DC Motor

A DC motor is a motor that utilizes a constant polarity power source to produce mechanical work.
All this means is that you can connect it to a simple DC power source such as a battery to power it. This means no complex driving circuitry is needed, as most robots are powered by batteries.

Before we get into how you can use these motors in your project, we will take a look at how these are constructed and how they work internally.

Internal Construction and Working Principle

< Embed GIF:
https://en.wikipedia.org/wiki/File:Ejs_Open_Source_Direct_Current_Electrical_Motor_Model_Java_Applet_(_DC_Motor_)_80_degree_split_ring.gif >

A simple DC motor consists of a coil of conductors within the field of a pair of permanent magnets. The end terminals of the coil are electrically connected to a pair of split rings, also called commutators. This ensures that the direction of current switches direction every half cycle, so that the coils keep rotating in the same direction.

We know a current carrying conductor placed in an external magnetic field experiences a force. This force is what causes the shaft of the motor to rotate.

The commutator is the key component that lets this kind of motor to be powered by a DC source rather than an AC source.

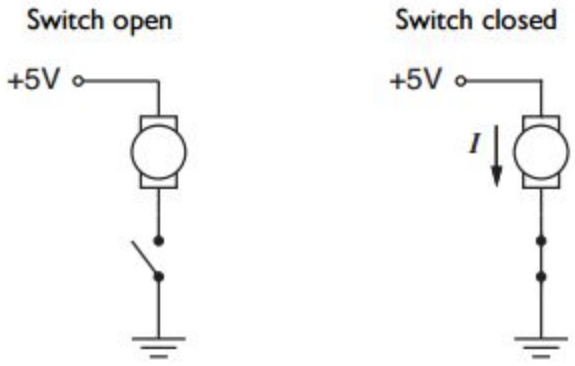
Powering a DC Motor

As you may have noticed, this motor is a two terminal device. But there is no polarity indication. So how do you know in which way to connect the battery or whatever power source you're using?

Take a closer look at the construction. Reversing the polarity just reverses the direction of the force, and therefore the direction of rotation. So you can connect the battery whatever way you want. If you want the motor to rotate the other way, just reverse the polarity. Pretty easy, eh?

The Simple Deal

So the simplest circuit for such a motor is to connect the motor to a battery with a switch in series, so that we can switch it on an off.



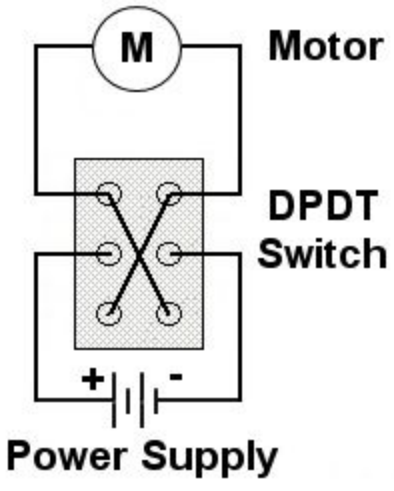
The Bi-directional Switch Circuit, a.k.a., DPDT Circuit

“But wait, what if I want to control the direction of rotation of the motor with a switch too?”

There’s a solution for this too, and it’s called a DPDT switch, or Double Pole Double Throw switch.

We recommend you take a look at how a DPDT switch works in the switches tutorial before proceeding.

The circuit diagram is as follows:



Try to follow the direction of the current. It flows in opposite directions in the two positions of the switch. Now we can change the direction of rotation too. Yaay!

Interfacing with microcontrollers

Now you can control the motor using switches. But what if you want to use this in a microcontroller based project?

You could try to power the motor directly from a microcontroller(MCU) output pin.

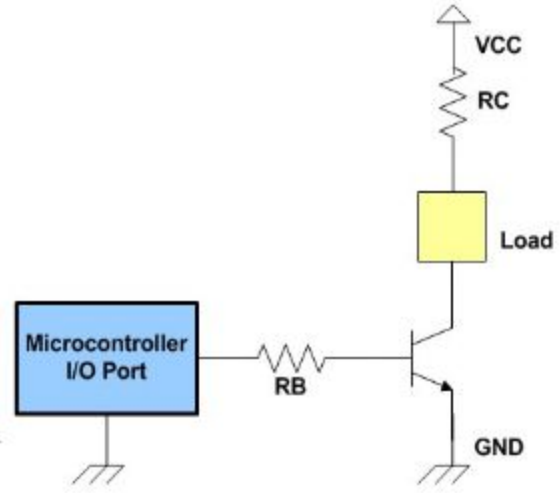
There are two problems with this approach:

- Most motors used in robotics are usually rated at 9V or 12V or more.
- MCU pins can source no more than a few milliamperes of current

This means that the motor won't get enough power, so will rotate slowly, or not work at all.

The Transistor Approach

To overcome this power limitation, we might use transistors as switches. The base of an npn transistor may be connected to an output pin of a MCU. When the output is high, the transistor conducts, allowing the motor to work at full operational power. When the output is low, the transistor stops conducting, and hence the motor stops. MOSFETs may also be used for this purpose.



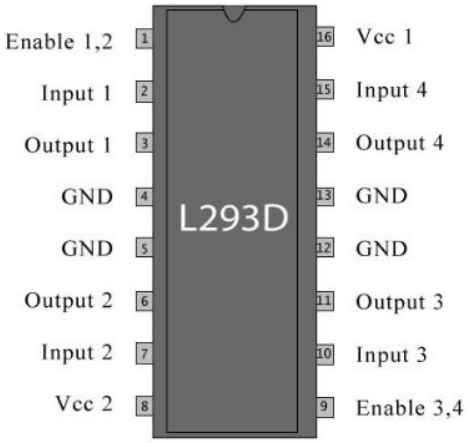
The value of RB is dependent on the exact application, but 500 to a 1000 ohm would be a safe starting point. RC may be omitted if VCC is less than 12V.

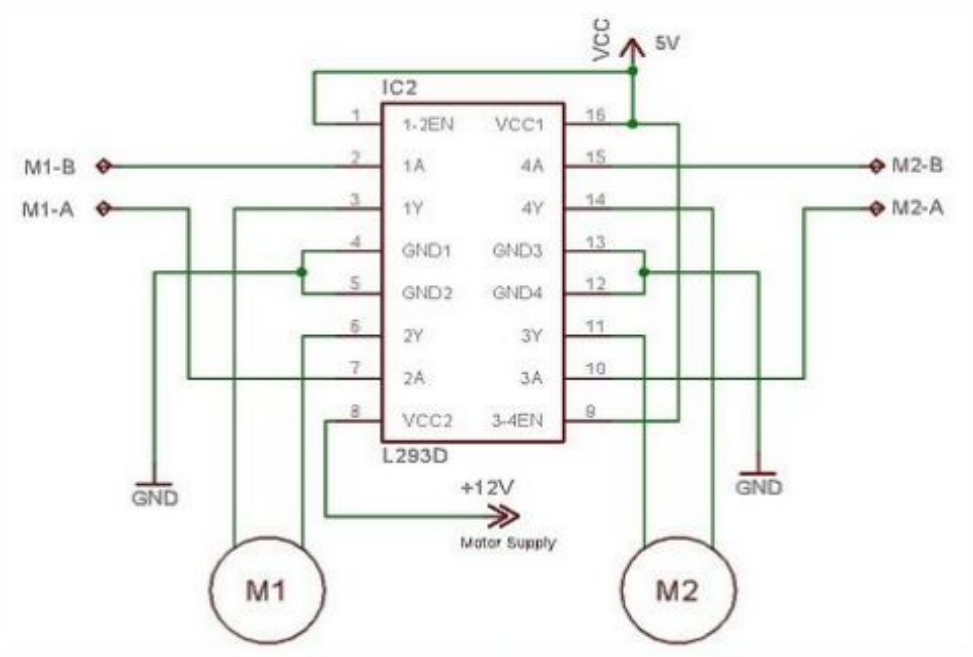
The downside to using this method is the motor only rotates in one direction.

The solution?

The Motor Driver IC setup

It's called an H Bridge motor driver circuit. Fancy nomenclature aside, this circuit is available as a common IC, the L293D.





Truth Table

A	B	Description
0	0	Motor stops
0	1	Motor runs clockwise
1	0	Motor runs anti-clockwise
1	1	Motor stops

Ending Notes

Flyback diode

In some sources, you might find a diode in parallel to the motor. This diode is a protection diode, known as a ‘flyback’ diode. Because a motor is an inductive load, when the current stops flowing, the inductive effect causes a large backwards EMF. This could fry sensitive electronics such as a transistor or a microcontroller.

Speed Control

If you want to control the speed of rotation of the motor, one way is to use a potentiometer in series with the motor. Adjusting the potentiometer will set the speed. A 100ohm potentiometer will work fine.

If the speed control needs to be done in a microcontroller in software, a PWM method may be applied. Check out more here:

< PWM tutorial link here >