CEC Continuing Education Center

DesignNews

DC Motor Controls with the RP2040 Pico

DAY 4: RP2040 Pico and DC Stepper Motors

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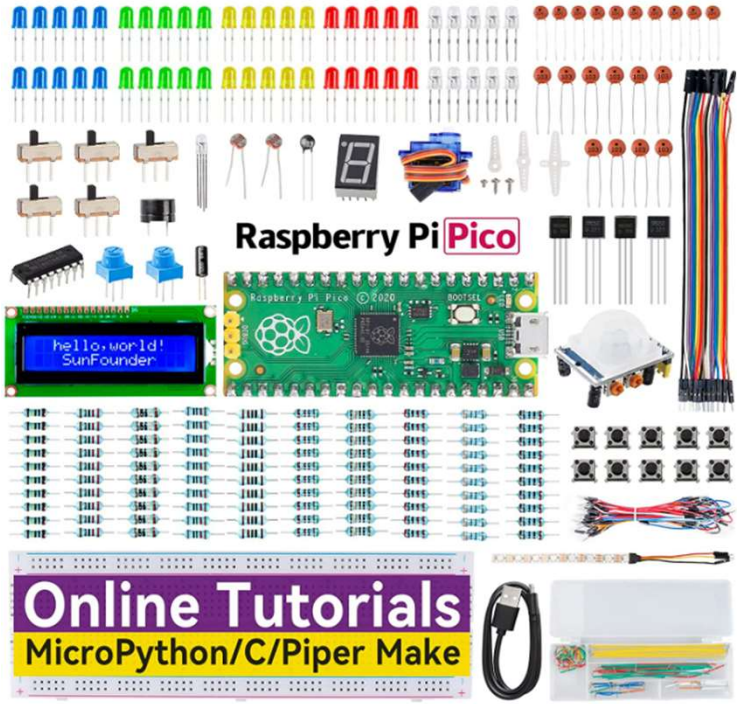
Dr. Don Wilcher

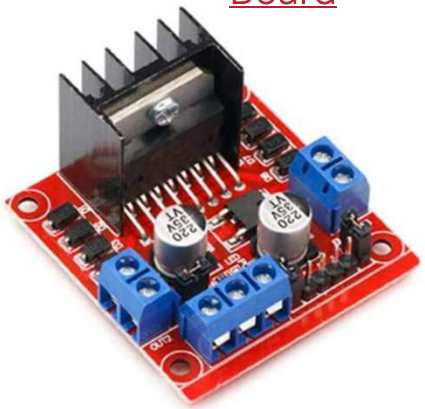
Visit ‘Lecturer Profile’ in your console for more details.

Course Kit and Materials

SunFounder Raspberry Pi Pico Starter Kit



L298N Motor Drive Controller Board



1 Channel Relay Module

ULN2003 4-Phase Stepper Motor with 5V Drive Board

1-5V – 6VDC Motor

Agenda:

- Stepper Motor Basics
- MicroPython Controls Lab Activities
- Lab: Stepper Motor Controller

Raspberry Pi RP2040 :

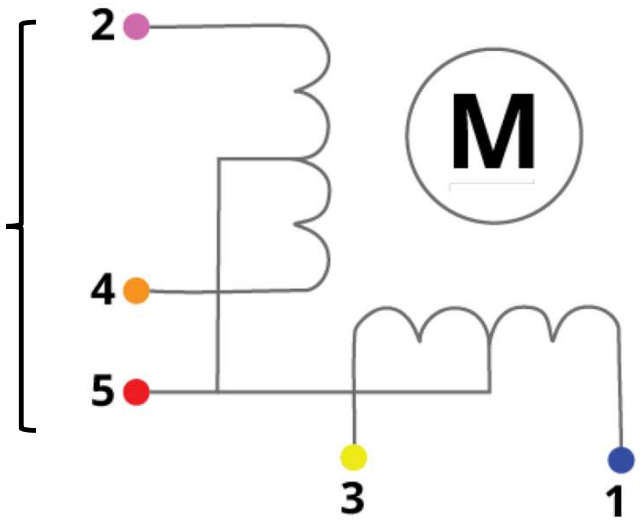
"Raspberry Pi RP2040 SoC, a surprisingly powerful yet radically low-cost microcontroller packing dual Arm Cortex-M0+ processors, the most energy-efficient Arm processor available" (Adams, 2021).

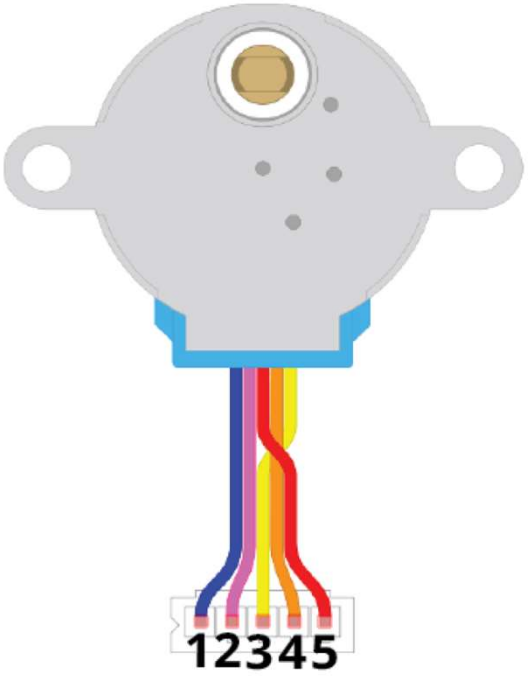
Stepper Motor Basics

- A Stepper Motor
  - a) is a brushless dc motor that moves in discrete steps
  - b) has several coils
    - i. organized in groups called phases
    - ii. each phase gets energized in sequence
- Stepper Motor rotates one step at a time
- A computer can control stepping: can get precise positioning.

Stepper Motor Basics. . .

Stepper Motor Coil Arrangement





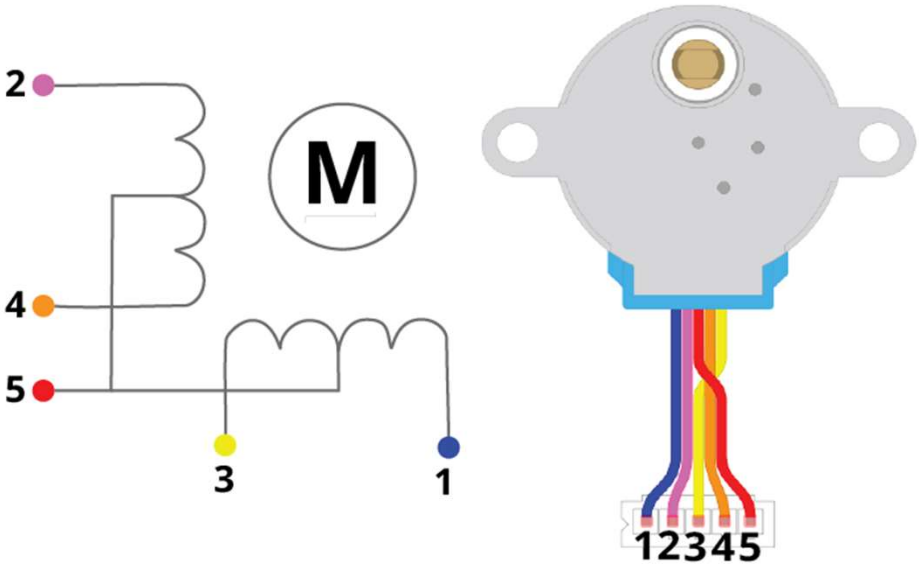
Question 1

A stepper motor is _____

a) a brushed DC motor
b) a DC motor
c) a brushless DC motor
d) an AC motor

Stepper Motor Basics. . .

Stepper Motor Pin Arrangement

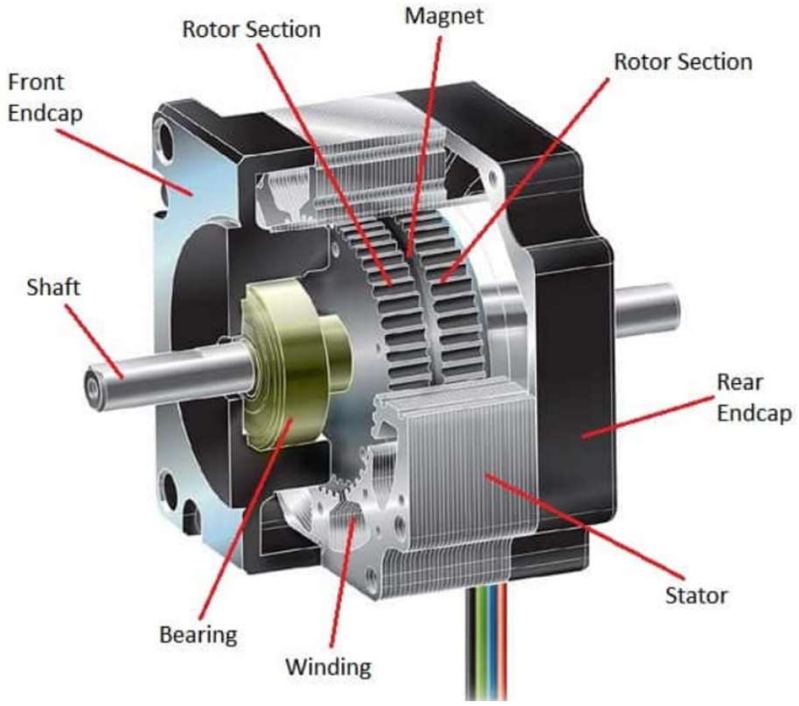


Pin Configuration Details

Pin Number	Coil Number	Colour
1	4	Blue
2	2	Pink
3	3	Yellow
4	1	Orange
5	Vcc	Red

Stepper Motor Basics. . .

Stepper Motor Construction



Stepper Motor Basics. . .

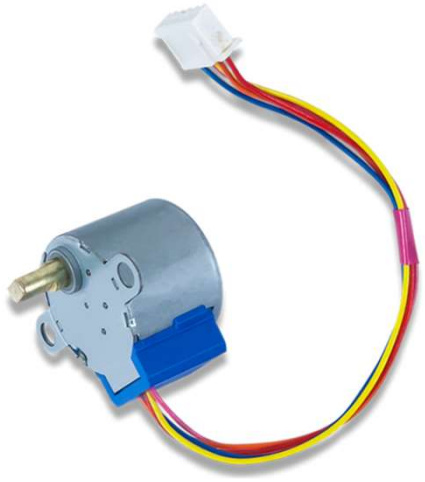
- A Stepper Motor is the preferred type of motor
  a) preferred use in precision motion control
  b) several precision motion applications include
    i. 3D printers
    ii. camera platforms
    iii. x,y plotters
    iv. precision gear motors

Stepper Motor Basics. . .

- Other devices that use stepper motors include
  a) clocks
  b) robots
  c) CNC machines
- Stepper motor is characterized by
  a) low power consumption,
  b) small volume,
  c) high conversion efficiency,
  d) simple structure

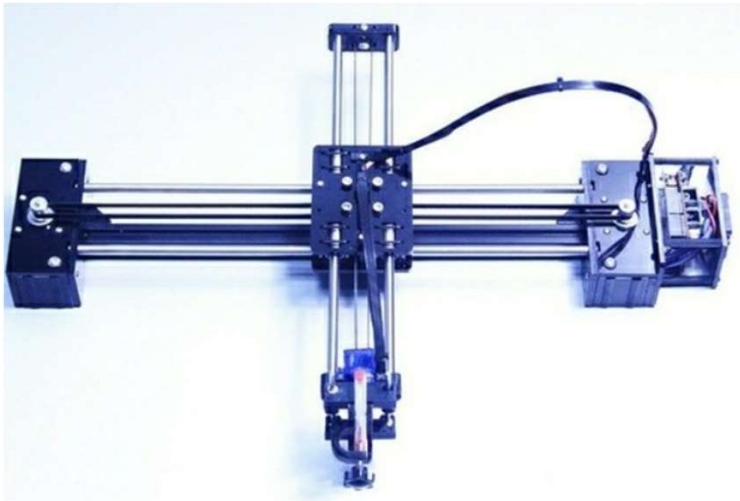
Stepper Motor Basics. . .

Various Stepper Motor sizes



Stepper Motor Basics. . .

Stepper Motor Applications



Question 2

A stepper motor is the preferred type of motor for accurate motion control.

a) False

b) True

MicroPython Control Lab Activities. . .

MicroPython Code

```
1  value = input ("Enter Value")
2  if value == "20":
3      print(value)
4  else:
5      print("Incorrect Value")
6
```

Output

```
Shell
>>> %Run -c $EDITOR_CONTENT

 Enter Value20
 20

>>>
```

MicroPython Control Lab Activities. . . .

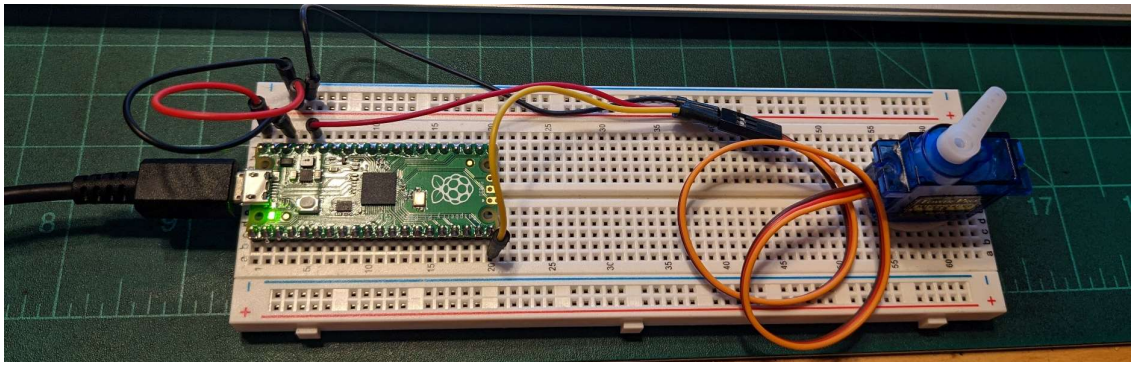
MicroPython Code

```
1  import machine
2
3  led = machine.Pin(25,machine.Pin.OUT)
4
5  bit = input ("Enter Control Bit")
6  if bit == "1":
7      print(bit)
8      led(1)
9      print("LED is ON")
10
11 else:
12     print(bit)
13     led(0)
14     print("LED is OFF")
```

Output

```
Shell
>>> %Run -c $EDITOR_CONTENT
  Enter Control Bit1
  1
  LED is ON

>>>
```



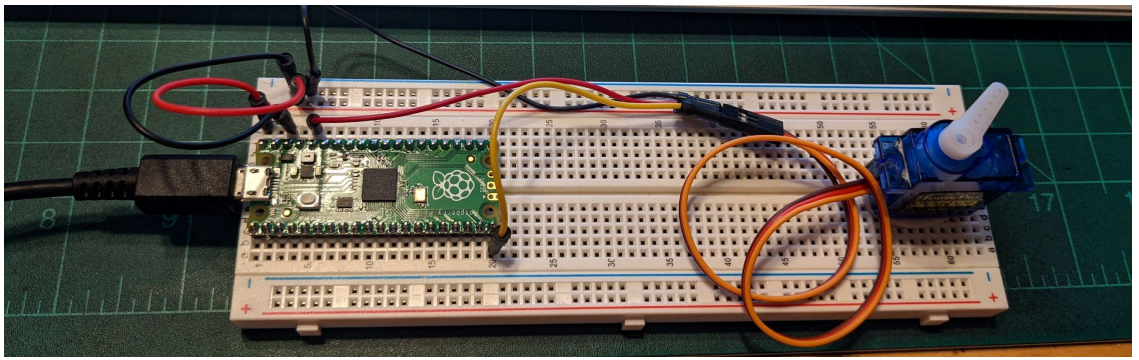
MicroPython Control Lab Activities . . .

MicroPython Code

```
1  import machine
2
3  led = machine.Pin(25,machine.Pin.OUT)
4
5  bit = input ("Enter Control Bit")
6  if bit == "1":
7      print(bit)
8      led(1)
9      print("LED is ON")
10
11 else:
12     print(bit)
13     led(0)
14     print("LED is OFF")
```

Output

```
Shell
>>> %Run -c $EDITOR_CONTENT
  Enter Control Bit0
  0
  LED is OFF
>>>
```



MicroPython Control Lab Activities . . .

MicroPython Code

```
1  from machine import Pin
2  from time import sleep
3
4  IN1 = Pin(2,Pin.OUT)
5  IN2 = Pin(3,Pin.OUT)
6  IN3 = Pin(4,Pin.OUT)
7  IN4 = Pin(5,Pin.OUT)
8
9  pins = [IN1, IN2, IN3, IN4]
10
11 sequence = [[1,0,0,0],[0,1,0,0],[0,0,1,0],[0,0,0,1]]
12
13 while True:
14     for step in sequence:
15         for i in range(len(pins)):
16             pins[i].value(step[i])
17             print(pins[i])
18             print(step[i])
19             sleep(1)
```

Stepper Motor Rotates in CW Direction

Output

```
Shell
Pin(4, mode=OUT)
0
Pin(5, mode=OUT)
0
Pin(2, mode=OUT)
0
Pin(3, mode=OUT)
0
Pin(4, mode=OUT)
1
Pin(5, mode=OUT)
0
```

MicroPython Control Lab Activities . . .

MicroPython Code

```
1  from machine import Pin
2  from time import sleep
3
4  IN1 = Pin(2,Pin.OUT)
5  IN2 = Pin(3,Pin.OUT)
6  IN3 = Pin(4,Pin.OUT)
7  IN4 = Pin(5,Pin.OUT)
8
9  pins = [IN1, IN2, IN3, IN4]
10
11 sequence = [[0,0,0,1],[0,0,1,0],[0,1,0,0],[1,0,0,0]]
12
13 while True:
14     for step in sequence:
15         for i in range(len(pins)):
16             pins[i].value(step[i])
17             print(pins[i])
18             print(step[i])
19             sleep(1)
```

Stepper Motor Rotates in CCW Direction

Output

Shell

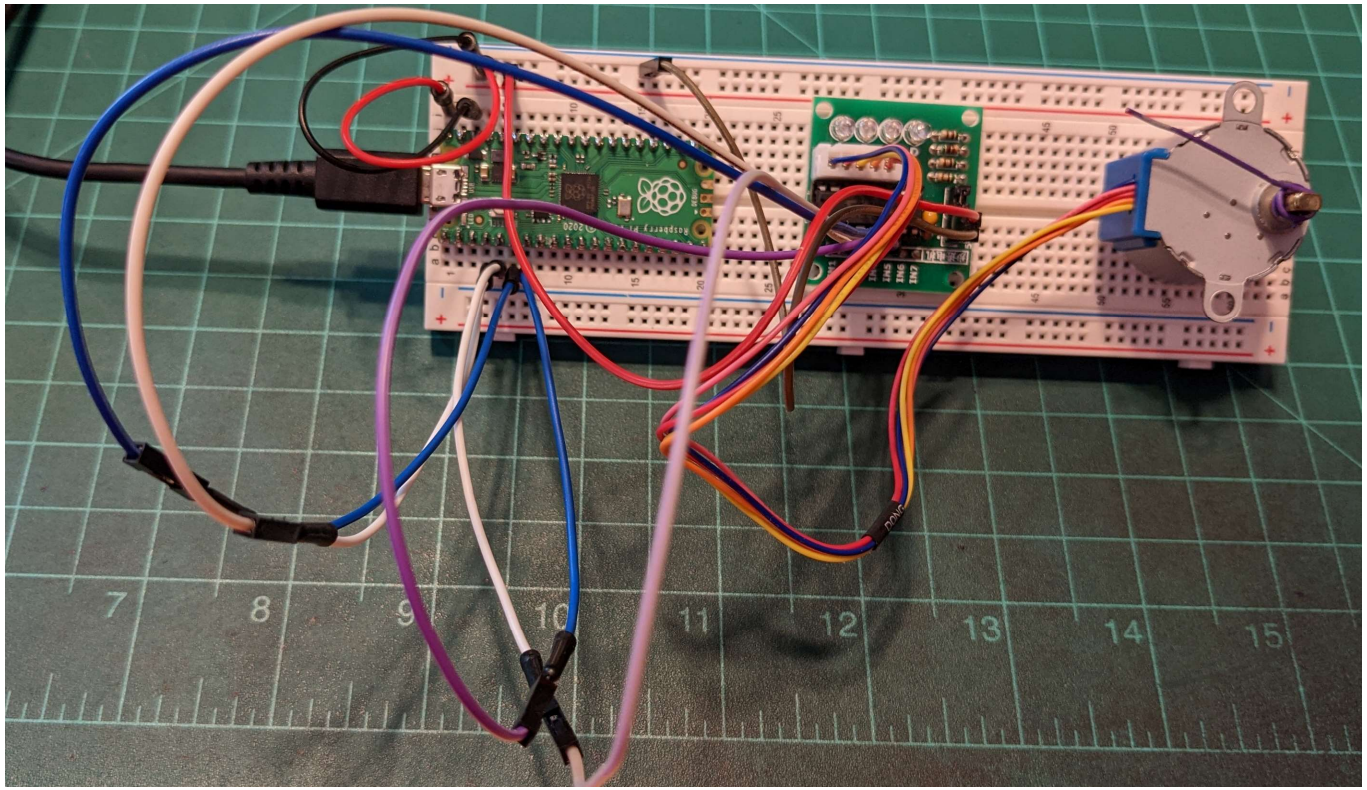
```
Pin(3, mode=OUT)
1
Pin(4, mode=OUT)
0
Pin(5, mode=OUT)
0
Pin(2, mode=OUT)
1
Pin(3, mode=OUT)
0
Pin(4, mode=OUT)
0
```

Question 3

Which sequence allows the stepper motor to rotate in a CCW direction?

a) [1,0,0,0], [0,1,0,0], [0,0,1,0], [0,0,0,1]
b) [1,1,0,0], [0,1,0,0], [0,0,1,0], [0,0,1,0]
c) [0,0,0,1], [0,0,1,0], [0,1,0,0], [1,0,0,1]
d) none of the above

Lab: Stepper Motor Controller



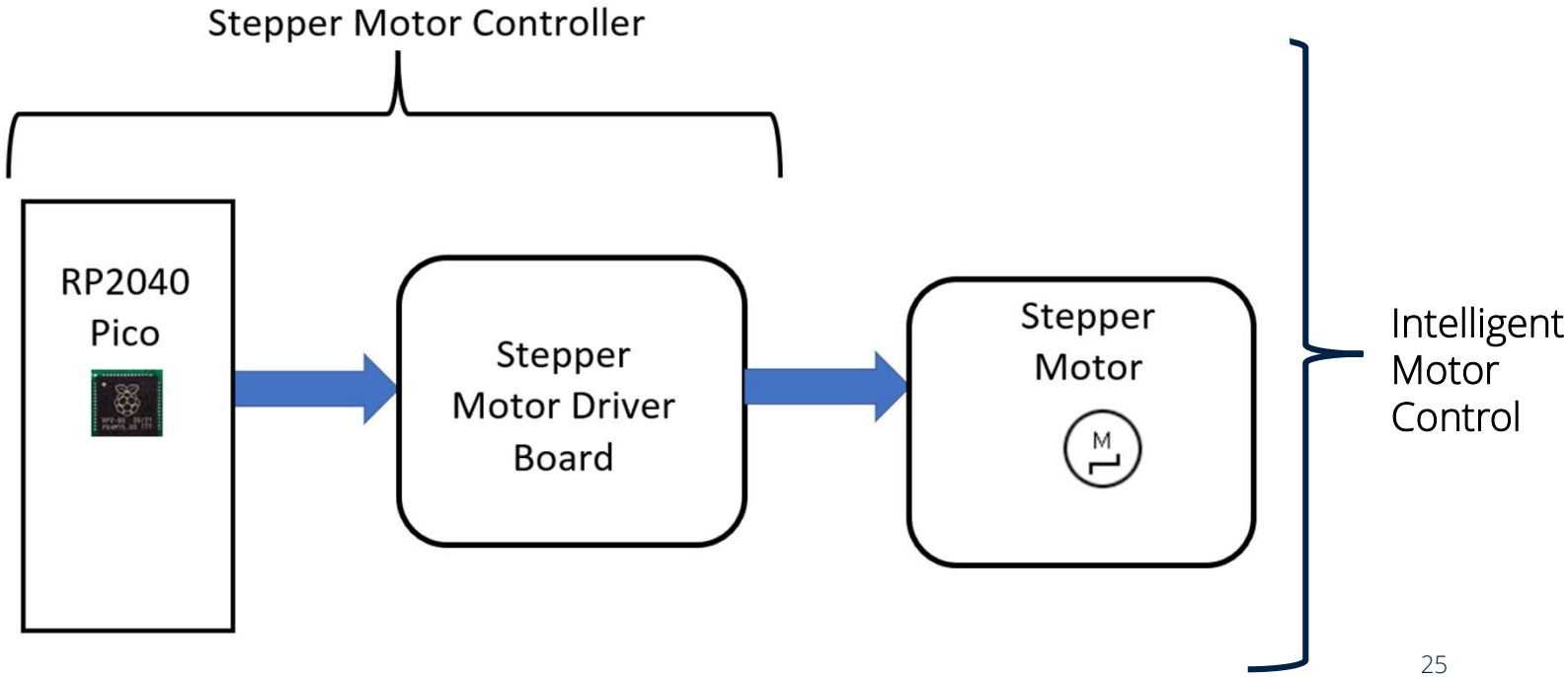
Lab: Stepper Motor Controller. . .

Big IDEAS (Learning Objectives):

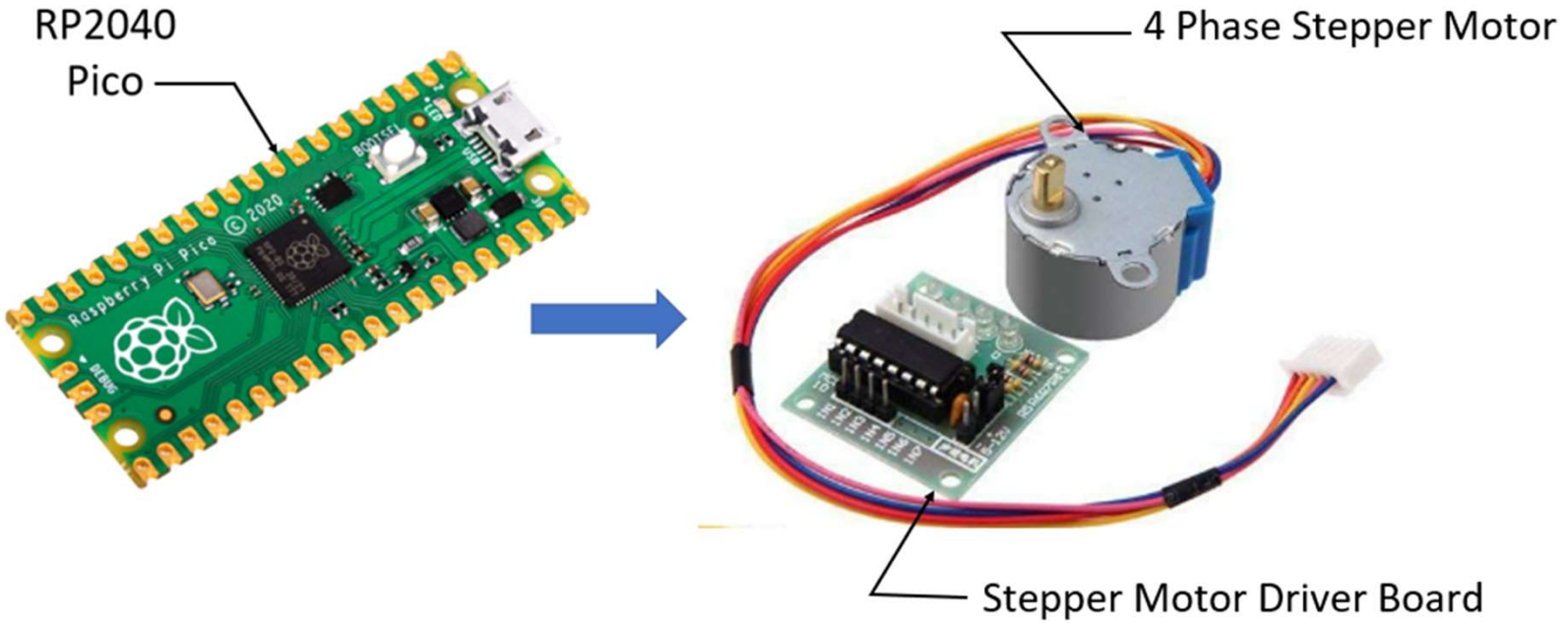
1. The participant will be able to wire a stepper motor to an RP2040 microcontroller.
2. The participant will be able to create a stepper motor controller code using MicroPython.
3. The participant will be able to test a stepper motor controller using MicroPython.

Lab: Stepper Motor Controller. . .

The RP2040 microcontroller easily controls a Stepper motor by providing the appropriate timed control stepped sequences to a driver motor board. The stepper motor board drives the coils of the brushless dc motor device



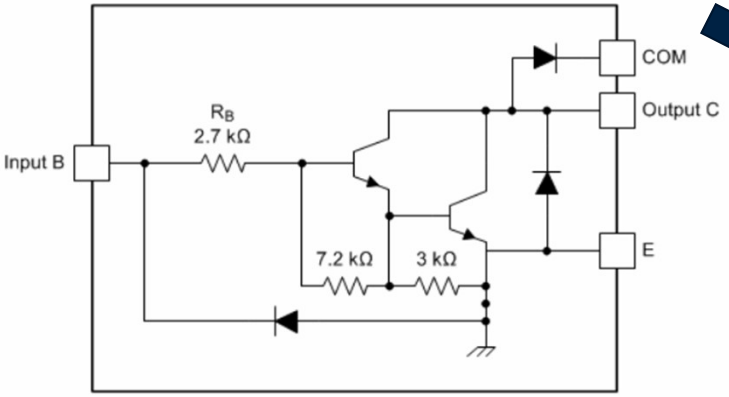
Lab: Stepper Motor Controller. . .



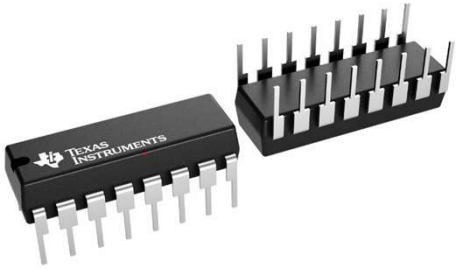
Lab: Stepper Motor Controller. . .

ULN2003 IC on Board

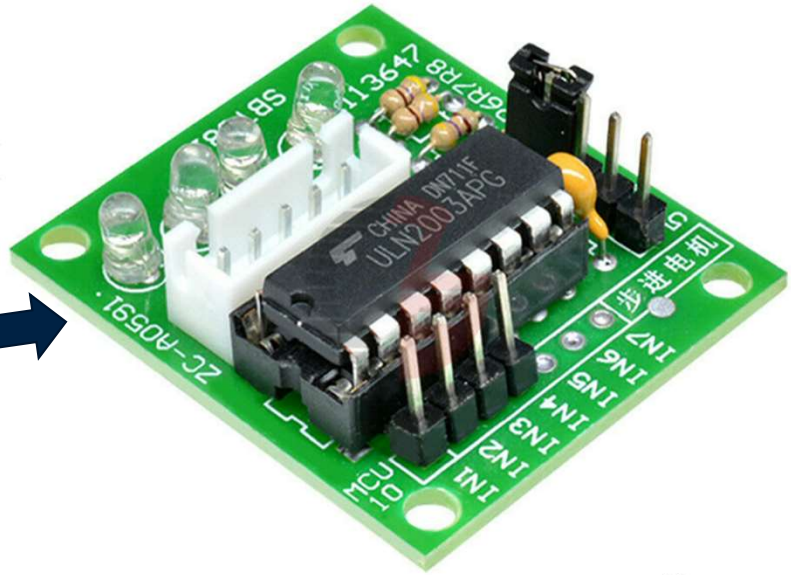
Darlington Driver



16pin Dual-In Package (DIP



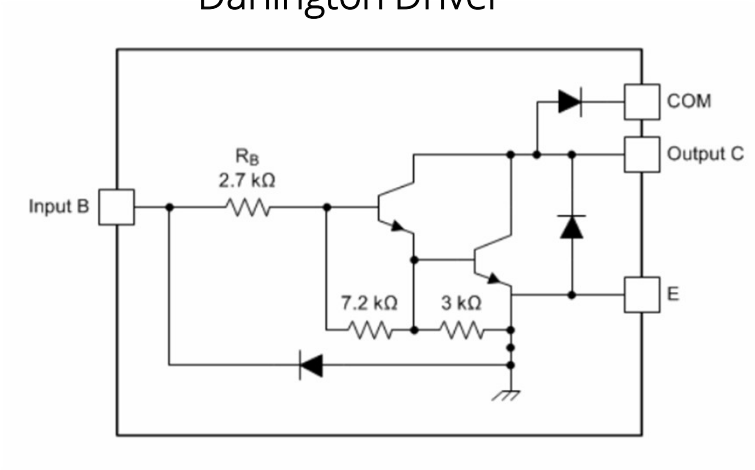
Stepper Motor Driver Board



Lab: Stepper Motor Controller. . .

ULN2003 IC on Board

Darlington Driver

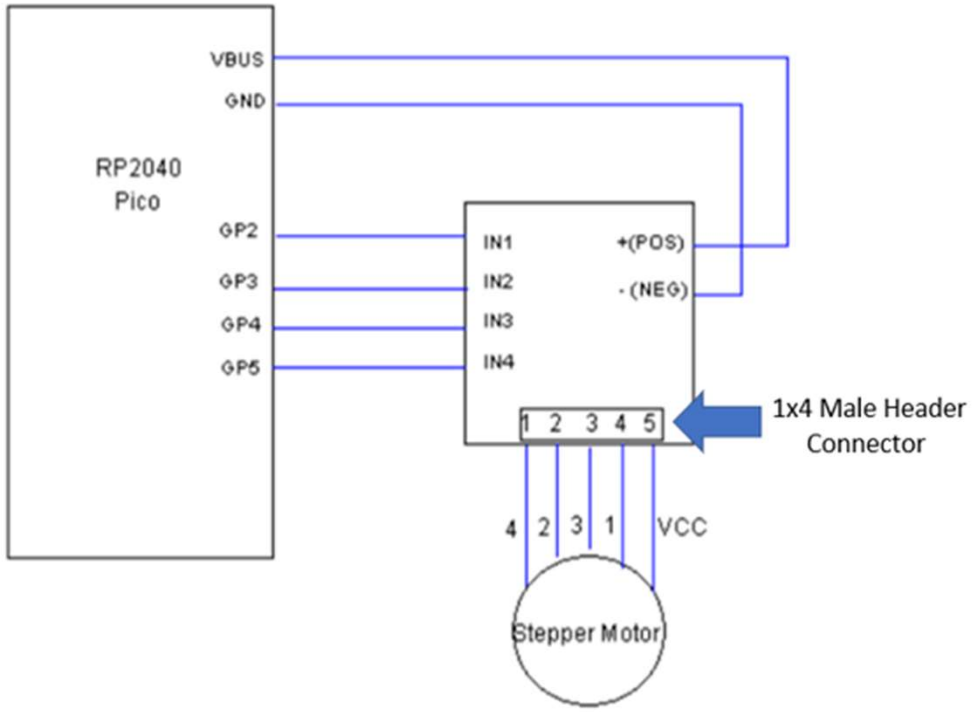


Basic Specifications

ULN2003 IC :

- 7 drivers per board
- CMOS and TTL compatible
- Output Current (Iout) per channel 500mA (max)

Lab: Servo Motor Controller. . .



Stepper Motor
Controller Circuit
Schematic Diagram

Pin Configuration Table

Pin Number	Coil Number	Color
1	4	Blue
2	2	Pink
3	3	Yellow
4	1	Orange
5	VCC	Red

Question 4

The benefit to using a ULN2003 IC with a stepper motor is

a) high input impedance
b) low output voltage
c) high output current per channel
d) none of the above

Lab: Servo Motor Controller. . .

To run the MicroPython Code, click the Run button

```
# import Pins and time libraries
from machine import Pin
from time import sleep

# Assign GPIO Pins to Stepper Motor Driver Board Input Pin Variables
IN1 = Pin(2,Pin.OUT)
IN2 = Pin(3,Pin.OUT)
IN3 = Pin(4,Pin.OUT)
IN4 = Pin(5,Pin.OUT)

# Create an array for Stepper Motor Driver Board Input Pin Variables
pins = [IN1, IN2, IN3, IN4]

# Create an array for Stepper Motor Drive Pattern
sequence = [[1,0,0,0],[0,1,0,0],[0,0,1,0],[0,0,0,1]]

# Enter either 1 or 0
bit = input ("Enter Control Bit")
if bit == "1": # if bit equals 1, start Stepper Motor Drive Sequence-Rotate Stepper Motor
     while True:
         for step in sequence:
             for i in range(len(pins)):
                 pins[i].value(step[i])
                 sleep(0.001)
else: # if bit equals 0, Run program again
    print ("Run User Interface")
```

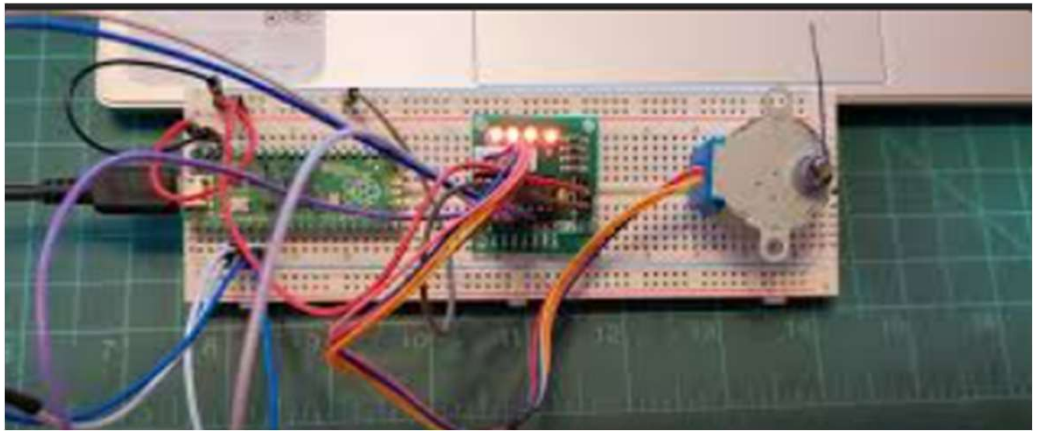
Lab: Servo Motor Controller. . .


```
Shell ×
>>> %Run -c $EDITOR_CONTENT
  Enter Control Bit1


Shell ×
>>> %Run -c $EDITOR_CONTENT
  Enter Control Bit0
  Run User Interface

>>>
```

Stepper Motor Controller
Output



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Question 5

If bit == 0, what is the output response of the MicroPython code?

a) Stepper Motor is Not Running
b) Stepper Motor is Idle
c) Run User Interface
d) none of the above

Thank you for attending

Please consider the resources below:

Adams, J. (2021, February 1). *Raspberry pi rp2040: Our microcontroller for the masses*. https://www.arm.com/blogs/blueprint/raspberry-pi-rp2040

RP2040 Datasheet. (2022). RP2040 datasheet: A microcontroller by raspberry pi. https://datasheets.raspberrypi.com/rp2040/rp2040-datasheet.pdf

Raspberry Pi Pico Resources: Raspberry Pi Documentation - Raspberry Pi Pico and Pico W

28BYJ-48 Stepper Motor with Raspberry Pi Pico using MicroPython: https://microcontrollerslab.com/28byj-48-stepper-motor-raspberry-pi-pico-micropython/

How To Use A Stepper Motor With The Raspberry Pi Pico: https://www.youngwonks.com/blog/How-to-use-a-stepper-motor-with-the-Raspberry-Pi-Pico

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