Lab 4 – Stepper Motor Control

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Grading Rubrics and Schedule

- **Pre-lab assignment (10 points):** Due on Nov. 05, 2018.
- **In-lab assignment (90 points):**
  - **Basic requirement:** 75 points
  - **Something cool:** 15 points
  - **Dates:**
    - **Nov. 05, 2018**
    - **Nov. 12, 2018**
    - **Nov. 19, 2018**
- **There is NO post-lab assignment for this lab!**
- **Your lab will be graded only on Nov. 19, 2018 by the end of class! Do not miss class in that day!**

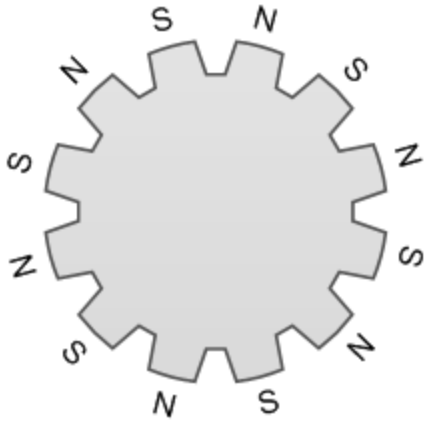
Step Angle

$$Step\ Angle = \frac{360^{\circ}}{steps\ per\ revolution}$$

$$steps\ per\ revolution = P \times T$$

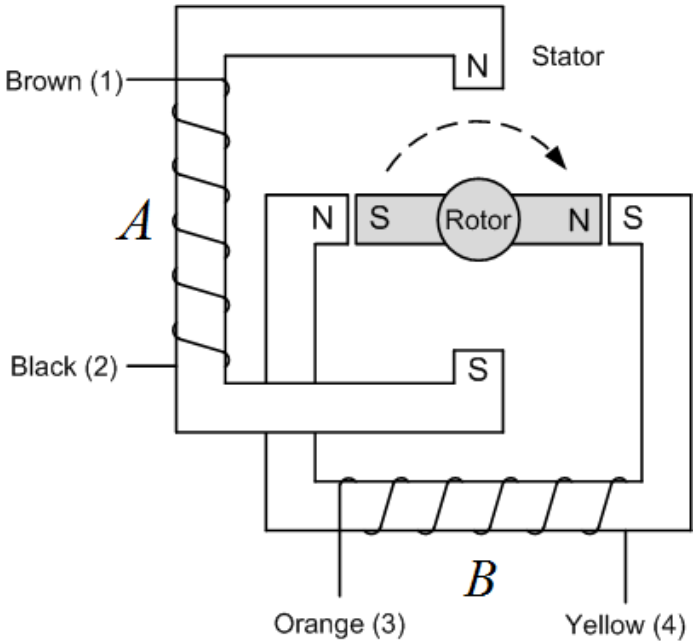
where P is the total number of phases on the stator, and T is the total number permanent-magnetic poles available on the rotor.

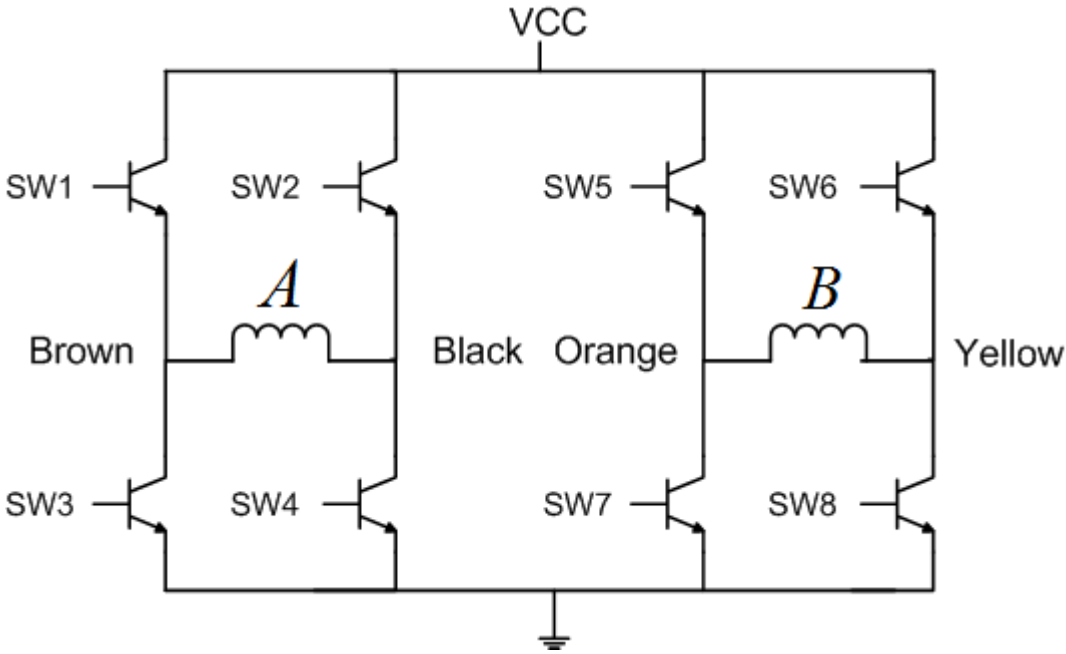
Rotor with only two poles



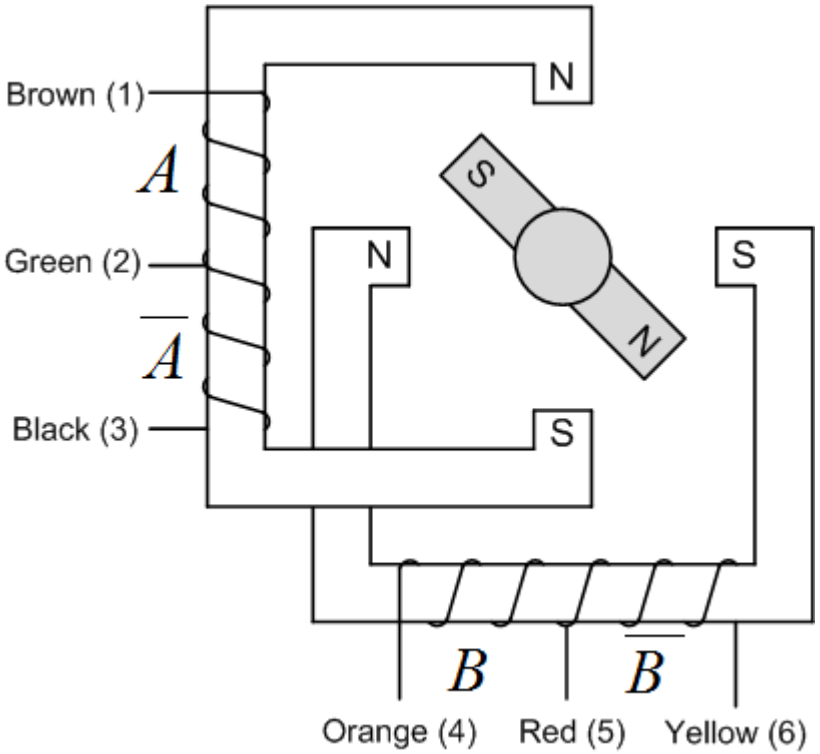
Rotor with 12 poles

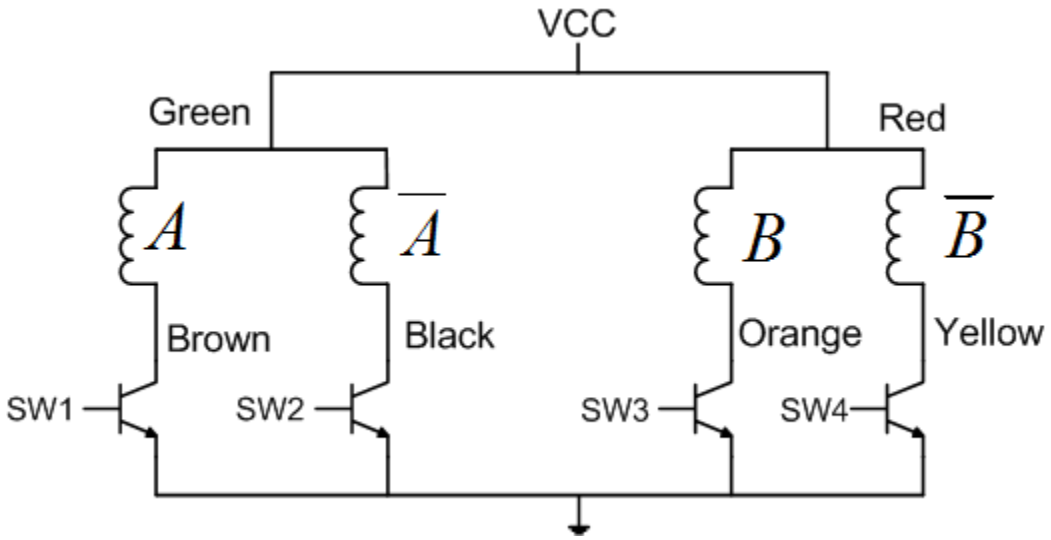
Bipolar Stepper Motor



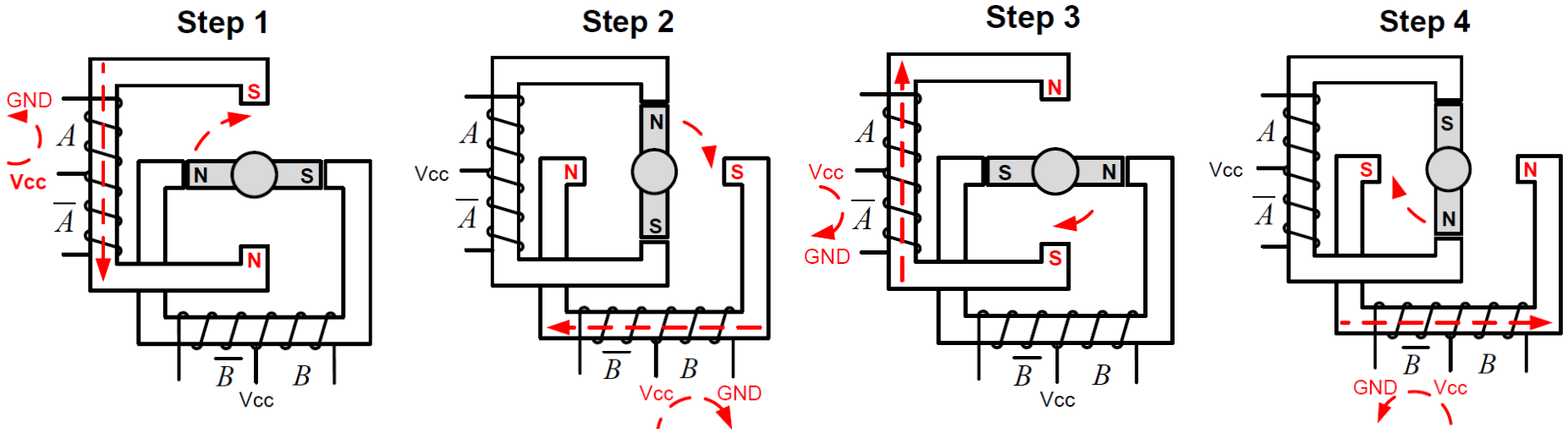


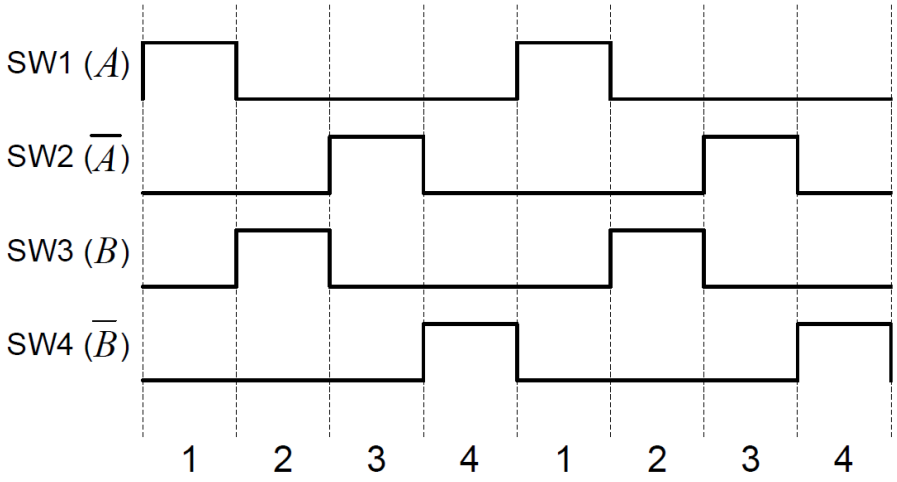
Unipolar Stepper Motor



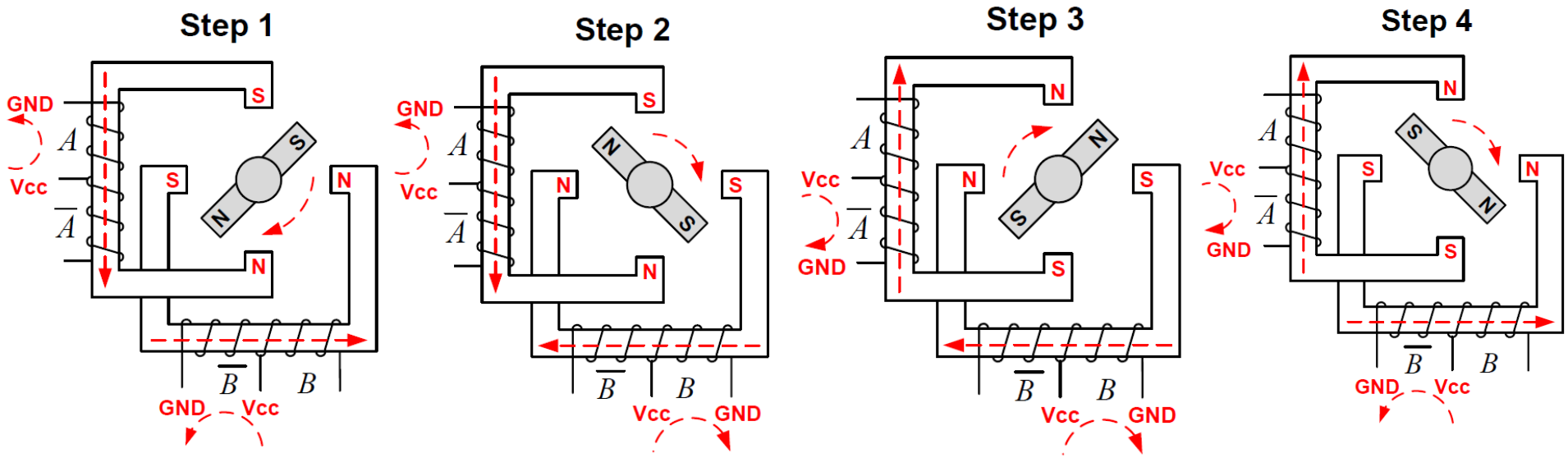


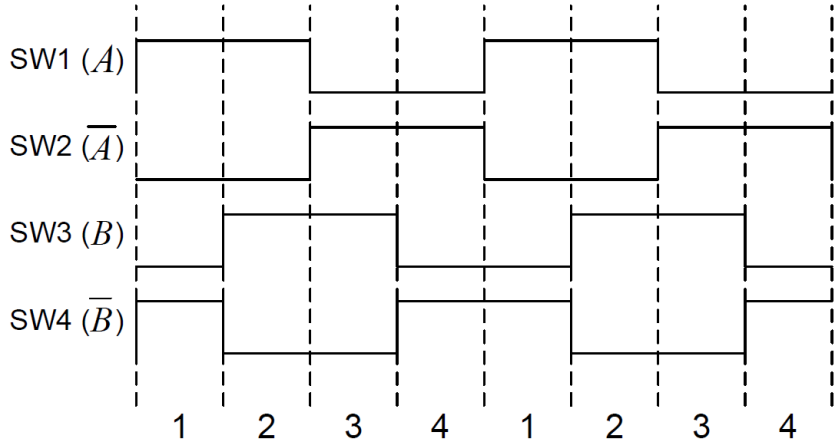
Wave Stepping





Full Stepping





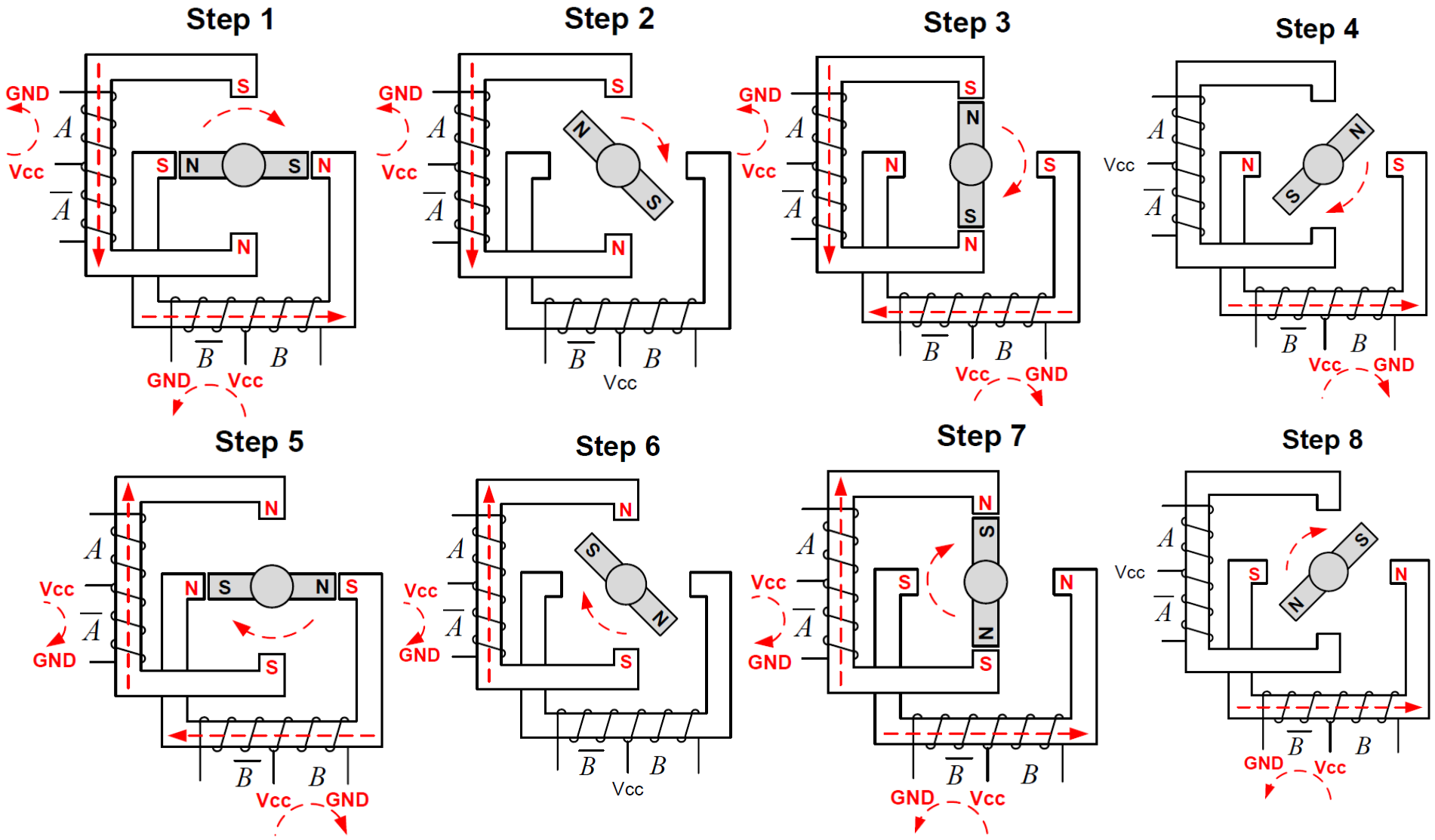
Clockwise sequence:

$$A\bar{B}, AB, \bar{A}B, \bar{A}\bar{B}$$

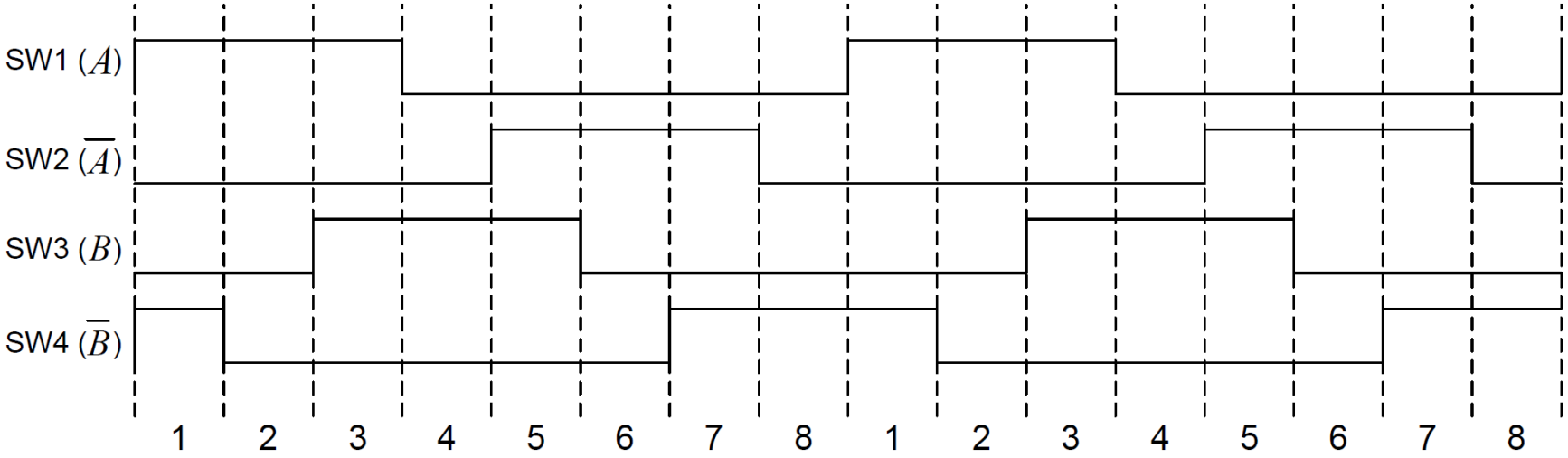
Counter-clockwise sequence:

$$\bar{A}\bar{B}, \bar{A}B, AB, A\bar{B}$$

Half Stepping



Half Stepping



Clockwise sequence:

$$A\bar{B}, A, AB, B, \bar{A}B, \bar{A}, \bar{A}\bar{B}, \bar{B}$$

Counter-clockwise sequence:

$$\bar{B}, \bar{A}\bar{B}, \bar{A}, \bar{A}B, B, AB, A, A\bar{B}$$

Basic requirement

- Turn the stepper motor **EXACTLY** 360 degrees clockwise by using half-stepping *or* full-stepping. **(75 points).**

Full-stepping

- Internal motor: 32 steps per revolution
- Great reduction ratio: 1/63.68395, approximately 1/64
- Thus, it takes $32 \times 64 = 2048$ steps per revolution for the output shaft

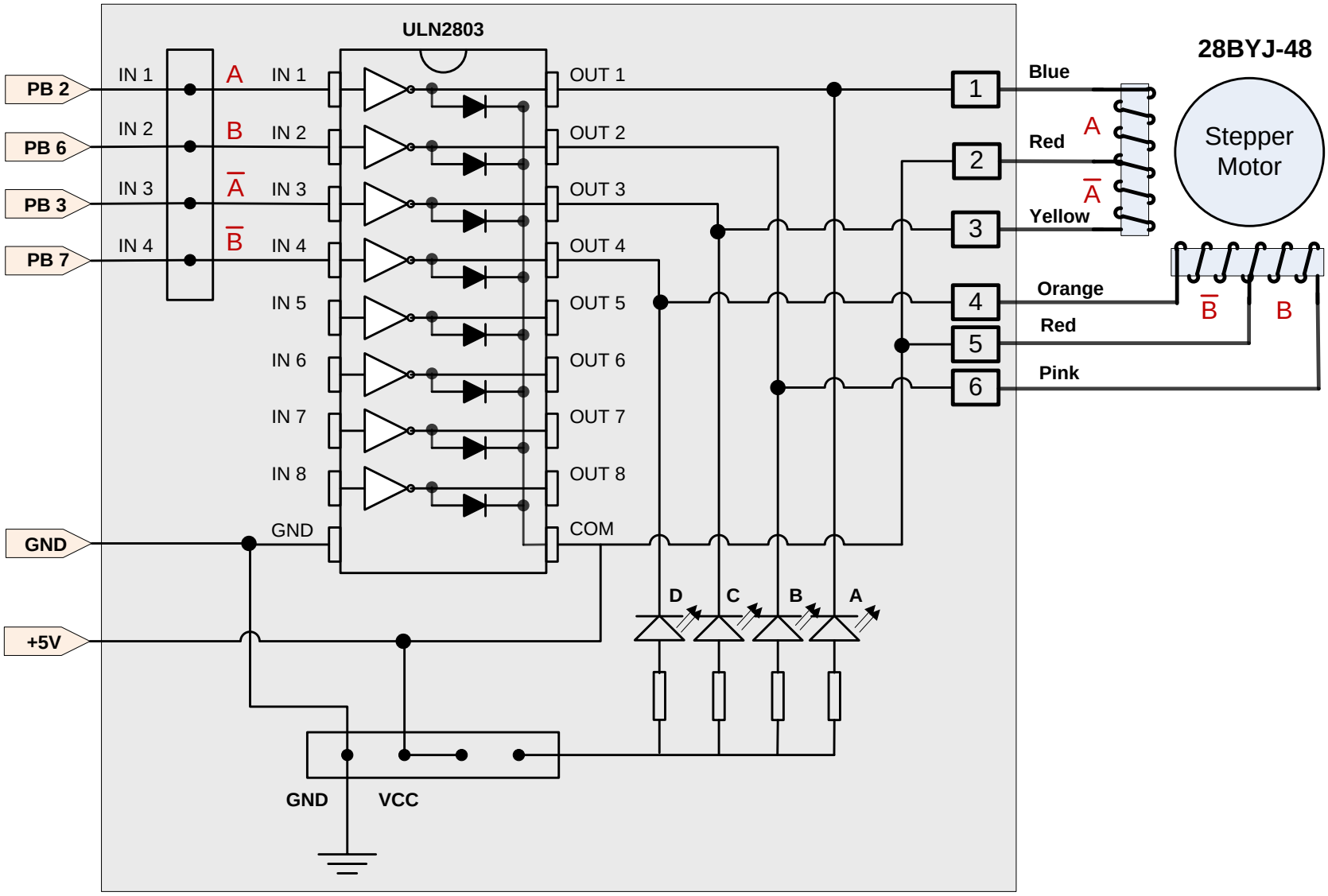
Half-stepping

- Internal motor: 64 steps per revolution
- Great reduction ratio: $1/63.68395 \approx 1/64$
- Thus, it takes $64 \times 64 = 4096$ steps per revolution for the output shaft

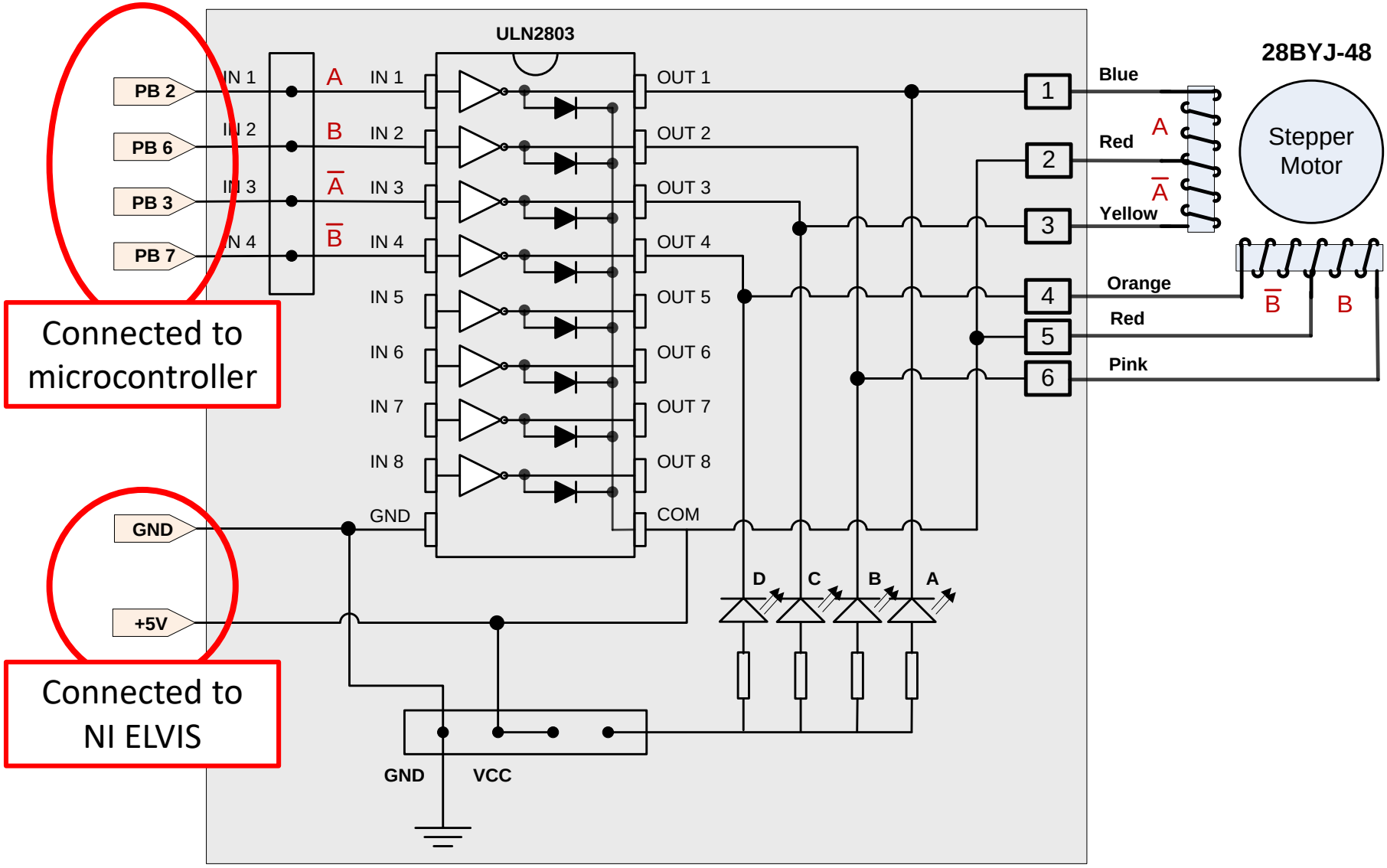
Something cool

- **These are some examples of something cool (you just need to do one of them):**
  - Use the keypad to set a specific degree to which the motor should rotate.
  - The motor should smartly choose either clockwise or counter-clockwise to make a minimum amount of rotation.
  - Display the degree and turning direction of the motor in real time using the LCD.
  - Perform micro-stepping to rotate the motor smoothly.
  - Etc.
- **NOTE:** If you want to get 100 points in this lab, you will have to do something cool!

Interfacing the Stepper Motor



Interfacing the Stepper Motor



Programming Assignment

- A **startup Keil uVision project** is available online. It contains the following files: ***main.c***, and ***SysClock.c.***
- Extract the zip-file and open **Lab4.uvprojx** to start working on your assignment (there is no need to set up anything in the project).
- In order to complete the basic lab requirement, you only have to write code in the ***main.c*** file.
- More specifically, you should complete two methods:
  - **GPIO_Motor_Init():**
    - Configure GPIO port B pins to drive the stepper motor.
  - **Full_Stepping()**:
    - Write code to drive the stepper motor using the full stepping method.

Office Hours

- Office hours will be **ONLY** on **Wednesdays from 2pm to 4pm**!
- If you need more time to finish the assignment, do not miss classes and/or office hours!

- **No additional office hours will be offered!**

Hands-On Lab

- We will have an **ungraded** hands-on lab on Nov. 26 and Dec. 03, 2018!
- On this hands-on lab, the T.A. will show step-by-step how to write an assembly project to turn on the red and green LEDs.
- **Your participation in the hands-on lab will be awarded with up to 10 points in the lab with the lowest grade.**