

FIRE-GUARD

FIRE-GUARD® Arc Fault Circuit Interrupter (AFCI)

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CH115AF



CH115CAF



BR115AF



BR115CAF

Product Description

Eaton's FIRE-GUARD Arc Fault Circuit Interrupter (AFCI) is a residential circuit breaker that incorporates advanced Electronic Technology which recognizes the unique current and/or voltage signatures associated with arcing faults, and acts to interrupt the circuit to reduce the likelihood of an electrical fire.

With the Cutler-Hammer FIRE-GUARD AFCI, protection from arcing faults is combined with the protection afforded by standard residential circuit breakers. The FIRE-GUARD AFCI protects against arcing directly as well as responding to overcurrents by conventional thermal and magnetic trips.

FIRE-GUARD AFCI can also be equipped with 5 mA ground fault personnel protection, providing a residential circuit breaker that protects against arcing faults, thermal overloads and short circuits, and in addition, 5 mA ground fault protection in one integrated design.

Eaton Corporation has the widest selection of AFCI product solutions on the market today.

Application Description

Fire Prevention

The AFCI product is a rare fire safety product in that it is pro-active and not re-active by nature. Most fire safety products such as smoke detectors, fire extinguishers, escape ladders, oxygen bottles and the like expect that a fire has already started and will be used to safely exit or mitigate the problem. The AFCI product is pro-active in that it detects a problem that can cause fires and works to mitigate the problem before the fire begins.

Household electrical problems caused more than 67,000 fires and more than \$800 million in property losses in 2003. Electrical fires cause an estimated 485 deaths annually and injure almost 2,300 more. Electrical fires can be caused by numerous problems, including appliance defects or misuse, incorrect installation of wiring, or misapplied electrical cords.

In 1992, the Consumer Product Safety Commission (CPSC) contracted with Underwriters Laboratories (UL) to research and evaluate products and

technology that could reduce the likelihood of residential fires. UL identified that "arcing faults" could eventually lead to the ignition of a fire as one possible cause of residential fires.

Historical Perspective

Prior to the FIRE-GUARD AFCI, present-day residential circuit breakers were designed to protect wiring from excessive heating by opening automatically when an overload condition was present. These breakers typically contain a bimetal and magnetic trip element. During low current overloads, heating of the bimetal element causes the breaker to unlatch the contact-separation mechanism, turning power off in the affected circuit. For high overcurrent conditions, such as short circuits, the high magnetic field associated with high current flow causes the "instantaneous tripping" of the breaker mechanism. The breaker response time is a function of the circuit current and time, with faster response at higher currents. In particular, the circuit breaker Time versus Current characteristics, is selected to prevent conductor damage. Present overcurrent devices, such as circuit breakers and fuses, represent a major safety feature in today's residences. They prevent excessive temperatures in the conductors or conductor insulation and they reduce the incidence of household fires, to a great extent, through their prevention of overheating effects.

The response time of present-day circuit breakers is determined solely by the duration and magnitude of the circuit overcurrent. This response is adequate to protect the wiring if the circuit wiring integrity has been maintained. However, once this integrity has been compromised via broken wires or deteriorated insulation, electric arcs can occur. These arcs are characterized by a plasma flame which can release temperatures in excess of 6000°C. An arcing fault can go undetected by a thermal, as well as magnetic trip element. The challenge answered by the FIRE-GUARD AFCI is to enhance circuit protection by identifying the presence of arcing faults, and responding to their presence by opening the circuit in times which are faster than standard circuit breakers. By integrating custom electronics into a present-day circuit breaker, the FIRE-GUARD meets the challenge and offers enhanced protection from household fires.

Arcs in Wiring

Parallel Arcs

Electrical arcs can be placed into two categories. The most familiar and dramatic arcs in residential wiring are associated with short circuit arcs between two conductors. In a parallel arc, the load is paralleled by the arcing fault. An example would be the accidental severing of the power cord and a hedge trimmer or other power tool. A less obvious example would be the deterioration of insulation in the wiring behind a wall, due for example, to the cumulative effect of electrical surges, heat or moisture over many years. A parallel arc can often "sputter" on and off for extended periods of time without detection, increasing the risk of fire.

Series Arcs

Arcs can also occur at a break in a single conductor. These series arcs are relatively low current since they are in a series with the load. In practice, it is difficult to sustain such arcs since copper-to-copper arcing is unsustainable at 125 Vac. However, such arcing can occur in the presence of carbonized insulation. The arcs are typically sputtering and intermittent in nature, and tend to alert the homeowner since they lead to intermittent device operation such as flickering lighting loads.

Residential wiring has been divided into four zones. The Cutler-Hammer FIRE-GUARD AFCI will provide parallel arc detection and protection in Zones 1, 2 and 3 and it will respond to arcing to ground in all three of these zones. FIRE-GUARD AFCI responds to series arcs in two conductor plus ground fixed premises wiring (Type N-B wire) of Zone 1.

Types of AFCIs

There are three types of AFCI, the Branch Feeder Type, the Combination Type and the Dual Purpose AFCI.

UL 1699 defines the Branch Feeder and the Combination Types AFCI. The Combination Type AFCI is defined as "meeting the requirements for both the branch/feeder and outlet circuit AFCIs."

The Dual Purpose device incorporates either the Branch Feeder or the Combination device features and GFCI 5 mA ground fault detection.

The 2005 NEC permits the use of the Branch Feeder Type AFCI until January 1, 2008 after which time the Combination Type AFCI is required. The 2008 NEC permits only the Combination Type AFCI.

The Dual Purpose AFCI is applied in those locations where GFCI protection is required and AFCI protection is desired.

Eaton AFCIs include 30 mA equipment level ground fault protection.

Application Data

- FIRE-GUARD AFCI circuit breakers can be applied to all residential, commercial and industrial 15 and 20 ampere, 120/240 Vac applications utilizing a loadcenter approved for use with Cutler-Hammer Type CH or BR circuit breakers.
- FIRE-GUARD AFCI circuit breakers are to be applied in applications where you want to reduce the risk of electrical fires caused by electrical arcing, as well as protect conductors from overcurrents and short circuits.
- The single-pole FIRE-GUARD AFCI breaker is applied in single-phase 120 Vac applications. The 2-pole common trip FIRE-GUARD AFCI breaker is applied in 3-wire 120/240 Vac 3-wire circuits and 240 Vac circuits sourced by 120/240 Vac.
- The 2-pole independent trip FIRE-GUARD AFCI breaker is applied in 120 Vac multi-wired circuits utilizing a shared neutral (often referred to as a home-run circuit).
- The FIRE-GUARD Dual Purpose AFCI/GFCI breaker can be used when AFCI (UL 1699) and 5 mA GFCI (UL 943) protection is required.
- The FIRE-GUARD AFCI can be used in conjunction with a downstream GFCI device such as a receptacle or ground fault relay.
- All FIRE-GUARD AFCI type breakers are HACR rated.
- All FIRE-GUARD AFCI 15 and 20 ampere breakers are SWD rated.

The 2-pole AFCI breaker is required for shared neutral circuits. In many cases, contractors will run one 3-conductor wire in lieu of two runs of 2-conductor wire. (Note: When discussing the number of conductors in NM-B cable, the ground wire is not counted. Therefore, the 3-conductor NM-B has two hot and one neutral wire.) This wiring method saves a considerable amount of labor. AFCI breakers wire in the same manner as GFCI in that the neutral wire is brought back and connected to the breaker, and the pigtail of the breaker is wired to the neutral bar. In a shared neutral application, since two circuits are sharing one neutral wire, it is impossible to connect the one neutral wire to two individual circuit breakers. The 2-pole AFCI allows for both circuits to share the neutral wire.

Technical Data and Specifications

Ground Fault Detection

All Eaton AFCI breakers include some level of ground fault detection and protection. The Branch Feeder and Combination Type AFCI inherently come equipped with 30 mA Equipment Level earth leakage detection and protection. This feature helps to identify such wiring problems as grounded neutrals.

When specified through proper catalog number selection, the AFCI can be equipped with 5 mA GFCI detection and protection. This product includes either the Branch Feeder or Combination Type arc fault detection, thermal and magnetic overload current protection, and 5 mA ground fault. This is the most complete circuit protection breaker on the market today.

Technical Data

AFCI circuit breakers include the following:

- UL 1699.
- UL 1998.
- UL 489.
- UL 943 (for Dual Purpose Devices Only).
- UL 1053 (Branch Feeder Only).
- Heating, air conditioning & Refrigeration (HACR) Rated.
- Switching Duty (SWD) Rated.
- Compatible with downstream GFCI Devices.
- Available in 15 and 20 ampere configurations.
- Available in 10 kAIC and 22 kAIC configurations (some models).
- AFCI breakers will operate at temperatures above the standard thermal magnetic circuit breaker. This is due to the presence of the electronics within the circuit breaker. Per UL standard 489 for molded case circuit breakers, the breaker must not exceed 50°C rise over ambient at both line and load terminals in open air. In an enclosure, the temperature rise over ambient must not exceed a 60°C rise. Eaton's AFCIs operate well within these limits.

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Typical Causes of Arcing Faults

Arcing faults can occur in homes, apartments, or any other residential dwellings where there is deterioration in wire insulation caused by one or more of these hazardous situations.

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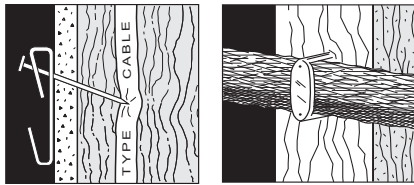


Figure 4-10. When cable has been punctured by a nail or stapled too tightly against a stud, the insulation can be severed and arcing can occur.

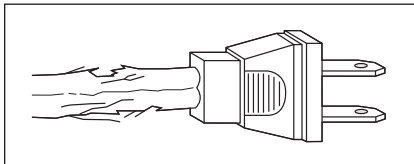


Figure 4-11. Damaged, abused or worn extension cords can pose an arcing situation.



Plug-on Neutral Combination Type AFCI brings time savings and a neater loadcenter thus enabling contractors to meet the 2008 National Electrical Code and not compromise time and neatness.

Table 4-32. Protection Capabilities

Protection Device	Type of Protection	Advantage
Branch Feeder AFCI	Thermal	Protects conductor against overload.
	Magnetic	Protects conductor against short circuits.
	30 mA Earth Leakage Detection	Identifies wiring errors such as grounded neutrals.
	Branch Feeder Arc Fault	Reduces risk of electrical fires started by parallel and series arcing faults in installed wiring and parallel arcing faults in connected cords.
Combination Type AFCI	Thermal	Protects conductor against overload.
	Magnetic	Protects conductor against short circuits.
	30 mA Earth Leakage Detection	Identifies wiring errors such as grounded neutral.
	Branch Feeder Arc Fault	Reduces risk of electrical fires started by parallel and series arcing faults in installed wiring and parallel arcing faults in connected cords.
Dual Purpose AFCI and GFCI	Thermal	Protects conductor against overloads.
	Magnetic	Protects conductor against short circuits.
	Branch Feeder or Combination Type Arc Fault	Reduces risk of electrical fires started arcing faults. The level of detection is dependent upon the type of Arc Fault breaker being employed.
	GFCI (5 mA Leakage Detection)	Protects people from fatal electric shock.

Standards and Certifications

- Cutler-Hammer AFCIs are listed to UL 1699, the standard for arc fault circuit interrupters and UL 489, the standard for circuit breakers.
- AFCIs with 5 mA GFCI protection are available that meet UL 943, the standard for ground fault circuit interrupters.
- NEC 210.12 – 1999 NEC
 - A. **Definition** — An arc-fault circuit interrupter is a device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.
 - B. **Dwelling Unit Bedrooms** — All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere receptacle outlets installed in dwelling unit bedrooms shall be protected by an arc fault circuit interrupter(s). This requirement shall become effective January 1, 2002.
- NEC 210.12 – 2002 NEC
 - A. **Definition** — An arc fault circuit interrupter is a device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.
 - B. **Dwelling Unit Bedrooms** — All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets installed in dwelling unit bedrooms shall be protected by an arc fault circuit interrupter listed to provide protection of the entire branch circuit.

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■ NEC 210.12 – 2005 NEC

- A. **Definition** — An arc fault circuit interrupter is a device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.
- B. **Dwelling Unit Bedrooms** — All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit bedrooms shall be protected by a listed arc fault circuit interrupter, combination type installed to provide protection of the branch circuit.

Branch/feeder AFCIs shall be permitted to be used to meet the requirements of 210.12(B) until January 1, 2008.

FPN: For information on types of arc fault circuit interrupters, see UL 1699-1999, standard for Arc Fault Circuit Interrupters.

Exception: The location of the arc-fault circuit interrupter shall be permitted to be at other than the origination of the branch circuit in compliance with (a) and (b):

- a. The arc fault circuit interrupter installed within 1.8 m (6 ft.) of the branch circuit overcurrent device as measured along the branch circuit conductors.
- b. The circuit conductors between the branch circuit overcurrent device and the arc fault circuit interrupter shall be installed in a metal raceway or a cable with a metallic sheath.

■ NEC 210.12 – 2008 NEC

- A. **Definition** — An arc fault circuit interrupter is a device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.
- B. **Dwelling Unit Bedrooms** — All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets installed in dwelling unit family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways or similar rooms or areas shall be protected by a listed arc fault circuit interrupter, combination type, installed to provide protection of the branch circuit.

Exception No. 1 — Where RMC, IMC, EMT or steel armored cable, Type ac, meeting the requirements of 250.118 using metal outlet and junction boxes is installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a combination AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

Exception No. 2 — Where a branch circuit to a fire alarm system installed in accordance with 760.41(B) and 760.121(B) is installed in RMC, IMC, EMT or steel armored cable, Type ac, meeting the requirements of 250.118, with metal outlet and junction boxes, AFCI protection shall be permitted to be omitted.

It should be noted that in the cases above, as per Article 100 of the NEC, an "Outlet" is "A point on the wiring system at which current is taken to supply utilization equipment." This would include lighting outlets, receptacle outlets, and fire alarm outlets.

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Product Selection

Table 4-33. Type CH 3/4-Inch (19.1 mm) Wide FIRE-GUARD AFCI Circuit Breakers

Poles	Ampere Rating	Configuration	Catalog Number	Price U.S. \$
Single-Pole 10 kAIC	15	Branch Feeder AFCI	CH115AF	
		Branch Feeder AFCI with GFCI	CH115AFGF	
		Branch Feeder AFCI in Clamshell Package	CH115AFCS	
	20	Branch Feeder AFCI	CH120AF	
		Branch Feeder AFCI with GFCI	CH120AFGF	
		Branch Feeder AFCI in Clamshell Package	CH120AFCS	
Double-Pole 10 kAIC ①②	15	Branch Feeder AFCI Common Trip	CH215AF	
		Branch Feeder AFCI Independent Trip	CH215AFIT	
		Branch Feeder AFCI Common Trip	CH220AF	
	20	Branch Feeder AFCI Common Trip	CH220AF	
		Branch Feeder AFCI Independent Trip	CH220AFIT	
		Branch Feeder AFCI Independent Trip	CH220AFIT	

① Common trip refers to 2-pole 240 volt load application sourced by 120/240 Vac (See Figure 4-14).
 ② Independent trip refers to 2-pole shared neutral circuits (see Figure 4-13 and Figure 4-15).
 ③ Requires plug-on neutral loadcenter.

Table 4-34. Type BR 1-Inch (25.4 mm) Wide AFCI Circuit Breakers

Poles	Ampere Rating	Configuration	Catalog Number	Price U.S. \$
Single-Pole 10 kAIC	15	Branch Feeder AFCI	BR115AF	
		Branch Feeder AFCI with GFCI	BR115AFGF	
		Branch Feeder AFCI in Clamshell Package	BR115AFCS	
	20	Branch Feeder AFCI	BR120AF	
		Branch Feeder AFCI with GFCI	BR120AFGF	
		Branch Feeder AFCI in Clamshell Package	BR120AFCS	
Double-Pole 10 kAIC ④⑤	15	Branch Feeder AFCI Common Trip	BRL215AF	
		Branch Feeder AFCI Independent Trip	BRL215AFIT	
		Branch Feeder AFCI Common Trip	BRL220AF	
	20	Branch Feeder AFCI Common Trip	BRL220AF	
		Branch Feeder AFCI Independent Trip	BRL220AFIT	
		Branch Feeder AFCI Independent Trip	BRL220AFIT	

④ Common trip refers to 2-pole 240 volt load application sourced by 120/240 Vac (See Figure 4-14).
 ⑤ Independent trip refers to 2-pole shared neutral circuits (see Figure 4-13 and Figure 4-15).

Table 4-35. UL Classified Branch Feeder AFCIs

Poles	Ampere Rating	Configuration	Catalog Number	Price U.S. \$
Single-Pole	15	AFCI	CL115AF	
	20	AFCI	CL120AF	

Type CL 1-Inch Wide per Pole Classified Arc Fault Circuit Interrupters —
 Fit Square D HOMELINE®, GE, Siemens, Murray®, Thomas & Betts® and Crouse-Hinds® Loadcenters

Poles	Ampere Rating	Configuration	Catalog Number	Price U.S. \$
Single-Pole	15	AFCI	CL115AF	
	20	AFCI	CL120AF	

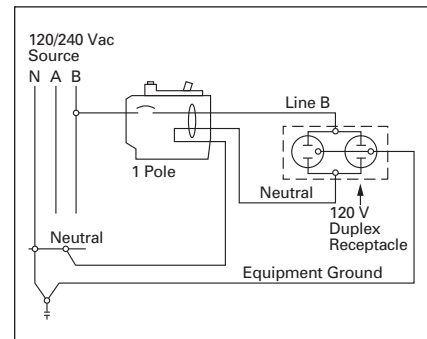


Figure 4-12. Single-Pole Single 120 Volt Load Application Sourced by 120/240 Vac

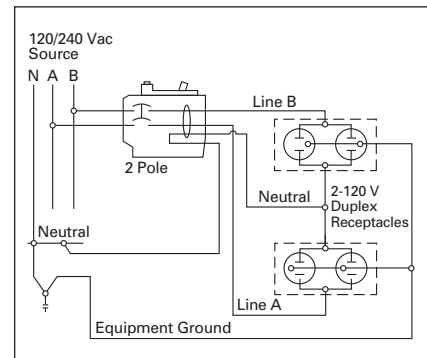


Figure 4-13. 2-Pole Shared Neutral with Multi-Duplex Receptacle Application

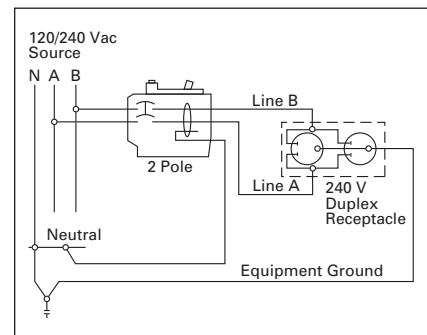


Figure 4-14. 2-Pole 240 Volt Load Application Sourced by 120/240 Vac

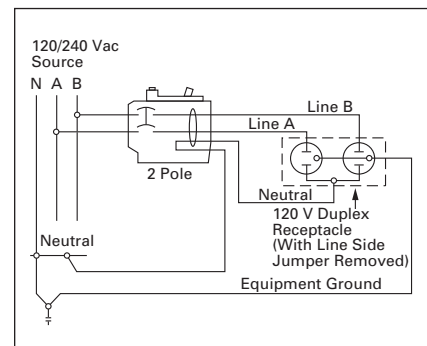


Figure 4-15. 2-Pole Shared Neutral with Duplex Receptacle Application

Discount Symbol 22CD

AFCI PRODUCT SELECTION GUIDE



■ CHTYPE AFCI PRODUCTS - 3/4"

Catalog Number	Style Number	Description
CH115AF	96-5654-1	CH 3/4" FIREGUARD AFCI 1 Pole, 15 Amp, 120/240Vac, 10kAIC
CH115AFCS	CH115AFCS	CH 3/4" FIREGUARD AFCI 1 Pole, 15 Amp, 120/240Vac, 10kAIC, Clam Shell
CH115AFGF	96-3880-7	CH 3/4" FIREGUARD AFCI 1 Pole, 15 Amp With 5ma GFCI
CH115CAF	96-6244-1	CH 3/4" FIREGUARD COMBINATIONTYPE AFCI 1 Pole, 15 Amp, 120/240Vac, 10kAIC
CH115CAFCS	66C1255G155	CH 3/4" FIREGUARD COMBINATIONTYPE AFCI 1 Pole, 15 Amp, 120/240Vac, 10kAIC CLAM SHELL
CH115CAFPN	96-6244-11	CH 3/4" FIREGUARD COMBINATIONTYPE AFCI 1 Pole, 15 Amp, 120/240Vac, 10kAIC, Plug-On-Neutral
CH120AF	96-5654-2	CH 3/4" FIREGUARD AFCI 1 Pole, 20 Amp, 120/240Vac, 10kAIC
CH120AFCS	CH120AFCS	CH 3/4" FIREGUARD AFCI 1 Pole, 20 Amp, 120/240Vac, 10kAIC, Clam Shell
CH120AFGF	96-3880-8	CH 3/4" FIREGUARD AFCI With 5ma GFCI 1 Pole 20 Amp
CH120CAF	96-6244-2	CH 3/4" FIREGUARD COMBINATIONTYPE AFCI 1 Pole, 20 Amp, 120/240Vac, 10kAIC
CH120CAFCS	66C1255G156	CH 3/4" FIREGUARD COMBINATIONTYPE AFCI 1 Pole, 20 Amp, 120/240Vac, 10kAIC, CLAM SHELL
CH120CAFPN	96-6244-12	CH 3/4" FIREGUARD COMBINATIONTYPE AFCI 1 Pole, 20 Amp, 120/240Vac, 10kAIC, Plug-On-Neutral
CH215AF	96-5352	CH 3/4" FIREGUARD AFCI 2 Pole 15 Amp, 120/240Vac, 10kAIC
CH215AFGF	96-5351	CH 3/4" FIREGUARD AFCI With 5 ma GFCI 2 Pole 15 Amp 240V
CH215AFIT	96-5352-3	CH 3/4" FIREGUARD AFCI 2 Pole 15 Amp For Shared Neutral Circuit
CH220AF	96-5352-2	CH 3/4" FIREGUARD AFCI 2 Pole 20 Amp 240V
CH220AFGF	96-5351-2	CH 3/4" FIREGUARD AFCI With 5 ma GFCI 2 Pole 20 Amp 240V
CH220AFIT	96-5352-4	CH 3/4" FIREGUARD AFCI 2 Pole 20 Amp For Shared Neutral Circuit

AFCI PRODUCT SELECTION GUIDE ■ ■ ■ ■



■ **BR TYPE AFCI PRODUCTS - 1"**

Catalog Number	Style Number	Description
BR115AF	66C1111G01	BR 1" FIREGUARD AFCI 1 Pole 15 Amp, 10kAIC
BR115AFBP50	66B1104G07	BR 1" FIREGUARD AFCI 1 Pole 15 Amp, 10kAIC
BR115AFCS	BR115AFCS	BR 1" FIREGUARD AFCI 1 pole, 15 amp, 120/240Vac, 10kAIC, Clam Shell
BR115AFGF	7804C61G07	BR 1" FIREGUARD AFCI With 5 ma GFCI 1 Pole 15 Amp
BR115CAF	66C1141G01	BR 1" FIREGUARD COMBINATIONTYPE AFCI 1 Pole 15 Amp, 10kAIC
BR120AF	66C1111G02	BR 1" FIREGUARD AFCI 1 Pole 20 Amp, 10kAIC
BR120AFBP50	66B1104G18	BR 1" FIREGUARD AFCI 1 Pole 20 Amp, 10kAIC
BR120AFCS	BR120AFCS	BR 1" FIREGUARD AFCI 1 pole, 20 amp, 120/240Vac, 10kAIC, Clam Shell
BR120AFGF	7804C61G08	BR 1" FIREGUARD AFCI With 5 ma GFCI 1 Pole 20 Amp
BR120CAF	66C1141G02	BR 1" FIREGUARD COMBINATIONTYPE AFCI 1 Pole 20 Amp, 10kAIC
BR215AF	66C1153G01	BR 1" FIREGUARD AFCI 2 Pole 15 Amp 240V
BR215AFGF	66C1152G01	BR 1" FIREGUARD AFCI with 5ma GFCI 2 pole 15 amp 240V
BR215AFIT	66C1153G03	BR 1" FIREGUARD AFCI 2 Pole 15 Amp For Shared Neutral Circuit
BR220AF	66C1153G02	BR 1" FIREGUARD AFCI 2 Pole 20 Amp 240V
BR220AFGF	66C1152G02	BR 1" FIREGUARD AFCI With 5 ma GFCI, 2 pole, 20 amp 240V
BR220AFIT	66C1153G04	BR 1" FIREGUARD AFCI 2 Pole 20 Amp For Shared Neutral Circuit
BRC115AF	66C1112G01	BR 1" FIREGUARD AFCI 1 Pole 15 Amp
BRC120AF	66C1112G02	BR 1" FIREGUARD AFCI 1 Pole 20 Amp
BRH115AF	7804C61G09	BR 1" FIREGUARD AFCI 1 Pole 15 Amp, 22kAIC
BRH120AF	7804C61G10	BR 1" FIREGUARD AFCI 1 Pole 20 Amp, 22kAIC