Motor Types—DC Motors

A DC Motor

A motor converts electrical energy into rotational kinetic energy.

Advantages
- Simple to control
- High speed
- Range of powers and voltages

Disadvantages
- Relatively inefficient (approx 75%)
- High inertia (doesn't stop straight away)
- Accurate position control is difficult – requires a closed loop system
- Speed affected changes with load
- Low torque—usually needs gearing

Inside a high power motor

Motor Types—Stepper Motors

A stepper motors are found in equipment where very high accuracy and small movements are required. They can be found in disc drives, printers and CAM machines. They are able to move in discrete steps of several degrees at a time.

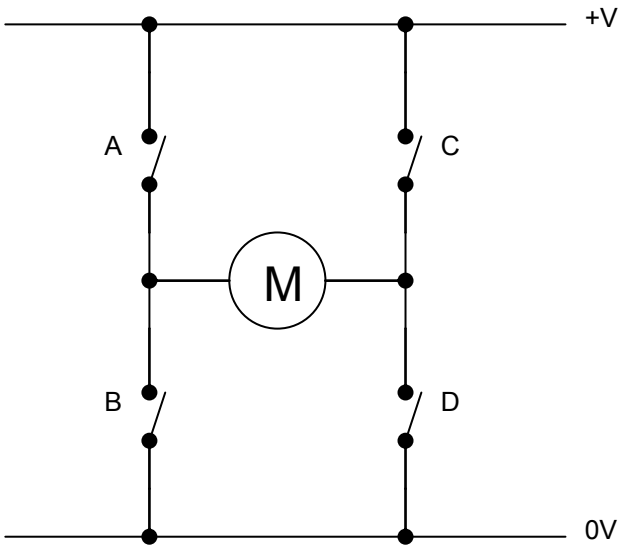
A stepper motor

Advantages
- Can accurately control position
- Can accurately control speed
- Can change direction
- High torque
- Position of shaft can be locked in place
- Low inertia

Disadvantages
- Expensive
- More difficult to control than DC Motors
- Limited speed

H-Bridge Circuit

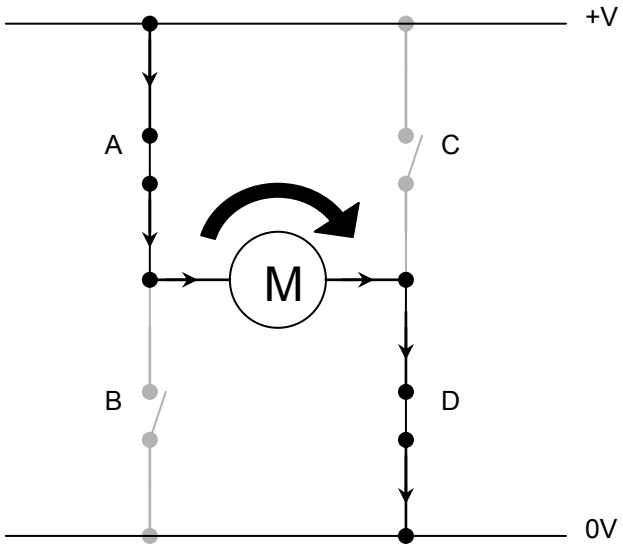
A H-Bridge circuit allows the direction of a motor to be controlled by controlling the direction of current flowing through it. The circuit shown allows uses four SPST switches.



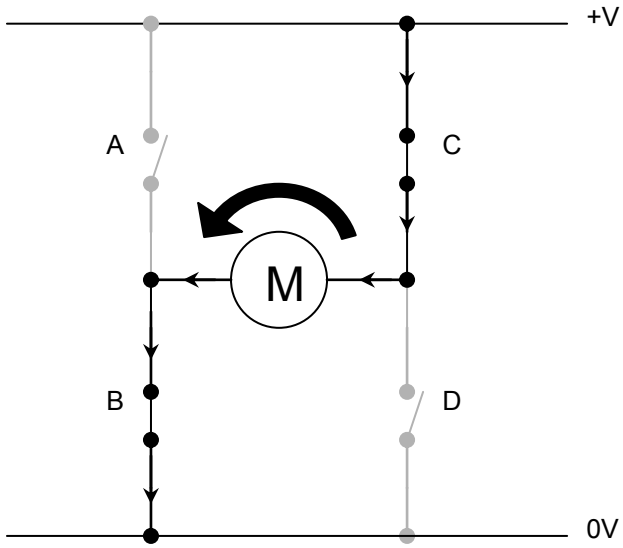
A	B	C	D	Motor
OFF	OFF	OFF	OFF	Off
ON	OFF	OFF	ON	Clockwise
OFF	ON	ON	OFF	Anti-clockwise
ON	*ON*	*ON*	*ON*	*Not Allowed*
OFF	*ON*	*OFF*	*ON*	*Brake*

How it works

The circuits below show how the switches can be set to control the direction of the motor:



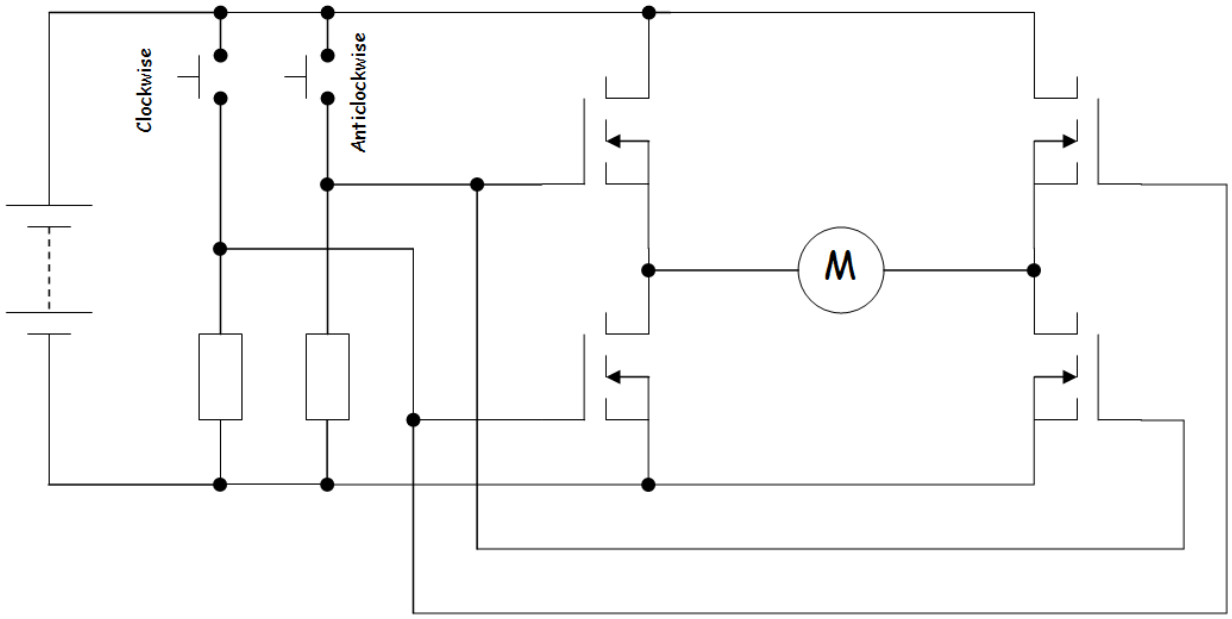
A&D closed—Clockwise



B&C closed—anticlockwise

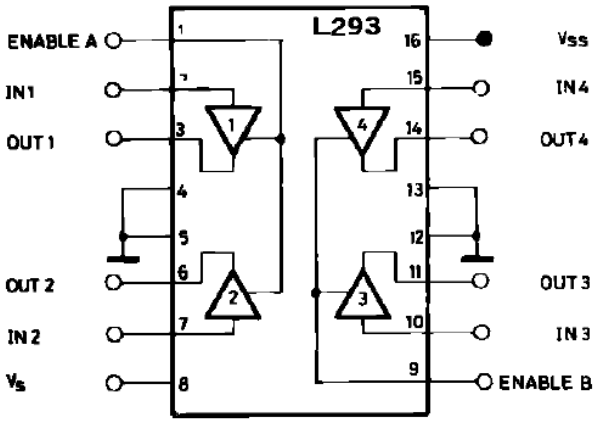
FET H-Bridge Circuit

The circuit shown below allows the direction of the motor to be controlled by two PTM switches:



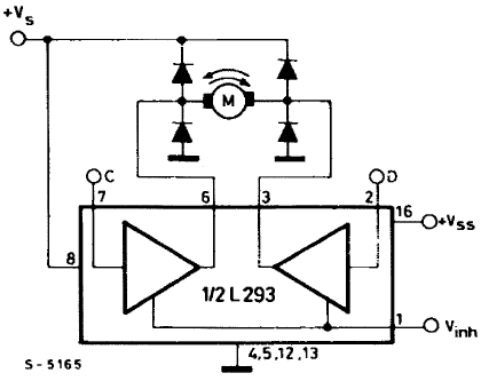
L293 Driver IC

This IC contains two half-H bridge driver circuits. It can be used to control the direction of a motor as well as being able to drive a motor in one direction. Vss is the power supply that connects to the same voltage as the circuit controlling it. Vs can be a larger voltage allowing the driving of higher power loads. The ENABLE inputs must be high in order to activate the outputs. When they are low the outputs will be switched off irrespective of the control inputs.



L293 H-Driver

The circuit to the right shows half of the IC being used to control the direction of a single motor. The outputs are controlled as shown below:

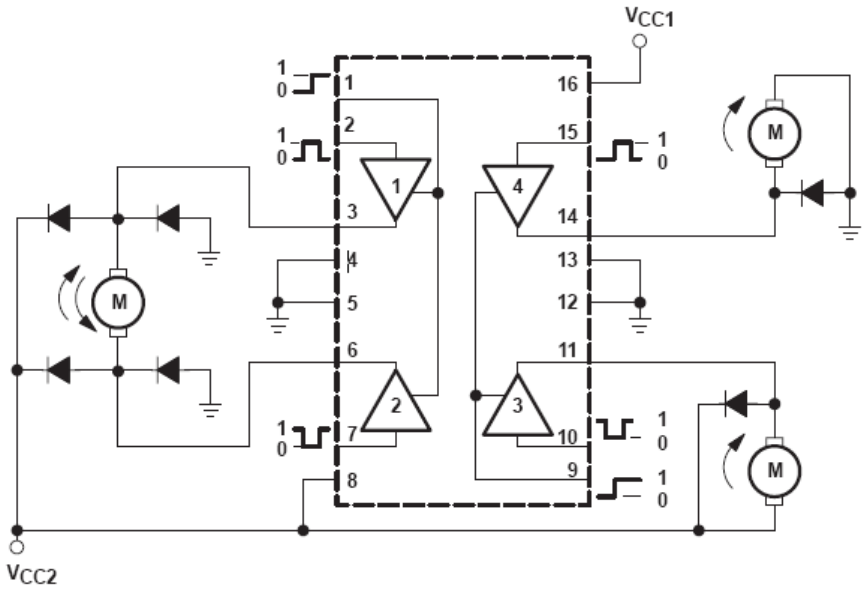


Controlling the direction of a motor

Input C	Input D	Motor
0	0	Off
0	1	Anti-Clockwise
1	0	Clockwise
1	1	Off

L293 Controlling three motors

The circuit shown here allows three motors to be controlled. One motor's direction can be controlled whereas the other can only be switched on or off. This circuit can be modified to control four motors uni-directionally or two motors bi-directionally.



L293 Controlling three motors

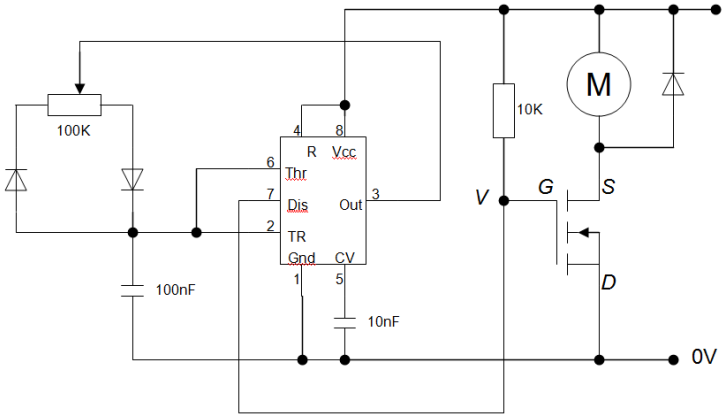
Protection Diodes

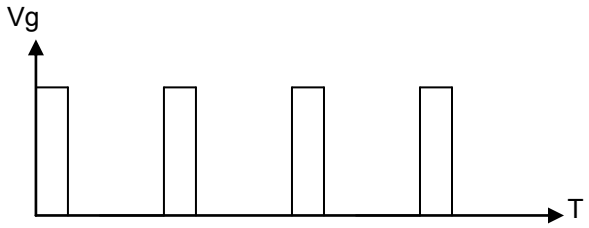
As discovered in earlier studies transistors need to be protected from back-emf from inductive loads. The diodes shown on this diagram are for this purpose. Although they appear on the outside of the IC they are in fact built in.

Pulse Width Modulation Speed control

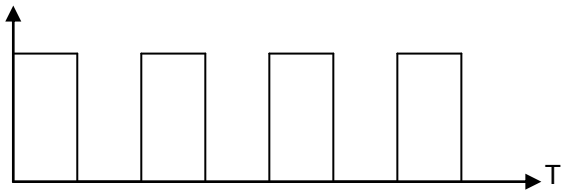
It is possible to control the speed of a motor by simply limiting the current flowing through it. This could be done very easily using a resistor in series with the motor, unfortunately this is highly inefficient and will affect the torque of the motor.

The circuit shows a PWM circuit based on a 555 Timer IC. The circuit produces pulses of power to the motor depending on the position of the potentiometer. The length of the pulses determines the speed of the motor: the longer the pulse the faster the motor spins.

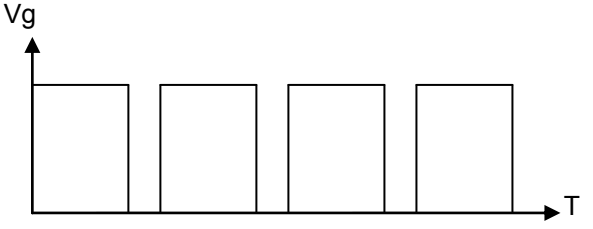




Mark/Space ration = 1:4
Motor runs at 1/4 speed



Mark/Space ration = 1:2
Motor runs at 1/2 speed



Mark/Space ration = 3:4
Motor runs at 3/4 speed