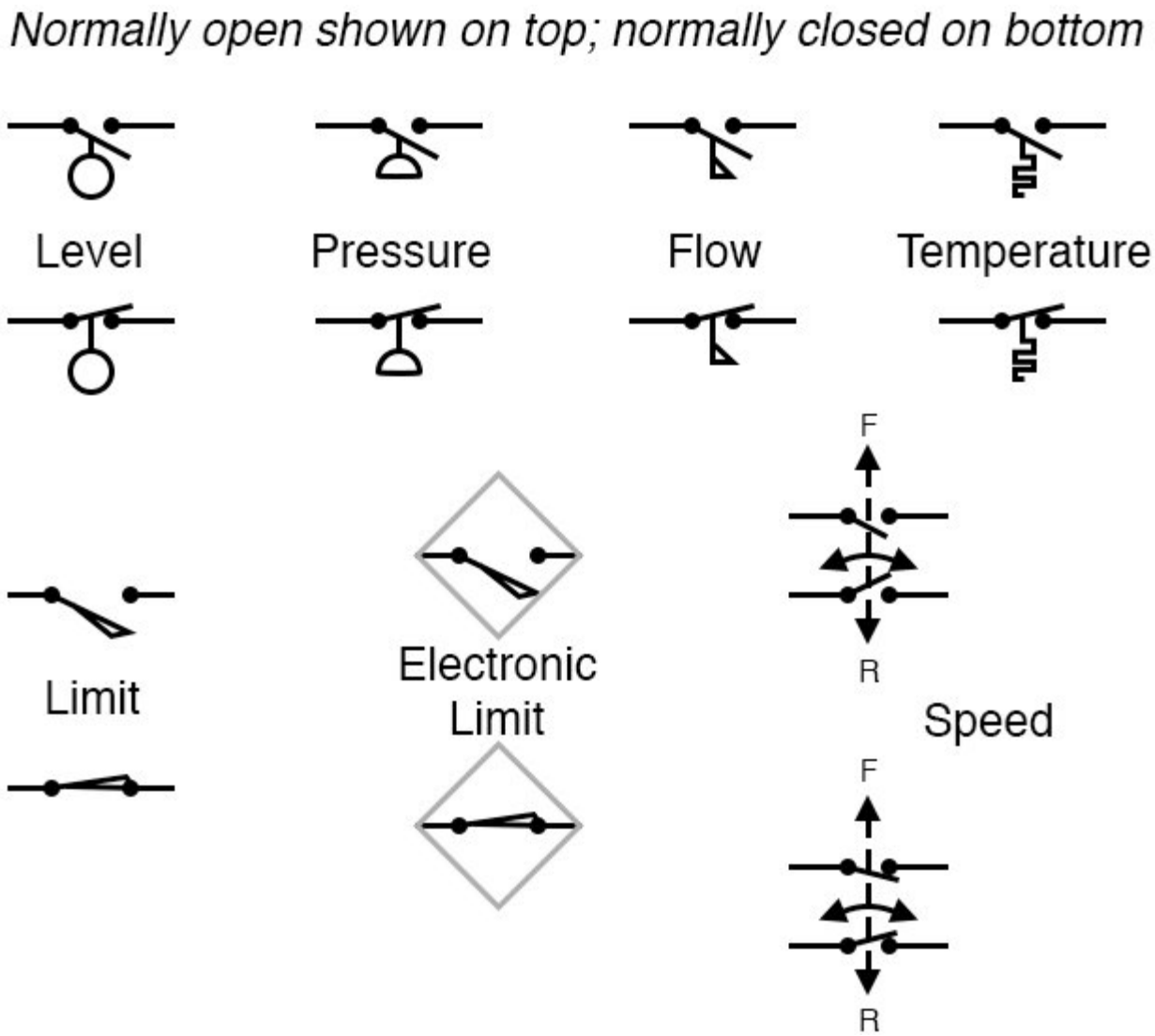
SWITCHES

Switches


Normally open shown on top; normally closed on bottom
Level
Pressure
Flow
Temperature
Limit
Electronic
Limit
F
R
Speed
F
R

Flow Switch

- In industrial processing, flow is the movement of liquids, steam, and gases through a processing system. Flow rate measurement is used to measure the volume of fluid process media passing through a specific cross-sectional area per unit of time. Monitoring flow rate measurements is essential in controlling the safe movement of fluid within an industrial system. The monitoring and control of flow is a requirement for all industries that process fluid media.

Flow switch

- flow switches are used to monitor and control the flow rate of fluid within an industrial process system. Automated industrial systems that process fluid media rely heavily on flow switches to ensure safe and optimal flow rates. Flow switches respond to pre-set flow rate levels and perform two functions when those levels are reached: namely, closing its contacts and turning a specific piece of equipment ON, or opening its contacts and turning a specific piece of equipment OFF.

Flow sensor and Flow switch

- While flow switches and flow sensors both can be used to monitor media flow within a system, the difference between a flow switch and a flow sensor is that a flow sensor can only monitor and display information – flow switches monitor flow and send trip signals and trigger specific actions from machines within the system.

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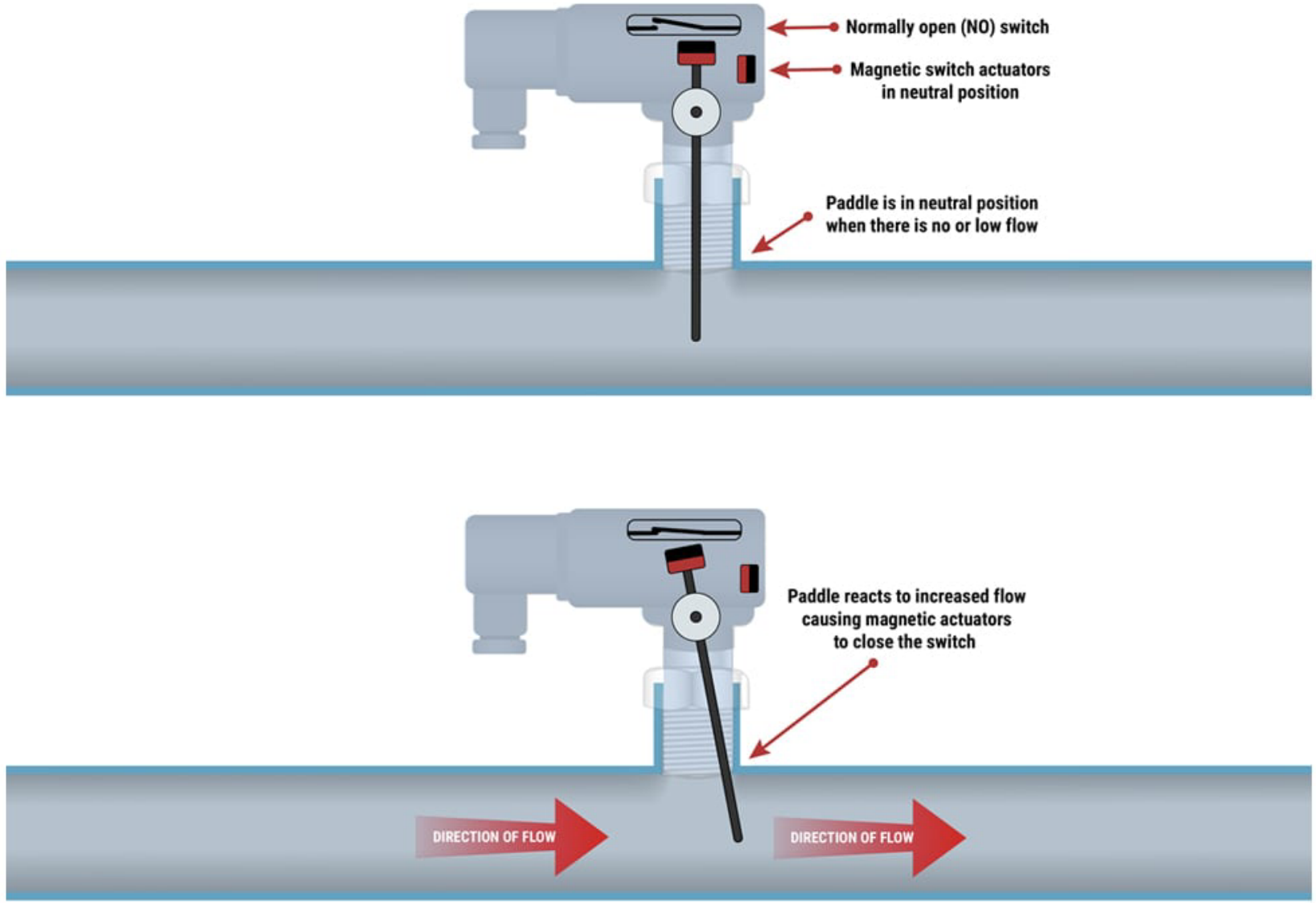
- There are a variety of different types of flow switches on the market today – functioning in a variety of different ways – but what all flow switches have in common is that when the flow rate reaches a switch's set-point, it can either open or close the circuit which triggers an action: whether it's turning a pump on or off or it's actuating an alarm.

  Flow switches are either configured to be Normally Open (NO) or Normally Closed (NC). This refers to the default state of the switch. With a NO switch, the circuit is open (OFF) until triggered otherwise. With a NC switch, the circuit is closed (ON) until triggered otherwise

Paddle Flow switch

- The paddle design flow switch is constructed with a hinged or spring-mounted paddle, which makes direct contact with the media flowing through the pipe. The paddle is held in position when the media is flowing at the target rate (or setpoint). An increase or a decrease in the flow rate will move the paddle from its setpoint, which, in turn, throws a small switch triggering the specified action.

PADDLE TYPE FLOW SWITCH



Level Switch

- Liquid level switches detect liquid levels or interfaces between liquids such as oil and water, or liquid and solid interfaces. Liquid level switches are used in a number of liquid container monitoring applications including flow line monitoring, heaters and furnaces, as well as other household appliances, automotive applications, and control technology.
- **Principle:** This is a simple limit switch based level switch. When the float moves with the raise in level then the output contact changes & it indicates the level position.

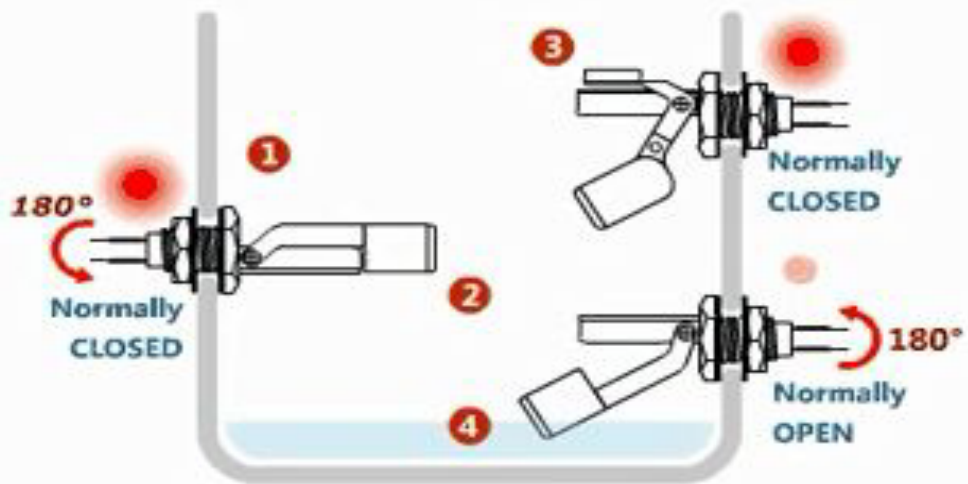
WORKING OF LEVEL SWITCH
SIDE MOUNTING

1 Versatile

Easy installation inside tank for lateral mounting or vertical mounting through Ø16mm hole or 1/2" NPT thread.

2 Works NO / NC

The same Level Switch works normally open or normally closed, just rotate 180°.



3 Encrusting Liquids

Level Switch for internal side surface mounting. The magnetic float stays away from the sensor body to avoid the liquid contact.

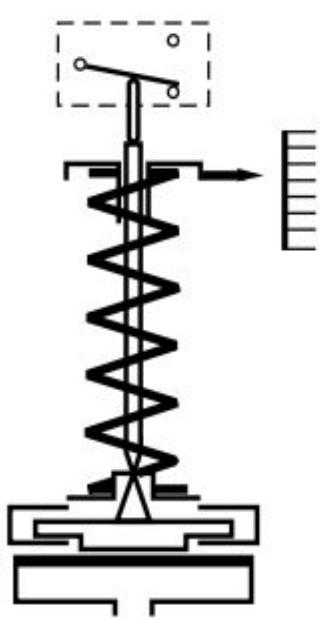
4 Application

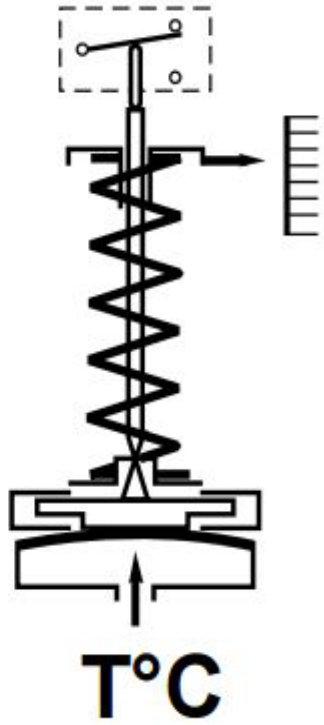
Level Switches available in various materials according to the chemical resistance of liquid.

- They are used as a measurement device, a monitoring control, or warning alarm, such as when to turn a mechanism on or off. Level switches are equipped with a mechanical or electrical output, depending on their design, and can be open or closed.
- Types of Level Switches
- Capacitance type
- Inductive type
- Paddle type
- Float type
- Diaphragm type
- Displacer type

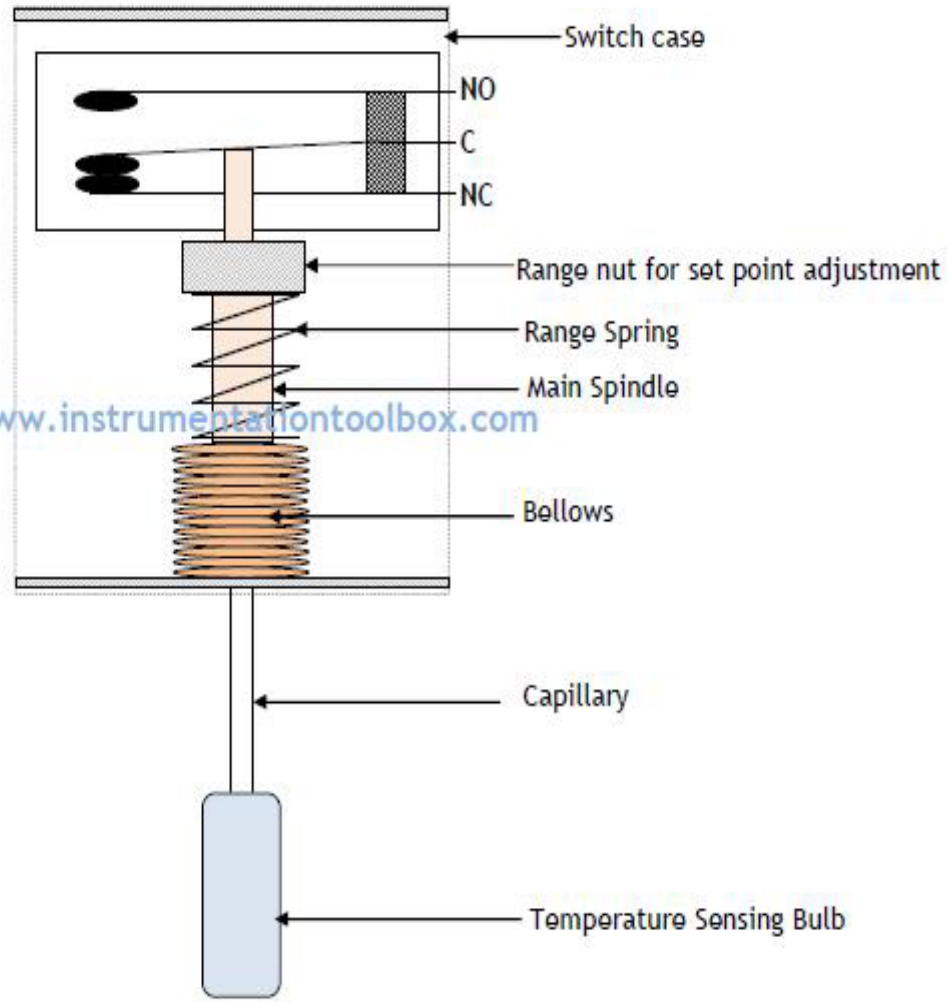
Temperature Switch

Temperature Switch has a vapour filled flexible sensing element actuates a micro switch by means of a piston when temperature reaches the setpoint. The set point is adjusted by means of a compressible spring or a adjustable screw installed in the switch.

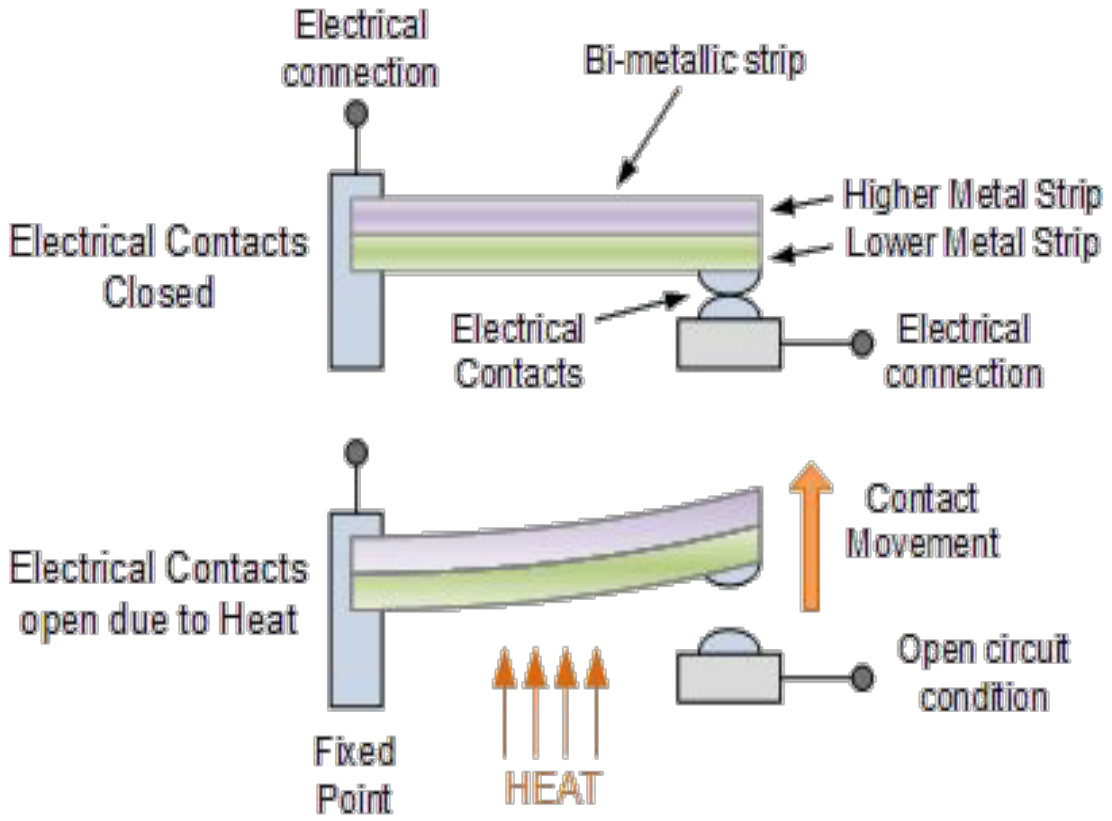




- Fluid in the sensing bulb reacts to the temperature variations and increase the pressure in the bellows element when the temperature rises. A rise in the bulb temperature compresses the bellows and moves the spindle upwards until spring force and bellows pressure are in equilibrium. This movement of the spindle is transferred to the switch and causes on-off action.



- Bimetallic
  Temperature switch



Pressure Switch

- A pressure switch is a simple electromechanical device that is triggered by pressure to turn an electrical circuit on or off. The pressure point that activates the switch is called its set point, and the pressure threshold that deactivates the switch is called the cut out point. A pressure switch consists of the following key components:
- A **diaphragm** that acts as the pressure detection element. It is typically made of a pliable material that is sensitive to pressure.
- An **adjustment spring** to vary the set or cut out points. Some switches have separate springs for controlling the set and cut out points.

- A pressure switch is a passive device since the presence or absence of pressure is all that is necessary for it to function. The pressure on the diaphragm compresses a calibrated spring. When the spring tension reaches or exceeds the set point, it will move the contacts from open to closed in a NO switch or closed to open in an NC switch.

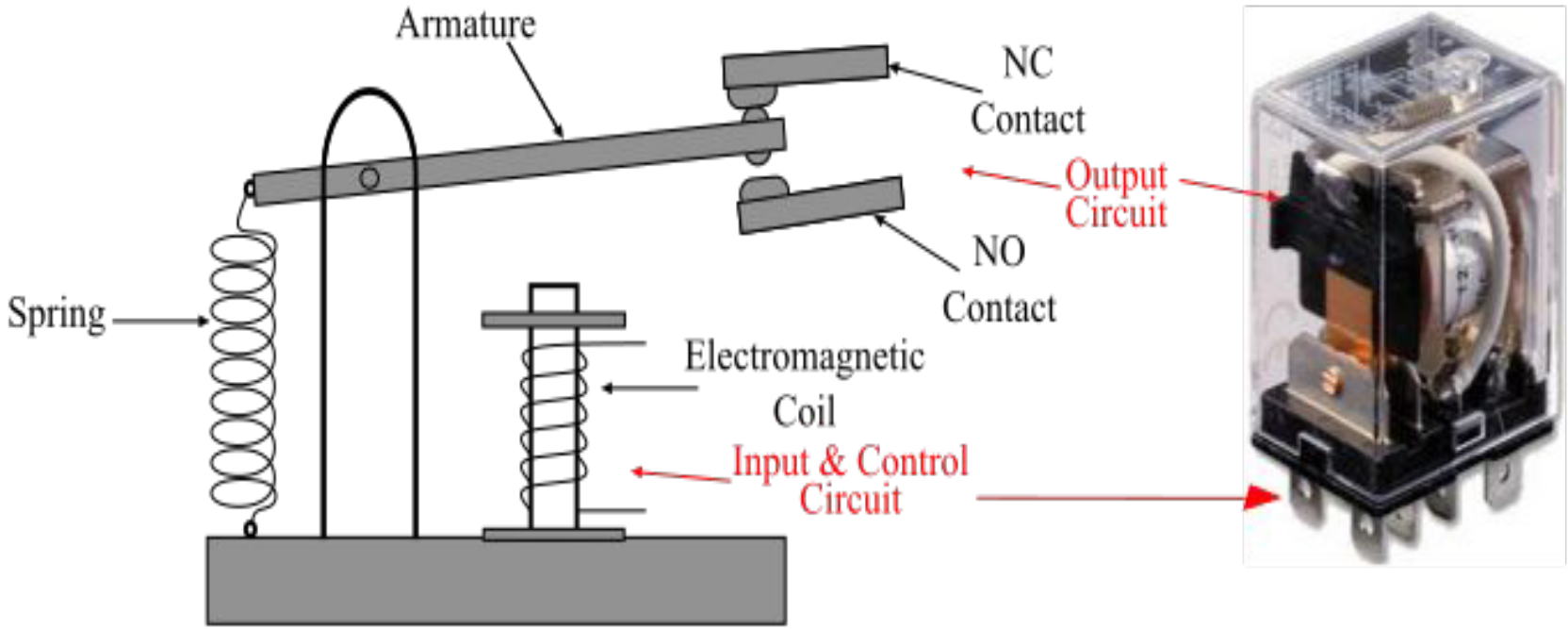
- **Compressed air systems**. Pressure switches turn on or turn off the compressor at the set point.
- **Process equipment**. Fluid and gas flow control equipment use pressure switches to maintain a steady rate of flow.

Vibration Switch

- **Mechanical Vibration Switches** provide vibration protection for low- to medium-speed machinery. An inertia sensitive mechanism activates a snap-action switch.
- The mechanical vibration switch contacts can be used to activate an alarm or initiate equipment shutdown as per our requirement.

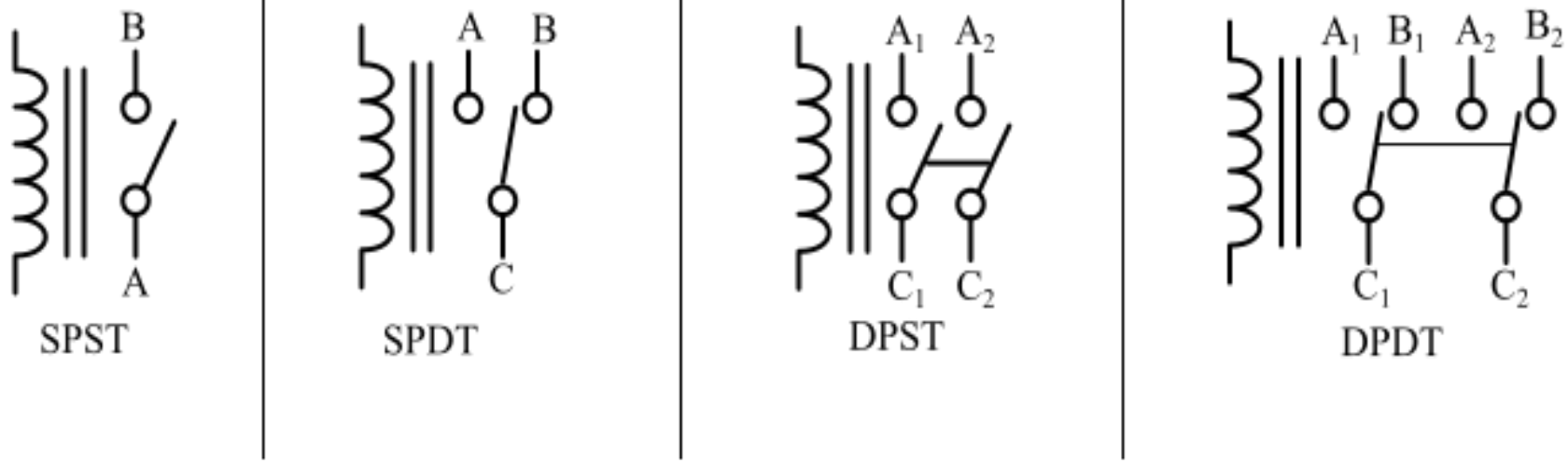
Electromechanical Relay

- **Electromechanical Relay**
- An electromechanical relay is a type of relay which function using a magnetic field produced by an electromagnetic coil when a control signal is applied to it. It is called as electromechanical since it has moving contacts in the output circuit which are operated by applying an electrical signal.
- **Electromechanical Relay: Working Principle**
- An electromechanical relay transfers signals between its contacts through a mechanical movement. It has three sections viz. *input section, control section* and *output section*.


Armature
NC
Contact
Output
Circuit
NO
Contact
Spring
Electromagnetic
Coil
Input & Control
Circuit

- The *input section consists* of input terminals where a small control signal is to be applied. The *control section* has an electromagnetic coil which gets energised when control input signal is applied to the input terminals and the *output section* consists of an movable armature and mechanical contacts – movable and stationary, the movement of the armature makes or breaks the electrical circuit.
- When an input control voltage is applied to the electromagnetic coil, it gets magnetised and the armature is attracted by the magnetic field produced by the coil. The movable mechanical contacts are attached to the armature, thus when the armature moves towards the electromagnet, the contacts closes, making the output circuit switched on. When the control signal is removed, the armature comes back to its original position by the force of spring, making output circuit off.

- **Classification of EMRs based on their applications**
- **General Purpose Relays** – Such as miniature relays, latching relays, timer relays, contactors, machine tool relays, hybrid relays, smart relays, signal relays, automobile relays and PCB relays etc.
- **Protection Relays** – Such as thermal overload relays, earth fault relays, under or over voltage relays, under or over current relays,differential relays, distance protection relays, sequence protection relays, electronic relays etc.
- **Classification of EMRs based on contact configurations**
- Single-Pole Single-Throw (SPST)
- Single-Pole Double-Throw (SPDT)
- Double-Pole single-Throw (DPST)
- Double-Pole Double-Throw (DPDT)


B
A
SPST
A
B
C
SPDT
A1
A2
C1
C2
DPST
A1
B1
A2
B2
C1
C2
DPDT

EMR Specifications

- Pole Type
- AC/DC Coil Voltage
- Throw(Single/Double)
- NO/NC Type
- Maximum Current
- Coil Resistance
- Make time
- Break time
- Operating Temperature

Applications

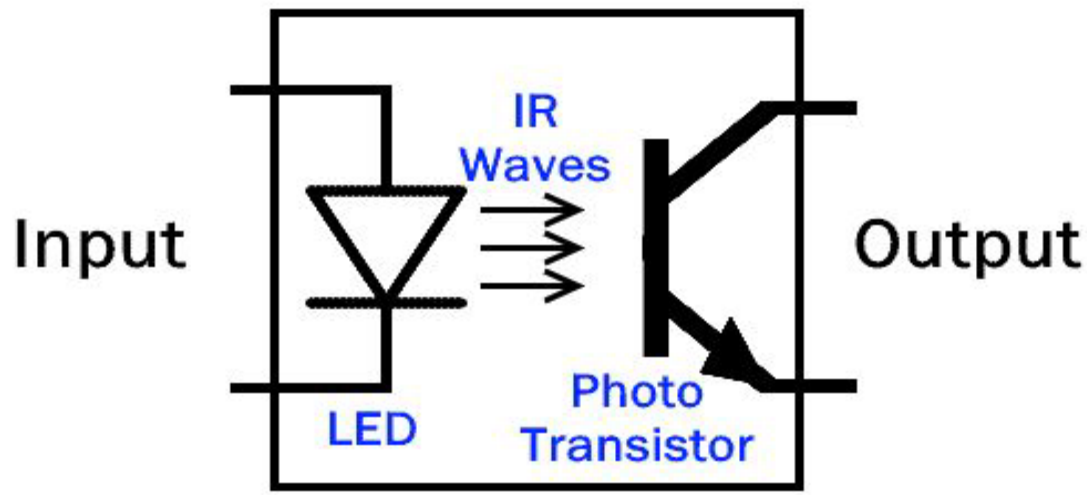
- The typical applications of electromechanical relays include motor control,
- automotive applications such as an electrical fuel pump,
- industrial applications where control of high voltages and currents is intended, controlling large power loads,

Solid state relays(SSR)

- Solid state relay (**SSR**) is an electronic switching device made of **semiconductors** that switch (On & Off) a high voltage circuit using a low voltage at its control terminals.
- Unlike EMR (Electromagnetic relay) that has a coil & mechanical switch (physical contacts), the SSR relay uses Optocoupler to isolate the control circuit from the controlled circuit.

- SSR relay has two sets of terminals i.e input terminals & output terminals.
- These two terminals are the input control terminal. It is connected to a low power circuit that controls its switching.
- The control input of an SSR relay is designed for DC or AC circuit separately.
- The output terminals of **SSR** relay switches on and off depending on the control input.
- Normally, the electrical connection between these terminals remains open. When the relay activates, these terminals connect together providing a closed path.
- The output terminals are specifically designed for either **AC** or **DC** circuit. Unlike EMR relay, an SSR relay cannot switch both AC & DC signal using the same terminals.

- The input of the SSR relay activates the optocoupler which switches the Load circuit. The optocoupler has no physical connection & it isolates the low voltage circuit from the high voltage circuit.
- Optocoupler has an **LED** at its input which emits **infrared** light when a voltage is applied. These **IR waves** are received by the **photo-sensor** (Photo-transistor, photodiode etc.) on its output end. The Photo-sensor converts the light signal into an electrical signal & switches on the circuit.



Opto-coupler

- **Advantages**
- SSR switching time is much **faster** than EMR (Electromechanical relay) relay.
- It has no **physical contacts**.
- There is no issue of contacts **spark & wear out**.
- They have a longer **lifespan** than EMR relays.
- SSR relay Switch off at 0 AC load current which prevents any **arch** or electrical **noise**.
- **Vibrations** or **movement** does not affect its operation.
- It has very **low power** consumption as compared to EMR relay.
- SSR relay is very easily controlled by **logic circuits**(**microcontrollers**)
- **Disadvantages**
- It has a **complex** design as compared to EMR relay
- There is a **voltage drop** across its load terminals.
- It has a **leakage** current during **off state**.
- SSR relays dissipate too much **heat**.
- It cannot switch **low voltages** as compared to EMR relay.
- SSR relay switching depends on the voltage of the controlled circuit.

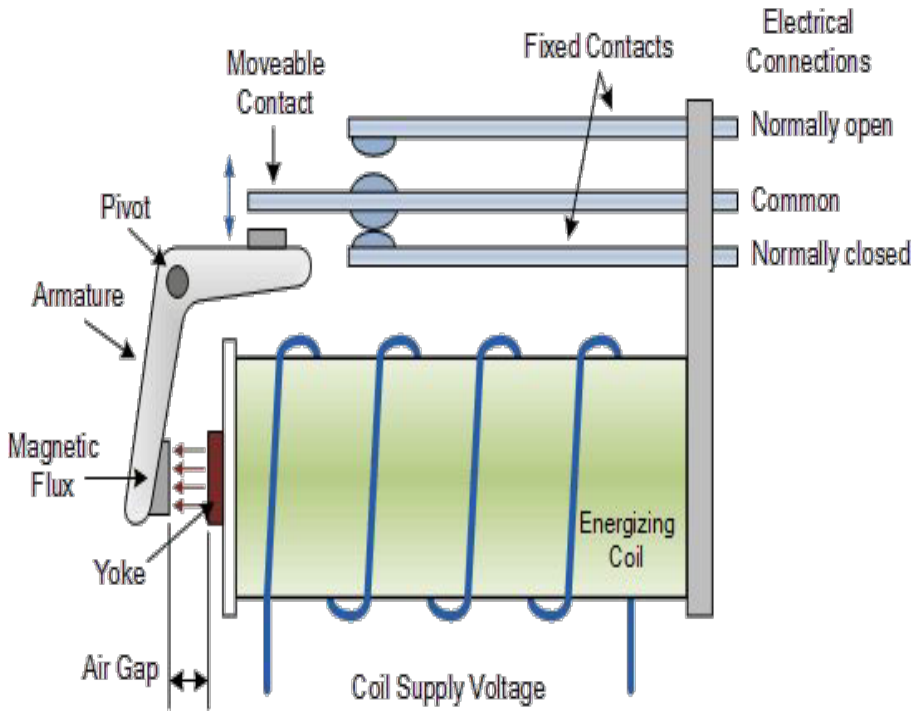
Applications

- Generally, SSR relay are used for switching purpose i.e. ON/OFF control of AC Power.
- It is used to control the power i.e. motor speed control, light and fan dimming, power switching etc.
- They are also use to drive electric heaters to control the temperature.
- SSR can be used as a latch which is useful in case of kettles.
- In communication lines, photocoupler SSR relay are used to eliminate relay driving current flowing through it.
- Solid state relay are mostly used in High load switching

Interposing Relay

- An interposing relay is simply an auxiliary relay that is used to isolate two different systems or devices from one another.

- In Industrial Automation, generally when people say 'interposing relay' it means a relay that is used for interposing, meaning to separate or put a barrier between two circuits.
- It normally consists of a coil that is energised by either AC or DC power and activates contacts that are used to trigger another circuit.
- Construction of a relay.



Overload relay

- An overload relay, also referred to as a relay switch, is a device that opens the circuit in the event of an electrical, thermal or power overload. When mounted with a contactor they create a motor starter. Overload relays are normally closed, meaning they only open if they experience an overload. They are used to protect motors from damage in a number of applications across industrial and commercial sectors, among others. They are available in a number of current ratings which can be adjustable on some models.
- Common types of overload relays.
- Overload relays are typically one of two types: thermal relays or electrical relays. The overload mechanism inside thermal relays consists of a bimetallic strip in conjunction with a heating element. When the heating element experiences an excessive current, the bimetallic strip bends and opens the normally closed contact, thus interrupting the circuit. These have adjustable current ratings to meet a variety of application requirements. On the other hand, electronic relays rely on electrical components which measure the current flowing through. While these are more accurate and are available across more current ratings, thermal relays can be more cost-effective.

Contactor

- A contactor is an electrical device which is used for switching an electrical circuit on or off. It is considered to be a special type of relay. However, the basic difference between the relay and contactor is that the contactor is used in applications with higher current carrying capacity, whereas the relay is used for lower current applications. Contactors can be field mounted easily and are compact in size. Generally, these electrical devices feature multiple contacts. These contacts are in most cases normally open and provide operating power to the load when the contactor coil is energized. Contactors are most commonly used for controlling electric motors.
- There are various types of contactors, and each type has its own set of features, capabilities, and applications. Contactors can break current over a wide range of currents, from a few amperes to thousands of amperes, and voltages from 24 VDC to thousands of volts. In addition, these electrical devices come in varying sizes, from hand-held dimensions to sizes measuring a meter or yard on one side (approximately).
- The most common application area of the contactor is high-current load. Contactors are known for their capability to handle currents of over 5000 amperes and high power over 100 kW. Heavy motor currents produce arcs when being interrupted. These arcs can be reduced and controlled using a contactor.


M6
220V 50Hz
A1
A2
1 L1
3 L2
5 L3
13 NO
SASSIN
3SC8
18 10
10
SASSIN
2 T1
4 T2
6 T3
14 NO


1L1
3L2
5L3
LC1D
13 NO 21 NC A1
Schneider
Electric
TeSys
14 NO 22 NC A2
2T1
4T2
6T3

1. **Coil or Electromagnet:** This is the most crucial component of a contactor. The driving force that is required to close the contacts is provided by the coil or electromagnet of the contactor. The coil or electromagnet and contacts are protected by an enclosure.
2. **Enclosure:** Just like the enclosures used in any other application, contactors also feature an enclosure, which provides insulation and protection from personnel touching the contacts. The protective enclosure is made from different materials, such as polycarbonate, polyester, Nylon 6, Bakelite, thermosetting plastics, and others. Generally, the open-frame contactor features an additional enclosure, which protects the device from bad weather, hazards of explosion, dust, and oil.
3. **Contacts:** This is yet another important component of this electrical device. The current carrying task of the contactor is done by the contacts. There are different types of contacts in a contactor namely, contact springs, auxiliary contacts, and power contacts. Each type of contact has an individual role to play.

Operating Principle of a Contactor: The current passing through the contactor excites the electromagnet. The excited electromagnet produces a magnetic field, causing the contactor core to move the armature. A normally closed (NC) contact completes the circuit between the fixed contacts and the moving contacts. This permits the current to pass through these contacts to the load. When current is removed, the coil is de-energized and opens the circuit. The contacts of the contactors are known for their rapid open and close action.

- 1. Load Capacity
- Relays are generally classified as carrying loads of 10A or less, while a contactor would be used for loads greater than 10A,
- 2. Open/Closed Contact Standards
- Contactors are almost exclusively designed to operate with normally open (Form A) contacts. Relays on the other hand can and often are both Normally Open and/or Normally Closed depending on the desired function.

- 3. Safety Features (Spring-Loaded Contacts)
- Because contactors are typically carrying high loads, they often contain additional safety features like spring-loaded contacts to help ensure the circuit is broken when de-energized. This is important because in high load situations contacts can weld themselves together. This can create the dangerous situation of a circuit being energized when it is supposed to be off. Spring-loaded contacts help to reduce this chance, as well as ensure all circuits are broken at the same time. Since relays are typically for lower power, spring-loaded contacts are much less common.

- 4 Safety Features (Arc Suppression)
- Another safety feature commonly included in contactors, due to the high loads they typically carry, is arc suppression. Magnetic arc suppression works by extending the path an arc would have to travel. If this distance is extended further than the energy can overcome, the arc is suppressed. Since relays aren't designed for high loads, arcing is less of a concern and arc suppression is much less common on relays.
- 5. Safety Features (Overloads)
- Lastly, contactors are commonly connected to overloads that will interrupt the circuit if the current exceeds a set threshold for a selected time period, usually 10-30seconds. This is to help protect the equipment downstream of the contactor from damage due to current. Overloads are much less common on relays.
- Contactor vs Relay Applications
- Contactors are typically built for and used in 3-phase applications where a relay is more commonly used in single phase applications. A contactor joins 2 poles together, without a common circuit between them, while a relay has a common contact that connects to a neutral position. Additionally, contactors are commonly rated for up to 1000V, while relays are usually rated to only 250V.

- When selecting between the two, some very general rules you can follow to help
- **When to Use a Relay:**
- 10A or less current
- Up to 250VAC
- 1 phase
- **When to Use a Contactor:**
- 9A or more current
- Up to 1000VAC
- 1 or 3 phase

Starter

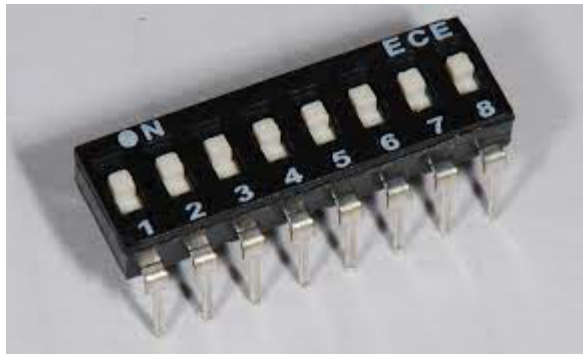
- Are used to start a motor
- It is a protecting device
- Initial current is very high to limit the current starters are employed.

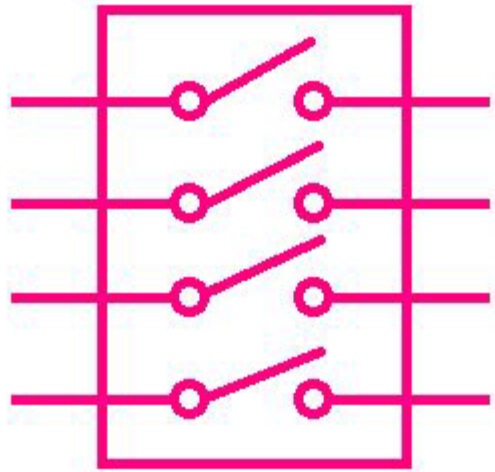
Panel Switches

- A push button switch is a small, sealed mechanism that completes an electric circuit when you press on it. When it's on, a small metal spring inside makes contact with two wires, allowing electricity to flow. When it's off, the spring retracts, contact is interrupted, and current won't flow. The body of the switch is made of non-conducting plastic.
- Toggle switches are actuated by moving a lever back and forth to open or close an electrical circuit. There are two basic types: maintained contact and momentary contact.
- Maintained contact toggle switches maintain the position to which they are moved or actuated. Momentary contact toggle switches do not.

- Rotary switch is a switch that controls the opening and closing of the main contact by rotating the handle.
- The working principle of the rotary switch is: change the resistance value within a range, and then there is a contact switch. This is the switch for the old TV and radio. The current electric fan has several gears, and several sets of lead wires connected to the fan winding. The speed is changed by changing the number of coils. The principle is similar to that of a potentiometer.

- A DIP switch is a dual in-line package switch, meaning that it consists of a series of switches in a single unit. It is an electromechanical device requiring a user to manually move the actuator so that a different electronic circuit is activated or deactivated. Commonly mounted on a PCB or breadboard, DIP switches allow users to quickly preconfigure or toggle an electronic device between a variety of settings or operating modes.





DIP Switch Symbol

Limit switch

- **The main function of a limit switch is to observe and control the physical movement of any machine.**
- A limit switch is an electromechanical device operated by a physical force applied to it by an object. Limit switches are used **to detect the presence or absence of an object**.
- The limit switch is used extensively in the control system. The limit switch also has a different role in automating our machine. Limit switches are commonly overused in CNC machine robotics and motor control functions. Apart from this, the limit switch is also used for safety purposes

- The lever of a limit switch is also called an actuator. This limit is located on the outside of the switch and is attached to the header. The lever always works up and down. When anything presses the lever of this limit switch, the contact inside the switch operates and the switch starts working.
- the lever of the limit switch is mounted on top of this operating header, due to which this operating header operates whenever there is any movement in the lever.
- the lever is fitted in the limit switch. And when the device comes in touch with it, this lever displaces. As it moves, the mini switch inside the limit switch operates.

- **The advantages of the limit switch are** Limit switches are quite accurate
- Limit switches operate at very low power.
- The cost is much lower compared to sensors.
- The limit switch can also be used in open spaces

- **disadvantages of the limit switch :**
- If it works for a long time, it is very likely to break down.
- It is necessary to come in direct contact with the working of the limit switch.
- If a device is moving fast then it becomes difficult to detect that device at that time.
- **Where is the limit switch used?**
- The presence or absence of any object can be detected.
- In speed detection.
- In automation.
- To know the position or travel limit.

- So why do we need to isolate different devices in the first place. Let’s consider a scenario where we have the need operate a device that requires 120VAC, but the PLC in which we need to control this device can only output 24VDC. There is no way to accomplish this output control without the use of a “interposing relay” The relay… in this case, would us a 24VDC coil that would open or close a contact on that relay that is rated for the 120VAC needed for the device we want to operate. Simply put, we use a small amount of voltage to control a high voltage device. Another benefit of using a relay in this manor, is that if a spike in voltage or current occurs on the device we are operating, the relay will act as a “buffer” between the PLC and the higher voltage device. Because of this, the relay also provides some protection to the PLC. So, the worst case scenario is… we may have to replace a relay that has become damaged, but the PLC will remain undamaged. This logic can also apply to inputs that need to be read by the PLC, but don’t input at the proper voltage or current. So what other scenarios do you see this type of isolation method being used? It is very common to see interposing relays being using in the automotive industry. One of the most common applications is the starter motor in our vehicle. In order to start our car, we need to initiate some kind of start command or control, which is why we turn the key… this is our start command. However, the starter motor in our cars draws a lot of current. It would be unsafe and very impractical to have the key switch that amount of current. Instead, a solenoid relay (which acts like an interposing relay) is used to switch a relatively safe of amount of current, that in turn switches a much higher amount of current in a safer location within the vehicle to provide the amperage that is needed to crank the starter motor.