April,2023 Semester

ICT 6641
Advanced Embedded System Design

Lecture#7: Motor Interfacing

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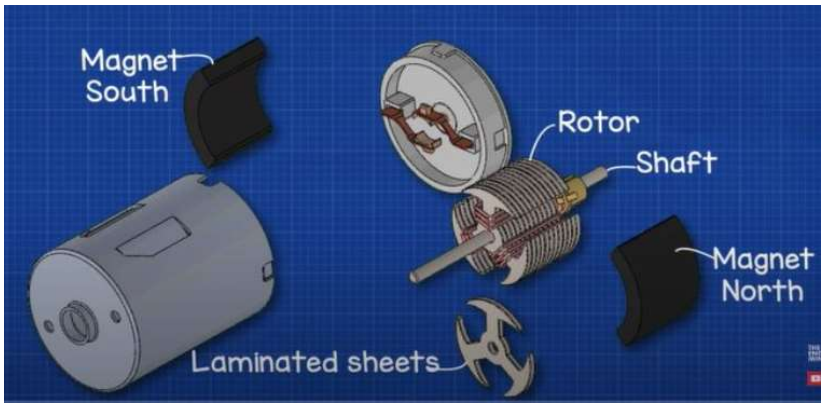
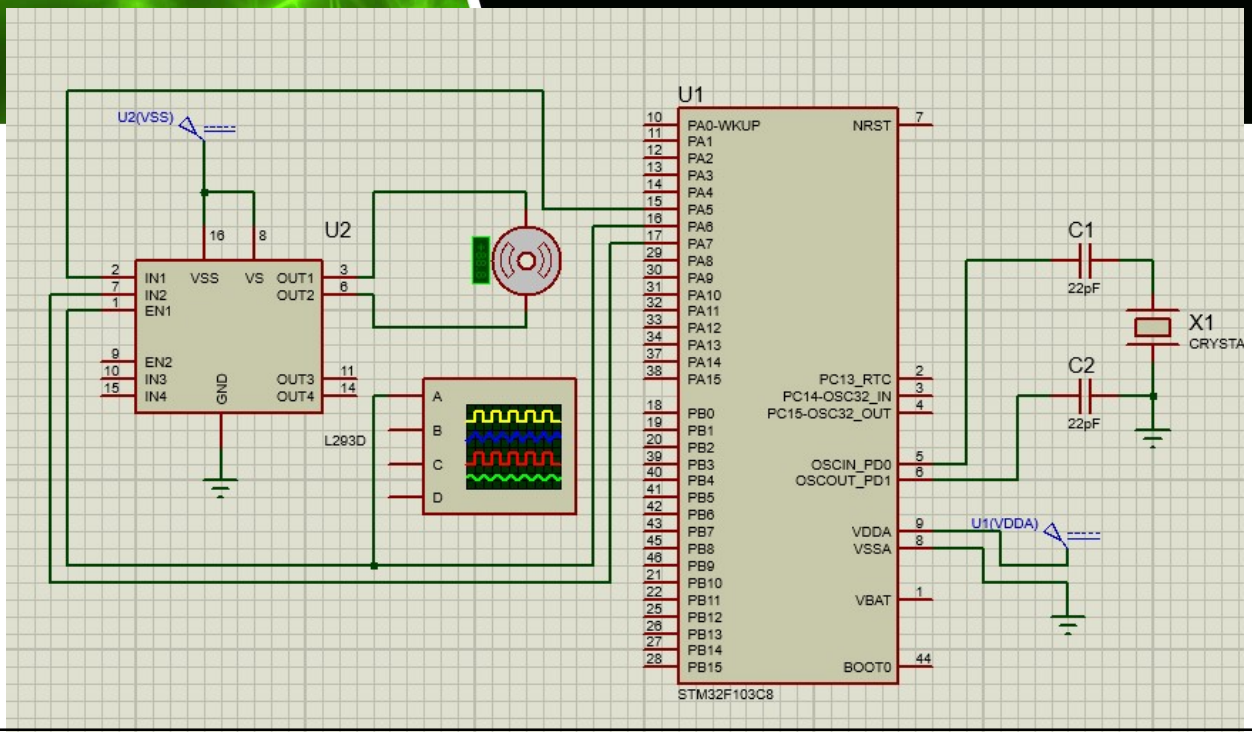
DC Motor

- DC (Direct Current) Motors are two wire (power & ground), continuous rotation motors.
- When you supply power, a DC motor will start spinning until that power is removed.
- Most DC motors run at a high RPM (revolutions per minute), examples being computer cooling fans, or radio controlled car wheels!
- The speed of DC motors is controlled using pulse width modulation (PWM).
- Each pulse is so rapid that the motor appears to be continuously spinning.

How does a DC motor work?

- A DC motor or direct current motor is an electrical machine that transforms electrical energy into mechanical energy by creating a magnetic field that is powered by direct current.
- When a DC motor is powered, a magnetic field is created in its stator.
- The field attracts and repels magnets on the rotor; this causes the rotor to rotate.
- To keep the rotor continually rotating, the commutator that is attached to brushes connected to the power source supply current to the motors wire windings.





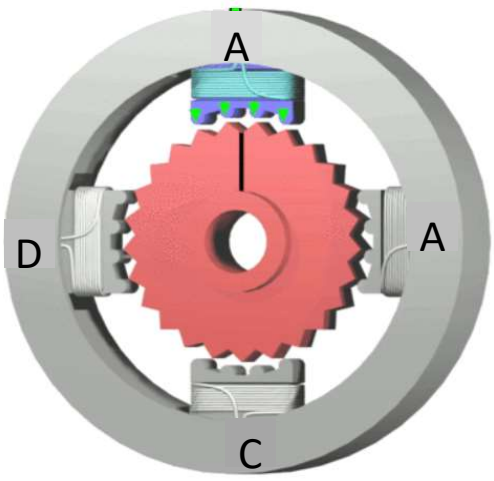
Basic Principle

- Stepper motor is a brushless DC motor that rotates in steps.
- This is very useful because it can be precisely positioned without any feedback sensor, which represents **an open-loop** controller.
- The stepper motor consists of a **rotor** that is generally a **permanent magn**et and it is surrounded by the windings of the stator.
- As we activate the windings step by step in a particular order and let a current flow through them they will magnetize the stator and make electromagnetic poles respectively that will cause propulsion to the motor.

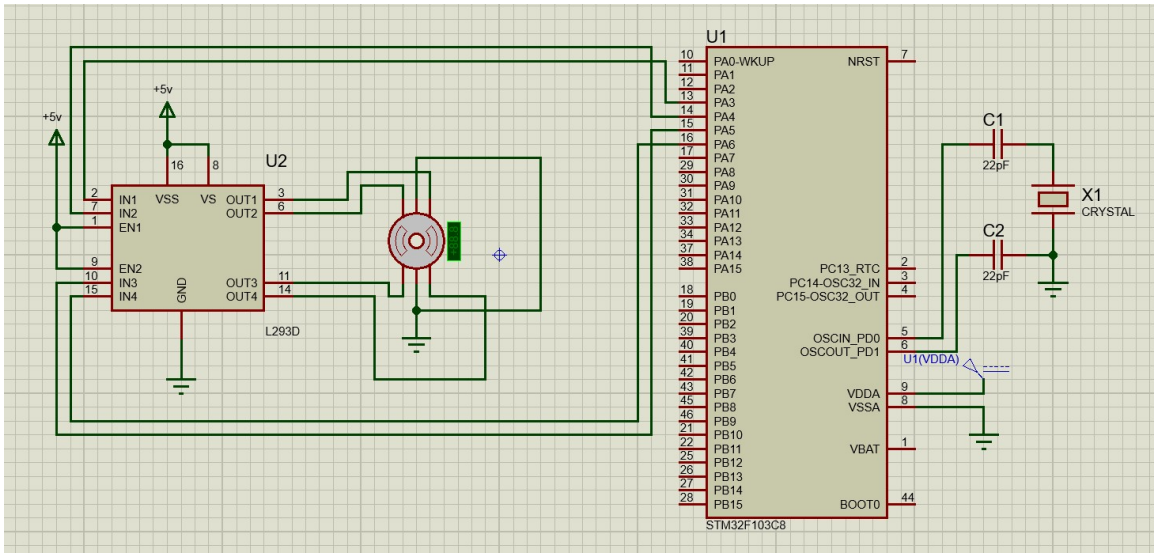
To see an animated video, ctrl+click on the following link: https://cdn-learn.adafruit.com/assets/assets/000/016/204/original/components_StepperMotor.gif?1448311630

Exciting two coils

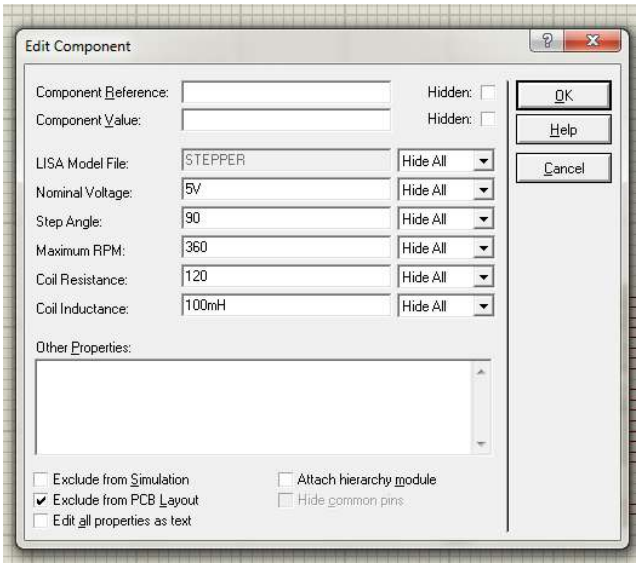
STEP#1 – ONLY COIL A
STEP#2 – COIL A & B
STEP#3 – ONLY COIL B
STEP#4 – COIL B & C
STEP#5 – ONLY COIL C
STEP#6 – COIL C & D
STEP#7 – ONLY COIL D
STEP#8 – COIL D & A



Interfacing a Stepper Motor in Proteus



Properties of the Stepper Motor



To make one pin high and others low

```
HAL_GPIO_WritePin(IN1_PORT, IN1_PIN, GPIO_PIN_SET); // IN1
HAL_GPIO_WritePin(IN2_PORT, IN2_PIN, GPIO_PIN_RESET); // IN2
HAL_GPIO_WritePin(IN3_PORT, IN3_PIN, GPIO_PIN_RESET); // IN3
HAL_GPIO_WritePin(IN4_PORT, IN4_PIN, GPIO_PIN_RESET); // IN4 ;
```

Stepper Motor (continued….)

- Stepper motors are available in two varieties; unipolar or bipolar.
- Bipolar motors are the strongest type of stepper motor and usually have four or eight leads.
- They have two sets of electromagnetic coils internally, and stepping is achieved by changing the direction of current within those coils.
- Unipolar motors, identifiable by having 5,6 or even 8 wires, also have two coils, but each one has a center tap.
- Unipolar motors can step without having to reverse the direction of current in the coils, making the electronics simpler.

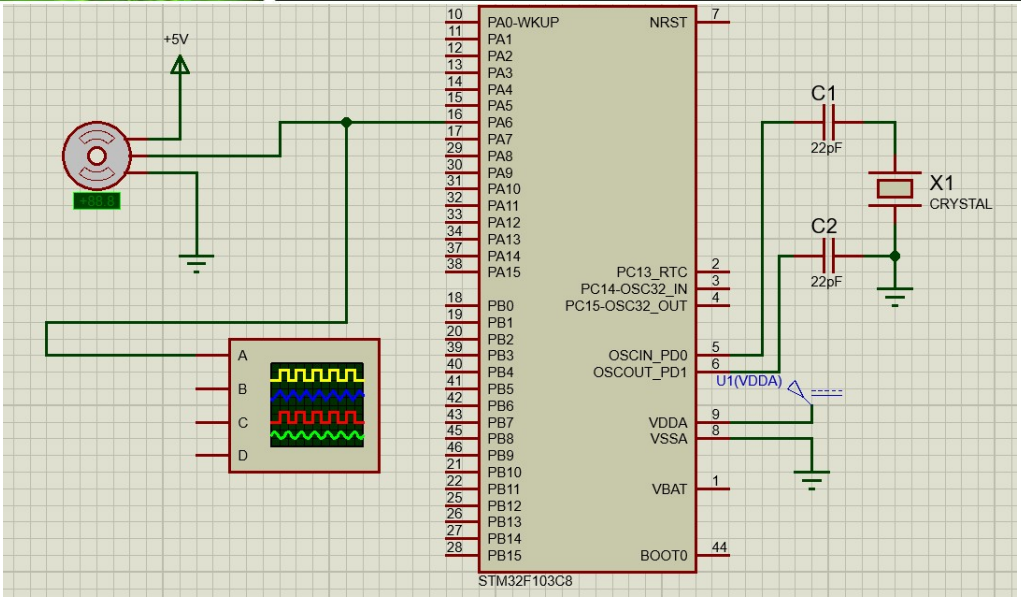
The Servo Motor

- Servo motors are generally an assembly of four things: a DC motor, a gearing set, a control circuit and a position-sensor.
- The position of servo motors can be controlled more precisely than those of standard DC motors, and they usually have three wires (power, ground & control).
- Power to servo motors is constantly applied, with the servo control circuit regulating the draw to drive the motor.
- Servo motors do not rotate freely like a standard DC motor.
- Instead the angle of rotation is limited to 180 Degrees (or so) back and forth.
- Servo motors receive a control signal that represents an output position and applies power to the DC motor until the shaft turns to the correct position, determined by the position sensor.

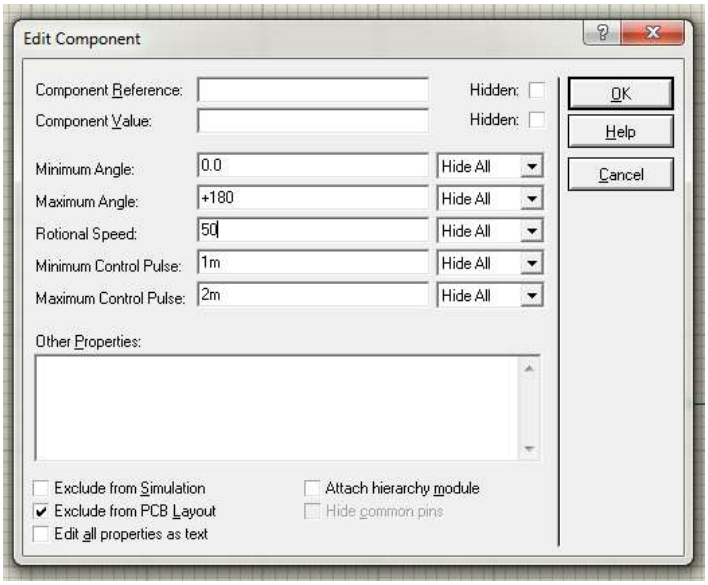
Servo Motor (continued…..)

- PWM is used for the control signal of servo motors.
- However, unlike DC motors it's the duration of the positive pulse that determines the position, rather than speed, of the servo shaft.
- A neutral pulse value dependent on the servo (usually around 1ms) keeps the servo shaft in the center position.
- Increasing that pulse value will make the servo turn clockwise, and a shorter pulse will turn the shaft anticlockwise.
- The servo control pulse is usually repeated every 20 milliseconds.
- When a servo is commanded to move, it will move to the position and hold that position, even if external force pushes against it.
- The servo will resist from moving out of that position, with the maximum amount of resistive force the servo can exert.

Interfacing a Servo Motor in Proteus



Properties of the Servo Motor



Thanks