Lab 2: Stepper Motor Control

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Lab 2 Objectives

- **First Objective (55 points):**
  - Turn the stepper motor **EXACTLY** 360 degrees clockwise by using full-stepping.

- **Second Objective (15 points):**
  - Re-implement the first objective using Assembly language.

OR

  - Use the joystick to control the motor in the following way:
    - Make the motor move **clockwise using full-stepping** when the **right button** is pressed.
    - Make the motor move **counter-clockwise using full-stepping** when the **left button** is pressed.
    - Make the motor move **clockwise using half-stepping** when the **up button** is pressed.
    - Make the motor move **counter-clockwise using half-stepping** when the **down button** is pressed.

    - **Note:** For each button press, the motor should only do ONE full rotation.

Lab 2 Schedule

- **Pre-lab Assignment** (10 points):
  - **For Monday labs:** Due on March 11, 2019.
  - **For Wednesday labs:** Due on March 13, 2019.

- **Lab 2** will take a total of **two weeks**:
  - You should show your working lab in the second week:
    - **For Monday labs:** Due on March 25, 2019.
    - **For Wednesday labs:** Due on March 27, 2019.

    - No extension will be given!

Grading Policy for Lab 2

Description	Points	Due date for Monday labs	Due date for Wednesday labs
Pre-lab assignment	10 points	March 11	March 13
Attendance and Class Participation	10 points	March 11 and 25	March 13 and 27
Code Organization	10 points	March 25	March 27
First Objective	55 points	March 25	March 27
Second Objective	15 points	March 25	March 27
	Total:	**100 points**	

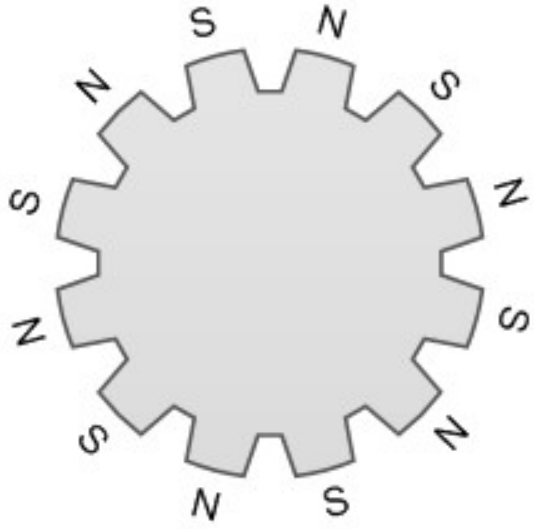
Step Angle

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

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

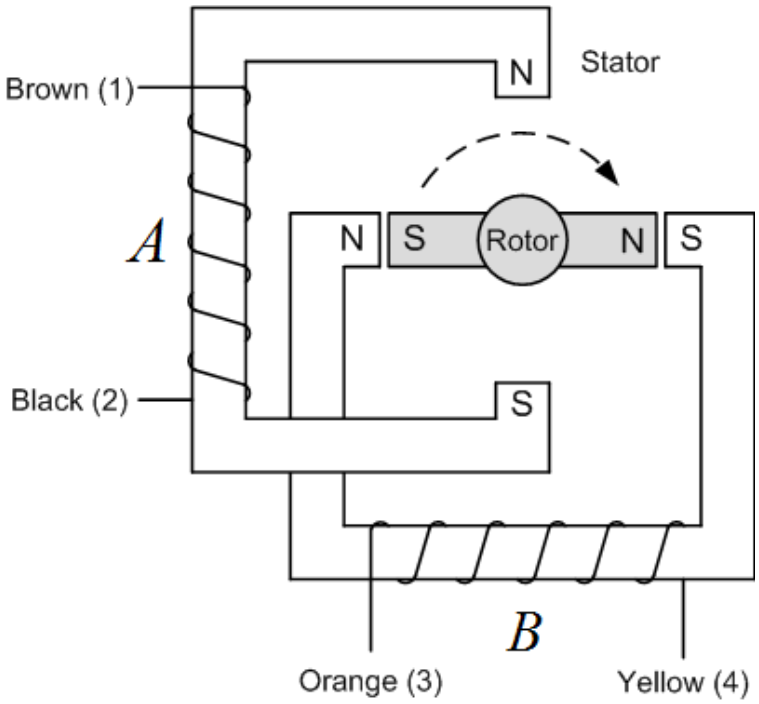
where P is the total number of phases on the stator, and T is the total number permanent-magnetic poles available on the rotor.

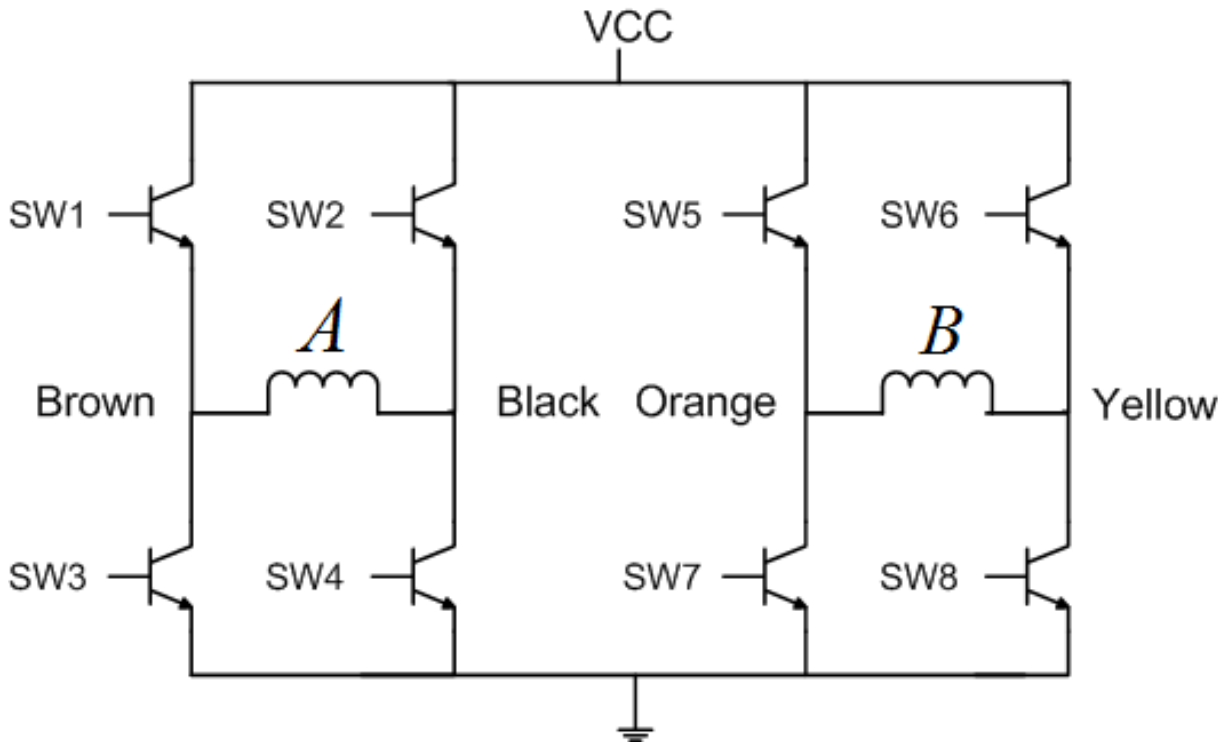
Rotor with only two poles



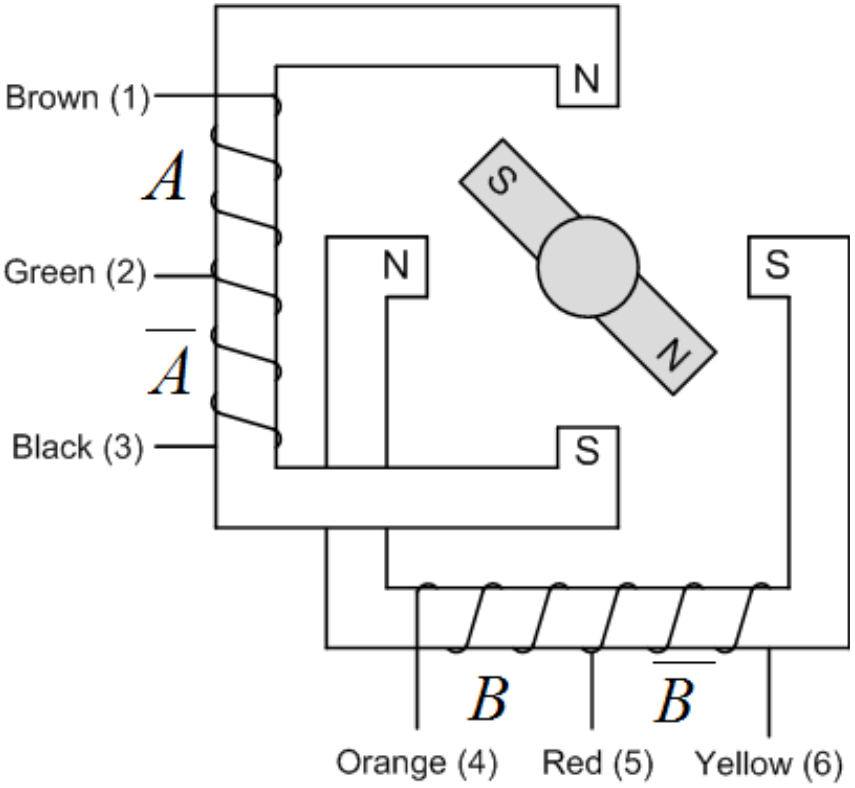
Rotor with 12 poles

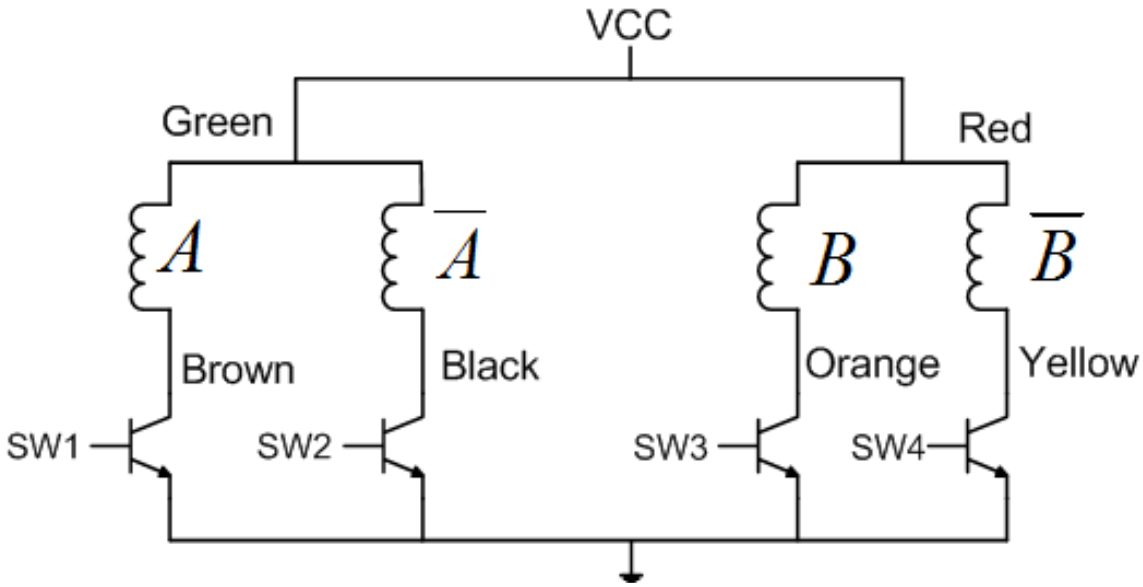
Bipolar Stepper Motor



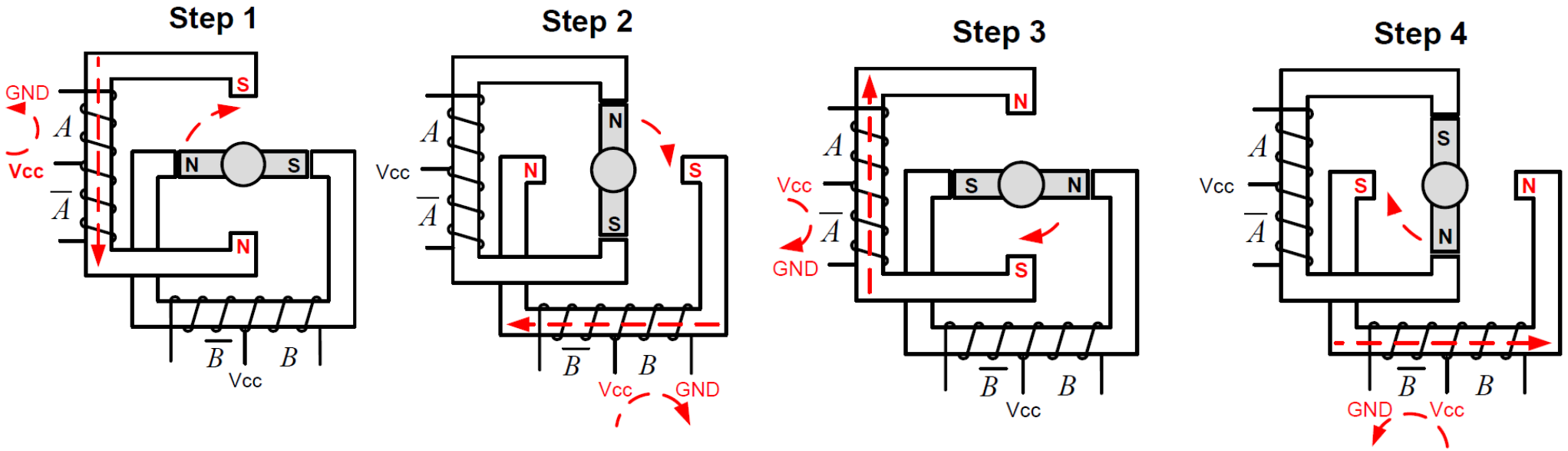


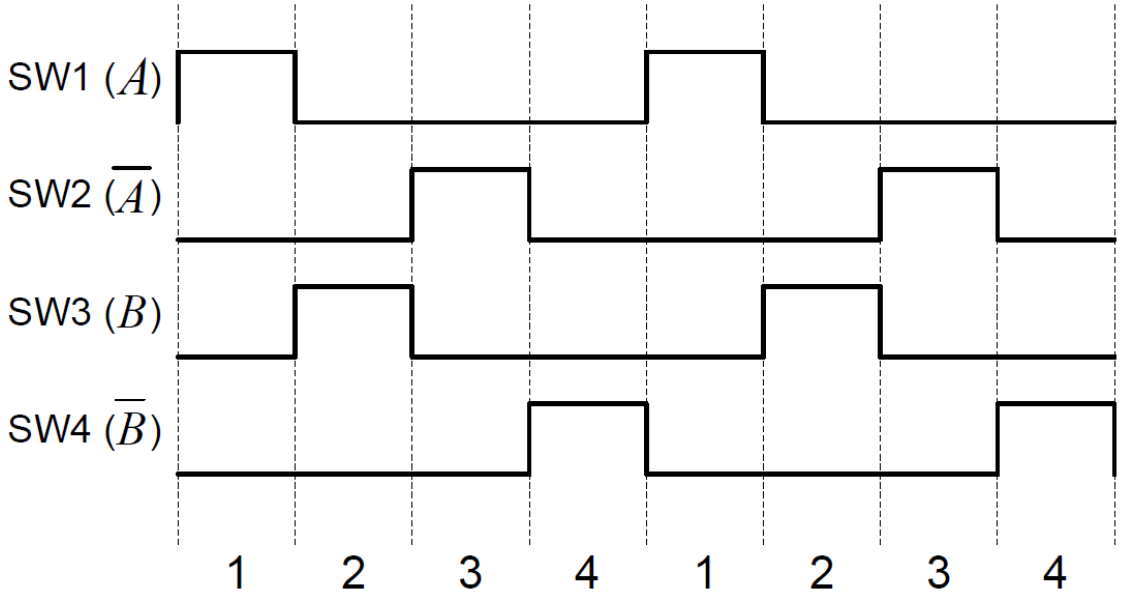
Unipolar Stepper Motor



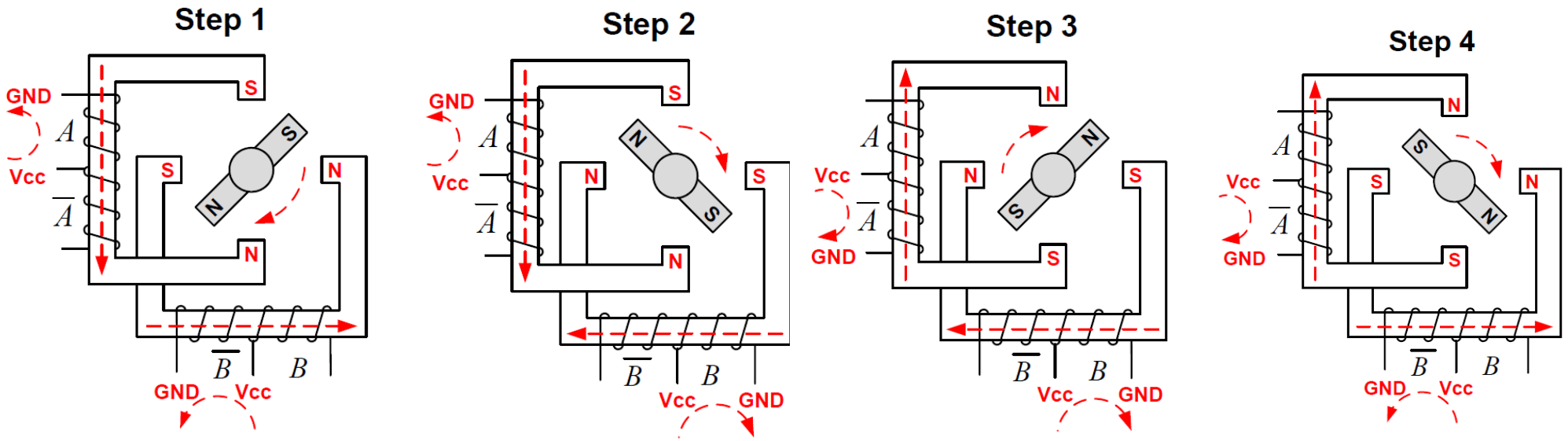


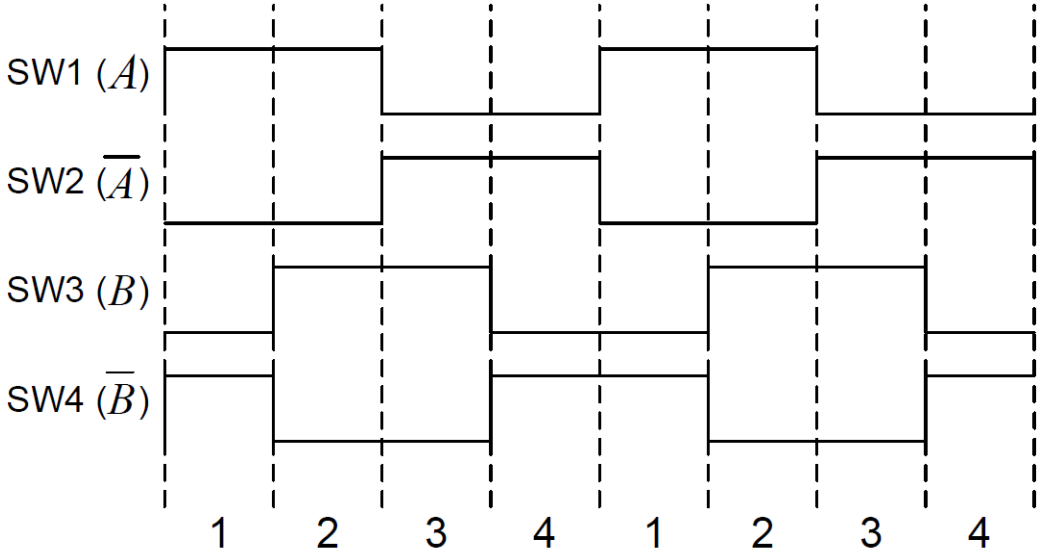
Wave Stepping





Full Stepping





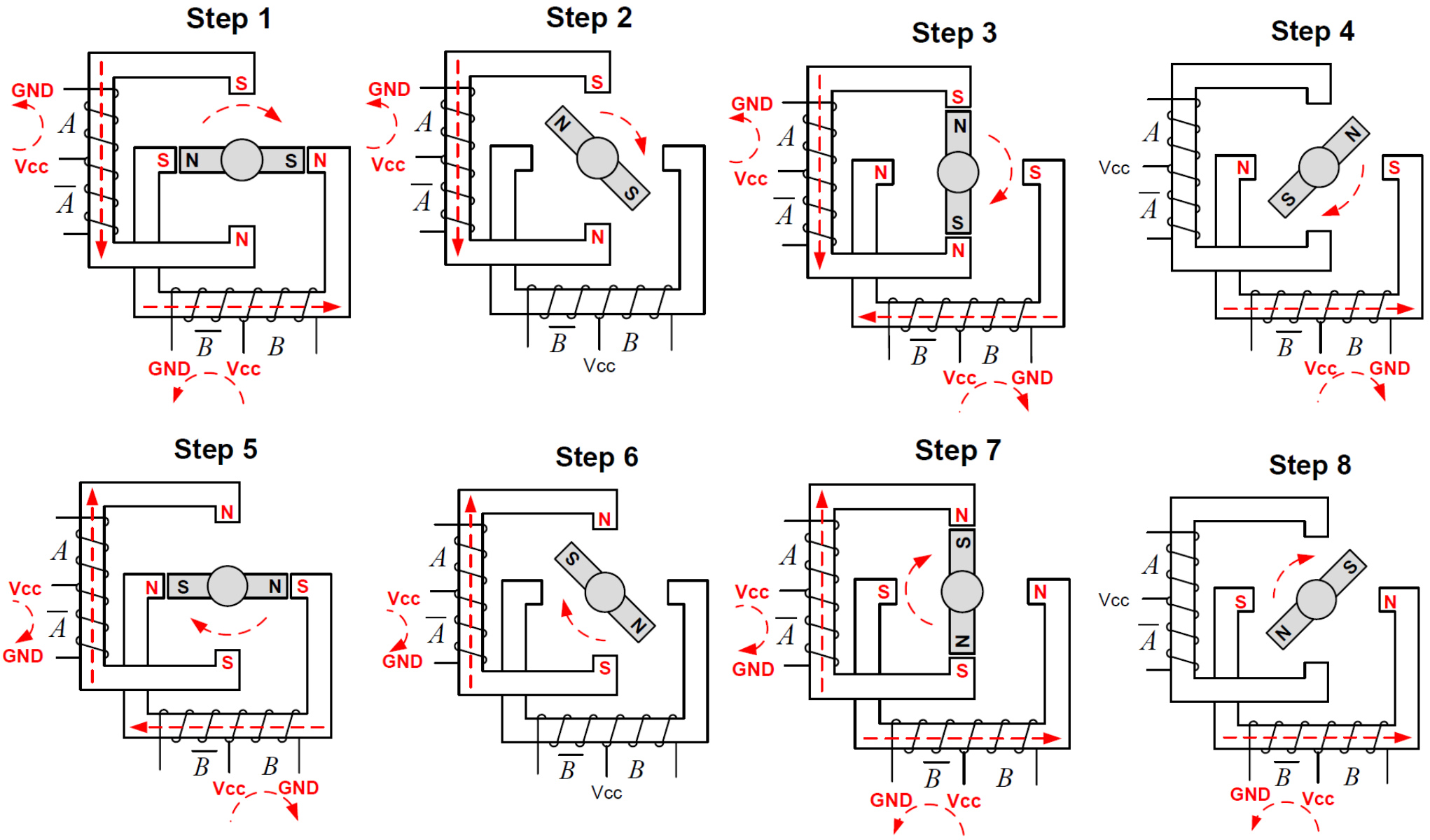
Clockwise sequence:

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

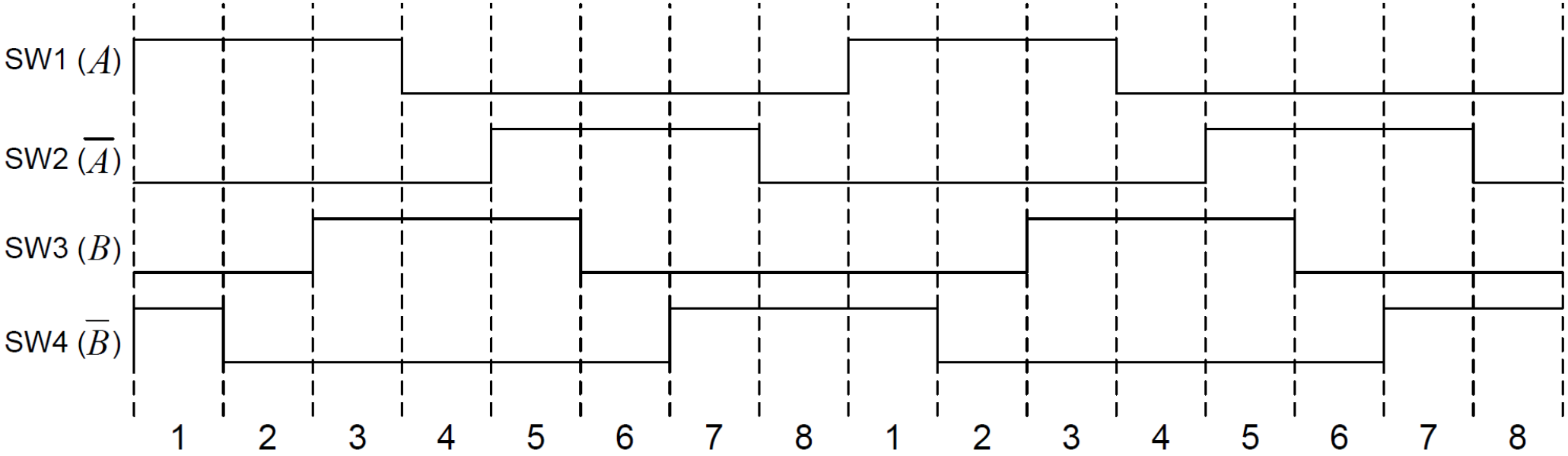
Counter-clockwise sequence:

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

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:

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

28BYJ-48 Stepper Motor

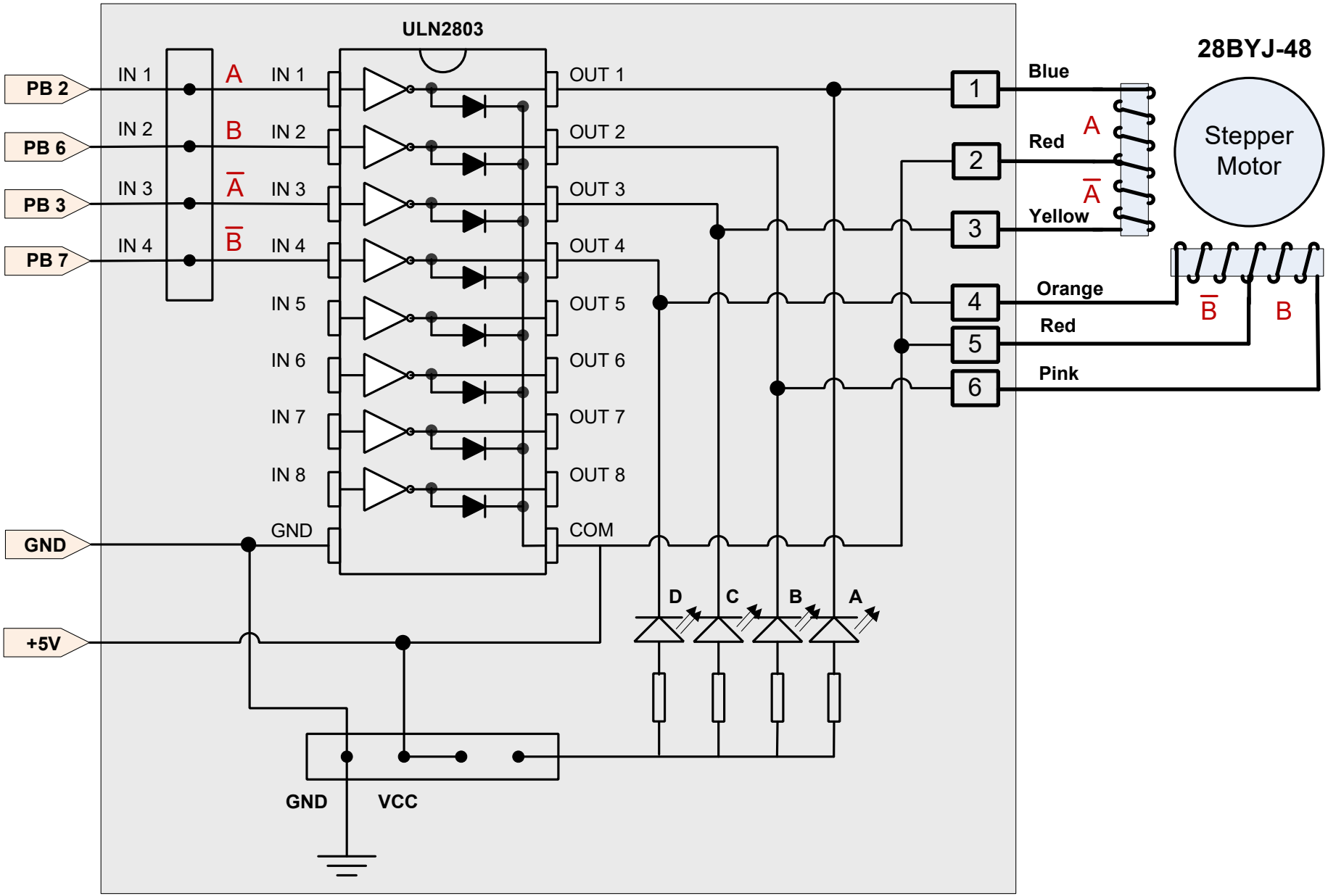
Full-stepping

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

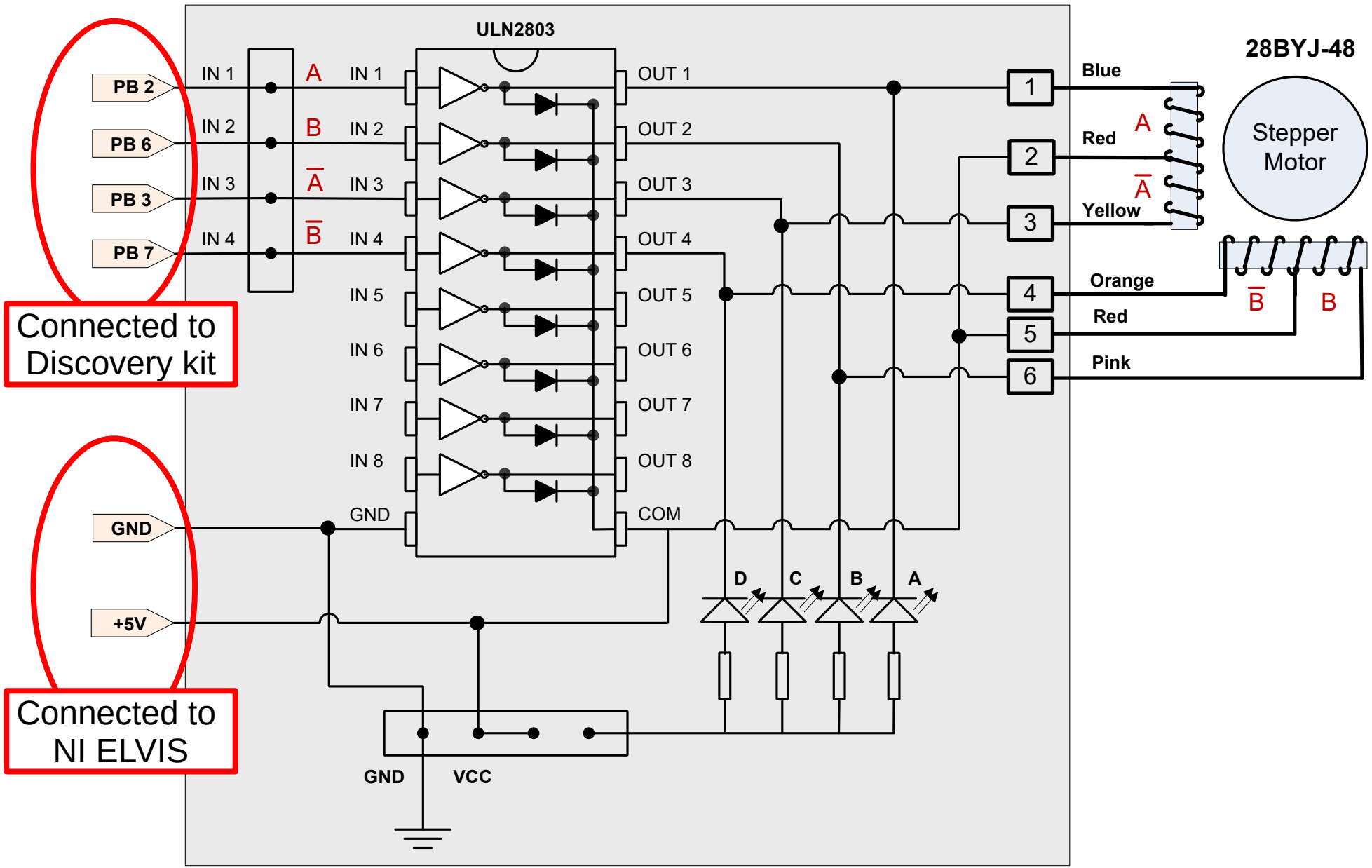
Half-stepping

- Internal motor: 64 steps per revolution
- Great reduction ratio: 1/63.68395 ≈ 1/64
- Thus, it takes *64×64=4096* steps per revolution for the output shaft

28BYJ-48 Stepper Motor



28BYJ-48 Stepper Motor



Lab Assignment

- A startup code in a zip-file (filename: ***Lab 2 – Startup Code.zip***) is available on **D2L**. It contains the following files: ***main.c***, ***SysClock.c***, ***SysClock.h***, and ***stm32l476xx.h***.
  - **Download** and **extract** the startup code.
  - Create a new C Project using System Workbench for STM32 IDE.
  - Move the files ***main.c*** and ***SysClock.c*** to your project's ***src*** folder.
  - Move the files ***SysClock.h*** and ***stm32l476xx.h*** to your project's ***inc*** folder.

Lab Assignment

- In order to complete the lab objectives, you only need to write code in the ***main.c*** file.
  - For the ***first objective***, you should complete two functions:
    - ***GPIO_Init()***:
      - Set up the GPIO port B to be used to control the stepper motor.
    - ***Clockwise_Full_Stepping()***:
      - This function will effectively move the stepper motor.
      - You should complete this function by following the textbook's section 16.4.
- For the ***second objective***, you will have to figure out the code by yourself.

Lab Assignment

- There will be not lab demo questions this time!
- However, Lab 3 will have demo questions!