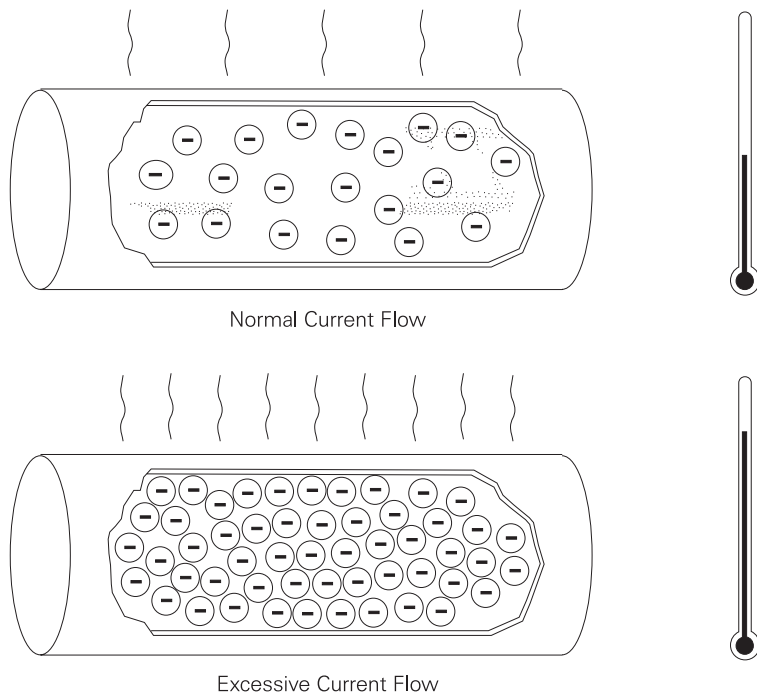


Overcurrent Protection

Load centers use circuit breakers to provide protection against overcurrent. The *National Electrical Code*® defines overcurrent as *any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault* (Article 100-definitions).

Current flow in a conductor always generates heat. The greater the current flow, the hotter the conductor. Excess heat is damaging to electrical components. For that reason, conductors have a rated continuous current carrying capacity or ampacity. Overcurrent protection devices are used to protect conductors from excessive current flow. These protective devices are designed to keep the flow of current in a circuit at a safe level to prevent the circuit conductors from overheating.

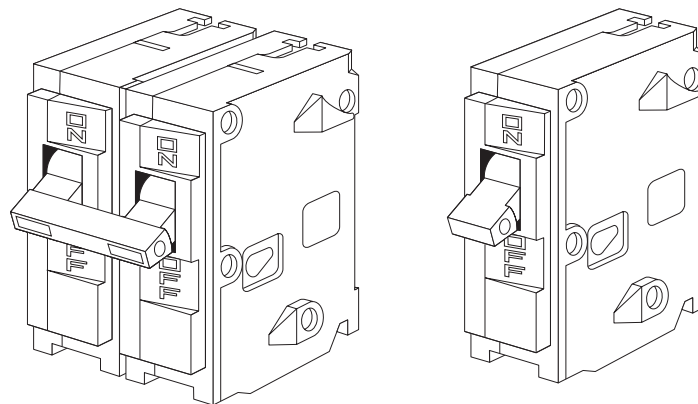


Circuit protection would be unnecessary if overloads and short circuits could be eliminated. Unfortunately, overloads and short circuits do occur. To protect a circuit against these currents, a protective device must determine when a fault condition develops and automatically disconnect the electrical equipment from the voltage source. Slight overcurrents can be allowed to continue for a short time, but as the current magnitude increases, the protection device must open faster. Short circuits must be interrupted instantly.

Circuit Breakers

The *National Electrical Code*® defines a circuit breaker as a device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.

Circuit breakers provide a manual means of energizing and deenergizing a circuit. In addition, circuit breakers provide automatic overcurrent protection of a circuit. A circuit breaker allows a circuit to be reactivated after a short circuit or overload is cleared. Unlike fuses which must be replaced when they open, a simple push of the handle to the "Off" then "On" position restores the circuit. If a circuit reopens upon reset to the "On" position, a qualified electrician should be consulted to determine the problem.



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Ampere Rating

Every circuit breaker has a specific ampere, voltage, and fault current interruption rating. The ampere rating defines the maximum current a circuit breaker can carry without tripping. Siemens residential circuit breakers are available with ratings from 15-125 amps.

Voltage Rating

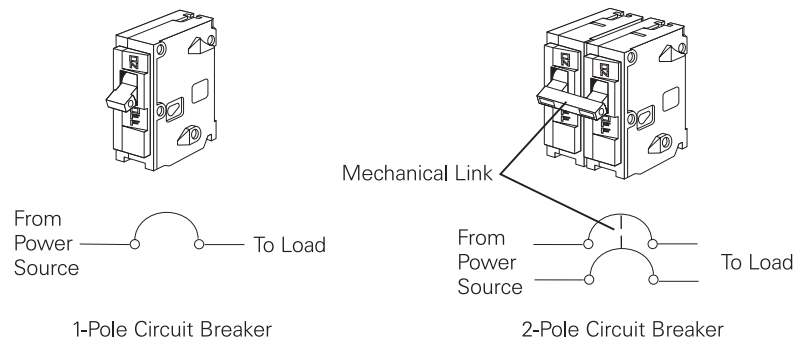
Each circuit breaker is also rated for the maximum voltage it can handle. In residential applications, single-pole breakers protect 120 volt branch circuits; two-pole breakers protect 240 volt branch circuits. Siemens residential circuit breakers have a voltage rating of 120/240 volts. The rating of a circuit breaker can be higher than the circuit voltage, but never lower.

Short Circuit Interrupting Rating

The circuit breaker's short circuit interrupting rating is the maximum available fault current which a breaker is designed to interrupt. Siemens residential circuit breakers have interrupting ratings from 10,000 amps to 65,000 amps. The available fault current is rarely above 10,000 amps in single-family homes.

Poles

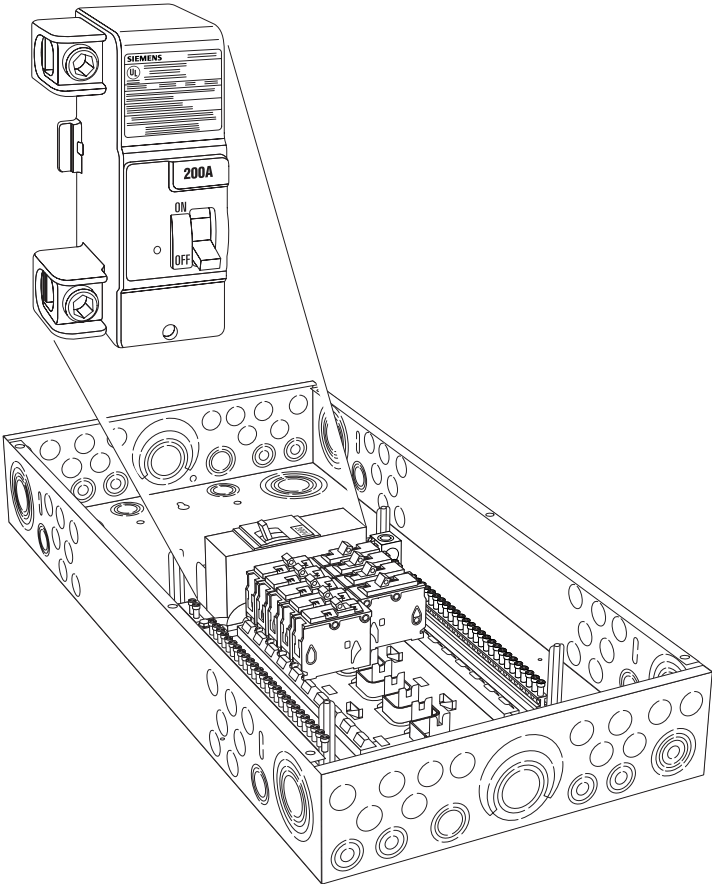
Pole describes the number of isolated circuits that can pass through the circuit breaker at one time. A 1-pole circuit breaker can carry the current through one circuit. A 2-pole circuit breaker can carry the current through two circuits simultaneously. The two circuits are mechanically connected so that they open or close at the same time.



Circuit Breakers

Main Circuit Breaker

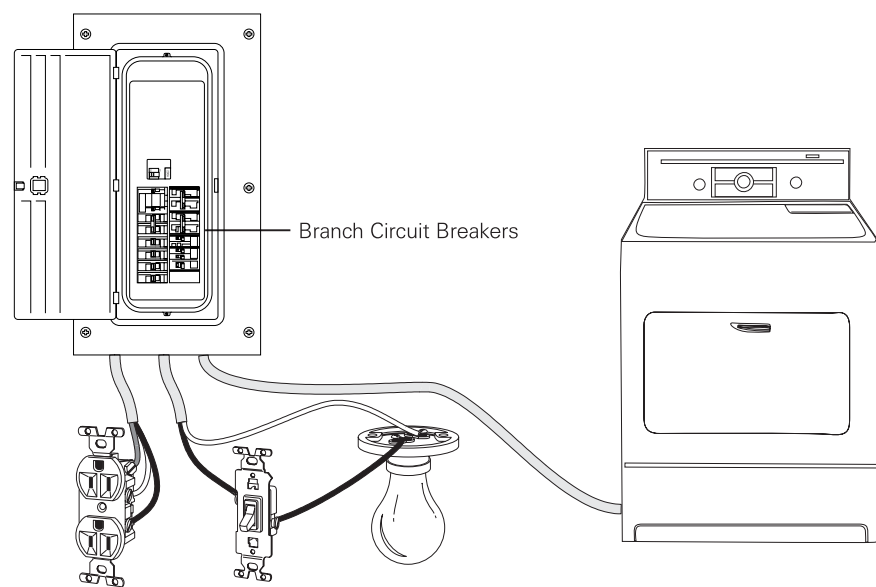
It is important to note the difference between a main breaker and branch circuit breakers. The main breaker of a load center shuts off power to the entire load center and all circuits supplied by that load center. The main circuit breaker has the same rating as the load center.



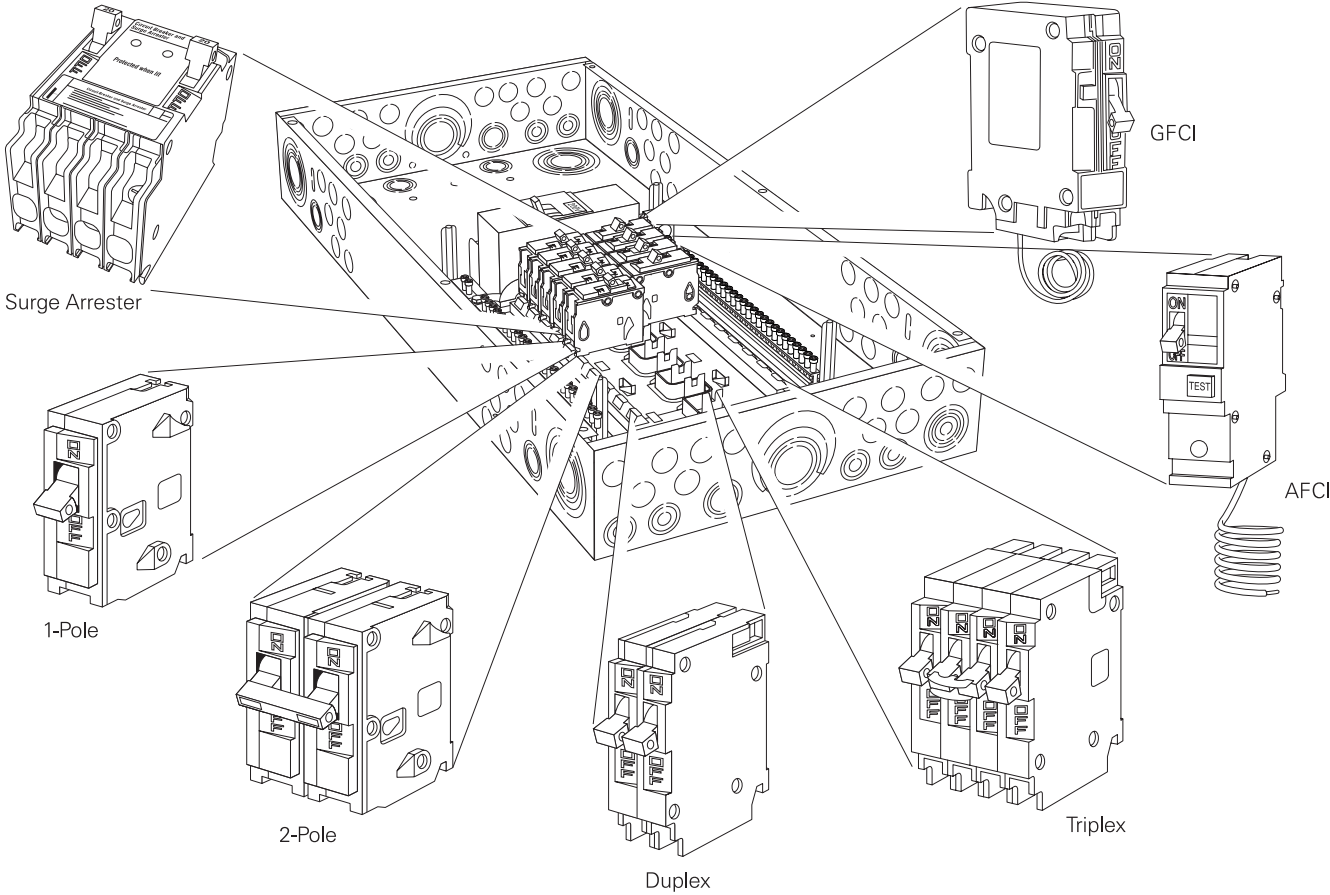
Branch Circuit Breakers

Branch circuit breakers provide protection for each branch circuit conductor in the distribution system. Typical branch circuits:

- 15 and 20 ampere, 120 volt supply power for lighting circuits and electrical outlets
- 20 ampere, 120 volt supply power for some kitchen and bath electrical outlets
- Appliances requiring larger amounts of power, such as clothes dryers, ranges, furnaces and air conditioners use separate branch circuit breakers rated for the appropriate voltage and current

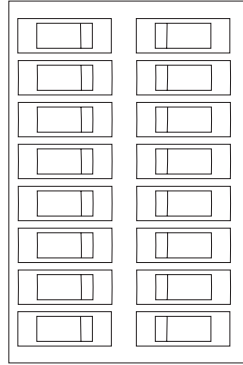


Siemens manufactures several circuit breakers for use in branch circuits. These include 1-pole, 2-pole, duplex, triplex, quadplex, surge arrester, AFCI, and GFCI circuit breakers. Surge arrester, AFCI, and GFCI circuit breakers are speciality circuit breakers and will be discussed individually.

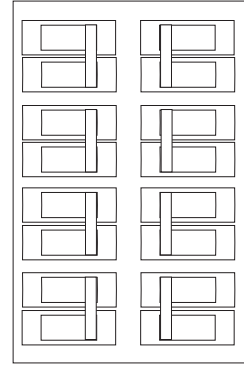


Full-Size Breakers

A full-size, 1-pole breaker requires one space (1") and a full-size, 2-pole breaker requires two spaces (2"). If a 16-space load center were selected, 16 full-size 1-pole breakers, 8 full-size 2-pole breakers, or a combination of 1- and 2-pole breakers in a combination that does not exceed 16 spaces can be used.



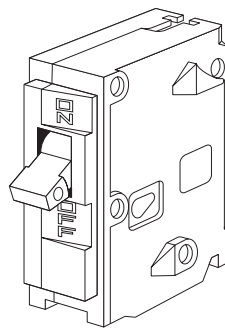
16 Full-Size Breakers
1-Pole Breakers
16 Spaces=16 Circuits



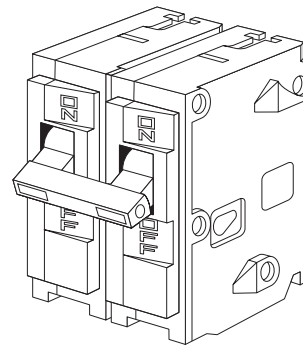
8 Full-Size
2-Pole Breakers
16 Spaces=8 Circuits

1- and 2-Pole, Full-Sized Circuit Breakers

Siemens 1- and 2-pole circuit breakers are available with the following ratings.



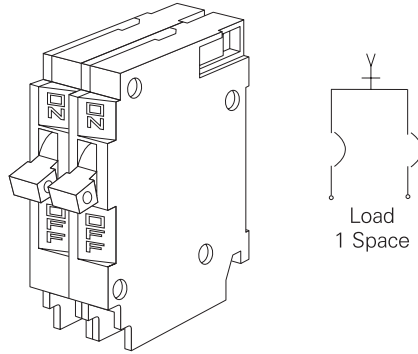
1-Pole
15 - 50 Amp Ratings
10K AIC
Requires 1" (1 Space)



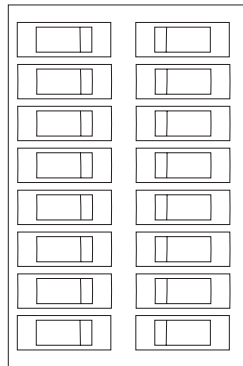
2-Pole
15 - 125 Amp Ratings
10K AIC
Requires 2" (2 Spaces)

Dual Breakers

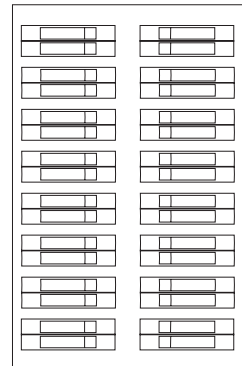
In most cases only full-size breakers are used. There are times, however, when extra branch circuits are needed but all spaces are used. Some Siemens load centers are designed to accept dual breakers. A dual breaker is two breakers in a housing that has the same dimensions of a full-size, 1-pole breaker.



In a 16 space/32 circuit load center, 16 circuits are available if full-sized 1-pole circuit breakers are used. In a 16 space/32 circuit load center, 32 circuits are available if dual 1-pole breakers are used.



16 Full-Size Breakers
1-Pole Breakers
16 Spaces=16 Circuits

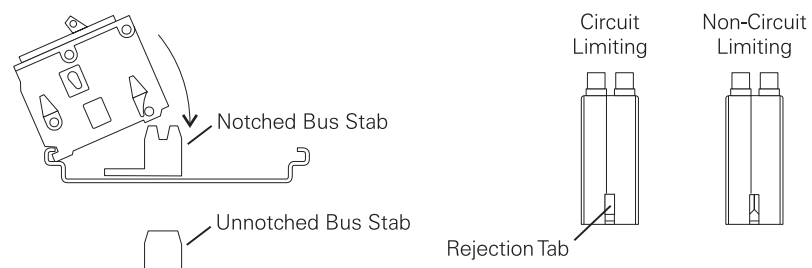


16 Dual Breakers
1-Pole Breakers
16 Spaces=32 Circuits

Circuit Limiting

Duplex circuit breakers can be used with load centers that have notched bus stabs. A rejection tab on the circuit breaker prevents the circuit breaker from being installed on a load center with unnotched tabs. This is referred to as circuit limiting. The number of notched tabs in a load center is limited by UL requirements. This limits the number of circuits available and helps prevent a load center from being overloaded.

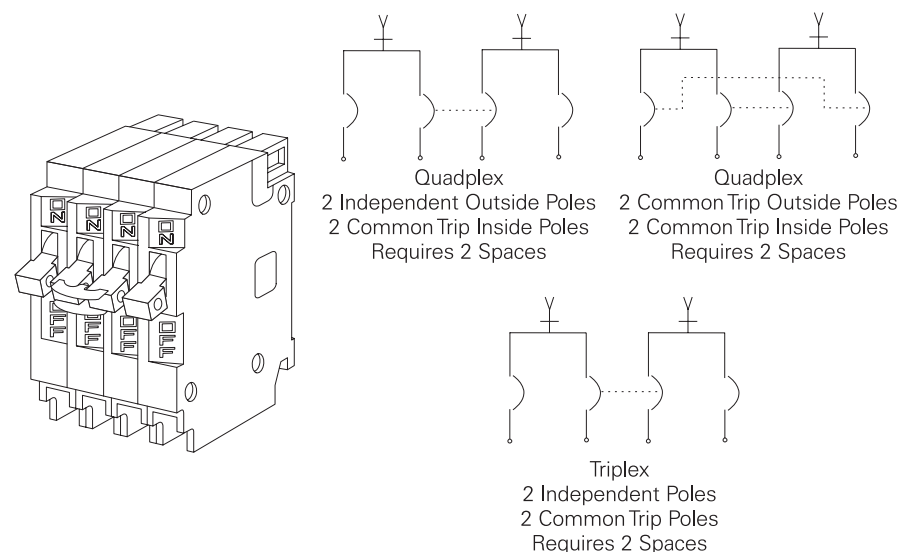
Special duplex circuit breakers are available that are not circuit limiting. These circuit breakers do not have a rejection tab and are designed for use on load centers built prior to 1965 when circuit limitations were introduced. These circuit breakers are referred to as non-circuit limiting.



Triplex, Quadplex Breakers

Siemens also offers triplex and quadplex circuit breakers. Triplex circuit breakers provide a 2-pole common trip breaker for 120/240 VAC circuits and two single poles for 120 VAC circuits.

Quadplex breakers provide two sets of handle-tied, two-pole breakers for 120/240 VAC circuits. Both triplex and quadplex breakers require two panel spaces.



Catalog Numbers

To help identify each type of circuit breaker a catalog number is assigned. The catalog number provides a description of the circuit breaker, including voltage, amps, interruption rating, number of poles, and type.

Standard Breakers

Standard, Ground Fault and Arc Fault Breakers					
1	Denotes Siemens Brand type QP Breaker				
2	GFCI Breaker (if blank, disregard)				
3	Number of Poles (1= 1-pole 2 =2-pole 3 =3-pole)				
4	Amperage				
5	Arc Fault Breaker (if blank, disregard)				
EXAMPLES	QF230: 2-Pole 30 amp Ground Fault Circuit Interrupter				
	1	2	3	4	5
	↓	↓	↓	↓	↓
	Q	F	2	30	
	Q120AF: 1-Pole 20 amp Arc Fault Circuit Interrupter				
	1	2	3	4	5
	↓	↓	↓	↓	↓
	Q		1	20	AF
	Q120: 1-Pole 20 amp Circuit Breaker				
	1	2	3	4	5
	↓	↓	↓	↓	↓
	Q		1	20	

Dual and Quad Breakers

Dual & Quad Breakers					
1	Denotes Siemens Brand type QP Breaker				
2	Represents breaker as including 2 double pole Breakers (if blank, represents 2 single pole breakers)				
3	Amperage of first Breaker				
4	Amperage of second Breaker				
5	Represents 2 single pole outer breakers and 1 double pole inner breaker (with common trip)				
6	Represents Non-Circuit Limiting Breaker				
EXAMPLES	Q23020: 1 Double Pole 30 amp breaker and 1 Double pole 20 amp breaker				QUAD
	1	2	3	4	
	↓	↓	↓	↓	
	Q	2	30	20	
Q23020CT: 2 Single Pole 30 amp breakers and 1 Double pole 20 amp breaker					TRIPLEX
1	2	3	4	5	
↓	↓	↓	↓	↓	
Q	2	30	20	CT	
Q1520: 1 Single Pole 15 amp breaker and 1 single pole 20 amp breaker					DUAL (TANDEM)
1	2	3	4		
↓	↓	↓	↓		
Q		15	20		
Q2020N: 2 Single Pole 20 amp breakers (non-circuit limiting)					DUAL (TANDEM)
1	2	3	4	6	
↓	↓	↓	↓	↓	
Q		20	20	NC	

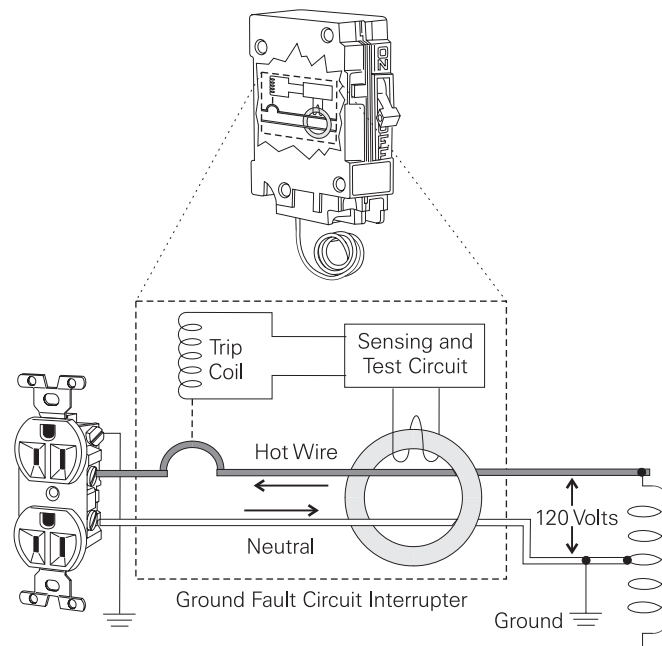
Review 3

1. Current flow in a conductor always generates _____ .
2. Pole describes the number of _____ circuits that can pass through the circuit breaker at one time.
3. The _____ circuit breaker shuts off power to the entire load center and all circuits supplied by that load center.
4. A _____ breaker is two breakers in a housing that has the same dimensions of a full-size, 1-pole breaker.
5. The number of duplex breakers that can be used in a load center is limited by UL. This is known as _____ .
6. Triplex and quadplex circuit breakers require _____ panel spaces.

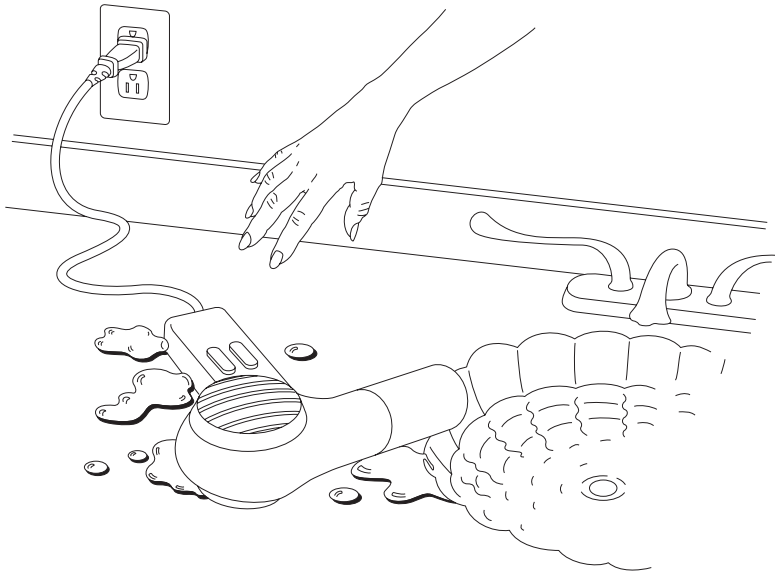
Ground Fault Protection

A ground fault occurs when a current-carrying conductor comes in contact with ground. A faulty appliance or the presence of water in contact with a conductor are two possible ways a ground fault can occur. One way ground fault protection is accomplished is by the use of GFCI receptacles. These are installed in place of a normal receptacle. Another way is with a GFCI circuit breaker such as the Siemens Type QPF GFCI circuit breakers. Any receptacle connected to the same circuit as the QPF GFCI circuit breaker is ground fault protected.

A ground fault circuit interrupter (GFCI) compares current on the hot wire with current returning on the neutral wire. Under normal circumstances the current is equal.



When a ground fault occurs some of the current will return to the source through ground. In the following illustration, for example, a ground fault has occurred in a common household appliance. Anyone coming in contact with the appliance will become part of the circuit. The sensing and test circuit will detect that the amount of current returning on the neutral is less than the current on the hot wire. The sensing and test circuit will cause the trip coil to automatically open the circuit breaker, removing power from the appliance. GFCI devices trip between 4 to 6 milliamps. The amount of time it takes for a GFCI device to trip depends on the current. The higher the current the faster the device will trip.



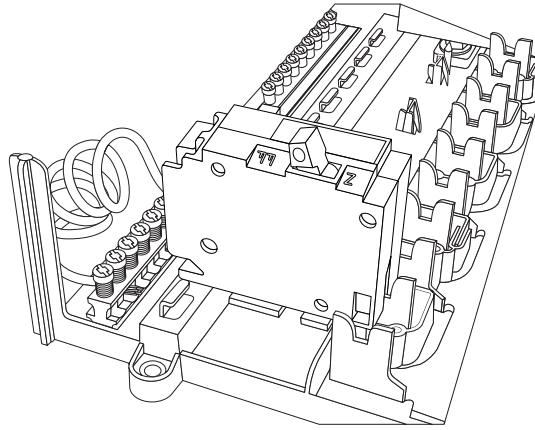
Areas Requiring GFCI

Circuits providing power to certain areas of the home require ground fault circuit interrupters (GFCI). *NEC*® Article 210.8 describes the requirements for location of GFCIs. Ground fault protection is required on the following circuits:

- Bathroom receptacles
- Residential garage receptacles
- Outdoor receptacles
- Receptacles in unfinished basements
- Receptacles in crawl spaces
- Receptacles within six feet of a kitchen or bar sink
- Pools

Installing GFCI Breakers

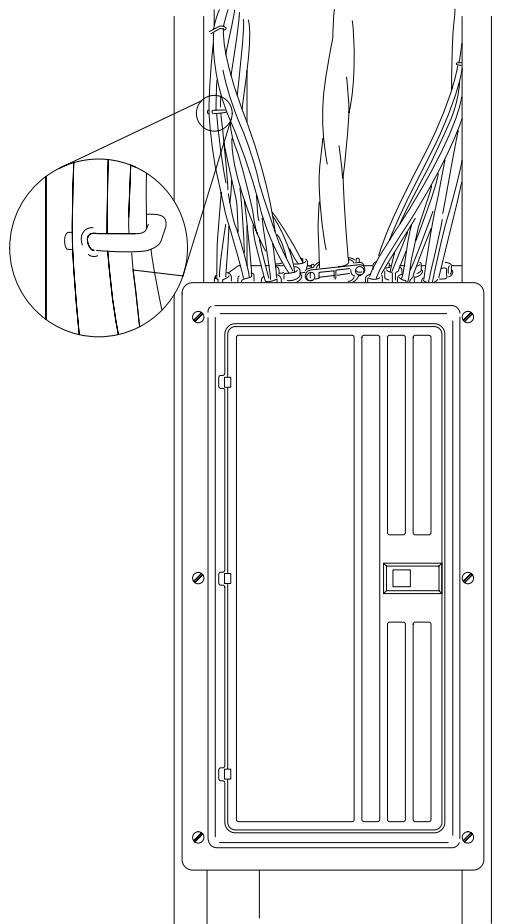
GFCI type circuit breakers have one white neutral lead which is connected to the neutral bus in the load center. The phase and load neutral are connected to lugs in the GFCI. They mount in the load center in the same way as a standard circuit breaker.



Arc Fault Protection

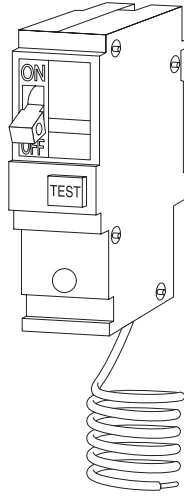
AFCI vs GFCI

GFCI devices are designed to protect a person from getting a shock when touching an ungrounded appliance. Arc Fault Circuit Interrupters (AFCI), in comparison, protect against a fire being started from an unintended arc. An arc fault occurs when a current-carrying conductor has an arcing condition to ground or another conductor. Damaged insulation, for example, can lead to an arc fault, which may not generate enough fault current to trip a circuit breaker. In the following example a staple has been driven through the insulation of a wire during installation.



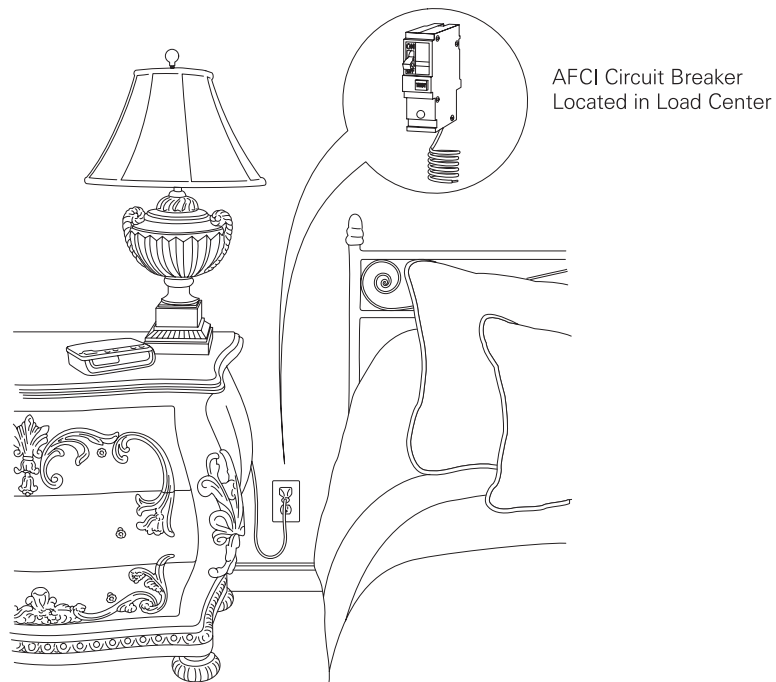
AFCI Circuit Breaker

An AFCI device is intended to provide protection from the effects of arc faults by recognizing the characteristics unique to arcing and de-energizing the circuit when an arc fault is detected. The arc generated will cause the AFCI to trip. Arcs normally generated from electric equipment such as a light switch or power drill will not cause the AFCI to trip.



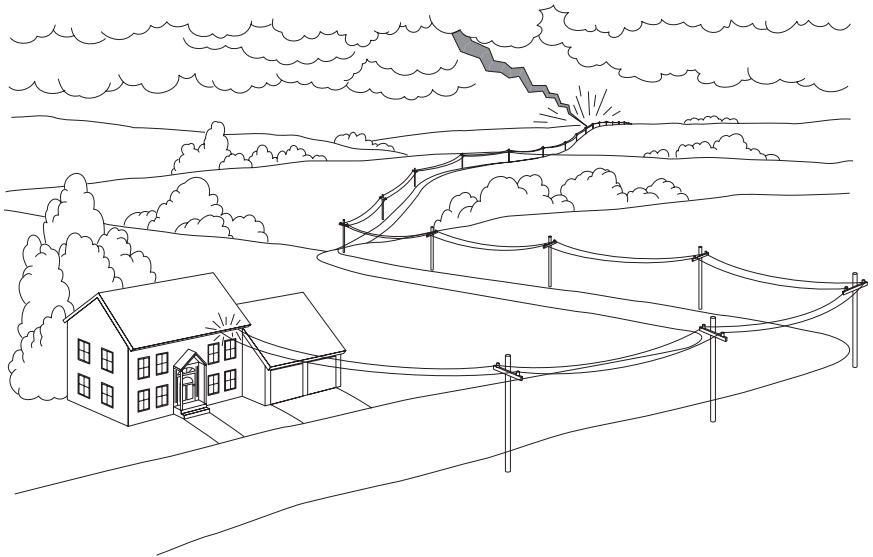
NEC® Article 210.12

Arc-Fault Circuit Interrupter protection was first introduced in the 1999 *National Electrical Code*®. NEC® Article 210.12 and has an effective date of 2002. This requirement applies to all branch circuits that supply 125-volt, single-phase, 15- and 20-amp receptacle outlets installed in dwelling unit bedrooms.



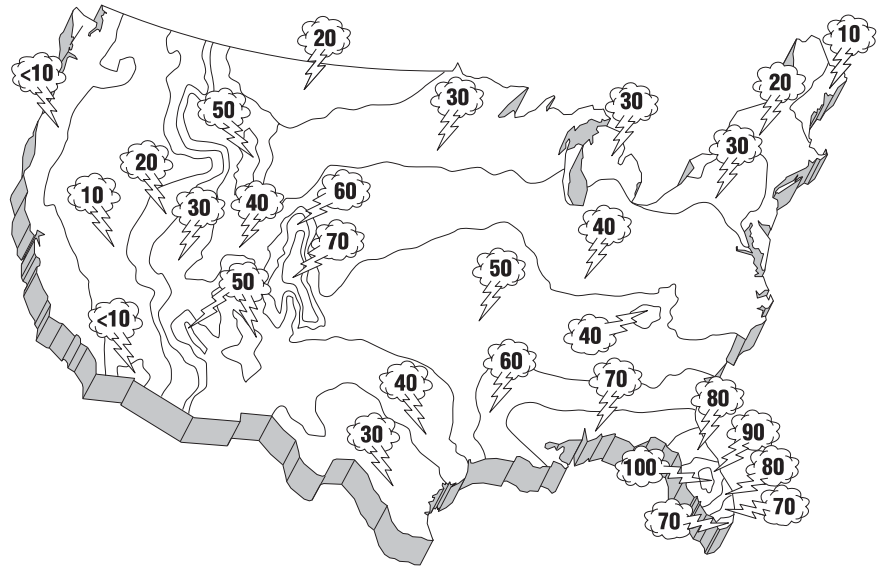
Surge Protection

Today's homes have many semiconductor-based devices such as televisions, VCRs, stereos, computers and microwave ovens. These devices are highly susceptible to voltage spikes. Devices used in the home which generate voltage spikes include vacuum cleaners and other motor driven devices, and spark igniters on gas ranges, furnaces and water heaters. The most damaging voltage spikes are caused by lightning strikes. A lightning strike on a power line several miles away still has the potential to cause extensive electrical damage in a home. Lightning strikes on high voltage lines are generally dissipated by utility transmission and arresters. The average home, however, will experience eight to ten voltage surges of 1,000 to 10,000 volts annually. Damage to expensive electrical equipment can be instantaneous or cumulative.



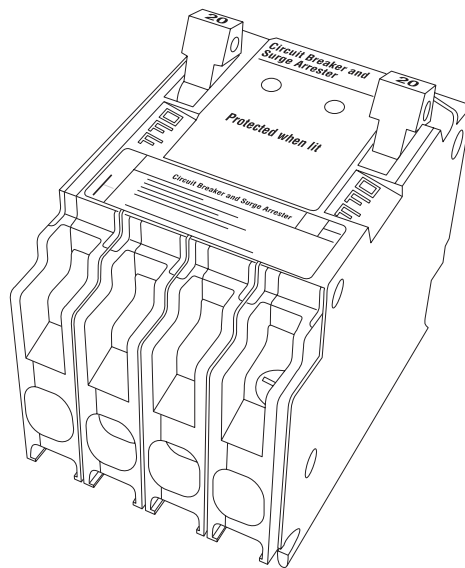
Thunderstorms

A typical lightning strike consists of 25,000 amps at 30 million volts. The following map shows the approximate mean annual number of days with thunderstorms in the United States.



Siemens Circuit Breaker Surge Arrester

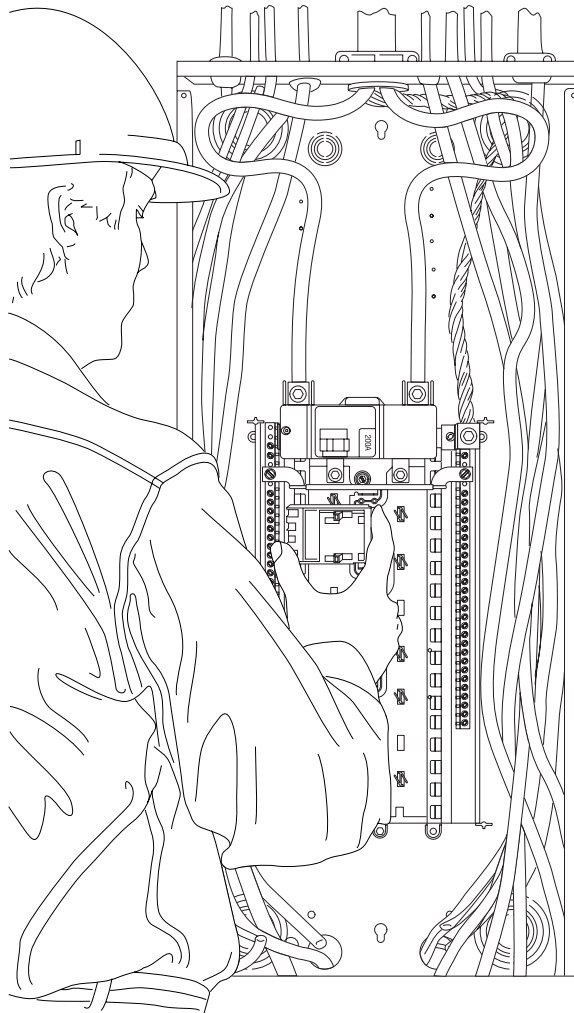
An electrical surge, whether it is caused by electrical equipment or lightning, always seeks ground. Any component between the source of the surge and ground can be damaged. Siemens circuit breaker surge arresters provide a preferred route to ground, bypassing expensive and sensitive equipment.



Installation

Installation is as simple as mounting a conventional circuit breaker in a Siemens load center. After power is switched off and the trim removed, the circuit breaker/surge arrestor plugs into place. A lead wire is provided to connect the ground side of the module to the load center's neutral bus. It is best to position the circuit breaker/surge arrestor in the first position of the load center and connect the lead wire in the first neutral position.

One device provides protection for the electrical system. Two red LEDs indicate that the device is working. The device does not require a dedicated space and can be added on to existing Siemens load centers. The circuit breaker portion of the surge arrestor can be used on noncritical lighting circuits to provide additional visual indication that the device is working. If the device trips due to a high voltage surge, it is reset like any other circuit breaker in the panel.



Clamping Voltage

Clamping voltage is the amount of voltage allowed across a surge suppression device when it is conducting a specific current created by a surge. The clamping voltage of the Siemens surge arrester is 600 volts at 1500 amps, and 800 volts at 5000 amps.

Peak Current Rating

Peak current rating specifies the maximum energy that can be dissipated from a single surge without causing the protecting device to sacrifice itself. The Siemens surge arrester can withstand impulse currents as high as 40,000 amps, and energy levels as high as 960 joules line-to-line

Review 4

1. A ground fault occurs when a current-carrying conductor comes in contact with _____ .
2. The *NEC*® does not require GFCI protection in which of the following areas?
 - a. Bathroom receptacles
 - b. Living room receptacles
 - c. Outdoor receptacles
 - d. Pools
3. An arc fault condition occurs when a current-carrying conductor has an arcing condition to _____ or another conductor.
4. The *NEC*® requires AFCI in _____ receptacles.
5. A typical lightning strike consists of _____ amps.
6. Siemens circuit breaker surge arresters are best installed in the _____ position of a load center.
7. Siemens surge arresters can withstand impulse currents as high as _____ amps.