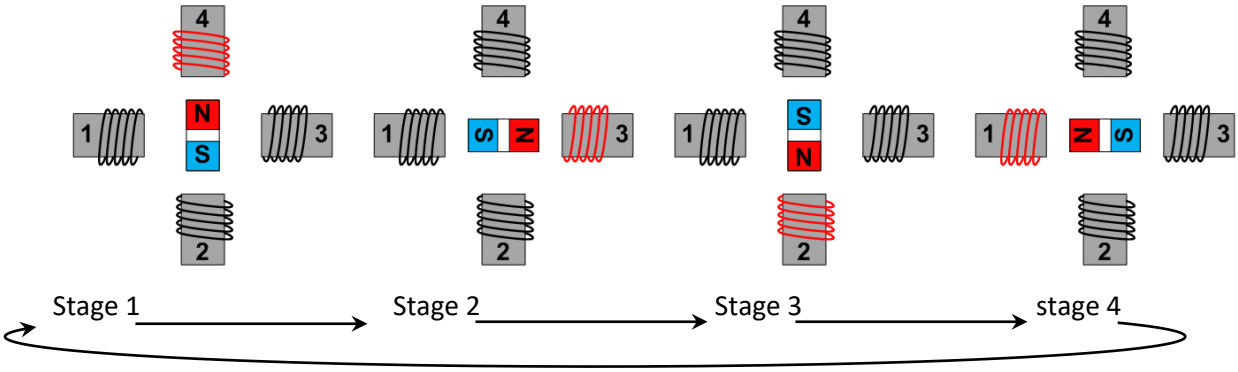
05.01 Stepper motor introduction

The aim of this assignment is to evaluate the different control methods of a stepper motor.
For this reason we do not use a stepper motor library.

A stepper motor must be controlled in steps:



In the picture above, only one coil is active at a time. The permanent magnet in the middle is attached to the shaft and follows the magnetic field that rotates around the shaft in the various steps.

The control is therefore carried out via the following table:

Step	Reel1	Reel2	Coil3	Coil4
1	Off	Off	Off	On
2	Off	Off	On	Off
3	Off	On	Off	Off
4	On	Off	Off	Off

05.01 Stepper motor commands

https://www.makerguides.com/28byj-48-stepper-motor-arduino-tutorial/

Information about the 28BYJ-48 stepper motor and ULN2003 driver board

The 28BYJ-48 is one of the cheapest stepper motors you can find. Although it is not super accurate or powerful, it is a great motor to use for smaller projects or if you just want to learn about stepper motors.

This motor is often used to automatically adjust the vanes of an air conditioner unit. It has a built-in gearbox, which gives it some extra torque and reduces the speed drastically.

Below you can find the specifications for both the stepper motor and driver that are used in this tutorial.

28BYJ-48 Stepper Motor Specifications

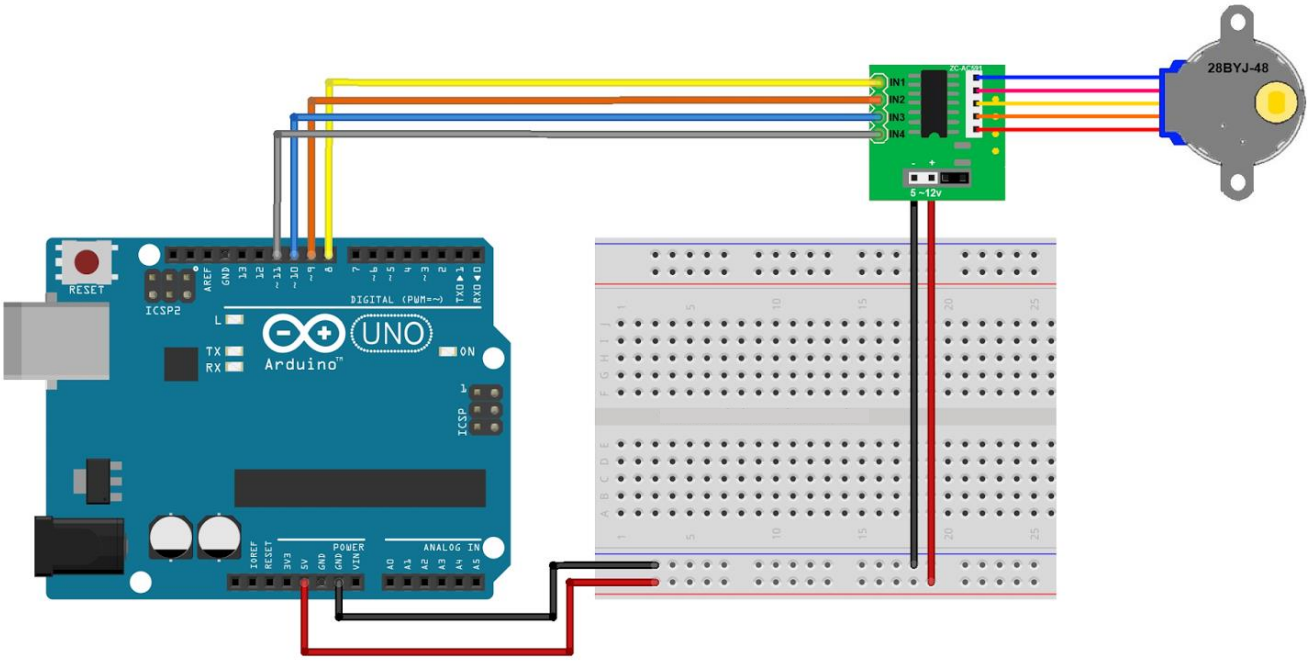
Rated voltage	5 V
Coil Resistance	50 Ohms
Coil Type	Unipolar
Diameter – shaft	0.197" (5.00 mm)
Length – shaft and bearing	0.394" (10 mm)
Features	Flatted shaft
Size/dimension	Round – 1.100" dia (28.00 mm)
Mounting hole spacing	Flatted Shaft
Gear reduction	1/64 (**see note**)
Step angle	Half step mode (recommended): 0.0879° Full step mode: 0.176°
Steps per revolution	Half step mode: 4096 (**see note**) Full step mode: 2048
Termination style	Wire leads with connector
Motor type	Permanent Magnet Gear Motor
Number of phases	4

Type motor (Unipolair of Bipolair): Unipolar

Stap resolutie (in graden per stap):

- In half step mode (recommended): 0.0879 degrees
- Full step mode: 0.176 degrees

Bereken hoeveel stappen je nodig hebt voor 1 omwenteling: 360/0.0879 approx 4096 in half step mode and 360/0.176 approx 2045 in full step mode



Connect the motor to the microcontroller as shown below:

The green board is an output stage for switching inductive loads. The microcontroller cannot supply the current needed by the stepper motor. The microcontroller will now only give a control signal, the printed circuit board will provide the current.

Again, **do NOT** use stepper lib for these tasks.

Set the used pins as output and make sure they follow the pattern described on page 1. You can check this pattern via the LEDs on the green PCB.

The coil is energised with a 1 or HIGH signal.

Make sure there is a 10 ms delay between each step.

If it works:

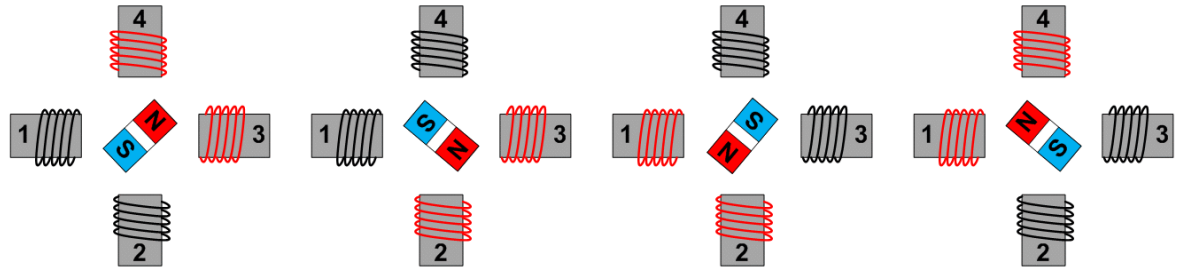
Try to gently hold back the shaft of the motor.

Try this again with a delay of 2 ms.

When do you experience the greatest resistance at 10ms or at 2ms

With 10 ms because the position it is more stable whenever presents more delay. If the delay is short, then the activation of other coils makes the position more unstable

With the table on page 1, only one coil is energised each time. The same effect can be obtained by energising 2 coils:

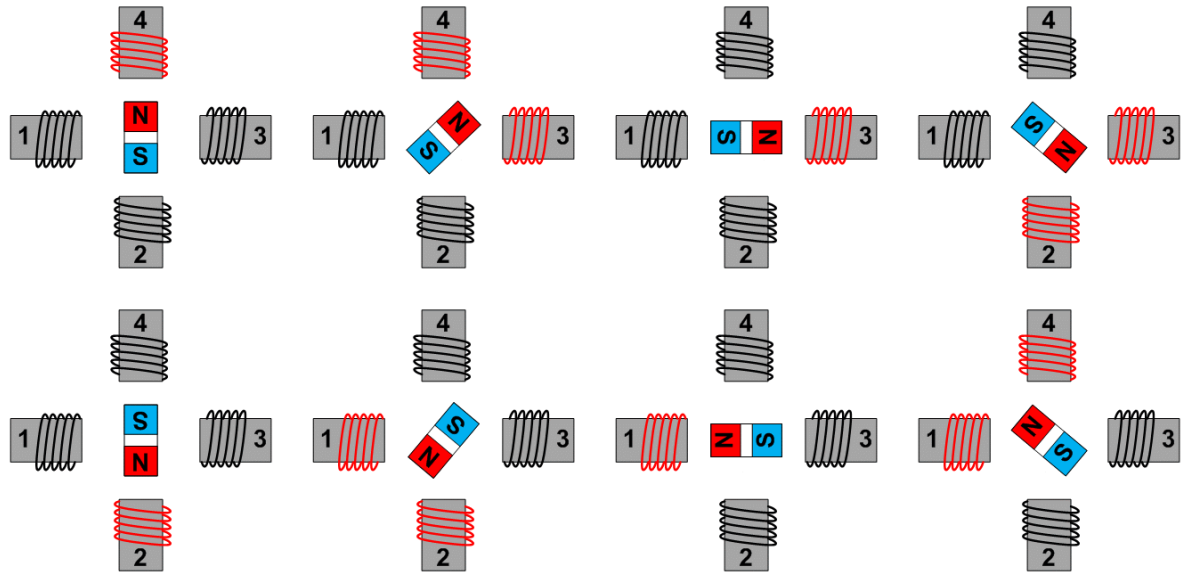


Step	Reel1	Reel2	Coil3	Coil4
1	On	On	Off	Off
2	Off	On	On	Off
3	Off	Off	On	On
4	On	Off	Off	On

Normally, the motor should then also have 2 times more power. Test this with a delay of 2ms and compare with the previous test that only 1 coil is energised per step.

Indeed, even at 2ms delay you have a substantial stability at each step of the rotation in comparison with the single coil activation.

Another method to excite the coils is the Half step method. It is actually a combination of the 2 previous methods. The advantage of this method is that it increases the resolution. A motor with a resolution of 1.8° per step will have a resolution of 0.9° per step. This is also the "preferred" method for our stepping motor.



The table then looks as follows:

Step	Reel1	Reel2	Coil3	Coil4
1	On	Off	Off	Off
2	On	On	Off	Off
3	Off	On	Off	Off
4	Off	On	On	Off
5	Off	Off	On	Off
6	Off	Off	On	On
7	Off	Off	Off	On
8	On	Off	Off	On

Be sure to use the Half Step method and make a programme that rotates the motor axis 90° in the hour hand direction, waits for a moment and then rotates it 90° in the opposite direction.

How can you make the motor run the other way round (without changing the electrical diagram)?

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Create a function that allows you to ask for a number of steps in a certain direction:
for example: `moveSteps(-512); //turn motor -45°.`