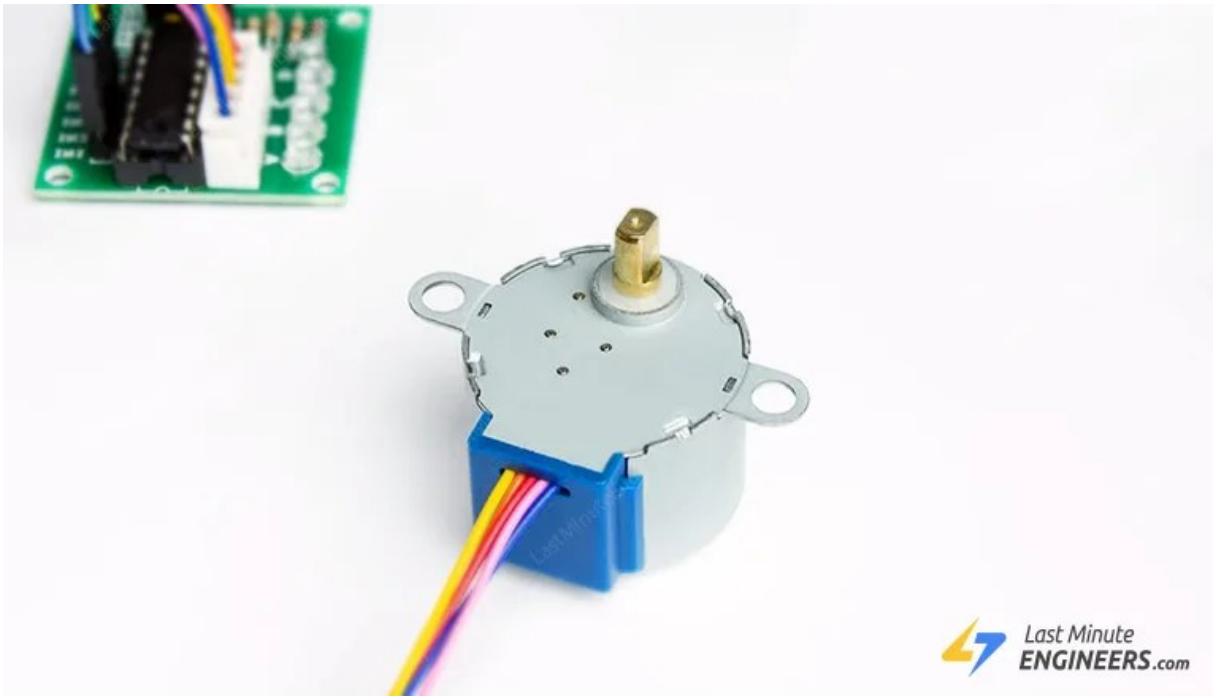
Control 28BYJ-48 Stepper Motor with ULN2003 Driver & Arduino



We are surrounded by stepper motors without even realizing it, as they are used in so many everyday items, including window blinds, 3D printers, DVD players, security cameras, and CNC machines. We're a lot closer to stepper motors than you think.

Stepper motors fall somewhere between a conventional DC motor and a servo motor. They can rotate continuously like DC motors and be positioned precisely (in discrete steps) like servo motors.

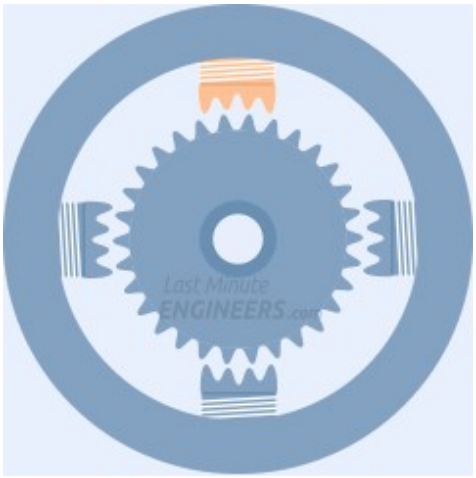
If you're just getting started with stepper motors, the 28BYJ-48 is a great choice. They typically come with a ULN2003-based driver board, making them very simple to use

Do you know how these stepper motors work?

Stepper motors use a cogged wheel and electromagnets to nudge the wheel round a 'step' at a time.

Each high pulse sent energizes the coil, attracting the teeth closest to the cogged wheel and rotating the motor in precise and fixed angle increments known as steps.

The number of steps that the stepper motor has in a 360 degree rotation is actually the number of teeth on the cog.



The way you pulse these coils determines how the motor operates.

- The sequence of pulses determines the spinning direction of the motor.
- The frequency of the pulses determines the speed of the motor.
- The number of pulses determines how far the motor will turn.

By energizing the coils in the correct sequence, the motor is rotated.

The 28BYJ-48 Stepper Motor

The 28BYJ-48 is a 5-wire unipolar stepper motor that runs on 5V. It's perfect for projects that require precise positioning, like opening and closing a vent.

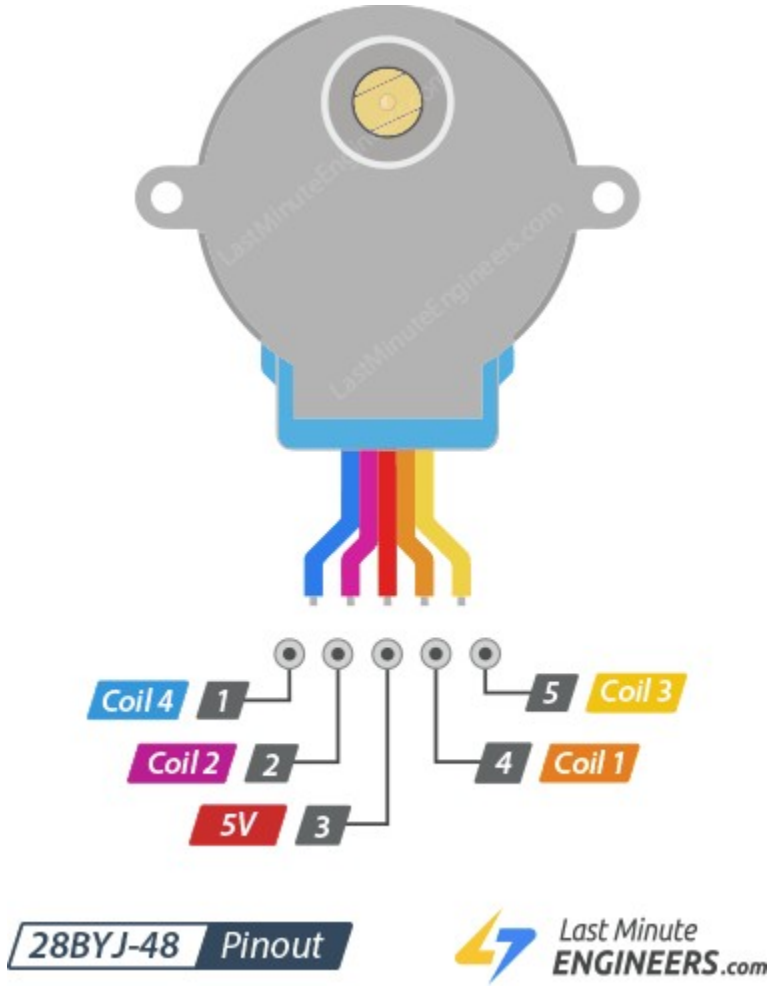
Because the motor does not use contact brushes, it has a relatively precise movement and is quite reliable.

Despite its small size, the motor delivers a decent torque of 34.3 mN.m at a speed of around 15 RPM. It provides good torque even at a standstill and maintains it as long as the motor receives power.

The only drawback is that it is somewhat power-hungry and consumes energy even when it is stationary.

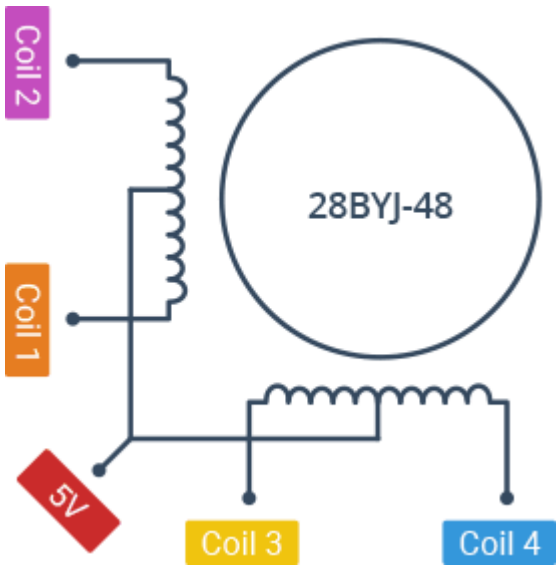
Pinout

The 28BYJ-48 stepper motor has five wires. The pinout is as follows:



The 28BYJ-48 has two coils, each of which has a center tap. These two center taps are connected internally and brought out as the 5th wire (red wire)

Together, one end of the coil and the center tap form a Phase. Thus, 28BYJ-48 has a total of four phases

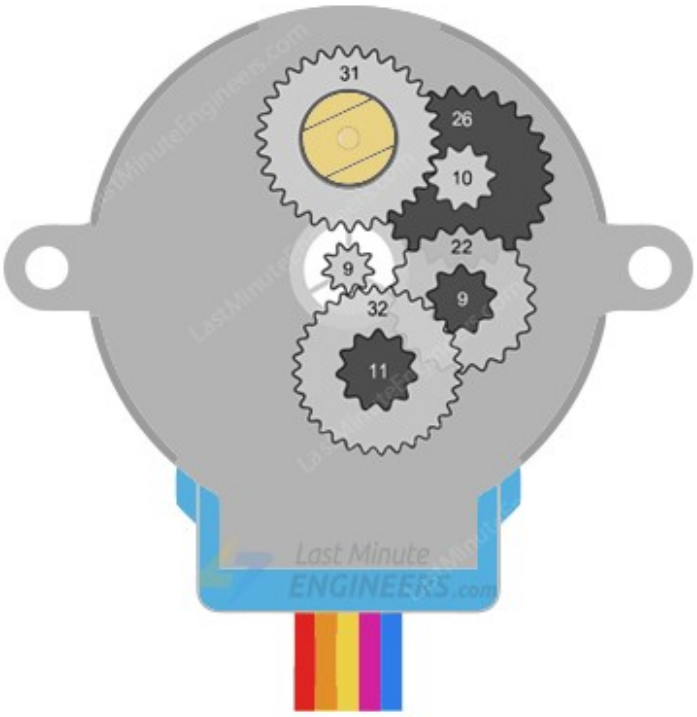


The red wire is always pulled HIGH, so when the other lead is pulled LOW, the phase is energized.

The stepper motor rotates only when the phases are energized in a logical sequence known as a **step sequence**.

Gear Reduction Ratio

According to the data sheet, when the 28BYJ-48 motor is operated in full-step mode, each step corresponds to a rotation of 11.25°. This means there are 32 steps per revolution (360°/11.25° = 32).



Gear Ratios:

- 32 / 9
- 22 / 11
- 26 / 9
- 31 / 10

Multiplying the gear ratios:

$$\frac{32}{9} \times \frac{22}{11} \times \frac{26}{9} \times \frac{31}{10} = 63.68395$$

Round 63.68395 up: 64

This gives us a 64:1 gear ratio over all

In addition, the motor features a 1/64 reduction gear set (actually, it is 1/63.68395, but 1/64 is a good enough approximation for most purposes).

This means that there are in fact 2038 steps (32*63.68395 steps per revolution = 2037.8864 approximately 2038 steps).

Power Consumption

The 28BYJ-48 typically draws about 240 mA.

Because the motor consumes a significant amount of power, it is preferable to power it directly from an external 5V power supply rather than from the Arduino.

It is worth noting that the motor consumes power even when it is at rest in order to maintain its position.

Technical Specifications

Here are the specifications:

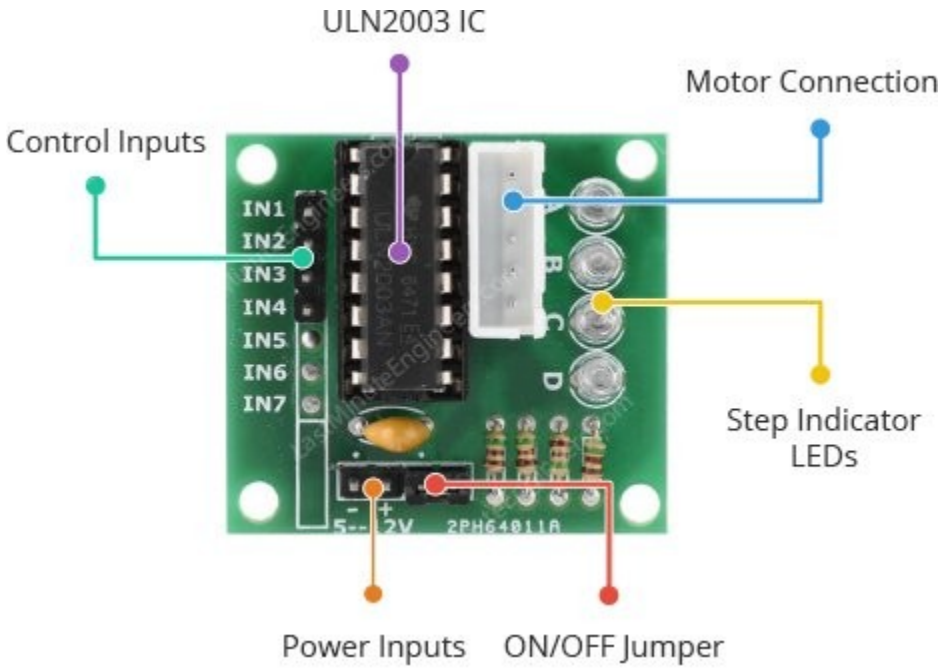
Operating Voltage	5VDC
Operating Current	240mA (typical)
Number of phases	4
Gear Reduction Ratio	64:1
Step Angle	5.625°/64
Frequency	100Hz
In-traction Torque	>34.3mN.m(120Hz)
Self-positioning Torque	>34.3mN.m
Friction torque	600-1200 gf.cm
Pull in torque	300 gf.cm

The ULN2003 Driver Board

Because the 28BYJ-48 stepper motor consumes a significant amount of power, it cannot be controlled directly by a microcontroller such as Arduino. To control the motor, a driver IC such as the ULN2003 is required; therefore, this motor typically comes with a ULN2003-based driver board.

The ULN2003, known for its high current and high voltage capability, provides a higher current gain than a single transistor and allows a microcontroller's low voltage low current output to drive a high current stepper motor.

The ULN2003 consists of an array of seven Darlington transistor pairs, each of which can drive a load of up to 500mA and 50V. This board utilizes four of the seven pairs.

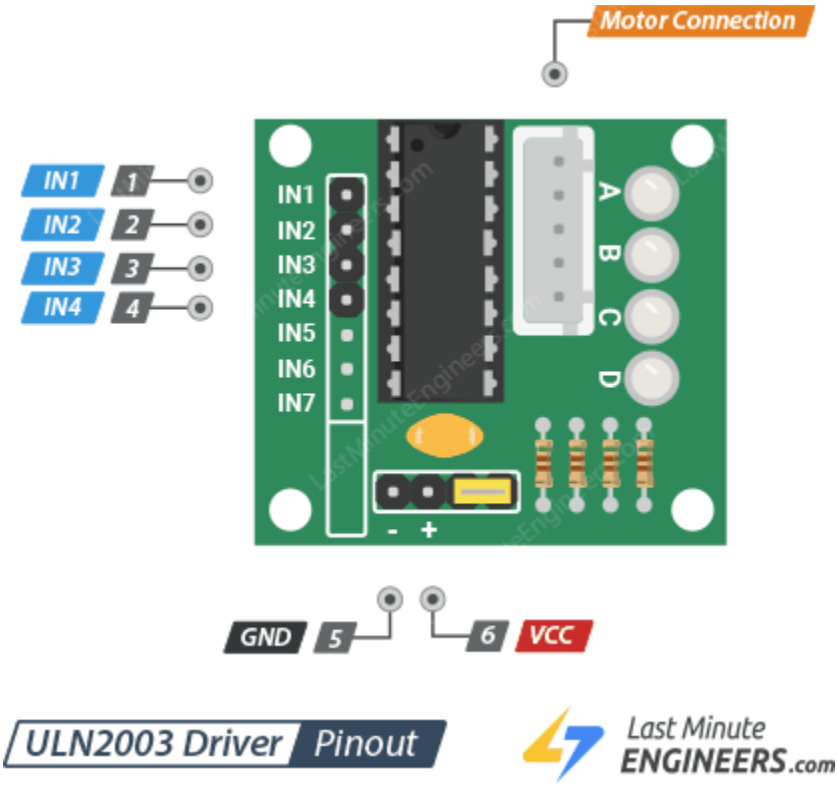


The board has four control inputs and a power supply connection.

Additionally, there is a Molex connector that is compatible with the connector on the motor, allowing you to plug the motor directly into it.

ULN2003 Stepper Driver Board Pinout

The ULN2003 stepper driver board has the following pinout:



IN1 – IN4 are motor control input pins. Connect them to the Arduino's digital output pins.

GND is the ground pin

VCC pin powers the motor. Because the motor consumes a significant amount of power, it is preferable to use an external 5V power supply rather than from the Arduino.

Motor Connector This is where the motor plugs in. The connector is keyed, so it will only go in one way.

Wiring 28BYJ-48 Stepper Motor and ULN2003 Driver to an Arduino

Let’s get the motor connected to our Arduino!

The connections are straightforward. Begin by connecting an external 5V power supply to the ULN2003 driver.

Warning:

The stepper motor can be powered directly from the Arduino, but this is not recommended because the motor can generate electrical noise on its power supply lines, which may damage the Arduino.

Connect the driver board’s IN1, IN2, IN3, and IN4 to Arduino digital pins 8, 9, 10, and 11, respectively. Then connect the stepper motor to the ULN2003 driver.

Finally, make sure your circuit and Arduino share a common ground