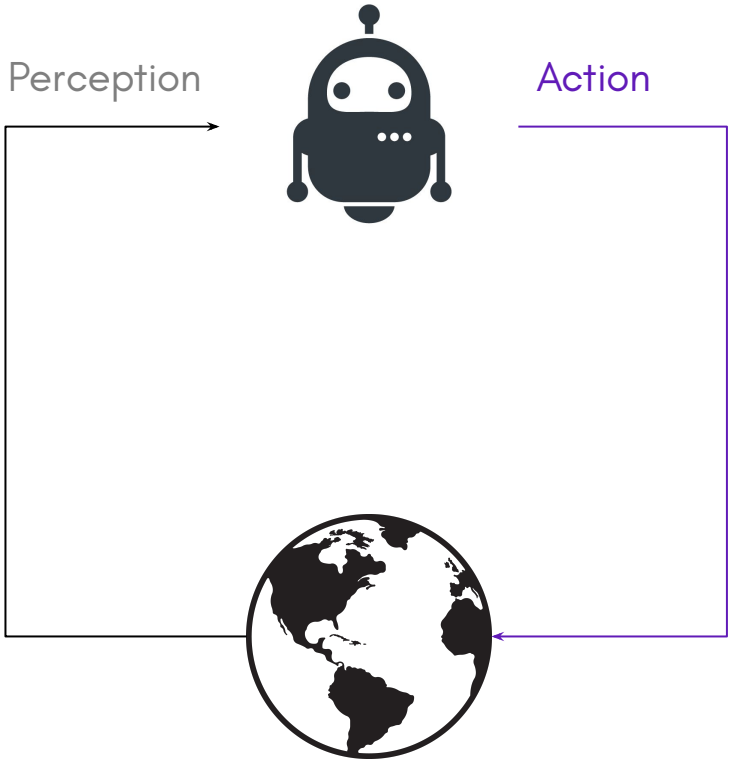
ENGR 3421: Robotics I

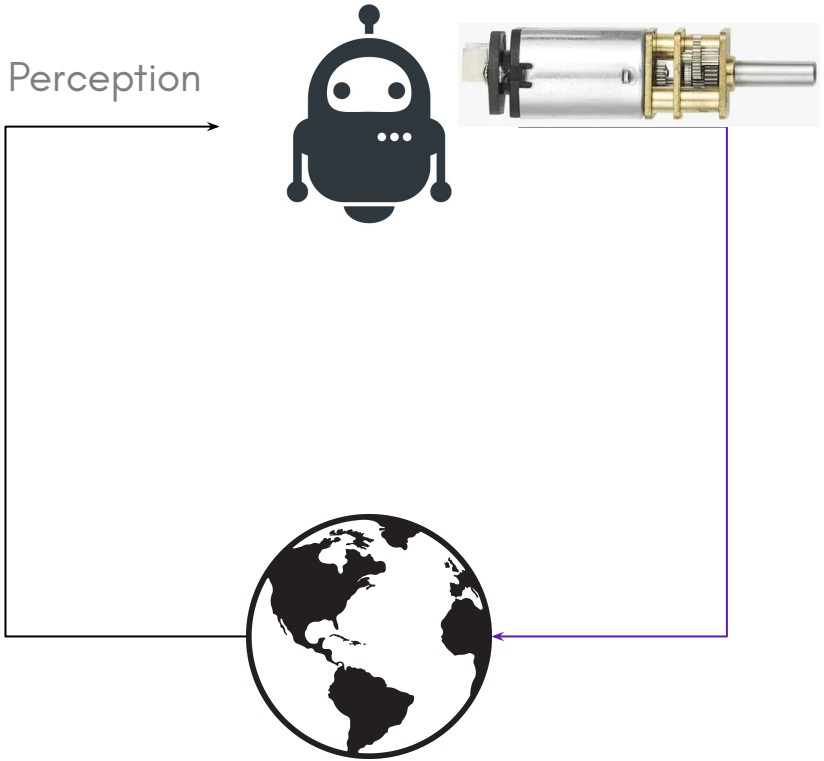
Motor Spin-Up

09/09/2025

A Robot Needs to Move



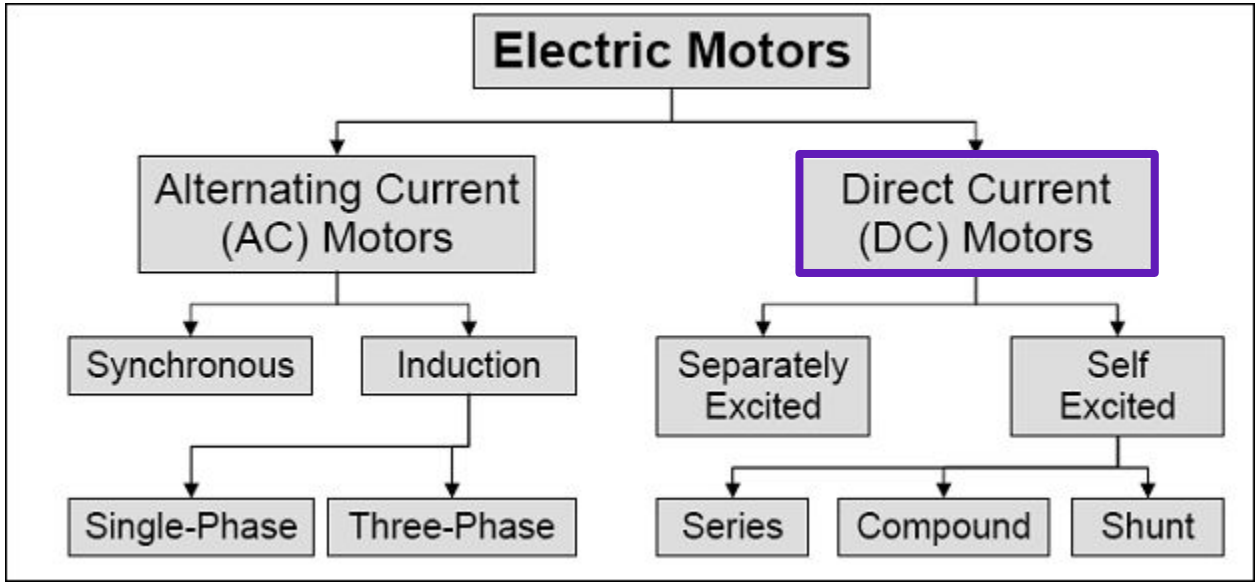
A Robot Needs a Actuator to Move



Actuators

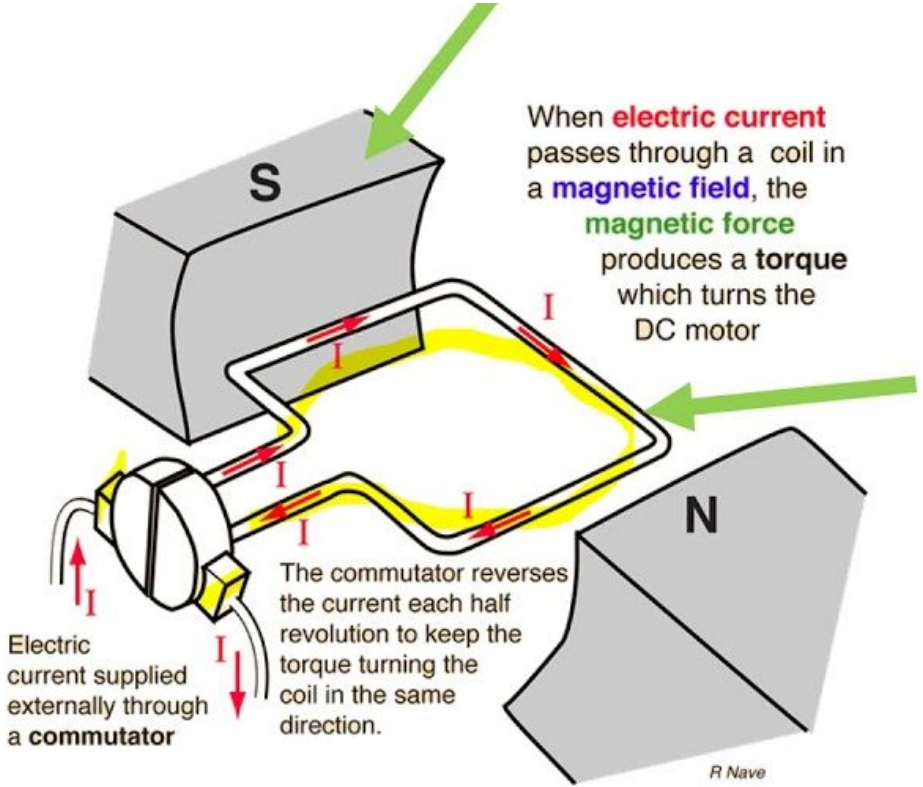
- Electric Motors
- Gasoline Engines
- Hydraulic Actuators
- Pneumatic Actuators
- Solenoids
- Artificial Muscles
- ...

Types of Motors



DC Motors

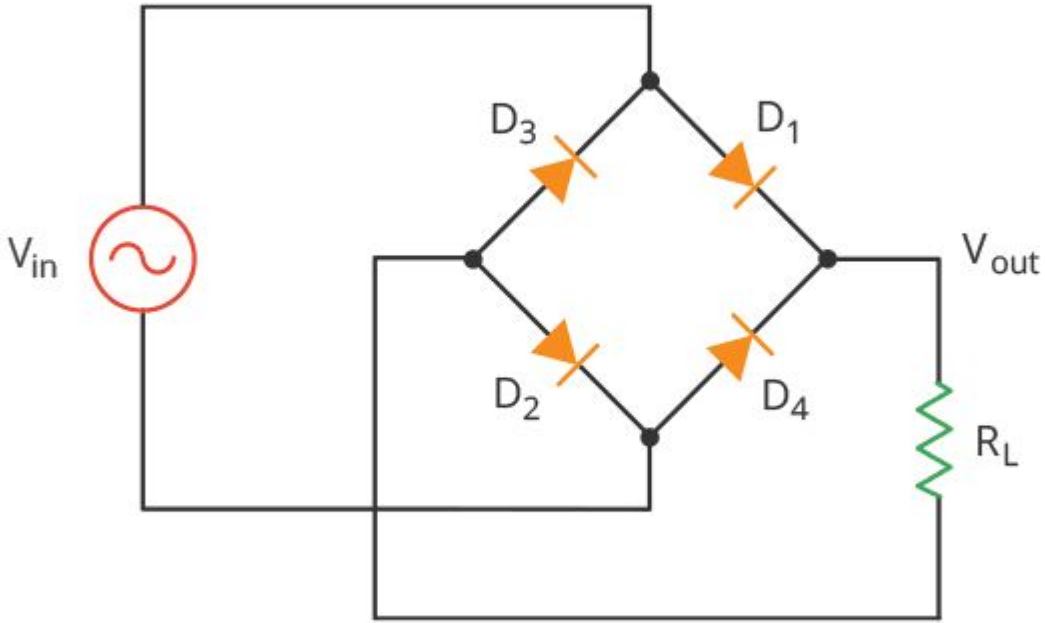
How does a DC Motor Work



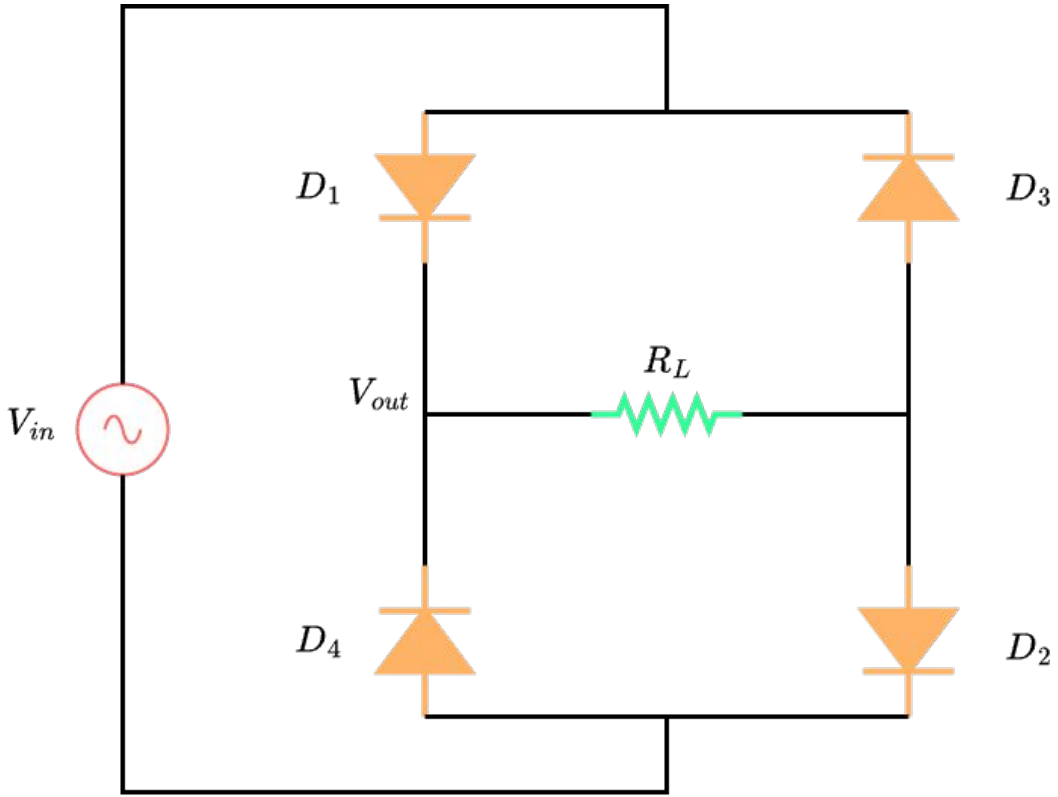
N20/Micro Gearmotor

Gear ratio:	**100:1**
Rated Speed @ 6V:	120 rpm
Rated Current @ 6V:	0.155 A
Stall current @ 6V:	**0.55 A**
Stall torque @ 6V:	1.75 kg·cm
Rated Speed:	120 rpm
Rated Current:	0.155 A
Operating Voltage :	**1.5 to 12 V**

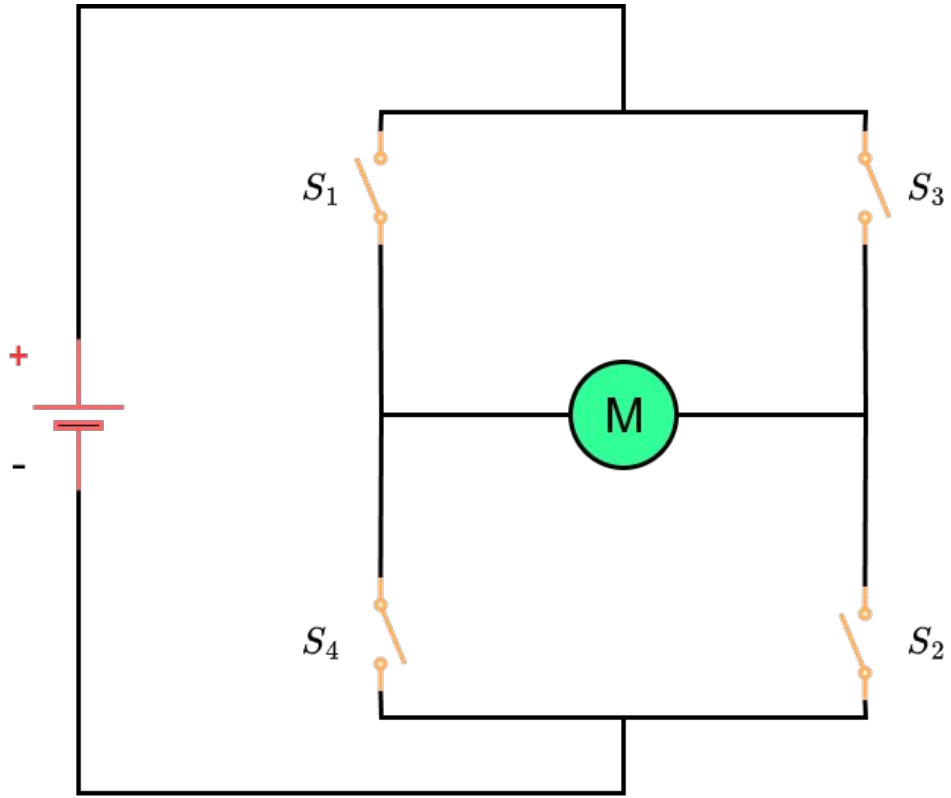
Full-Bridge Rectifier (Electronics Review)



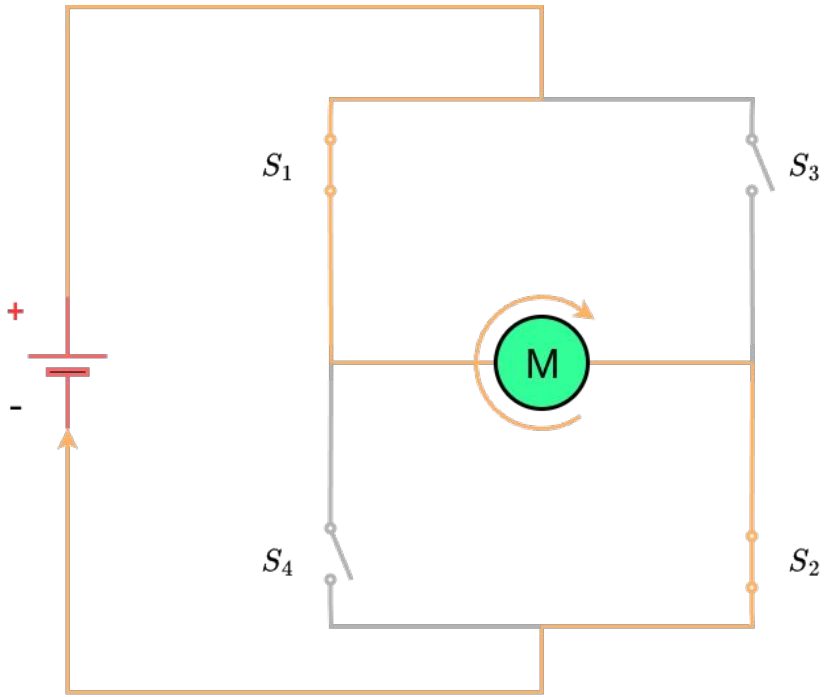
H-Bridge Rectifier (Full-Bridge Equivalent)

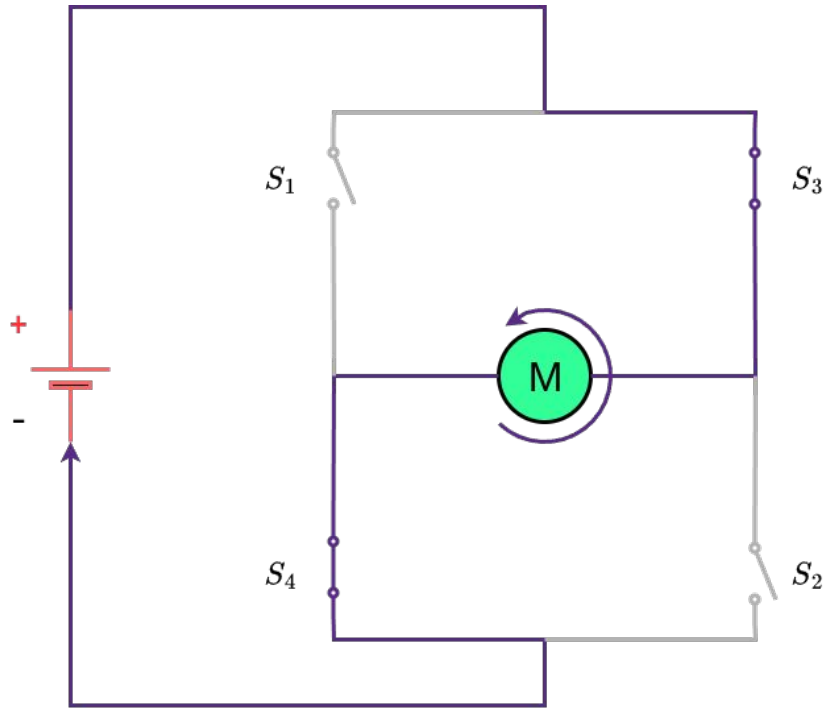


H-bridge Motor Driver

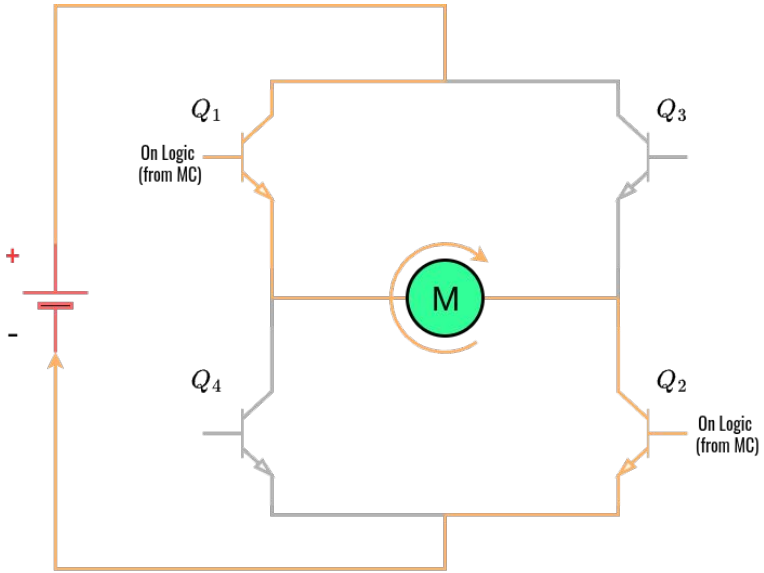


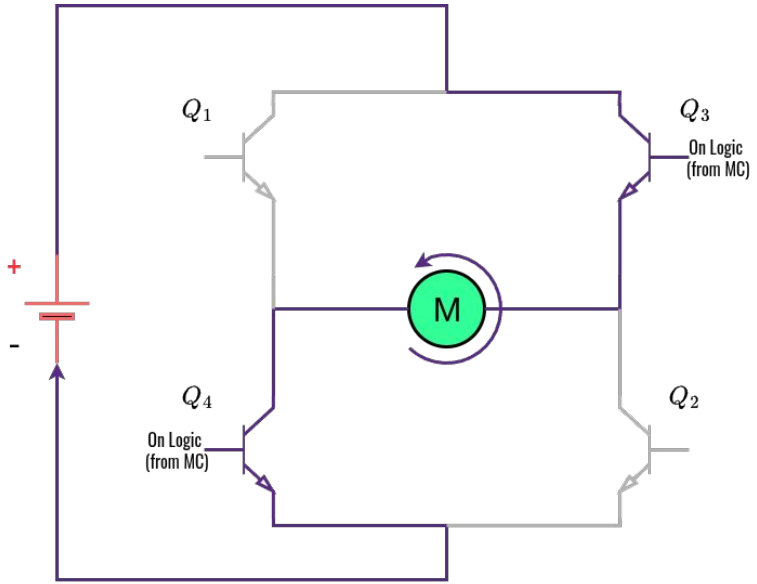
H-bridge Driving Circuit





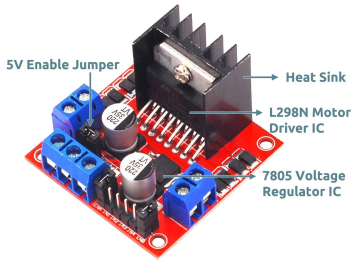
Transistor H-bridge



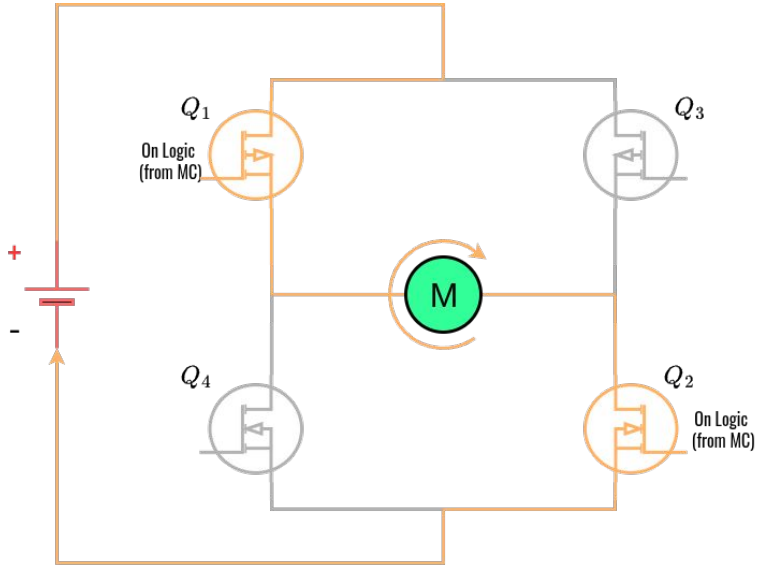


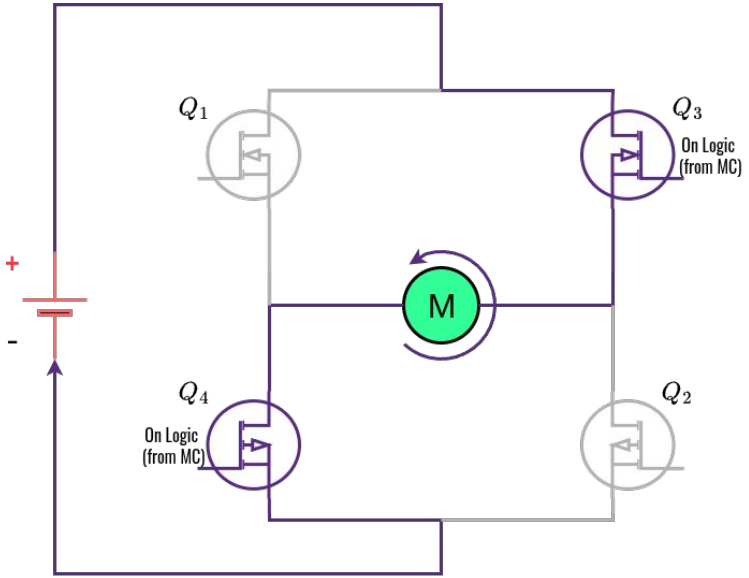
Example: L298N

- Transistors voltage drop = 0.7 V
- Total drop = 1.4 V



MOSFET H-bridge

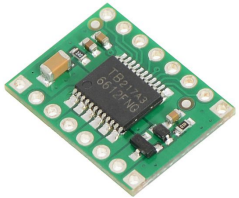




Example: TB6612FNG

- MOSFET voltage drop = 0.1 V
- Total drop = 0.2 V

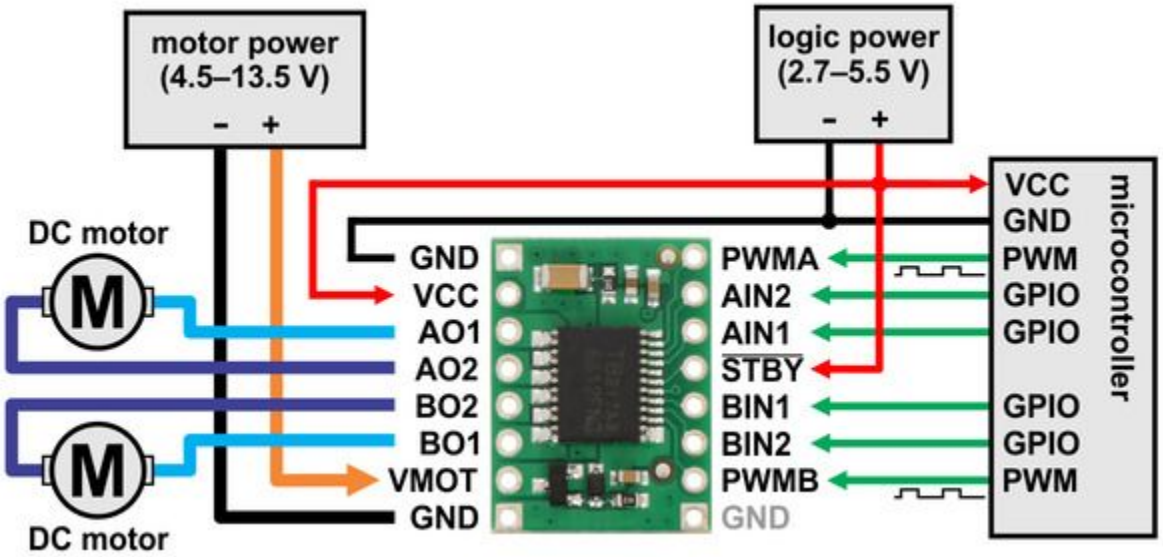
Pololu TB6612FNG Dual Motor Driver Carrier



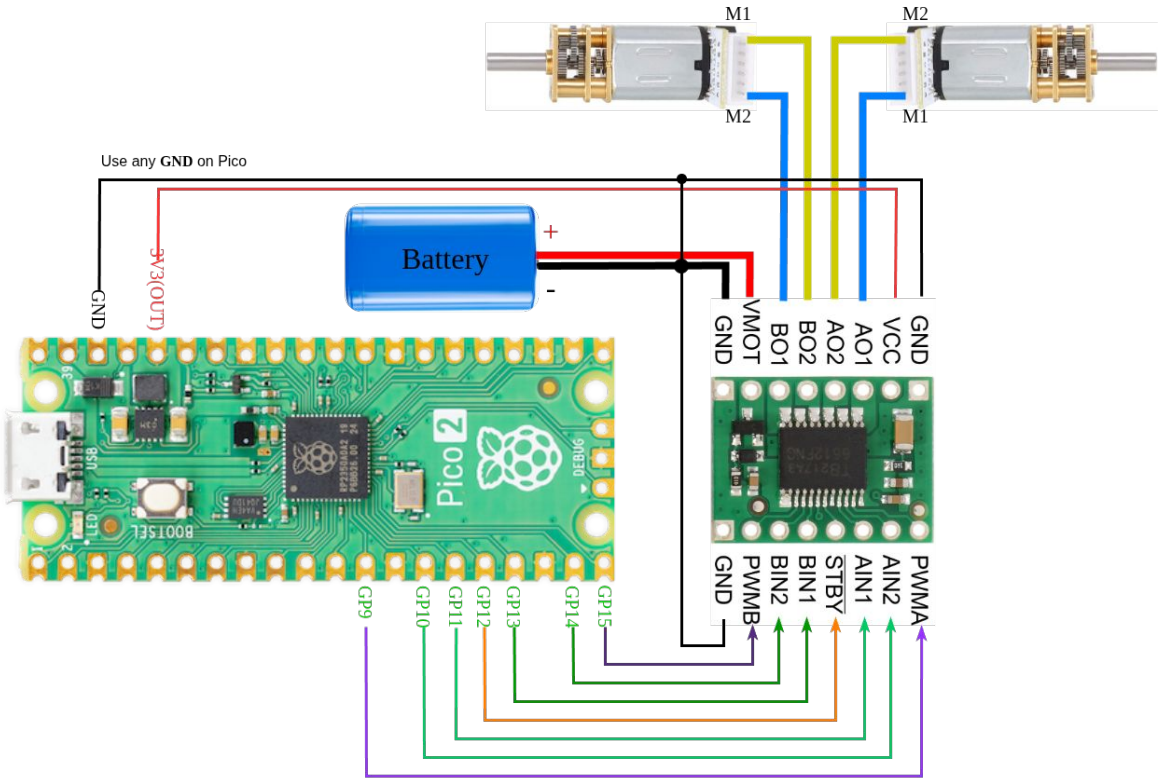
Stall current @ 6V	0.55 A
Operating Voltage	1.5 to 12 V

Number of H-Bridge	2
Motor Voltage	4.5 V to 13.5 V
Logic Voltage	2.7 V to 5.5 V
Output current continuous	1 A / channel
Output current maximum	3 A / channel
Features	Built-in thermal shutdown circuit; Reverse-power protection.

Motor Driver Wiring (General)



Motor Driver Wiring (Pico)



```
from machine import Pin, PWM
from time import sleep

# SETUP
pwm = PWM(Pin(9))
pwm.freq(1000)
in1 = Pin(10, Pin.OUT)
in2 = Pin(11, Pin.OUT)
stby = Pin(12, Pin.OUT)
stby.off()

# LOOP
stby.on()
print("motor driver enabled")
in1.off()
in2.on()
pwm.duty_u16(50_000)
print("forward")
sleep(2)
pwm.duty_u16(0)
print("stop")
sleep(1)
in1.on()
in2.off()
pwm.duty_u16(50_000)
print("backward")
sleep(2)
pwm.duty_u16(0)
print("stop")
sleep(1)
stby.off()
print("motor driver disabled")
```

Can you tune motor speed?

Can you drive both motors?