1. Study about embedded components such as sensors and actuators.

Sensor: A sensor is an object whose purpose is to detect events or changes in its environment, and then provide a corresponding output. A sensor is a type of transducer; sensors may provide various types of output, but typically use electrical or optical signals. For example, a thermocouple generates a known voltage (the output) in response to its temperature (the environment).

- A Sensor is used for taking Input
- It is a transducer that converts energy from one form to another for any measurement or control purpose

Ex. A Temperature sensor

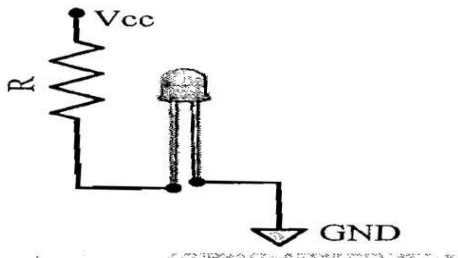
Actuator: An actuator is a component of machines that is responsible for moving or controlling a mechanism or system. An actuator requires a control signal and source of energy. The control signal is relatively low energy and may be electric voltage or current, pneumatic or hydraulic pressure, or even human power

Actuator is used for output. It is a transducer that may be either mechanical or electrical which converts signals to corresponding physical actions.

I/O subsystem: The I/O sub system of the embedded system facilitates the interaction of embedded system with the external world

LED (Light Emitting Diode):

LED is an important output device for visual indication in any embedded system.LED used as an indicator for the status of various signals or situations. LED is a p-n junction diode and contains a **CATHODE** and **ANODE.** For functioning the anode is connected to +ve end of power supply and cathode is connected to –ve end of power supply. The maximum current flowing through the LED is limited by connecting a RESISTOR in series between the power supply and LED as shown in the figure below



LED interfacing

There are two ways to interface an LED to a microprocessor/microcontroller:

The Anode of LED is connected to the port pin and cathode to Ground : In this approach the port pin sources the current to the LED when it is at logic high(i.e. 1).

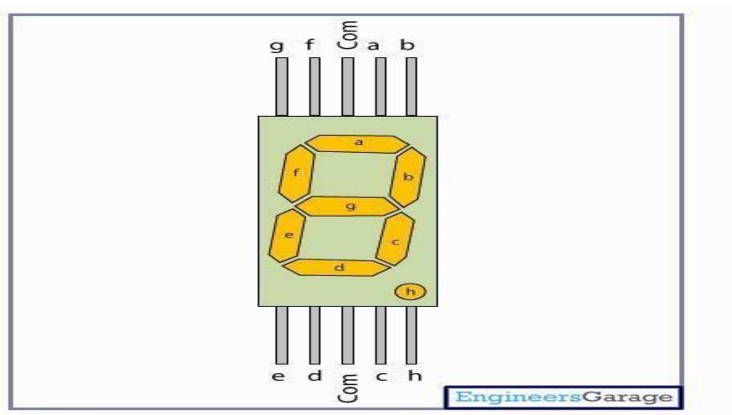
The Cathode of LED is connected to the port pin and Anode to Vcc : Here the port pin sinks the current and the LED is turned ON when the port pin is at Logic low (i.e. 0)

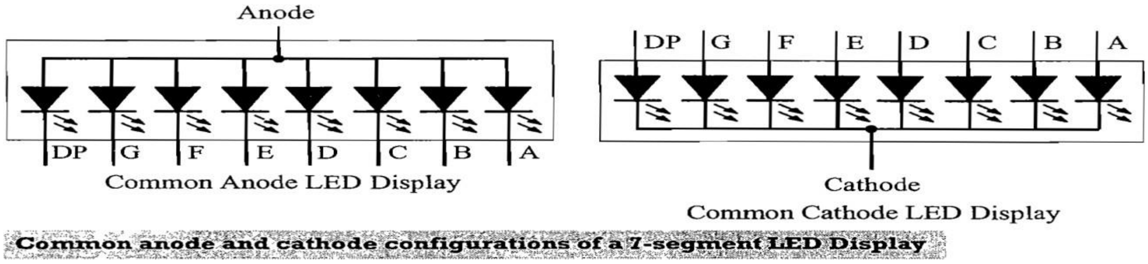
Segment LED display:

- **It** is the most basic electronic display device that can display digits from 0-9.
- They find wide application in devices that display numeric information like digital clocks,radio, microwave ovens, electronic meters etc.
- The most common configuration has an array of eight LEDs arranged in a special pattern to display these digits.
- They are laid out as a squared-off figure ‘8’. Every LED is assigned a name from 'a' to 'h'and is identified by its name.
- Seven LEDs 'a' to 'g' are used to display the numerals while eighth LED 'h' is used to display the dot/decimal.

A seven segment is generally available in ten pin package. While eight pins correspond to the eight LEDs, the remaining two pins (at middle) are common and internally shorted. These segments come in two configurations, namely, Common cathode (CC) and Common anode (CA). In CC configuration, the negative terminals of all LEDs are connected to the common pins. The common is connected to ground and a particular LED glows when its corresponding pin is given high. In CA arrangement, the common pin is given a high logic and the LED pins are given low to display a number.

Pin diagram:



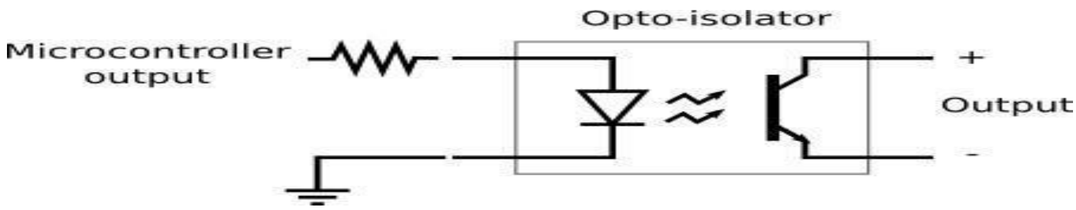


For common cathode configurations, the anode of each LED segment is connected to the port pins of
the port to which the display is interfaced. The anode of the common anode LED display is connected to the SV supply voltage through a current limiting resistor and the cathodé of each LED segment is connected to the respective port pin lines. For an LED segment to lit in the Common anode LED configuration, the port pin to which the cathode of the LED segment is connected should be at logic 0.

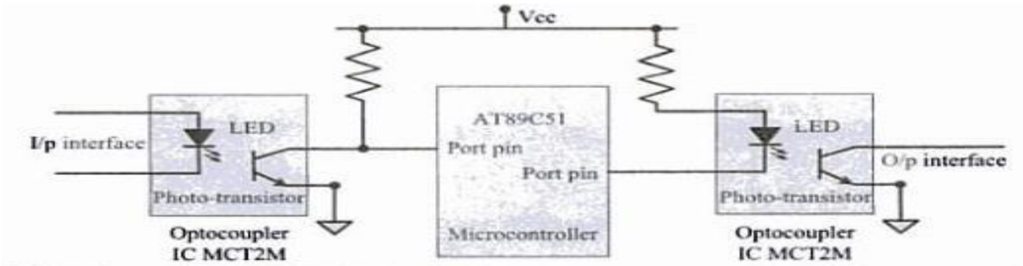
7 – segment LED display is popular choice for low cost embedded applications like, public telephone call monitoring devices, point of scale terminals, etc..

Optocoupler: Optocoupler is , also called photocoupler, or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Optocoupler prevent high voltages from affecting the system receiving the signal. Commercially available opto- isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 10 kV/μs.

An optocoupler consists of an LED and a phototransistor in the same opaque package.



when an electrical current is applied to the LED, infrared light is produced and passes through the material inside the optoisolator. The beam travels across a transparent gap and is picked up by the receiver, which converts the modulated light or IR back into an electrical signal. In the absence of light, the input and output circuits are electrically isolated from each other.



2.17 Optocoupler in Input and Output circuit

Optocoupler is available as ICs from different semiconductor manufacturers. The MCT2M IC from Fairchild semiconductor is an example for optocoupler IC.

STEPPER MOTOR

A stepper motor 1s an electro-mechanical device which generates discrete displacement (motion) in response, to de electrical signals. It differs from the normal de motor in its operation. The de motor produces continuous rotation on applying de voltage whereas a stepper motor produces discrete rotation in response to the de voltage applied to it. Stepper motors are widely used in industrial embedded applications, consumer electronic products and robotics control systems. The feed mechanism of a printer/fax makes use of stepper motors for its functioning.

Based on the coil winding arrangements, a two-phase stepper motor is classified into two. They are:

1. Unipolar
2. Bipolar

1. **Unipolar**

   A unipolar stepper motor contains two windings per phase. The direction of rotation (clockwise or anticlockwise) of a stepper motor is controlled by changing the direction of current flow. Current in one direction flows through one coil and in the opposite direction flows through the other coil. It is easy to shift the direction of rotation by just switching the terminals to which the coils are connected.

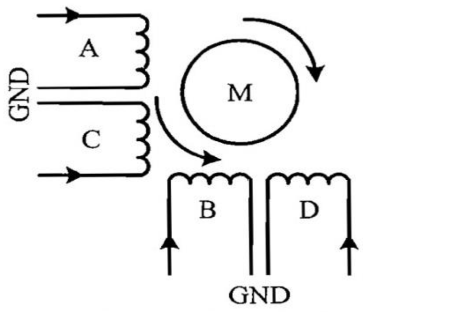


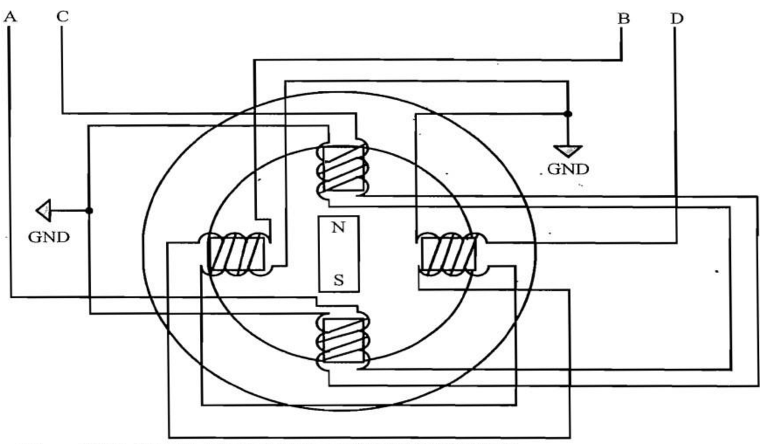
Fig. 2.18 **2-Phase unipolar stepper motor**

Figure 2.18 illustrates the working of a two-phase unipolar stepper motor.

The coils are represented as A, B, C and D. Coils A and C carry current in opposite directions for phase 1 (only one of them will be carrying current one at a time)

2.Bipolar:

A bipolar stepper motor contains single winding per phase.For reversing the motor rotation the current flow through the winding is reversed dynamically. It requires complex circuitry for current flow reversal. The stator winding details for a two phase unipolar stepper motor is shown in Fig 2.19



Stator Winding details for a 2 Phase unipolar stepper motor

The stepping of stepper motor can be implemented in different ways by changing the sequence of activation of the stator windings. The different stepping modes supported by stepper motor are explained below.

Full Step.

In the full step mode both the phases are energised simultaneously. The coils A, B, C and D are energised in the following order:

STEP	COIL A	COIL B	COIL C	COIL D
1	H	H	L	L
2	L	H	H	L
3	L	L	H	H

4	H	L	L	H

It should be noted that out of the two windings, only one winding of a phase is energized at a time

Wave Step

In the wave step mode only one phase is energized at a time and each coils of the phase is energized alternatively .The coils A,B,C and D are energized in the following order

STEP	COIL A	COIL B	COIL C	COIL D
1	H	H	L	L
2	L	H	L	L
3	L	L	H	L
4	L	L	L	H

Half Step

It uses the combination of wave & full step.It has the highest torque and stability. The coil energizing sequence for half step is given below

STEP	COIL A	COIL B	COIL C	COIL D
1	H	L	L	L
2	L	H	L	L
3	L	H	L	L
4	L	H	H	L
5	L	L	H	L
6	L	L	H	H
7	L	L	L	H
8	H	L	L	H

The rotation of the stepper motor can be reversed by reversing the order in which the coil is energized ,Two-phase unipolar stepper motors are the popular choice for embedded applications. The current requirement for stepper motor is little high and hence the port pins of a microcontroller/processor may not be able to drive them directly. Also the supply voltage required to operate stepper motor varies normally in the range SV o 24 V. Depending on the current and voltage requirements, special driving circuits are required to interface the stepper motor with microcontroller/processors. Commercial off-the-shelf stepper motor driver ICs are available in the market and they can be directly interfaced to the microcontroller port. ULN2803 is an octal peripheral driver array available from ON semiconductors and ST microelectronics for driving a SV stepper motor. Simple driving circuit can also be built using transistors.

The following circuit diagram (Fig 2.20) illustrates the interfacing of a stepper motor through driver circuit connected to the port pins of a microcontroller/processor.

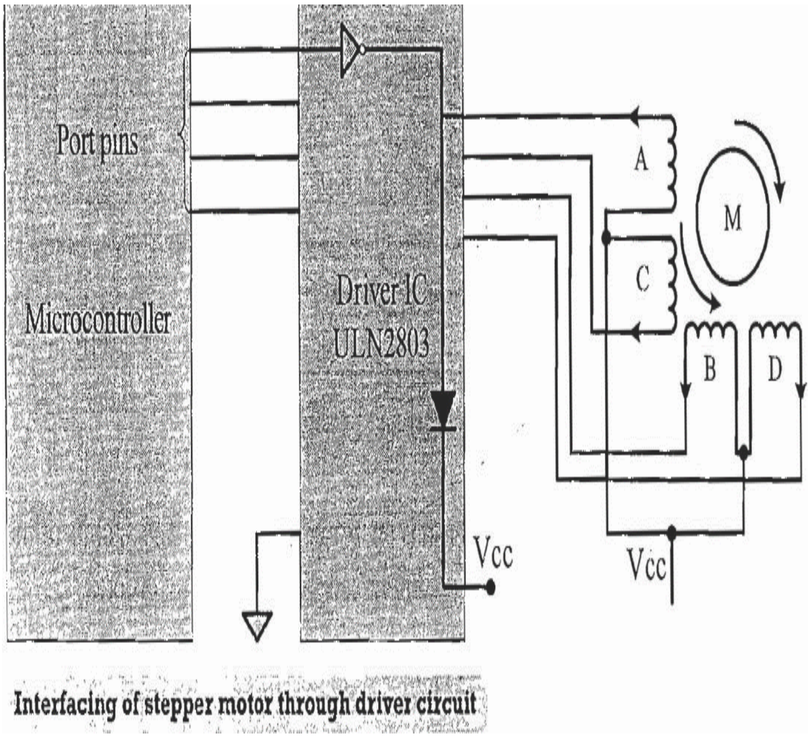


Fig 2.20 Interfacing of a Stepper Motor

Push Button

Push Button Switch It is an input device. Push button switch comes in two configurations, namely "Push to Make' and 'Push to Break'. In the 'Push to Make' configuration, the switch is normally in the open state and it makes a circuit contact when it is pushed or pressed. In the 'Push to Break' con-figuration, the switch is normally in the closed state and it breaks the circuit contact when it is pushed or pressed. The push button stays in the 'closed' (For Push to Make type) or 'open' (For Push to Breaktype) state as long as it is kept in the pushed state and it breaks/makes the circuit connection when it is released. Push button is used for generating a mo-mentary pulse. In embedded application push button is generally used as reset and start switch and pulse |generator. The Push button is normally connected to the port pin of the host processor/controller. Depend- port pin Port pin,on the way in which the push button interfaced to the controller, it can generate either a 'HIGH' pulse or 'LOW' pulse. Figure 2.23 illustrates how the pushbutton can be used for generating "LOW" and 'HIGH'pulses**.**

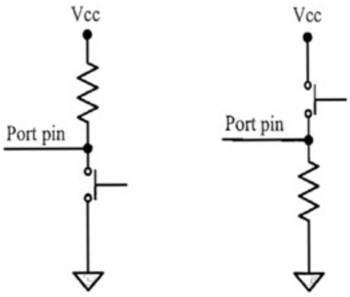


Fig 2.23 PushButton LOW and HIGH pulse