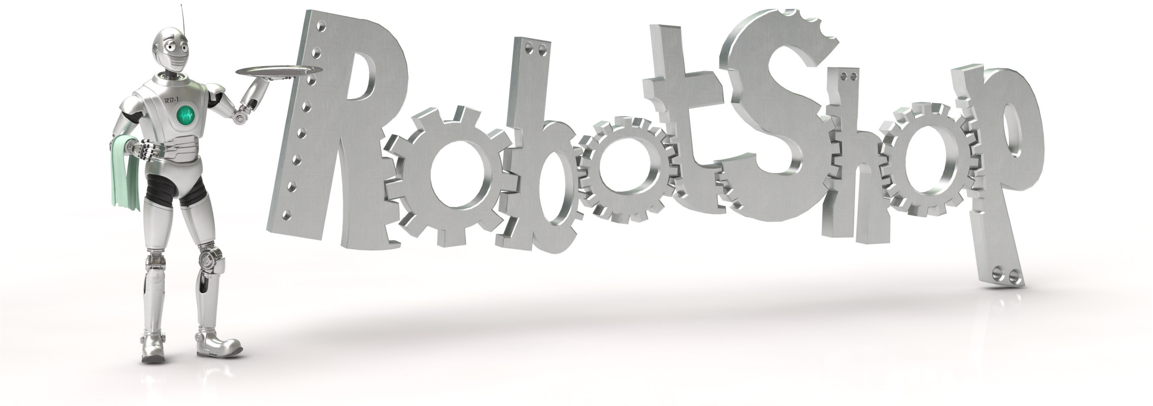


Adafruit Motor Shield
RB-Ada-02

F.A.Q.

How many motors can I use with this shield?

You can use 2 DC servos that run on 5V and up to 4 DC motors or 2 stepper motors (or 1 stepper and up to 2 DC motors)

Can I connect more motors?

No, at this time it is not possible to stack the shield or otherwise connect it up easily to control 4 steppers, for example.

What is the LED for?

The LED indicates motor power. If it is not lit, then the DC/Stepper motors will not run. The servo ports are 5V powered and does not use the DC motor supply

Im trying to build this robot and it doesn't seem to run on a 9V battery....

Please read the user manual for information about appropriate power supplies

Can this shield control small 3V motors?

Not really, its meant for larger, 6V+ motors. In theory you should be able to get it working with 3V motors but I have no information on how to do so or whether it will work

What is the power connector on the shield for? How do I power my motors?

Please read the user manual for information about appropriate power supplies

My Arduino freaks out when the motors are running! Is the shield broken?

Motors take a lot of power, and can cause 'brownouts' that reset the Arduino. For that reason the shield is designed for seperate (split) supplies - one for the electronics and one for the motor. Doing this will prevent brownouts. Please read the user manual for information about appropriate power supplies

I have good solid power supplies, but the DC motors seem to 'cut out' or 'skip'

Try soldering a ceramic or disc 0.1uF capacitor between the motor tabs (on the motor itself!) this will reduce noise that could be feeding back into the circuit (thanks macegr!)

What pins are not used on the motor shield?

All 6 analog input pins are available. They can also be used as digital pins (pins #14 thru 20)

Digital pin 2, and 13 are not used.

Digital pin 11: DC Motor #1 / Stepper #1
Digital pin 3: DC Motor #2 / Stepper #1
Digital pin 5: DC Motor #3 / Stepper #2
Digital pin 6: DC Motor #4 / Stepper #2
These pins are in use only if the DC/Stepper noted is in use

Digital pin 4, 7, 8 and 12 are used to drive the DC/Stepper motors via the latch
These pins are in use if any DC/steppers are used

Digitals pin 9: Servo #1 control
Digital pin 10: Servo #2 control
These pins are used only if that particular servo is in use

I get the following error trying to run the example code: "error: AFMotor.h: No such file or directory...."

Make sure you have installed the AFMotor library

How do I install the library?

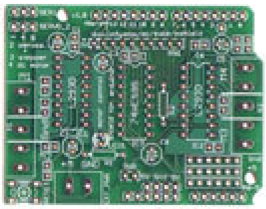
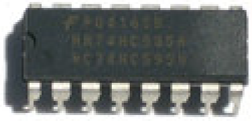
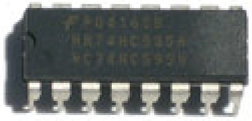
Download the latest Arduino library file and uncompress the folder. Place the folder AFMotor into the **Arduino/hardware/library** folder. That is, find your Arduino install folder, then open up hardware & library and drag AFMotor into it. Inside AFMotor should be a AFMotor.c and AFMotor.h file

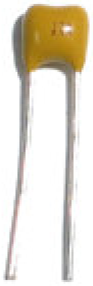
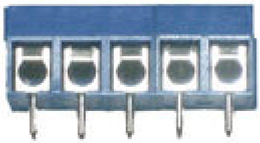
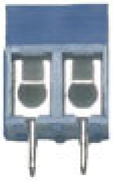
I have two stepper motors and I want to run them simulaneously but the example code can only control one and then the other?

The stepper motor library step() routine does not have the ability to run both motors at a time. Instead, you will have to 'interleave' the calls. For example, to have both motors step forward 100 times you must write code like this:

```
for (i=0; i<100; i++) {
motor1.step(1, FORWARD, SINGLE);
motor2.step(1, FORWARD, SINGLE);
}
```

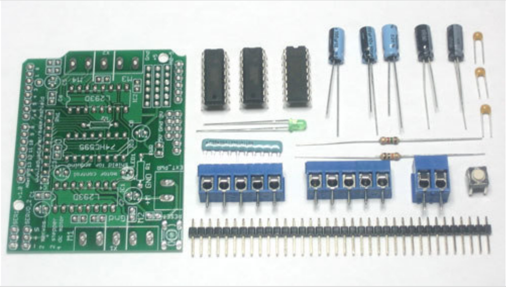
Parts list

Image	Name	Description	Distributor	Qty
	PCB	Printed circuit board	Adafruit	1
	IC1, IC2	L293D Dual H-bridge * See note on usage page for replacing with SN754410	Digikey Mouser	2
	IC3	74HC595N Serial to parallel output latch	Digikey Mouser	1
	LED1	3mm LED, any color Motor power indicator	Digikey Mouser	1
	R1	1.5K resistor for LED1 Brown Green Red Gold	Digikey Mouser	1
	R2	10K pulldown resistor Brown, Black, Orange, Gold	Digikey Mouser	1

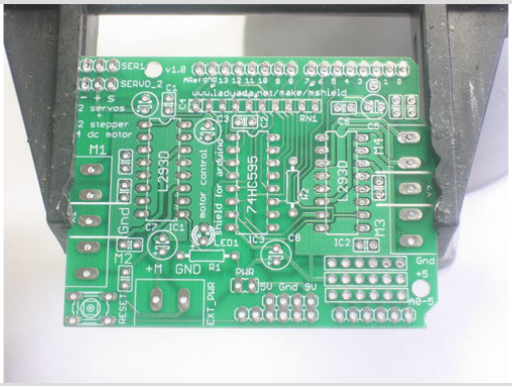
	RN1	10-pin bussed 10K-100K resistor network	Digikey Mouser	1
	C2, C4, C6	0.1uF ceramic capacitor	Digikey Mouser	3
	C1, C3, C5	100uF / 6V capacitor	Digikey Mouser	3
	C7, C8	47uF / 25V capacitor	Digikey Mouser	2
	X1	5-position 5.08 terminal block (Or a 3-position and a 2-position)	Mouser	2
	X2	2-position 5.08 terminal block	Mouser	1

	RESET	6mm tactile switch	Digikey Mouser	1
	PWR	Jumper/shunt	Digikey Mouser	1
		36 pin male header (1x36)	Digikey Mouser	1

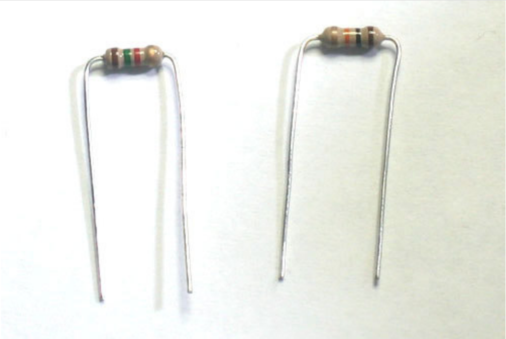
Assembly



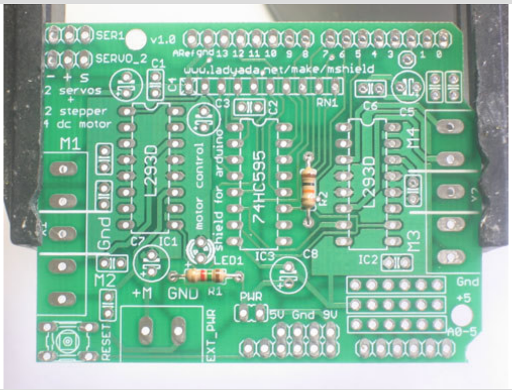
First, check that you have all the parts! Look over the parts list shown on the left. Also check to make sure you have the necessary tools for assembly.



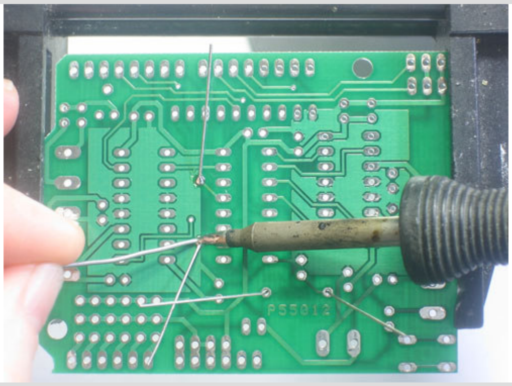
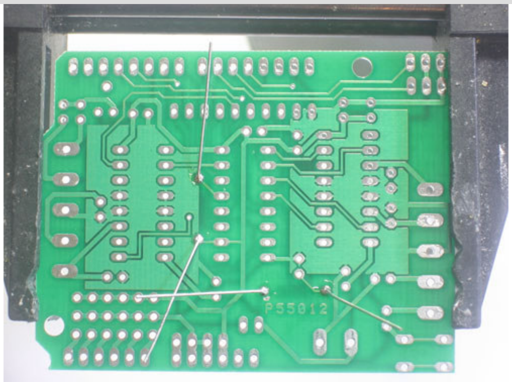
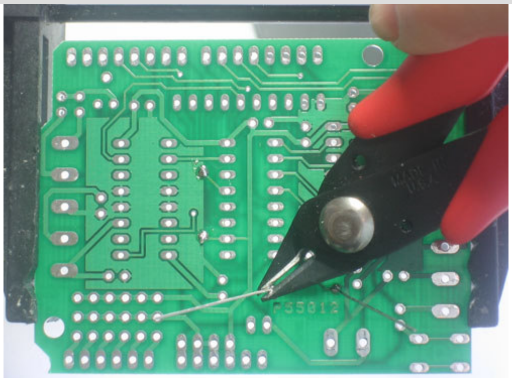
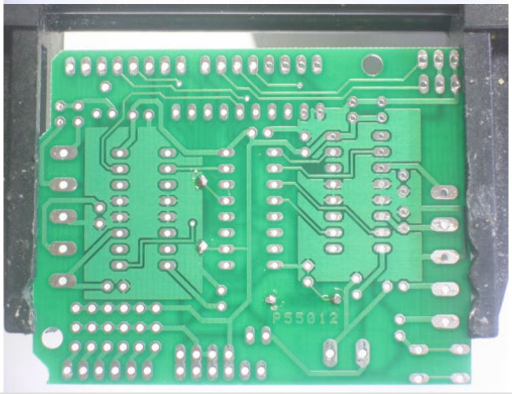
Place the motor shield PCB in a vise or other circuit-board holder and turn on your soldering iron to 700 degrees.

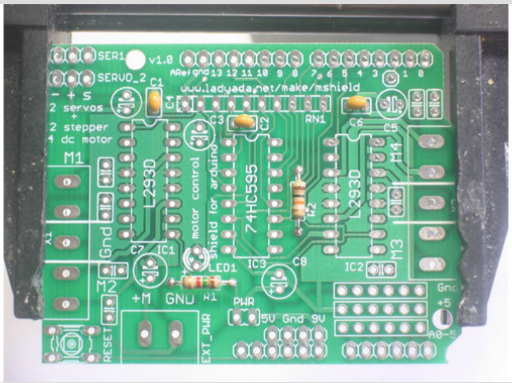
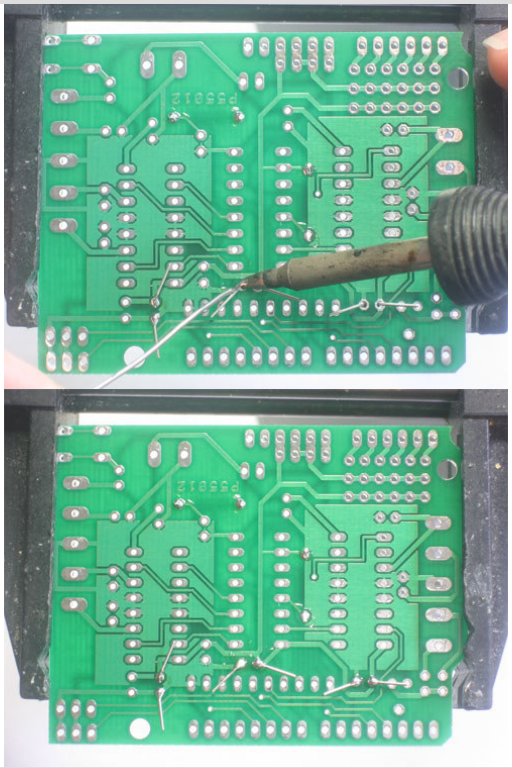
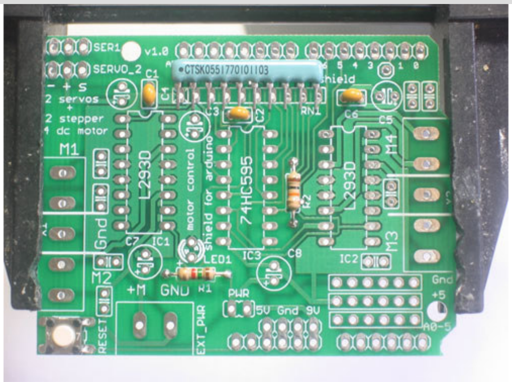


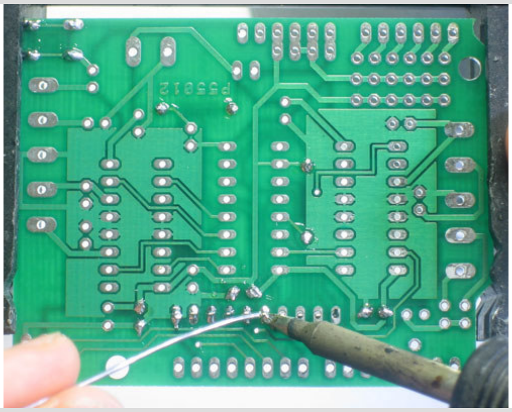
The firt parts to go in are the two resistors, R1 and R2. Bend the resistors so that they look like staples, as seen in this photo



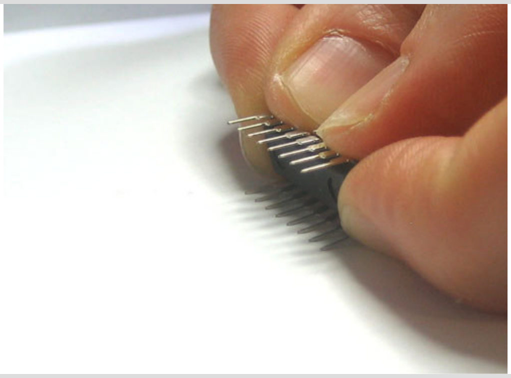
Next, slip the resistors into the PCB as shown, so that they sit flat against the circuit board. Bend the wire legs out a bit so that when the board is flipped over
Resistors are not polarized, that means you can put them in "either way" and they'll work just fine.

	Using your soldering iron tip, heat the resistor wire lead and the metal ring (pad) at the same time, after a few seconds, poke a little solder in so that it melts into a nice cone. Remove the solder and then remove the soldering iron. Do this for all 4 wires.
	Check your work, you should have clean solder joints
 	Clip the long leads, just above the solder joint using diagonal cutters

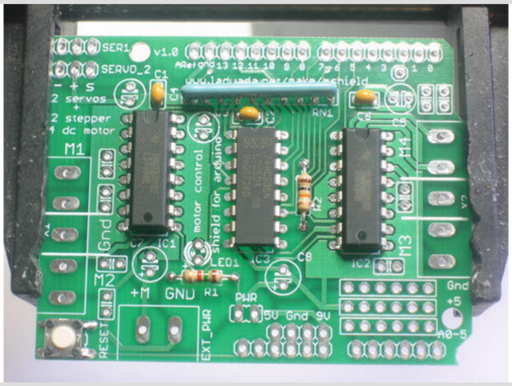
	Next place the three yellow ceramic capacitors C4, C2 and C6. Ceramic capacitors are not polarized so you can put them in "either way" and they work fine. Bend the leads out just like you did with the resistors.
	Solder all 6 wires, then clip them as you did with the resistors.
	Next is the 6mm tactile switch RESET and the resistor network RN1. The tact switch is used to reset the Arduino since its not possible to reach the reset button once the motor shield is on. The resistor network is used to pull-down the pins on the motor driver chips so that they don't power up the motors before the Arduino sketch tells them to. The tactile switch can go in 'either way'. The resistor network, however, must go in a certain way. Make sure the end with a dot is posititioned so it is at the same end as the X in the silkscreened image of the resistor network. (See picture on left)



Flip the board over and solder in the resistor network and switch. You won't need to clip the leads as they are quite short aleady.



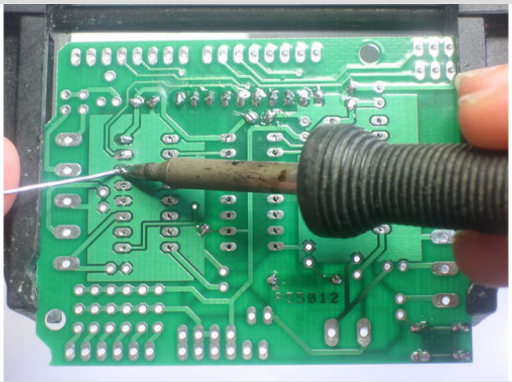
Next are the three integrated circuits (ICs) IC1, IC2 and IC3. When ICs come from the factory, the legs are angled out somewhat which makes it difficult to insert them into the PCB. Prepare them for soldering by gently bending the legs against a flat tabletop so that they are perfectly straight.



ICs must be placed in the correct orientation to work properly. To help with placement, each chip has a U notch at the top of the chip. On the circuit board there is a printed out image of the chip outline and one end has a U notch. Make sure the chip notch is on the same end as the image notch. In this PCB, all are facing the same way.

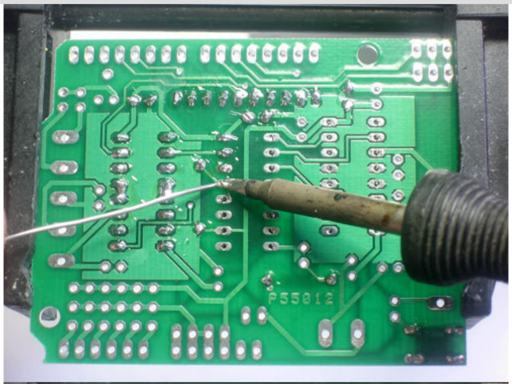
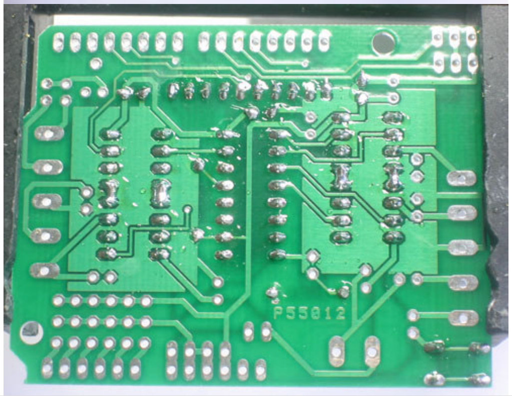
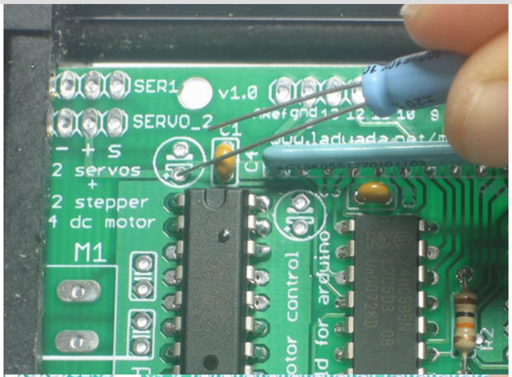
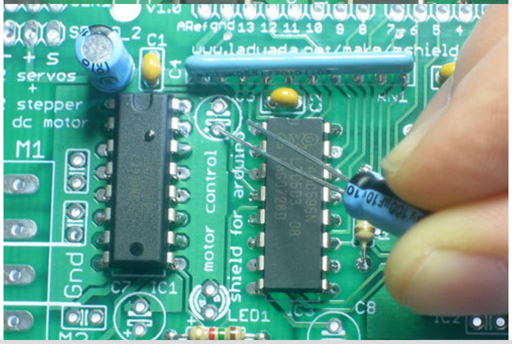
Gently insert the three chips. Check to make sure none of the legs got bent or broken.

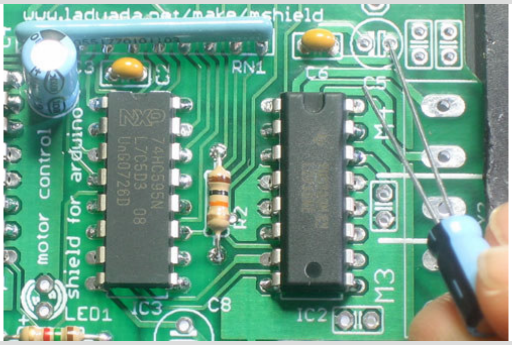
The 74HC595 goes in the middle, and the two L293Ds go on either side.

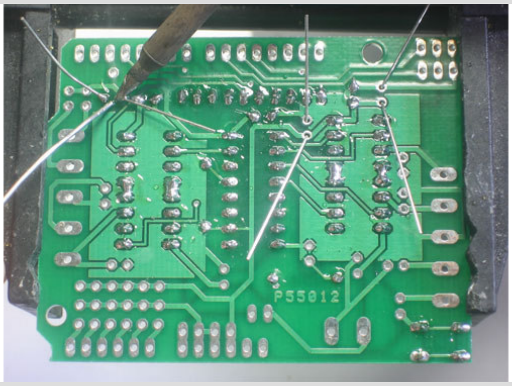


Solder each pin of the chips.

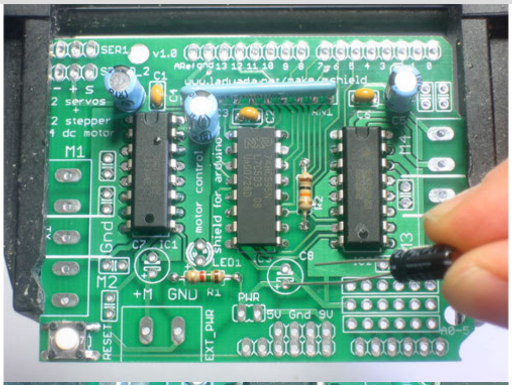
The four 'middle' pins of the L293D motor driver chips are tied to a large heat sink and thus may end up getting 'bridged' with solder as shown in the second image.

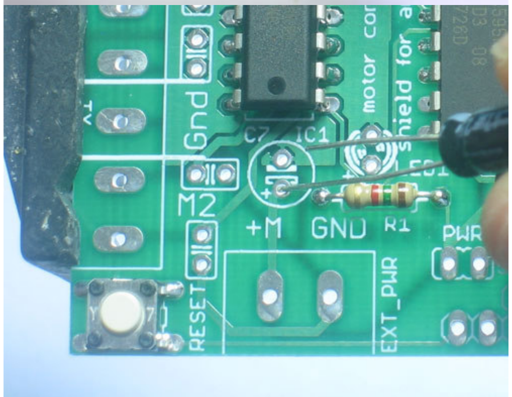
 	
 SER1 v1.0 SERVO_2 C1 C4 2 servos 2 stepper 4 dc motor M1 motor control d for arduino  servos stepper dc motor M1 C1 C4 www.laduada.net/make/mshield motor control shield for arduino Gnd C7 IC1 LED1 C8	Next are the three 100uF electrolytic capacitors C1, C3 and C5. Electrolytic capacitors are polarized and must be placed in the correct orientation or they could pop! The long leg of the capacitor is the positive (+) leg and goes into the hole marked with a +. The close-up images shown here indicate with hole is the + one.



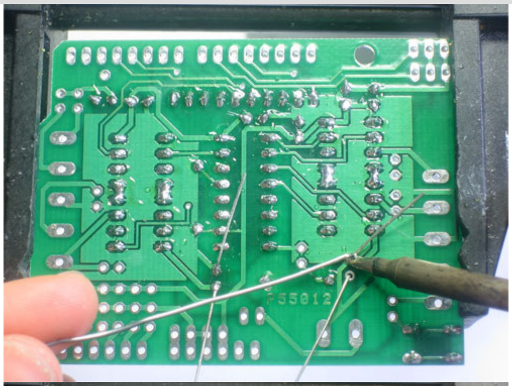
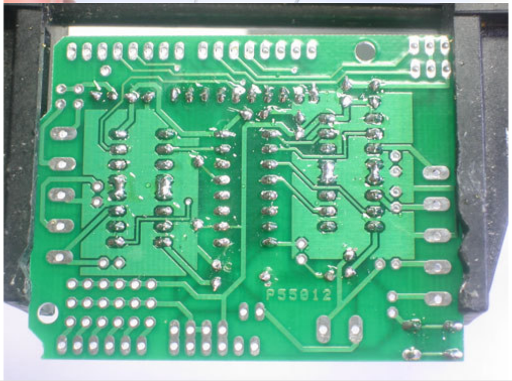
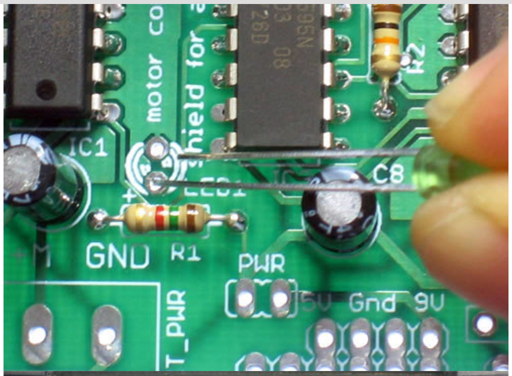
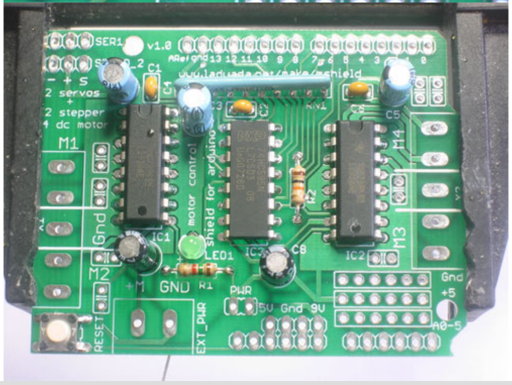


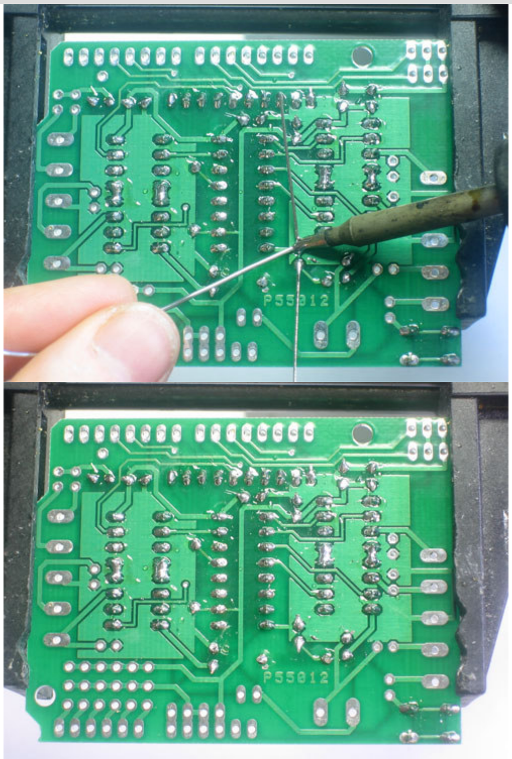
After double-checking their polarity, solder and clip the three capacitors



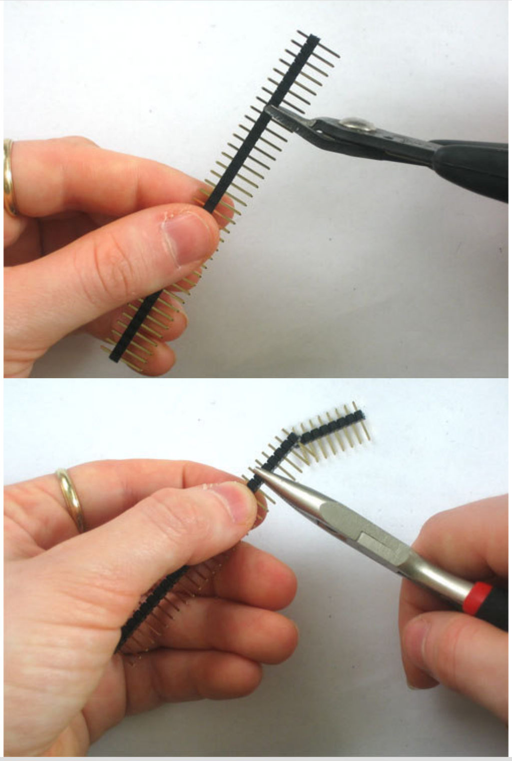


Place the two 47uF remaining electrolytic capacitors, C7 and C8 These are also polarized so make sure the long lead is inserted into the + hole in the silkscreened image.

 	Solder and clip the two capacitors
 	Next is the 3mm LED used to indicate motor power. LEDs are polarized, just like capacitors, and the long lead is the positive (+) lead. Make sure the LED is placed correctly otherwise it wont work!



Solder and clip the LED leads.

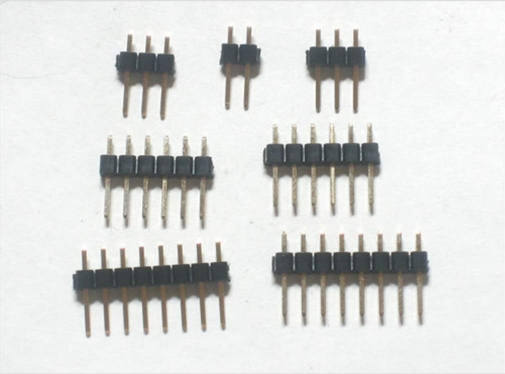


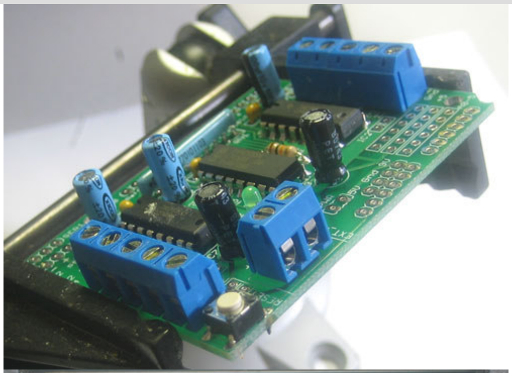
Next its time to make the headers for the jumper, servos and arduino.

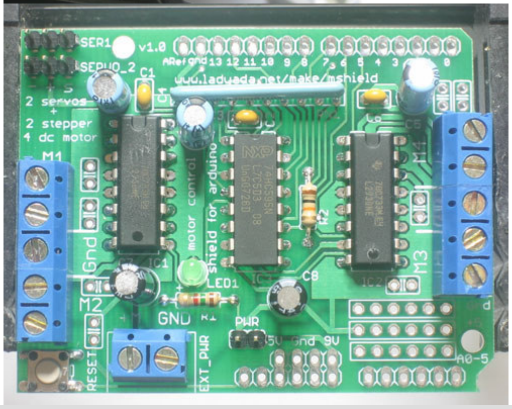
We use one stick of 36-pin 'breakaway' header, and break it apart to make smaller strips. You can use diagonal cutters or pliers to snap off the pieces.

Break the 36-pin header into 2 8-pin, 2 6-pin, 2 3-pin and 1 2-pin headers.

If you have an NG arduino, you may want 1 6-pin header and 1 4-pin header instead of 2 6-pin headers.

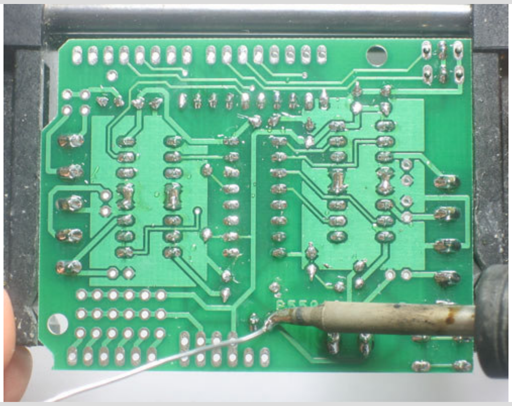




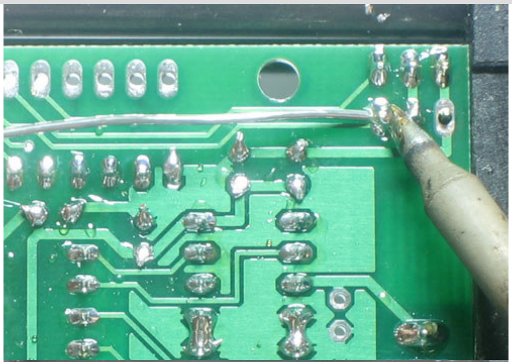
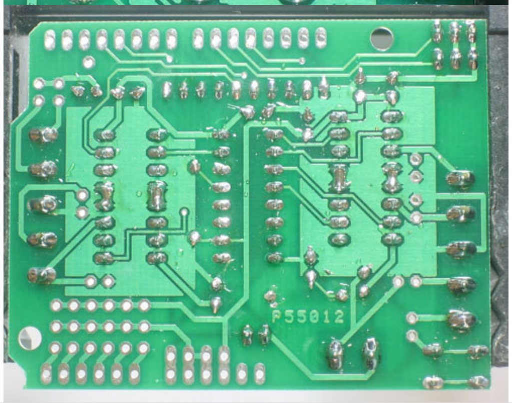
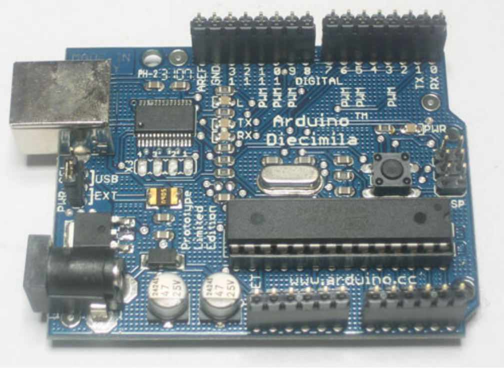
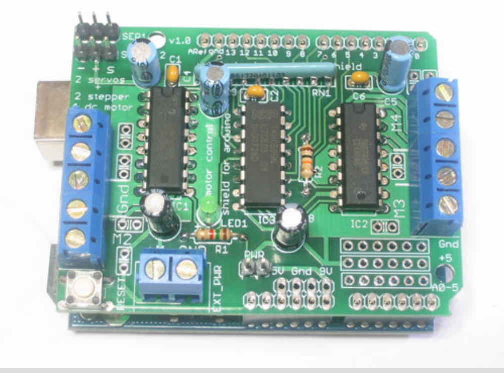


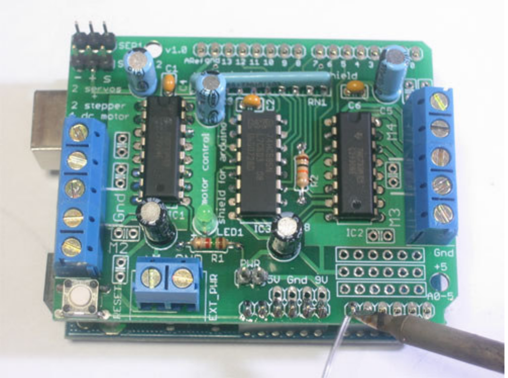
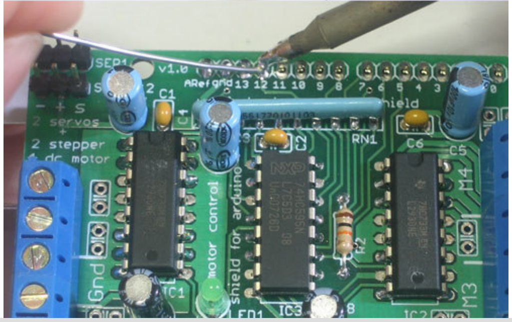
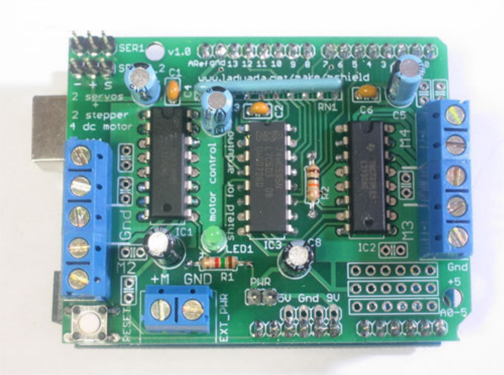
The 2 3-pin pieces go in the servo connections in the top left corner. The 2-pin piece goes in the PWR jumper in the bottom center.

Also, place the 3 large screw terminals for the motor and external motor-power wires. If you received only 2 and 3-position terminal blocks, slide them together so that you have 2 5-position terminals and 1 2-position terminal.



Solder in the 3 pieces of header and the three terminal blocks

 	
 	Next, place the 8-pin and 6-pin headers into the Arduino board. This will make sure that the headers are perfectly lined up. Make sure the Arduino is not plugged in or powered! Place the motor shield on top of the Arduino, making sure that all the header lines up.

 SER1 v1.0 2 servos 2 stepper dc motor motor control shield for arduino LED1 IC3 IC2 RN1 M4 M3 Gnd +5 A0-5 EXT_PWR RESET PWR 5V Gnd 9V SER1 v1.0 ARef gnd 13 12 11 10 9 8 2 servos 2 stepper 4 dc motor motor control shield for arduino C1 C4 C2 RN1 C6 C5 M4 M3 IC1 IC3 IC2 LED1 Gnd R2	Solder in each pin of the header.
 SER1 v1.0 www.ladyada.net/make/mshield 2 servos 2 stepper 4 dc motor motor control shield for arduino RN1 M4 M3 IC1 IC3 IC2 LED1 +M GND R1 PWR 5V Gnd 9V Gnd +5 A0-5 EXT_PWR RESET	You're done!

Powering your DC motors, voltage and current requirements

Motors need a lot of energy, especially cheap motors since they're less efficient. The first important thing to figure out what voltage the motor is going to use. If you're lucky your motor came with some sort of specifications. Some small hobby motors are only intended to run at 1.5V, but its just as common to have 6-12V motors. The motor controllers on this shield are designed to run from **4.5V to 36V**. (However, in theory they should be OK down to about 2.5V?)

Current requirements: The second thing to figure out is how much current your motor will need. The motor driver chips that come with the kit are designed to provide up to 600 mA per motor, with 1.2A peak current. If you need more current you can 'double up' the motor (connect your motor to two ports at once) for 1.2A per motor, 2.4A peak. Note that once you head towards 1A you'll probably want to put a heatsink on the motor driver, otherwise you will get thermal failure, possibly burning out the chip.

On using the SN754410: Some people use the SN754410 motor driver chip because it is pin-compatible, has output diodes and can provide 1A per motor, 2A peak. After careful reading of the datasheet and discussion with TI tech support and power engineers it appears that **the output diodes were designed for ESD protection only** and that using them as kickback-protection is a hack and not guaranteed for performance. For that reason the kit does not come with the SN754410 and instead uses the L293D with integrated kickback-protection diodes. If you're willing to risk it, and need the extra currrent, feel free to buy SN754410's and replace the provided chips.

Need more power? Buy another set of L293D drivers and solder them right on top of the ones on the board (piggyback). Voila, double the current capability!

You can't run motors off of a 9V battery so don't even waste your time/batteries! Use a big Lead Acid or NiMH battery pack. It’s also very much suggested that you set up two power supplies (split supply) one for the Arduino and one for the motors. **99% of 'weird motor problems**' are due to noise on the power line from sharing power supplies and/or not having a powerful enough supply!

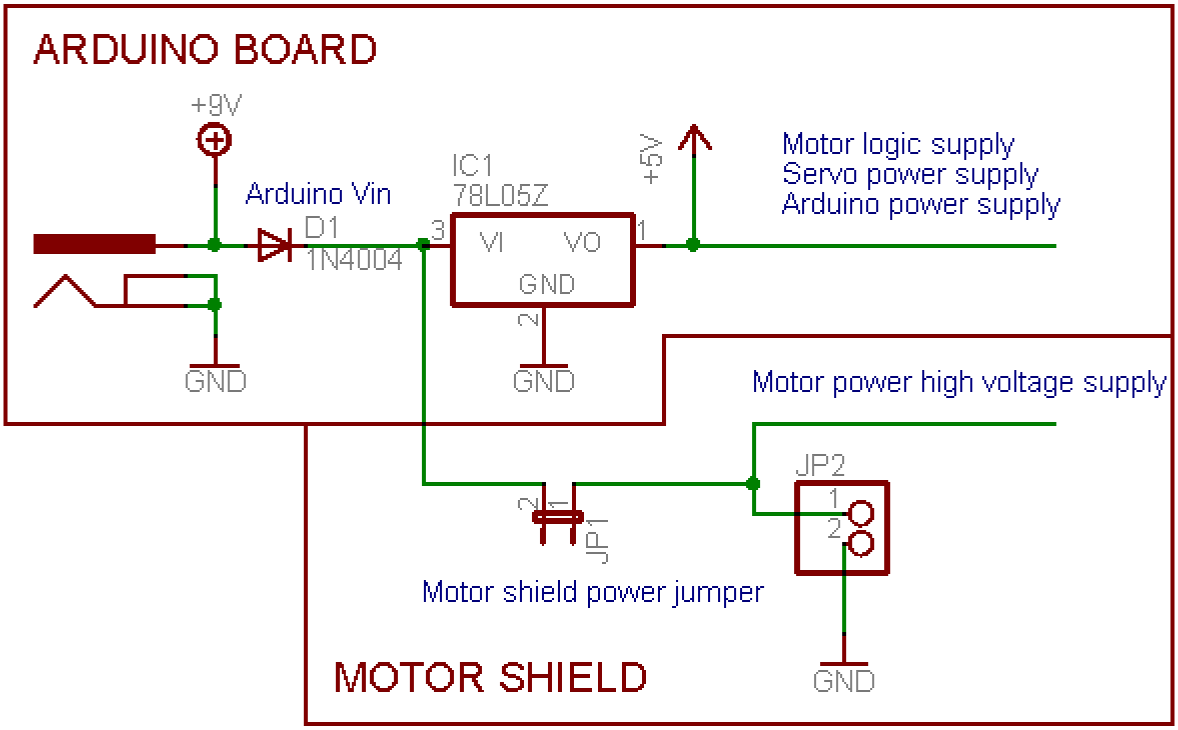
How to set up the Arduino + Shield for powering motors

Servos are powered off of the same regulated 5V that the Arduino uses. This is OK for the small hobby servos suggested. If you want something beefier, cut the trace going to + on the servo connectors and wire up your own 5-6V supply!

The DC motors are powered off of a 'high voltage supply' and NOT the regulated 5V. **Don't connect the motor power supply to the 5V line**. This is a very, very bad idea unless you are sure you know what you're doing!

There are two places you can get your motor 'high voltage supply' from. One is the DC jack on the Arduino board and the other is the 2-terminal block on the shield that is labeled **EXT_PWR**. The DC Jack on the Arduino has a protection diode so you won't be able to mess things up too bad if you plug in the wrong kind of power. However the **EXT_PWR terminals on the shield do not have a protection diode** (for a fairly good reason). **Be utterly careful not to plug it in backwards** or you will destroy the motor shield and/or your Arduino!

Here's how it works:

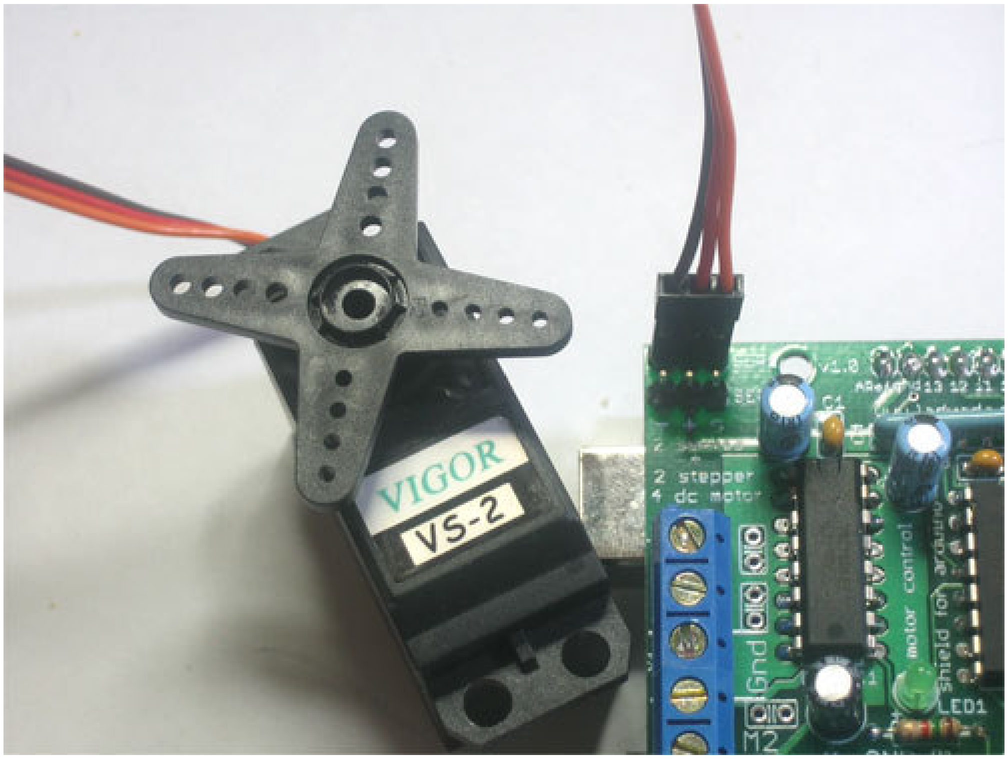


If you would like to have a **single DC power supply for the Arduino and motors**, simply plug it into the DC jack on the Arduino or the 2-pin PWR_EXT block on the shield. Place the power jumper on the motor shield.
If you have a Diecimila Arduino, set the Arduino power source jumper to EXT.
Note that you may have problems with Arduino resets if the battery supply is not able to provide constant power, and it is not a suggested way of powering your motor project

If you would like to have the **Arduino powered off of USB** and the **motors powered off of a DC power supply**, plug in the USB cable. Then connect the motor supply to the PWR_EXT block on the shield. Do not place the jumper on the shield. This is a suggested method of powering your motor project (If you have a Diecimila Arduino, don't forget to set the Arduino power jumper to USB. If you have a Diecimila, you can alternately do the following: plug the DC power supply into the Arduino, and place the jumper on the motor shield.)

If you would like to have **2 separate DC power supplies for the Arduino and motors**. Plug in the supply for the Arduino into the DC jack, and connect the motor supply to the PWR_EXT block. Make sure the jumper is removed from the motor shield. If you have a Diecimila Arduino, set the Arduino jumper to EXT. This is a suggested method of powering your motor project. Either way, if you want to use the DC motor/Stepper system the motor shield LED should be lit indicating good motor power

Servos



Hobby servo

Hobby servos are the easiest way to get going with motor control. They have a 3-pin 0.1" female header connection with +5V, ground and signal inputs. The motor shield simply brings out the 16bit PWM output lines to 2 3-pin headers so that it's easy to plug in and go. They can take a lot of power so a 9V battery won't last more than a few minutes!

The nice thing about using the onboard PWM is that it's very precise and goes about its business in the background. You can use the ServoTimer1 library as is

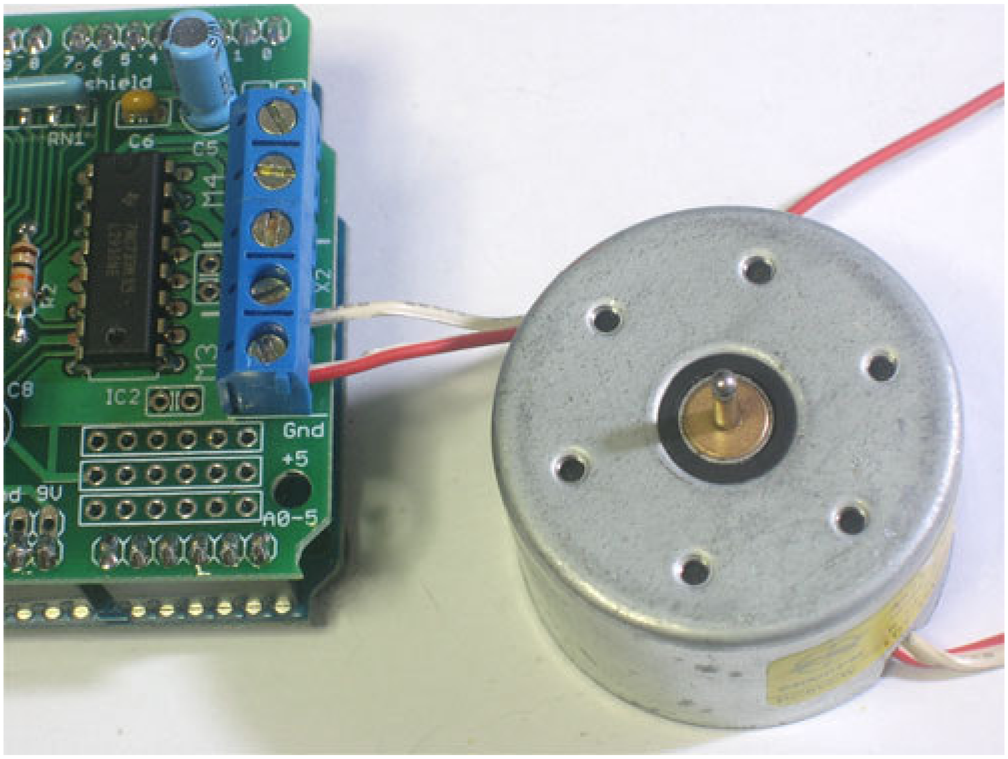
Using the servos is easy:

1. Install the ServoTimer1 library as indicated on its webpage
2. Make sure you include **<ServoTimer1.h>**
3. Create a **ServoTimer1** object for each servo you want (up to 2)
4. Attach the servos to pin 9 (servo A) or 10 (servo B) using **attach()**
5. Finally, when you want to set the position of the servo, simply use **write(ANGLE)** where **ANGLE** ranges from 0 to 180. 90 is "dead center" for position-servos and "not moving" for continuous-rotation servos.

```
#include <ServoTimer1.h>

ServoTimer1 servo1;
ServoTimer1 servo2;
```

```
void setup() {
  Serial.begin(9600);            //
set up Serial library at 9600 bps
  Serial.println("Servo test!");
  servo1.attach(10);
  servo2.attach(9);
}


void loop() {
  Serial.print("tick");
  servo1.write(180);
  servo2.write(0);
  delay(1000);

  Serial.print("tock");
  servo1.write(0);
  servo2.write(180);
  delay(1000);
}
```

DC Motors



DC motor

DC motors are used for all sort of robotic projects. The motor shield can drive up to 4 DC motors bi-directionally. That means they can be driven forwards and backwards. The speed can also be varied at 0.5% increments using the high-quality built in PWM. This means the speed is very smooth and won't vary!

Note that the H-bridge chip is not really meant for driving loads over 0.6A or that peak over 1.2A so this is for *small* motors. Check the datasheet for information about the motor to verify its OK.

To connect a motor, simply solder two wires to the terminals and then connect them to either the **M1, M2, M3,** or **M4**. Then follow these steps in your sketch

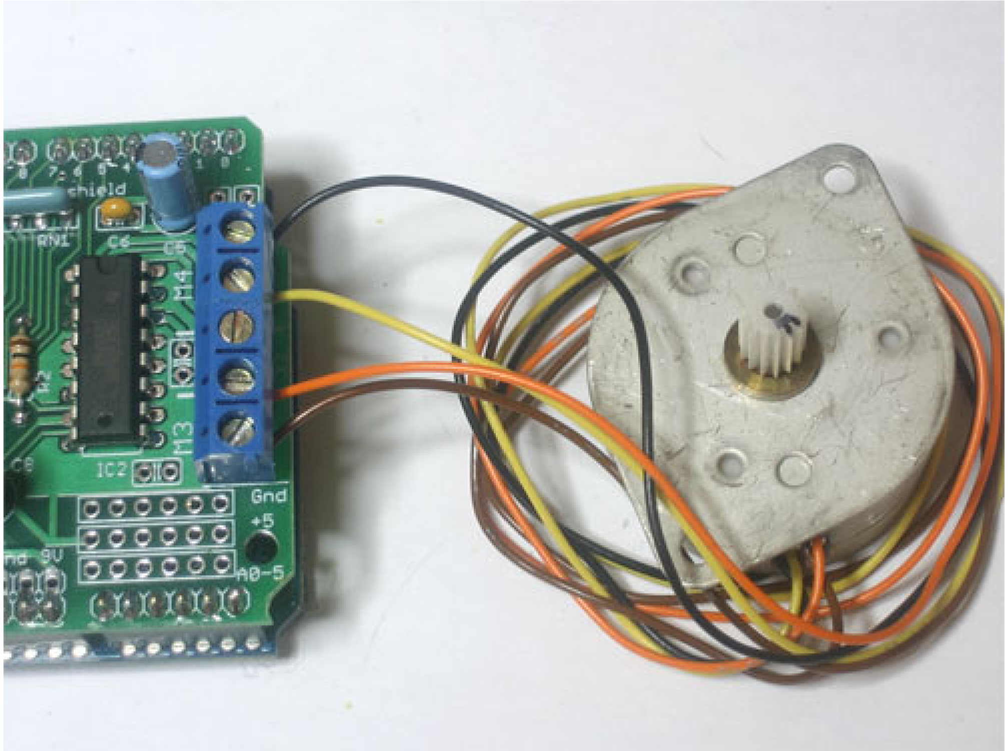
1. Make sure you include **<AFMotor.h>**
2. Create the AF_DCMotor object with **AF_DCMotor(*motor#, frequency*)**, to setup the motor H-bridge and latches. The constructor takes two arguments.

3. The first is which port the motor is connected to, **1, 2, 3** or **4**.
   frequency is how fast the speed controlling signal is.
4. For motors 1 and 2 you can choose **MOTOR12_64KHZ**, **MOTOR12_8KHZ**, **MOTOR12_2KHZ**, or **MOTOR12_1KHZ**. A high speed like 64KHz wont be audible but a low speed like 1KHz will use less power. Motors 3 & 4 are only possible to run at 1KHz and will ignore any setting given
5. Then you can set the speed of the motor using **setSpeed(*speed*)** where the ***speed*** ranges from 0 (stopped) to 255 (full speed). You can set the speed whenever you want.
6. To run the motor, call **run(*direction*)** where ***direction*** is **FORWARD**, **BACKWARD** or **RELEASE**. Of course, the Arduino doesn't actually know if the motor is 'forward' or

'backward', so if you want to change which way it thinks is forward, simply swap the two wires from the motor to the shield.

```
#include <AFMotor.h>


AF_DCMotor motor(2, MOTOR12_64KHZ);
// create motor #2, 64KHz pwm


void setup() {
  Serial.begin(9600);           //
set up Serial library at 9600 bps
  Serial.println("Motor test!");


  motor.setSpeed(200);     // set
the speed to 200/255
}


void loop() {
  Serial.print("tick");


  motor.run(FORWARD);      // turn
it on going forward
  delay(1000);


  Serial.print("tock");
  motor.run(BACKWARD);     // the
other way
  delay(1000);


  Serial.print("tack");
  motor.run(RELEASE);      //
stopped
  delay(1000);
}
```

Steppers



A bi-polar stepper motor - 4 wires

Stepper motors are great for (semi-)precise control, perfect for many robot and CNC projects. This motor shield supports up to 2 stepper motors. The library works identically for bi-polar and uni-polar motors

For unipolar motors: to connect up the stepper, first figure out which pins connected to which coil, and which pins are the center taps. If its a 5-wire motor then there will be 1 that is the center tap for both coils. There's plenty of tutorials online on how to reverse engineer the coils pinout. The center taps should both be connected together to the GND terminal on the motor shield output block. then coil 1 should connect to one motor port (say M1 or M3) and coil 2 should connect to the other motor port (M2 or M4).

For bipolar motors: its just like unipolar motors except there's no 5th wire to connect to ground. The code is exactly the same.

Running a stepper is a little more intricate than running a DC motor but its still very easy

1. Make sure you include **<AFMotor.h>**
2. Create the stepper motor object with **AF_Stepper(*steps*, *stepper#*)** to setup the motor H-bridge and latches. ***Steps*** indicates how many steps per revolution the motor has. a 7.5degree/step motor has 360/7.5 = 48 steps. ***Stepper#*** is which port it is connected to. If you're using M1 and M2, its port 1. If you're using M3 and M4 its port 2
3. Set the speed of the motor using **setSpeed(*rpm*)** where ***rpm*** is how many revolutions per minute you want the stepper to turn.

4. Then every time you want the motor to move, call the **step(*#steps*, *direction*, *steptype*)** procedure. ***#steps*** is how many steps you'd like it to take**.** ***direction*** is either **FORWARD** or **BACKWARD** and the step type is **SINGLE, DOUBLE. INTERLEAVE** or **MICROSTEP**. "Single" means single-coil activation, "double" means 2 coils are activated at once (for higher torque) and "interleave" means that it alternates between single and double to get twice the resolution (but of course its half the speed). "Microstepping" is a method where the coils are PWM'd to create smooth motion between steps. There's tons of information about the pros and cons of these different stepping methods in the resources page. You can use whichever stepping method you want, changing it "on the fly" to as you may want minimum power, more torque, or more precision.
5. By default, the motor will 'hold' the position after its done stepping. If you want to release all the coils, so that it can spin freely, call **release()**
6. The stepping commands are 'blocking' and will return once the steps have finished. If someone wants to be awesome and write a version of the library that does background stepping that would be cool! :)

```
#include <AFMotor.h>


AF_Stepper motor(48, 2);


void setup() {
  Serial.begin(9600);           //
set up Serial library at 9600 bps
  Serial.println("Stepper test!");

  motor.setSpeed(10);  // 10 rpm

  motor.step(100, FORWARD, SINGLE);
  motor.release();
  delay(1000);
}

void loop() {
  motor.step(100, FORWARD, SINGLE);
  motor.step(100, BACKWARD,
SINGLE);

  motor.step(100, FORWARD, DOUBLE);
  motor.step(100, BACKWARD,
DOUBLE);

  motor.step(100, FORWARD,
INTERLEAVE);
  motor.step(100, BACKWARD,
INTERLEAVE);
```

```
  motor.step(100, FORWARD,
MICROSTEP);
  motor.step(100, BACKWARD,
MICROSTEP);
}
```

If you want two stepper motors to step at once you'll need to write something like this:

```
void doublestep (int steps, int
direction, int style) {
  while (steps--) {
    motor1.step(1, direction,
style);
    motor2.step(1, direction,
style);
  }
}
```