ENGR 3421:Robotics I

Motors Spin-Up

09/05/2023

Outline

- DC Motor
- Servo Motor
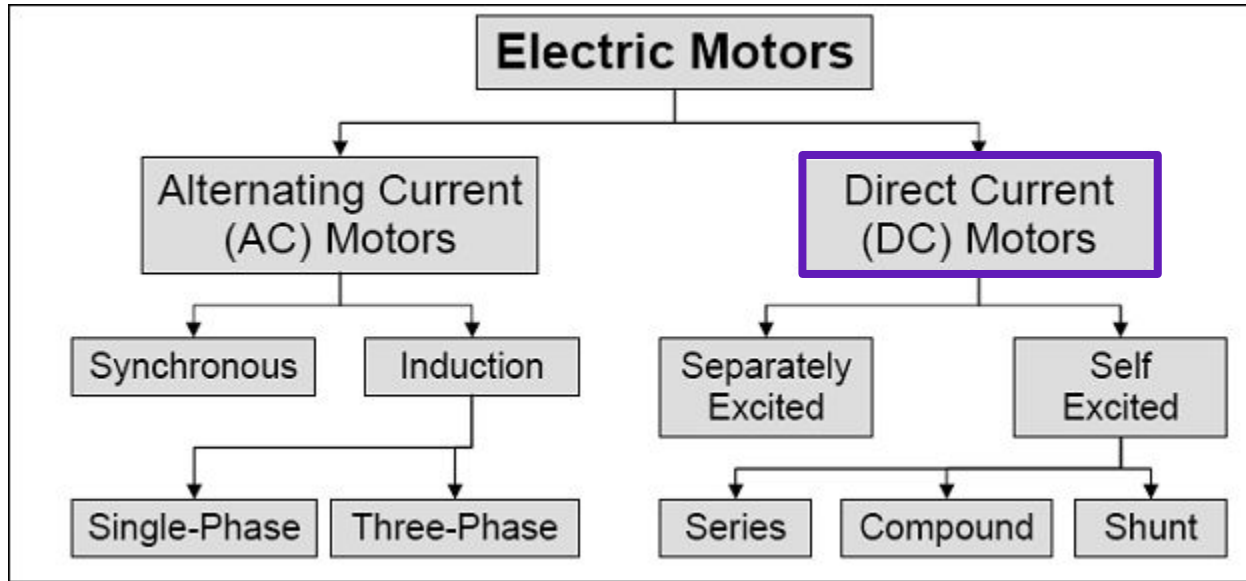
A Robot Needs to Move
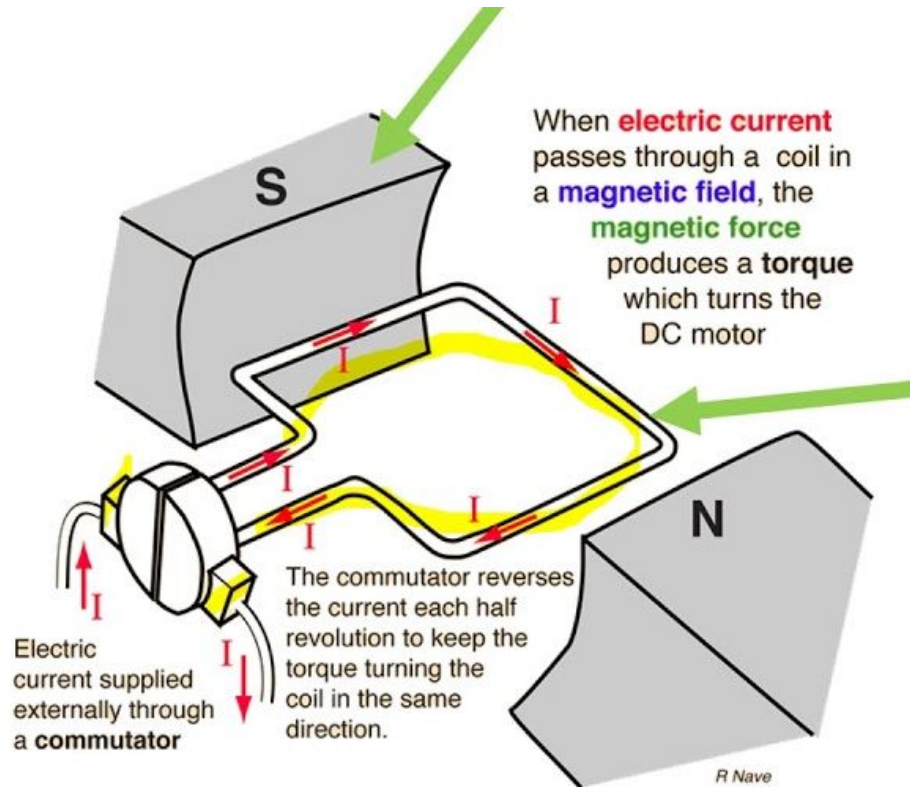

Perception

Action
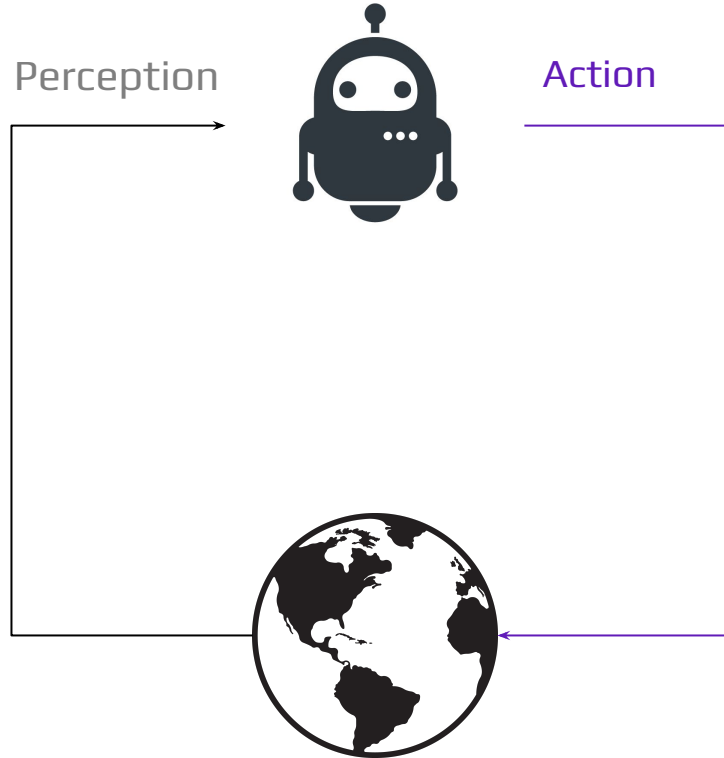
Actuators

- **Motors**
- Hydraulic Actuators
- Pneumatic Actuators
- Solenoids
- Artificial Muscles
- ...

Types of Motors

DC Motors

How does a DC Motor Work

When **electric current** passes through a coil in a **magnetic field**, the **magnetic force** produces a **torque** which turns the DC motor

Electric current supplied externally through a **commutator**

The commutator reverses the current each half revolution to keep the torque turning the coil in the same direction.

R Nave

Gearmotor

voltage	no-load performance	stall extrapolation
6 V	210 RPM, 500 mA	9.1 kg·cm (130 oz·in), 6.0 A

Gear ratio: 46.85:1

No-load speed @ 6V: 210 rpm

No-load current @ 6V: 0.50 A

Stall current @ 6V: 6.0 A

Stall torque @ 6V: 9.1 kg·cm

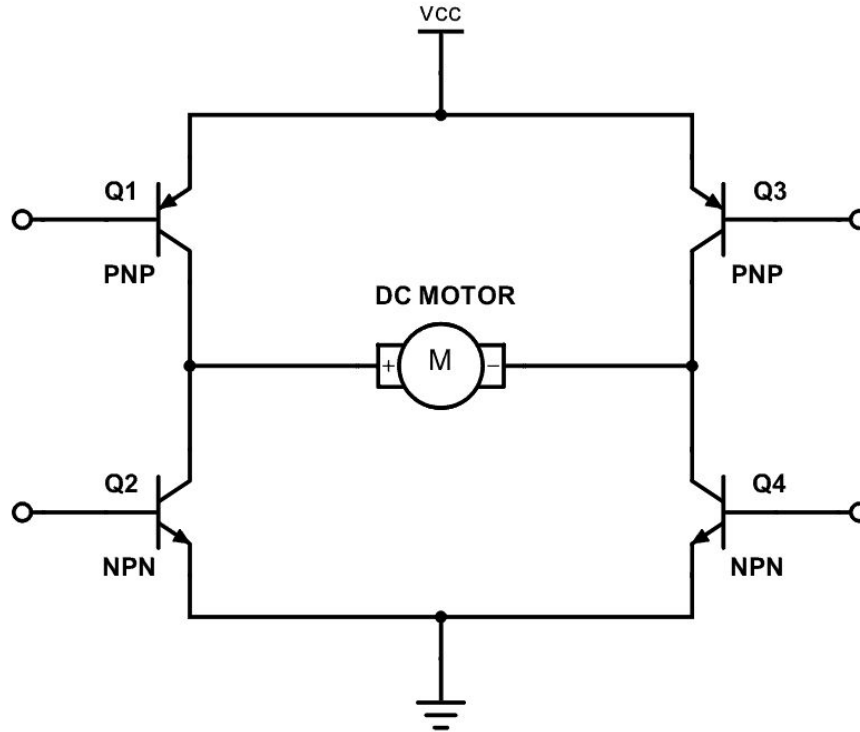**Max output power @ 6V:**   4.9 W

Motor type: 6V, 6.0A stall (HP 6V)

H-bridge Driving Circuit
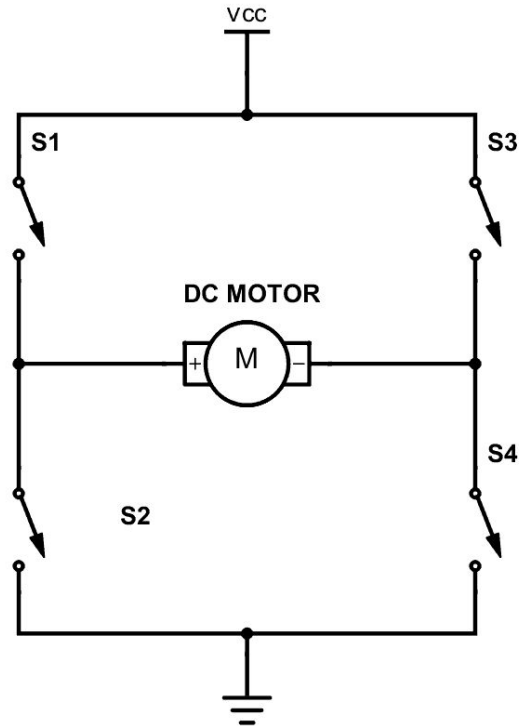
H-bridge Driving Circuit

Transistor H-bridge

VCC

Q1 PNP
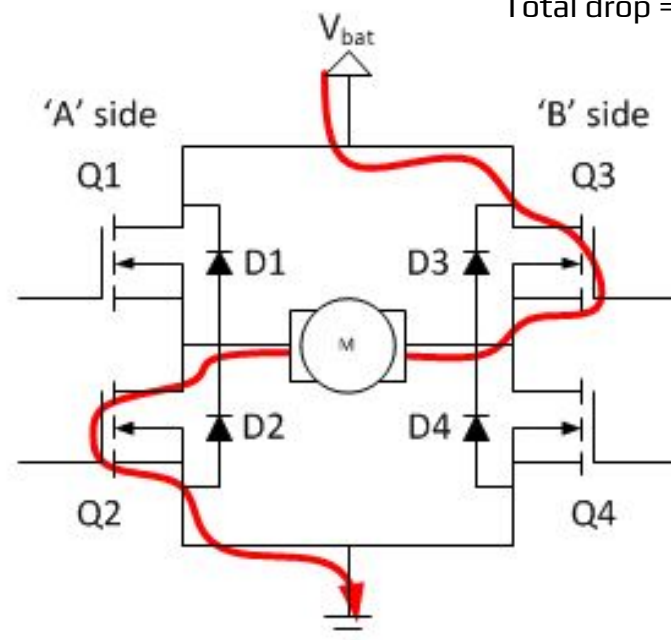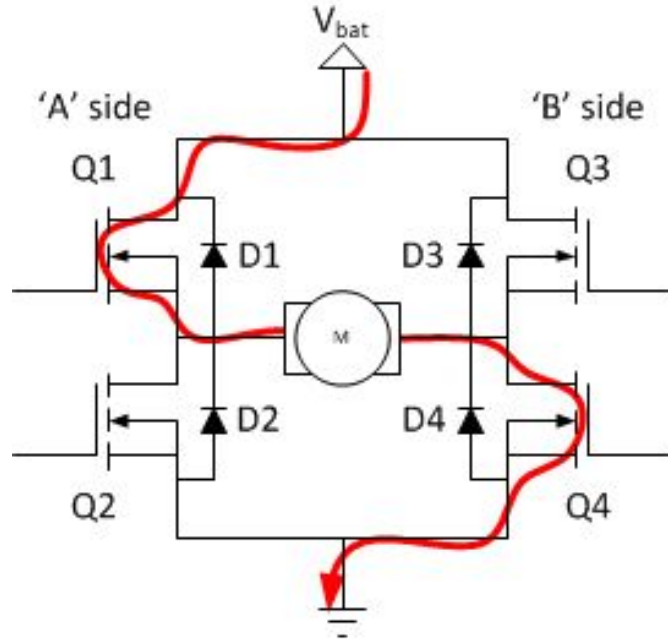
Q3 PNP

DC MOTOR
M

Q2 NPN

Q4 NPN
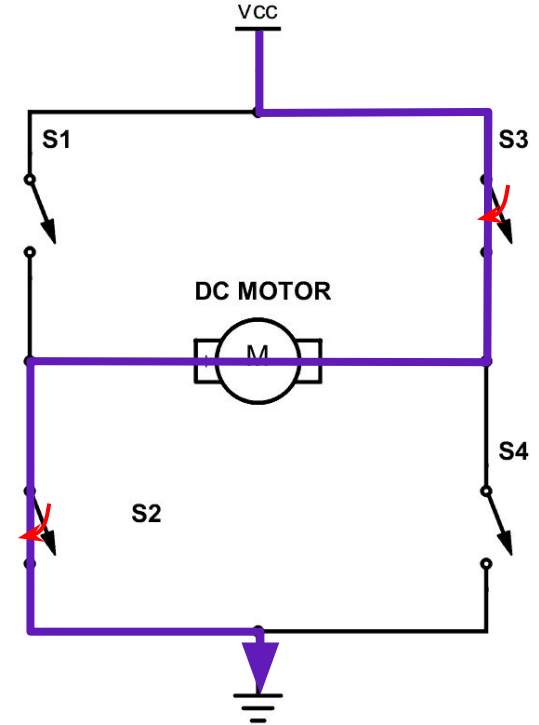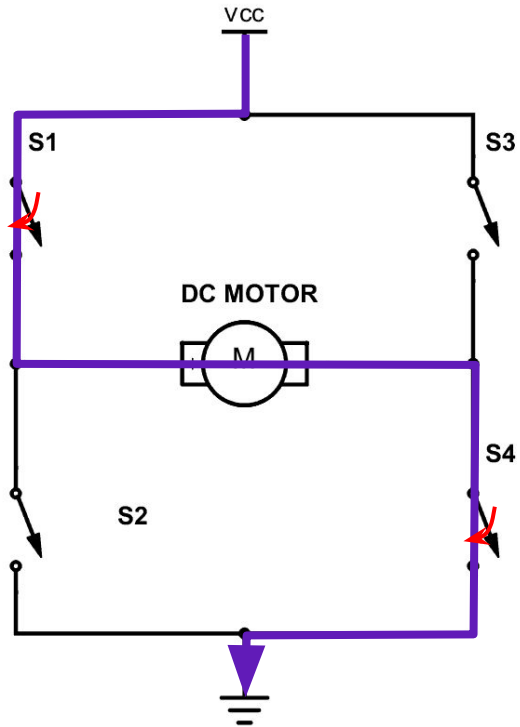
Transistors drop = 0.7 V
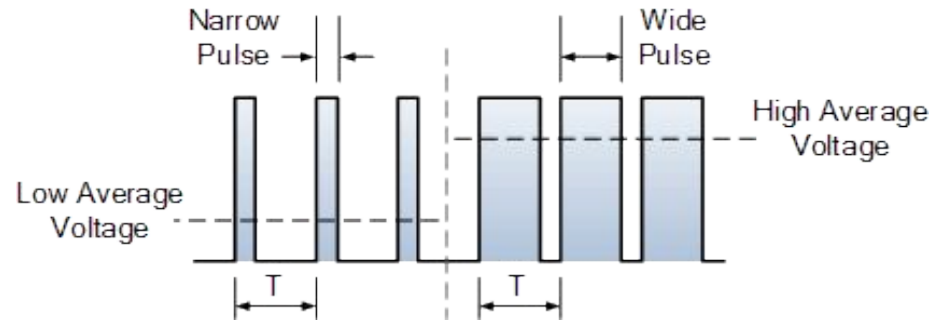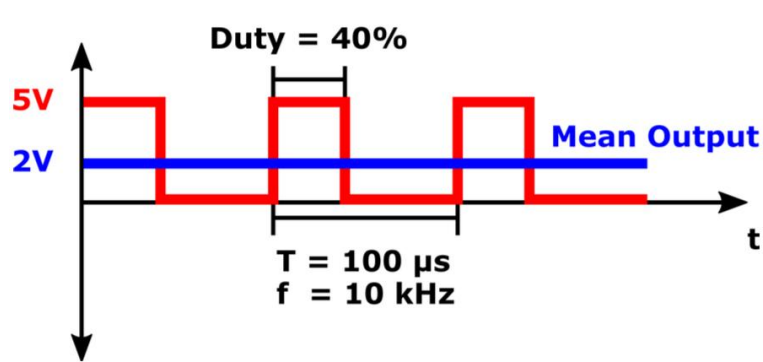
Total drop = 1.4 V

MOSFET H-bridge

MOSFET drop = 0.1 V

Total drop = 0.2 V

Pulse Width Modulation (PWM)

PWM SIGNAL

Duty = 40%

5V

2V **Mean Output**

T = 100 μs
f = 10 kHz

t

Narrow
Pulse

Wide
Pulse

High Average
Voltage

Low Average
Voltage

T

T

Motor Driver Board — MDD10A

MDD10A
Dual Channel 10Amp DC Motor Driver

Motor 1

V motor input:
- 5 - 30VDC

Motor 2

DC Brushed Motor:
- 30A Peak
- 10A Continuous

Output Indicator LEDs

Power Indicator LED

Control Signal Input:
- Two independent channels
- 3.3V to 5.0V logic
- Sign-Magnitude
- Locked Antiphase
- Upto 20KHz PWM frequency
- Arduino and Raspberry Pi compatible

Manual/Test buttons
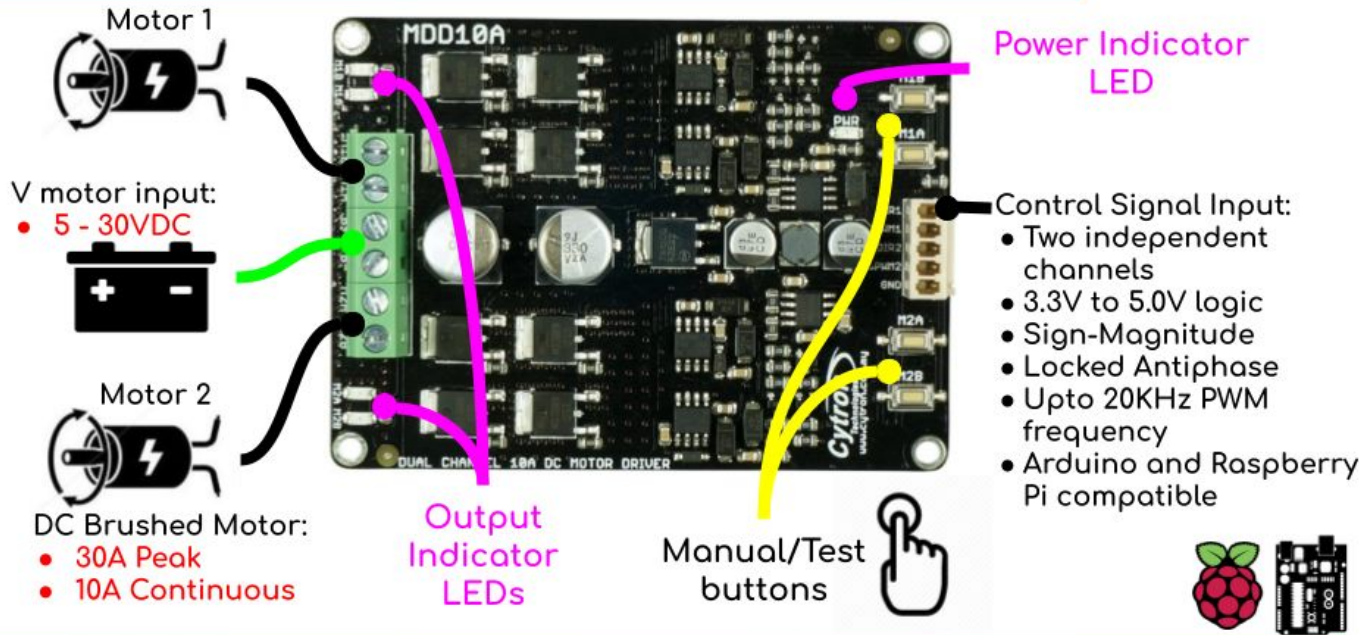
MDD10A Wiring
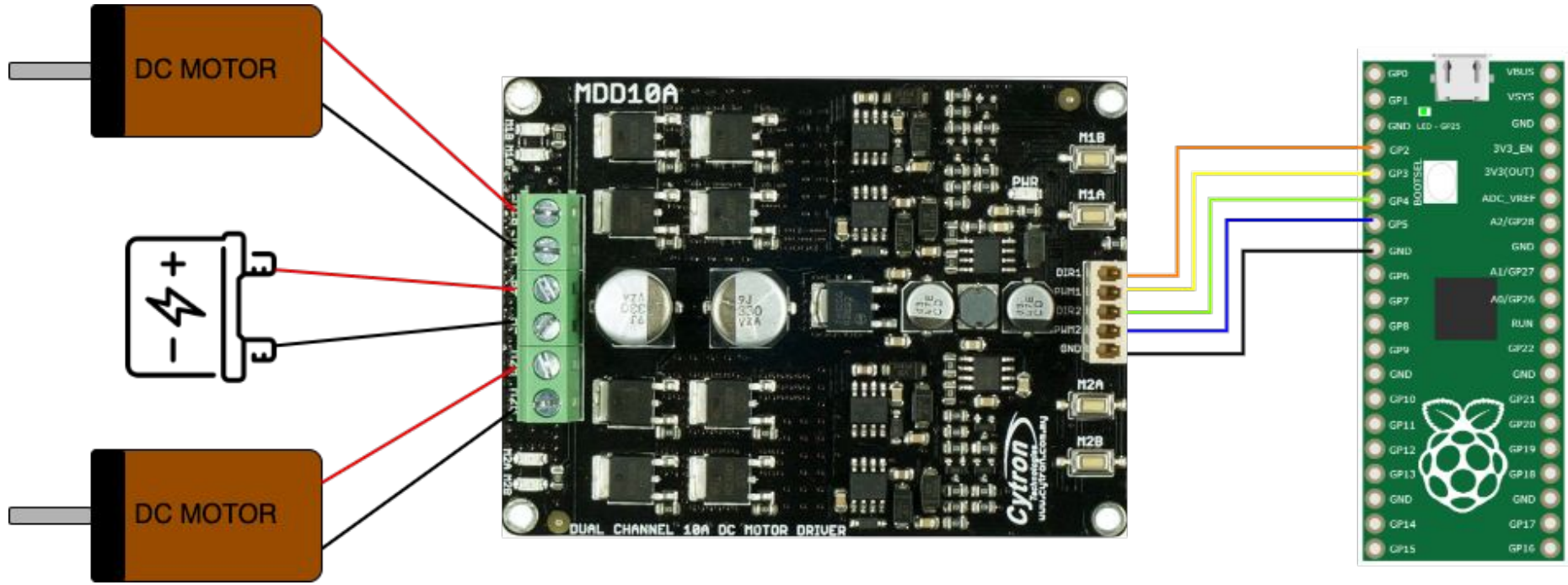
Drive DC Motors

```python
from machine import Pin, PWM

# SETUP
DIR1 = Pin(2, Pin.OUT)
PWM1 = PWM(Pin(3))
DIR2 = Pin(4, Pin.OUT)
PWM2 = PWM(Pin(5))
PWM1.freq(100)
PWM2.freq(100)

# LOOP
DIR1.value(0)
for duty in range(65536):
    PWM1.duty_u16(duty)
for duty in reversed(range(65536)):
    PWM1.duty_u16(duty)
DIR1.value(1)
for duty in range(65536):
    PWM1.duty_u16(duty)
for duty in reversed(range(65536)):
    PWM1.duty_u16(duty)
```

Create A Motor Driver Class

```python
from machine import Pin, PWM


class MotorDriver:
    def __init__(self, DIR_pin, PWM_pin):
        # pin config
        self.M_DIR = Pin(DIR_pin, Pin.OUT)  # motor direction
        self.M_PWM = PWM(Pin(PWM_pin))  # motor speed
        self.M_PWM.freq(1000)
        # init
        self.M_PWM.duty_u16(0)

    def forward(self, duty=0):
        assert 0 <= duty <= 1  # make sure duty in range [0, 1]
        self.M_DIR.value(1)
        self.M_PWM.duty_u16(int(65535 * duty))

    def backward(self, duty=0):
        assert 0 <= duty <= 1
        self.M_DIR.value(0)
        self.M_PWM.duty_u16(int(65535 * duty))

    def stop(self):
        self.M_PWM.duty_u16(0)
```
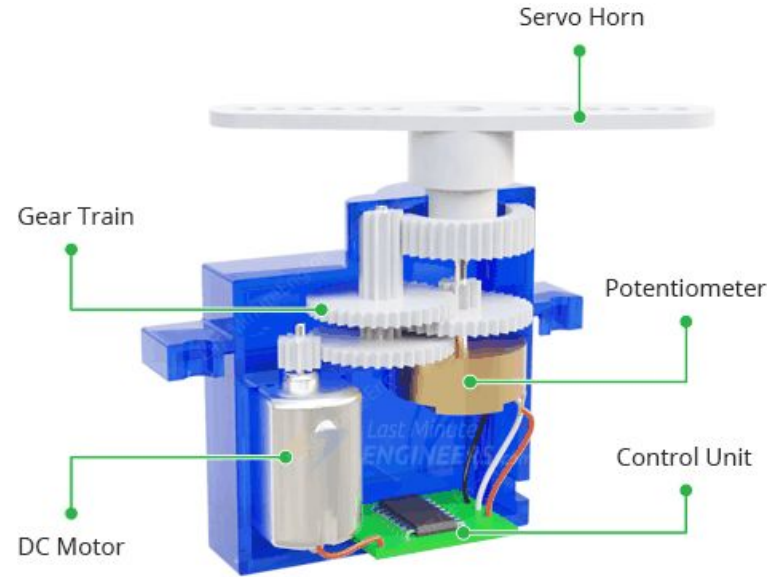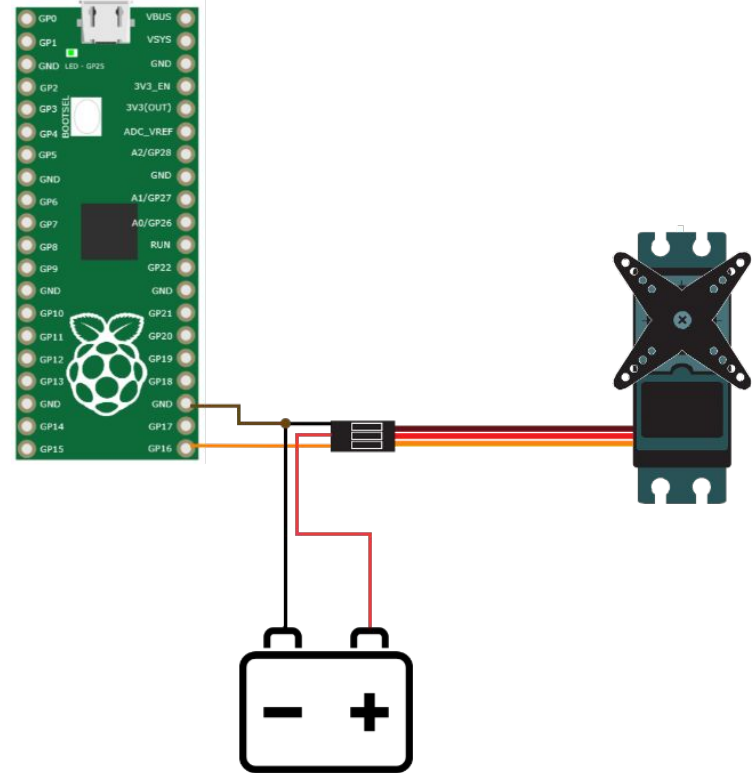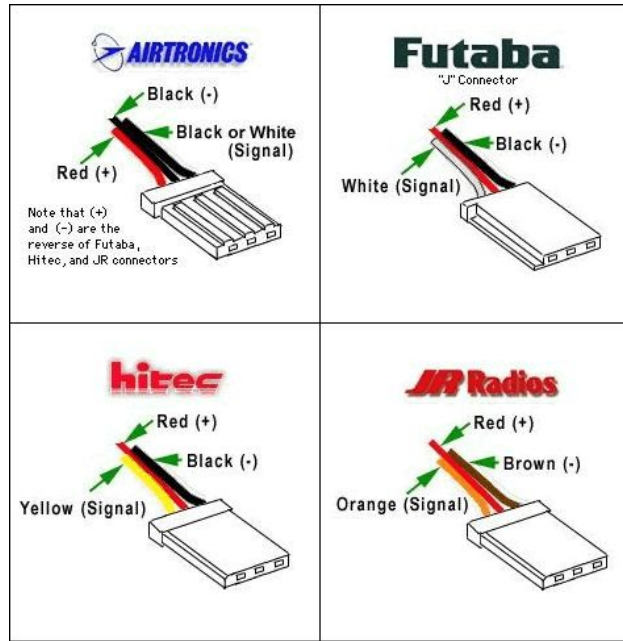
Servo Motor

A servo motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity, and acceleration.

- We use hobbyist servo motor.
- Range of motion usually limited to 90, 180, 270 degrees.
- There are continuous rotation servo motors.
- Use a PWM signal with 50 Hz frequency to control.
- ...

Servo Horn

Gear Train

Potentiometer

DC Motor

Control Unit

Servo Motor Wiring

Drive A Servo Motor

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

# SETUP
servo = PWM(Pin(13))
servo.freq(50)

# LOOP
servo.duty_ns(int(500*1000))
sleep(1)
servo.duty_ns(int(1500*1000))
sleep(1)
servo.duty_ns(int(1000*1000))
sleep(1)
```

```python
"""
Require micropython-servo library:
https://pypi.org/project/micropython-servo/
"""
from servo import Servo
from time import sleep

# SETUP
my_servo = Servo(pin_id=13)
my_servo.write(0)
sleep(1)

# LOOP
for i in range(181):
    my_servo.write(i)
    print(f"angel: {i} deg")
    sleep(0.1)

my_servo.write(90)
sleep(1)
```