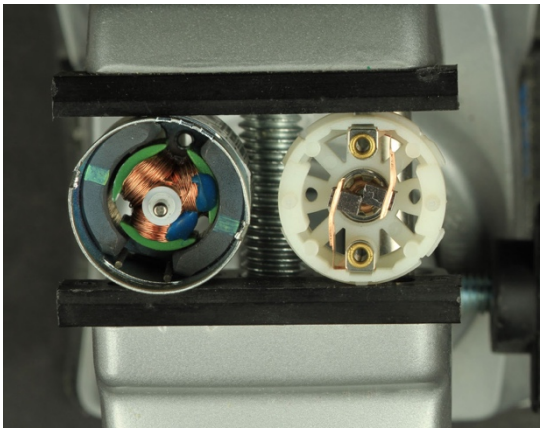
Student Resource: Why use a Motor Shield?

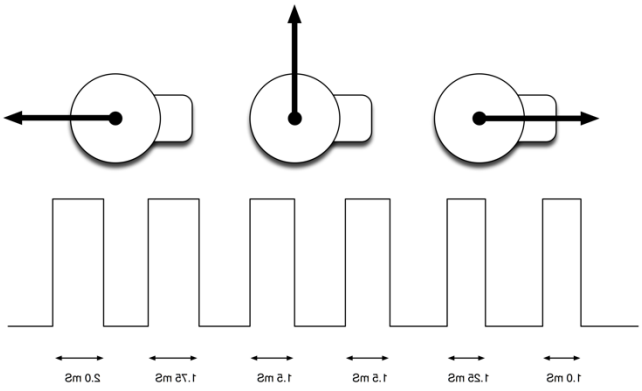
The **Adafruit Motor Shield** is a great and quick way to control **DC motors**, **servos** or even **stepper motors** to be used in robotics and mechatronics projects.

DC Motors



Brushed DC motors are probably the most common type of motor there is. These motors can be found in everything from hand-held fans and cordless drills, to cell phone buzzers and steel mills. These motors are used to power cars and trains, and not just the toy ones! They use brushes that rub on a segmented copper ring so that the current through the armature coils alternates as the motor spins. We opened one up in the photo to the right, so you can see the magnets and coils in the left and the spring-loaded brushes on the right. DC motors are available in a wide variety of sizes, ranging from tiny motors for miniature devices up to and including large industrial motors capable of many horsepower. Check out the Motor selection guide: https://learn.adafruit.com/adafruit-motor-selection-guide

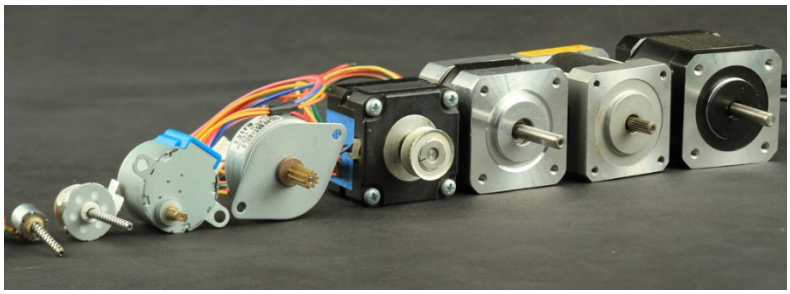
Servos



Servo motors are controlled by pulses of varying lengths and have a back and forth motion. The position of the servo motor is set by the length of a pulse. The servo expects to receive a pulse roughly every 20 milliseconds. If that pulse is high for 1 millisecond, then the servo angle will be zero, if it is 1.5 milliseconds, then it will be at its center position and if it is 2 milliseconds it will be at 180 degrees.

Watch this short video on what is inside a servo motor: https://learn.adafruit.com/adafruit-arduino-lesson-14-servo-motors/inside-a-servo

Stepper Motors



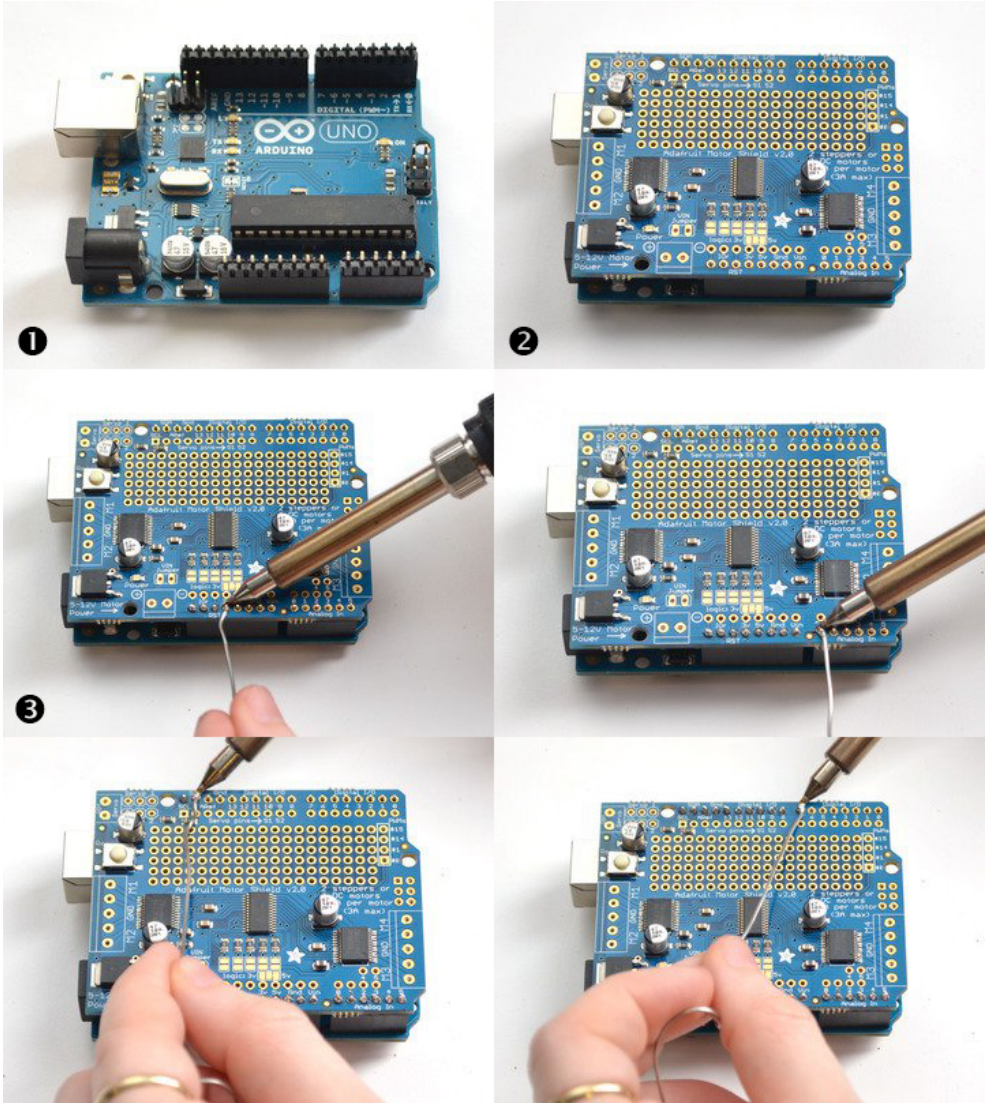
Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time. With a computer controlled stepping you can achieve very precise positioning and/or speed control. For this reason, stepper motors are the motor of choice for many precision motion control applications. Stepper motors come in many different sizes and styles and electrical characteristics. This guide details what you need to know to pick the right motor for the job. Stepper motors are good for:

- **Positioning** – Since steppers move in precise repeatable steps, they excel in applications requiring precise positioning such as 3D printers, CNC, Camera platforms and X,Y Plotters. Some disk drives also use stepper motors to position the read/write head.
- **Speed Control** – Precise increments of movement also allow for excellent control of rotational speed for process automation and robotics.
- **Low Speed Torque** - Normal DC motors don't have very much torque at low speeds. A Stepper motor has maximum torque at low speeds, so they are a good choice for applications requiring low speed with high precision.

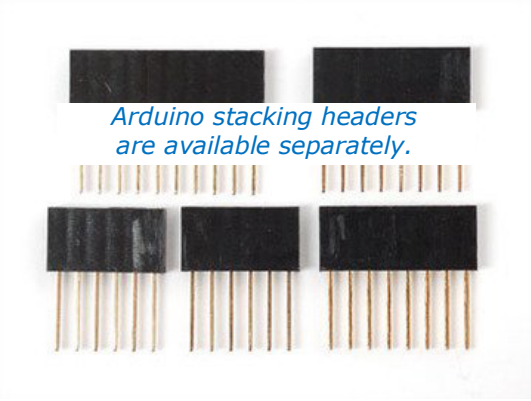
Student Resource:
Part 1: Installing Headers and Terminals

A. Installing standard headers

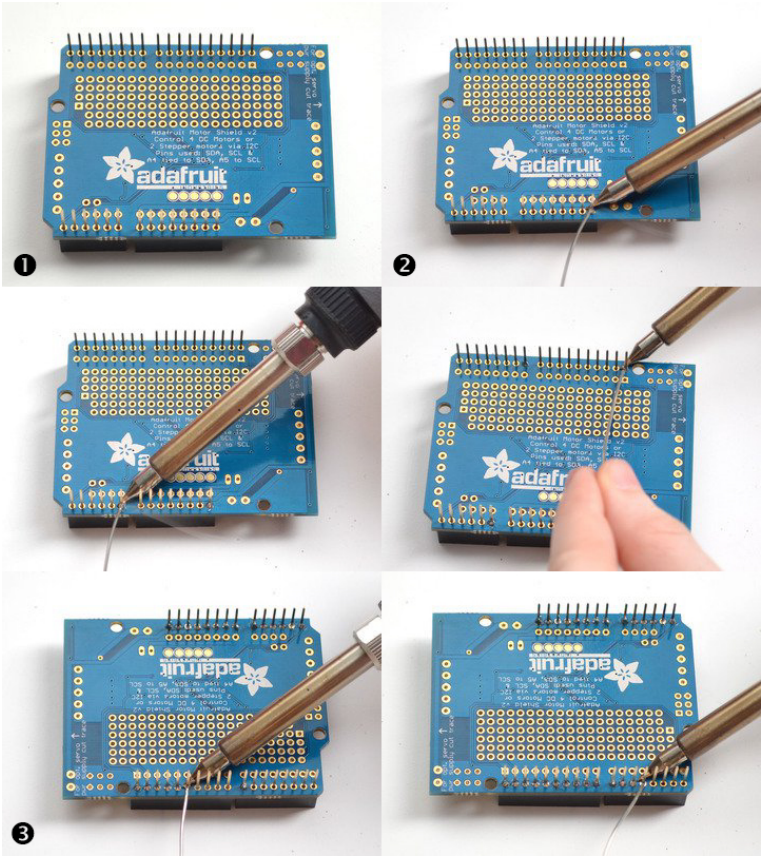
1. Break apart the 0.1 in header into 6-, 8- or 10-pin-long pieces and slip the long ends into the headers of their Arduino boards.
2. Place the assembled shield on top of the headered Arduino so that all the short parts of the header are sticking through the outer set of pads.
3. Solder each one of the pins into the shield to make a secure connection. When finished, skip to Step C to install terminal blocks.



B. Installing stacking headers


Arduino stacking headers are available separately.

1. Slide the 10-pin, 2 x 8-pin and 6-pin stacking headers into the outer rows of the shield from the top. Then flip the board over so it is resting on the four headers.
   Tip: *If necessary, pull on the legs to straighten them out.*
2. Tack one pin of each header to get them set in place before soldering.
   Tip: *If the headers get crooked, one pin can be re-heated and re-positioned to straighten them up.*
3. Once all the headers have been tacked and straightened, go back and solder the remaining pins for each header.
   Tip*: Though not shown below, the 2 x 3 stacking header should be soldered in as well. Even though this shield does not use it, the one above may need those pins*

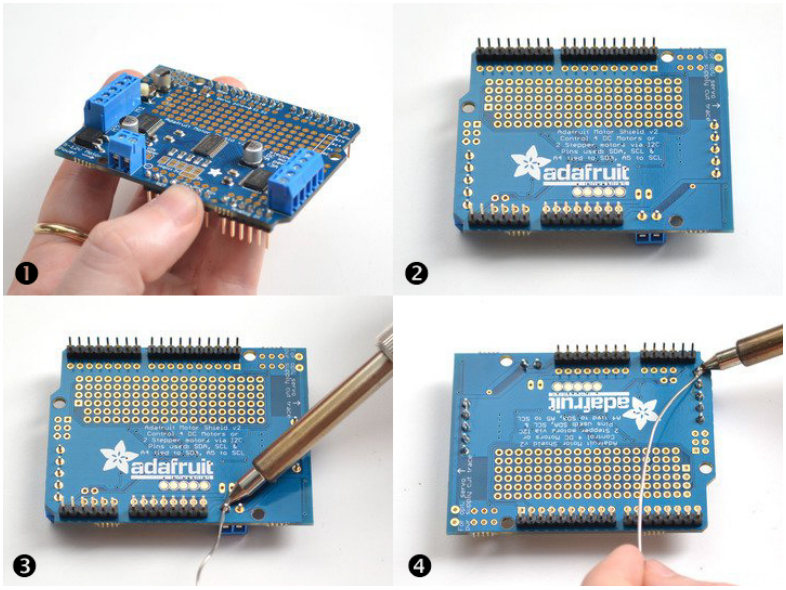


C. Installing terminal blocks

1. Slide the 3-pin terminal blocks into 2-pin terminal blocks to create 2 x 5-pin and 1 x 2-pin blocks.

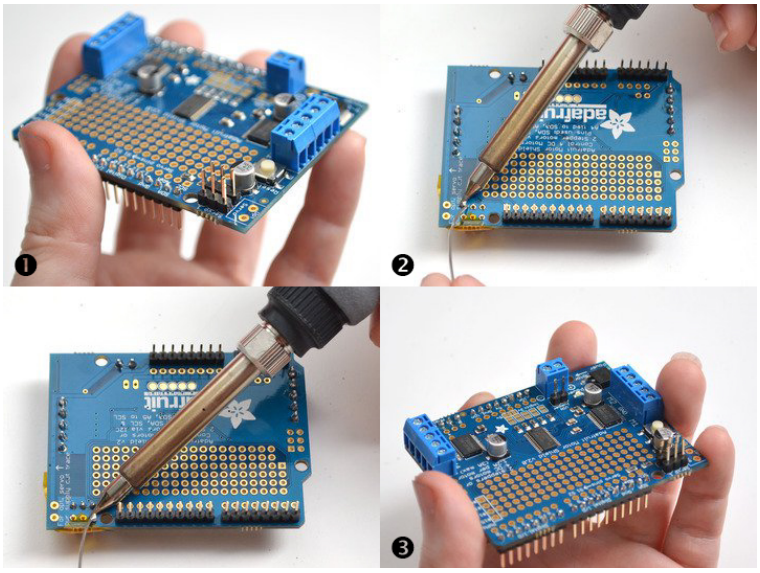
Tip: *The two 5-pin sets go on either side. The 2-pin piece goes near the bottom of the shield. The open holes of the terminal blocks should be facing out****.***

2. Flip the board over and solder the pins of the terminal blocks.
3. Solder in the two pins of the external power terminal block.
4. Solder in both motor blocks (5 pads each).



D. Making servo connections

1. Place the 2 x 3-pin header, short legs down, into the top corner where it says Servo 1 and Servo 2.
   Tip: *The part may need to be slightly angled to fit into both sets of 3-pin holes. This is an intentional part of the design that helps keep the header in place.*
2. Flip the board over and solder the 6 pins
3. Break off a 2-pin piece of header and place it next to the power terminal block, short legs down. If necessary, tape it in place. Solder it in.



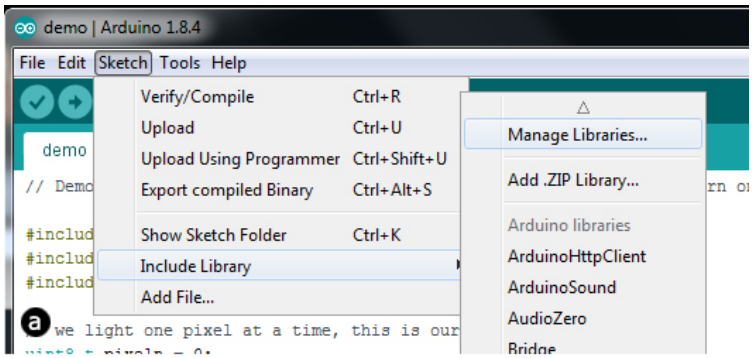
Student Resource:
Part 2: Installing Software

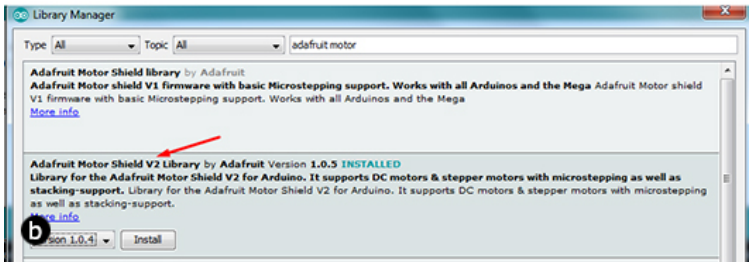
1. Install the Adafruit_Motor_Shield_V2_Library, available on Adafruit's github repository.

   Tip: *Using the Arduino library manager is recommended; follow the steps below to use.*

   a. From the integrated development environment (IDE), open the library manager.
   b. Type in "adafruit motor" to locate the library.
   c. Click Install.

(Optional) To use AccelStepper for acceleration control or for simultaneous control of multiple stepper motors, download and install the AccelStepper library.





Student Resource:
Part 3: Running the Example Code

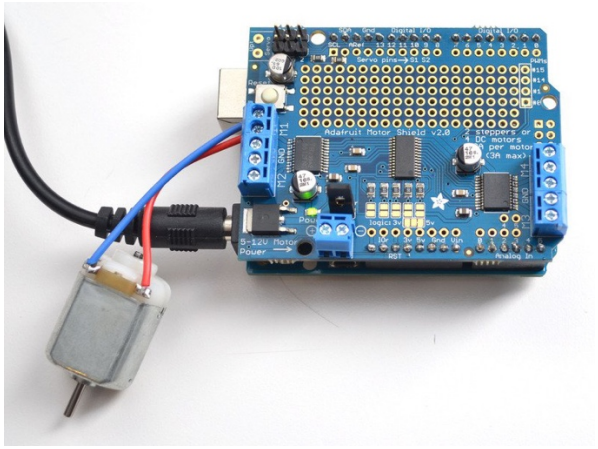
A. DC motor test

1. Restart the IDE to make sure the new library is loaded.

2. Plug the shield into the Arduino and connect a DC motor to motor port 1.
Tip: *It does not matter which wire goes into which terminal block, as motors are bi-directional.*

3. Connect to the top two terminal ports. Do not connect to the middle pin, which is a ground (GND).

   Tip: *See the photo below for the red and blue wire example. Be sure to screw down the terminal blocks to make good connections.*



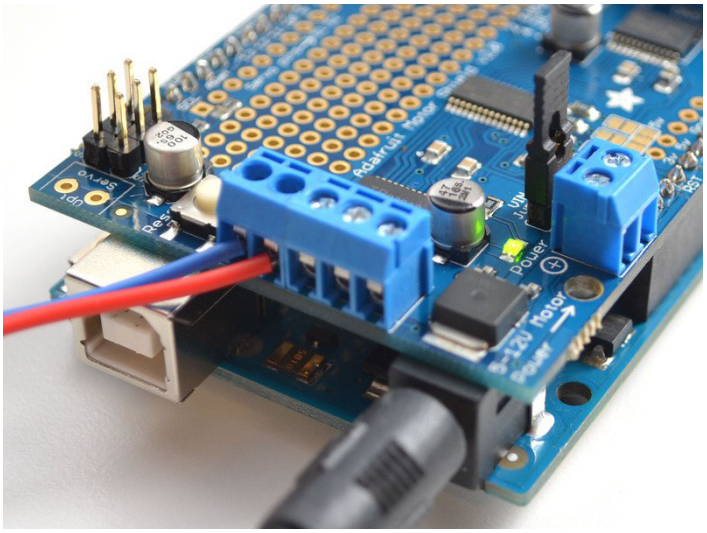
4. Supply 5 – 12 V DC to power the motor, using one of two methods.

   a. Use the DC barrel jack to power the Arduino. Insert the VIN jumper *(shown as the tall black handle right next to the green power LED in the photo below)*.

   -or-

   b. Use the DC barrel jack or USB port to power the Arduino, then use the 5 – 12 V DC motor power terminal port *(shown as the double terminal block next to the green power LED)* to power the shield. Remove the VIN jumper.

Tip: If the green power LED next to the power terminal block isn't brightly lit, do NOT continue!



5. After verifying that the motor is connected properly with the power LED brightly lit, upload the DC motor test code.

    a. In the IDE, load File -> Examples -> Adafruit_MotorShield -> DCMotorTest
    Tip: *You should see and hear the DC motor turn on and move back and forth. If they have trouble seeing the movement, attaching a slip of paper or tape can help them visualize it.*

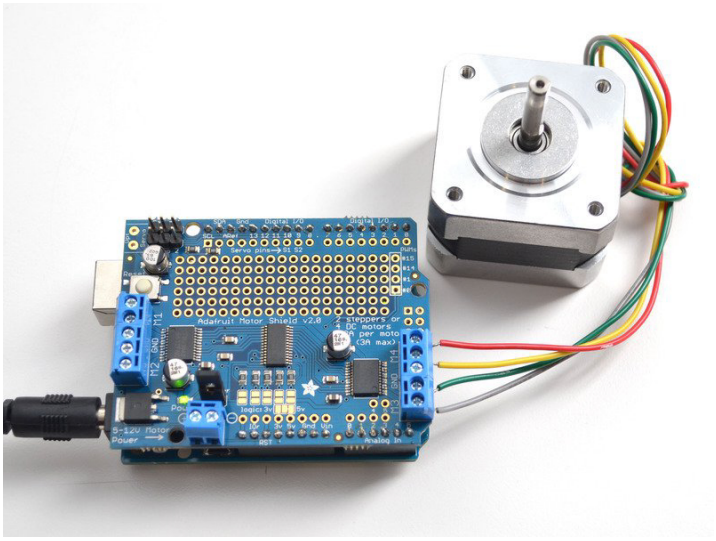
B. Stepper motor test

1. Restart the IDE to make sure the new library is loaded.

2. Plug the shield into the Arduino and connect a stepper motor to motor port 2. ***Tip:*** *Note that, unlike DC motors, the wire order does matter.*

3. Connect to the top two terminal ports (coil #1) and the bottom two terminal ports (coil #2).

    a. For a bipolar motor, do not connect to the middle pin (GND).
    b. For a unipolar motor with 5 wires, connect the common wire to GND.
    c. For a unipolar motor with 6 wires, connect the two "center coil wires" together to GND.



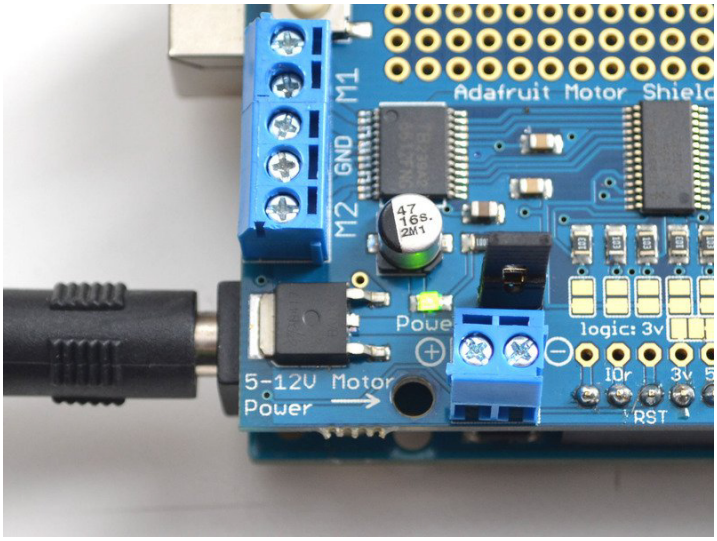
4. Supply 5 – 12 V DC to power the motor, using one of two methods:

    a. Use the DC barrel jack to power the Arduino. Insert the VIN jumper *(shown as the tall black handle right next to the green power LED in the photo below)*.

    -or-

    b. Use the DC barrel jack or USB port to power the Arduino, then use the 5 – 12 V DC motor power terminal port *(shown as the double terminal block next to the green power LED)* to power the shield. Remove the VIN jumper.

Tip**: **If the green power LED next to the power terminal block isn't brightly lit, you should NOT continue!



5. After verifying that the motor is connected properly with the power LED lit up brightly, upload the stepper motor test code.

    a. In the IDE, load File -> Examples -> Adafruit_MotorShield -> StepperTest
    Tip: *You should see and hear the stepper motor turn on and move back and forth. If they have trouble seeing the movement, attaching a slip of paper or tape can help them to visualize it. There are four ways to move a stepper, with varying speed, torque and smoothness tradeoffs. This example code will demonstrate all four.*

Student Worksheet: Reflection

Did you get your motor shield work?

What problem(s) did you encounter and how did you work through them?

Share any new insight(s) you may have had along