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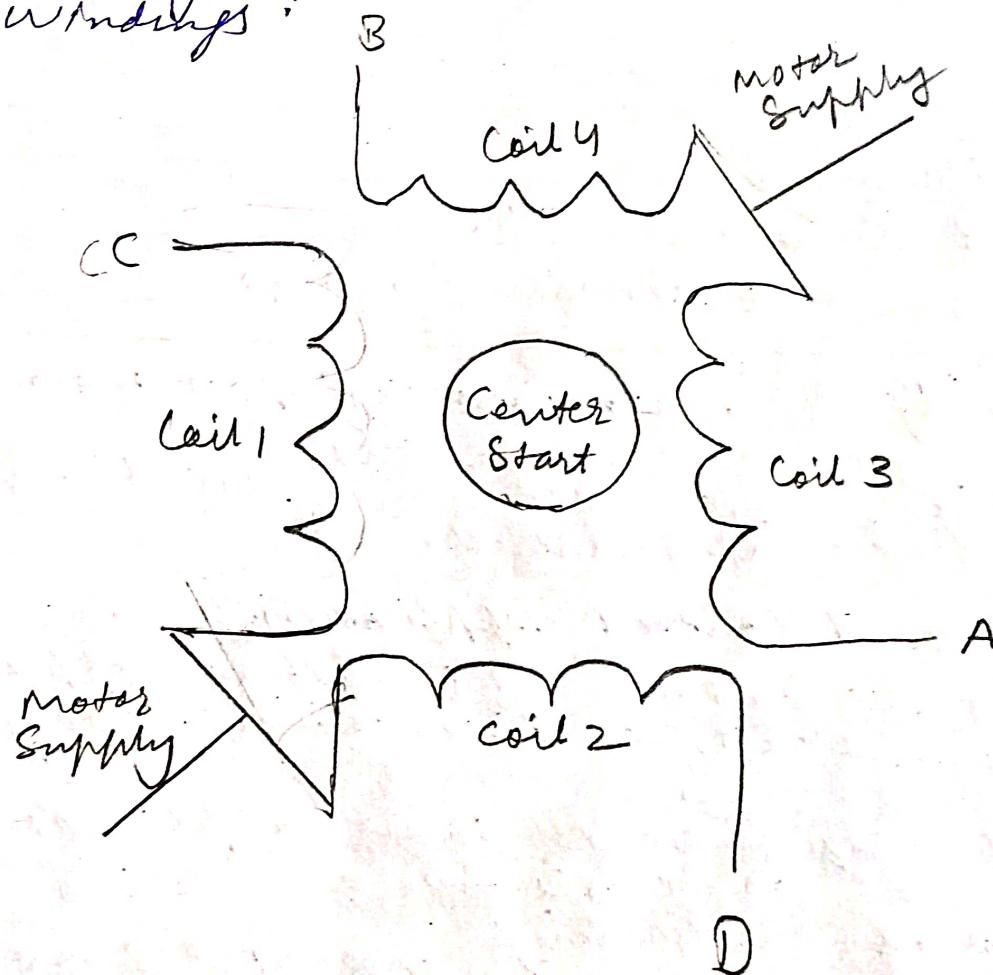
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Department of: Electronic ScienceName Sanjeet Kumar Class TYBSC Roll No. 29Batch _____ Expt. No. EL362 P-II Date 19/05/2022

Remark

- Topic → Interfacing PIC microcontroller, Stepper motor.
- * Interfacing of stepper motor with ^{W/} PIC 16F877A microcontroller
 - Automations and Control Applications! →
The PIC microcontroller can be used in different applications, such as peripherals, audio accessories, video games, etc.
Based on the requirements some applications are explained as below: →
 - (1) Stepper motor Interfacing
 - (2) AC phase control using TRIAC - Zero Crossing Detector
 - (3) DC motor speed control using PWM.
- Interfacing of Stepper Motor with PIC 16F877A
- A stepper motor is a brushless, Synchronous DC electric motor, which divides the full rotation into a number of equal steps.
- It finds great application in field of microcontrollers such as robotics.
- Unipolar motor is the most popular Stepper motor among electronic hobbyist

- Because of its ease of operations and availability.
- Normally Stepper motor have FOUR stator windings.



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Stepper Motor Specifications

Drive System	Unipolar
Step angle	1.8° Full step
Phase / windings	0.9° half - step
Voltage & current	(1/2) 1.2 V at 400 mA
Resistance per phase	30 ohms
Inductance per phase	23 mH
Holding Torque	2000 g-cm
Detent Torque	220 g-cm max
Weight	0.24 kg (0.5165.)
Max continuous power	5 W
Rotor inertia	22 g-cm²
Insulation resistance	> 100 MΩ at 500 VDC
Dielectric Strength	500 V. 80 Hz/ minute
Ambient Temperature	-10°C to +55°C

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- Stepper motor can be easily interfaced with PIC microcontroller by using motor driver as 2293D or ULN2003
- Three different types of Stepping modes for unipolar Stepper motor are as below:-
 - a) wave Drive
 - b) Full Drive
 - c) Half Drive
- The step size is given as -

$$\text{Step size} = \frac{360^\circ}{\text{no. of turns or steps}}$$

Example - 100 step motor then,

$$\text{Step size} = \frac{360^\circ}{100} = 3.6 \text{ degree per step increment/decrement}$$
- Stepper Motor
 - It is a device used to obtain an accurate position control of rotating shafts.
- Rotating shaft in terms of steps
 - Angle θ may be calculated as
$$\theta = \frac{360^\circ}{\text{no. of rotor teeth}}$$

→ rotor rotates by one teeth position.
- The count for one teeth position rotating the shaft of the Stepper motor through a specified angle may be calculated from the no. of rotor teeth

$$C = \text{no. of rotor teeth}$$

$$360 \times \theta^\circ$$

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a) Wave Drive : - In this mode only EM is energized at a time. The torque will be less when compared to full drive. This drive power consumption is more. So it is rarely used.

Step	Blue	Pink	Yellow	Orange
------	------	------	--------	--------

1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

b) full drive - In this mode two stator electromagnets are energised at a time. It is one usual method used for driving and the motor will run at its full torque in this mode of driving.

Step	Blue	Pink	Yellow	Orange
------	------	------	--------	--------

1	1	1	0	0
2	0	1	1	0
3	0	0	1	1
4	1	0	0	1

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(c) Half Step:-

In this mode alternatively one and two phase are energized. This mode is commonly to increase the angular resolution of the motor but the torque is less approximately 70%. At its half step position (when only a single phase is on).

Step	Blue	Pink	Yellow	Orange
1	1	0	0	0
2	1	1	0	0
3	0	1	0	0
4	0	1	1	0
5	0	0	1	0
6	0	0	1	1
7	0	0	0	1
8	1	0	0	1

Driver / C ULN2003:-

- ▷ ULN2003 is high-voltage, high-current Darlington arrays each containing seven open collector Darlington pairs with common emitters.
- ▷ Each channel is rated at 500 mA and can withstand peak currents of 600 mA.
- ▷ Suppression diodes are included for bidirectional clamping and the inputs are pulsed opposite the outputs to simplify board layout.
- ▷ From this driver we can connect seven inputs for amperes of lesser current.

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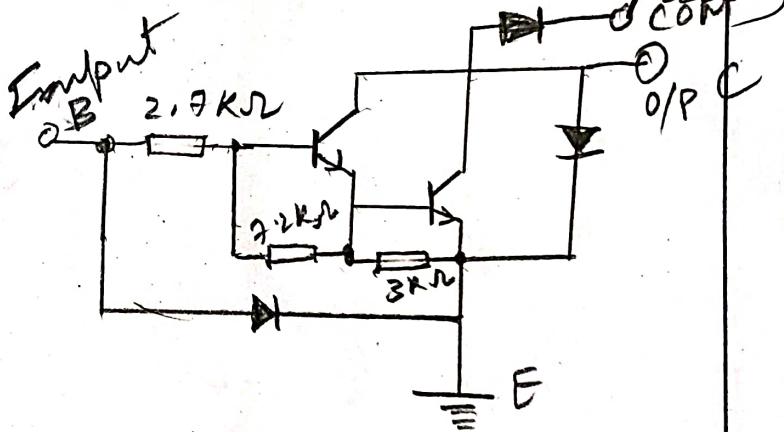
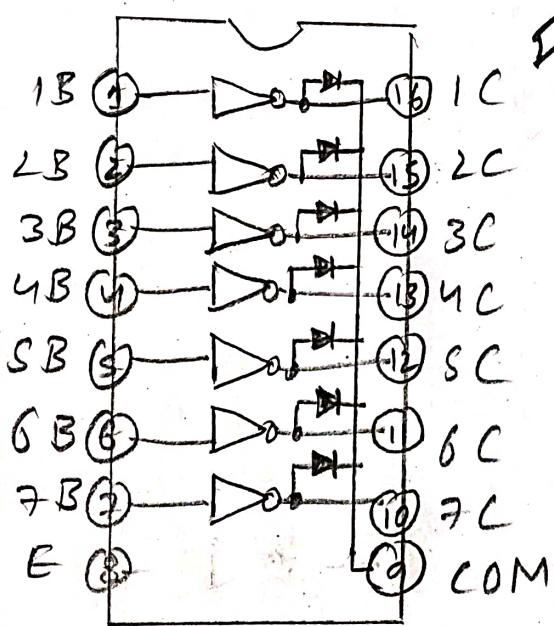
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→ The pin diagram and two transistor circuit is shown in next slide -

Pin Diagram of IC ULN2003 :-

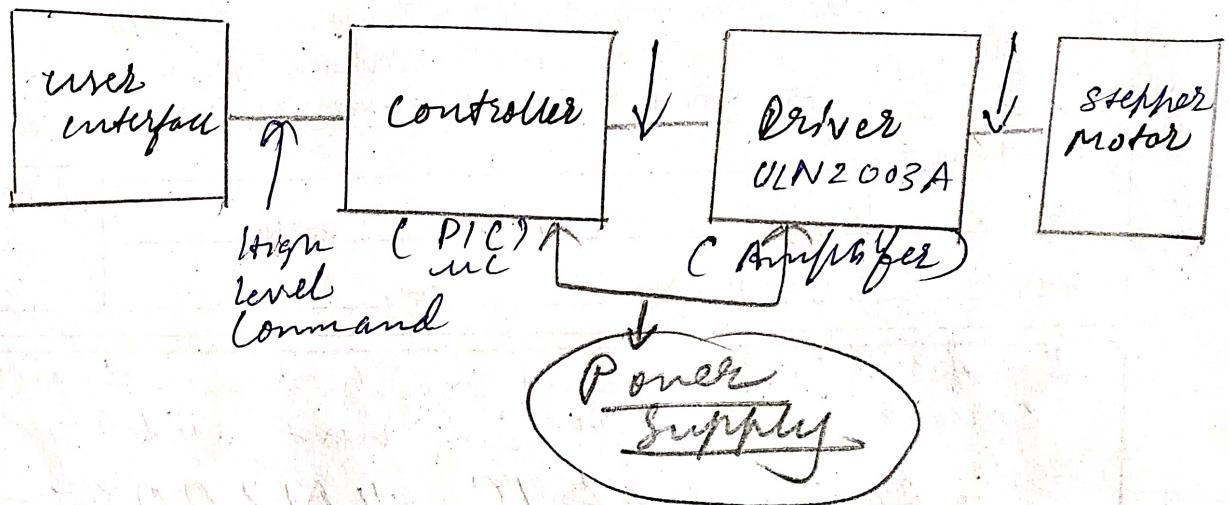
(Logic Diagram) →

Schematic (Each Darlington pair)



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Block Diagram (Interface of stepper motor with PIC16F877)



Interfacing of Stepper motor with PIC16F877

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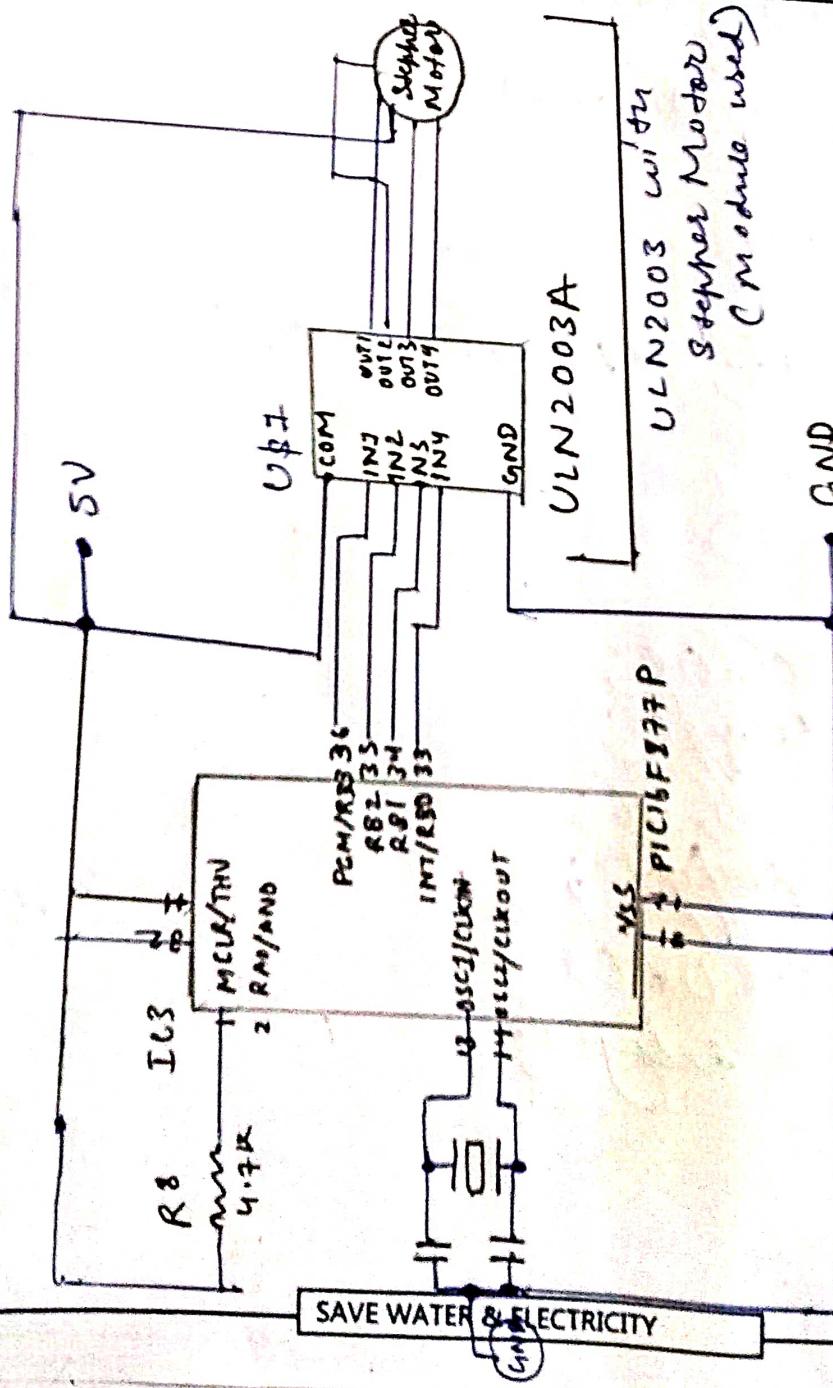
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C Program for Interfacing of Stepper motor with PIC16F877:-

```
#include <pic.h>
#define SW RB4
void delay()
{
    unsigned int i, j;
    for (i = 0; i < 100; i++)
        for (j = 0; j < 1000; j++)
}
void main()
{
    TRISB = 0x10; // RB4 as input pin
    write(1);
    if (SW == 1)
    {
        PORTB = 0x0C;
        delay();
        PORTB = 0x06;
        delay();
        PORTB = 0x03;
        delay();
    }
}
```

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PORT B = 0x09;
delay();
}
else
{
PORT B = 0x09;
delay();
PORT B = 0x03;
delay();
PORT B = 0x06;
delay();
PORT B = 0x0C;
delay();
}
}
}
}

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What is a Stepper Motor?

A Stepper motor is a digital device, more precisely a digital DC motor. Stepper or Steppe motor allows you to select a certain degree of movement. Rather than making a whole spin it can divide the spin into smaller parts.

Applications:

- The stepper motor is used for precise positioning within a motor like hard disk drives, robotics, telecopes and some toys.
- Industrial Machines — Stepper motors are used in automotive gauge and machine tooling automated production equipments.
- Security — New surveillance products for the security industry
- Medical — Stepper motors are used inside medical Scanners, Samplers and also found inside digital dental photography.

- * Stepper motors can be a good choice whenever controlled movement is required.
They can be used to advantage in applications where you need to control rotation angle, speed, position and synchronism.
- These include
 - Type writers / Line Printers / Tapedrives / Floppy disk drives
 - Numerically - controlled machine tools / Process control Systems / X-Y plotters

Why a Stepper motor?

- Relatively inexpensive
- Ideal for open loop positioning control
 - Can be implemented without feedback
 - Minimizes sensing devices
 - Just count the steps!
- Torque
 - Holds its position firmly when not turning
 - Eliminates mechanical brakes.
 - Produces better torque than DC motors at lower speeds.
- ④ Positioning application

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- Stepper motors are DC motors that move in discrete steps. They have multiple coils that are organized in groups called "phases". By energizing each phase in sequence, the motor will rotate, one step at a time. With a computer controlled stepping you can achieve very precise positioning and/or speed control.
- A stepper motor, you notice is that they have no brushes or commutator (the parts of a DC motor that reverse the electrical current and keep the rotor - the rotating part of a motor - constantly turning in the same direction). In other words, stepper motors are exempted of what we call brushless motors. (You'll also find brushless motors in many electric vehicles, hidden away in the wheel hub; used in that way, they're called hub motors.)

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- An ordinary DC motor and a stepper motor is in the design of the stator and the rotor. Instead of one large magnet on the outside (the stator) and one large coil rotating inside it (the rotor), a Stepper motor has an inner magnet effectively divided up into many separate sections, which looks like teeth on a gear wheel. The outer coils have corresponding teeth that provide magnetic impulses, attracting, repelling, and making the teeth of the inner wheel rotate by small steps.
- A stepper motor can stay still, in a certain position, once it's rotated through a particular angle. That's obviously crucially important if you want a motor to power something like a robot arm, which might have to rotate a certain amount and then remain in precisely that spot until another part of the robot does something else. This feature is sometimes called holding torque (torque is the rotary force something has, so "holding torque" simply means a stepping motor's ability to stay still).
- Stepper motors - It's an electromagnetic device that converts digital pulses into mechanical rotation. Advantages of step motors are low cost, high torque at low speeds and a simple rugged construction that operates in almost any environment.

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① Science to technology check out (EEE10)

Why need (Stepper motor)

- Computer control
- Precise motion
- Open loop controller

Bar's Concept

* So, how does it work?

- Teeth
- Steps
- Brushless DC electric motor
- Needs Stepper motor driver circuit

Pros

- Holding Torque
- No need for feedback
- Long Reliability

Cons

- No feedback on missed step
- Low torque at high. Speed
- Complex Driver

What next?

- Encoder feedback
- Advanced Stepper motor Controller

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