Input Output Devices

Sensors and Acuators

Dr. Munesh Singh

Indian Institute of Information Technology Design and Manufacturing
Kancheepuram, Chennai, Tamil Nadu

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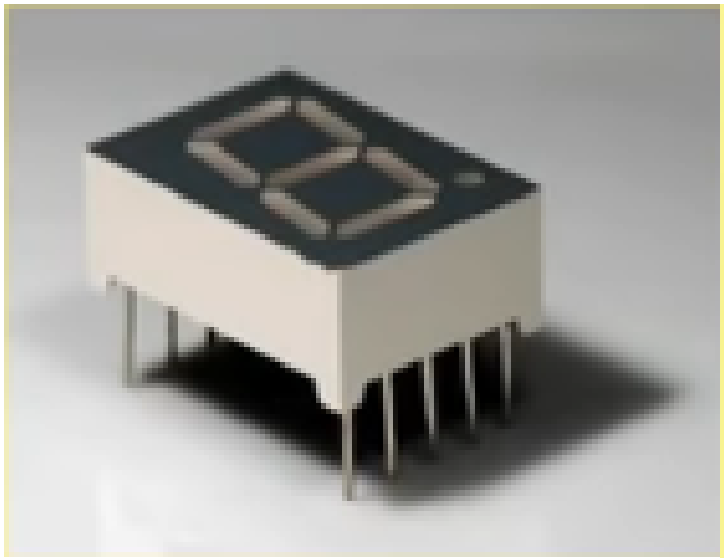
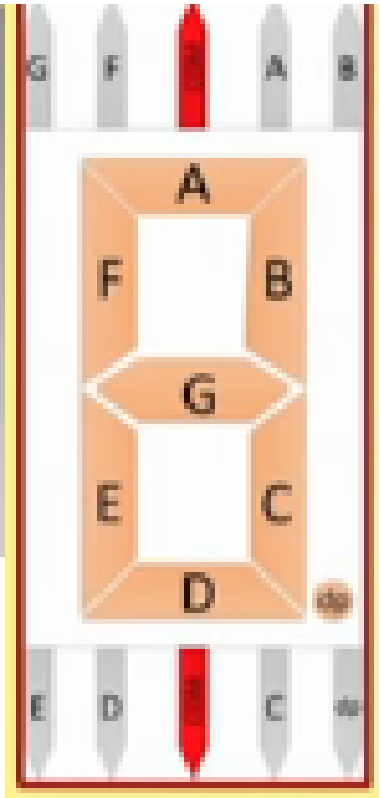
What is 7-Segment LED Display?

- It is a display device consisting of 8 LEDs used for number display purpose.
  - Seven line segments and a dot point.
- It can display 0-9 for Decimal and 0-F in Hexadecimal





Two Types of 7-segment Display Units

Common Anode

- The common point (COM) connects to a positive voltage source, and a segment pin should connect with ground to glow the LED.

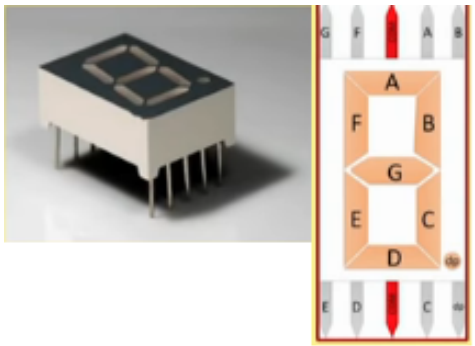
Common Cathode

- The common point (COM) connects to ground, and a segment pin should connect with positive voltage source to glow the LED.

- Point to note:
  - To glow a LED, about 5-10 mA current should be made to flow.
  - Current limiting resistance is used (1 for common, or individual for segments)
  - Drop across LED is typically 1.2 V.

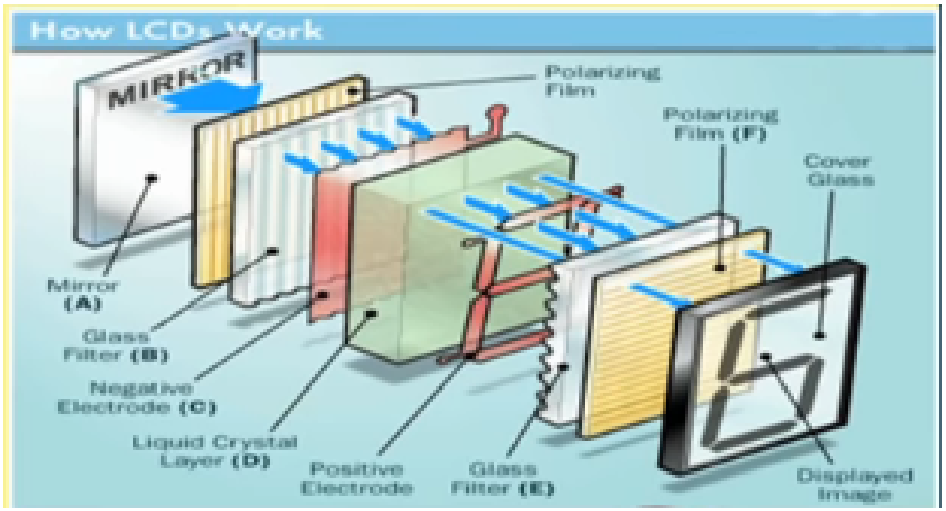
A Typical Interface

- Consider a common anode display unit.
- If a segment line is set to GND, it will glow.
  - To display 0, we apply A=B=C=D=E=FGND, and G=Vcc
  - To display 5, we apply A=C=D=F=G=GND, and B=E=Vcc.
  - To display F, we apply A=E=F=G=GND, and B=C=D=Vcc.
- To display arbitrary characters, the seven segment line can be driven from micro controller port lines.
- For common cathode display, the conversion will be just the reverse.
  - GND for OFF, Vcc for ON.



What is Liquid Crystal Display (LCD)?

- It is a type of display screen used in numerous applications.
  - Very low power consumption as compared to LED.
- LCD units are very thin and is composed of several layers.
  - Two polarized panel, with a liquid crystal solution sandwiched between them
  - Light is projected through the layers and is colorized as it passes, thereby producing the visual image.



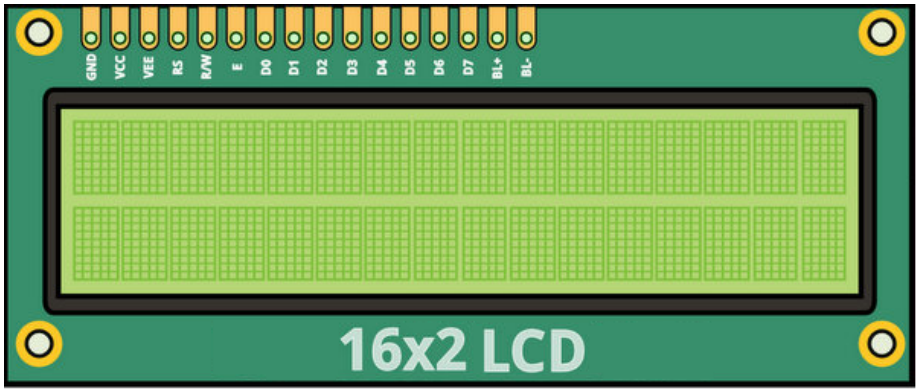
Working Principle

- When an electric current is applied to the liquid crystal molecules, they untwist.
  - Result in a change in the angle of light.
  - The polarized layers are responsible for either blocking the light or allowing it to pass.
- A reflecting mirror is arranged at the back of the unit.
- An electrode plane is used to allow the current to flow in selected areas.
- The entire arrangement is placed inside a sealed casing, with necessary electronics for controlling the device.

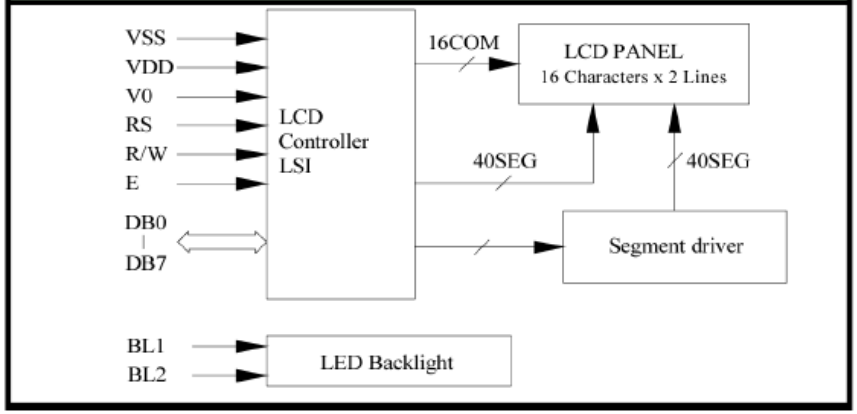
The JHD162A LCD Display Unit

- The JHD162A LCD display unit consist of 16 pins and can display 16x2 monochrome characters.
  - Two lines of display, where each line can hold 16 characters.
  - Can be interfaced in 4-bit mode or 8-bit mode.

JHD162A Pin Description



BLOCK DIAGRAM



PIN CONNECTIONS

PIN	Symbol	Level	Function
1	VSS	—	GND(0V)
2	VDD	—	Supply Voltage for Logic(+5V)
3	V0	—	Power supply for LCD
4	RS	H/L	H: Data; L: Instruction Code
5	R/W	H/L	H: Read; L: Write
6	E	H/L	Enable Signal
7	DB0	H/L	Data Bus Line
8	DB1	H/L	
9	DB2	H/L	
10	DB3	H/L	
11	DB4	H/L	
12	DB5	H/L	
13	DB6	H/L	
14	DB7	H/L	
15	BL1	—	Backlight Power(+5V)
16	BL2	—	Backlight Power(0V)

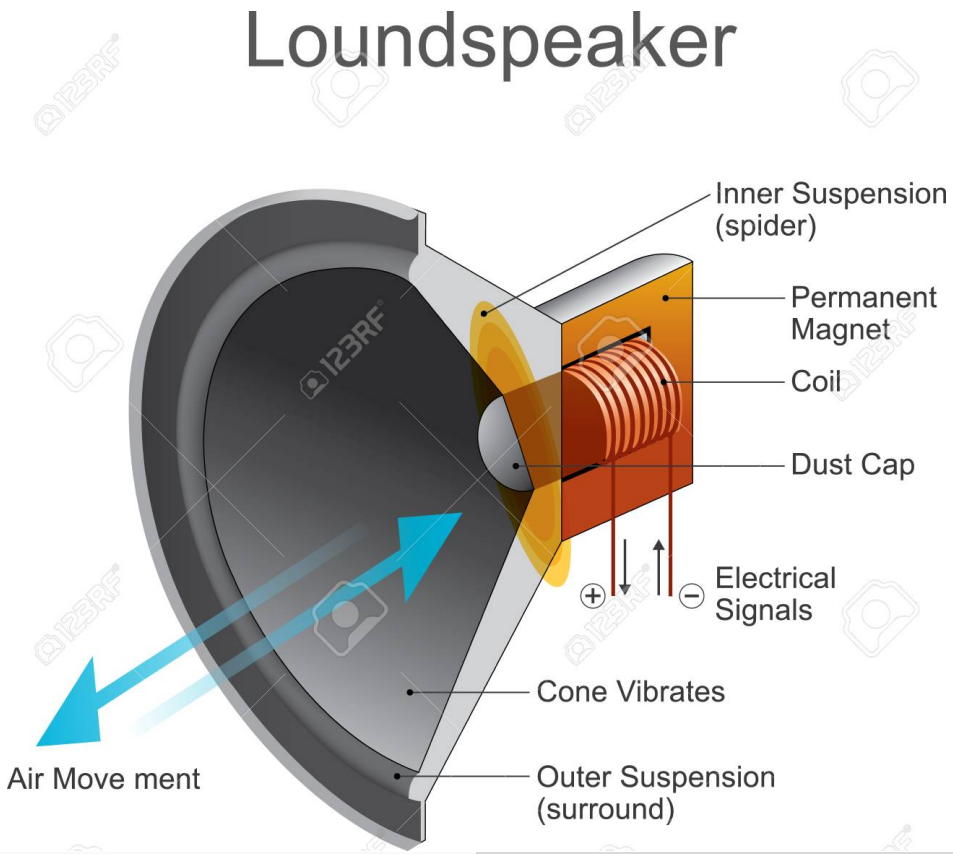
How to Display Characters usin 4-bit Interface?

- Data are send out as nibbles and not as bytes.
  - D3-D0 are not connected in this mode.
  - D7-D4 are used to transfer the nibbles.
- The commands and data are still 8-bits long, but are transferred as mentioned
  - The most significant nibble is transferred first, followed by the least significant nibble.
- The detailed command codes are available in the LCD module data sheet.
  - There are variety of libraries are available

What is a Speaker?

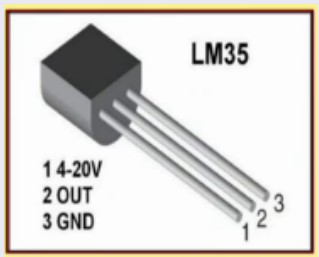
- It is an electro-acoustic transducer, which converts an electrical audio signal into a corresponding sound.
- It consist of the following:
  - A permanent magnet that is fixed
  - A movable electromagnet attached to a diaphragm.
- How it works?
  - When a current flows through the coil of the electromagnet, a magnetic field is produced in the direction determined by the polarity of the input signal.
  - The two magnets either attract or repel.

- Changes in the input audio signal.
  - The electromagnet experiences attractive and repulsive forces.
  - Causes the electromagnet (and diaphragm) to vibrate back and forth.
  - The frequency of the vibrations determine the pitch of the output sound produced
  - An amplifier circuit can magnify the magnitude of vibrations.



What is LM35?

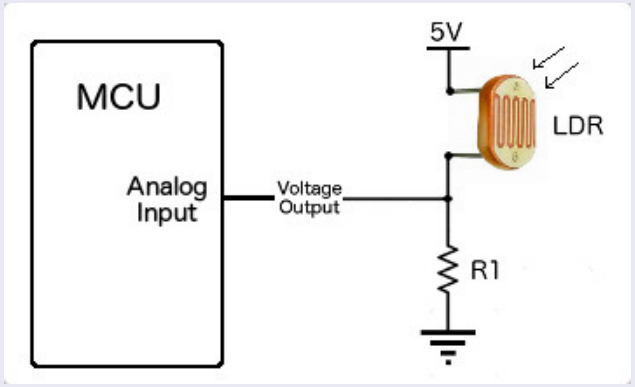
- The LM35 series are precision integrated-circuit temperature sensors with an output voltage linearly proportional to the centigrade.
  - Does not require any external calibration and provides accuracy of (+-0.25 C) at room temperature
  - It is a low-power device, and draws only 60 micro amp current from the power supply
  - It can operate over the range -55C to 150 C
  - Operates for supply voltage from 4V to 20 V



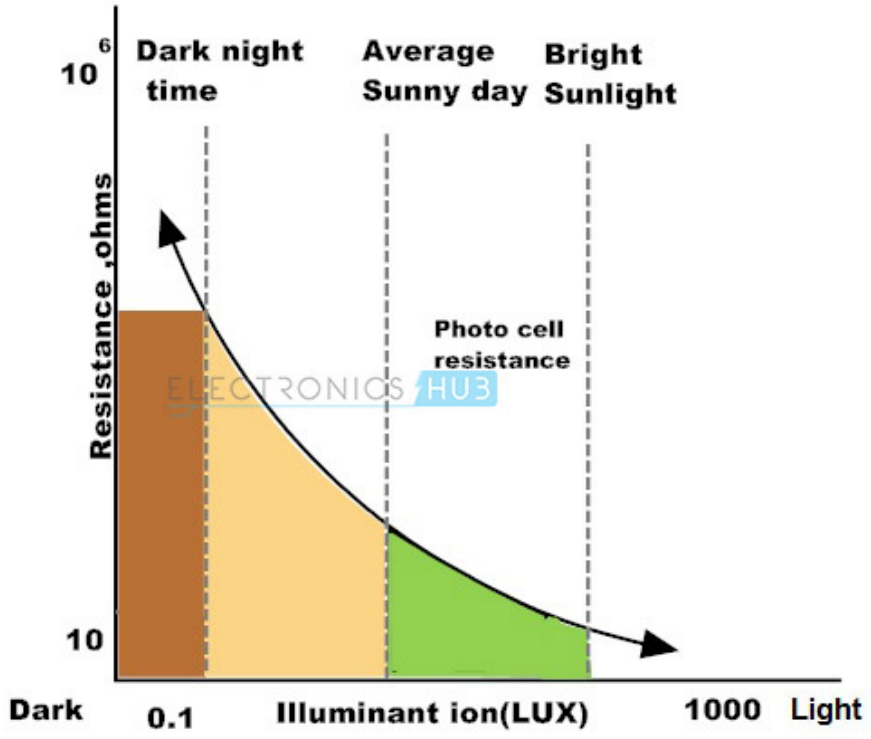
The analog output increases by 10mV for every degree rise in temperature

What is Light Dependent Resistor (LDR)?

- A LDR or a photo-resistor is a device whose resistance is a function of the incident electromagnetic radiation.
- It is made up of semiconductor material having high high resistance.
  - When light (photons) fall on the device, the electron in the valence band of the semiconductor material are excited to the charge carries.
  - This result in an increase in the number of charge carriers.
  - Thus, the flow of current is increased, resulting in a decrease of resistance.

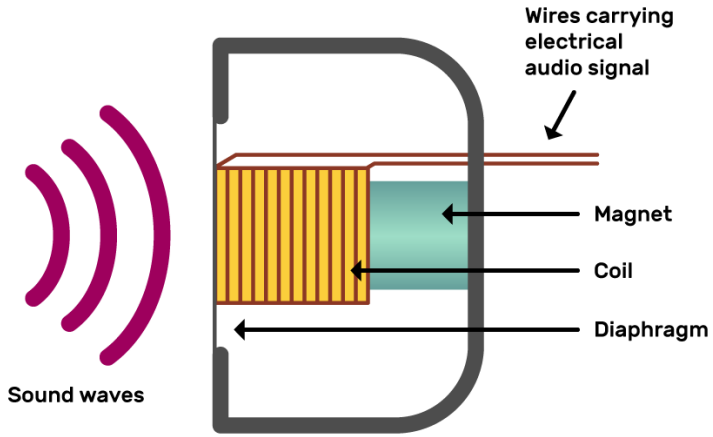


- The variation of resistance with incident light is non-linear.
  - May therefore require calibration.
- The change in resistance can be by an order of magnitude.
- When light is incident on a LDR, it usually takes 8-12 ms for the change in resistance to take place, while it takes one or more seconds for the resistance to rise back again to its initial value after removal of light



What is a Microphone?

- A microphone is functionally the opposite of a speaker.
  - Convert sound waves into electrical signals.
  - Very similar in design to a speaker.
- How does a microphone work?
  - The diaphragm (much smaller as compared to a speaker) moves back and forth when the sound waves hit it.
  - The coil, attached to the diaphragm, also moves back and forth.
  - The permanent magnet produces a magnetic field that cuts through the coil, As the coil moves, an electric current flows through it.
  - Sound energy gets converted into electricity


Wires carrying
electrical
audio signal
Magnet
Coil
Diaphragm
Sound waves

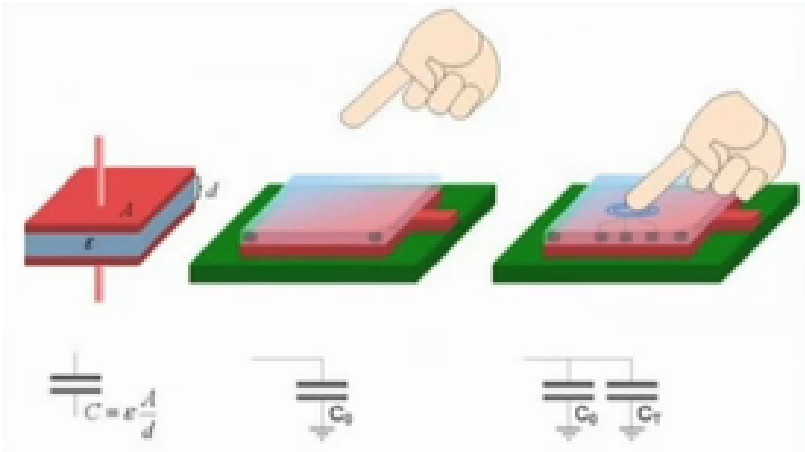

SHURE
SM58

What is Capacitive Sensing?

- Capacitive sensing is a technology based on capacitive coupling that can detect and measure anything that is conductive or has a dielectric different from air.
- The working of a touch sensor is similar to that of a simple switch
  - When there is contact with the surface of the touch sensor, the circuit is closed inside the sensor and there is a flow of current.
  - When the contact is released, the circuit is opened and no current flows.
  - Two types capacitive and resistive.
- Many applications in human interface devices:
  - Trackpads, touchscreens, touch switches, etc.

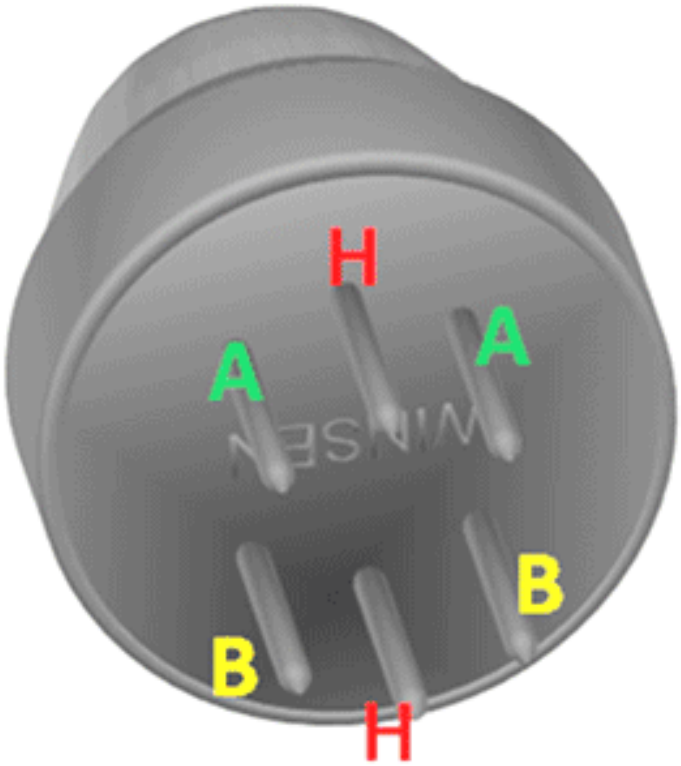
Principle of Operation

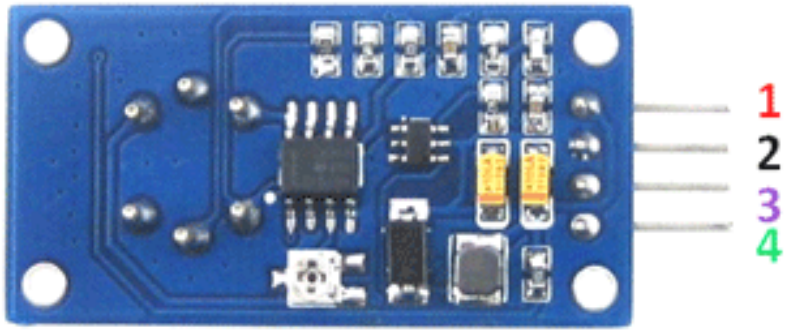
- The capacitance of a parallel plate capacitor $= \epsilon_0 * \epsilon_r * A/d$, where ϵ_0 is the permittivity of free space, ϵ_r is the relative permittivity of the dielectric material, A is the area of the plates, and d is the distance between them.
- The capacitance will increase if a conductive object touches or approaches the sensor electrodes



MQ135 Gas Sensor

- The MQ135 sensor is used to measure air quality.
  - Uses a small heater inside with an electrochemical sensor.
  - They are sensitive to a range of gases and are used indoors at room temperature.
  - It generates an analog voltage signal as output/.
- What is there inside?
  - A layer of tin dioxide (SnO_2) inside aluminum oxide microtubes (measuring electrodes), and a heating element inside a tubular casing
  - Has high sensitivity to Ammonia, Sulphate and Benzene stream, and also sensitive to other harmful gases



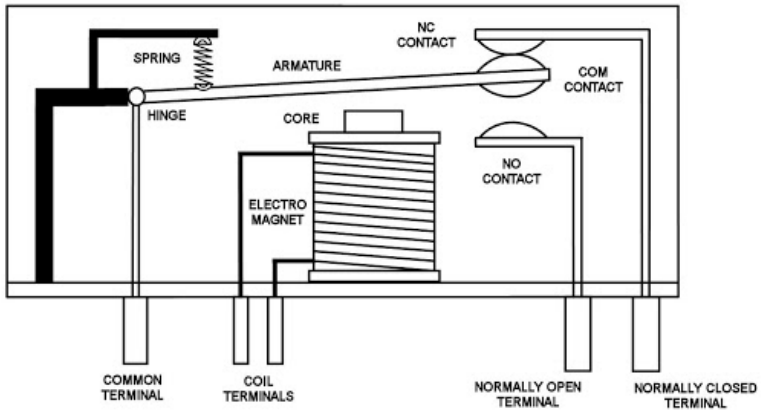


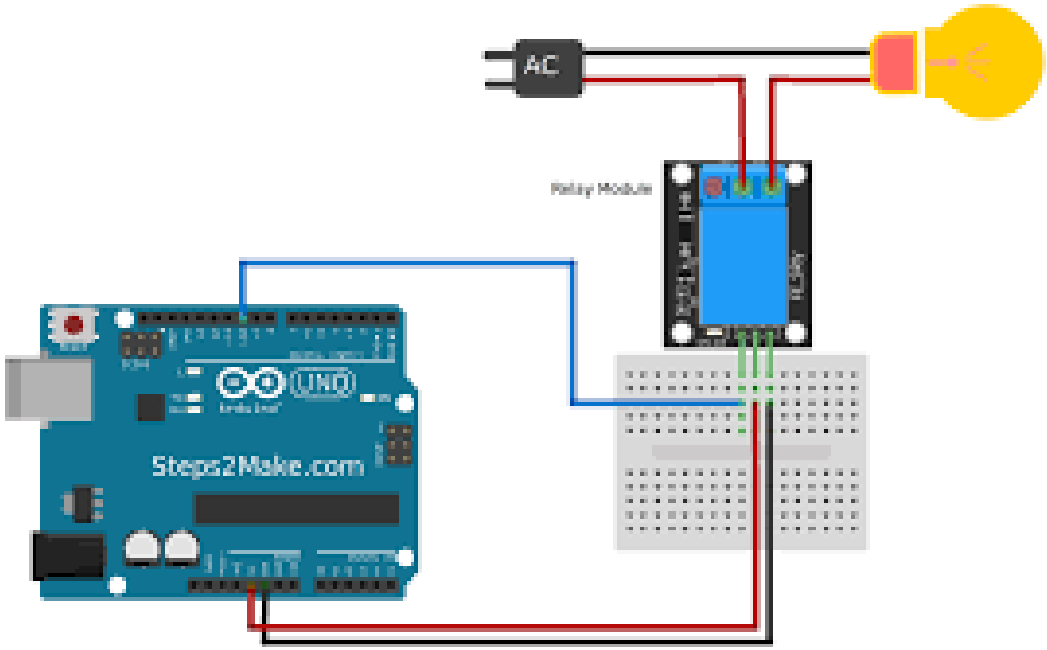
Pin No.	Pin Name
1	Vcc(+5V)
2	Ground
3	Digital Out
4	Analog out

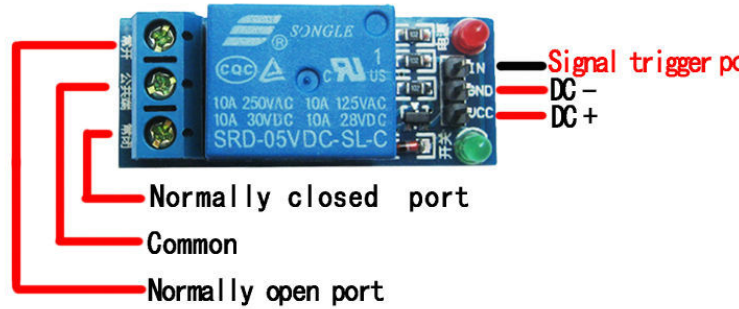
Actuator: Mechanical Relay

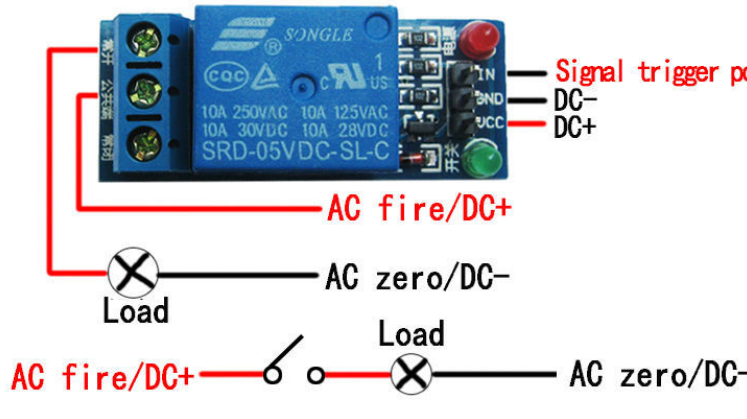
What is Mechanical Relay?

- It is a device that can turn on or turn off power supplied to another devices
  - For switching, we need to apply a small amount of power (to an electromagnet).
  - This allows high-power circuit to be controlled by low-power devices.



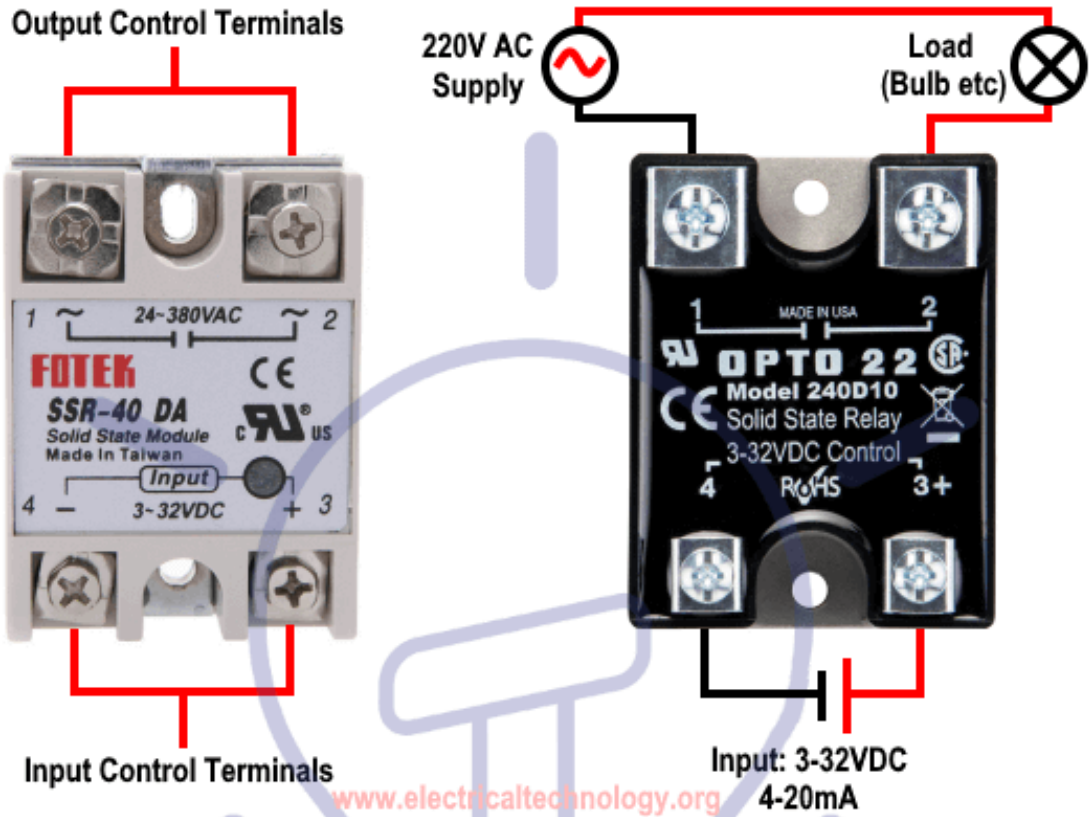

AC
Steps2Make.com


SRD-05VDC-SL-C
Signal trigger po
DC –
DC +
Normally closed port
Common
Normally open port

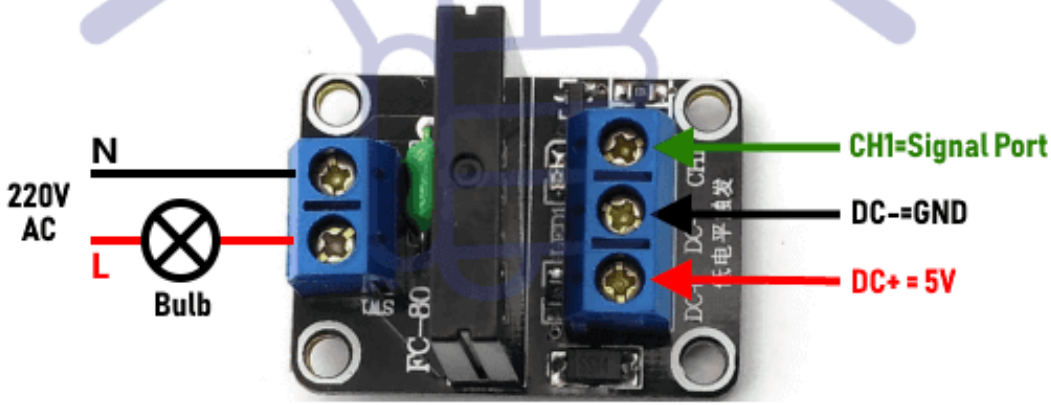

SRD-05VDC-SL-C
Signal trigger po
DC–
DC+
AC fire/DC+
AC zero/DC–
Load
Load
AC fire/DC+
AC zero/DC-

What is Solid-state Relay?

- It is an electronic switching device that switches ON or OFF when a small external voltage is applied across its control terminals.
- It consist of:
  - A sensor that responds to an appropriate input (control signal)
  - A solid-state electronic switching device that switches power to the load circuitry.
  - A coupling mechanism to enable he control signal to activate this switch.
- Similar to electromechanical relay in functionality, but not moving parts.
  - They uses semiconductor devices like thyristors and power transistors.
  - Current of 100's of amperes can be switched



SSR Relay Terminals & Connections



1-Channel 5V SSR Relay Connection

Thank You