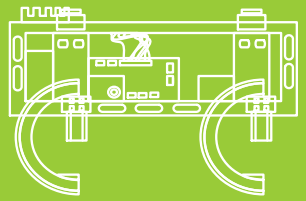
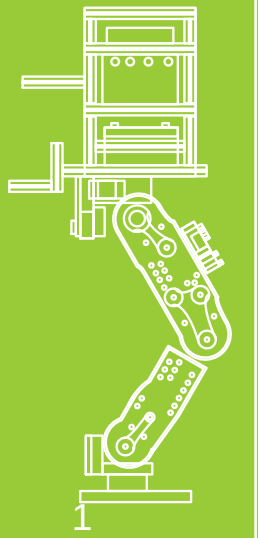
# 實驗六 馬達控制

111-2 機電系統原理與實驗一



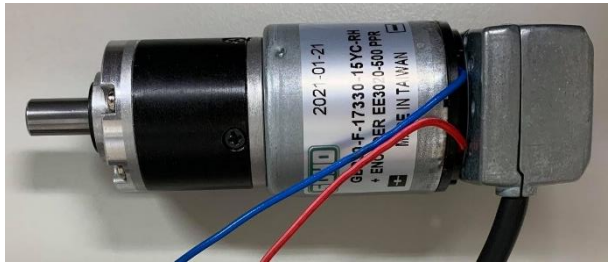


# 實驗目的

- 使用L298N控制馬達
  - 馬達正反轉
  - PWM 控馬達轉速快慢
- 讀取編碼器
- Position Control (PID)

# Motor & Encoder

- **Motor (SOHO 17330-15YC)**
  - Volt：12V
  - Cont. Torque：19g-cm
  - **Gearhead (GBP30-F)**
    - Ratio：16
    - Cont. Torque：12kg-cm
- **Encoder (EE3020-500)**
  - Volt：5V ± 10%
  - Phase Difference：90° ± 45°
  - Response Frequency：40kHz
  - **綠(B)DIO/ENC.B 紅(+)5V 白(A) DIO/ENC.A 黑(-)GND**

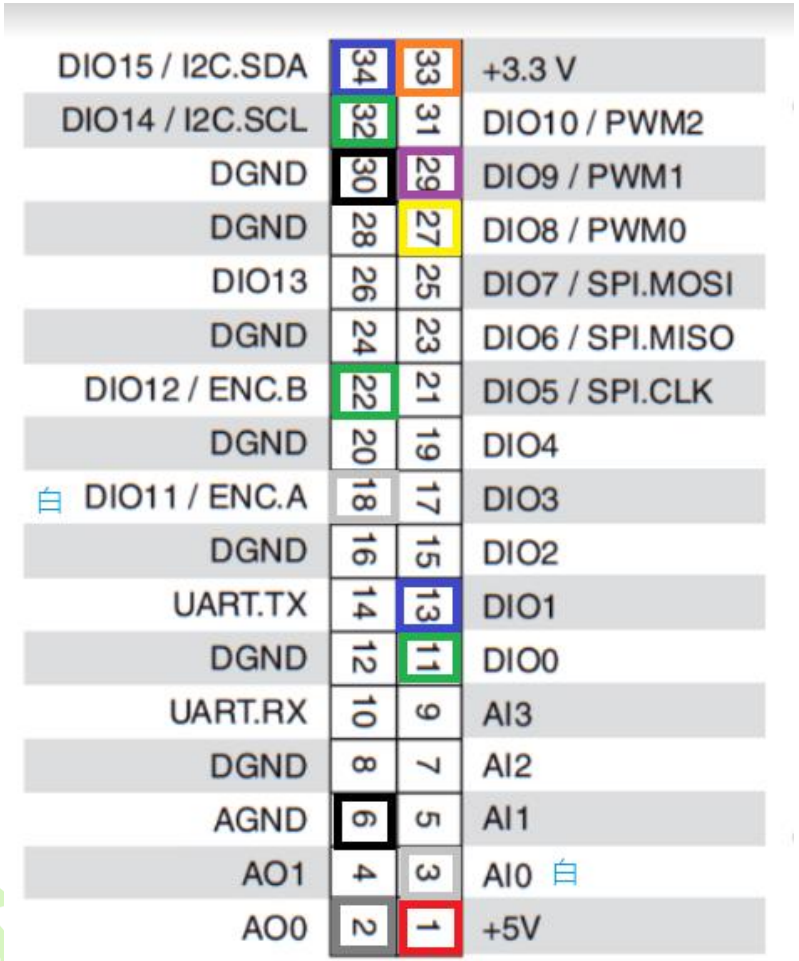


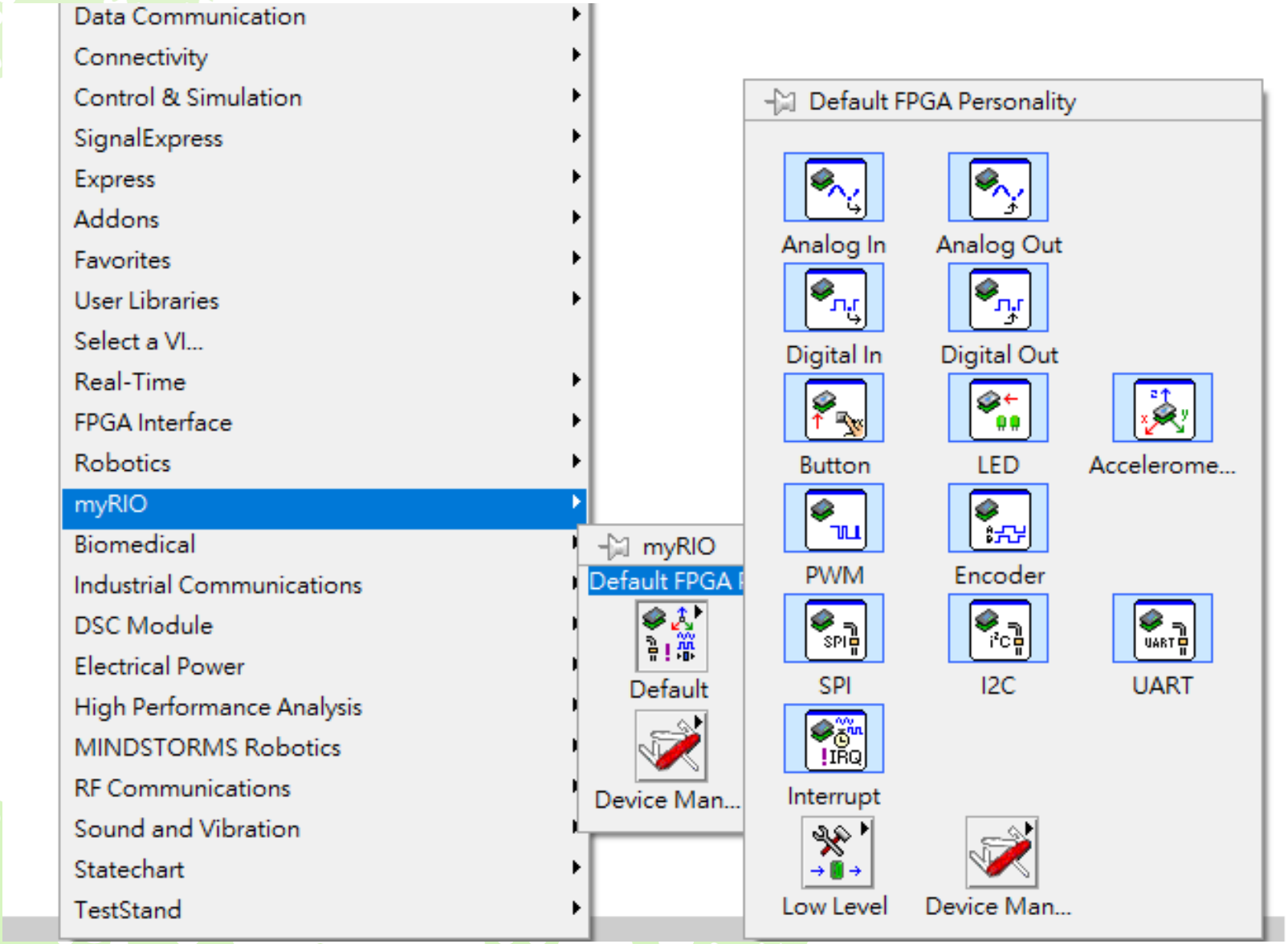

**Encoder電壓接錯會燒掉**

# Encoder連接myRIO

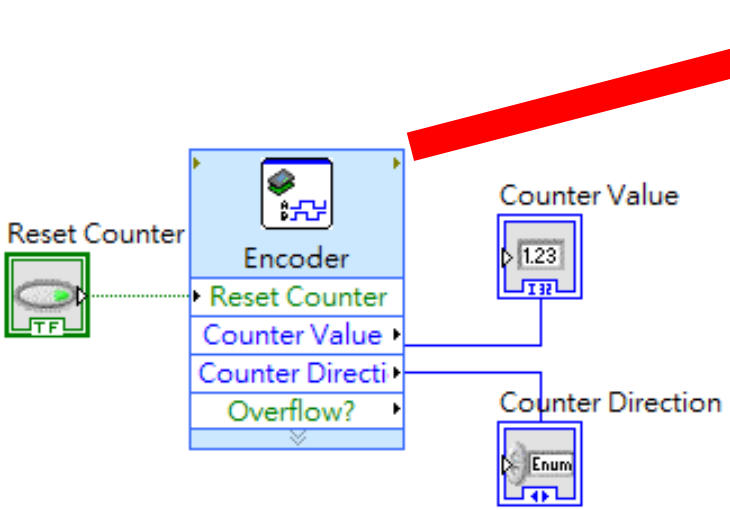
- **DIO12/ENC.B (pin 22) (綠)**
- **DIO11/ENC.A (pin 18) (白)**
- **Encoder供電：5V / DGND**

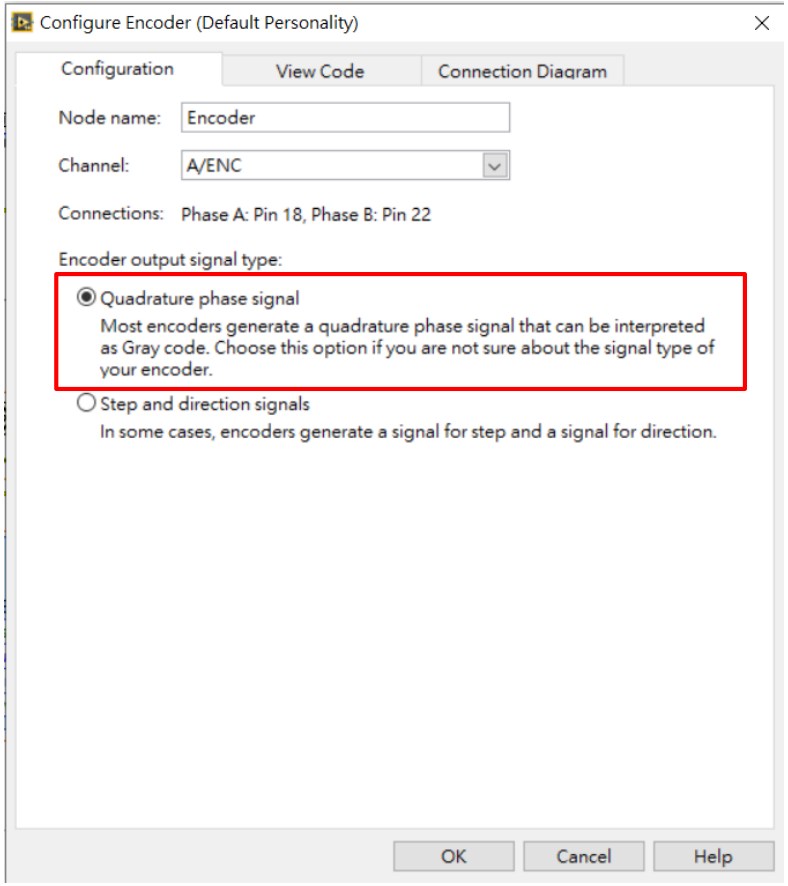
**Encoder電壓接錯會燒掉**



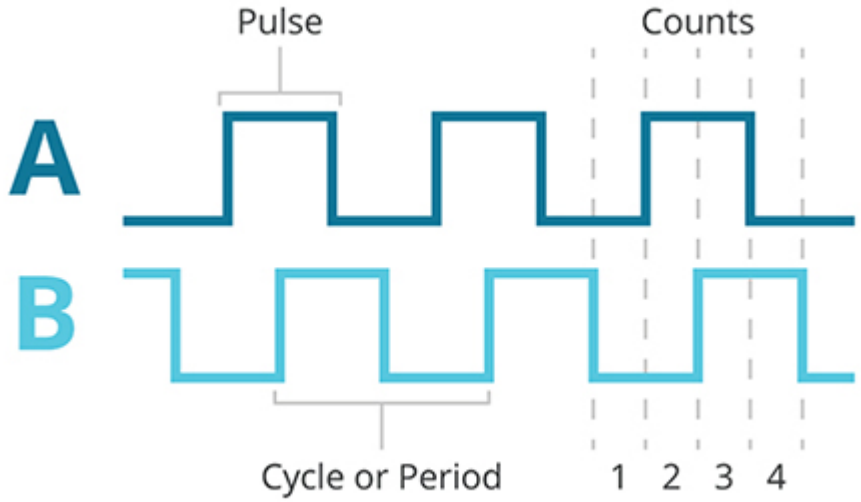

Data Communication
Connectivity
Control & Simulation
SignalExpress
Express
Addons
Favorites
User Libraries
Select a VI...
Real-Time
FPGA Interface
Robotics
myRIO
Biomedical
Industrial Communications
DSC Module
Electrical Power
High Performance Analysis
MINDSTORMS Robotics
RF Communications
Sound and Vibration
Statechart
TestStand
myRIO
Default FPGA
Default
Device Man...
Default FPGA Personality
Analog In
Analog Out
Digital In
Digital Out
Button
LED
Accelerome...
PWM
Encoder
SPI
I2C
UART
Interrupt
Low Level
Device Man...

# Code-Encoder



# Encoder 相位



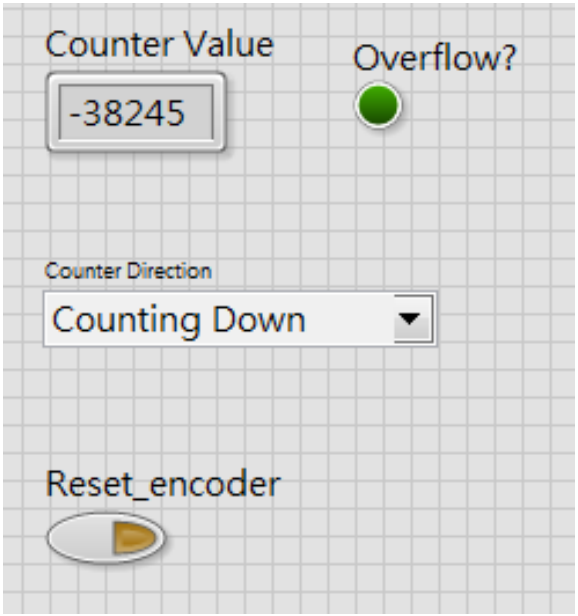

| 0 | 0 |
|---|---|
| 1 | 0 |
| 1 | 1 |
| 0 | 1 |

# User Interface顯示位置、圈數

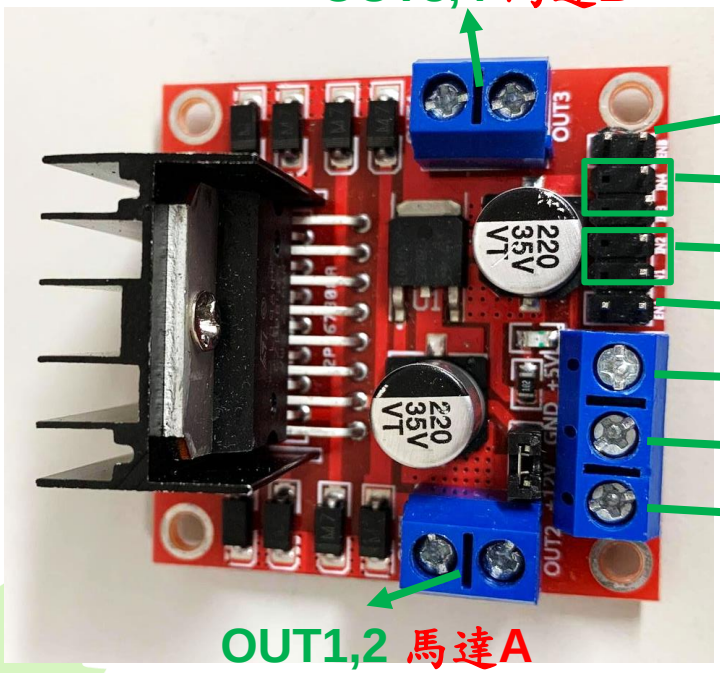
- **將Encoder讀值轉換成圈數(rev)**
  - 減速機 1:16
  - Encoder解析度：500
  - 每一片光盤對應encoder之解析度為4
  - 馬達輸出軸轉一圈，Encoder讀值為32000 counts (16x500x4)
- **計算Position (Degree or Radian)**
  - 將圈數轉換成Degree or Radian

# User Interface

## Encoder



# 馬達驅動模組 (L298N)



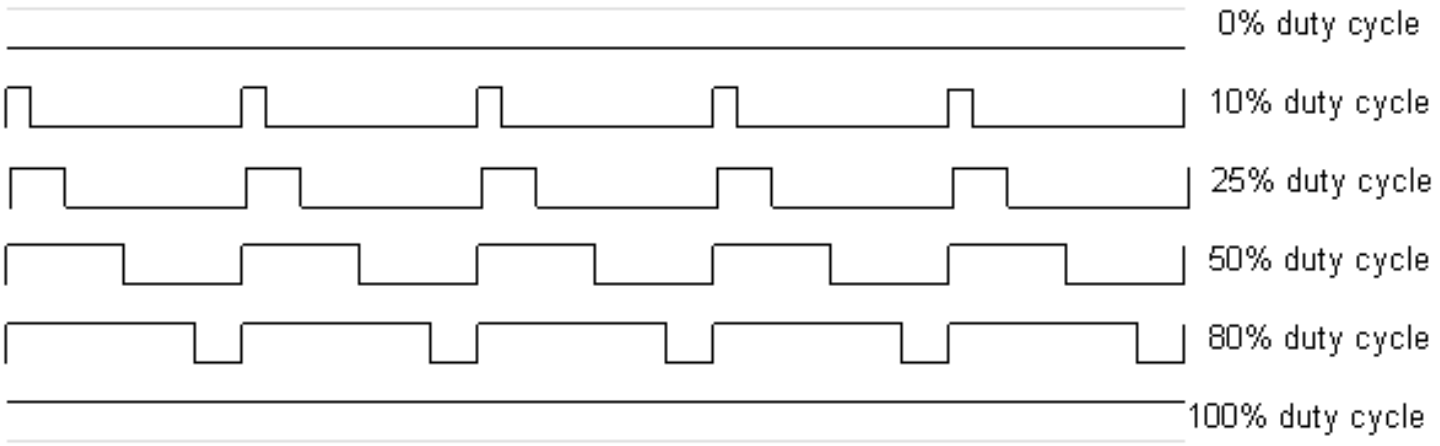
# 馬達驅動模組 (L298N)

| | 運作方式 | IN 1 | IN 2 |
|---|---|---|---|
| 馬達 A | 順時針 | High | Low |
| | 逆時針 | Low | High |
| | 停止 | Low | Low |

| | 運作方式 | IN 3 | IN 4 |
|---|---|---|---|
| 馬達 B | 順時針 | High | Low |
| | 逆時針 | Low | High |
| | 停止 | Low | Low |

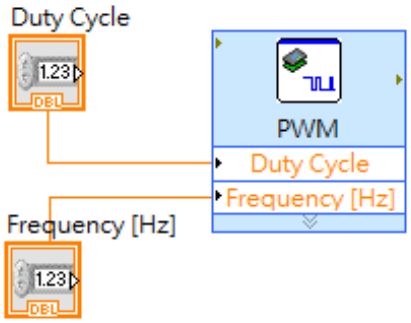
# Pulse Width Modulation (PWM)

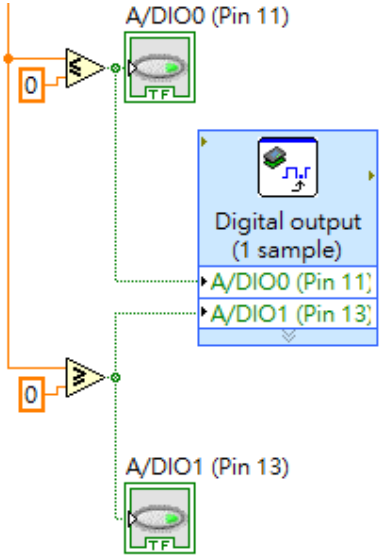
- Frequency (200Hz)
- Duty cycle



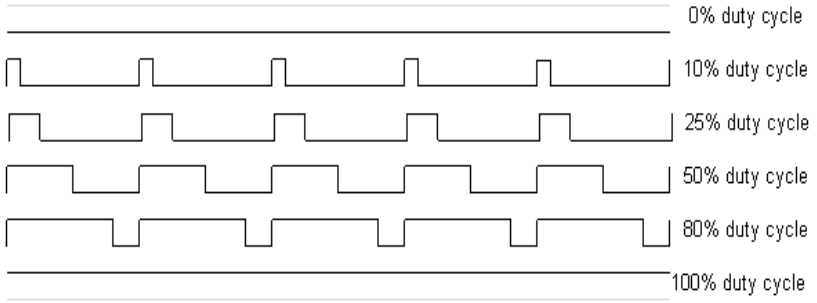

Ref:https://blog.csdn.net/samxx8/article/details/53229069

# Code-Motor



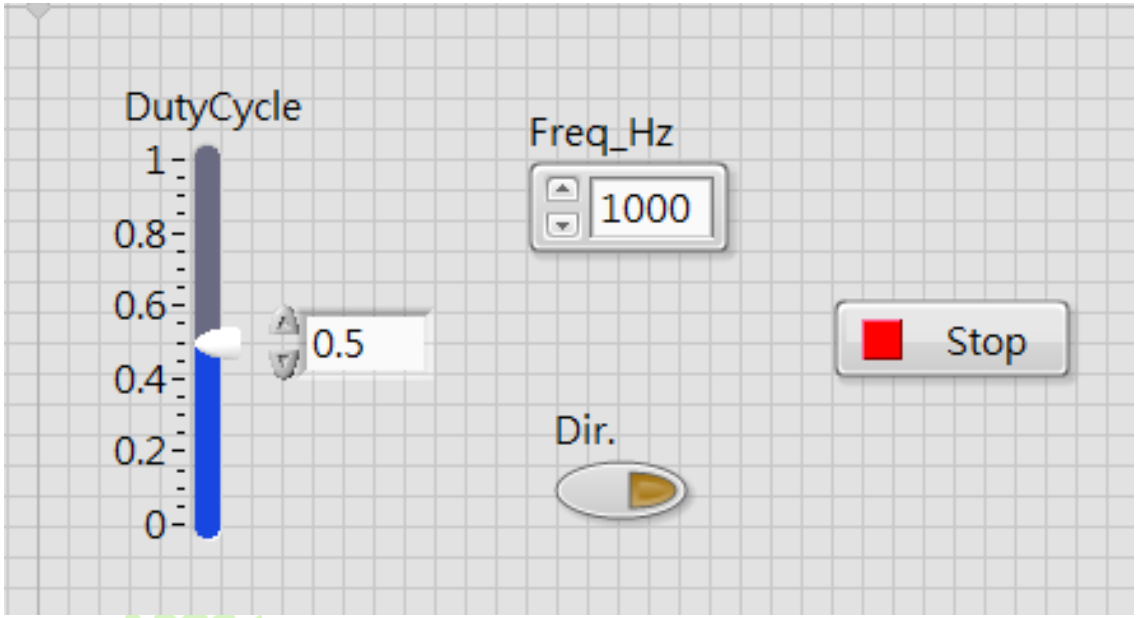

- **PWM (Speed)**
  - Duty cycle (0~1)
  - Frequency 200Hz
  - L298N ENA



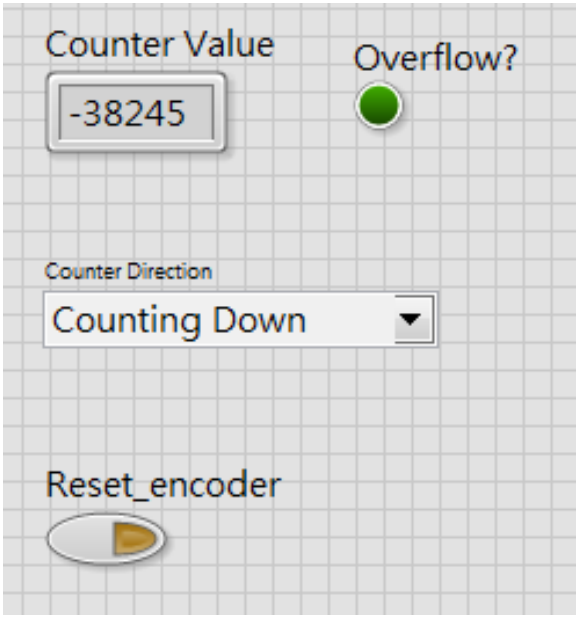

- **DIO (Direction)**
  - 控制L298N之**IN1,2**來決定馬達**A**正反轉
  - DIO (Boolean)

# User Interface

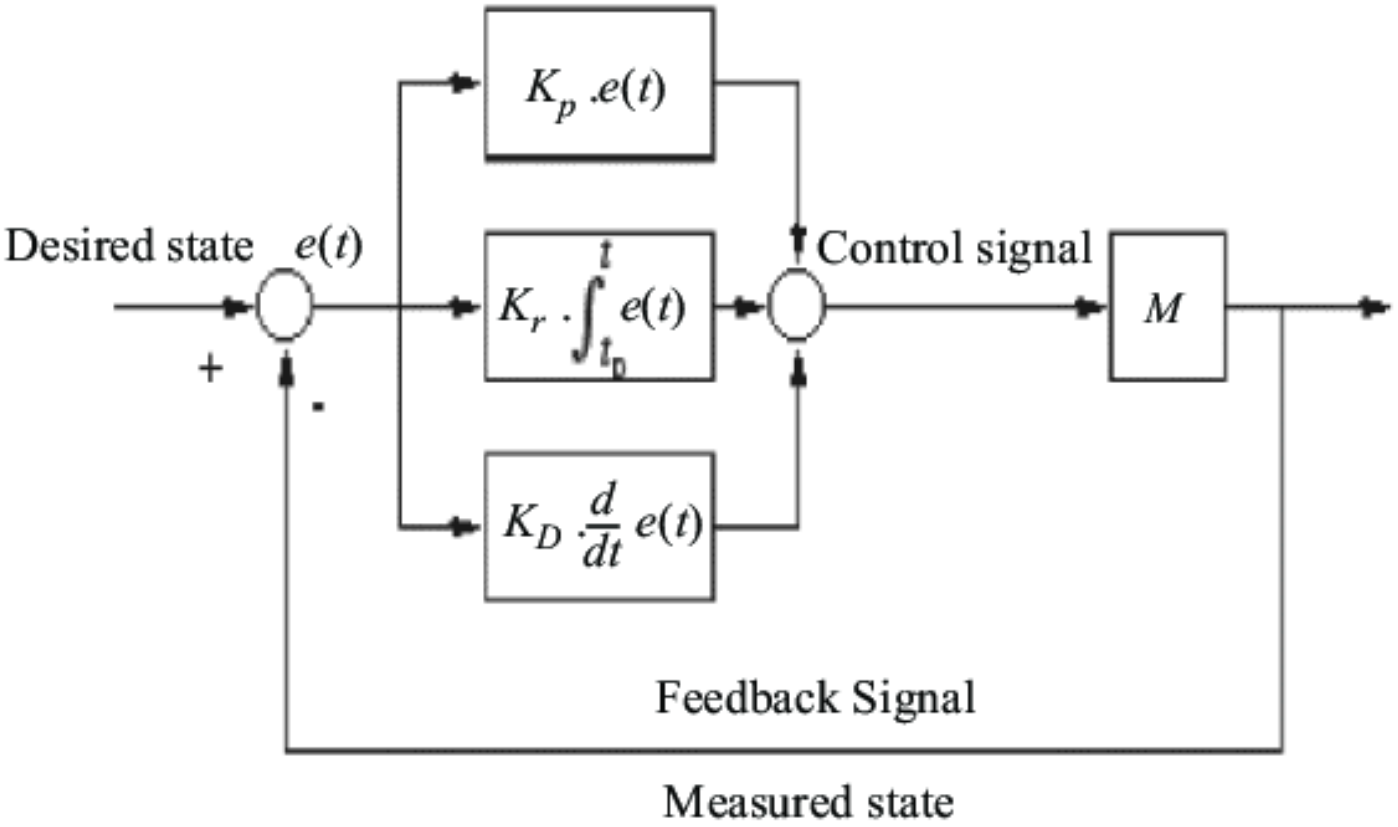
## Motor




## Encoder



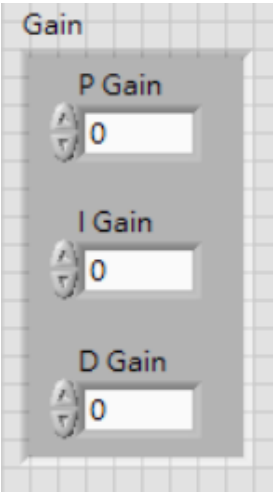
# PID Position Control

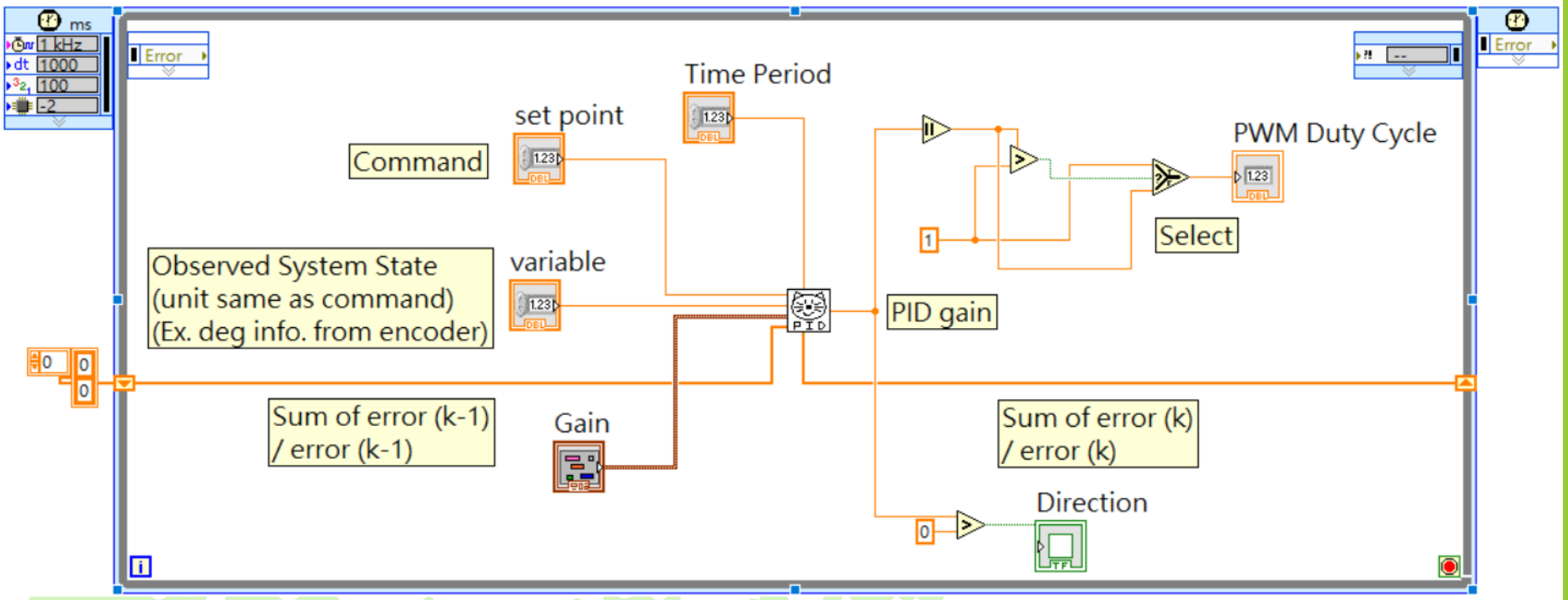



https://www.researchgate.net/figure/Block-diagram-of-a-system-with-PID-controller_fig1_268802558

# Position Control

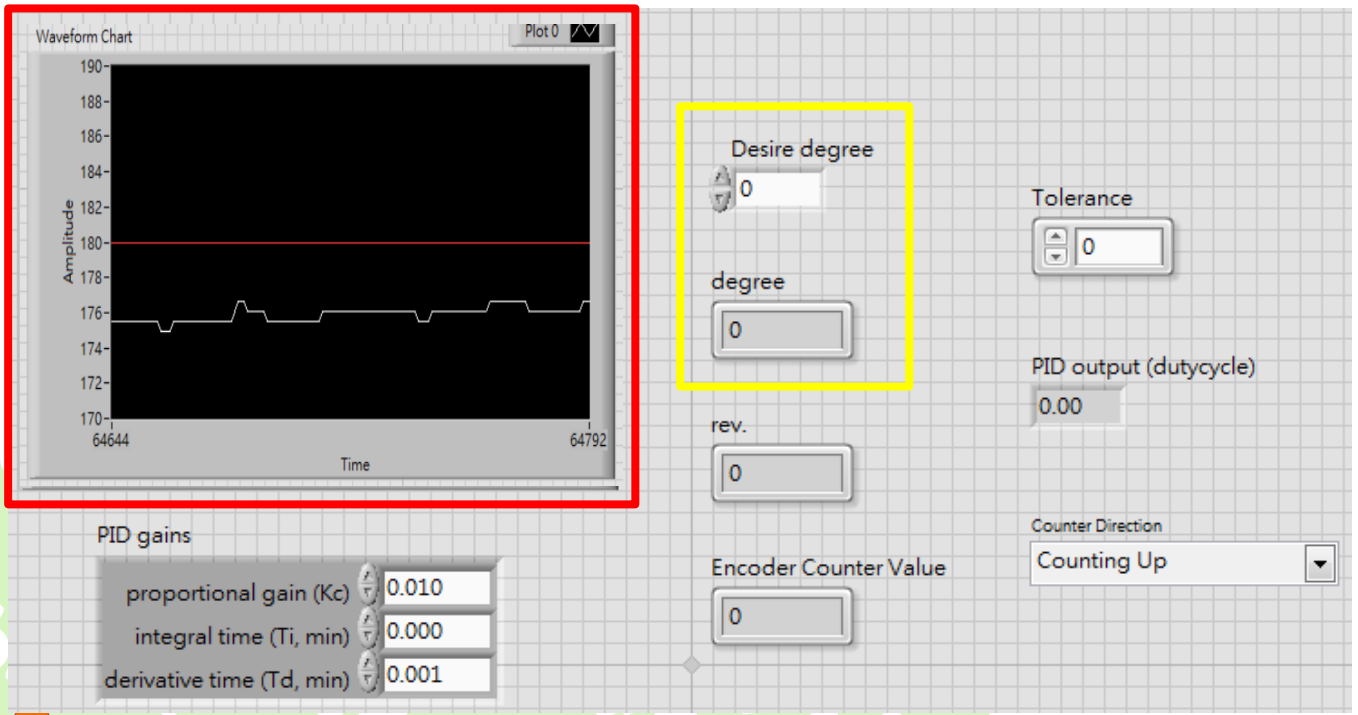
- PID 控制器說明



# Position Control

- **User Interface 需顯示**
  - Set Point / Desired degree (以Indicator顯示)
  - Current Degree (以Indicator顯示)
  - Waveform Chart(Desire Degree & Current Degree)



# Position Control

- **PID VI**
  - Setpoint = Desire Degree
  - Process Variable = Current Degree
  - Time Period = Loop Time (sec)
  - PID gain → Create Control
  - 確保 PWM Duty Cycle <= 100%
  - 記得判斷正反轉，用DIO控制L298N !

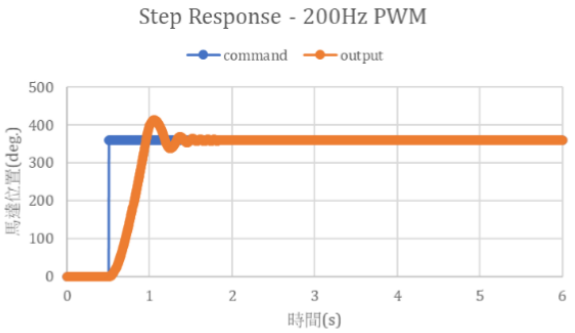
- **Waveform chart**
  - 同時顯示 Desire Degree 和 Current  Degree

# 配分

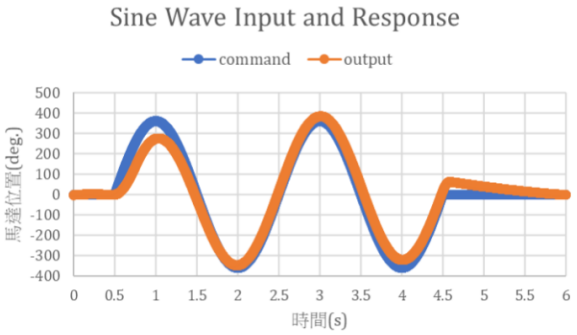
- **實驗驗收 17:30前**
  - **編碼器與馬達基本操作**
    - 讀取編碼器、角度換算**10%**
    - 馬達正反轉、快慢調整**10%**
  - **Position Control**
    - Setpoint **10%**
    - Sine Wave **10%**
- **實驗報告 4/13前 60% (建議2-5頁)**
  - 探討PWM頻率對系統的影響
  - 探討PID各項參數對系統的影響(Overshoot, Steady-State Error, Settling Time…等)
  - **Setpoint**，計算Steady-State Error，需繳CSV檔
  - **Sine Wave**，計算RMSE(方均根誤差) ，需繳CSV檔
  - Labview程式截圖
  - 實驗照片

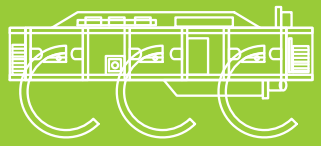
# 實驗報告說明

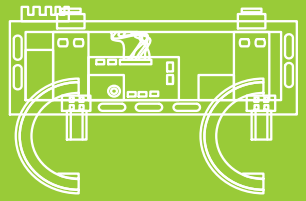
- **Setpoint**
  - **0**˚ (0~0.5s) **360**˚ (0.5-5s)
  - Steady-State Error
  - Write Spreadsheet
    - Type：CSV
    - 內容：期望值、實際值、時間(0-5s)
  - PID參數

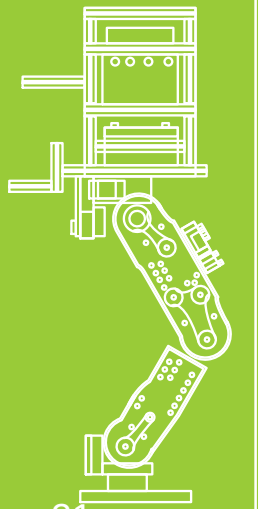



- **Sine Wave**
  - **0**˚ (0~0.5s), **Sine Wave** $\pm 360°,\ 0.5Hz$ (0.5-4.5s), **0**˚ (4.5~6s)
  - RMSE
  - Write Spreadsheet
    - Type：CSV
    - 內容：期望值、實際值、時間(0-6s)
  - PID參數









# Velocity Control

- 超前部屬：
  - 如何做到速度控制?

- 計算Angular Velocity
  - 現在loop的position扣掉上一個loop的position，除以一個迴圈的時間