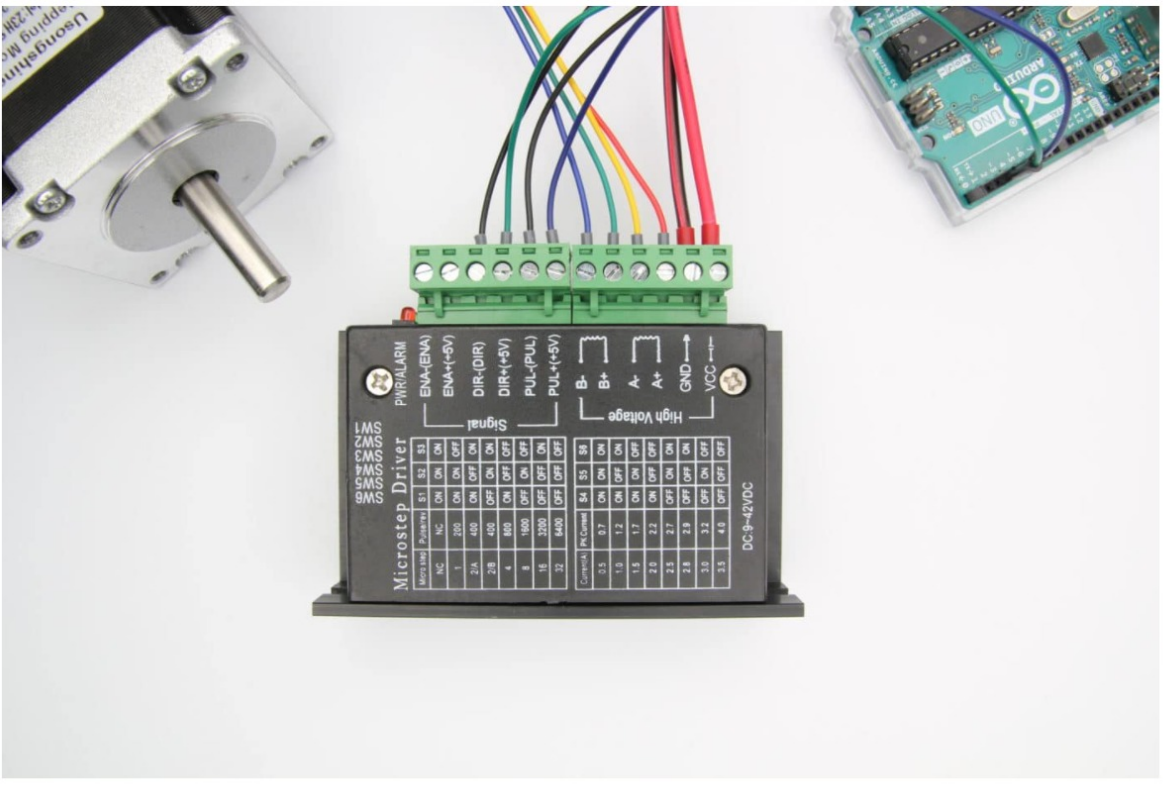

TB6600 Stepper Motor Driver with Arduino Tutorial

30 Comments / Arduino, Motor Controls, Tutorials

In this tutorial, you will learn how to control a stepper motor with the TB6600 microstepping driver and Arduino. This driver is easy to use and can control large stepper motors like a 3 A NEMA 23.

I have included a wiring diagram and 3 example codes. In the first example, I will show you how you can use this stepper motor driver without an Arduino library. This example can be used to let the motor spin continuously. In the second example, we will look at how you can control the speed, number of revolutions, and spinning direction of the stepper motor. Finally, we will take a look at the AccelStepper library. This library is fairly easy to use and allows you to add acceleration and deceleration to the movement of the stepper motor.

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After each example, I break down and explain how the code works, so you should have no problems modifying it to suit your needs.

If you have any questions, please leave a comment below.

If you would like to learn more about other stepper motor drivers, then the articles below might be useful:

- TB6560 Stepper Motor Driver with Arduino Tutorial
- How to control a stepper motor with A4988 driver and Arduino
- 28BYJ-48 Stepper Motor with ULN2003 Driver and Arduino Tutorial
- How to control a Stepper Motor with Arduino Motor Shield Rev3

Supplies

Hardware components

	TB6600 stepper motor driver	× 1	Amazon
	NEMA 23 stepper motor	× 1	Amazon
	Arduino Uno Rev3	× 1	Amazon
	Power supply (24/36 V)	× 1	Amazon
	Jumper wires	× 4	Amazon
	USB cable type A/B	× 1	Amazon

Tools

	Wire stripper		Amazon
	Small screwdriver		Amazon
	Self-adjusting crimping pliers (recommended)*		Amazon
	Wire ferrules assortment (recommended)*		Amazon

*Hackaday wrote a great article on the benefits of using wire ferrules (also known as end sleeves).

Software

	Arduino IDE

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About the driver

The TB6600 microstepping driver is built around the Toshiba TB6600HG IC and it can be used to drive two-phase bipolar stepper motors.

With a maximum current of 3.5 A continuous, the TB6600 driver can be used to control quite large stepper motors like a NEMA 23. Make sure that you do not connect stepper motors with a current rating of more than 3.5 A to the driver.

The driver has several safety functions built-in like over-current, under-voltage shutdown, and overheating protection.

You can find more specifications in the table below. Note that the exact specifications and dimensions can differ slightly between manufacturers. Always take a look at the datasheet of your particular driver, before connecting power.

TB6600 Specifications

Operating voltage	9 – 42 V
Max output current	4.5 A per phase, 5.0 A peak[1]
Microstep resolution	full, 1/2, 1/4, 1/8 and 1/16[2]
Protection	Low-voltage shutdown, overheating and over-current protection
Dimensions	96 x 72 x 28/36 mm
Hole spacing	88, ⌀ 5 mm
Cost	Check price

[1] These are the specifications for the TB6600HG IC, the driver itself has a maximum current rating of 3.5 A and 4.0 A peak.
[2] See comment on fake/upgraded TB6600 drivers below.

For more information, you can check out the datasheet and manual below:

Toshiba TB6600 Datasheet

TB6600 Manual

Fake or 'upgraded' TB6600 drivers

I recently took apart one of the TB6600 drivers I ordered and found out that it didn't actually use a TB6600HG chip. Instead, it used a much smaller TB67S109AFTG chip, also made by Toshiba. The performance and specifications of these chips are similar, but the TB6600HG does have a higher peak current rating (up to 5 A) and it is just a much larger chip with better heatsinking overall.

There is a very simple way to check if your driver uses a TB6600HG chip or a TB67S109AFTG chip, **the TB6600HG only supports up to 1/16 microstepping** (see datasheet), whereas the TB67S109AFTG goes to 1/32. The main reason manufacturers switched over to this other chip is probably price. Below you can find links to the chips on LCSC.com which shows that the TB67S109AFTG is around $1.50 cheaper.

TB6600HG: https://lcsc.com/product-detail/Motor-Drivers_TOSHIBA_TB6600HG_TB6600HG_C66042.html
TB67S109AFTG: https://lcsc.com/product-detail/Motor-Drivers_TOSHIBA_TB67S109AFTG_TB67S109AFTG_C92125.html

You can buy genuine TB6600 drivers on Amazon, like this 4-axis driver board but most use the TB67S109AFTG chip. You can tell it uses the TB6600HG chip from the pins sticking out of the PCB and it also only goes up to 1/16 microstepping.

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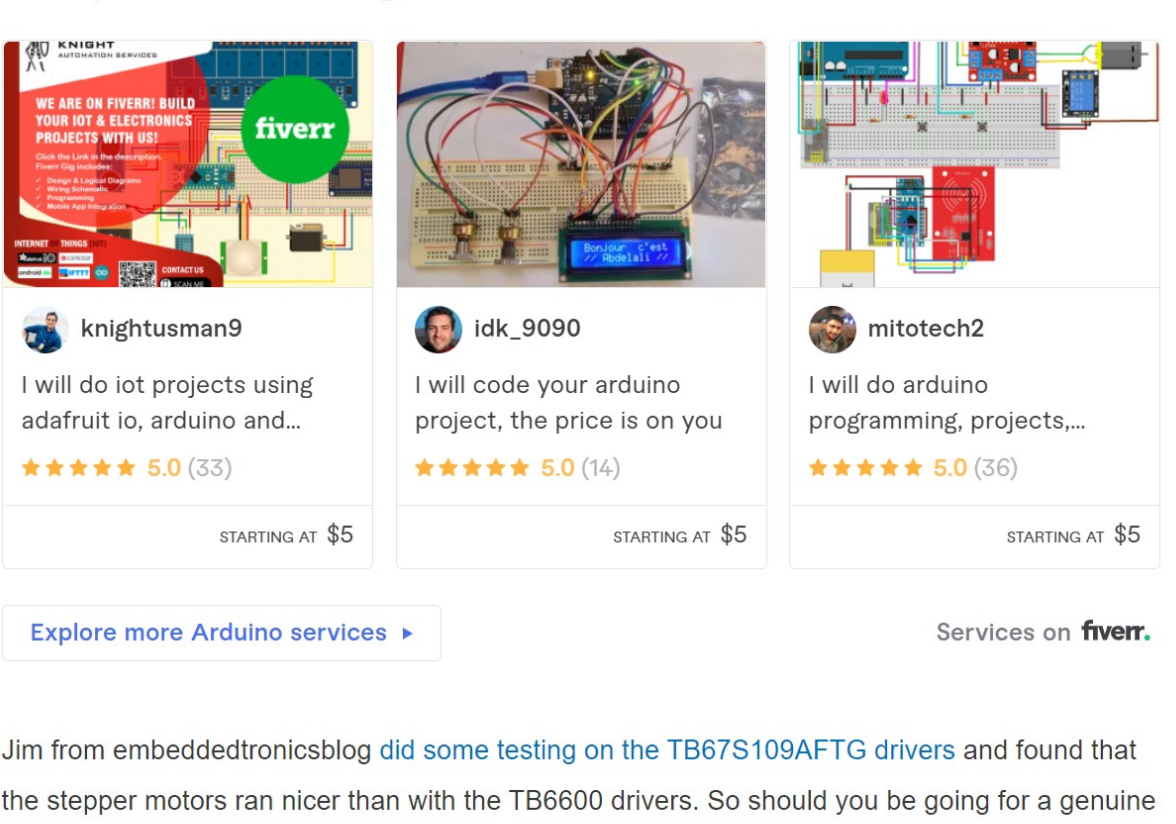

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Jim from embeddedtronicsblog did some testing on the TB67S109AFTG drivers and found that the stepper motors ran nicer than with the TB6600 drivers. So should you be going for a genuine TB6600 or the 'upgrade'? I would say it depends on whether you really need the high current output or if you rather prefer up to 1/32 microstepping.

You can find the datasheet for the TB67S109AFTG below.

TB67S109AFTG Datasheet

Alternatives

Note that the TB6600 is an analog driver. In recent years, digital drivers like the DM556 or DM542 have become much more affordable. Digital drivers usually give much better performance and quieter operation. They can be wired and controlled in the same way as the TB6600, so you can easily upgrade your system later.

I have used the DM556 drivers for my DIY CNC router and they have been working great for several years.

TB6600 vs TB6560

When shopping for a TB6600 stepper motor driver, you will probably come across the slightly cheaper TB6560 driver as well. This driver can be controlled with the same code/wiring, but there are some key differences.

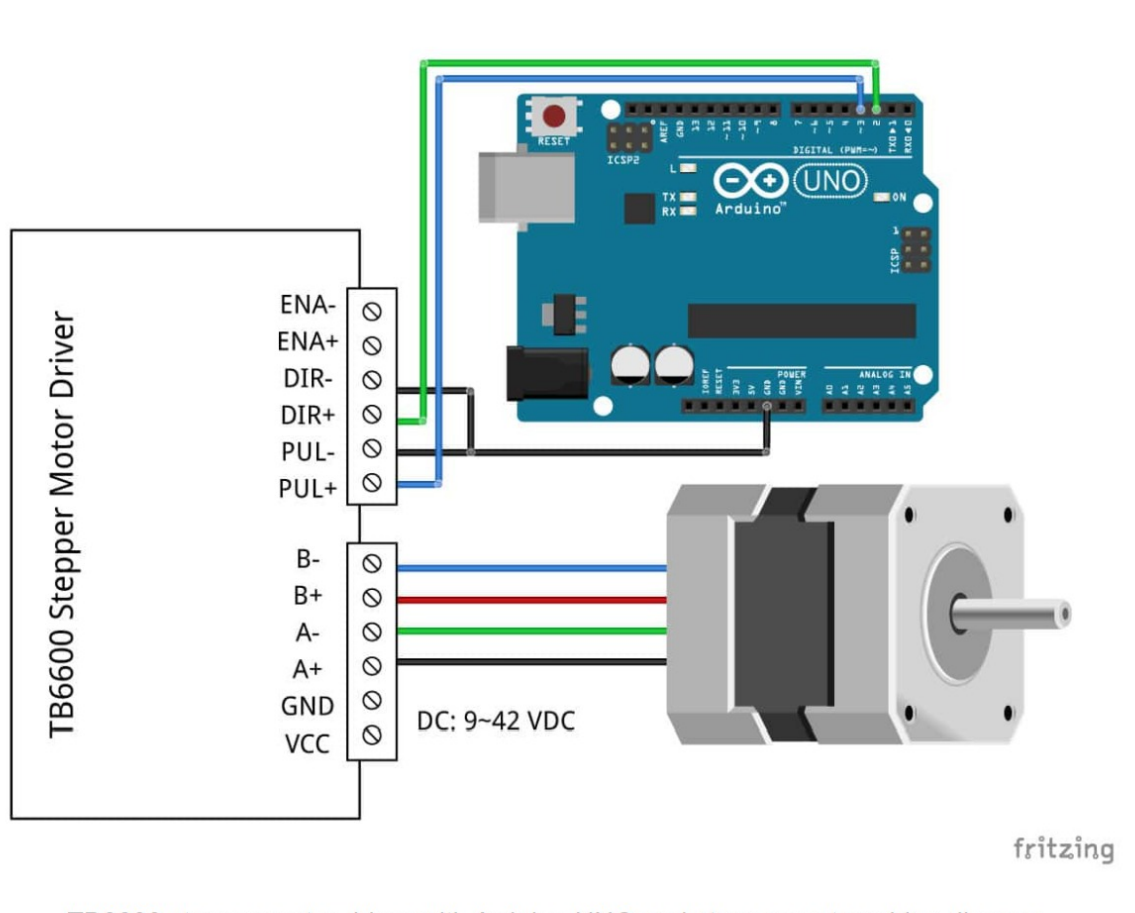
	TB6560	TB6600
Operating voltage	10 – 35 VDC, 24 VDC recommended	9 – 42 VDC, 36 VDC recommended
Max output current	3 A per phase, 3.5 A peak	3.5 A per phase, 4 A peak
# Current settings	14	8
Microstep resolution	full, 1/2, 1/8 and 1/16	full, 1/2, 1/4, 1/8, 1/16 and 1/32*
Clock frequency	15 kHz	200 kHz
Cost	Check price	Check price

*Drivers using TB67S109AFTG chip.

So the main differences are the higher maximum voltage, higher maximum current, and up to 1/32 microstepping. The TB6600 also has a better heatsink and a nicer overall form factor. If you want to control larger stepper motors or need a higher resolution, I recommend going with the TB6600.

Wiring – Connecting TB6600 to stepper motor and Arduino

Connecting the TB6600 stepper motor driver to an Arduino and stepper motor is fairly easy. The wiring diagram below shows you which connections you need to make.



TB6600 stepper motor driver with Arduino UNO and stepper motor wiring diagram

In this tutorial, we will be connecting the driver in a common cathode configuration. This means that we connect all the negative sides of the control signal connections to ground.

The connections are also given in the table below:

TB6600 Connections

TB6600	Connection
VCC	9 – 42 VDC
GND	Power supply ground
ENA-	Not connected
ENA+	Not connected
DIR-	Arduino GND
DIR+	Pin 2 Arduino
PUL-	Arduino GND
PUL+	Pin 3 Arduino
A-, A+	Coil 1 stepper motor
B-, B+	Coil 2 stepper motor

Note that we have left the enable pins (ENA- and ENA+) disconnected. This means that the enable pin is always LOW and the driver is always enabled.

How to determine the correct stepper motor wiring?

If you can not find the datasheet of your stepper motor, it can be difficult to figure out which color wire goes where. I use the following trick to determine how to connect 4 wire bipolar stepper motors:

The only thing you need to identify is the two pairs of wires which are connected to the two coils of the motor. The wires from one coil get connected to A- and A+ and the other to B- and B+, the polarity doesn't matter.

To find the two wires from one coil, do the following with the motor disconnected:

1. Try to spin the shaft of the stepper motor by hand and notice how hard it is to turn.
2. Now pick a random pair of wires from the motor and touch the bare ends together.
3. Next, while holding the ends together, try to spin the shaft of the stepper motor again.

If you feel a lot of resistance, you have found a pair of wires from the same coil. If you can still spin the shaft freely, try another pair of wires. Now connect the two coils to the pins shown in the wiring diagram above.

(If it is still unclear, please leave a comment below, more info can also be found on the RepRap.org wiki)

TB6600 microstep settings

Stepper motors typically have a step size of 1.8° or 200 steps per revolution, this refers to full steps. A microstepping driver such as the TB6600 allows higher resolutions by allowing intermediate step locations. This is achieved by energizing the coils with intermediate current levels.

For instance, driving a motor in 1/2 step mode will give the 200-steps-per-revolution motor 400 microsteps per revolution.

You can change the TB6600 microstep settings by switching the dip switches on the driver on or off. See the table below for details. Make sure that the driver is not connected to power when you adjust the dip switches!

Please note that these settings are for the 1/32 microstepping drivers with the TB67S109AFTG chip. Almost all the TB6600 drivers you can buy nowadays use this chip. Typically you can also find a table with the microstep and current settings on the body of the driver.

Microstep table

S1	S2	S3	Microstep resolution
ON	ON	ON	NC
ON	ON	OFF	Full step
ON	OFF	ON	1/2 step
OFF	ON	ON	1/2 step
ON	OFF	OFF	1/4 step
OFF	ON	OFF	1/8 step
OFF	OFF	ON	1/16 step
OFF	OFF	OFF	1/32 step

Generally speaking, a smaller microstep setting will result in a smoother and quieter operation. It will however limit the top speed that you can achieve when controlling the stepper motor driver with an Arduino.

TB6600 current settings

You can adjust the current that goes to the motor when it is running by setting the dip switches S4, S5, and S6 on or off. I recommend starting with a current level of 1 A. If your motor is missing steps or stalling, you can always increase the current level later.

Current table

Current (A)	Peak current	S4	S5	S6
0.5	0.7	ON	ON	ON
1.0	1.2	ON	OFF	ON
1.5	1.7	ON	ON	OFF
2.0	2.2	ON	OFF	OFF
2.5	2.7	OFF	ON	ON
2.8	2.9	OFF	OFF	ON
3.0	3.2	OFF	ON	OFF
3.5	4.0	OFF	OFF	OFF

Basic TB6600 with Arduino example code

With the following sketch, you can test the functionality of the stepper motor driver. It simply lets the motor rotate at a fixed speed.

You can upload the code to your Arduino using the Arduino IDE. For this specific example, you do not need to install any libraries.

In the next example we will look at controlling the speed, number of revolutions and spinning direction of the stepper motor.

You can copy the code by clicking on the button in the top right corner of the code field.

```
/* Example sketch to control a stepper motor with TB6600 stepper motor driver and Arduino without a library: continuous rotation. More info: https://www.makerguides.com */

// Define stepper motor connections:
#define dirPin 2
#define stepPin 3

void setup() {
  // Declare pins as output:
  pinMode(stepPin, OUTPUT);
  pinMode(dirPin, OUTPUT);

  // Set the spinning direction CW/CCW:
  digitalWrite(dirPin, HIGH);
}

void loop() {
  // These four lines result in 1 step:
  digitalWrite(stepPin, HIGH);
  delayMicroseconds(500);
  digitalWrite(stepPin, LOW);
  delayMicroseconds(500);
}
```

As you can see, the code is very short and super simple. You don't need much to get a stepper motor spinning!

Code explanation

The sketch starts with defining the step (PUL+) and direction (DIR+) pins. I connected them to Arduino pin 3 and 2.

The statement `#define` is used to give a name to a constant value. The compiler will replace any references to this constant with the defined value when the program is compiled. So everywhere you mention `dirPin`, the compiler will replace it with the value 2 when the program is compiled.

```
// Define stepper motor connections:
#define dirPin 2
#define stepPin 3
```

In the `setup()` section of the code, all the motor control pins are declared as digital OUTPUT with the function `pinMode(pin, mode)`. I also set the spinning direction of the stepper motor by setting the direction pin HIGH. For this we use the function `digitalWrite(pin, value)`.

```
void setup() {
  // Declare pins as output:
  pinMode(stepPin, OUTPUT);
  pinMode(dirPin, OUTPUT);

  // Set the spinning direction CW/CCW:
  digitalWrite(dirPin, HIGH);
}
```

In the `loop()` section of the code, we let the driver execute one step by sending a pulse to the step pin. Since the code in the loop section is repeated continuously, the stepper motor will start to rotate at a fixed speed. In the next example, you will see how you can change the speed of the motor.

```
void loop() {
  // These four lines result in 1 step:
  digitalWrite(stepPin, HIGH);
  delayMicroseconds(500);
  digitalWrite(stepPin, LOW);
  delayMicroseconds(500);
}
```

---

2. Example code to control rotation, speed and direction

This sketch controls both the speed, the number of revolutions and the spinning direction of the stepper motor.

```
/* Example sketch to control a stepper motor with TB6600 stepper motor driver and Arduino without a library: number of revolutions, speed and direction. More info: https://www.makerguides.com */

// Define stepper motor connections and steps per revolution:
#define dirPin 2
#define stepPin 3
#define stepsPerRevolution 1600

void setup() {
  // Declare pins as output:
  pinMode(stepPin, OUTPUT);
  pinMode(dirPin, OUTPUT);
}

void loop() {
  // Set the spinning direction clockwise:
  digitalWrite(dirPin, HIGH);

  // Spin the stepper motor 1 revolution slowly:
  for (int i = 0; i < stepsPerRevolution; i++) {
    // These four lines result in 1 step:
    digitalWrite(stepPin, HIGH);
    delayMicroseconds(2000);
    digitalWrite(stepPin, LOW);
    delayMicroseconds(2000);
  }

  delay(1000);

  // Set the spinning direction counterclockwise:
  digitalWrite(dirPin, LOW);

  // Spin the stepper motor 1 revolution quickly:
  for (int i = 0; i < stepsPerRevolution; i++) {
    // These four lines result in 1 step:
    digitalWrite(stepPin, HIGH);
    delayMicroseconds(1000);
    digitalWrite(stepPin, LOW);
    delayMicroseconds(1000);
  }

  delay(1000);

  // Set the spinning direction clockwise:
  digitalWrite(dirPin, HIGH);

  // Spin the stepper motor 5 revolutions fast:
  for (int i = 0; i < 5 * stepsPerRevolution; i++) {
    // These four lines result in 1 step:
    digitalWrite(stepPin, HIGH);
    delayMicroseconds(500);
    digitalWrite(stepPin, LOW);
    delayMicroseconds(500);
  }

  delay(1000);

  // Set the spinning direction counterclockwise:
  digitalWrite(dirPin, LOW);

  // Spin the stepper motor 5 revolutions fast:
  for (int i = 0; i < 5 * stepsPerRevolution; i++) {
    // These four lines result in 1 step:
    digitalWrite(stepPin, HIGH);
    delayMicroseconds(500);
    digitalWrite(stepPin, LOW);
    delayMicroseconds(500);
  }

  delay(1000);
}
```

How the code works:

Besides setting the stepper motor connections, I also defined a `stepsPerRevolution` constant. Because I set the driver to 1/8 microstepping mode I set it to 1600 steps per revolution (for a standard 200 steps per revolution stepper motor). Change this value if your setup is different.

```
// Define stepper motor connections and steps per revolution:
#define dirPin 2
#define stepPin 3
#define stepsPerRevolution 1600
```

The `setup()` section is the same as before, only we don't need to define the spinning direction just yet.

In the `loop()` section of the code, we let the motor spin one revolution slowly in the CW direction and one revolution quickly in the CCW direction. Next, we let the motor spin 5 revolutions in each direction with a high speed. So how do you control the speed, spinning direction and number of revolutions?

```
// Set the spinning direction clockwise:
  digitalWrite(dirPin, HIGH);

  // Spin the stepper motor 1 revolution slowly:
  for(int i = 0; i < stepsPerRevolution; i++)
  {
    // These four lines result in 1 step:
    digitalWrite(stepPin, HIGH);
    delayMicroseconds(2000);
    digitalWrite(stepPin, LOW);
    delayMicroseconds(2000);
  }
```

Control spinning direction:

To control the spinning direction of the stepper motor we set the DIR (direction) pin either HIGH or LOW. For this we use the function `digitalWrite()`. Depending on how you connected the stepper motor, setting the DIR pin high will let the motor turn CW or CCW.

Control number of steps or revolutions:

In this example sketch, the for loops control the number of steps the stepper motor will take. The code within the for loop results in 1 (micro)step of the stepper motor. Because the code in the loop is executed 1600 times (stepsPerRevolution), this results in 1 revolution. In the last two loops, the code within the for loop is executed 8000 times, which results in 8000 (micro)steps or 5 revolutions.

Note that you can change the second term in the for loop to whatever number of steps you want. `for(int i = 0; i < 800; i++)` would result in 800 steps or half a revolution.

Control speed:

The speed of the stepper motor is determined by the frequency of the pulses we send to the STEP pin. The higher the frequency, the faster the motor runs. You can control the frequency of the pulses by changing `delayMicroseconds()` in the code. The shorter the delay, the higher the frequency, the faster the motor runs.

Installing the AccelStepper library

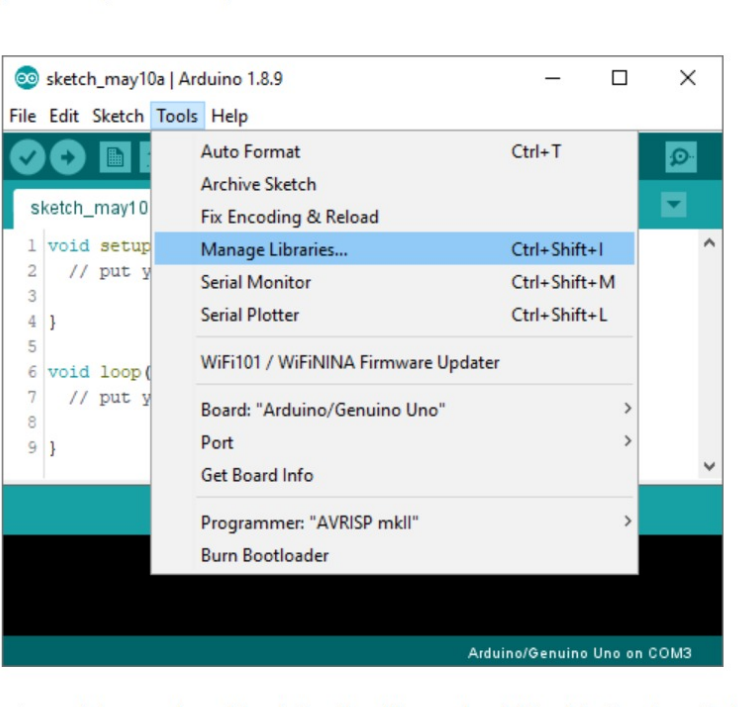
The AccelStepper library written by Mike McCauley is an awesome library to use for your project. One of the advantages is that it supports acceleration and deceleration, but it has a lot of other nice functions too.

You can download the latest version of this library here or click the button below.

AccelStepper-1.59.zip

You can install the library by going to **Sketch > Include Library > Add .ZIP Library…** in the Arduino IDE.

Another option is to navigate to **Tools > Manage Libraries…** or type Ctrl + Shift + I on Windows. The Library Manager will open and update the list of installed libraries.



sketch_may10a | Arduino 1.8.9
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
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Board: "Arduino/Genuino Uno"
Port
Get Board Info
Programmer: "AVRISP mkII"
Burn Bootloader
Arduino/Genuino Uno on COM3

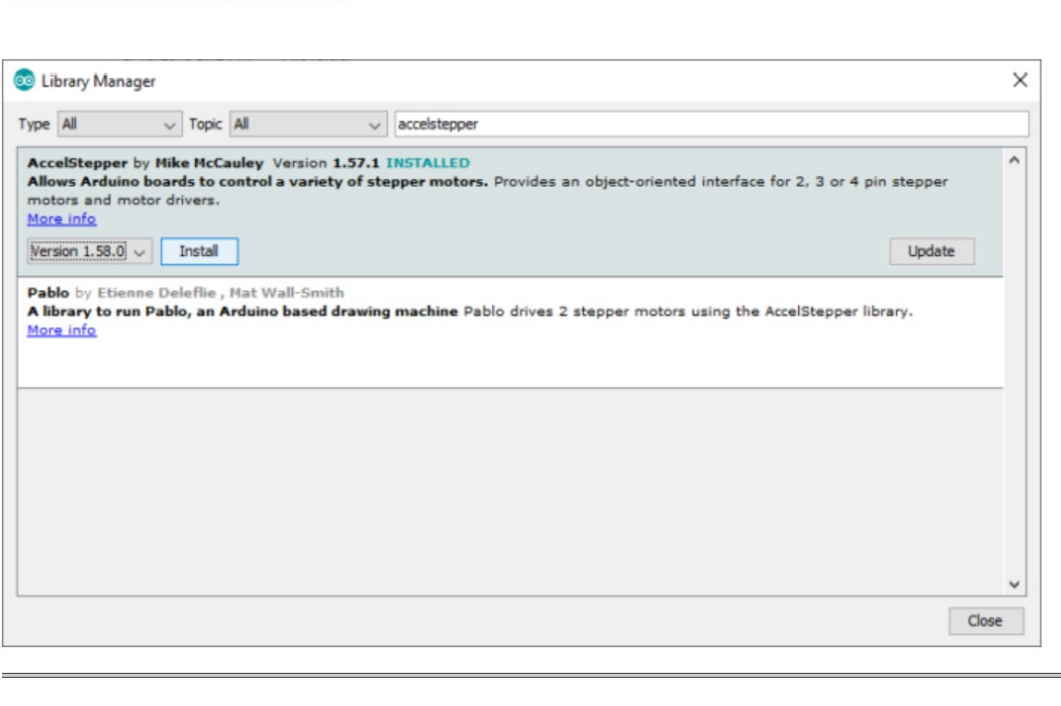
```
void setup
  // put y

}

void loop(
  // put y

}
```

You can search for 'accelstepper' and look for the library by Mike McCauley. Select the latest version and then click Install.



AccelStepper by **Mike McCauley** Version **1.57.1 INSTALLED**
Allows Arduino boards to control a variety of stepper motors. Provides an object-oriented interface for 2, 3 or 4 pin stepper motors and motor drivers.
More info

Pablo by Etienne Deleflie , Mat Wall-Smith
A library to run Pablo, an Arduino based drawing machine Pablo drives 2 stepper motors using the AccelStepper library.
More info

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3. AccelStepper example code

With the following sketch, you can add acceleration and deceleration to the movements of the stepper motor, without any complicated coding. In the following example, the motor will run back and forth with a speed of 1000 steps per second and an acceleration of 500 steps per second squared.

Note that I am still using the driver in 1/8 microstepping mode. If you are using a different setting, play around with the speed and acceleration settings.

```
/* Example sketch to control a stepper motor with TB6600 stepper motor driver, AccelStepper library and Arduino: acceleration and deceleration. More info: https://www.makerguides.com */

// Include the AccelStepper library:
#include <AccelStepper.h>

// Define stepper motor connections and motor interface type. Motor interface type must be set to 1 when using a driver:
#define dirPin 2
#define stepPin 3
#define motorInterfaceType 1

// Create a new instance of the AccelStepper class:
AccelStepper stepper = AccelStepper(motorInterfaceType, stepPin, dirPin);

void setup() {
  // Set the maximum speed and acceleration:
  stepper.setMaxSpeed(1000);
  stepper.setAcceleration(500);
}

void loop() {
  // Set the target position:
  stepper.moveTo(8000);
  // Run to target position with set speed and acceleration/deceleration:
  stepper.runToPosition();

  delay(1000);

  // Move back to zero:
  stepper.moveTo(0);
  stepper.runToPosition();

  delay(1000);
}
```

Code explanation:

The first step is to include the library with `#include <AccelStepper.h>`.

```
// Include the AccelStepper library:
#include <AccelStepper.h>
```

The next step is to define the TB6600 to Arduino connections and the motor interface type. The motorinterface type must be set to 1 when using a step and direction driver. You can find the other interface types here.

```
// Define stepper motor connections and motor interface type. Motor interface type must be set to 1 when using a driver:
#define dirPin 2
#define stepPin 3
#define motorInterfaceType 1
```

Next, you need to create a new instance of the AccelStepper class with the appropriate motor interface type and connections.

In this case, I called the stepper motor 'stepper' but you can use other names as well, like 'z_motor' or 'liftmotor' etc. `AccelStepper liftmotor = AccelStepper(motorInterfaceType, stepPin, dirPin);`. The name that you give to the stepper motor will be used later to set the speed, position, and acceleration for that particular motor. You can create multiple instances of the AccelStepper class with different names and pins. This allows you to easily control 2 or more stepper motors at the same time.

```
// Create a new instance of the AccelStepper class:
AccelStepper stepper = AccelStepper(motorInterfaceType, stepPin, dirPin);
```

In the setup(), besides the maximum speed, we need to define the acceleration/deceleration. For this we use the function `setMaxSpeed()` and `setAcceleration()`.

```
void setup() {
  // Set the maximum speed and acceleration:
  stepper.setMaxSpeed(1000);
  stepper.setAcceleration(500);
}
```

In the loop section of the code, we let the motor rotate a predefined number of steps. The function `stepper.moveTo()` is used to set the target position (in steps). The function `stepper.runToPostion()` moves the motor (with acceleration/deceleration) to the target position and blocks until it is at the target position. Because this function is blocking, you shouldn't use this when you need to control other things at the same time.

```
  // Set the target position:
  stepper.moveTo(8000);
  // Run to target position with set speed and acceleration/deceleration:
  stepper.runToPosition();
```

If you would like to see more examples for the AccelStepper libary, check out my tutorial for the A4988 stepper motor driver: