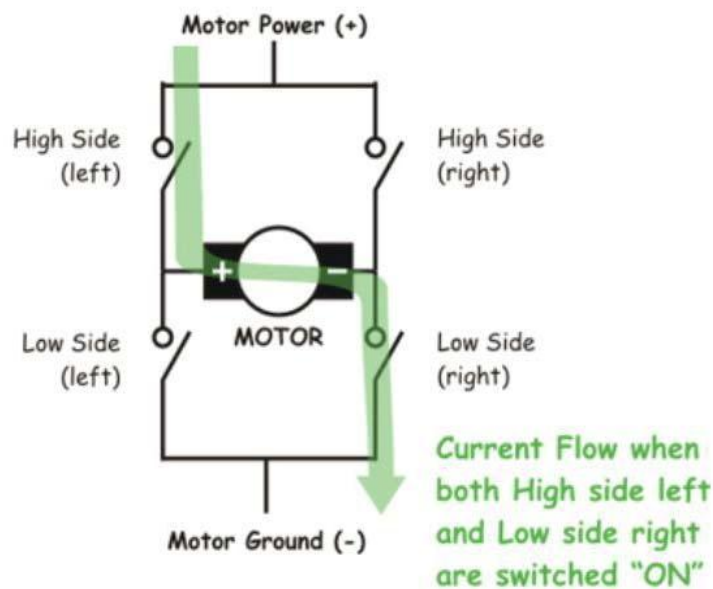# MOTOR DRIVER / H-BRIDGE

Whenever we are talking about driving a motor through the outputs of our microcontroller, it is not easy to do that work. This is so because our motors specification tells to drive it on 12v dc but our microcontroller can give a max of 5v. So to drive a motor we need some drivers which can amplify the 5v voltage to 12v. . These days many IC manufacturers have H-bridge motor driver available in the market like L293D is most used H- Bridge driver IC. H-bridge can also be made with the help of transistors and MOSFETs etc. rather of being cheap, they only increase the size of the design board, which is sometimes not required so using a small 16 pin IC is preferred for this purpose. The driver which we are using here to drive the motor is an IC L293D.

**WORKING THEORY OF H-BRIDGE**

The name "H-Bridge" is derived from the actual shape of the switching circuit which controls the motion of the motor. It is also known as "Full Bridge". Basically there are four switching elements in the H-Bridge as shown in the figure below.
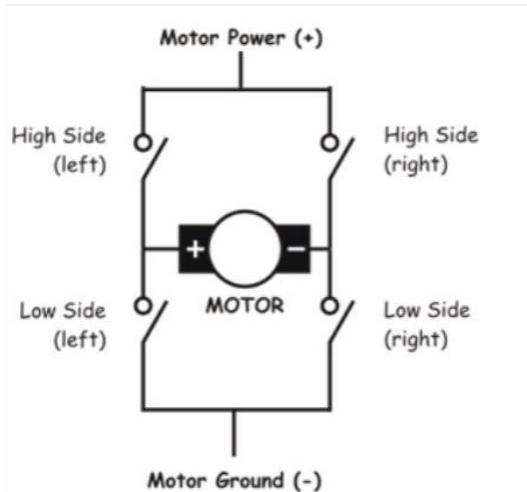


As you can see in the figure above there are four switching elements named as "High side left", "High side right", "Low side right", "Low side left". When these switches are turned on in pairs motor changes its direction accordingly. Like, if we switch on High side left and Low side right then motor rotate in forward direction, as current flows from P\power supply through the motor coil goes to ground via switch low side right. This is shown in the figure below.

Motor Power (+)

High Side (left)

High Side (right)

Low Side (left)

MOTOR

Low Side (right)

Motor Ground (-)

Current Flow when both High side left and Low side right are switched "ON"

Similarly, when you switch on low side left and high side right, the current flows in opposite direction and motor rotates in backward direction. This is the basic working of H-Bridge. We can also make a small truth table according to the switching of H-Bridge explained above.
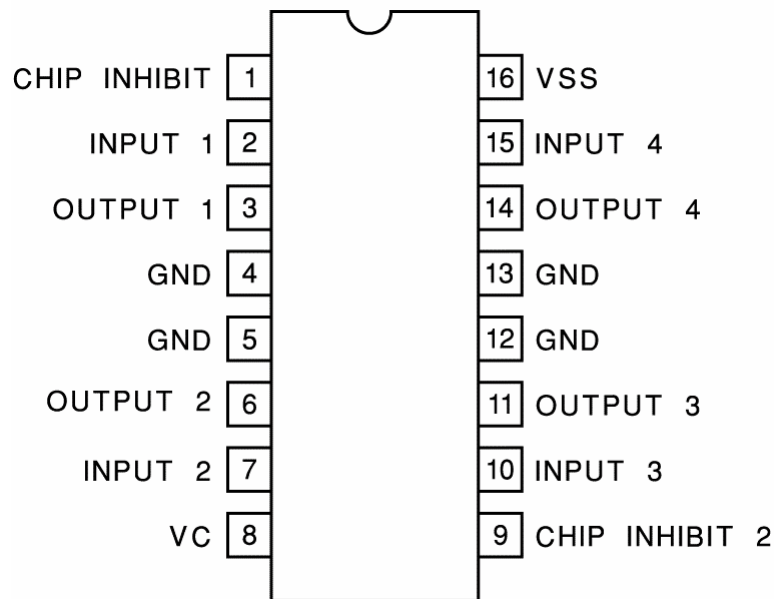
| Truth Table | | | | |
|---|---|---|---|---|
| High Left | High Right | Low Left | Low Right | Description |
| On | Off | Off | On | Motor runs clockwise |
| Off | On | On | Off | Motor runs anti-clockwise |
| On | On | Off | Off | Motor stops or decelerates |
| Off | Off | On | On | Motor stops or decelerates |

As already said, H-bridge can be made with the help of transistors as well as MOSFETs; the only thing is the power handling capacity of the circuit. If motors are needed to run with high current then lot of dissipation is there. So head sinks are needed to cool the circuit.

Now you might be thinking why I did not discuss the cases like High side left on and Low side left on or high side right on and low side right on. Clearly seen in the diagram, you don't want to burn your power supply by shorting them. So that is why those combinations are not discussed in the truth table.

So we have seen that using simple switching elements we can make our own H-Bridge, or other option we have is using an IC based H-bridge driver.

### ▶L293D Dual H-Bridge Motor Driver

| | | | | |
|---|---|---|---|---|
| CHIP INHIBIT | 1 | | 16 | VSS |
| INPUT 1 | 2 | | 15 | INPUT 4 |
| OUTPUT 1 | 3 | | 14 | OUTPUT 4 |
| GND | 4 | | 13 | GND |
| GND | 5 | | 12 | GND |
| OUTPUT 2 | 6 | | 11 | OUTPUT 3 |
| INPUT 2 | 7 | | 10 | INPUT 3 |
| VC | 8 | | 9 | CHIP INHIBIT 2 |

L293D is a dual H-Bridge motor driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion. You can make use of all the four I/Os to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF, output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver.

A simple schematic for interfacing a DC motor using L293D is shown below.
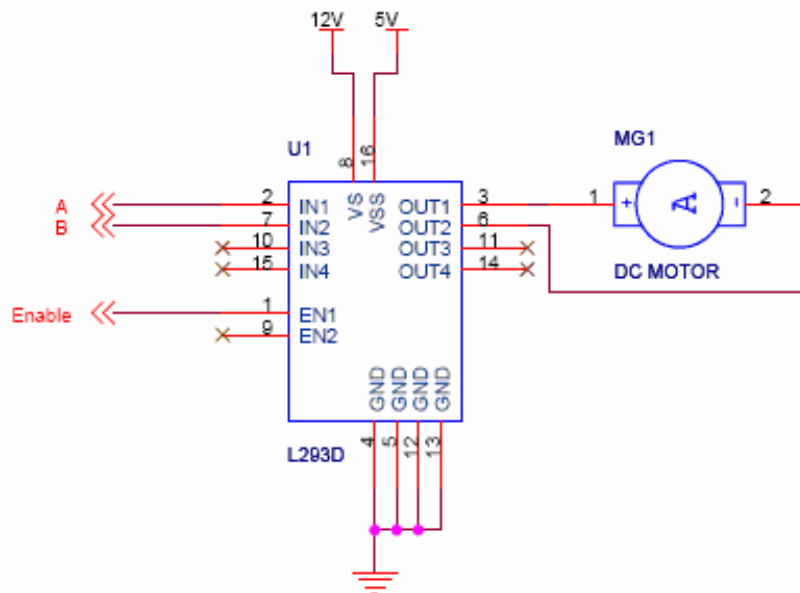


Truth Table

| A | B | Description |
|---|---|-------------|
| 0 | 0 | Motor stops or Breaks |
| 0 | 1 | Motor Runs Anti-Cloclwise |
| 1 | 0 | Motor Runs Clockwise |
| 1 | 1 | Motor Stops or Breaks |

For above truth table, the Enable has to be Set (1). Motor Power is mentioned 12V, but you can connect power according to your motors.

As you can see in the circuit, three pins are needed for interfacing a DC motor (A, B, Enable). If you want the o/p to be enabled completely then you can connect Enable to VCC and only 2 pins needed from controller to make the motor work.

As per the truth mentioned in the image above it's fairly simple to program the microcontroller. It's also clear from the truth table of BJT circuit and L293D the programming will be same for both of them, just keeping in mind the allowed combinations of A and B.