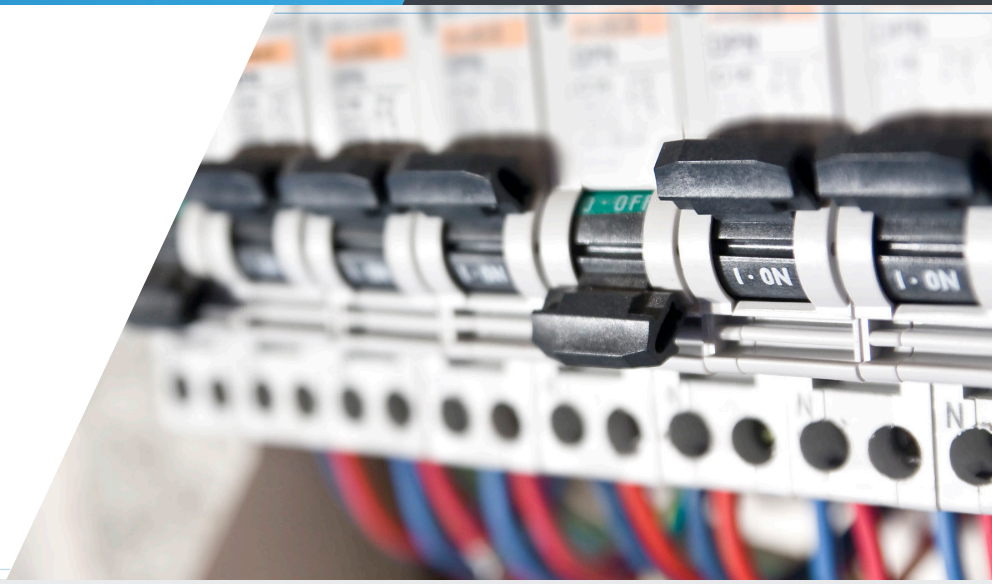
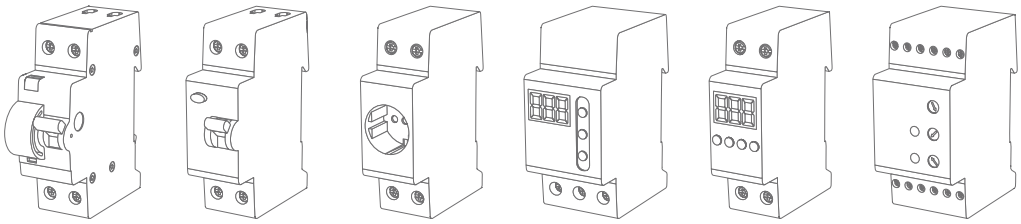
THE BASICS OF A CIRCUIT BREAKER



From home electrical systems to advanced industrial circuits, circuit breakers protect power systems from electrical power overloads, ground faults, arc faults, and other scenarios where electricity could pose a safety risk to people and property. In the case of a fault, circuit breakers interrupt the flow of electricity, limiting the energy available to cause damage. What types of circuit breakers exist and why? Let's take a quick look.



How Does a Circuit Breaker Work?

The most common type of circuit breaker consists of an electromagnet and a movable armature with an electrical contactor at the end. The arm is connected to a spring or other actuator. The arm contactor makes contact with a stationary contactor inside the breaker, completing the circuit and allowing electricity to flow. When a problem occurs, the actuator forces the contactors apart, stopping the flow of electricity. The voltage (electrical power standing still), current (voltage moving through a conductor over time), and where the breaker will be installed are the primary factors to consider when choosing a circuit breaker.

TYPES OF CIRCUIT BREAKERS

MINIATURE CIRCUIT BREAKER (MCB)

MCBs are commonly used in low-voltage applications such as 24 V DC or 125 V AC circuits. These devices have current ratings ranging from 0.5 A to 30 A. Miniature breakers can be found in automobiles, small appliances, and office equipment, among other applications. They typically have a generic mounting system, such as a DIN rail, or are housed inside a control panel.

MOLDED CASE CIRCUIT BREAKER (MCCB)

MCCBs are the most common type of circuit breaker. They have higher current-carrying capacity than miniature breakers, ranging from 3 A to more than 4,000 A. In these devices, a thermal-magnetic trip unit typically opens the circuit breaker when the electrical current exceeds the breaker's rating, causing a metal sensor to actuate, or turn on. Molded case circuit breakers are widely used in residential and commercial applications.

INSULATED CASE CIRCUIT BREAKER (ICCB)

ICCBs are similar to molded case circuit breakers, but unlike MCCBs, insulated case breakers often use an electronic circuit to monitor electrical current and a stored energy mechanism that is usually charged by manipulating a charging handle. They have the functionality of a larger, more capable iron- or air-frame circuit breaker or a low-voltage power breaker with a molded plastic frame instead of a metal frame. These breakers, along with the remaining breakers on our list, are regularly reconditioned and returned to service.

AIR CIRCUIT BREAKER (ACB)

ACBs are the first breakers on our list to move exclusively beyond low voltage (0–0.6 kV) to medium-voltage power distribution (0.6 kV–33 kV). Unlike the breakers discussed earlier, an ACB's metal frame is used to support internal components rather than providing an insulating layer (made of plastic in the low-voltage breakers described above). While MCBs and MCCBs are regularly used near the devices they protect, with their higher load capabilities, ACBs can act as disconnect switches for industry and other power-hungry applications. ACBs generally have an upper limit of 15 kV but are regularly replaced by more reliable vacuum circuit breakers.

VACUUM CIRCUIT BREAKER (VCB)

A VCB has a vacuum interrupter, sometimes called a vacuum bottle, and a spring-loaded moving contact. A vacuum interrupter is made of two electrodes in a vacuum chamber. The arc that forms when the contacts open is extinguished in the vacuum.

GAS CIRCUIT BREAKER (SF6)

While overcurrent protection from a VCB can be degraded by metal molecules floating inside the chamber, reducing the ability of the vacuum to quench an electrical arc, gas circuit breakers typically use a dielectric insulating gas such as sulfur hexafluoride (SF6) to help cool down and quickly extinguish an arc. Advantages include low maintenance, lower operating noise, and no emission of hot gases. Gas circuit breakers are commonly used for high-voltage applications and with utility-grade equipment ranging from 35 kV up to 500 kV and beyond. An advantage with this type of circuit breaker is that it can be used to make and break relatively large currents under normal as well as fault conditions. Also, it has low maintenance costs and a longer life than an ACB. VCBs are primarily used in power generation facilities and heavy industrial applications.

CONNECTIONS

A circuit breaker has multiple connection types:

PLUG-IN – Plug-in circuit breakers connect to the bus bar using plugs on either side of the breaker. This allows for easy installation and removal of a breaker. Popular plug-in breakers include the Square D I-Line plug-in system, although different manufacturers utilize different plug-in systems.

BOLT-ON – Bolt-on breakers connect to the bus bar using threaded studs. These studs are placed through holes in the bus bar and tightened down with nuts and washers. This connection is often the least expensive and most secure. However, it can be hard to install, replace, or temporarily remove a bolt-on breaker.

FEED-THROUGH – Feed-through circuit breakers have lugs on both sides that allow cables to be connected to the breaker. They are sometimes called cable in, cable out breakers because cables are utilized to send power to and from (for example, line/load) the breaker.

POLES

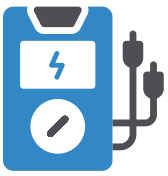
The number of poles determines how many completely separate circuits can be simultaneously protected by a circuit breaker.

ONE POLE: Typically used in fans, lighting equipment, and single-phase applications. This is the most common configuration found in households.

TWO POLES: Used when connecting to multiple phases of a single or 3-phase circuit. This configuration is commonly used in homes for 240 V circuits, such as dryers and air conditioners.

THREE POLES: Used in 3-phase applications. This is commonly used to feed 3-phase subpanels or 3-phase-rated equipment such as large motors.

FOUR POLES: Used in 3-phase systems with an extra fourth pole to protect the neutral circuit within the system. This is commonly used in data centers and scenarios requiring a high degree of coordination or protection of sensitive equipment.



VOLTS VS CURRENT

Voltage is electricity at rest and is measured in volts, while current is an electrical charge in motion over time and is measured in amps. The difference between the high point (+) and low point (–) in an electrical field defines the potential or voltage present. In alternating current (AC) systems, the voltage changes from negative to positive and back to positive in a continuous wave. Direct current (DC) systems maintain a consistent voltage, either positive (+) or negative (–).

AMPS

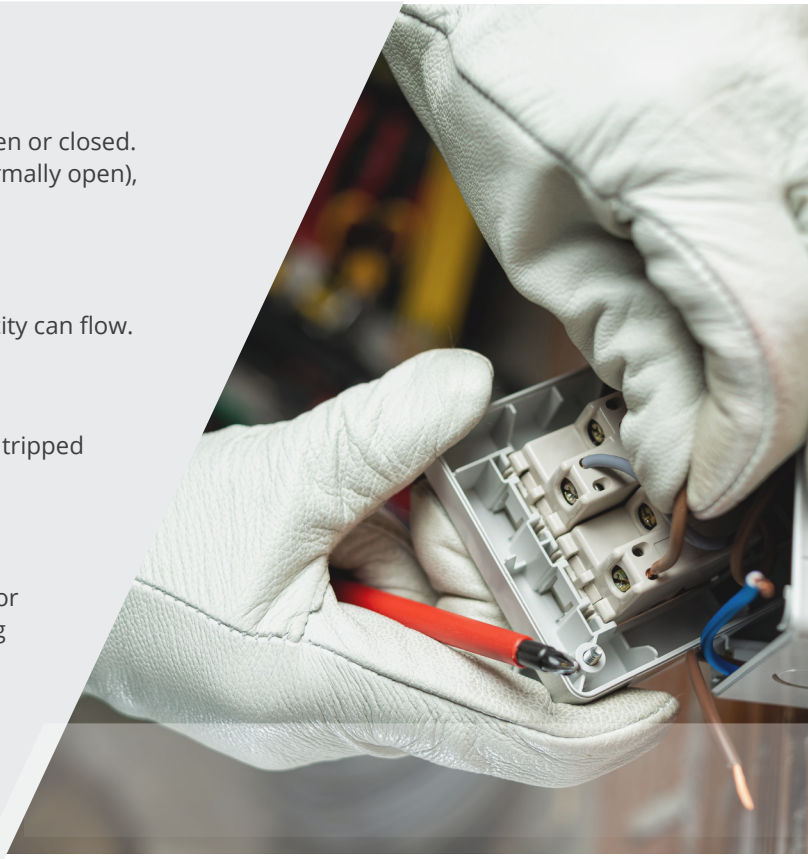
Amperes are the units used to measure current, or an electrical charge in motion. When describing voltage, current, and resistance, a common analogy is a water tank. In this analogy, charge is represented by the water amount, voltage is represented by the water pressure, and current is represented by the water flow.

AIC RATING AMPERE INTERRUPTING CAPACITY

Ampere interrupting capacity is the maximum current that a circuit breaker has been designed to interrupt, protecting downstream equipment and people. AIC is measured in amps at a particular voltage (for example, 18 kA @ 480 V or 65 kA @ 480 V).

ACCESSORIES

Various circuit breaker accessories come into play to enable features such as remote indication and automatic operation. A few examples:



AUXILIARY SWITCH

The auxiliary switch indicates the breaker's present condition: open or closed. The switch commonly defines operational states, such as NO (normally open), NC (normally closed), or a combination of the two.

CLOSED SWITCH

A closed switch indicates whether the circuit is closed and electricity can flow.

BELL ALARM

A bell alarm provides remote indication that a circuit breaker has tripped due to an electrical fault.

MOTOR/ELECTRIC OPERATOR

Circuit breaker springs can be very powerful. In some cases, a motor or electric operator helps compress a spring so it can open, moving the electrical contacts away from each other, and interrupting electrical flow in the case of a fault. Also used to remotely charge a circuit breaker without the need for physical access.

SHUNT TRIP

A shunt trip remotely trips a breaker when voltage is applied. It is used to safely trip a breaker via a remote panel or to automatically trip it using another device (such as another circuit breaker).

CONCLUSION

Circuit breakers are an integral part of technology. Their role in preventing loss to property and keeping your loved ones safe is indispensable. This article just scratches the surface. For more in-depth knowledge, we encourage you to read other blogs and articles on circuit breakers. Please call us should you have questions.

Check out our inventory of millions of different kinds of circuit breaker parts, available at our online shop at **electrical.com**.

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