# Circuit breakers:

## Approvals and tripping technologies


### Types of circuit breakers and device protection

To ensure safety in manufacturing plants, it is important to understand the difference between branch circuit protection (circuit breakers) and device protection (manual motor protectors, supplementary protectors, or solid-state overcurrent protectors). There is significant overlap in the specific applications in which these devices should be used, so substantial care and consideration must be taken during the selection process to ensure design requirements are addressed with the appropriate product.

Electrical power and control systems require circuit protection to prevent fires, shock hazards, equipment damage, and power system failure. As part of an optimized system design process, the electrical engineering team specifies the required overcurrent protective devices.

The National Electric Code (NEC) sets requirements for installing circuit breakers to maintain safety standards. These requirements are based on the different markets and industries where the products will be used. The American market also specifies compliance with UL standards. Phoenix Contact has overcurrent protection products that comply with the following UL standards: UL 489, UL 508, UL 1077, and UL 2367. In addition, many of these products have been approved for use in applications that require NEC Class 2 and/or Class I Division 2 ratings.

## Standards and approvals

### UL 489 circuit breakers

UL 489 circuit breakers, commonly referred to as branch circuit protectors, are utilized to protect electrical conductors from the effects of thermal overloads and short circuits. Any power that enters or exits the control cabinet must be protected by a UL 489 circuit breaker. These circuit breakers provide electrical isolation for maintenance purposes. While the focus of these is on protecting the electrical conductor from failure, they are commonly used for device protection as well.

Use UL 489 circuit breakers to ensure your electrical conductors are properly protected and to deliver power to nearly any type of load including motors, heaters, lamps, etc.

### UL 508 manual motor protectors

UL 508 is the standard for products used in the construction of industrial control panels (UL 508A), defining the requirements for industrial control devices and their accessories, design rules, and safety standards for the interconnects, fusing, and protection components utilized by the panel. Manual motor protectors are not evaluated to provide branch circuit protection and are considered device protection.

UL 508 Listed manual motor protectors are intended specifically for use on motors for on/off control and overload protection.

### UL 1077 supplementary protectors

UL 1077 supplementary protectors are devices that provide overcurrent protection in electrical equipment where branch-circuit overvoltage protection is already provided or is not required. Supplementary protectors are the most basic form of device protection.

Supplementary protectors can be used for the protection of control devices including relays, starter coils, solenoids, electronics, and the like.

### UL 2367 solid-state overcurrent protectors

The UL 2367 standard covers solid-state overcurrent protectors. These devices are solid-state switches that limit the output current to a safe level when the output load exceeds the current limit threshold or when a load-side short-circuit is present. Devices approved to this standard can be viewed as the electronic equivalent to mechanical devices evaluated to UL 1077, and they are considered device protection.

Use solid-state overcurrent protectors on the load side of an isolating transformer, power supply, or battery to limit current to safe levels when a fault occurs on their output. They are ideal for protecting highly sensitive end devices and in applications that have long conductor lengths.

### NEC Class 2

The NEC (National Electric Code) is the American standard for the safe installation of electrical cables and devices, as well as “low power circuits,” which are often referred to as “NEC Class 2 circuits”. Circuits that conduct less than 100 VA are not considered hazardous to life and limb or liable to cause fires. Parts of UL 1310 are employed to test for NEC Class 2 approval.

### Class I Division 2

Hazardous (classified) locations, as defined by the NEC, are locations where fire or explosion hazards may exist due to the presence of flammable gases, vapors, or flammable liquids. This means that all mechanical and electrical equipment intended for use in potentially explosive atmospheres must be Class I Division 2 approved.



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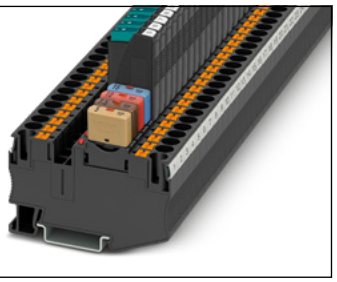
# Types of tripping technology

Overcurrent protection is a key factor in system reliability. In the event of overload and short circuits, overcurrent protectors selectively shut down the faulty circuit, allowing all other system parts to remain in operation. There are different overcurrent protection technologies: thermal, thermal-magnetic, hydraulic-magnetic, and electronic. The differences lie in their tripping techniques and behavior.

Overcurrent protectors are used in production systems and assembly machines to protect conductors and loads from overload and short circuit events, removing faulty loads from the system when such events occur. To ensure maximum system reliability, it must be clearly understood what types of overcurrents need to be addressed. Once understood, select the appropriate tripping technology to ensure the necessary level of protection for different circuits and individual loads.

### Thermal supplementary protectors (UL 1077)

Thermal supplementary protectors utilize a bimetallic strip that trips when heated to protect against overloads. This technology has a slow-reacting characteristic curve that can differentiate between safe temporary increases in current and prolonged overloads. This can take between 300ms and several minutes. In the event of overloads, this timeframe is more than sufficient.



### Thermal-magnetic circuit breakers and supplementary protectors (UL 1077 and UL 489)

In addition to the overload protection of a thermal device, the magnetic tripping function provides protection in the event of a short circuit. Various tripping characteristics address sensitive loads or avoid nuisance tripping from inrush currents. For short circuit events, a magnetic solenoid provides a rapid tripping response within a few milliseconds.

### Solid-state overcurrent protectors (UL 2367)

Solid-state overcurrent protectors reliably protect against both overloads and short-circuit currents. Tripping is extremely precise and intelligent, based on the overload condition. The dynamic tripping characteristic allows these devices to pass intended inrush currents while rapidly tripping in short circuit events.

### Hydraulic-magnetic supplementary protectors (UL 1077)

Like thermal-magnetic devices, hydraulic-magnetic supplementary protectors provide both overload and short circuit protection. A solenoid coil is combined with a spring-loaded actuator inside a cylinder filled with a dampening fluid that trips depending on the magnetic flux created by the current flowing through it. These protectors provide a delay on normal overcurrent, and trip quickly on short circuits.



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