TP n°: 2 Implementation of a control using microcontrollers:

Controlling of DC motors and stepper motors using microcontrollers

I. Objective

The objective of this work is to apply different types of control to a DC motor and a unipolar stepper motor using a 16F84 microcontroller.

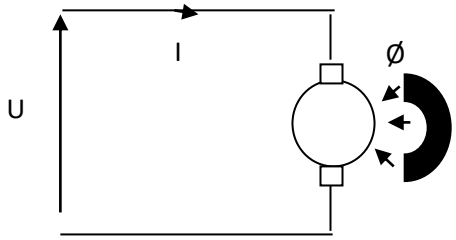
II. Required Equipment

Microcomputer workstation, ISIS and MIKROC software;

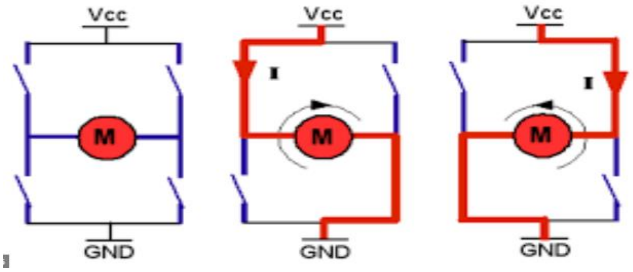
III. Introduction

III. 1 DC motor

A Direct Current (DC) motor is a motor that converts the energy of a direct current into mechanical energy. Depending on the excitation method, there are several types: independently excited, series, parallel, and compound.



To reverse the direction of rotation of a DC motor, simply reverse the polarity of the power supply voltage. This can be done by swapping the positive and negative connections at the motor terminals.



III.2 Stepper motor

Stepper motors are low-power electric motors; their advantage lies in allowing precise positioning, controlled by microprocessors. They are used in computing (printers, floppy disk drives, etc.), in robotics (machine tools), and in fields as diverse as medical equipment, automotive applications, and gaming machines.

The rotor turns in small, successive angular movements, called steps. The number of steps, the speed, and the direction of rotation can be adjusted by a circuit that controls the power supply to the inductor coils mounted on the stator.

Based on their construction, three types of stepper motors can be distinguished:

- Permanent magnet motors,
- Variable reluctance motors,
- Hybrid motors.

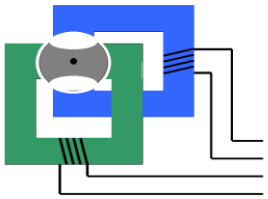
III.2.1. Types of Stepper Motors

Depending on the power supply method of the stepper motor, there are two types: bipolar motors (with 4 wires) and unipolar motors (with 6 wires):

1- The Bipolar Motor

The windings of a bipolar motor are powered alternately in one direction and then the other. They create first a north pole and then a south pole, hence the name bipolar.

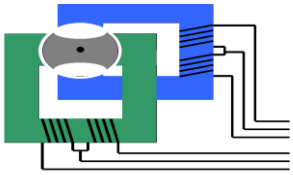
Bipolar motor



2- The unipolar motor

The windings of a unipolar motor are always powered in the same direction by a single voltage, hence the name unipolar.

unipolar motor



III.2.2. Types of Stepper Motor Control

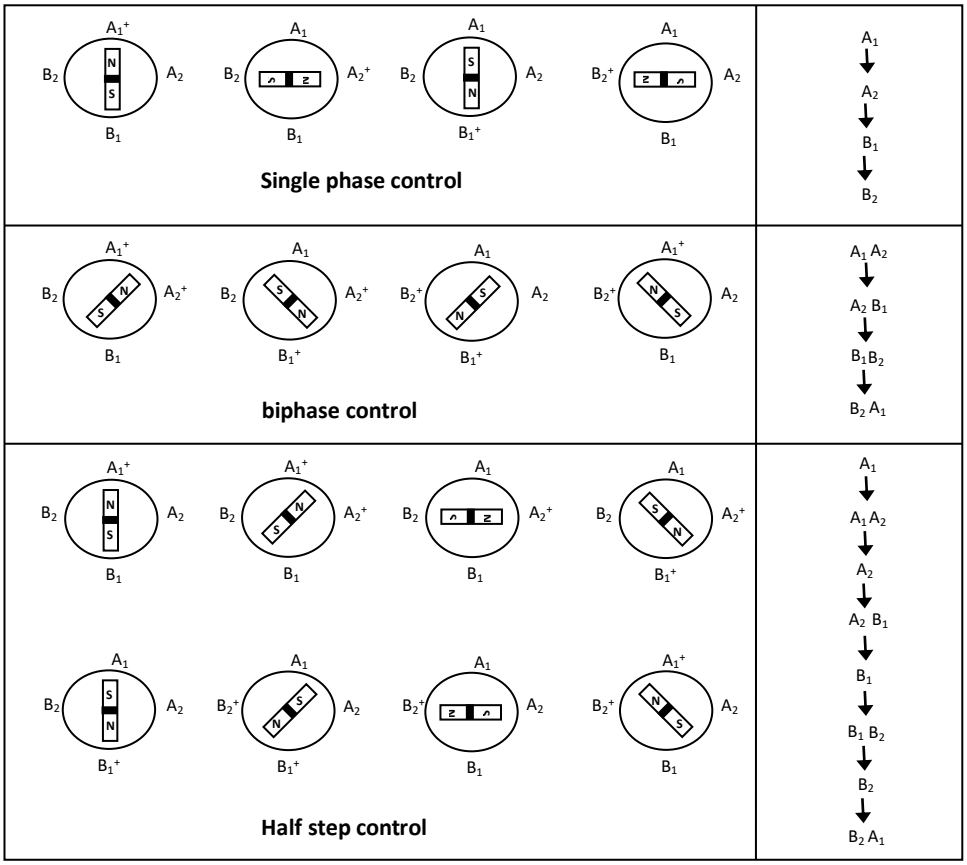
There are three ways to power the windings of a unipolar or bipolar stepper motor:

1- Single-phase control: This involves powering only one phase at a time. This is the simplest method, but also the least efficient, as the motor does not develop significant torque (due to the presence of the magnetic field of only one phase).

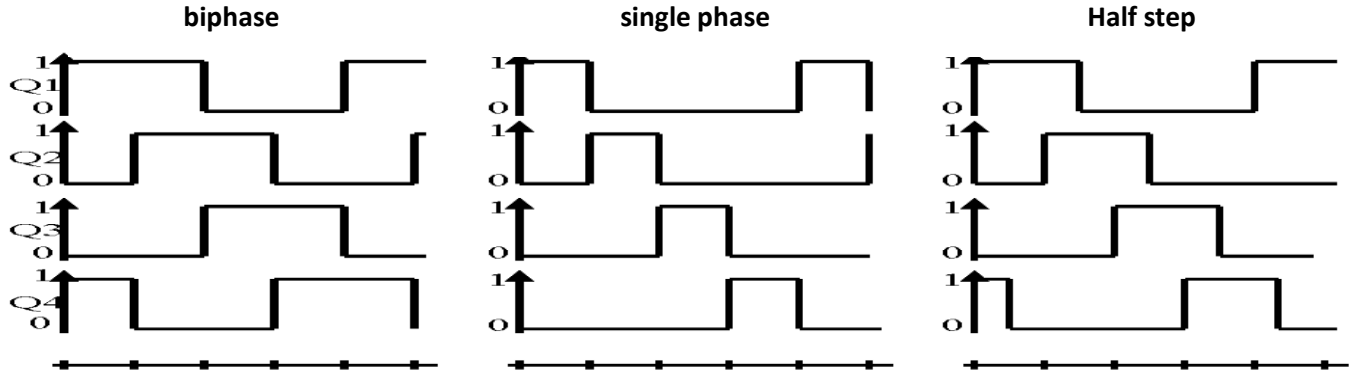
2- bi-phase control: This is the most efficient method. Two phases are constantly powered, which provides high torque.

3- Half-step control: This allows for doubling the motor's precision, but the torque becomes irregular because for every other step, the control is single-phase, and for the other steps, it is bi-phase.

The following table/diagram shows the different control modes:

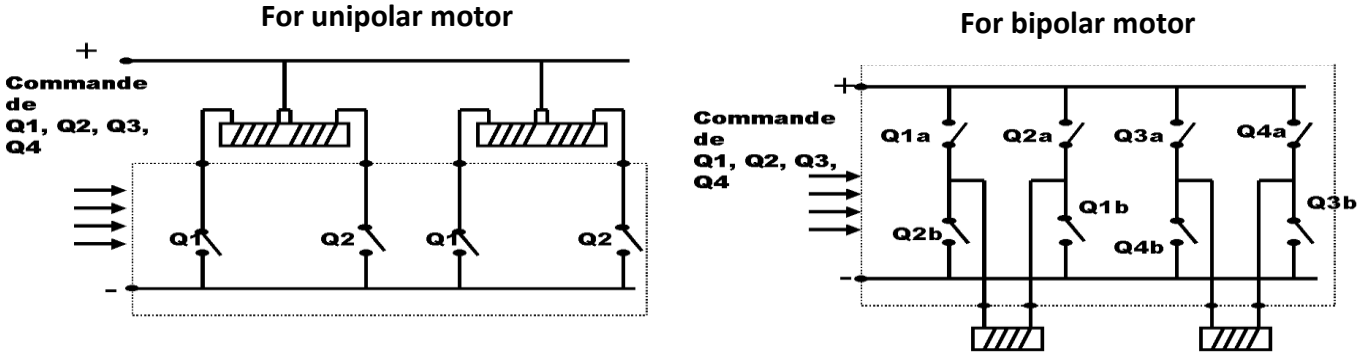


II.2.3. Chronogram



II.2.4. Power supply diagrams for a stepper motor

The power supply diagram for a stepper motor is given as follows:



III. Simulation work:

Part 1:

1.1- Implement the control of a DC motor using a pushbutton and the PIC 16F84 microcontroller (this work allows the following functionality: when the button is pressed, the motor turns, and when the same button is released, the motor stops).

1.2- Implement a control system for reversing the direction of rotation of a DC motor using two push buttons and a PIC 16F84 microcontroller (one button for forward motion and the other for reverse motion).

Part 2:

2.1- Apply single-phase control to the unipolar stepper motor using the PIC 16F84.

2.2- Apply bi-phase control to the unipolar stepper motor using the PIC 16F84.

2.3- Apply half-step control to the unipolar stepper motor using the PIC 16F84.

2.4- Apply single-phase control to the unipolar stepper motor using the PIC 16F84 with inversion of direction via a switch (two directions of rotation: forward and reverse).