- A logic gate is a basic or fundamental building block of a digital circuit.
- Generally we discuss logic gates having two inputs and one output.
- At any instant, every terminal has one of the two binary conditions low (0) or high (1),

  representing voltage levels.

In most logic gates, the low state is approximately zero volts (0 V), while the high state is approximately positive five volts (+5 V). In logic gates we get output in Boolean either **true (1)** or **false (0)**.

There are two types of logic circuits one is combinational and other is sequential logic circuit

In digital circuit theory, **sequential logic** is a type of **logic** circuit whose output depends not only on the present value of its input signals but on the sequence of past inputs. While, **combinational logic devices are** those whose output depends only on present input. So logic gates are **combinational logic devices.**

AND GATE

The AND operation in Boolean algebra is similar to the **multiplication** in ordinary algebra. The output Y is **"True"** (1) (HIGH) when both the inputs (A & B) are **"True"** (1) (HIGH). Otherwise, the output is "False" (0) (LOW). To understand it more clearlu check the truth table for two input AND gate. Symbol of AND gate shown below –

Symbol AND Gate

Symbol AND Gate

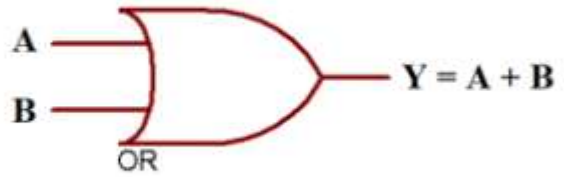
Truth Table for Two Input AND Gate

INPUT		Output of AND Gate
A	B	Y = A . B
0	0	0
0	1	0
1	0	0
1	1	1

OR GATE

The OR operation in Boolean algebra is similar to the **addition** in ordinary algebra. The output **Y** is **"True"** (1) (HIGH) when **either** of the inputs (A or B) **or both** the inputs are **"True"** (1) (HIGH). If both the inputs are "False" (0) (LOW), only then the **output Y** is **False** (0) (LOW). To understand it more clearly check the truth table for two input OR gate. Symbol of OR gate shown below –

Symbol OR Gate



Symbol OR Gate

INPUT		Output of OR Gate
A	B	Y = A + B
0	0	0
0	1	1
1	0	1
1	1	1

NOT GATE

The NOT operation in Boolean algebra is nothing but complementation or inverse of logic. For logic 0 gives 1 and for 1 gives 0. This operation is indicated by a bar "–" over the input variable. Symbol of NOT gate shown below –

Symbol NOT Gate

Symbol NOT gate

Truth Table NOT Gate

INPUT	Output of NOT Gate
A	Y = Ā
0	1
1	0

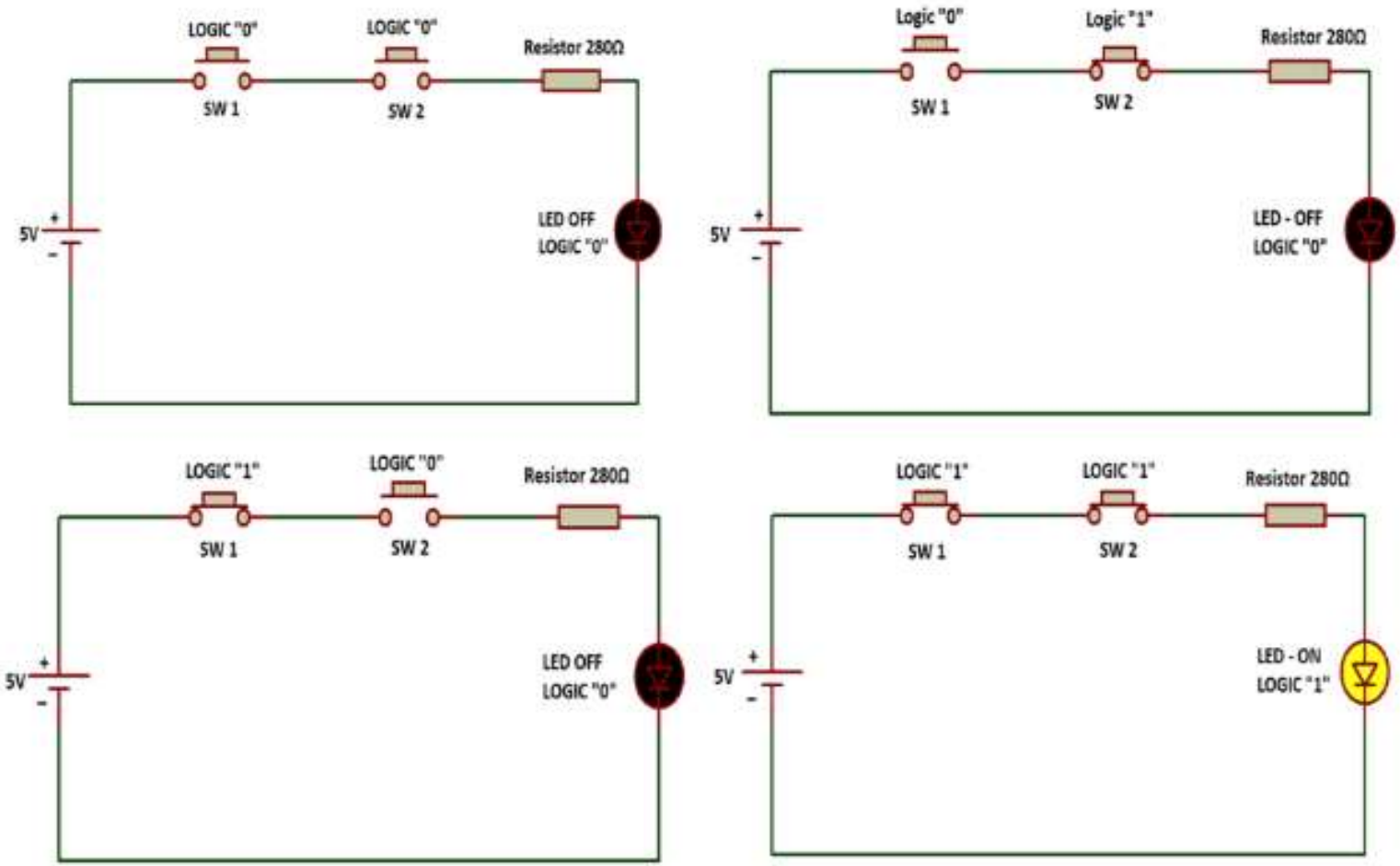
LOGIC GATES USING SWITCH

AND GATE USING ⏻ SWITCH

As we know 2 input AND gate needs, 2 input device, that's why we are using 2 button (input device). And we need an output device that is LED. We connect buttons in **series** for **AND Gate**.

- So when **both** buttons are **not pressed** it means input logic is **"0 and 0"**, In that case LED will **not glow**.
- When **any button** is **not pressed**, the LED will **not glow**, it means the logic is **"0 and 1"** or **"1 and 0"**.
- Only when **both** buttons get **pressed** logic are **"1 and 1", LED will glow** as seen in image below.

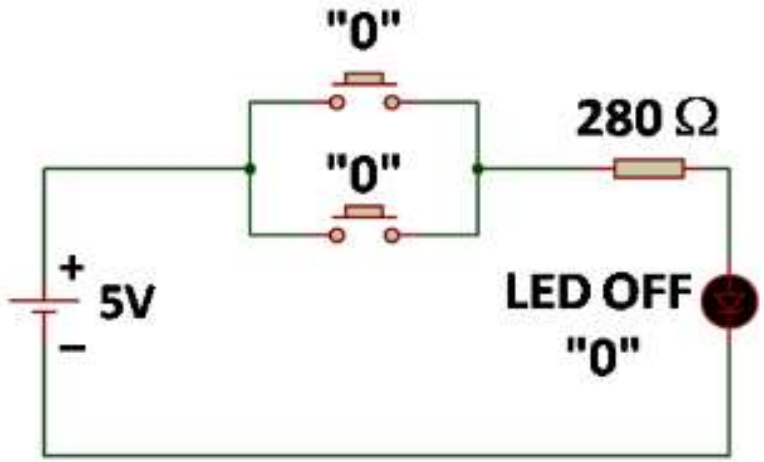
So we can say our circuit follows the AND gate truth table.

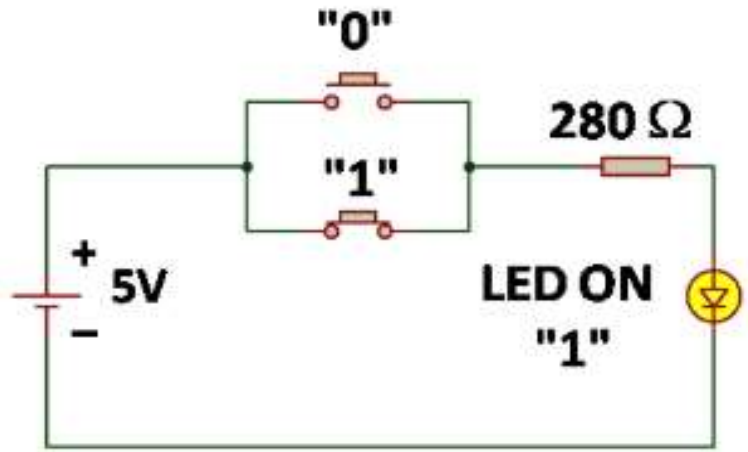


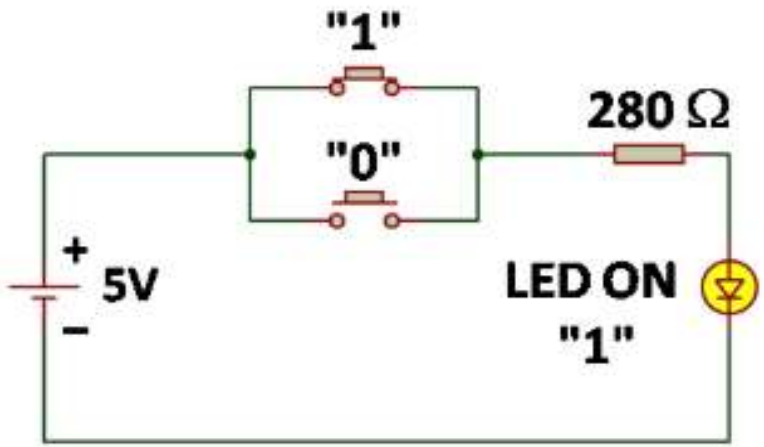
OR GATE USING SWITCH

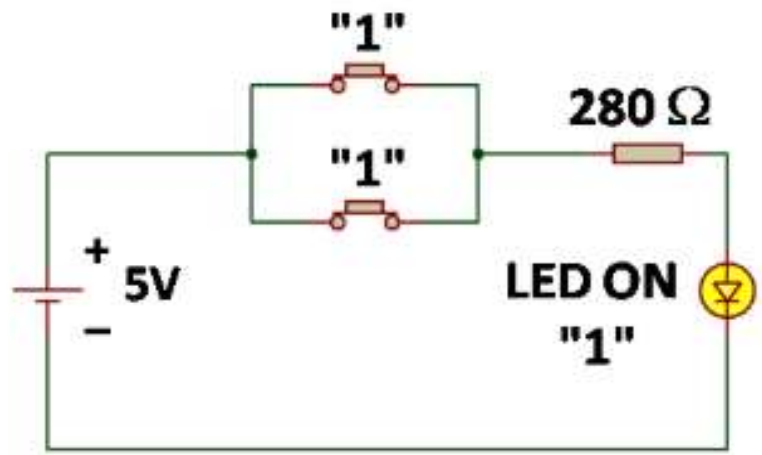
Similarly, we know 2 input OR gate needs, 2 input devices, that's why we are using 2 buttons (input device). And we need an output device that is LED. We connect buttons in **parallel** for **OR Gate**.

- Here, when **both** buttons are **unpressed** it means input logic is **"0 and 0"**, In that case LED will not glow.
- When **any button** is **pressed**, the LED will glow, it means the logic is **"0 and 1"** or **"1 and 0"**.
- And, when **both** buttons get **pressed, the logic** is **"1 and 1", the LED will glow** as seen in the image below.


"0"
"0"
280 Ω
+
5V
−
LED OFF
"0"


"0"
"1"
280 Ω
+
5V
−
LED ON
"1"


"1"
"0"
280 Ω
+
5V
−
LED ON
"1"


"1"
"1"
280 Ω
+
5V
−
LED ON
"1"

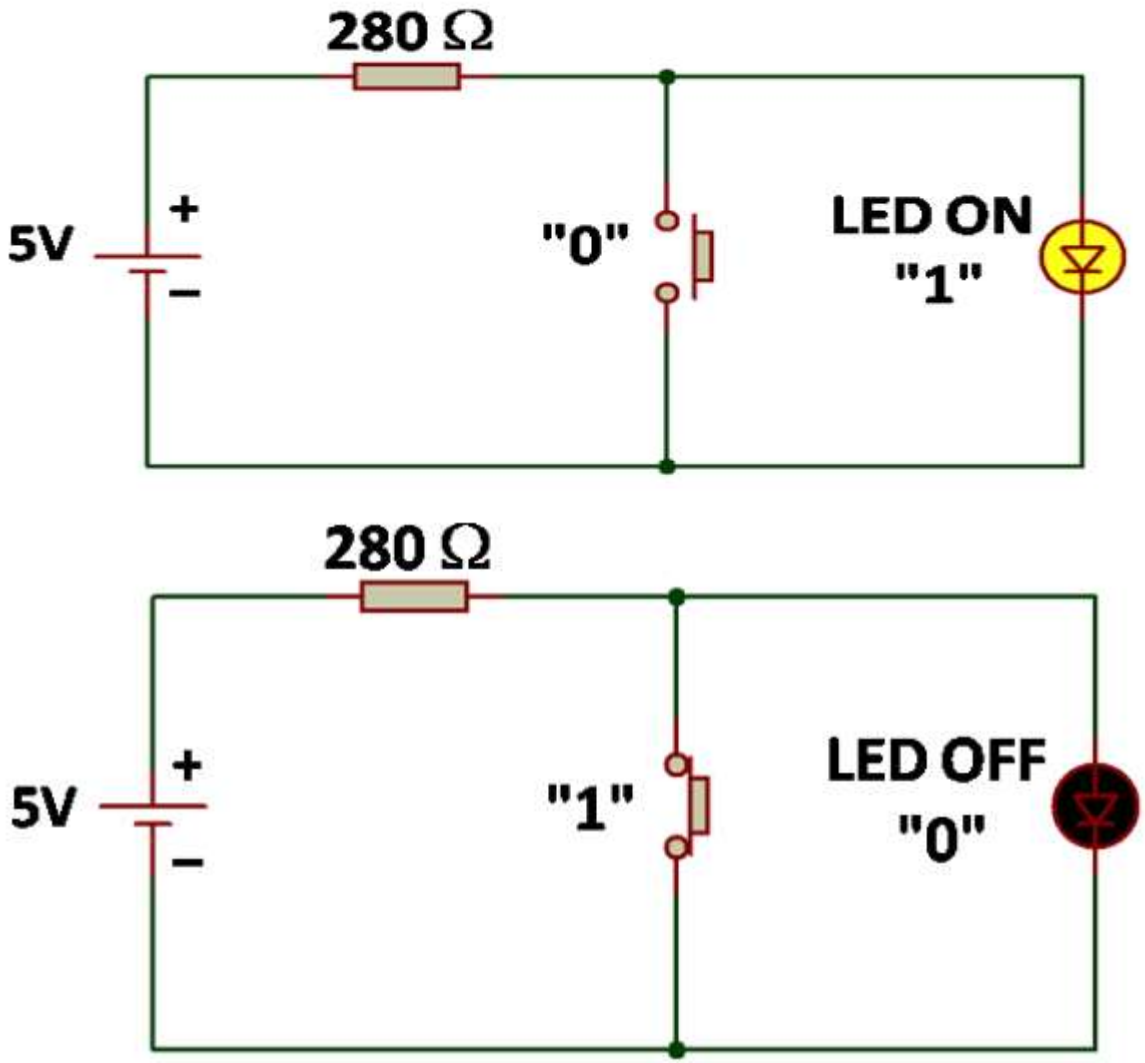
NOT GATE USING SWITCH

NOT gate is different from above gate in such a manner, we need only 1 input, that's why we are using only 1 button (input device). And for output LED is used. We connect buttons in **parallel** for **NOT Gate**. NOT gate is also known as a logic inverter.

- Here, when **you press the button** it means input logic is **"1"**, In that case LED will **not glow** means output is **logic "0"**.
- And, when you don't **press the button** it means input logic is **"0"**, In that case LED will **glow** means output is **logic "1"**.

Reason resistor connected before button because voltage needs to drop at some resistance to flow current. If we connect the resistor after the button then as you press the button the battery is short circuited.

So we can say our circuit follows the NOT gate truth table.



What is the Fuse?

A fuse is a protective device designed to interrupt the flow of excessive current in an electrical circuit. It consists of a metal wire or strip that melts when the current exceeds a predetermined level, thereby breaking the circuit and preventing potential damage or fire hazards. Fuses are simple, cost-effective, and reliable, making them a fundamental component in both residential and industrial electrical installations.

Key Functions of a Fuse:

- **Overcurrent Protection:** Prevents damage to electrical devices by stopping excessive current.
- **Safety Assurance:** Reduces the risk of electrical fires and equipment failures.
- **Circuit Isolation:** Isolates faulty sections of a circuit to maintain overall system integrity.

Types of Fuses

DC Fuse

Direct Current (DC) fuses are specifically engineered to protect circuits operating on DC power sources. Unlike AC, where current periodically reverses direction, DC provides a constant flow of current in one direction, requiring fuses that can handle this steady state without frequent interruptions.

Characteristics of DC Fuses:

- **High Interrupting Capacity:** Capable of safely breaking high DC currents without causing damage.
- **Minimal Voltage Drop:** Ensures efficient operation by maintaining low resistance.
- **Robust Construction:** Designed to handle continuous current flow without degradation.

Applications of DC Fuses:

- **Automotive Electrical Systems:** Protects components like alternators and batteries.
- **Battery-Powered Devices:** Safeguards against overcurrent in portable electronics.
- **Solar Power Installations:** Ensures safe operation of photovoltaic systems.

Advantages:

- **Reliable Protection:** Consistently interrupts excessive current, preventing damage.
- **Long Lifespan:** Durable under continuous DC conditions.
- **Compact Sizes:** Suitable for space-constrained applications.

AC Fuse

Alternating Current (AC) fuses are tailored for circuits where the current direction alternates periodically. AC fuses must effectively manage the cyclical nature of the current to prevent nuisance blows while ensuring protection against genuine overcurrent conditions.

Characteristics of AC Fuses:

- **Quick-Acting:** Respond rapidly to sudden current spikes.
- **Handles Voltage Fluctuations:** Designed to operate reliably under varying voltage conditions.
- **Compatibility with Standard AC Frequencies:** Typically rated for 50 Hz or 60 Hz systems.

Applications of AC Fuses:

- **Household Electrical Systems:** Protects home appliances and wiring.
- **Industrial Machinery:** Safeguards heavy-duty equipment and motors.
- **Power Distribution Networks:** Ensures safe transmission of electricity in grids.

Advantages:

- **Efficient Protection:** Quickly interrupts overcurrent, minimizing damage.
- **Versatile Use:** Suitable for a wide range of AC-powered devices.
- **Cost-Effective:** Provides reliable protection at an affordable price.

Rewirable Fuses

Rewirable fuses, also known as blown fuses, allow for the replacement of the fuse element after it has operated. They are commonly used in applications where fuse replacement is straightforward and cost-effective.

Characteristics of Rewirable Fuses:

- Replaceable Element: The metal wire or strip can be easily replaced after blowing.
- Cost-Effective: Generally cheaper than non-rewirable fuses, especially for low-risk applications.
- Simple Design: Easy to install and replace without specialized tools.

Applications of Rewirable Fuses:

- Old-Style Electrical Appliances: Used in vintage or legacy equipment.
- Simple Protective Circuits: Suitable for low-voltage, low-current applications.
- Educational Kits: Often used in teaching environments for demonstration purposes.

Advantages:

- Reusable: Allows multiple uses by replacing the blown element.
- Ease of Maintenance: Simple to check and replace without professional assistance.
- Affordability: Ideal for applications where cost is a significant factor.

Totally Enclosed or Cartridge Type Fuses

Totally Enclosed Fuses, often referred to as cartridge fuses, are encased in a durable, sealed housing that provides protection against environmental factors like moisture, dust, and debris. These fuses are widely used in industrial and high-power applications where robust protection is necessary.

Characteristics of Totally Enclosed Fuses:

- **Durable Housing:** Resistant to environmental contaminants, ensuring reliable operation.
- **High Interrupting Capacity:** Capable of safely breaking high currents without causing damage.
- **Various Sizes and Ratings:** Available in multiple configurations to suit different applications.

Applications of Totally Enclosed Fuses:

- **Industrial Control Systems:** Protects complex machinery and control circuits.
- **Power Distribution Boards:** Ensures safe distribution of electricity in large installations.
- **Electrical Panels:** Safeguards electrical components within distribution panels.

Advantages:

- **Enhanced Protection:** Sealed environment prevents external factors from affecting fuse performance.
- **Reliability:** Consistently operates under harsh conditions without failure.
- **Versatility:** Suitable for a wide range of high-power applications.

D-Type Cartridge Fuses

D-Type Cartridge Fuses are a subset of cartridge fuses characterized by their compact, cylindrical shape with a distinctive "D" rating. They are designed for applications requiring reliable overcurrent protection in confined spaces.

Characteristics of D-Type Cartridge Fuses:

- **Fast-Acting Protection:** Quickly responds to overcurrent conditions to prevent damage.
- **Compact Design:** Suitable for installations with limited space.
- **Low to Medium Current Ratings:** Ideal for protecting smaller circuits and devices.

Applications of D-Type Cartridge Fuses:

- **Electronic Devices:** Protects sensitive electronics from overcurrent.
- **Communication Equipment:** Ensures reliable operation of communication systems.
- **Medical Instruments:** Safeguards critical medical devices against electrical faults.

Advantages:

- **Space-Efficient:** Fits easily into compact electrical systems.
- **Reliable Operation:** Provides consistent protection for sensitive applications.
- **Ease of Installation:** Simple to integrate into various electrical setups.

Link Type Cartridge or High Rupturing Capacity (HRC) Fuses

Link Type Cartridge Fuses, also known as High Rupturing Capacity (HRC) Fuses, are designed to safely interrupt high currents without causing damage to the surrounding equipment. They feature a robust construction that can handle severe overcurrent conditions, making them ideal for industrial and high-voltage applications.

Characteristics of Link Type Cartridge/HRC Fuses:

- **High Interrupting Capacity:** Capable of breaking extremely high currents safely.
- **Robust Construction:** Designed to withstand harsh operating conditions.
- **Minimal Arc Flash:** Efficiently quenches arcs during interruption, enhancing safety.

Applications of Link Type Cartridge/HRC Fuses:

- **Power Distribution Systems:** Protects large-scale electrical distribution networks.
- **Industrial Machinery:** Safeguards heavy-duty equipment and motors.
- **High-Voltage Applications:** Ensures reliable protection in high-voltage environments.

Advantages:

- **Enhanced Safety:** Minimizes risk of equipment damage and fire hazards.
- **Durability:** Reliable performance under extreme overcurrent conditions.
- **Versatility:** Suitable for a wide range of high-power applications.

Dropout Fuse

Dropout Fuses are designed to provide a visible indication when they have operated. Typically, they incorporate a marker or dropper that falls away once the fuse has blown, signaling the need for replacement. This feature is particularly useful for maintenance and monitoring purposes.

Characteristics of Dropout Fuses:

- **Visual Indication:** Provides a clear sign that the fuse has blown.
- **Easy Identification:** Facilitates quick detection and replacement of faulty fuses.
- **Reliable Operation:** Maintains consistent performance under overcurrent conditions.

Applications of Dropout Fuses:

- **Control Panels:** Enhances maintenance by indicating blown fuses.
- **Electrical Enclosures:** Useful in environments requiring regular monitoring.
- **Maintenance Systems:** Streamlines maintenance processes by providing visual alerts.

Advantages:

- **Improved Maintenance:** Simplifies the process of identifying and replacing blown fuses.
- **Enhanced Safety:** Ensures that faulty fuses are promptly addressed.
- **User-Friendly:** Facilitates easy monitoring without specialized tools.

Striker Fuse

Striker Fuses utilize a striking mechanism to initiate the blowing of the fuse. This design allows for precise control over the operating characteristics and enhances the fuse's responsiveness to overcurrent conditions. Striker fuses are often used in applications requiring high precision and reliability.

Characteristics of Striker Fuses:

- **Precision Blow:** Controlled mechanism ensures accurate response to overcurrent.
- **Enhanced Responsiveness:** Quickly interrupts excessive current to protect circuits.
- **Durable Design:** Built to withstand repeated operations without degradation.

Applications of Striker Fuses:

- **Safety-Critical Applications:** Ensures reliable protection in essential systems.
- **Automated Protective Circuits:** Integrates seamlessly into automated control systems.
- **High-Precision Electrical Systems:** Protects sensitive and critical electrical components.

Advantages:

- **Accurate Protection:** Minimizes false blows and ensures protection is only triggered by genuine overcurrent conditions.
- **Reliability:** Consistently performs under demanding conditions.
- **Long Lifespan:** Durable construction reduces the need for frequent replacements.

Switch Fuse

Switch Fuses integrate a switching mechanism within the fuse body, allowing the fuse to be easily operated without the need for replacement. This design combines the functionality of a fuse with that of a switch, offering convenient protection and control.

Characteristics of Switch Fuses:

- Integrated Switch: Enables easy operation without replacing the fuse.
- Reusable Design: Can be reset after an overcurrent event.
- Combined Protection and Control: Offers both protective and operational capabilities.

Applications of Switch Fuses:

- Residential Electrical Systems: Provides both protection and control in home wiring.
- Low-Voltage Applications: Suitable for small-scale electrical setups.
- Circuit Breaker Replacements: Offers a more convenient alternative to traditional fuses.

Advantages:

- Convenient Operation: Eliminates the need for replacing fuses after each operation.
- Dual Functionality: Combines protection with the ability to switch circuits on and off.
- Cost-Effective: Reduces maintenance costs by offering reusable protection.

High Voltage High Rupturing Capacity (HRC) Fuses

High Voltage High Rupturing Capacity (HRC) Fuses are specifically engineered to protect high-voltage electrical systems. They possess an exceptionally high interrupting capacity, making them suitable for large-scale power distribution and transmission networks.

Characteristics of High Voltage HRC Fuses:

- **Superior Interrupting Capacity:** Can safely break extremely high currents without causing damage.
- **Designed for High-Voltage Environments:** Suitable for use in systems operating at very high voltages.
- **Robust and Reliable:** Ensures consistent performance under severe electrical conditions.

Applications of High Voltage HRC Fuses:

- **Power Transformers:** Protects transformers from overcurrent and short-circuit conditions.
- **High-Voltage Transmission Lines:** Safeguards transmission networks from electrical faults.
- **Industrial Power Systems:** Ensures reliable protection in high-power industrial environments.

Advantages:

- **Enhanced Safety:** Minimizes risks associated with high-voltage electrical faults.
- **Durable Performance:** Reliable operation in demanding high-voltage applications.
- **Essential for Power Systems:** Critical component in maintaining the integrity of large-scale electrical networks.

Cartridge Type HV HRC Fuse

Cartridge Type HV HRC Fuses are high-voltage fuses housed in a cartridge form factor. They are tailored for high-voltage applications where space and performance are critical considerations.

Characteristics of Cartridge Type HV HRC Fuses:

- Compact Design: Suitable for installations where space is limited.
- High Interrupting Capacity: Capable of handling very high currents safely.
- Efficient Arc Quenching: Minimizes the risk of damage during interruption.

Applications of Cartridge Type HV HRC Fuses:

- Electrical Substations: Protects critical components in power distribution.
- Industrial Power Systems: Safeguards machinery and high-voltage equipment.
- Power Distribution Networks: Ensures reliable protection in extensive electrical grids.

Advantages:

- Space-Efficient: Ideal for confined spaces without compromising protection.
- Reliable Protection: Consistently interrupts high currents without failure.
- Versatile Use: Suitable for a variety of high-voltage applications.

Liquid Type HV HRC Fuse

Liquid Type HV HRC Fuses incorporate a liquid medium within the fuse body to enhance arc quenching capabilities. This design allows for efficient interruption of high-voltage currents, minimizing the risk of damage and ensuring safe operation.

Characteristics of Liquid Type HV HRC Fuses:

- **Enhanced Arc Quenching:** Liquid medium effectively extinguishes arcs during interruption.
- **High-Voltage Suitable:** Designed to operate reliably under very high voltages.
- **Durable Construction:** Resistant to environmental factors and electrical stresses.

Applications of Liquid Type HV HRC Fuses:

- **High-Voltage Power Systems:** Protects extensive electrical networks and equipment.
- **Industrial Machinery:** Ensures safe operation of high-power industrial machines.
- **Power Generation Facilities:** Safeguards generators and other critical power components.

Advantages:

- **Efficient Arc Suppression:** Reduces the likelihood of equipment damage during overcurrent events.
- **Reliable Performance:** Consistently operates under extreme electrical conditions.
- **Suitable for Severe Environments:** Ideal for harsh industrial settings requiring robust protection.

Expulsion Type HV Fuse

Expulsion Type HV Fuses utilize an expulsion mechanism to forcefully separate the fuse element during an overcurrent event. This method ensures rapid interruption of the circuit, enhancing safety and protection.

Characteristics of Expulsion Type HV Fuses:

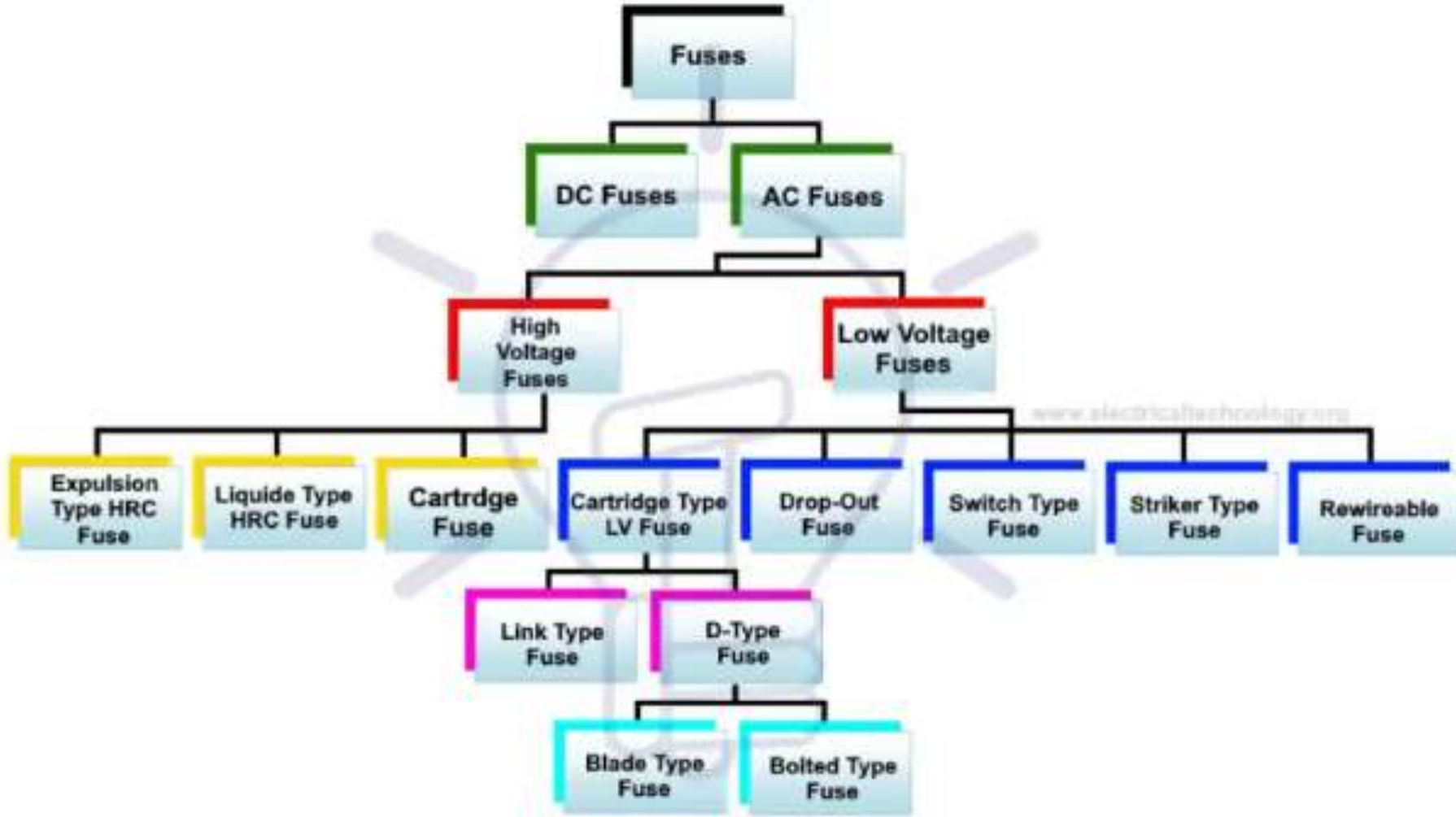
- **Rapid Interruption:** Quickly breaks the circuit to prevent damage.
- **High Reliability:** Ensures consistent operation under severe conditions.
- **Designed for High-Voltage Use:** Suitable for very high-voltage electrical systems.

Applications of Expulsion Type HV Fuses:

- **Power Generation Facilities:** Protects generators and other high-voltage components.
- **Transmission Networks:** Safeguards high-voltage transmission lines and equipment.
- **Industrial Power Systems:** Ensures reliable protection in large-scale industrial environments.

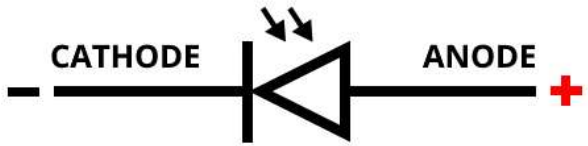
Advantages:

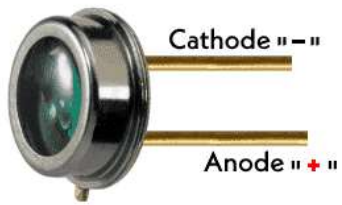
- **Enhanced Safety:** Minimizes the risk of prolonged overcurrent conditions.
- **Consistent Performance:** Reliable operation ensures continuous protection.
- **Essential for High-Voltage Systems:** Critical for maintaining the integrity of high-voltage electrical networks.

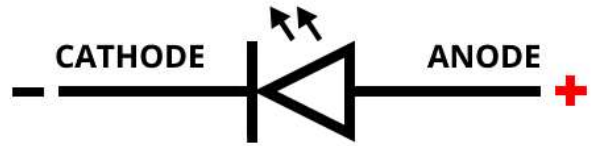

Fuses
DC Fuses
AC Fuses
High Voltage Fuses
Low Voltage Fuses
Expulsion Type HRC Fuse
Liquide Type HRC Fuse
Cartrdge Fuse
Cartridge Type LV Fuse
Drop-Out Fuse
Switch Type Fuse
Striker Type Fuse
Rewireable Fuse
Link Type Fuse
D-Type Fuse
Blade Type Fuse
Bolted Type Fuse

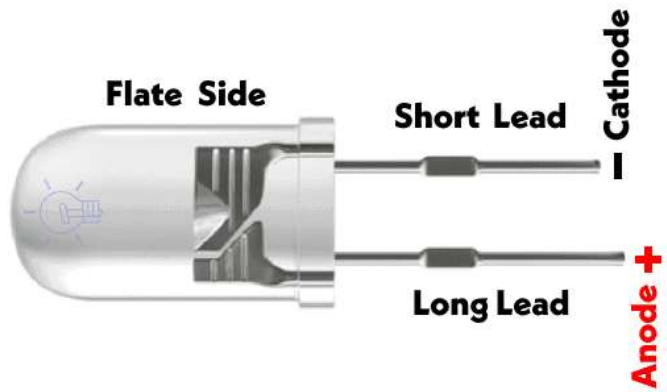
Zener Diode	Avalanche Diode
A Zener diode is a type of diode used to regulate voltage using the Zener effect in reverse bias.	An Avalanche diode is a type of diode used to prevent voltage surges using the avalanche effect in reverse bias.
It works on the Zener Effect which allows current due to the tunneling of electrons from the valance band of the P-type to the conduction band of the N-type semiconductor.	It works on the avalanche effect in which a high electric field forces electrons to accelerate and collide with other atoms to generate more electrons and reverse current.
It has a high doping concentration.	It has a low doping concentration.
It has a thin depletion region	It has a large depletion region.
It cannot handle high voltage. Thus it has low ratings.	An avalanche diode can easily handle large voltages.
The Zener diode is a low-power component	The Avalanche diode is a high-power component.
It has a negative temperature coefficient	It has a positive temperature coefficient
It is more reliable and precise in voltage regulations.	It is unreliable for voltage regulation but great for surge protection
The Zener diode generates low noise.	The avalanche diode generates avalanche noise.

Difference between LED and Photodiode









Photodiode

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LED

LED – Light Emitting Diode	Photodiode
LED or light-emitting diode converts electrical energy into light energy.	Photodiode converts electrical energy into light energy.
It works on the principle of Electro-Luminance i.e. material emits light energy when a current pass through it.	It works on the principle of the photoelectric effect.
The electron-hole recombination emits a photon.	The photon striking the junction energizes the electrons forming electron-hole pairs that generate current.
It is used to emit light.	It is used to detect light.
Its symbol shows arrows pointing outward.	Its symbol shows arrows pointing inward.
Silicon and germanium does not emit light. Gallium, arsenide, and phosphide compounds are used.	Any semiconductor not limited to silicon and germanium can be used depending on its performance.
LED is covered in dome-shaped epoxy resin that uniformly scatters light in all directions.	The photodiode has a large lens that focuses the light onto the junction.
It is only used in forward bias.	It is used in reverse bias.
Reverse biasing an LED can permanently damage it.	It can be used in both forward and reverse bias.
There is no reverse leakage current.	There is a significant reverse saturation current since it operates in reverse bias.
There is no light emission in absence of electrical current.	In the absence of light, current flows through it called the dark current.
LED is used for illumination, lighting, and display in alpha numeric and sign boards.	The photodiode is used for light sensing, circuit protection using optocoupler, high-speed optical communication.