M3x10 screws (10x)
- 3x1 magnets (2x)
- DC Power Jack Adapter Female
- 5V power supply, I have a 2A one.

Tools:

- Soldering iron
- Crimping tool or needle nose pliers
- CA glue

Printing:

There are 2 print profiles supplied, one is with a manual filament change (a pause) on the flaps. The second one is using an AMS.

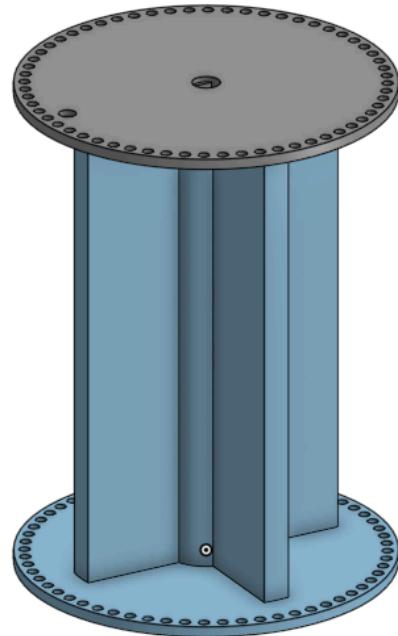
After you are done printing, I recommend putting the flaps in order starting from 0 to 59, it will be faster and easier to insert then in the holder later.



Assembly:

Flap holders:

First, put glue on the contact surface between the top part and bottom part of the flap holder, and press them together and wait for the glue to harden.



Once you have both of the flap holders finished, you can take a pile of the flaps and start inserting them in the holes. Insert the flap by bending it a little bit, make sure it is straight, when inserted in both holes.

The flap with 00 and bottom of 01 goes inline with the recess for the magnet as shown in the image.

For the hours flaps, make sure that when you turn the flap holder by the magnet hole facing right the numbers are in the right orientation.

For the minutes flaps, make sure that when you turn the flap holder by the magnet hole facing left the numbers are in the right orientation.

Note: The flap holder in the image is different, since it was an earlier prototype, but the process described is the same.



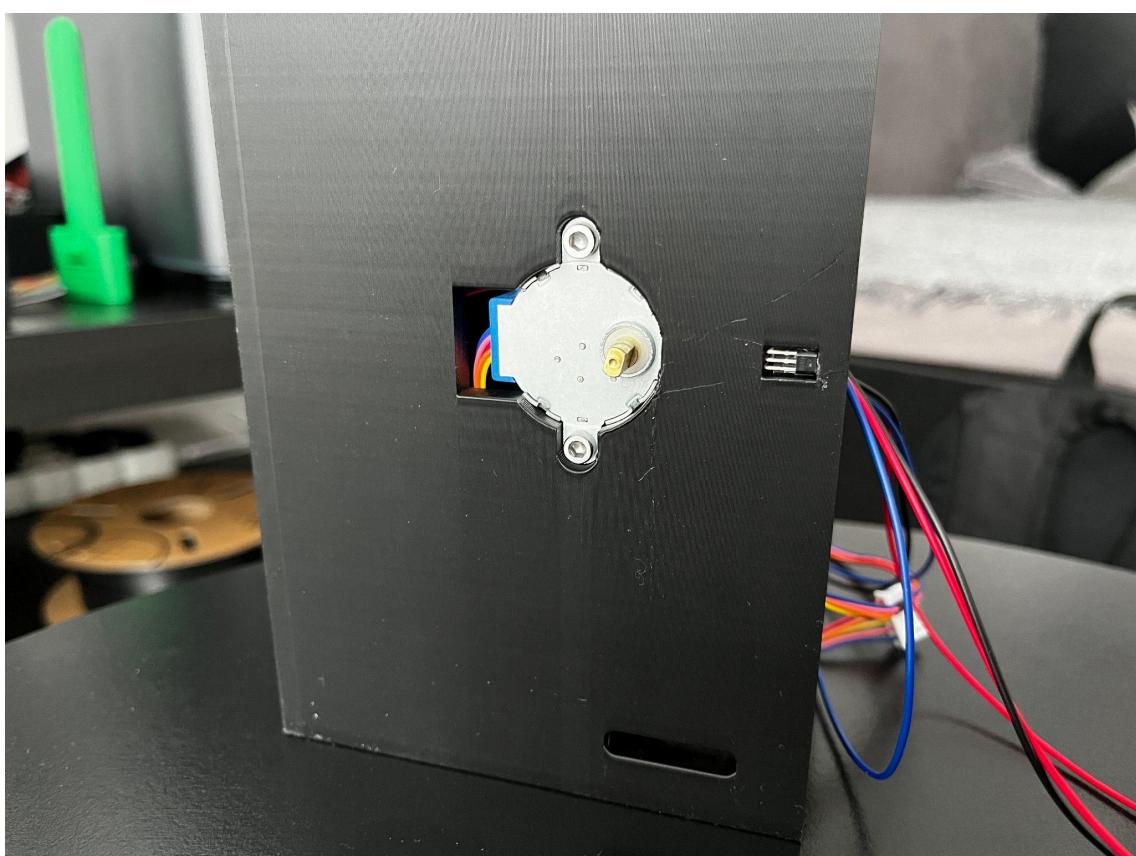
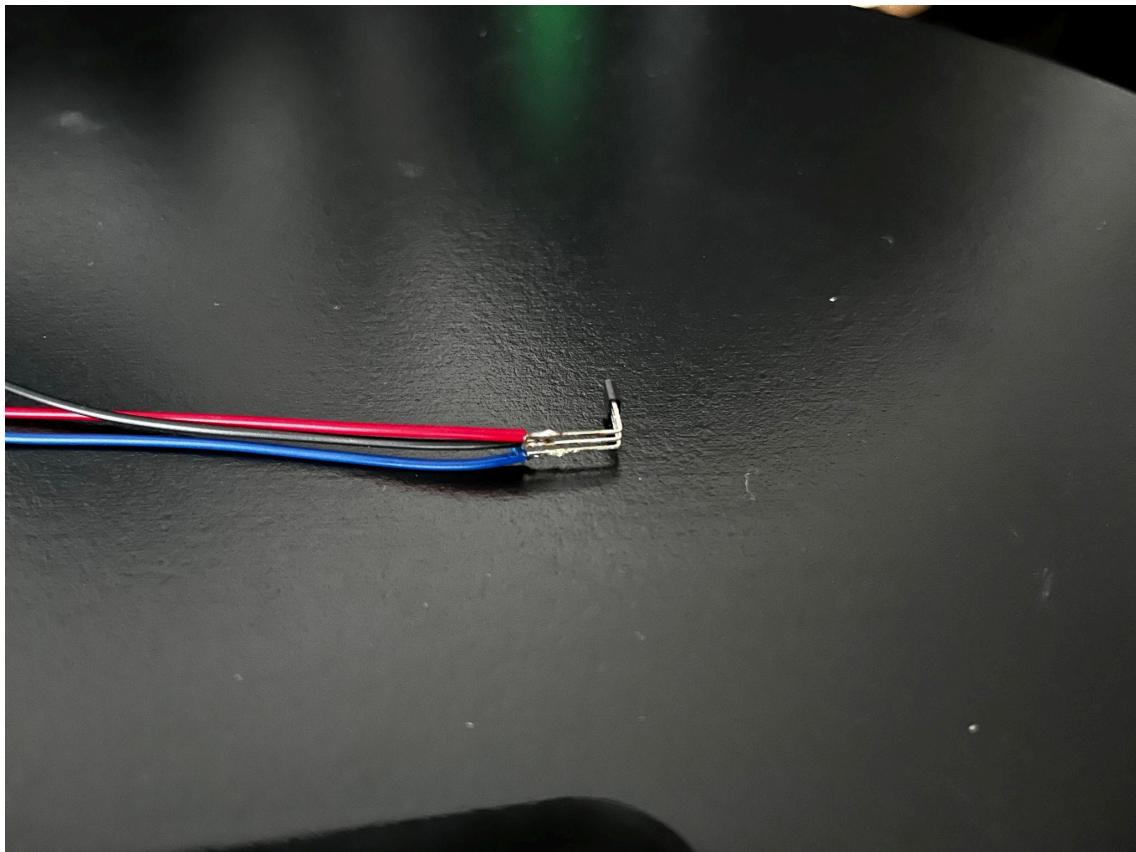


Now just start inserting the flaps that are connected with the previous one. You should end up with something like this. The second flap holder is basically mirrored.

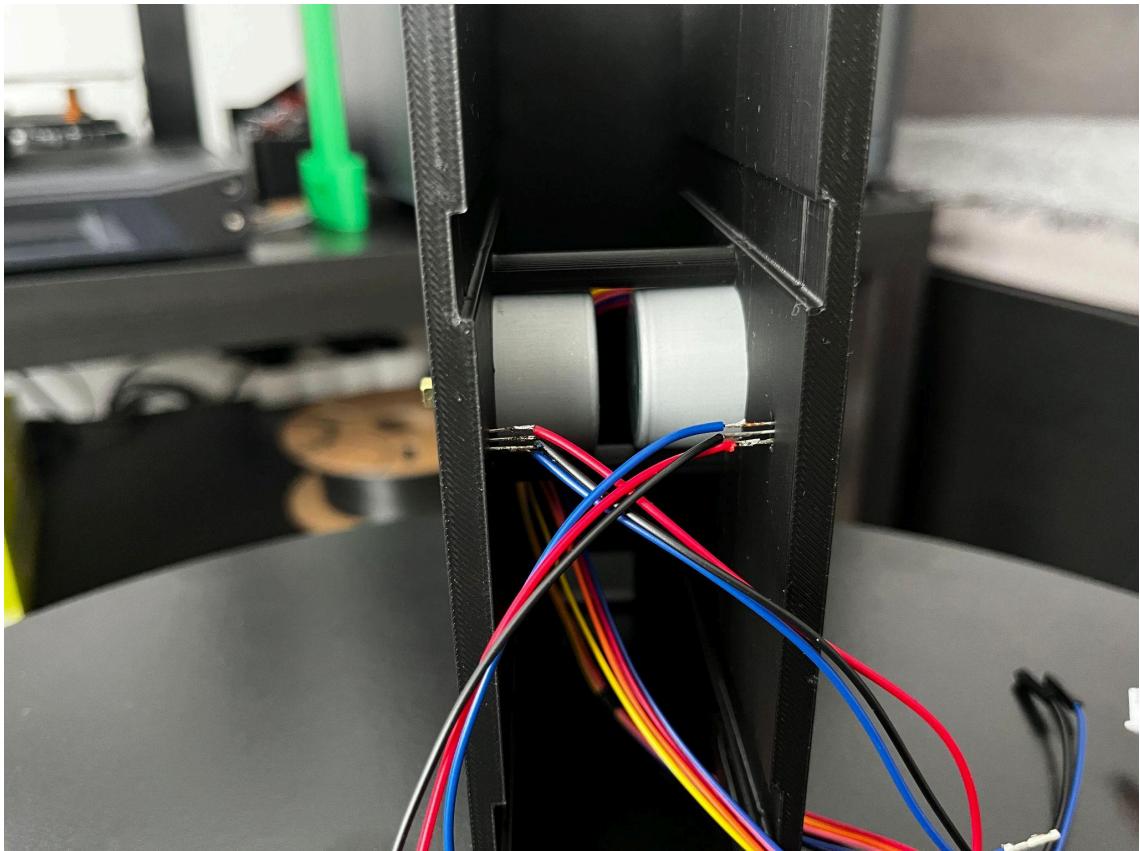


Electronics:

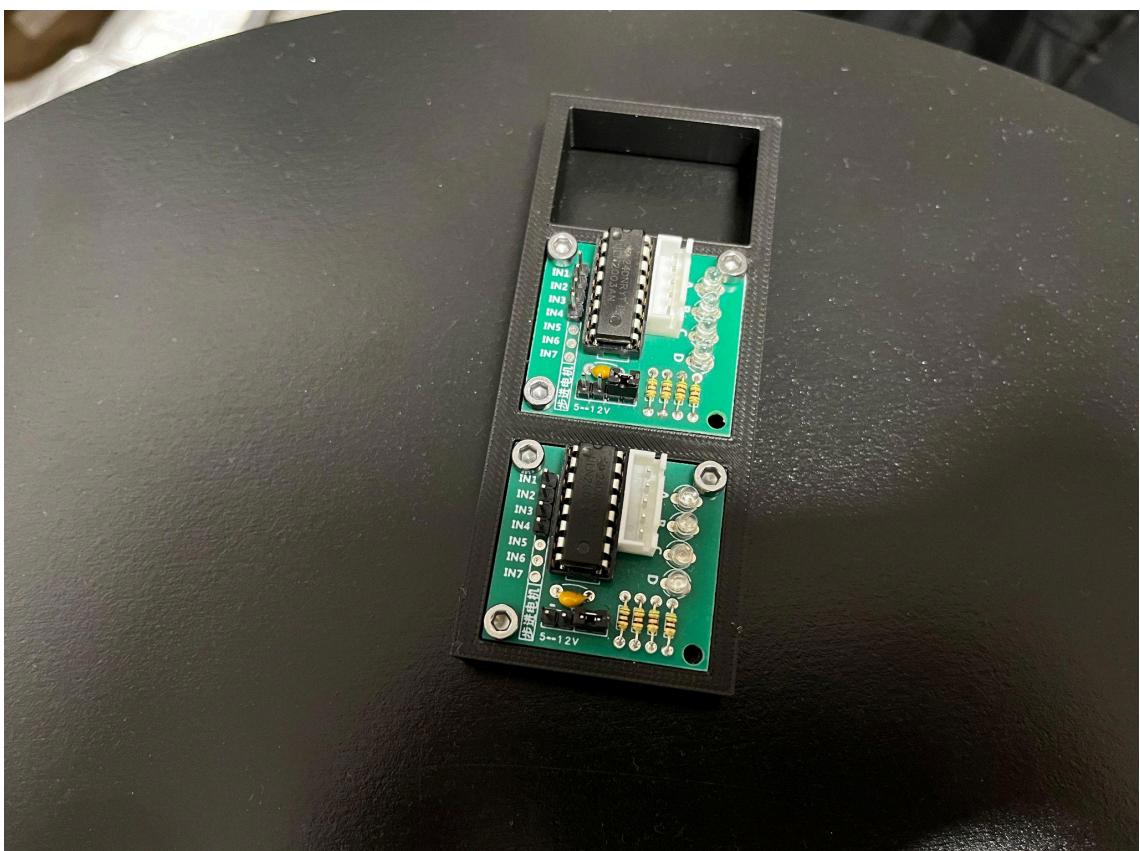
First bend the hall effect sensor pins, so that they fit inside the hole. Compare them with the hole to see where to bend them. Solder the 3 wires: power, ground and output. Refer to the datasheet for your hall effect sensor. Glue the hall effect sensors into the holes as shown below, press them down using the Inserter and a clamp while the glue is drying.



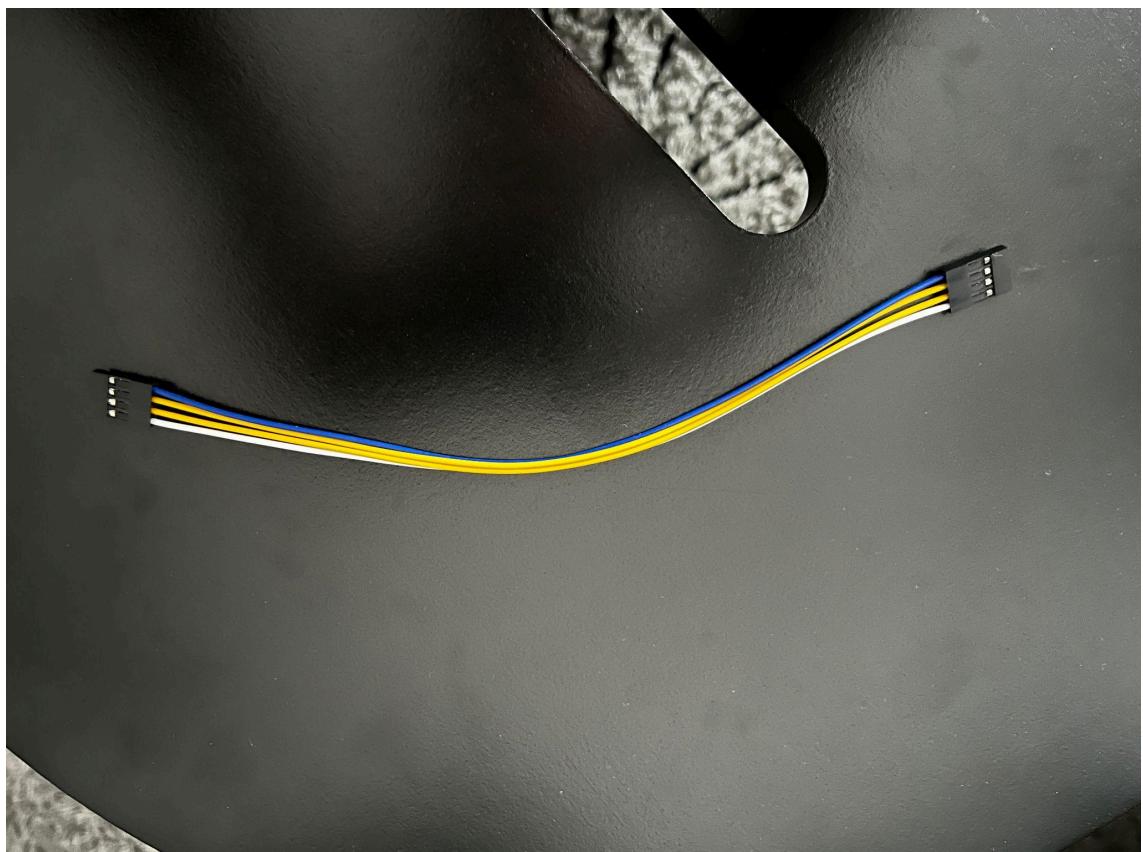
Next insert the stepper motors as shown above, they are quite a strong press fit. And screw them in place. The same on the other side



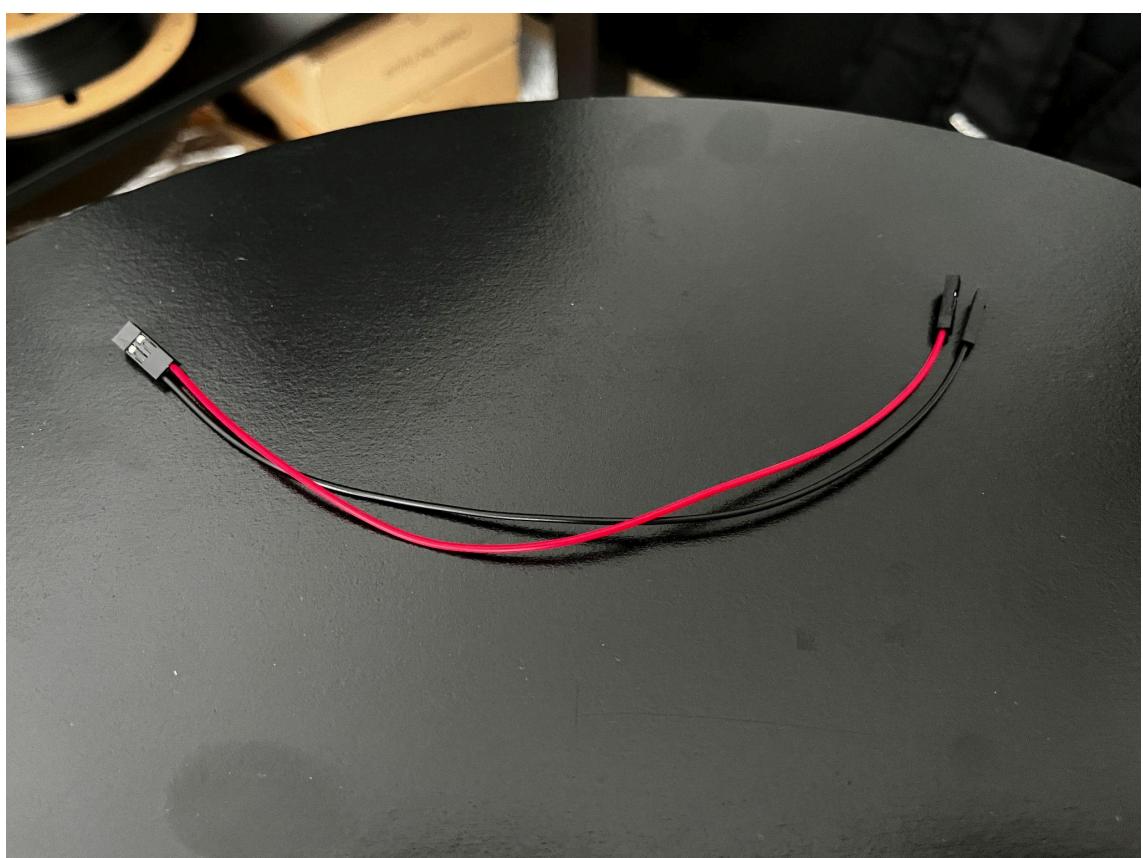
Screw the stepper motor drivers on the mount. If all four screws don't fit just screw those that do, since the manufacturing tolerance on these boards isn't very good. Do the same with the ESP32, once you finish connecting the wires shown below, since you won't be able to see the pin mapping otherwise.



Now slide the mount into the top recess, so that the notches can lock in place. Route the motor wires and connect them, mark which driver corresponds to which motor. Crimp connectors onto wires for IN 1-4 and power for steppers. For the stepper cables I put on both ends a 4x1 connector, since for my board the pins are in row. If your ESP32 doesn't have these in row, either use 1x1 connectors for each cable or change the pins in code. You need to make both cables twice.

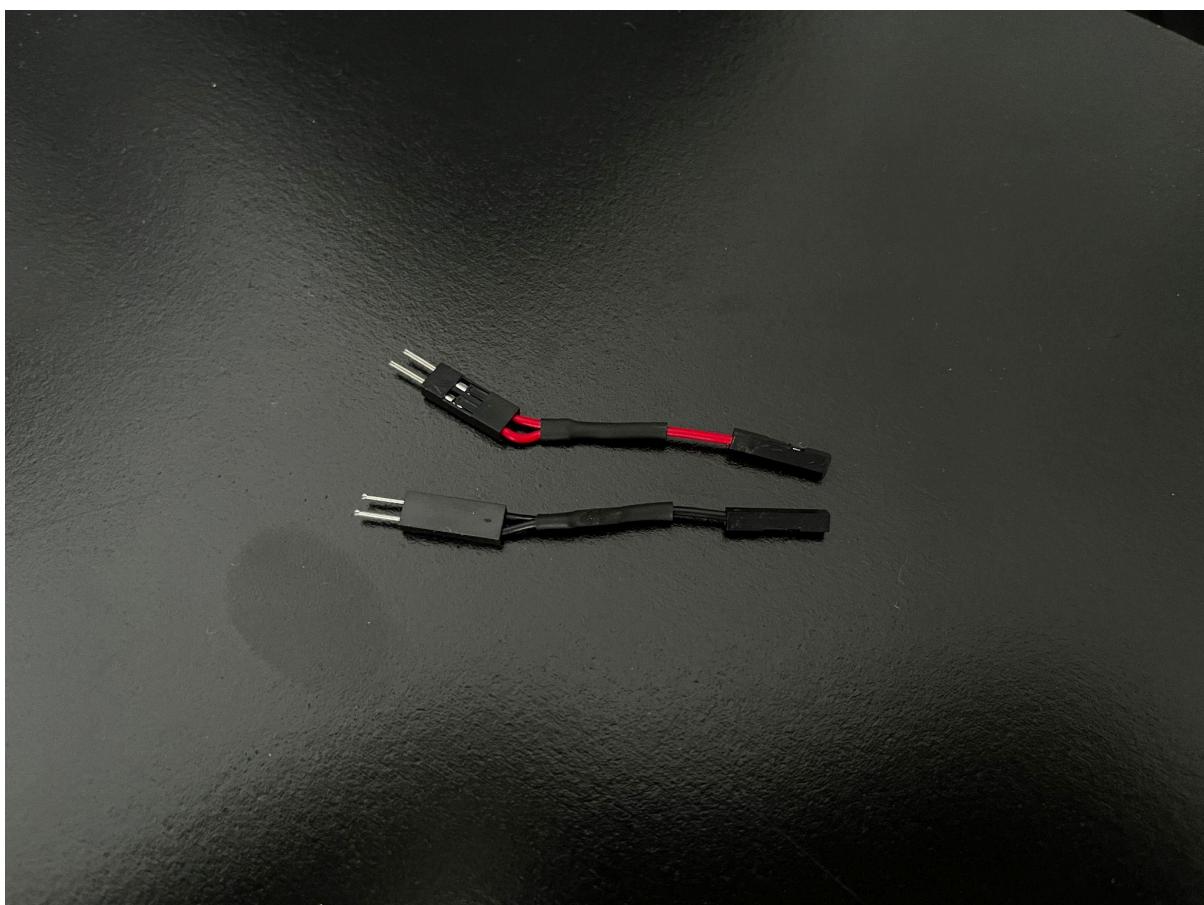
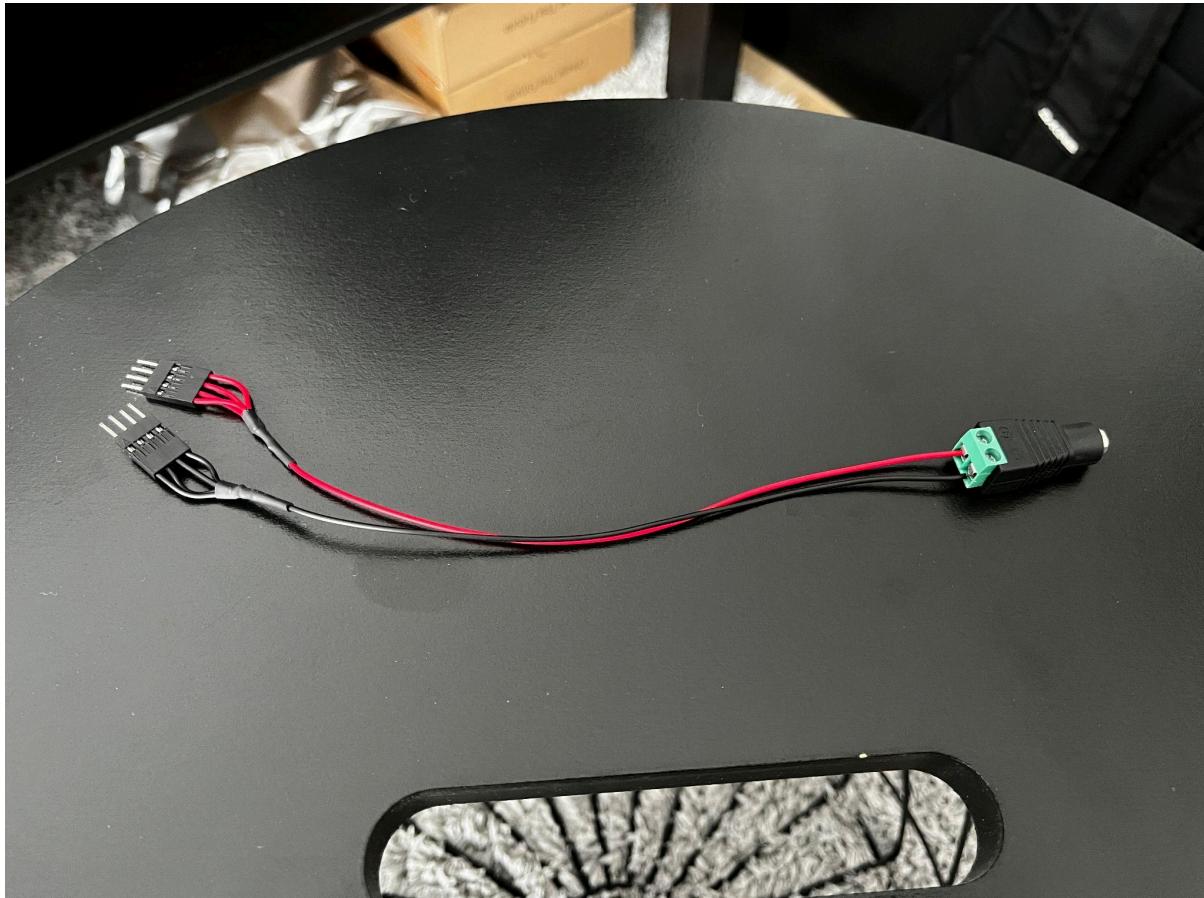


A



B

Now we need wires for main power and power for hall effect sensors. These 2 are separate since you can only supply 3.3V to ESP32 pins and the power supply is 5V. You only need 3 connectors for positive and negative on the C cable, but I had this one already made.



Pin mapping

Connect both the **A** cables to the IN 1-4 pins on the stepper motor driver board. Remember which of the 4 individual cables correspond to which IN.

Stepper motor for hours:

IN1 => 13

IN2 => 12

IN3 => 14

IN4 => 27

Stepper motor for minutes:

IN1 => 26

IN2 => 25

IN3 => 33

IN4 => 32

Connect both **B** cables with the 2x1 connector side to the stepper driver and the positive to positive **C** cable and negative to negative **C** cable.

Connect the **D** cables to 3.3V and GND and connect the hall effect sensors to that.

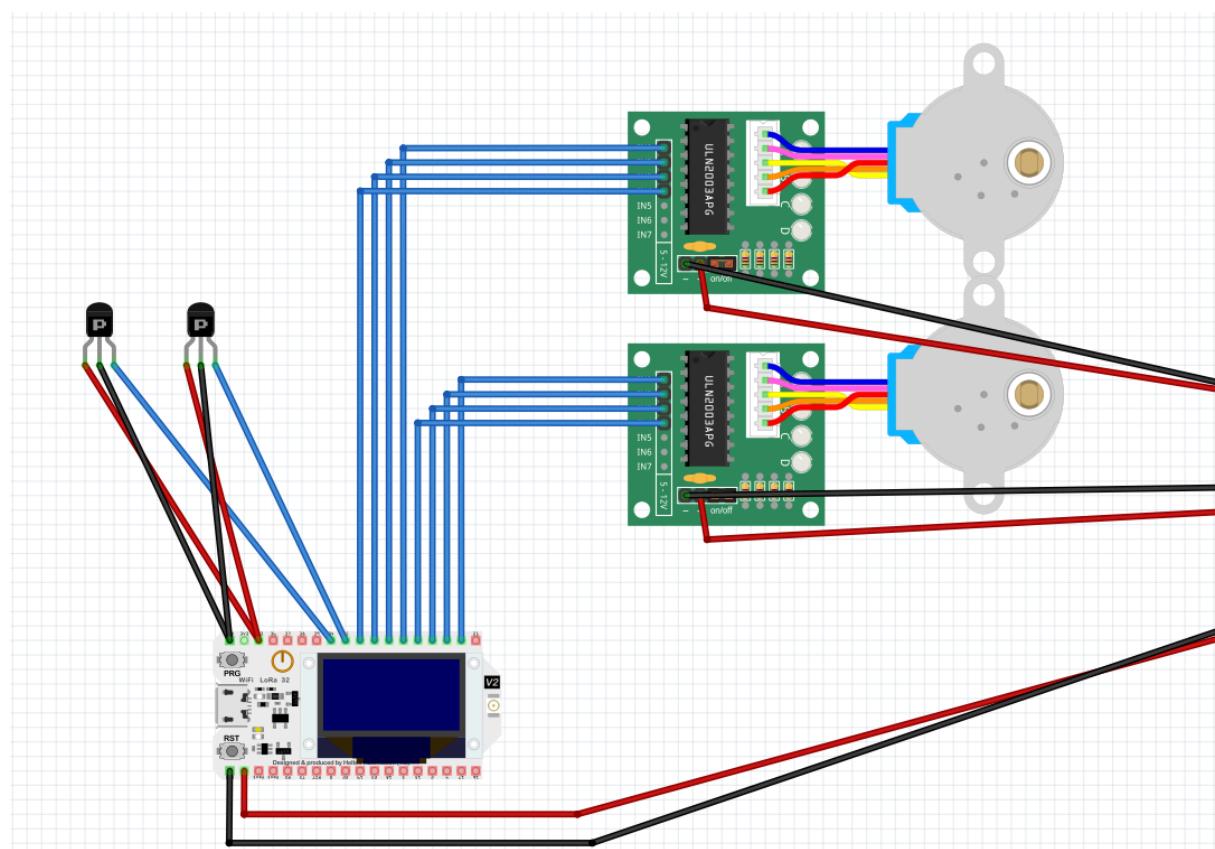
Hall effect sensor output:

stepper hours => 34

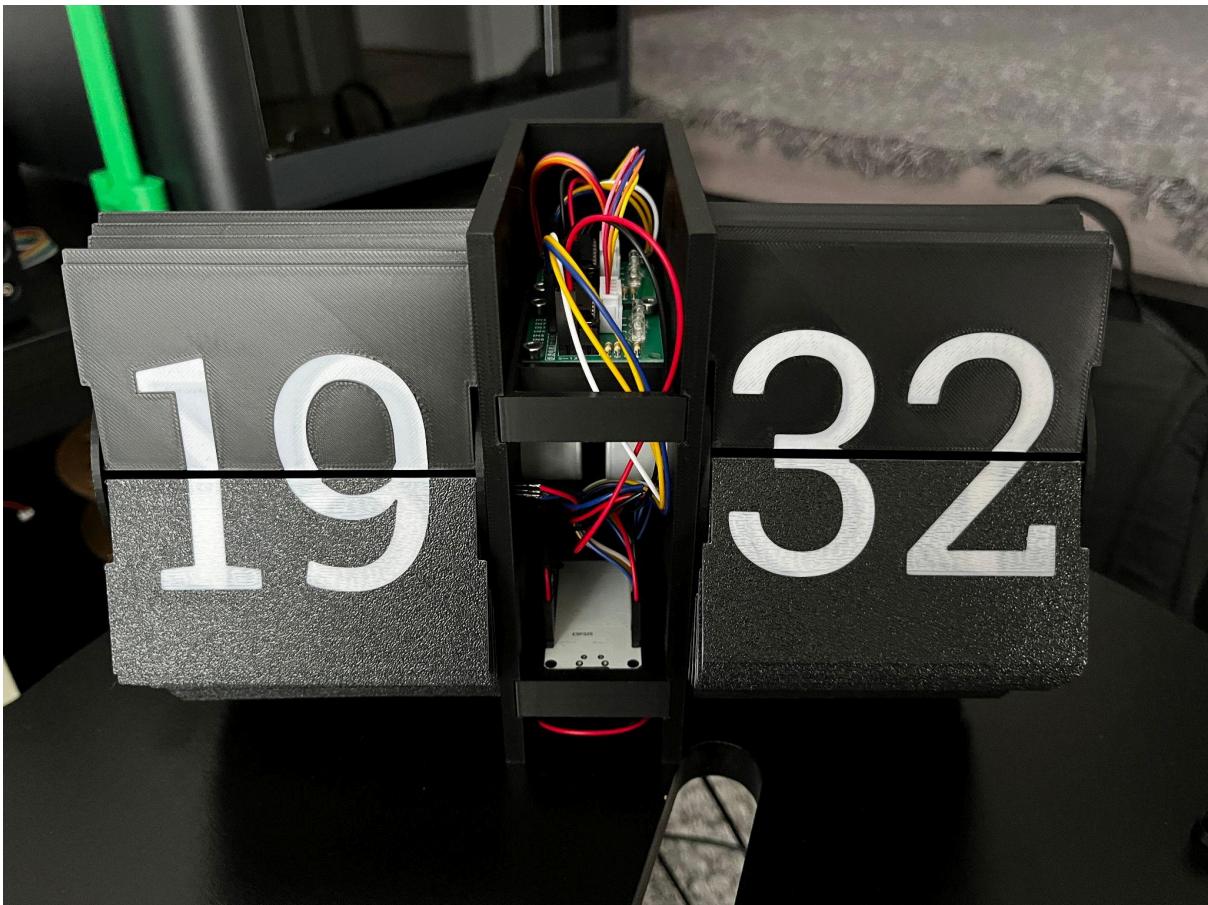
stepper minutes => 35

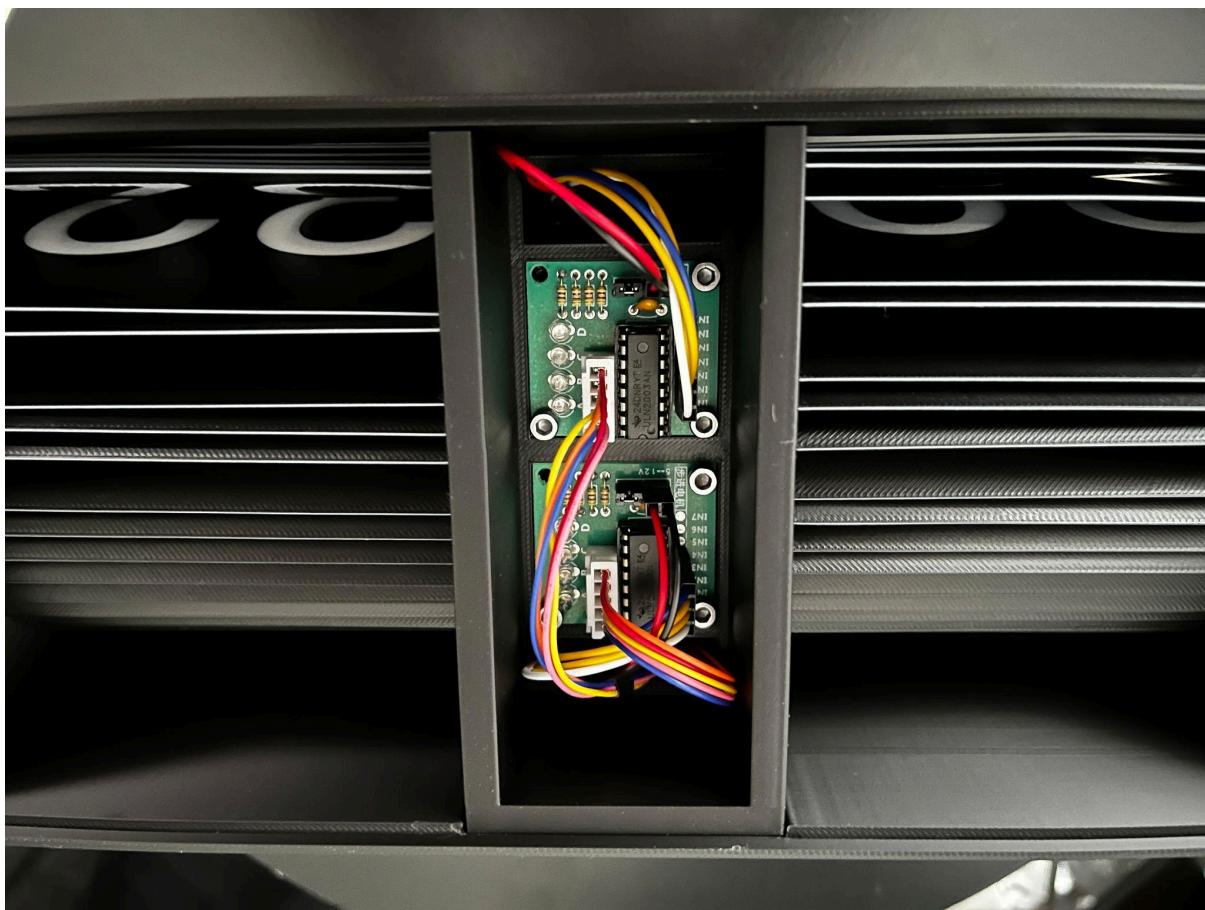
Now connect a cable going from positive **C** cable to VIN pin and from negative **C** to GND on the ESP32. This is to power the ESP32. Make sure your ESP32 has a VIN (connected to a voltage regulator) pin or a 5V pin.

Below is a simple example of how it should be connected.



Finishing





Flashing and Code

The code can be found [here](#). Before you flash anything, change the wifi name, password and your timezone offset from the GMT. The current one in the code is GMT+1.

Connect the ESP32 with a usb to your PC and use something like Arduino IDE or PlatformIO to flash.