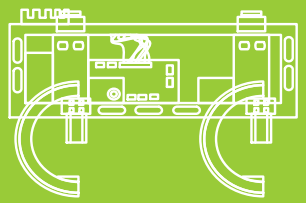
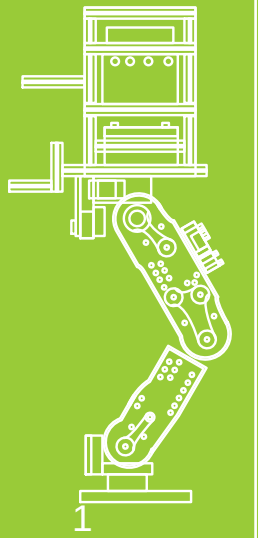
實驗五 步進馬達控制

112-2 機電系統原理與實驗一





實驗目的

- 使用步進馬達驅動器 TMC2209控制步進馬達
  - 馬達正反轉
  - 角度控制
  - 轉速快慢

Step Motor

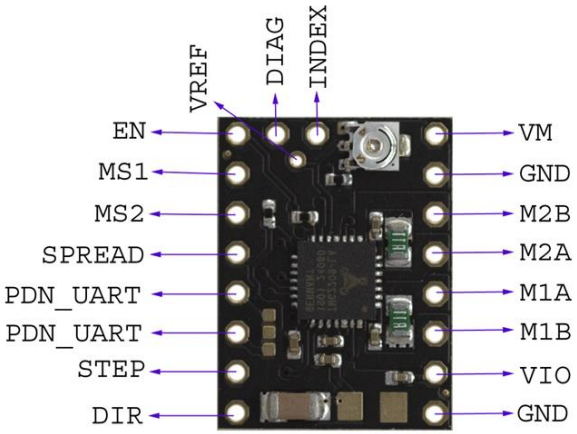
Item	Specification
Model	17HS4401
Motor Type	42 Stepper Motor
Size	NEMA 17
Step Angle	**1.8˚**
Voltage	**12-36V**
Current	1.68A
Resistance per Phase	1.65Ω
Holding Torque	0.4 N.m
Number of Leads	4
Operating Temperature	-20˚C ~ +50˚C
Weight	Approx. 280g
Applications	3D printers, CNC machines, robotic arms, precision positioning systems

Driver

Item	Specification
Model	TMC2209
Operating Voltage	4.75 V – 28 V
Current Per Phase	Max. 2 A
step resolution	1 to 1/256 steps

Wired

Pin Name	Description
VDD & GND	Connected to 5V and GND of Controller
VM & GND	Used to power the motor
M1A, M1B, M2A, M2B	Output Pins, Connected to the 4 Wires of motor
DIR	Motor Direction Control pin
STEP	Steps Control Pin
MS1, MS2	Microstep Selection Pins
FAULT	Fault Detection Pin
PDN_UART	UART and Auto Power Down
CLK	Clock Input
SPRD	Chopper mode selection
DIAG	Diagnostics Output (VIO=error)
INDEX	Index Output (one pulse per each four fullsteps)
EN	Enable Motor Outputs (GND=on, VIO=off)



Wired-Adjust the Verf

Vref PIN: 調整最大承受電流

$$I_{set} = I_{max} * Percentage\ \%$$

$$V_{ref} = I_{set}/係數$$

I_{max} :是馬達的最大額定電流

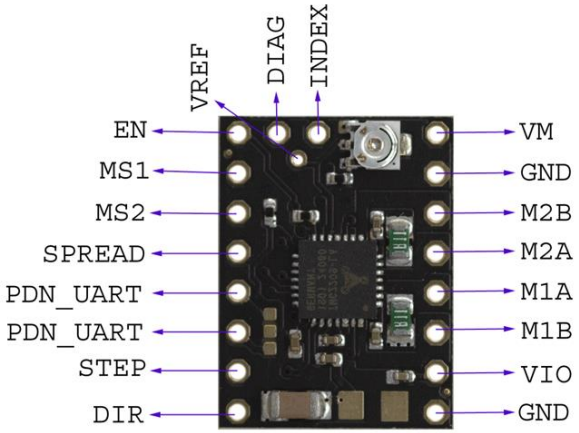
$Percentage\ (\%)$:

馬達驅動電流設定為馬達額定電流的75%至90%，以確保良好的性能和足夠的安全裕度。這有助於防止馬達過熱，同時仍提供足夠的扭力。

係數 = 2.5 (From datasheet)

$$I_{set} = 1.68 * 85\ \%$$

$$V_{ref} = \frac{1.428}{2.5} = 0.571$$



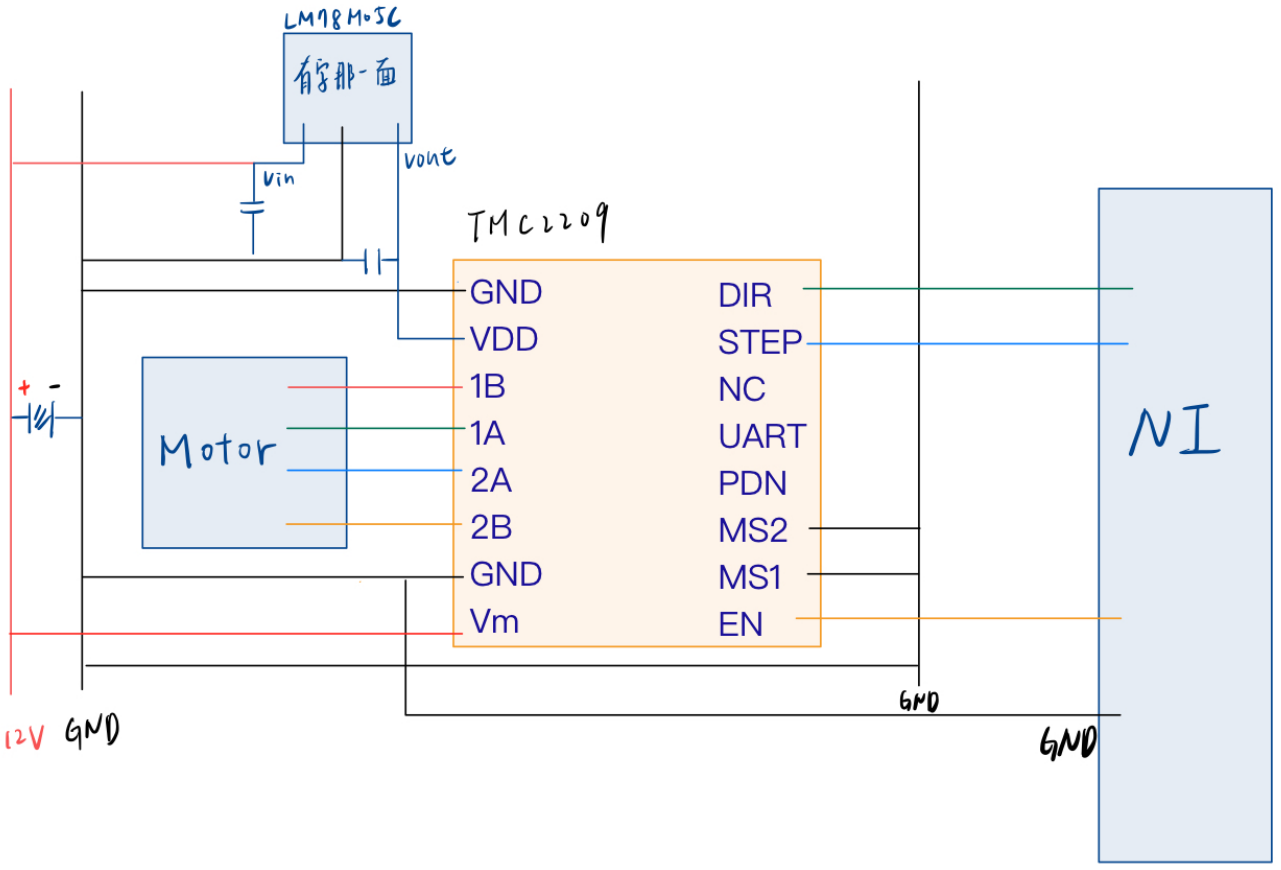
操作影片

: https://www.youtube.com/watch?v=VcyGzXIZm58

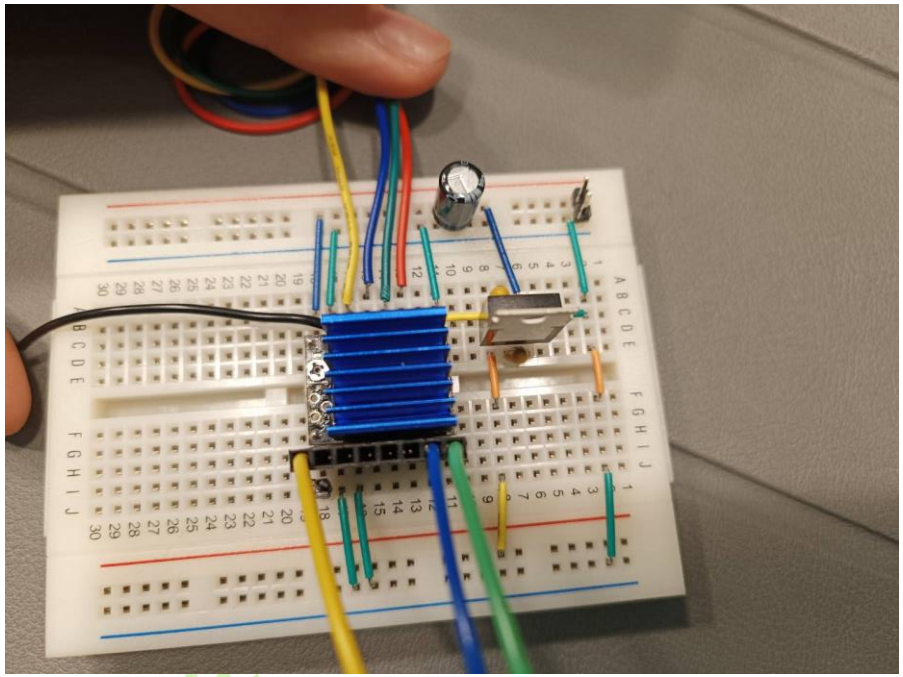
Wired

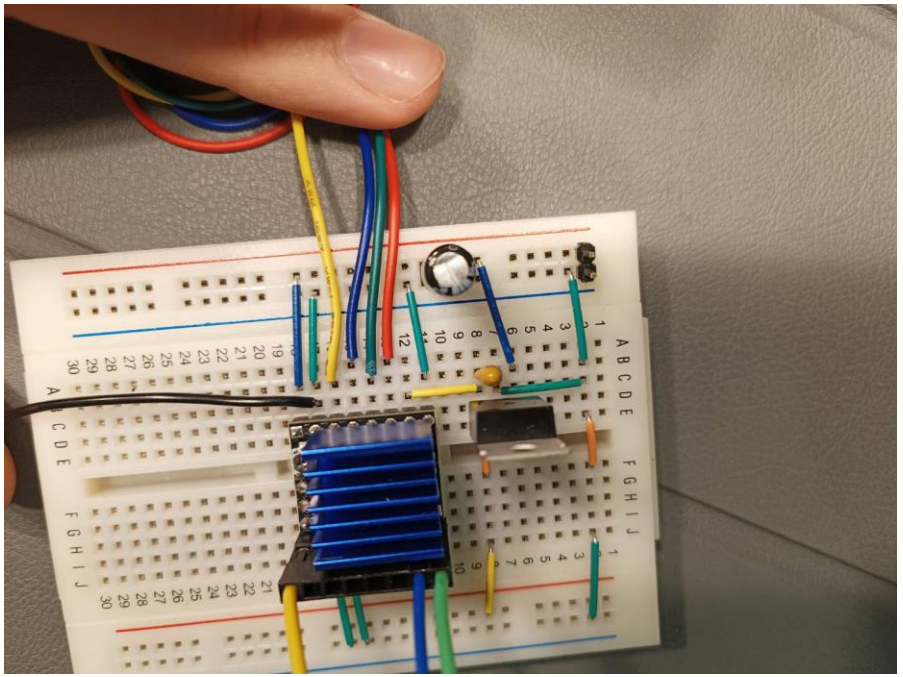
- **材料:**
  - 麵包版
  - TMC2209
  - 線材
  - NEMA 17 17HS4401
  - LM78M05C (5V 穩壓)
  - 鉭質電容 (Tantalum capacitor)　0.33uF 50V *2
  - 電解電容 (Electrolytic capacitor)　47uF 63V *1

Wired


LM1084-3.3
有穿排-面
Vin
Vout
TMC2209
GND
VDD
1B
1A
2A
2B
GND
Vm
DIR
STEP
NC
UART
PDN
MS2
MS1
EN
Motor
+
-
NI
12V
GND
GND
GND

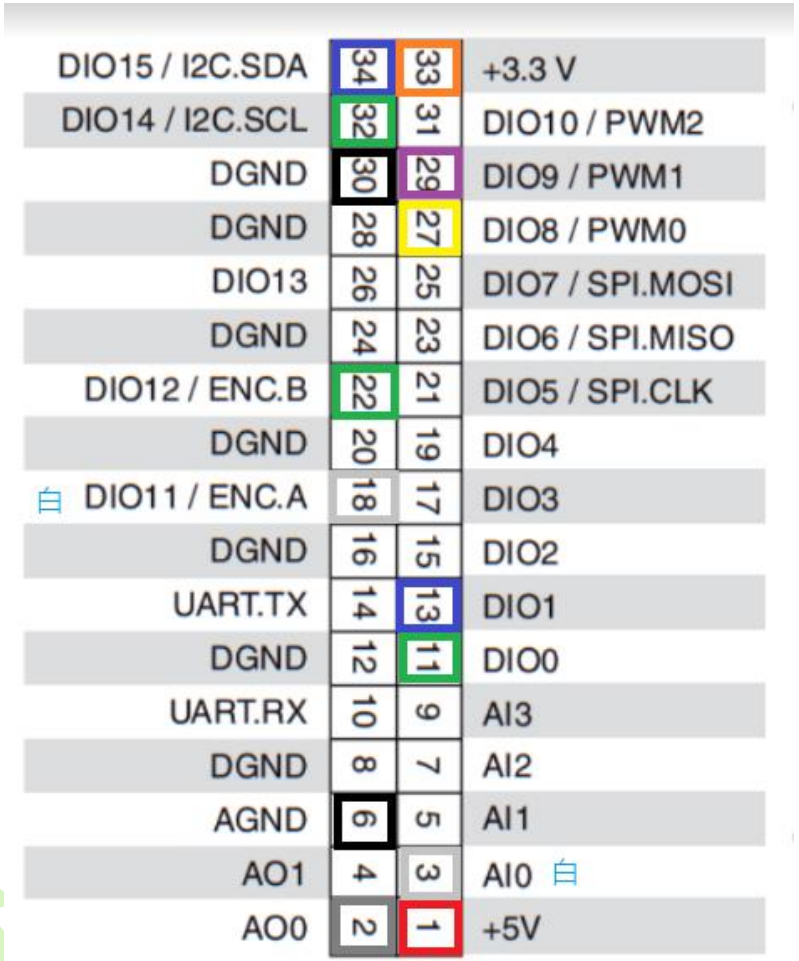
Wired

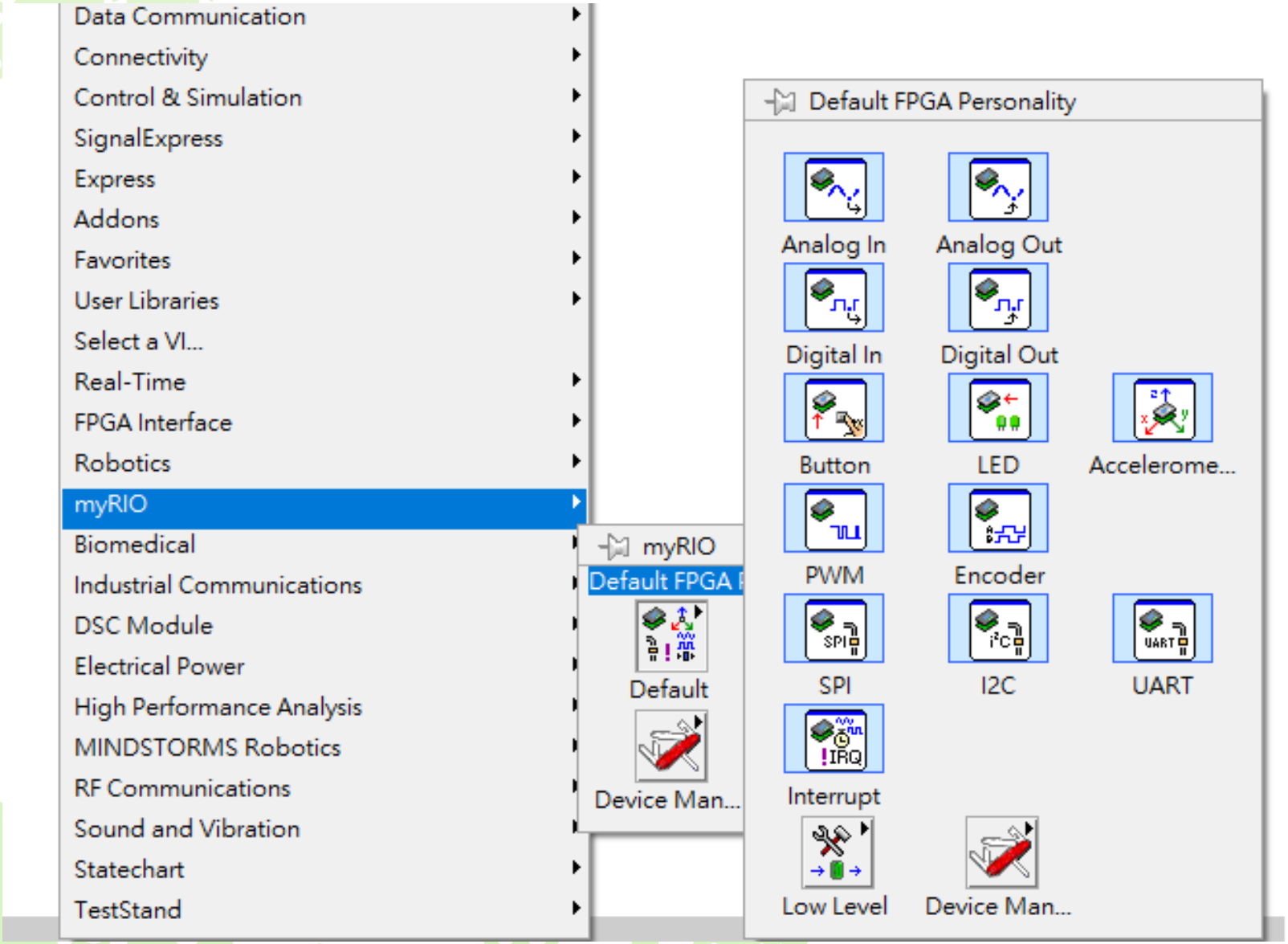




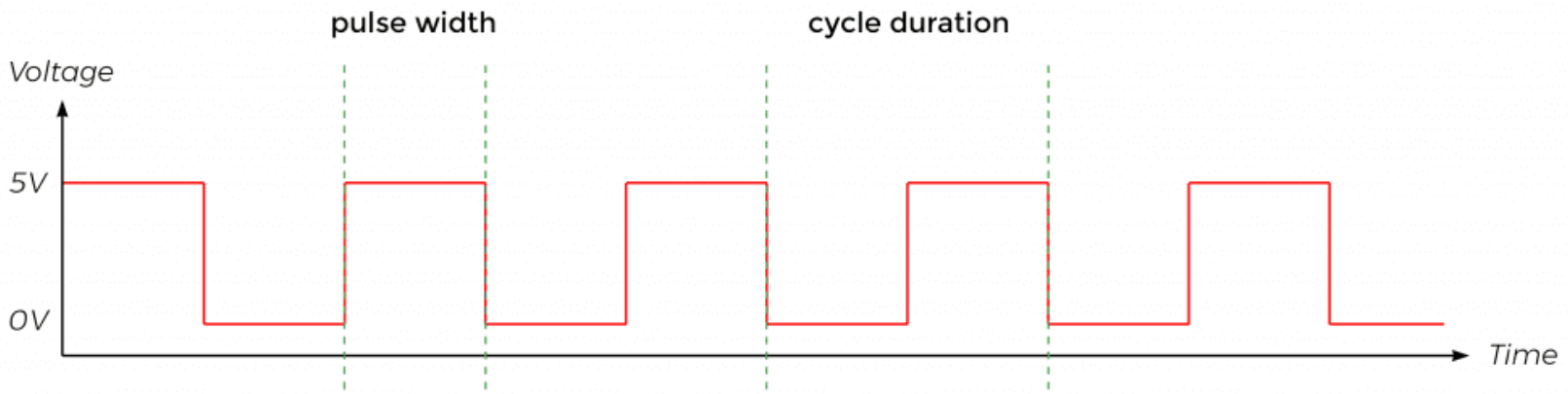
連接myRIO

- 選三個DigitalOutput
  - DIR (控制正反向)
  - En　(T = Disable; F = Enable)
  - STEP
- GND

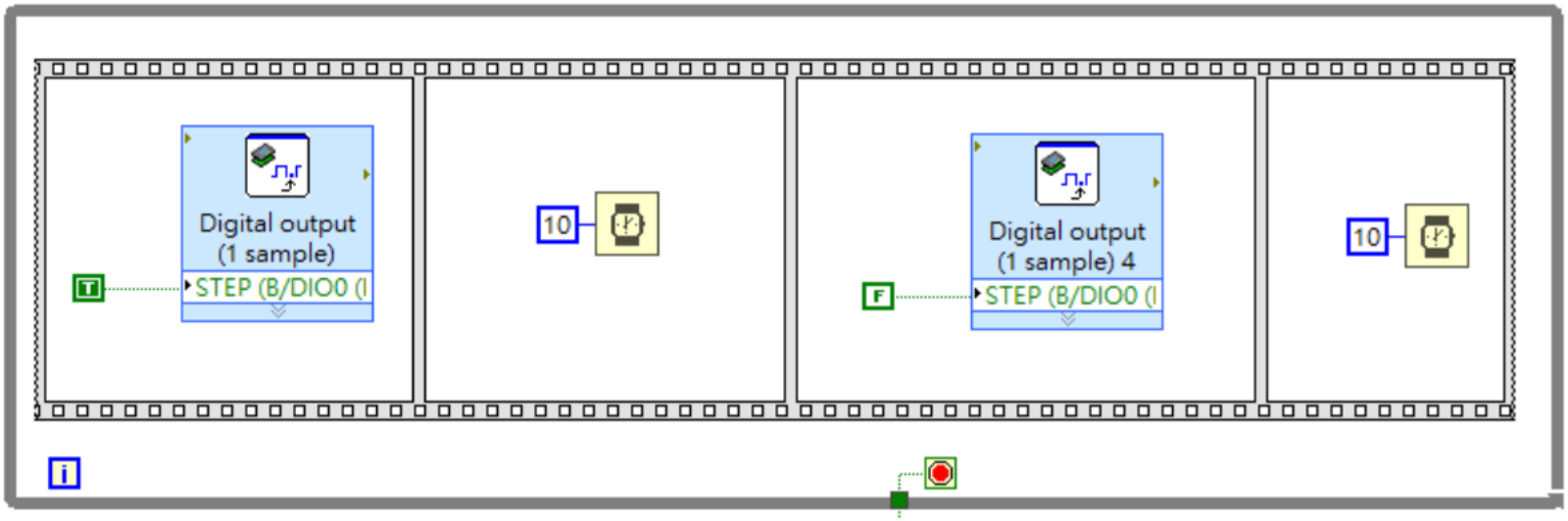



Data Communication
Connectivity
Control & Simulation
SignalExpress
Express
Addons
Favorites
User Libraries
Select a VI...
Real-Time
FPGA Interface
Robotics
myRIO
Biomedical
Industrial Communications
DSC Module
Electrical Power
High Performance Analysis
MINDSTORMS Robotics
RF Communications
Sound and 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...

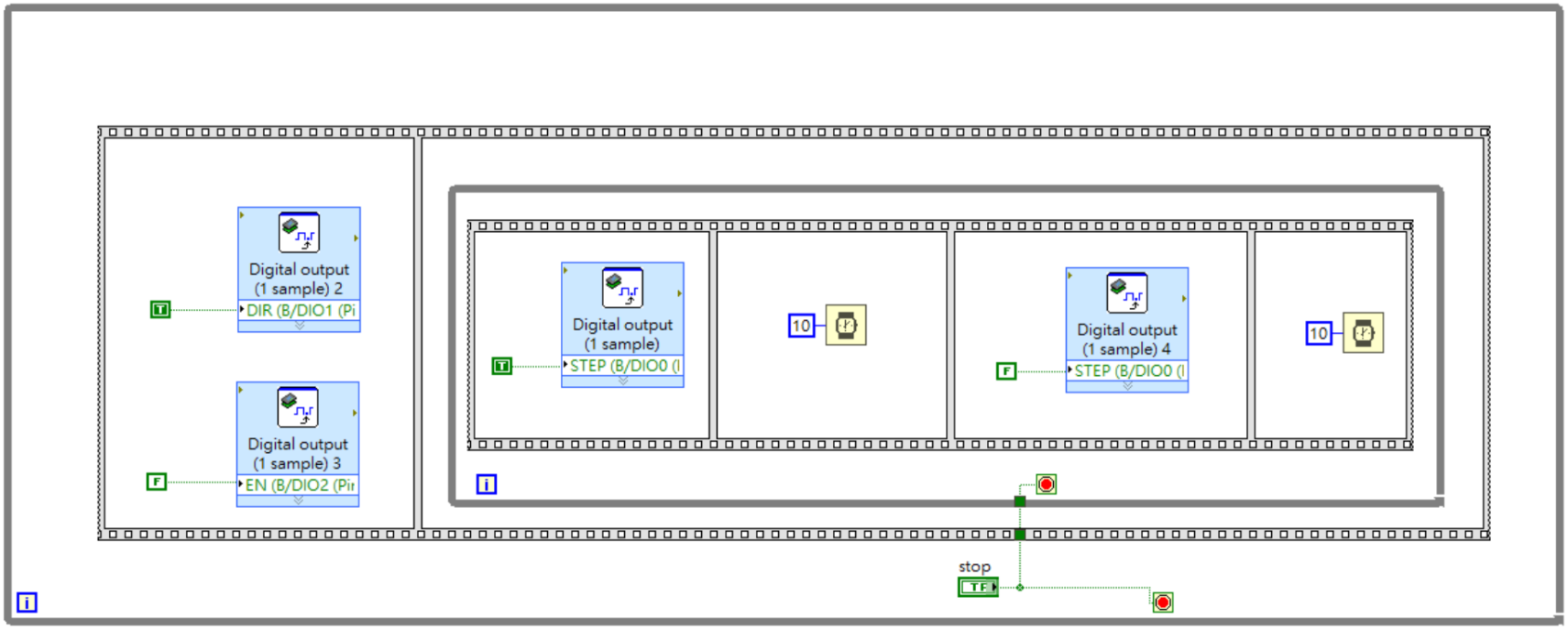
Pulse (Feed to Step signal)



Pulse (Feed to Step signal)

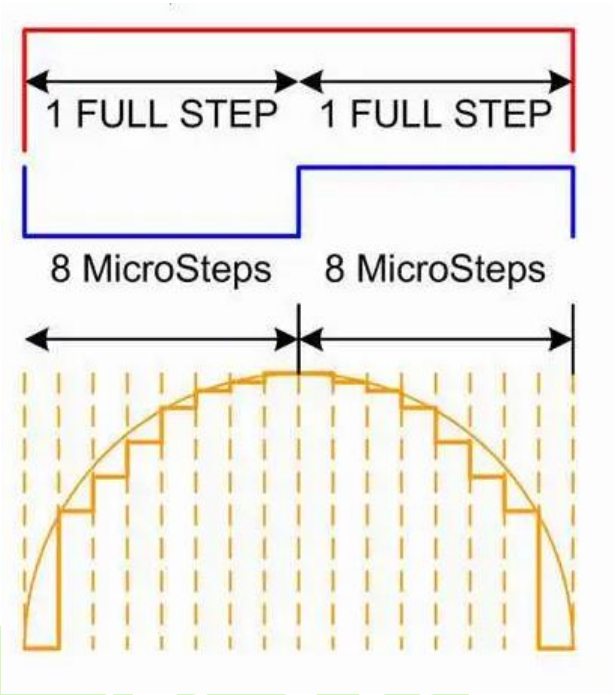


正反轉


Digital output
(1 sample) 2
DIR (B/DIO1 (Pi
Digital output
(1 sample) 3
EN (B/DIO2 (Pi
Digital output
(1 sample)
STEP (B/DIO0 (I
10
Digital output
(1 sample) 4
STEP (B/DIO0 (I
10
stop
TF

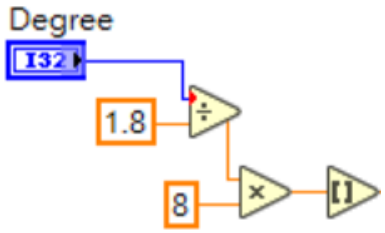
角度控制

步進馬達可以透過 microstep 驅動來實現更精細的步距角控制。
優點: 進行微小角度的位置控制，並且可以減少步進馬達的低速範圍的振動和雜訊



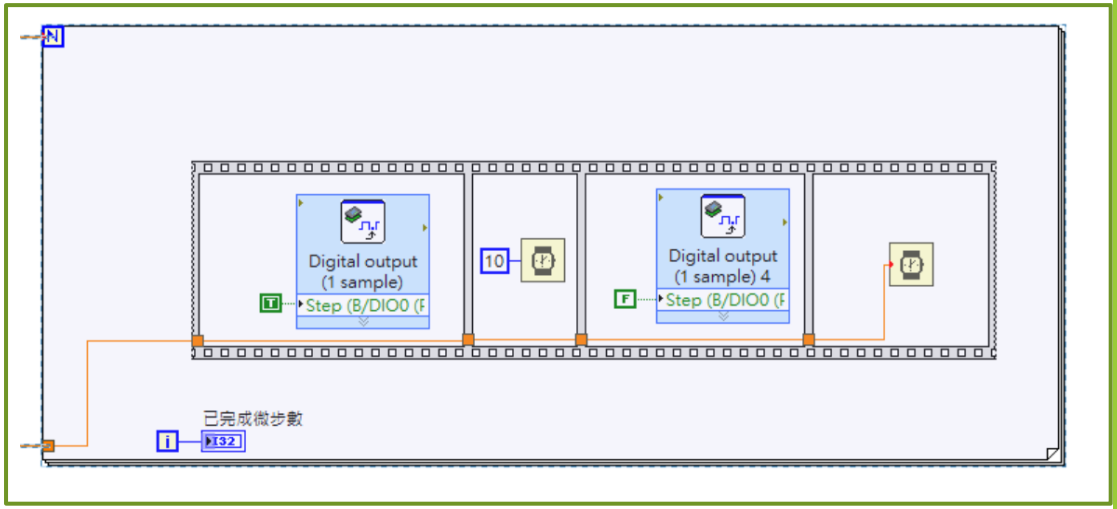
角度控制

計算 Microstep



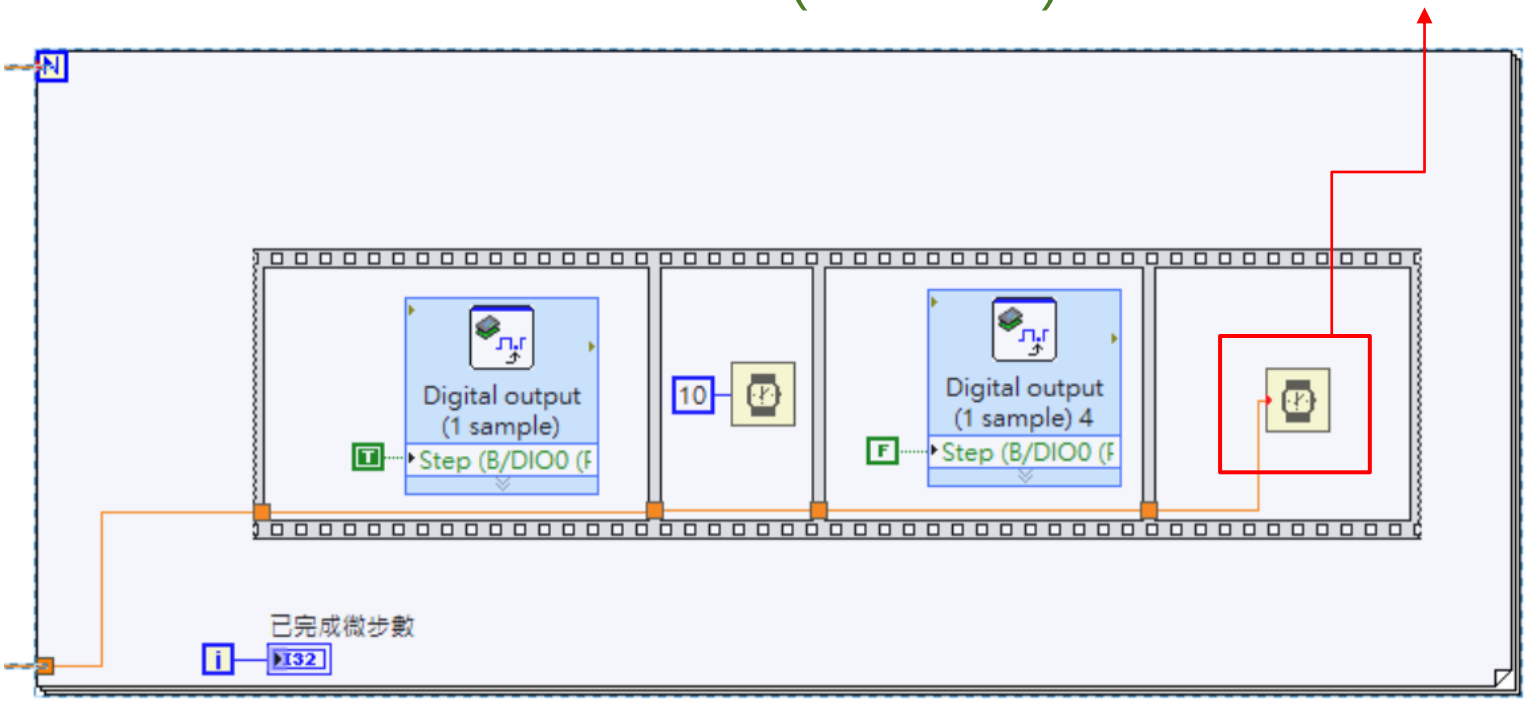
Round To Nearest Function

Microstep 決定了For loop 要跑幾圈



轉速控制

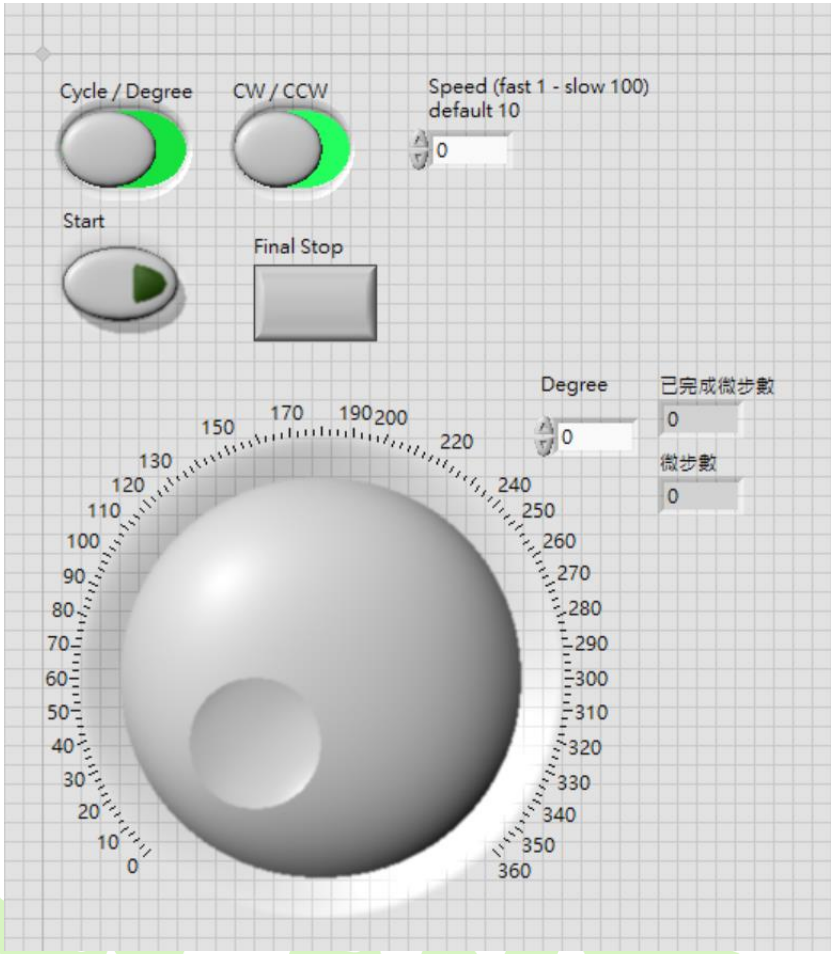
wait的時間決定轉速 (fast 1 - slow 100)
(default 10)



User Interface

- 計算出所需Microstep 並顯示
- 可指定角度(0-360)
- 可指定轉速(1-100)
- 可切換正反轉
- 可指定現在是角度控制還是單純Cycle
- 停止按鈕

User Interface



驗收

- **實驗驗收 17:30前**
  - 轉速控制
  - 角度控制
  - Cycle 控制
  - 正反轉切換