

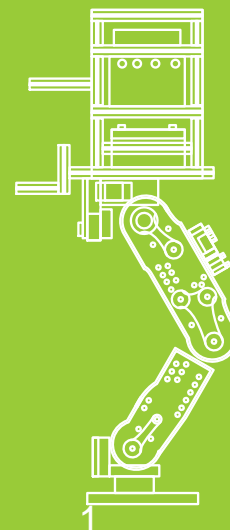
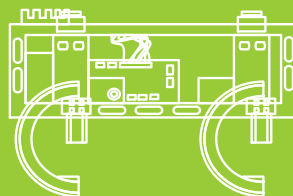


實驗六 馬達控制

111-2 機電系統原理與實驗一



Bio-inspired Robotic Laboratory





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 \pm 10%
- Phase Difference : $90^\circ \pm 45^\circ$
- 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

DIO15 / I2C.SDA	34	33	+3.3 V
DIO14 / I2C.SCL	32	31	DIO10 / PWM2
DGND	30	29	DIO9 / PWM1
DGND	28	27	DIO8 / PWM0
DIO13	26	25	DIO7 / SPI.MOSI
DGND	24	23	DIO6 / SPI.MISO
DIO12 / ENC.B	22	21	DIO5 / SPI.CLK
DGND	20	19	DIO4
白 DIO11 / ENC.A	18	17	DIO3
DGND	16	15	DIO2
UART.TX	14	13	DIO1
DGND	12	11	DIO0
UART.RX	10	9	AI3
DGND	8	7	AI2
AGND	6	5	AI1
AO1	4	3	AI0 白
AO0	2	1	+5V

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 I/O
Default
Device Man...

Default FPGA Personality



Analog In



Analog Out



Digital In



Digital Out



Button



LED



Accelerome...



PWM



Encoder



SPI



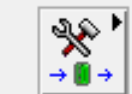
I2C



UART



Interrupt

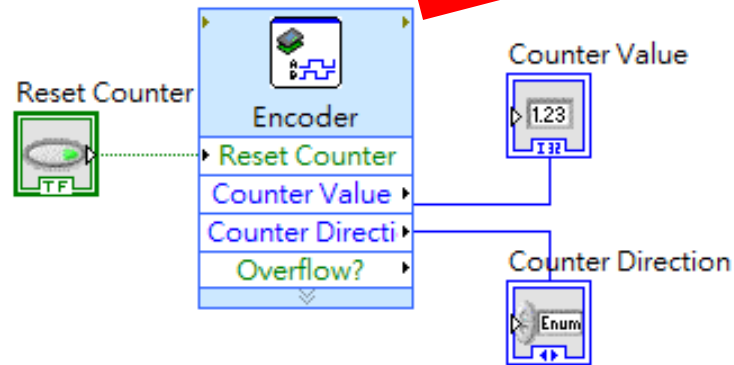


Low Level



Device Man...

Code-Encoder



Configure Encoder (Default Personality)

Configuration View Code Connection Diagram

Node name: Encoder

Channel: A/ENC

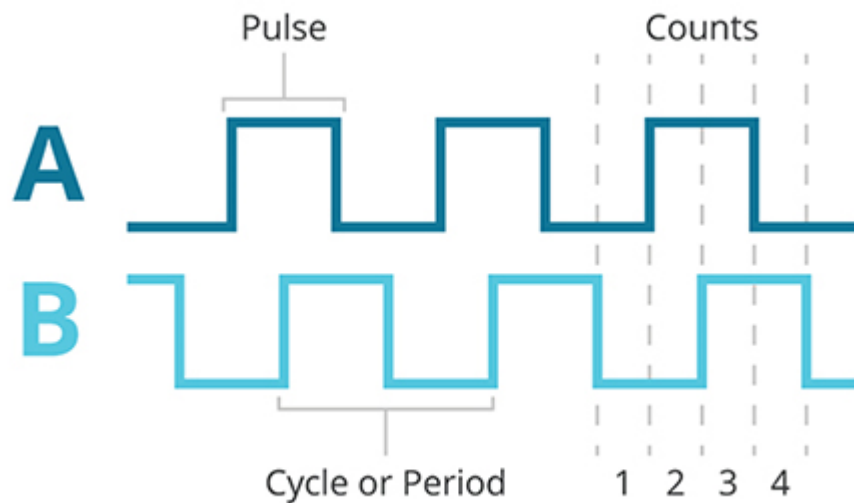
Connections: Phase A: Pin 18, Phase B: Pin 22

Encoder output signal type:

- ☒ Quadrature phase signal
Most encoders generate a quadrature phase signal that can be interpreted as Gray code. Choose this option if you are not sure about the signal type of your encoder.
- ☐ Step and direction signals
In some cases, encoders generate a signal for step and a signal for direction.

OK Cancel Help

Encoder 相位



0	0
1	0
1	1
0	1

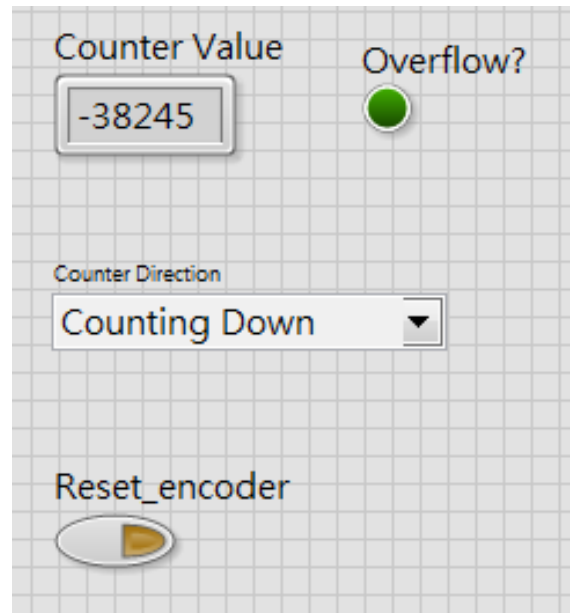


User Interface顯示位置、圈數

- **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



Counter Value

-38245

Overflow?

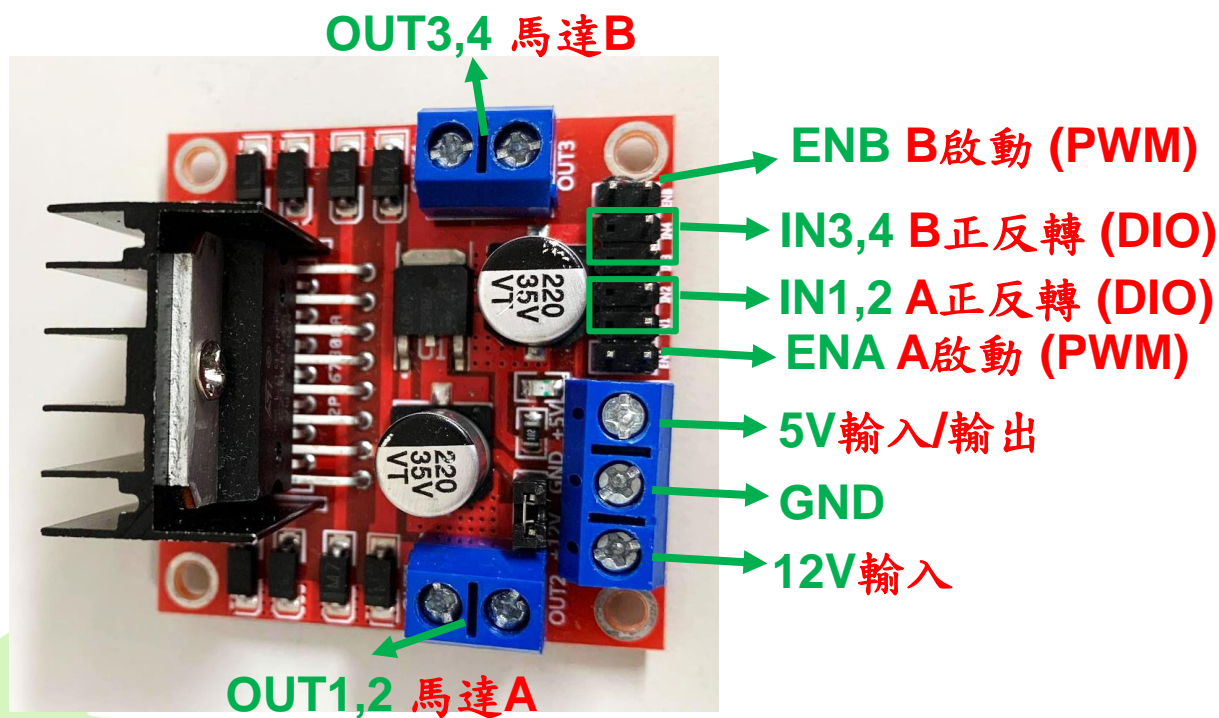
Counter Direction

Counting Down

Reset_encoder

The interface is set against a light gray grid background. It includes a text input field for the counter value, a green indicator light for overflow, a dropdown menu for counting direction, and a toggle switch for resetting the encoder.

馬達驅動模組 (L298N)





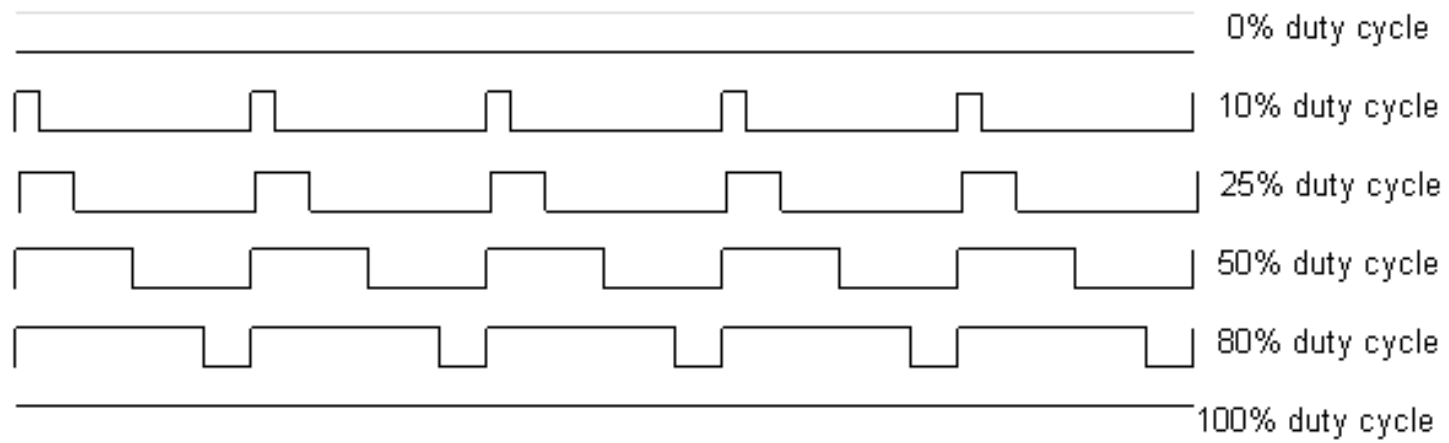
馬達驅動模組 (L298N)

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

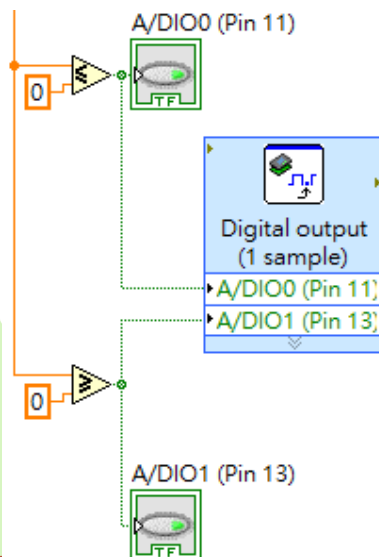
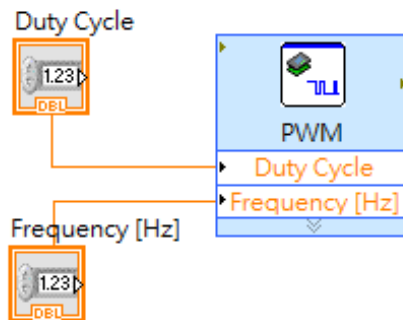
Pulse Width Modulation (PWM)

- Frequency (200Hz)
- Duty cycle



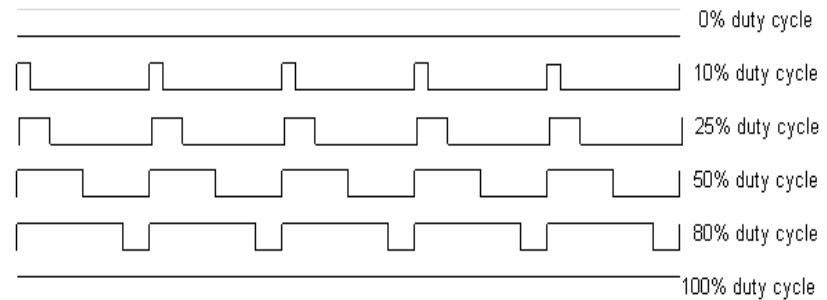
Ref: <https://blog.csdn.net/samxx8/article/details/53229069>

Code-Motor



• PWM (Speed)

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

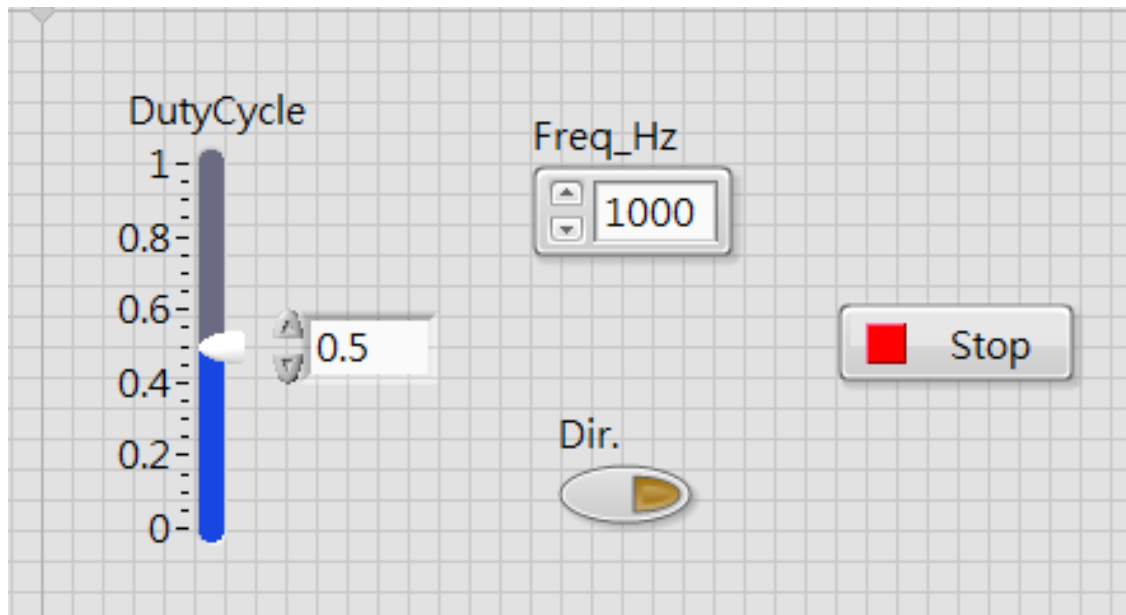


• DIO (Direction)

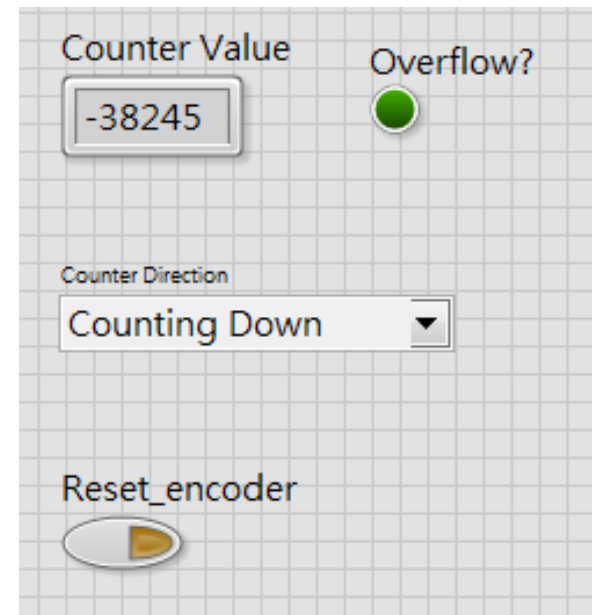
- 控制L298N之**IN1,2**來決定馬達**A**正反轉
- DIO (Boolean)

User Interface

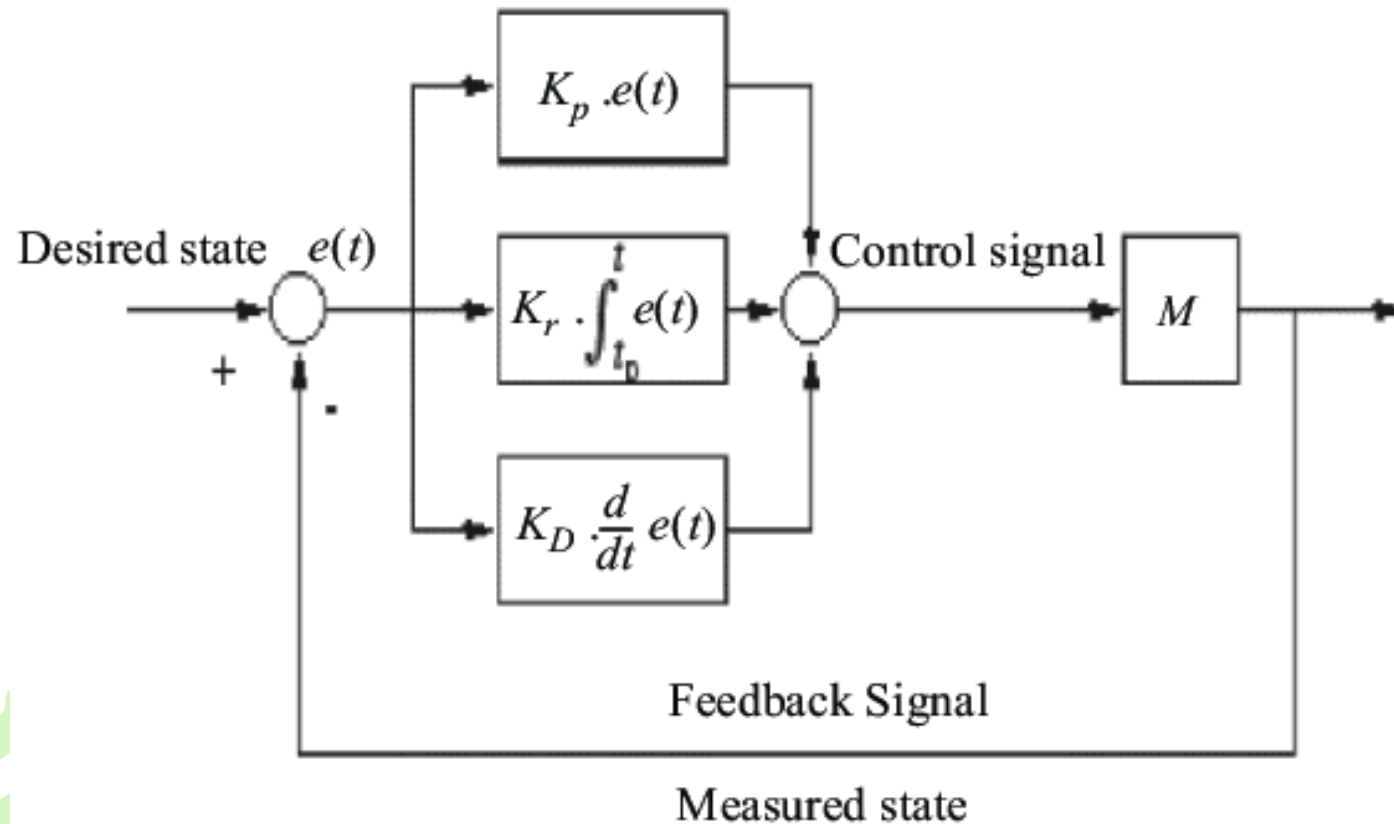
Motor



Encoder



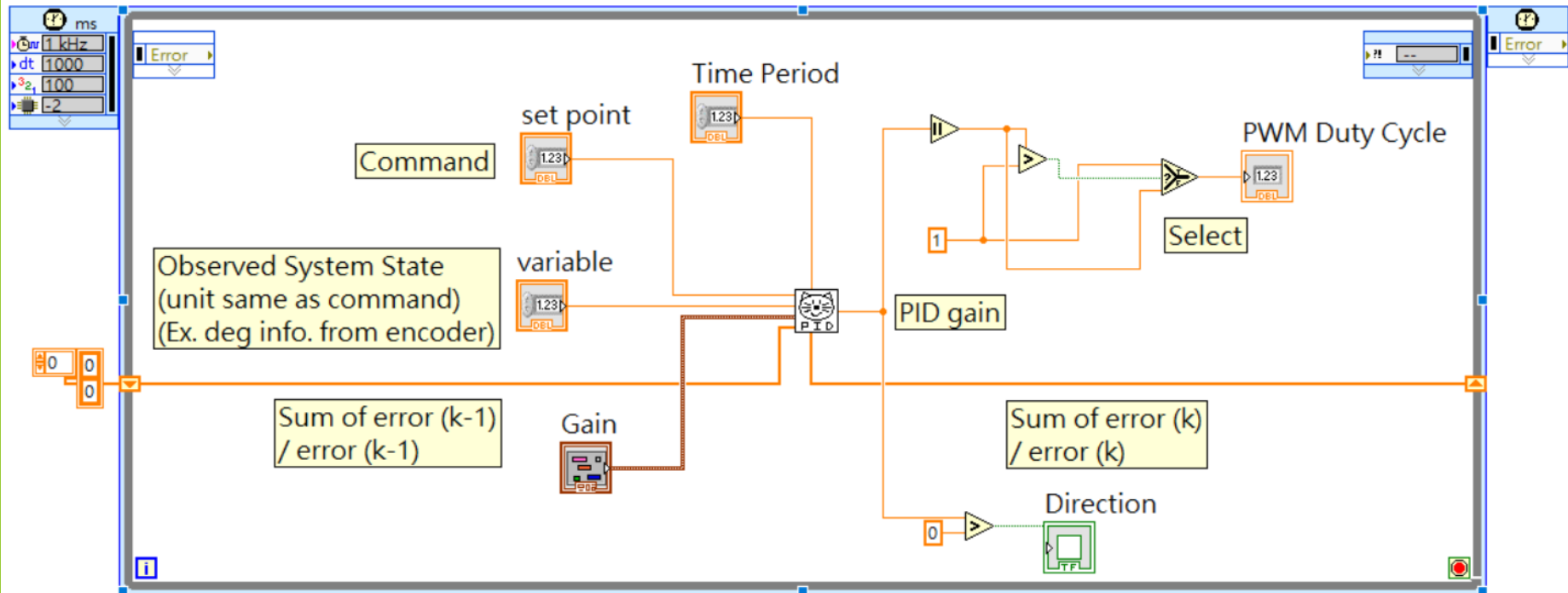
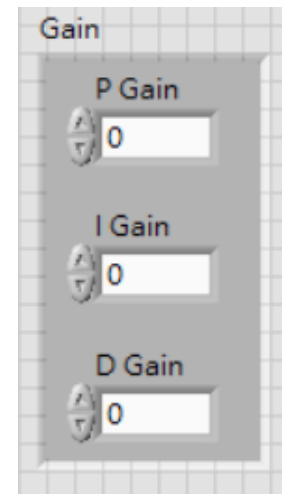
PID Position Control



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

Position Control

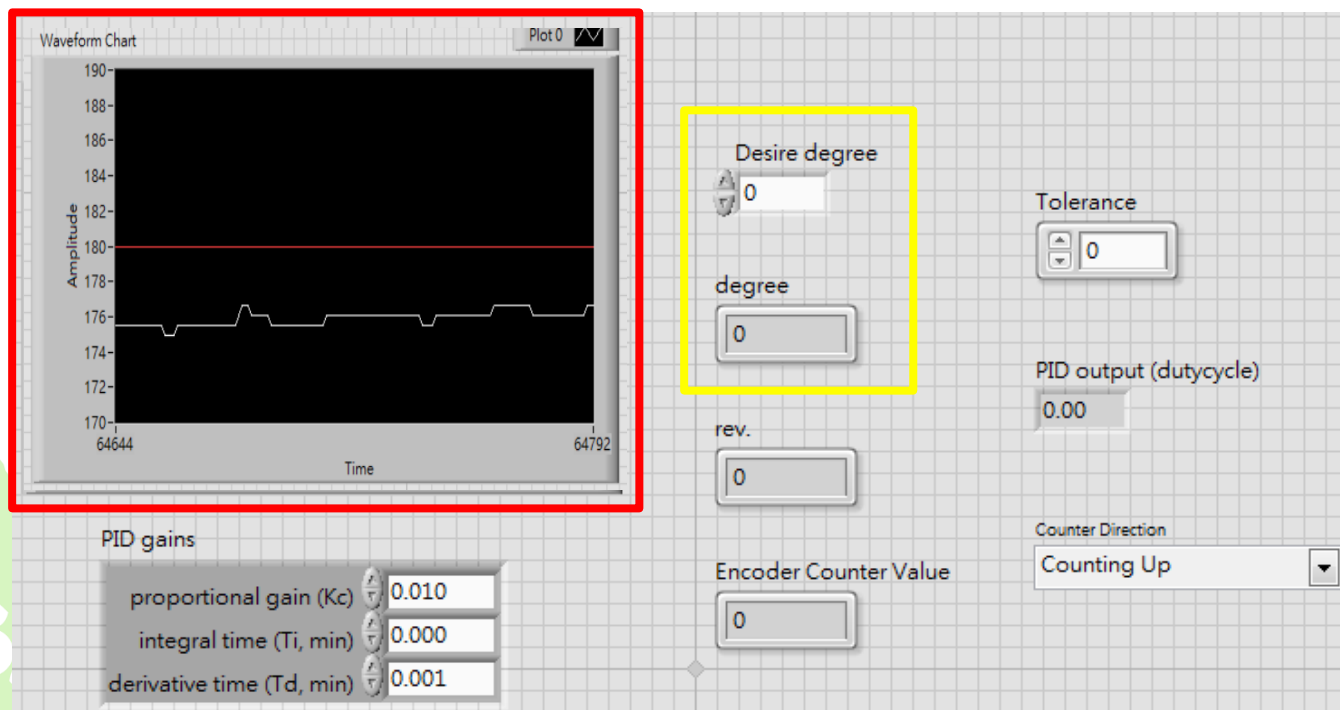
•PID 控制器說明



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 $\leq 100\%$
- 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

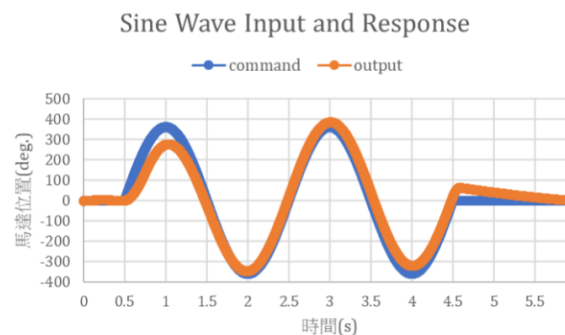
實驗報告說明

• 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

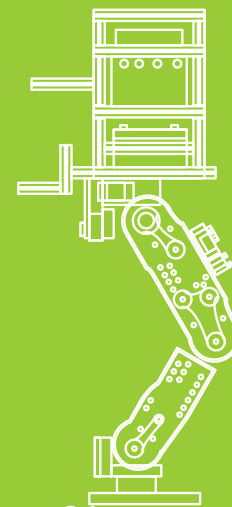
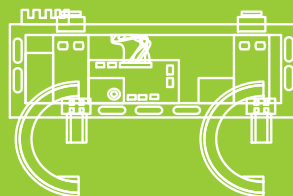
• Sine Wave

- 0° (0~0.5s), **Sine Wave $\pm 360^\circ$, 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





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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，除以一个迴圈的時間