

# Circuit Breakers & Trip Units — Low Voltage

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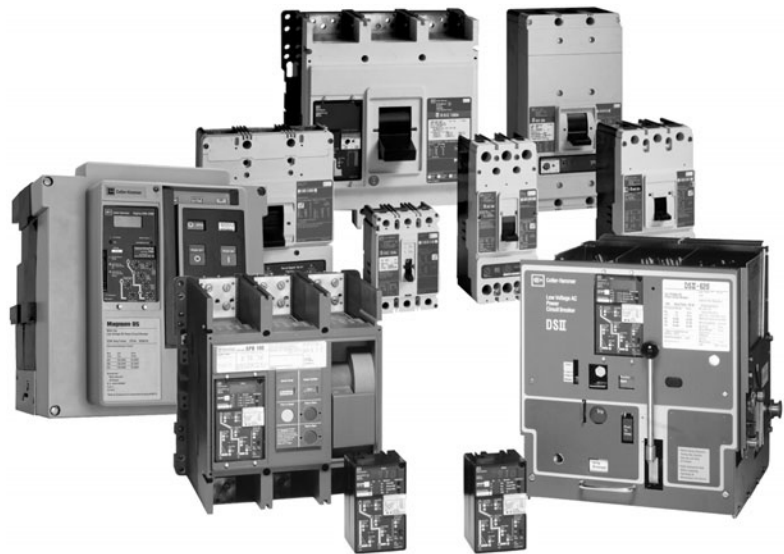
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### Specifications

See Eaton's Cutler-Hammer Product Specification Guide:

1995 CSI Format: Power Circuit Breakers — Magnum DS . . . . .	<b>Section 16475</b>
Power Circuit Breakers — DSII. . . . .	<b>Section 16475</b>
Molded Case Circuit Breakers . . . . .	<b>Section 16475</b>
Microprocessor Trip Units . . . . .	<b>Section 16904</b>
Enclosed Circuit Breakers . . . . .	<b>Section 16476</b>
2004 CSI Format: Power Circuit Breakers — Magnum DS . . . . .	<b>Section 26 28 11</b>
Power Circuit Breakers — DSII. . . . .	<b>Section 26 28 11</b>
Molded Case Circuit Breakers . . . . .	<b>Section 26 28 11</b>
Microprocessor Trip Units . . . . .	<b>Section 26 28 50</b>
Enclosed Circuit Breakers . . . . .	<b>Section 26 28 16.11</b>



Low Voltage Circuit Breakers

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Magnum DS

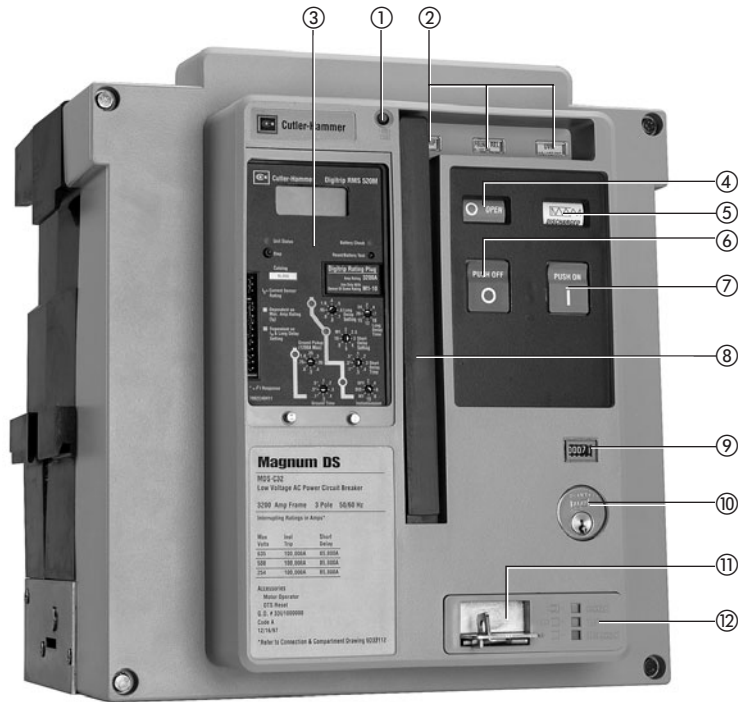
Eaton's Cutler-Hammer® Magnum™ DS Breakers are power circuit breakers designed and engineered specifically for use in Magnum DS Low Voltage Switchgear assemblies applied at nominal voltages of 240, 480 and 600 Vac. Six continuous ratings — 800 amperes through 6000 amperes — are covered by only two physical breaker sizes.

Controls and indicators are functionally grouped on the front of the breakers and the through-the-door design means they are easily viewed and accessible.

- ① Trip Flag
- ② Three Accessory Windows
- ③ Digitrip™ RMS Trip Unit
- ④ Contact Status Indicator (Open or Closed)
- ⑤ Spring Status Indicator (Charged or Discharged)
- ⑥ "Push Off" to Open Breaker Button
- ⑦ "Push On" to Close Breaker Button
- ⑧ Manual Charging Handle
- ⑨ Optional Operations Counter
- ⑩ Optional "Off" Key Lock
- ⑪ Padlockable Levering Device
- ⑫ Color-Coded Breaker Position Indicators

Magnum DS Breakers are 100% rated, UL® listed, and are built and tested in an ISO® 9000 certified facility to applicable standards including:

- ANSI C37.13
- NEMA® SG3
- ANSI C37.16
- UL 1066
- ANSI C37.17
- CSA® 22.2
- ANSI C37.50



Magnum DS Breaker

Magnum DS is also suitable for use in:

- UL 1558 low voltage switchgear.
- UL 891 low voltage switchboards.
- CSA 22.2.31 low voltage assemblies.



Integrally designed breaker steel cassette for drawout breakers provides clear indication of connect, test and disconnect positions.



The breaker can be conveniently racked in or out, stopping at the various positions with the door closed.



Faceplate controls facilitate operation of the breaker, and the three accessory mounting windows provide for easy identification.



The breaker spring charging handle is designed with sufficient space for operation even with a gloved hand.

**General Description**

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**Designed for Easy Access, Inspection and Minimal Maintenance**

The stored energy mechanism, control devices, accessories and secondary contacts are easily accessible by removing the front cover that is held in place by four captive screws. This can only be done when the breaker is in the disconnect position or removed from the cell.

The current sensor viewing window on the rear of the breaker allows for easy identification of the current sensor mounted inside.

The contact wear indicator eliminates the need for elaborate testing to determine if the contact assembly needs replaced.

Many minor replacement functions involving the mechanism, control, and/or accessories can be easily accomplished.

**Two-Step Stored Energy Mechanism for Manually and Electrically Operated Breakers**

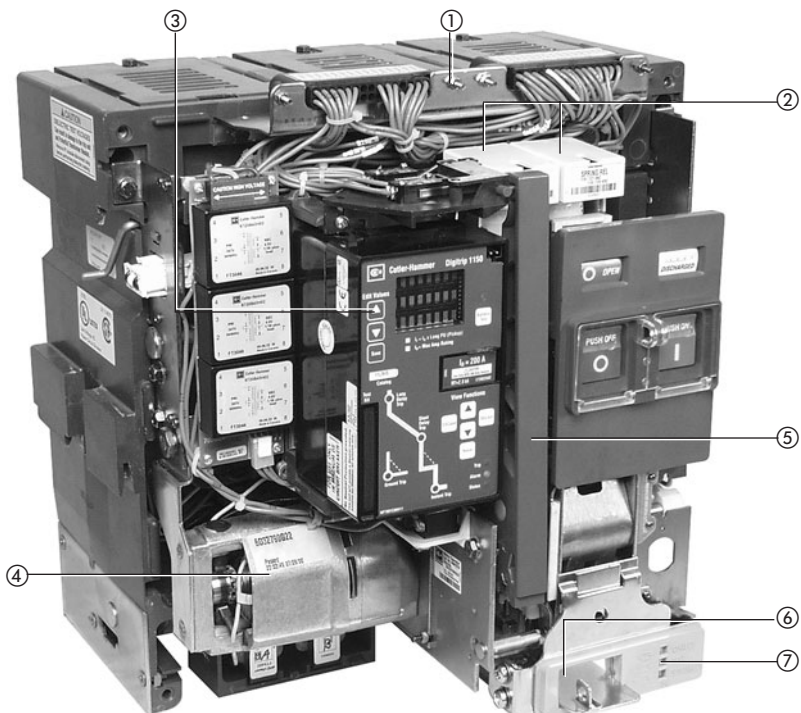
The potential energy is stored in the mechanism to close the breaker in five cycles or less. Sufficient energy to open the breaker remains available following the closing operation.

After closing, the charging spring can be recharged to provide potential energy for reclosing following a fault, providing high continuity of service. This feature allows for the following sequence: charge – close – recharge – open – close – open.

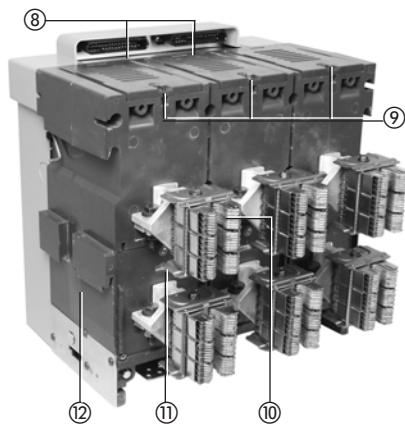
On manually operated breakers, closing springs are charged by hand. For electrically operated breakers, springs are charged by an electric motor but can be manually charged if no power is available.

**Increased Short Time and Interrupting Ratings**

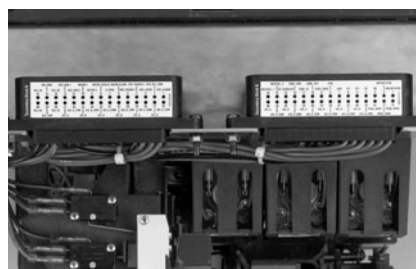
Eaton's Cutler-Hammer Magnum DS Power Circuit Breakers are available with short time ratings up to 85,000 amperes rms symmetrical and interrupting ratings up to 100,000 amperes rms symmetrical. These increased ratings far exceed ratings previously available on power circuit breakers.



*Internal View of Magnum DS Breaker*



*This rear view of a Magnum DS drawout breaker shows the designed-in safety feature of locating the secondary contacts away from the primary disconnects.*



*Positioning of the secondary contact subassembly is dedicated for installation, maintenance and testing. Top view shown with breaker cover removed, bottom of photo is front of breaker.*

- ① Secondary Wiring Points
- ② Field Installable Accessories (Three Maximum)
- ③ Digitrip RMS Trip Unit
- ④ Optional Electric Charging Motor
- ⑤ Manual Charging Handle
- ⑥ Padlockable Levering Device
- ⑦ Breaker Position Indicator
- ⑧ Secondary Contacts
- ⑨ Arc Chute Covers
- ⑩ Primary Finger Cluster Disconnects
- ⑪ Current Sensor Window
- ⑫ Rigid Frame Housing

General Description

**Flexible Current Path Increases Current Carrying Capability in Less Space**

- Multi-finger contact structure divides the current flow, increasing the thermal carrying capability of the entire current path.



Visual contact wear indicator shows when contact replacement is necessary.

- Flexible braided current path to the contact fingers reduces necessary current carrying space and provides a smooth connection, eliminating bolted joints and contact springs. This design helps increase breaker service life by reducing localized heat buildup and mechanical stress inherent in conventional bolted joints.

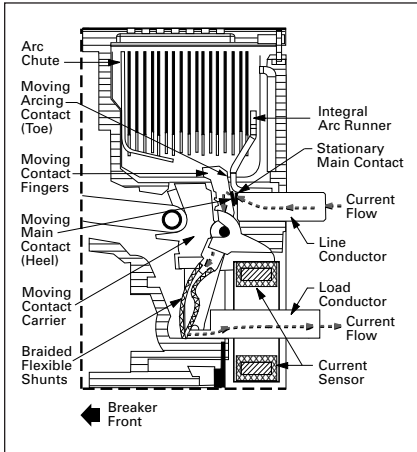


Figure 21.1-1. Cross-Section of Magnum DS Heel-Toe Contact

Unlike conventional power breaker designs utilizing separate arcing and main current carrying contacts, Eaton's Cutler-Hammer Magnum DS Circuit Breakers perform both functions on different parts of the same contact finger. Each finger has a moving main contact (heel) and a moving arcing contact (toe). A complete movable contact is merely the combination of a number of individual fingers.

As the circuit breaker is called upon to open, the toe and heel simultaneously touch. At that point, the current changes its path from the main contact to the arcing contact. As the heel lifts off, any remaining current is driven to the toe. The result is minimal arcing damage to the main contact (heel) providing for longer main contact life.

Upon closing, the toe absorbs most of the impact and deals with any arcing by touching down before the heel. Once again, the main contact (heel) is protected resulting in longer life.

**Arc Running System Provides Higher Interrupting Capacity in Less Space**

- Heel-toe contact structure is a single contact finger design that performs both main and arcing contact functions by controlling the arc direction. This design provides for longer contact life.
- Integral arc runner enhances the magnetic action of the arc chute by drawing the arc into the chute with increased efficiency, reducing arcing at the toe of the contacts. This exclusive design allows for higher arcing in a smaller space, resulting in increased interrupting ratings. Alternating V Arc Chute™ quickly divides and extinguishes the arc. The V Arc Chute reaction speed protects contact material, extending contact life.



Arc chutes can be easily removed and inspected. The contact wear indicator on the main contact assembly can also be inspected.

**Isolated View of Contact Opening Sequence**

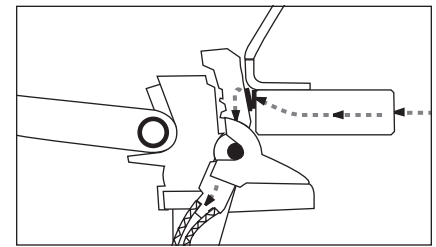


Figure 21.1-2. (1) Fully Closed Position  
Only the main contact (heel) touches and all current flow is through the main contact.

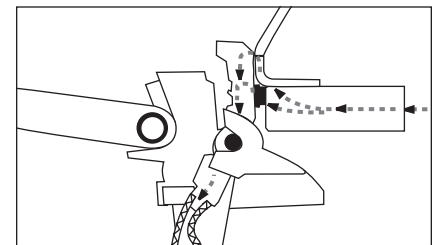


Figure 21.1-3. (2) Simultaneous Touching of All Contacts

The arcing contact (toe) touches down before the main contact (heel) lifts off with current flow dividing between main (heel) and arcing (toe) contacts.

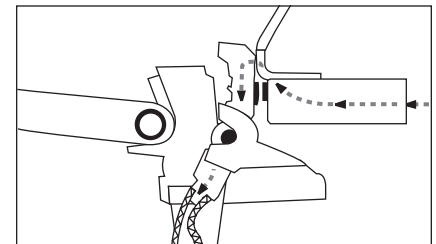


Figure 21.1-4. (3) Toe (Arcing) Contacts Touching

The main contact (heel) lifts off with the arcing contact (toe) still touching to deal with any arcing. Current flow is only through the arcing contact (toe).

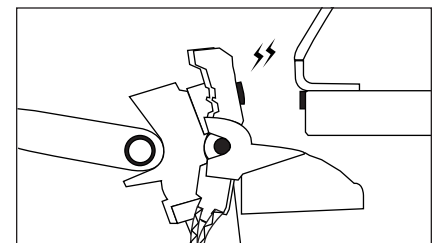


Figure 21.1-5. (4) Fully Open Position

Both the main (heel) and arcing (toe) contacts are open and there is no current flow. The arc dissipates up into the arc chute.

## General Description

**Rigid Frame Housing**

Eaton's Cutler-Hammer Magnum DS Breaker utilizes a rigid frame housing — an ANSI power breaker exclusive. This housing provides the strength and stability required in the mounting of the current path and operating mechanism.

- **Increased Uptime.** Because the current path is isolated and insulated inside a two-piece interconnected housing, any potential damage that may occur during arc interruption between the poles or outside of the breaker is minimized.
- **Increased Breaker Life.** By providing rigid support for the operating mechanism and the contact structure, mechanical stress is reduced, increasing reliability.
- **Design Reliability.** The housing reduces the number of frame parts in comparison with conventional ANSI power breakers, providing increased reliability.
- **Rigid Frame.** The engineered thermoset composite resin provides excellent structural properties, dielectric strength, and arc track resistance helping to provide the higher interrupting and short time (withstand) ratings in a smaller size.

**Built-in Safety Features Provide Optimum Operator Safety and System Security**

- **Improved C-loop current path design** provides dramatic improvements in both safety and efficiency. Higher current ratings increase the blow-on forces on the contact surfaces, allowing the proper downstream protective device to open, isolating the fault and increasing uptime.
- **Positive on** is indicated on the breaker faceplate. This unique interlocking feature prevents the levering door from being opened if the contacts are welded, protecting personnel from exposure to live primary contacts.
- **Making current release** prevents the breaker from closing in on a fault exceeding 25X peak  $\approx$  11X rms times the nominal current.
- **Keyed sensor plug** ensures error-free installation of the sensor in the field.
- **Deadfront faceplate** isolates the operator from the primary voltage when the breaker is energized.
- **Anti-pump** prevents any attempts to reclose the breaker on a short circuit fault if the close signal (mechanical or electrical) is maintained.
- **Interlocked levering door** cannot be opened until the contacts are in the open condition.
- **Three position indicators** on the faceplate for drawout mounting. Specific colors identify the breaker position.



*Breaker Position Indicator*

- **Connect.** Both main and secondary contacts are connected and the breaker is ready for normal operation.
- **Test.** Main disconnects are disengaged, secondary contacts are engaged. All functions of the breaker and trip unit can be tested in this position.
- **Disconnect.** A storage position in the compartment but the breaker is open and disconnected.

**Quality and Reliability**

Eaton performs consistent endurance and reliability tests on Magnum DS Breakers.

- **Mini-Life Tests.** A breaker is randomly selected from the production line daily, and tested for an average of 50 mechanical operations to assure performance as required.
- **Maxi-Life Tests.** MTBF testing continuously tests Magnum DS Breakers until they fail. This identifies potential performance issues with the breaker and provides statistical analysis for further improvement.

## A Common Family of Accessories for Both Frame Sizes

Eaton's Cutler-Hammer Magnum DS accessories fit all frame sizes.

Magnum DS through-the-window accessories are installed near the right front of the breaker. The unique windows in the breaker cover enable accessories to be quickly identified by name and rating.

Accessories are plug-in, providing for easy mounting and wiring to save both installation time and cost. This feature facilitates accessory changes and replacements by user personnel, eliminating the need to use factory trained personnel or outside service companies.

Modular accessories are keyed for fast error-free mounting in the field. For example, the spring release can only be mounted in the center cavity.



*The accessory cavity design, unique to ANSI power breakers, is accessible in the front of the breaker. Up to three accessories can be easily installed and wired in the field.*

## Factory Installed or Available as UL Listed Field Installable Kits

### Through-the-Window Electrical Accessories



**Accessory Windows**

- **Shunt Trip.** Provides remote controlled circuit breaker opening when energized by a voltage input.
- **Spring Release.** Remotely closes the breaker when its coil is energized by a voltage input.
- **Undervoltage Release (UVR).** Trips the breaker remotely when an existing voltage signal is lost or drops below an established threshold.

### Internal Accessories

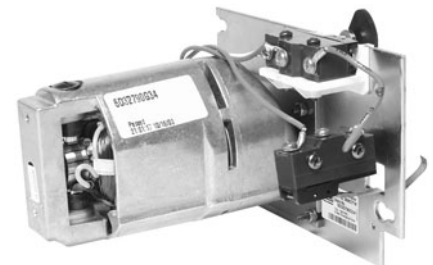
- **Auxiliary Switch.** Provides the capability to remotely indicate if the breaker is open or closed. Up to six normally open and six normally closed auxiliary contacts are available for customer use.
- **Overcurrent Trip Switch (Bell Alarm).** A set of normally open and normally closed contacts that indicate when a breaker trips.
- **Electrical Operator.** A universal type electric motor, internally mounted in the circuit breaker, that charges the closing springs automatically, facilitating remote or local closing.



*Through-the-window electrical accessories are identically sized, yet keyed for error-free mounting.*



*The auxiliary switch is an internal accessory that provides remote electrical indication if the breaker is open or closed.*



*An electric motor automatically charges the closing springs. In absence of control power, the springs can be manually charged.*



*Magnum DS modular design allows customers to mount accessories in the field.*

**Trip Units**

**Trip Units**

Eaton introduced the first microprocessor-based trip unit and has advanced the technology into a new family of UL and CSA listed Digitrip RMS Electronic and Programmable Trip Units designed and engineered exclusively for Magnum DS Breakers.

**Electronic Trip Units**

- Digitrip RMS 520 enables the user as many as nine phase and ground current protection settings for maximum flexibility in trip-curve shaping and multi-unit coordination, and adds ground current protection settings.
- Digitrip RMS 520M adds phase, neutral and ground current metering with a four-character LCD display window.
- Digitrip RMS 520MC adds communication of current values and breaker status (open, closed, tripped).

**Programmable Trip Units**

- Digitrip RMS 1150 provides programmability for more sophisticated distribution systems.
  - Increased protection and coordination capabilities.
  - Systems monitoring information including power factor, voltage, current, harmonic distortion values, and waveform capture with a three-line, (eight characters per line) LED display.

- Two programmable contacts for customer use.
- Time stamping of trip events for improved troubleshooting and diagnostics.
- Accuracy of 1% on current and voltage values and 2% on energy and power.
- Systems diagnostic information.
- PowerNet™ communications.



**Digitrip RMS 1150 Programmable Trip Unit**

This state-of-the-art trip unit with true rms sensing can be programmed at the faceplate or remotely with a PC using the PowerNet communications system. All system parameters as well as programming information can be viewed on the easy-to-read three-line digital display window.

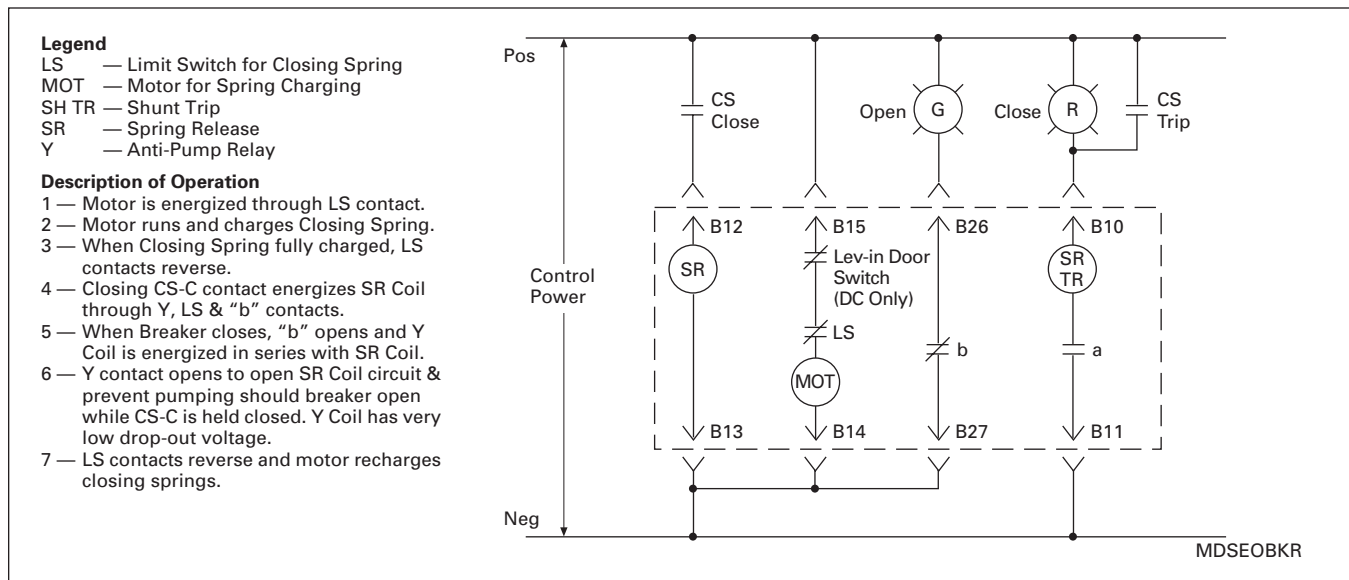
For additional information on trip units see **Section 21.5**.



**Digitrip 1150**



**Digitrip 520**



**Figure 21.1-6. Standard Control Diagram for Magnum Electrically Operated Breaker, in Magnum Switchgear, for ac or dc Control Source**



## Magnum DS Ratings

Table 21.1-1. Magnum DS UL 1066 Low Voltage Power Circuit Breakers

Frame Amperes	Breaker Type	Frame Type	rms Symmetrical Current Ratings kA 50/60 Hz ①					Available Current Sensor and Rating Plugs for Digitrip RMS Trip Unit (Establishes Breaker I <sub>n</sub> Rating)
			Interrupting at 254 Vac	Interrupting at 508 Vac	Interrupting at 635 Vac	Short Time Withstand Rating	Fixed Internal Inst. Trip	
800	MDN-408	Narrow	42	42	42	42	—	200, 250, 300, 400, 600, 630, 800
	MDN-508	Narrow	50	50	50	50	—	
	MDN-608	Narrow	65	65	65	65	—	
	MDN-C08	Narrow	100	100	65	30	14 x I <sub>n</sub>	
	MDS-408	Standard	42	42	42	42	—	
	MDS-608	Standard	65	65	65	65	—	
	MDS-808	Standard	85	85	85	85	—	
	MDS-C08	Standard	100	100	100	85	85	
	MDS-L08 ②	Standard	200	200	200	—	—	
	MDS-X08 ③	Standard	200	200	④	30	30	
1200	MDN-412	Narrow	42	42	42	42	—	200, 250, 300, 400, 600, 630, 800, 1000, 1200
	MDN-512	Narrow	50	50	50	50	—	
	MDN-612	Narrow	65	65	65	65	—	
	MDN-C12	Narrow	100	100	65	30	14 x I <sub>n</sub>	
	MDS-612	Standard	65	65	65	65	—	
	MDS-812	Standard	85	85	85	85	—	
	MDS-C12	Standard	100	100	100	85	85	
	MDS-L12 ②	Standard	200	200	200	—	—	
	MDS-X12 ③	Standard	200	200	④	30	30	
	1600	MDN-416	Narrow	42	42	42	42	
MDN-516		Narrow	50	50	50	50	—	
MDN-616		Narrow	65	65	65	65	—	
MDN-C16		Narrow	100	100	65	30	14 x I <sub>n</sub>	
MDS-616		Standard	65	65	65	65	—	
MDS-816		Standard	85	85	85	85	—	
MDS-C16		Standard	100	100	100	85	85	
MDS-L16 ②		Standard	200	200	200	—	—	
MDS-X16 ③		Standard	200	200	④	30	30	
2000		MDN-620	Narrow	65	65	65	65	—
	MDN-C20	Narrow	100	100	65	30	14 x I <sub>n</sub>	
	MDS-620	Standard	65	65	65	65	—	
	MDS-820	Standard	85	85	85	85	—	
	MDS-C20	Standard	100	100	100	85	85	
	MDS-L20 ②	Standard	200	200	200	—	—	
	MDS-X20 ③	Standard	200	200	④	30	30	
2500	MDS-625	Standard	65	65	65	65	—	200, 250, 300, 400, 600, 630, 800, 1000, 1200, 1250, 1600, 2000, 2500
	MDS-825	Standard	85	85	85	85	—	
	MDS-C25	Standard	100	100	100	85	85	
3000	MDS-630	Standard	65	65	65	65	—	200, 250, 300, 400, 600, 630, 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000
	MDS-830	Standard	85	85	85	85	—	
	MDS-C30	Standard	100	100	100	85	85	
3200	MDS-632	Standard	65	65	65	65	—	200, 250, 300, 400, 600, 630, 800, 1000, 1200, 1250, 1600, 2000, 2500, 3000, 3200
	MDS-832	Standard	85	85	85	85	—	
	MDS-C32	Standard	100	100	100	85	85	
	MDS-X32 ③	Double	200	200	④	85	50	
4000	MDS-840	Double	85	85	85	85	—	2000, 2500, 3000, 3200, 4000
	MDS-C40	Double	100	100	100	100	—	
	MDS-X40 ③	Double	200	200	④	50	50	
5000	MDS-850	Double	85	85	85	85	—	2500, 3000, 3200, 4000, 5000
	MDS-C50	Double	100	100	100	100	—	
	MDS-X50 ③⑤	Double	200	200	④	50	50	
6000	MDS-C60 ⑤	Double	100	100	100	100	—	3200, 4000, 5000, 6000

① Interrupting ratings shown based on breaker equipped with integral Digitrip RMS Trip Unit. Interruption ratings for non-automatic breakers are equal to the published Short Time Withstand Rating. These interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15-second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices. The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of 1/2 second each, with a 15-second interval of zero current between the two periods.

② Magnum DSL Current Limiting Power Circuit Breaker with Integral Current Limiters. Current Limiter selected determines short time and fixed instantaneous trip rating. Maximum voltage rating is 600 Vac.

③ Magnum DSX Current Limiting Power Circuit Breaker with Fast Opening Contacts.

④ Contact Eaton for product rating.

⑤ Breaker applied with fan cooling in tested enclosure.

Technical Data

Table 21.1-2. Digitrip RMS Adjustable Trip Settings

Time/Current Characteristics	Pickup Setting	Pickup Point (see note)	Time Band, Seconds
Long Delay	0.4, 0.5, 0.6, 0.7, 0.8 0.9, 0.95, 1.0	$I_n$ Times Long Delay Setting	2, 4, 7, 10, 12, 15, 20, 24 (at 6 times pickup value)
Instantaneous	Off, 2, 3, 4, 6, 10 $M_1$	$I_n$ Times Instantaneous Setting	—
Short Delay	2, 2.5, 3, 4, 6, 8, 10 $M_1$	$I_r$ Times Short Delay Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1 <sup>①</sup> , 0.3 <sup>①</sup> , 0.5 <sup>①</sup>
Ground Fault	0.25, 0.3, 0.35, 0.4, 0.5, 0.6, 0.75, 1.00 (1200 A Maximum)	$I_n$ Times Ground Fault Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1 <sup>①</sup> , 0.3 <sup>①</sup> , 0.5 <sup>①</sup>

<sup>①</sup>  $I^2t$  Response.

Note:  $I_n$  = Rating Plug Value,  $I_r$  = Long Delay Pickup Setting Times  $I_n$

Table 21.1-3. Magnum DS Breaker Control Device Voltages and Application Data

Breaker Control Device		24 Vdc	48 Vdc	125 Vdc	250 Vdc	120 Vac	240 Vac
Shunt Trip Circuit Voltage	70 to 110% (Required for 35 ms)	17 – 26 Vdc	34 – 53 Vdc	77 – 138 Vdc	154 – 275 Vdc	77 – 140 Vac	146 – 264 Vac
Power Consumption (Inrush)		250 Watts	250 Watts	450 Watts	450 Watts	450 VA	450 VA
Close Circuit Voltage	70 to 110% (Required for 200 ms)	17 – 26 Vdc	34 – 53 Vdc	77 – 138 Vdc	154 – 275 Vdc	77 – 140 Vac	146 – 264 Vac
Power Consumption (Inrush)		250 Watts	250 Watts	450 Watts	450 Watts	450 VA	450 VA
Spring Charge Motor Voltage	85 to 110%	20 – 26 Vdc	41 – 53 Vdc	94 – 138 Vdc	187 – 225 Vdc	93 – 140 Vdc	177 – 264 Vdc
Amps (Running)	Running	12.0 Amps	5.0 Amps	2.0 Amps	1.0 Amps	2.0 Amps	1.0 Amps
Amps (Inrush)	% of Running	300%	500%	600%	600%	600%	600%
Power Consumption		300 Watts	250 Watts	250 Watts	250 Watts	250 VA	250 VA
Charging Time		5 Sec	5 Sec	5 Sec	5 Sec	5 Sec	5 Sec

## Application Data

## Application

### Standards

Eaton's Cutler-Hammer Magnum DS circuit breakers meet or exceed all applicable requirements of ANSI Standards C37.13, C37.17, C37.50 and CSA.

### System Voltage and Frequency

Magnum DS breakers are designed for operation on ac systems only, 60 Hz or 50 Hz, 635 volts maximum.

### Continuous Current Ratings

Unlike transformers, generators and motors, circuit breakers are maximum-rated devices and have no built-in temporary overload current ratings. Consequently, it is vital that each application takes into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any Magnum DS breaker is limited to the sensor rating, or the frame size current rating, whichever is the lesser. For instance, an MDS-616 1600 ampere frame breaker with 800 ampere sensors has a maximum continuous rating of 800 amperes, but the same breaker with 1600 ampere sensors is limited to 1600 amperes maximum.

All current ratings are based on a maximum ambient air temperature of 40°C (104°F).

### Ambient Temperature

The temperature of the air surrounding the enclosure should be within the limits of:

-30°C (-22°F) to +40°C (104°F).

### Altitude

The breakers are applicable at their full voltage and current ratings up to a maximum altitude of 6,600 feet (2,012 m) above sea level. When installed at higher altitudes, the ratings are subject to the following correction factors in accordance with ANSI C37.20.1:

Table 21.1-4. Altitude Derating Factors

Altitude		Voltage Correction	Current Correction
Feet	Meters		
6,600	2,012	1.000	1.000
7,000	2,134	.989	.998
7,500	2,286	.976	.995
8,000	2,438	.963	.993
8,500	2,591	.950	.990
9,000	2,743	.933	.987
9,500	2,896	.917	.983
10,000	3,048	.900	.980
10,500	3,200	.883	.977
11,000	3,353	.867	.973
11,500	3,505	.850	.970
12,000	3,658	.833	.967
12,500	3,810	.817	.963
13,000	3,962	.800	.960

### Unusual Environmental and Operating Conditions

Special attention should be given to applications subject to the following conditions:

1. Damaging or hazardous fumes, vapors, etc.
2. Excessive or abrasive dust.

For such conditions, it is generally recommended that the switchgear be installed in a clean, dry room, with filtered and/or pressurized clean air. This method permits the use of standard indoor switchgear and avoids the derating effect of non-ventilated enclosures.

3. Salt spray, excessive moisture, dripping, etc.

Drip shields in equipment rooms and space heaters in indoor switchgear, or outdoor weatherproof enclosures, may be indicated, depending upon the severity of the conditions.

4. Excessively high or low ambient temperatures.

For ambient temperatures exceeding 40°C, and based on a standard temperature rise of 65°C, the continuous current ratings of breaker frame sizes, and also buses, current transformers, etc., will be subject to a derating factor calculated from the following formula:

$$\sqrt{\frac{105^{\circ}\text{C Total} - \text{Special Ambient, }^{\circ}\text{C}}{105^{\circ}\text{C Total} - 40^{\circ}\text{C Standard Ambient}}}$$

Circuit breakers are not adversely affected by very low outdoor ambient temperatures, particularly when energized and carrying load currents. The standard space heaters in weatherproof switchgear will raise the temperature slightly and prevent condensation.

Electrical components such as relays and instruments, however, must be applied within the manufacturer's specified limits.

5. Exposure to seismic shock.

Magnum DS assemblies and breakers have been certified for applications through UBC® Zone 4 and for the California Building Code. Assembly modifications are required, so such conditions must be specified.

6. Abnormally high frequency of operation.

In line with above, a lesser number of operations between servicing, and more frequent replacement of parts, may be indicated.

## Application

### Transformer Main Secondary Breakers

Transformer secondary breakers are required or recommended for one or more of the following purposes:

1. To provide a one-step means of removing all load from the transformer.
2. To provide transformer overload protection in the absence of an individual primary breaker, and/or when primary fuses are used.
3. To provide the fastest clearing of a short circuit in the secondary main bus.
4. To provide a local disconnecting means, in the absence of a local primary switch or breaker, for maintenance purposes.
5. For automatic or manual transfer of loads to alternate sources, as in double-ended secondary selective unit substations.
6. For simplifying key interlocking with primary interrupter switches.
7. To satisfy NEC® service entrance requirements when more than six feeder breakers are required.

Main secondary breakers must have adequate interrupting ratings, but not necessarily adequate continuous current ratings. They should be able to carry continuously not only the anticipated maximum continuous output of the transformer but also any temporary overloads.

For a fully selective system, instantaneous protection on main breakers should be defeated, as they typically cannot be coordinated with downstream devices.

Maximum capabilities of transformers of various types, can be found in **Section 14.0** It will be noted that the maximum ratings will often require the substitution of larger frame main breakers than those listed in the tables. Even if a self-cooled transformer only is considered, it should be remembered that with ratings of 750 kVA and higher, provision for the future addition of cooling fans is automatically included. It is recommended that the main breaker have sufficient capacity for the future fan-cooled rating, plus an allowance for overloads, if possible, particularly since load growth cannot always be predicted.

The same considerations should be given to the main bus capacities and main current transformer ratios.

### Bus Sectionalizing (Tie) Breakers

The minimum recommended continuous current rating of bus sectionalizing or tie breakers, as used in double-ended secondary selective unit sub-stations, or for connecting two single-ended substations, is one-half that of the associated main breakers. The interrupting rating should be at least equal to that of the feeder breakers. It is common practice to select the tie breaker of the next frame size below that of the main breakers. However, many users and engineers prefer that the tie breaker be identical to and interchangeable with the main breakers, so that under normal conditions it will be available as a spare main breaker.

In general, the tie breaker, like the main breaker, trip unit should have its instantaneous tripping defeated.

### Generator Breakers

In most applications where generators are connected through breakers to the secondary bus, they are used as emergency standby sources only, and are not synchronized or paralleled with the unit substation transformers. Under these conditions, the interrupting rating of the generator breaker will be based solely on the generator kVA and sub-transient reactance. This reactance varies with the generator type and rpm, from a minimum of approximately 9% for a 2-pole 3600 rpm turbine driven generator to 15% or 20% or more for a medium or slow speed engine type generator. Thus the feeder breakers selected for the unit substation will usually be adequate for a standby generator of the same kVA as the transformer.

Most generators have a 2-hour 25% overload rating, and the generator breaker must be adequate for this overload current. Selective type long and short delay trip protection only is usually recommended for coordination with the feeder breakers, with the long delay elements set at 125% to 150% of the maximum generator current rating for generator protection.

In the case of two or more paralleled generators, anti-motoring reverse power relays (device 32) are recommended for protection of the prime movers, particularly piston type engines. For larger generators requiring a Magnum MDS-632 or larger, voltage-restraint type overcurrent relays (device 51V) are recommended.

## Application Data

## Application

### Feeder Breakers — General

Circuit breakers for feeder circuit protection may be manually or electrically operated, with long and short delay or long delay and instantaneous type trip devices, and trip settings, as required for the specific circuit and load requirements.

General purpose feeder breakers, such as for lighting circuits, are usually equipped with long delay and instantaneous trip devices, with the long delay pickup set for the maximum load demand in the circuit. Where arcing fault protection is required, the instantaneous trip setting should be as low as practicable consistent with inrush requirements.

### Motor Starting Feeder Breakers

These breakers are usually electrically operated, with long delay and instantaneous tripping characteristics for motor running, locked rotor and fault protection. The breaker sensor rating should be chosen so that the long delay pickup can be set at 125% of motor full load current for motors with a 1.15 service factor, or at 115% for all other motors. Contactors are recommended for this application when there are a number of daily operations involved.

When system short circuits are less than 40 times the motor full load current, the motor breaker tripping characteristic should include a short delay characteristic for greater fault protection.

### Repetitive Duty

Repetitive breaker opening and closing, such as in frequent motor starting and stopping, are covered by ANSI standards C37.13 and C37.16. These standards list the number of operations between servicing (adjusting, cleaning, lubrication, tightening, etc.) and the total numbers of operations under various conditions without requiring replacement of parts, for the various breaker frame sizes.

For motor starting duty, with closing starting currents up to 600% and opening running currents up to 100% of the breaker frame size, at 80% power factor or higher, the endurance or total operations (not requiring parts replacement) will be as follows:

800 A Frame: 1400 operations  
1600 A Frame: 400 operations

The frequency of operation should not exceed 20 starts in 10 minutes or 30 in one hour.

### Group Motor Feeder Breakers

Typical loads for such circuits are motor control centers. The feeder breakers may be either manually or electrically operated as preferred, and are usually equipped with long and short delay trip protection only for coordination with the individual motor circuit devices. The minimum long delay pickup setting should be 115% of the running current of the largest motor in the group, plus the sum of the running currents of all other motors.

### Zone Selective Interlocking

By definition, a selectively coordinated system is one where by adjusting trip unit pickup and time delay settings, the circuit breaker closest to the fault trips first. The upstream breaker serves two functions: (1) back-up protection to the downstream breaker and (2) protection of the conductors between the upstream and downstream breakers. These elements are provided for on Digitrip trip units.

For faults which occur on the conductors between the upstream and downstream breakers it is ideally desirable for the upstream breaker to trip with no time delay. This is the feature provided by zone selective interlocking. Digitrip trip units include this option.

Zone selective interlocking is a communication signal between trip units applied on upstream and downstream breakers. Each trip unit must be applied as if zone selective interlocking were not employed, and set for selective coordination.

During fault conditions, each trip unit which senses the fault sends a restraining signal to all upstream trip units. This restraining signal results in causing the upstream trip to continue timing as it is set. In the absence of a restraining signal, the trip unit trips the associated breaker with no intentional time delay, minimizing damage to the fault point. This restraining signal is a very low level. To minimize the potential for induced noise, and provide a low impedance interface between trip units, twisted pair conductors are utilized for interconnection.

Ground fault and short delay pickup on Digitrip Trip Units have zone selective interlocking.

Zone selective interlocking may be applied as a type of bus differential protection. It must be recognized, however, that one must accept the minimum pickup of the trip unit for sensitivity.

It must also be recognized that not all systems may be equipped with zone selective interlocking. Systems containing multiple sources, or where the direction of power flow varies, require special considerations, or may not be suitable for this feature. Digitrip zone interlocking has been tested with up to three levels with up to 20 trip units per level.

Application Data

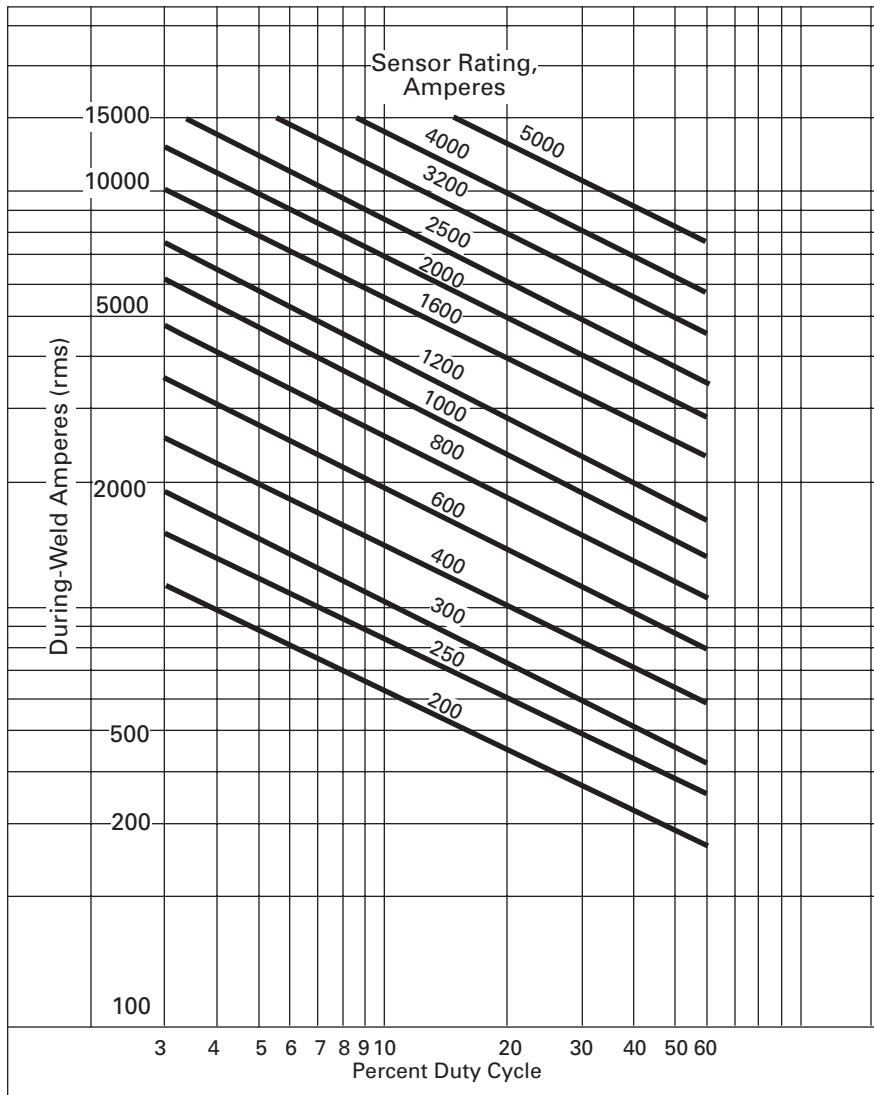


Figure 21.1-7. Magnum DS Breaker Sensor Selection Guide for Resistance Welding Applications

Resistance Welding

The application of Eaton’s Cutler-Hammer Magnum DS circuit breakers to resistance welding circuits is shown in **Figure 21.1-7** of the Sensor Selection Guide. Sensor ratings only are given; the breaker frame must be selected as required for interrupting ratings.

The Magnum DS microprocessor-based true rms sensing devices have a thermal memory and are well suited for this service. The thermal memory functions prevent exceeding the breaker and cable maximum permissible thermal energy level. The circuit also replicates time dissipation of thermal energy.

The size of the thermal memory is  $30 T (I_n / I_n)^2$  unit Amperes<sup>2</sup> seconds. It fills at a rate of  $(i_w / I_n)^2$  unit Amperes<sup>2</sup> seconds/second, trips at 30T seconds, and empties at the rate of  $(I_n / I_n)^2$  unit Amperes<sup>2</sup> seconds/second, where:

T = Long Time Delay Setting in seconds (range is 2-24 seconds)

$i_w$  = rms value of the welding current in amperes

$I_n$  = Rating plug current value in amperes

The memory is filled during the weld and empties during the non-welding period of the duty cycle.

These welding applications are based on long delay and instantaneous trip devices with the following settings. The long time delay setting is based on the weld amperes and duty cycle. Instantaneous trip setting is two times the average weld amperes (weld amperes times percent duty cycle) or higher.

**Note:** Making Current Release (MCR) may prevent closing the breaker during a welding cycle.

## General Description

## Contents

## DSII/DSLII

General Description . . . . .	21.2-1
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Type DSII Low Voltage  
Power Circuit Breakers

DSII with 910 Trip Unit

Type DSII Low Voltage Power Circuit Breakers provide:

- 100% rated, fully selective protection.
- Integral microprocessor-based breaker tripping systems.
- Two-step stored-energy breaker closing.

And many other features for coordinated, safe, convenient, trouble-free and economical control and protection of low voltage distribution systems.

## Maximum Ratings

- 600 Vac.
- 5000 amperes continuous.
- 200,000 amperes short circuit capacity.

## Type DSII Circuit Breaker Features

**Protection During Levering Operation.** When levering the breaker between the connected, test and disconnected positions, the operator is protected by a steel barrier (faceplate) from contact with live parts.

**Two-Step Stored Energy Closing Mechanism.** Spring charging (1) and spring release to close breaker (2) are independent operations, and always give positive control of the instant of closing.

**Motor Operated Stored-Energy Closing Mechanisms.** Supplied on electrically operated breakers. Standard control voltages are 48, 125 and 250 dc, and 120 and 240 ac.

**Remote Closing and Tripping.** Can be accomplished with manually operated breakers by charging the closing mechanism manually, then closing and tripping it remotely through electric spring release and shunt trip coils; available as optional attachments.

**Digitrip RMS Integral Microprocessor-Based Breaker Overcurrent Trip Systems.** Provides maximum reliability, true rms sensing as standard, excellent repeatability, and requires minimum maintenance. No external control source is required.

**Change in Trip Rating.** The overcurrent trip pickup range is established by a combination of trip unit rating plugs and the rating of the current sensors on the breaker.

**Interphase Barriers on Breakers.** Provide maximum insulation security. The barriers are easily removable for breaker inspection.

**Provision for Padlocking.** All breakers include provision for padlocking open to prevent electrical or manual closing. This padlocking also secures the breaker in the connected, test or disconnected position by preventing levering.

**Ease of Inspection and Maintenance.** Eaton's Cutler-Hammer Type DSII breakers are designed for maximum accessibility and the utmost ease of inspection and maintenance.



Two-Step Stored-Energy Closing

Two-step stored energy closing gives operator positive control of closing after spring mechanism is charged. Breaker can't close while still being charged. Operation is optional — full manual, full electric, or manual charge and electric close.

On manual breakers, the spring mechanism is manually charged by one downward stroke of the lever without pumping, and released by the mechanical "push-to-close" release button. On electrically operated breakers, the mechanism is normally charged and released electrically, but can be charged manually by pumping the charging lever 10 to 12 times and released mechanically.

An interlock discharges the closing springs as the breaker is removed from the compartment. The system is patterned after 5 kV and 15 kV Metal-Clad switchgear.

**General Description**

**Arc Chute**

There are three basic means of extinguishing an arc: lengthening the arc path; cooling by gas blast or contraction; deionizing or physically removing the conduction particles from the arc path. It was the discovery by Westinghouse of this last method which made the first large power air circuit breaker possible.

The DE-ION® principle is incorporated in all of these circuit breakers. This makes possible faster arc extinction for given contact travel; ensures positive interruption and minimum contact burning.

**Levering Mechanism**

The worm gear levering mechanism is self-contained on the breaker drawout element and engages slots in the breaker compartment. A removable crank is used to lever the breaker between the Connected-Test-Disconnected and Removed positions.

Mechanical interlocking is arranged so that levering cannot be accomplished unless the breaker is in the opened position.

**Stored-Energy Mechanism**

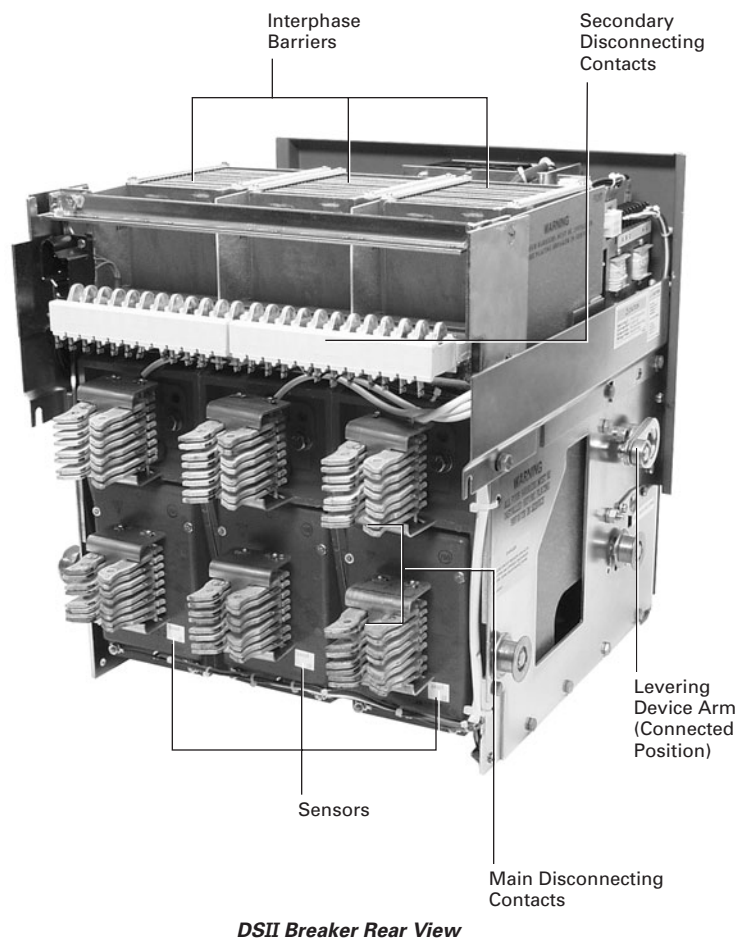
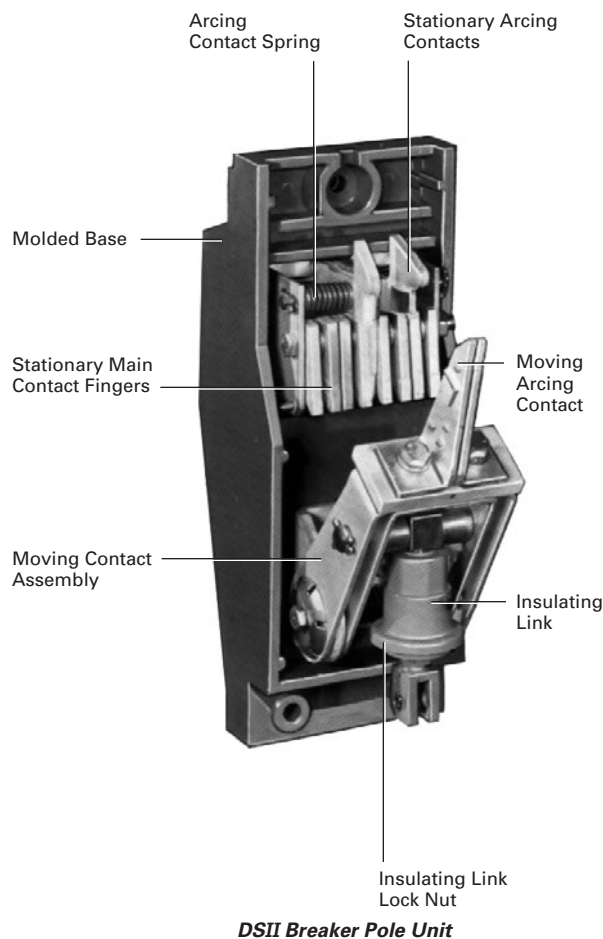
A cam-type closing mechanism closes the breaker. It receives its energy from a spring which can be charged by a manual handle on the front of the breaker or by a universal electric motor.

Release of the stored energy is accomplished by manually depressing a bar on the front of the breaker or electrically energizing a releasing solenoid.

**Contacts**

All Eaton's Cutler-Hammer air circuit breakers have solid block, silver tungsten, inlaid main contacts. This construction ensures lasting current-carrying ability, which is not seriously impaired even after repeated fault interruptions or repeated momentary overload.

The main contacts are of the butt type and are composed of a multiplicity of fingers to give many points of contact without alignment being critical.



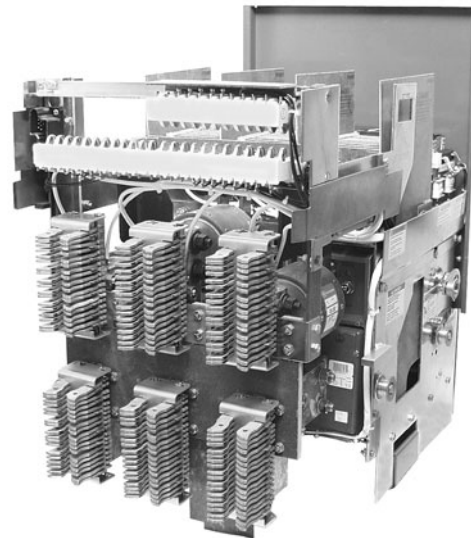


## General Description

## Type DSLII Limiter Type Air Circuit Breakers



DSLII-620 Front View



DSLII-620 Rear View

**Application**

Eaton's Cutler-Hammer Type DSLII breakers are coordinated combinations of Type DSII breakers and series connected current limiters. They are intended for applications requiring the overload protection and switching functions of air circuit breakers on systems whose available fault currents exceed the interrupting rating of the breakers alone, and/or the withstand ratings of "downstream" circuit components.

**Sizes and Arrangements**

Types DSLII-308 (800 ampere), DSLII-516 (1600 ampere), and DSLII-620 (2000 ampere) frame breakers include the limiters integrally mounted on the drawout breaker elements in series with the upper terminals.

Current limiters used in Types DSLII-632 and DSLII-840 combinations are mounted on separate drawout trucks in an additional equal size compartment.

**Scope of Fault Interruption**

With properly selected and coordinated limiters, it is expected that the breaker itself will clear overloads and faults within its interrupting rating, leaving the limiters intact and undamaged. The limiters will provide fast interruption of fault currents beyond the breaker rating, up to a maximum of 200,000 amperes symmetrical. Thus, on overloads and faults within the breaker interrupting rating, the breaker protects the limiters; on higher fault currents exceeding the breaker rating, the limiters protect the breaker.

**Protection Against Single Phasing**

Loads are protected against single phase operation by interlock arrangements which trip the circuit breaker whenever any one limiter blows. The breaker cannot be reclosed on a live source until there are three unblown limiters in the circuit.

On the Types DSLII-308, DSLII-516 and DSLII-620 breakers, the primaries of small auxiliary transformers are connected in parallel with the limiters.

The voltage between the ends of an unblown limiter is zero, but when any limiter blows, the associated transformer is energized and (1) operates an indicator identifying the blown fuse and (2) picks up a solenoid which raises the breaker trip bar, holding the breaker mechanically trip-free.

The DSLII-632 and DSLII-840 combinations with separately mounted limiters operate on the same principle except that the solenoid operates a micro-switch which trips the breaker electrically through a shunt trip coil.

**Safety Features**

The integral fuses on Types DSLII-308, DSLII-516 and DSLII-620 breakers are inaccessible until the breaker is completely withdrawn from its compartment, thereby ensuring complete isolation.

Likewise, the Types DSLII-632 and DSLII-840 fuses are inaccessible until the separate fuse truck is completely withdrawn and the fuses isolated. The fuse truck is key interlocked with the breaker to prevent withdrawal or insertion unless the breaker is locked open.

### General Description — Accessories/Trip Units

#### Optional Breaker Attachments and Accessories

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- A. Shunt trip on manually operated breakers, for any standard control voltage.
- B. Auxiliary contacts on manually or electrically operated breakers. Maximum of five normally open and five normally closed contacts are available on any breaker, manually or electrically operated. The contact rating is 10 amperes.
- C. Compartment position switch, six or 12 contacts, actuated by movement of drawout breaker between the connected and test positions. Most common uses are for disconnecting remote control circuits of electrically operated breaker, and for bypassing "b" interlocking auxiliary contacts, when breaker is withdrawn to test position.
- D. Undervoltage trip (ac and dc available). Acts to trip the breaker when the voltage on its solenoid coil is insufficient to restrain a spring-loaded core. The dropout point is within 30 to 60% of the nominal coil voltage and is not adjustable. Available as either instantaneous or time delay type. The time delay is within two to seven seconds after zero voltage occurs, and is not adjustable. The device automatically resets when the breaker opens; approximately one minute is required for resetting of the time delay type.
- E. Overcurrent trip switch (OTS). A latching type switch with two independent contacts either normally open or normally closed. Operates only when the breaker is tripped automatically on an overload or fault condition. It may be used for alarm and/or interlocking circuits. Resetting is done by a pushbutton on the breaker faceplate, or by a remote switch through an optional reset coil.

- F. Electric Lockout (optional on manual breakers). In order to close the breaker after manually charging the closing mechanism, it is necessary to operate an electrical pushbutton on the breaker faceplate. This pushbutton is wired-out to the secondary contacts so it may be wired in series with any required external interlocking. The mechanical "push-to-close" bar is made inoperative when the breaker is in the connected position.
- G. Electric close release on manually operated breakers, for any standard control voltage. Breaker can be closed by remote control switch or pushbutton after the closing spring is manually charged.
- H. Operation counter.
- I. Latch check switch.

#### Electronic Trip Units

Eaton offers the most comprehensive range of electronic trip units in the industry for power circuit breakers.

Digitrip electronic trip units are ac devices that employ microprocessor-based technology that provides a true rms current sensing means for proper correlation with thermal characteristics

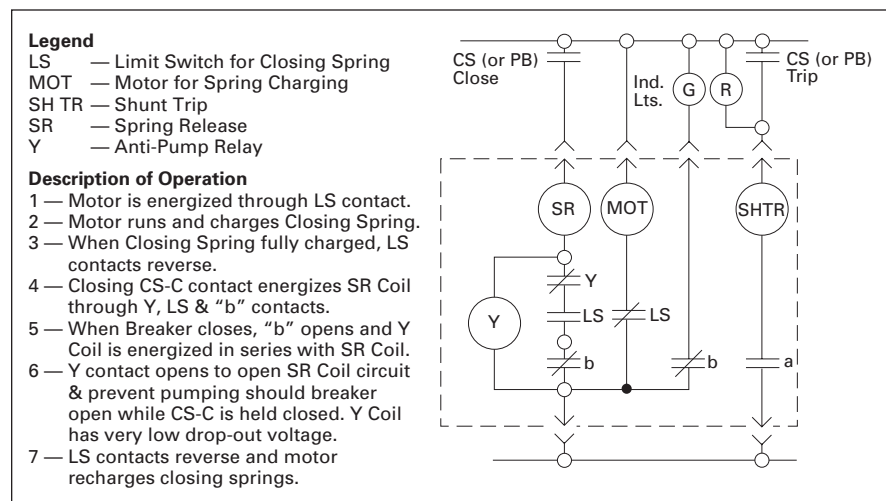
of conductors and equipment. The primary function of the Digitrip electronic trip unit is to provide circuit protection. This is achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip unit when preset current levels and time delay settings are exceeded. By sampling the current waveform at various points on the wave and calculating true rms current, the Digitrip is able to reduce nuisance tripping events due to non-sinusoidal wave shapes.

Electronic trip units are applied to distribution systems when high standards of protection and coordination are called for. In addition, electronic trip units can provide further enhanced features such as alarming, diagnostics, system monitoring and communications.

Cutler-Hammer rms sensing trip units for power breakers fall into two main categories:

- Front adjustable trip units:  
Digitrip RMS 510, 610, 810, 910.
- Programmable trip units:  
Digitrip OPTIM 750, 1050.

For additional information on trip units see **Section 21.4**.



**Figure 21.2-1. Standard Control Diagram for Type DSII Electrically Operated Breaker, in DSII Switchgear, for ac or dc Control Source**

**DSII Ratings**

**Table 21.2-1. Interrupting Ratings of Type DSII Breakers**

Breaker Type	Frame Size, Amperes	Ratings, rms Symmetrical Amperes					
		Interrupting Rating			Short Time Rating <sup>①</sup>		
		208-240 V	480 V	600 V	208-240 V	480 V	600 V
DSII-308	800	42,000	30,000	30,000	30,000	30,000	30,000
DSII-508	800	65,000	50,000	42,000	50,000	50,000	42,000
DSII-608	800	65,000	65,000	50,000	65,000	65,000	50,000
DSII-516	1600	65,000	50,000	42,000	50,000	50,000	42,000
DSII-616	1600	65,000	65,000	50,000	65,000	65,000	50,000
DSII-620	2000	65,000	65,000	50,000	65,000	65,000	50,000
DSII-632	3200	85,000	65,000	65,000	65,000	65,000	65,000
DSII-840	4000	130,000	85,000	85,000	85,000	85,000	85,000
DSII-850	5000	130,000	85,000	85,000	85,000	85,000	85,000

<sup>①</sup> Short circuit ratings of non-automatic breakers except the DSII-840 and DSII-850 which are 65,000.

**Table 21.2-2. Digitrip RMS Adjustable Trip Settings**

Time/Current Characteristic	Pickup Setting	Pickup Point (see note)	Time Band, Seconds
Long Delay	0.5, 0.6, 0.7, 0.8, 0.85, 0.9, 0.95, 1.0	$I_n$ Times Long Delay Setting	2, 4, 7, 10, 12, 15, 20, 24 (at 6 times pickup value)
Instantaneous	2, 2.5, 3, 4, 5, 6 $M_1=8, M_2=12$	$I_n$ Times Instantaneous Setting	—
Short Delay	2, 2.5, 3, 4, 5, 6 $S_1=8, S_2=10$	$I_r$ Times Short Delay Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1 <sup>②</sup> , 0.3 <sup>②</sup> , 6.5 <sup>②</sup>
Ground Fault	A (.25), B (.3), C (.35), D (.4), E (.5), F (.6), H (.75), K (1.0) (1200A Maximum)	$I_n$ Times Ground Fault Setting	0.1, 0.2, 0.3, 0.4, 0.5 (Flat Response) 0.1 <sup>②</sup> , 0.3 <sup>②</sup> , 0.5

<sup>②</sup>  $I^2t$  Response.

**Note:**  $I_n$  = Rating Plug Value  
 $I_r$  = Long Delay Pickup Setting x  $I_n$ .

**Table 21.2-3. Interrupting Ratings of Type DSLII Breakers**

Type	DSLII-308	DSLII-516	DSLII-620	DSLII-632	DSLII-840
Frame Size, Amperes	800	1600	2000	3200	4000
Maximum Interrupting Rating, rms Symmetrical Amperes, System Voltage 600 or Below	200,000	200,000	200,000	200,000	200,000

**Table 21.2-4. Control Voltages and Currents**

Control Voltage	48 dc	125 dc	250 dc	120 ac	240 ac
Close current (SR), ampere	5.0	2.0	1.0	3.0	2.0
Shunt trip current, ampere	5.0	2.0	1.0	2.0	1.0
Spring charge motor ampere	7.5	3.0	1.5	3.0	1.5
Control voltage range:					
Close —	38 – 56	100 – 140	200 – 280	104 – 127	208 – 254
Trip —	28 – 56	70 – 140	140 – 280	60 – 127	208 – 254

**Note:** Motor currents are running currents; inrush is approximately 400%. Motor running time to charge spring approximately 5 seconds.

**Table 21.2-5. Estimated Heat Loss Per Breaker**

Breaker Type	Watts
DSII-308 (DSLII-308)	400 (600)
DSII-516 (DSLII-516)	1000 (1500)
DSII-620 (DSLII-620)	1500 (2250)
DSII-632	2400
DSII-840	3000
DSII-850	4700
DSII-FT32	3600
DSII-FT40	4500

Maximum voltages at which the interrupting ratings in **Table 21.2-1** apply are:

**Table 21.2-6. Maximum Voltage Rating**

System Voltage	Maximum Voltage
208 or 240	254
480	508
600	635

These interrupting ratings are based on the standard duty cycle consisting of an opening operation, a 15-second interval and a close-open operation, in succession, with delayed tripping in case of short-delay devices.

The standard duty cycle for short-time ratings consists of maintaining the rated current for two periods of 1/2 second each, with a 15-second interval of zero current between the two periods.

**Table 21.2-7. Available Sensor Ratings for Digitrip RMS**

Breaker Type	Frame Size, Amperes	Sensor Ratings, Amperes
DSII-308, DSLII-308, DSII-508 or DSII-608	800	200, 300, 400, 600, 800
DSII-516, DSLII-516 or DSII-616	1600	200, 300, 400, 600, 800, 1200, 1600
DSII-620	2000	200, 300, 400, 600, 800, 1200, 1600, 2000
DSLII-620	2000	2000
DSII-632, DSLII-632	3200	2400, 3200
DSII-840, DSLII-840	4000	3200, 4000
DSII-850	5000	5000

**Table 21.2-8. Available Digitrip RMS Rating Plugs Marked 50/60 Hertz**

Sensor Ratings, Amperes	Plug Rating in Amperes ( $I_n$ )
200	100, 200
300	200, 250, 300
400	200, 250, 300, 400
600	300, 400, 600
800	400, 600, 800
1200	600, 800, 1000, 1200
1600	800, 1000, 1200, 1600
2000	1000, 1200, 1600, 2000 <sup>③</sup>
2400	1600, 2000, 2400
3200	1600, 2000, 2400, 3000, 3200
4000	2000, 2400, 3200, 4000
5000	3200, 4000, 5000

<sup>③</sup> 2000 ampere is the only plug available for DSLII-620.

**Note:** The rating plug is for 50 and 60 Hz applications. Rating plugs are not interchangeable with 60 Hz or 50 Hz only rating plugs.

Technical Data

The following curves illustrate the ratings, melting time-current characteristics and current limiting, or let-through characteristics, of limiters for Eaton's Cutler-Hammer Type DSLII breakers.

The let-through current for a given limiter application is readily determined by extending a vertical line from the applicable maximum available symmetrical fault amperes at the bottom margin to the characteristic line for the particular limiter, and from this intersection extending a horizontal line to the left margin and reading the peak current. The withstand rating of any circuit elements protected by the limiters should be at least equal to this peak current.

It will be noted that the let-through current increases with the limiter size or ampere rating; in other words, the maximum current limiting effect is obtained with the smallest size. This effect is to be expected, since the resistance decreases as the rating increases. If the vertical line from the bottom margin as described in the previous paragraph does not intersect the limiter characteristic line, it is indicated that the available system fault current is below the "threshold" current of that limiter, and it will offer no current limiting effect.

The current limiting principle is illustrated below:

- $I_a$  = The Available Peak Fault Current
- $t_m$  = The Melting Time
- $I_p$  = The Peak Let-Through Current
- $t_a$  = The Arcing Time
- $t_c$  = The Total Interrupting (Clearing) Time

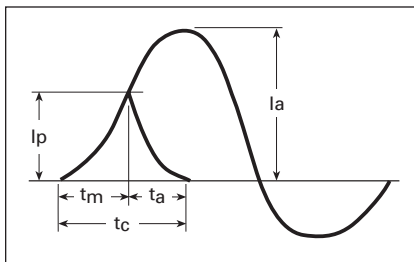


Figure 21.2-2. Current Limiting

Table 21.2-9. DSLII-632 and DSLII-840 Available Limiters

Breaker Type	Available Limiters, Amperes
DSLII-632	2500, 3000, 4000
DSLII-840	2500, 3000, 4000, 5000

Limiter Selection

The selection of a suitable limiter rating for a given application is generally governed by a choice of the following types of protection:

- A. Maximum protection of "downstream" components. Type DSLII breakers are often used for this purpose even when the maximum available fault currents are within the interrupting rating of the corresponding Type DSII unfused breakers.
- B. Protection of the circuit breaker only.

Case A would tend to use the smallest available limiter; Case B the largest. When downstream protection is required, the selection is usually a compromise, since certain small limiters cannot be coordinated with the breaker to avoid nuisance blowing on overloads or small and moderate short circuits.

Minimum, recommended, and maximum limiter sizes for Eaton's Cutler-Hammer Types DSLII-308, DSLII-516, and DSLII-620 breakers are given in table.

Table 21.2-10. DSLII Limiter Selection

Breaker Type	Sensor Rating, Amperes	Limiter Rating, Amperes		
		Minimum ①	Recommended ②	Maximum ③
DSLII-308	200	250	1200	2000
DSLII-308	300	400	1200	2000
DSLII-308	400	600	1200	2000
DSLII-308	600	800	1200	2000
DSLII-308	800	1200	1600	2000
DSLII-516	600	800	2000	3000
DSLII-516	800	1000	2000	3000
DSLII-516	1200	2000	2500	3000
DSLII-516	1600	—	3000	—
DSLII-620	2000	—	3000	—

- ① For use only when protection of downstream equipment is required. Not completely coordinated with breaker to avoid nuisance blowing.
- ② Lowest rating which can be coordinated with breaker to minimize nuisance blowing.
- ③ Highest available ratings, for protection of breaker only.

Table 21.2-11. Sensor, Plug and Limiter Selection

DSII Breakers	Sensor Rating, Amperes	Plug Rating, Amperes	Limiter Rating, Amperes (Applicable only to DSLII Breakers)
308, 508, 608	200	100, 200	250, 300, 400, 600, 800, 1200, 1600, 2000
	300	200, 250, 300	400, 600, 800, 1200, 1600, 2000
	400	200, 250, 300, 400	600, 800, 1200, 1600, 2000
	600	300, 400, 600	800, 1200, 1600, 2000
	800	400, 600, 800	1200, 1600, 2000
516, 616	200	100, 200	800, 1000, 1200, 1600, 2000, 2500, 3000
	300	200, 250, 300	800, 1000, 1200, 1600, 2000, 2500, 3000
	400	200, 250, 300, 400	800, 1000, 1200, 1600, 2000, 2500, 3000
	600	300, 400, 600	800, 1000, 1200, 1600, 2000, 2500, 3000
	800	400, 600, 800	1000, 1200, 1600, 2000, 2500, 3000
	1200	600, 800, 1000, 1200	2000, 2500, 3000
	1600	800, 1000, 1200, 1600	3000
620	200	100, 200	Not Applicable
	300	200, 250, 300	Not Applicable
	400	200, 250, 300, 400	Not Applicable
	600	300, 400, 600	Not Applicable
	800	400, 600, 800	Not Applicable
	1200	600, 800, 1000, 1200	Not Applicable
	1600	800, 1000, 1200, 1600	Not Applicable
	2000	1000, 1200, 1600, 2000 ④	3000 ⑤
	632	2400	1600, 2000, 2400
3200	1600, 2000, 2400, 3000, 3200	2500, 3000, 4000	
840	3200	1600, 2000, 2400, 3200	2500, 3000, 4000, 5000
	4000	2000, 2400, 3200, 4000	2500, 3000, 4000, 5000
850	5000	3200, 4000, 5000	Not Applicable

- ④ 2000 ampere is the only plug available for DSLII-620.
- ⑤ 3000 ampere is the only limiter available for DSLII-620.

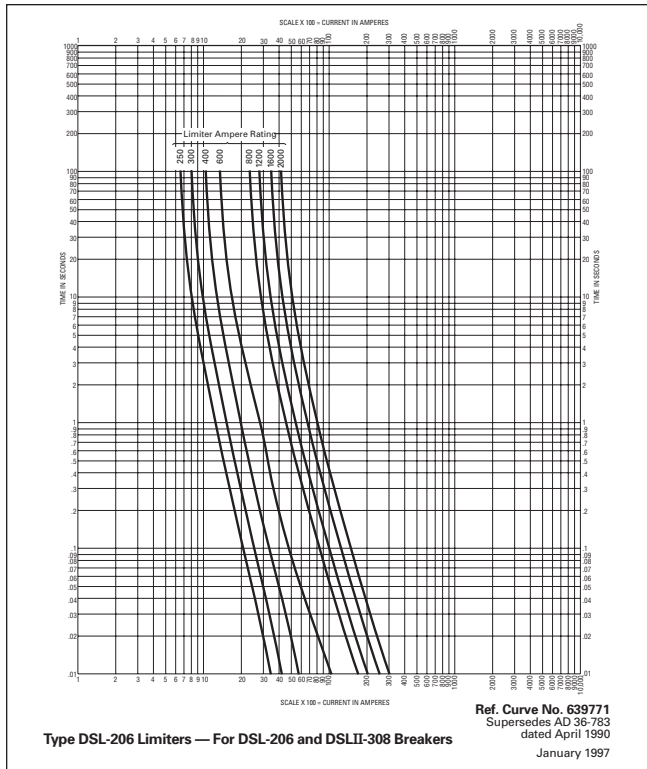


Figure 21.2-3. DSLII-308 Average Melting Time-Current Characteristics

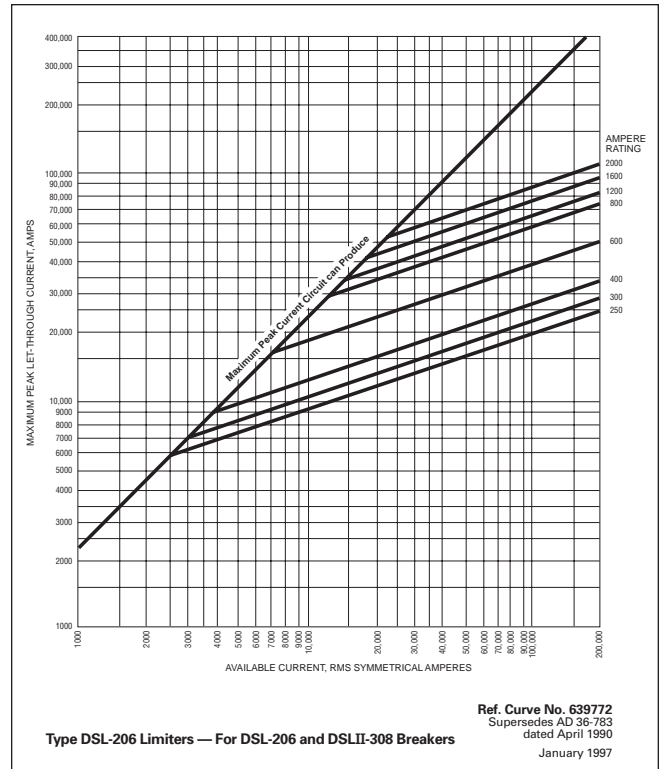


Figure 21.2-5. DSLII-308 Let-Through Characteristics

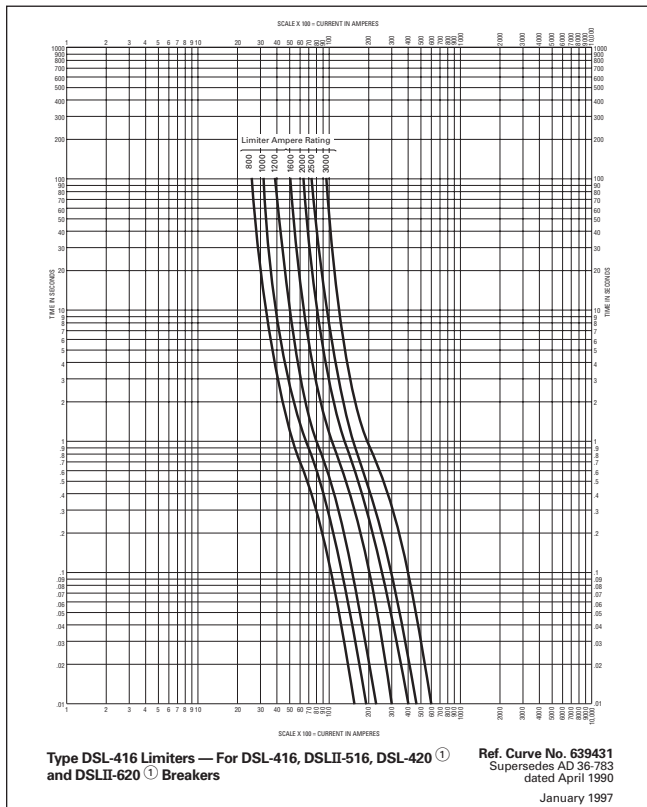


Figure 21.2-4. DSLII-516 and DSLII-620 Average Melting Time-Current Characteristics

① DSL-420 and DSLII-620 — use only 3000 limiter.

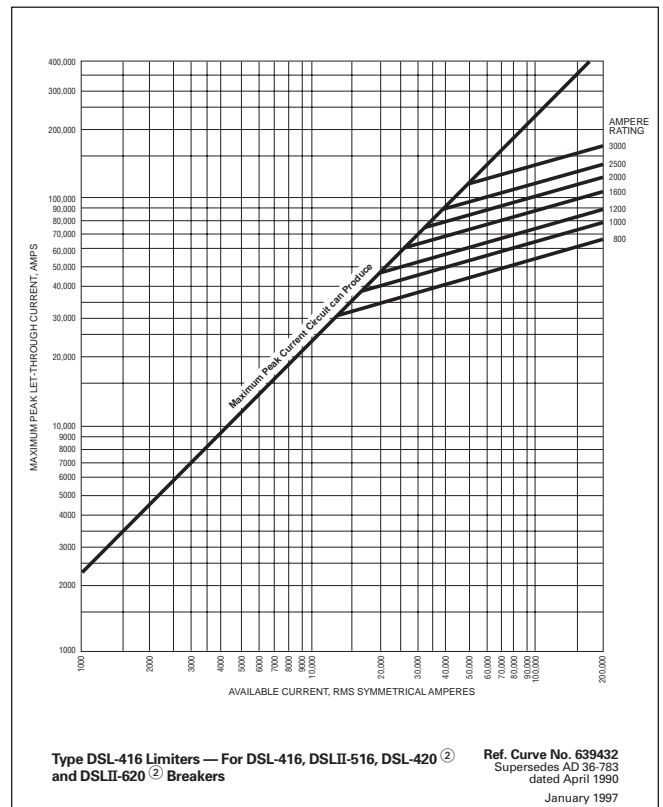


Figure 21.2-6. DSLII-516 and DSLII-620 Let-Through Characteristics

② DSL-420 and DSLII-620 — use only 3000 limiter.

Technical Data

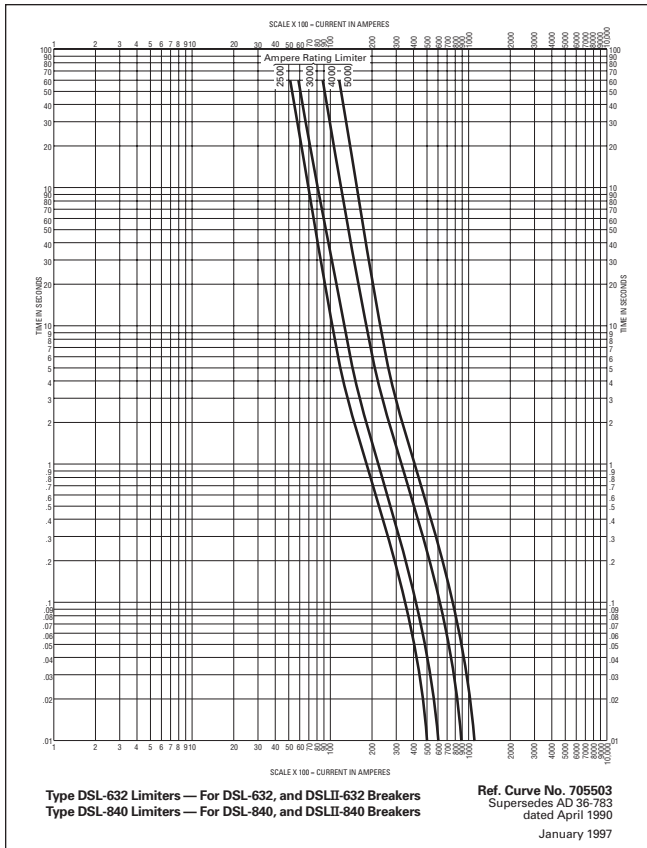


Figure 21.2-7. DSLII-632 and DSLII-840 Average Melting Time-Current Characteristics

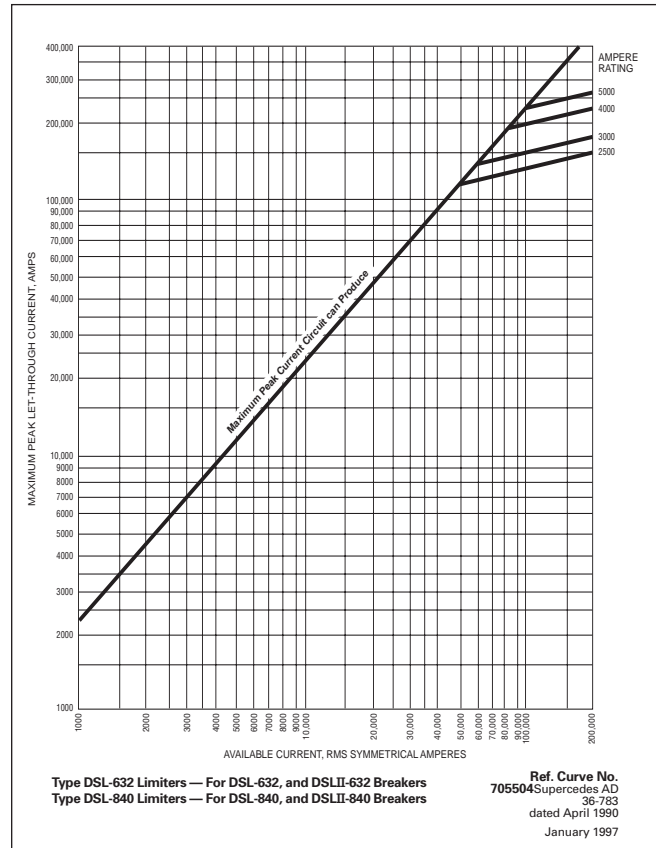


Figure 21.2-8. DSLII-632 and DSLII-840 Let-Through Characteristics

## Application Data

**Application****Standards**

Eaton's Cutler-Hammer DSII circuit breakers meet or exceed all applicable requirements of ANSI Standards C37.13, C37.17, C37.50 and CSA.

**System Voltage and Frequency**

DSII breakers are designed for operation on ac systems only, 60 Hz or 50 Hz, 635 volts maximum.

**Continuous Current Ratings**

Unlike transformers, generators and motors, circuit breakers are maximum-rated devices and have no built-in temporary overload current ratings. Consequently, it is vital that each application takes into consideration the maximum anticipated current demand, initial and future, including temporary overloads.

The continuous rating of any DSII breaker is limited to the sensor rating, or the frame size current rating, whichever is the lesser. For instance, a DS-616 1600 ampere frame breaker with 800 ampere sensors has a maximum continuous rating of 800 amperes, but the same breaker with 1600 ampere sensors is limited to 1600 amperes maximum.

All current ratings are based on a maximum ambient air temperature of 40°C (104°F).

**Ambient Temperature**

The temperature of the air surrounding the enclosure should be within the limits of:

-30°C (-22°F) to +40°C (104°F).

**Altitude**

The breakers are applicable at their full voltage and current ratings up to a maximum altitude of 6,600 feet (2,012 m) above sea level. When installed at higher altitudes, the ratings are subject to the following correction factors in accordance with ANSI C37.20.1:

**Table 21.2-12. Altitude Derating Factors**

Altitude		Voltage Correction	Current Correction
Feet	Meters		
6,600	2,012	1.000	1.000
7,000	2,134	.989	.998
7,500	2,286	.976	.995
8,000	2,438	.963	.993
8,500	2,591	.950	.990
9,000	2,743	.933	.987
9,500	2,896	.917	.983
10,000	3,048	.900	.980
10,500	3,200	.883	.977
11,000	3,353	.867	.973
11,500	3,505	.850	.970
12,000	3,658	.833	.967
12,500	3,810	.817	.963
13,000	3,962	.800	.960

**Unusual Environmental and Operating Conditions**

Special attention should be given to applications subject to the following conditions:

1. Damaging or hazardous fumes, vapors, etc.
2. Excessive or abrasive dust.

For such conditions, it is generally recommended that the switchgear be installed in a clean, dry room, with filtered and/or pressurized clean air. This method permits the use of standard indoor switchgear and avoids the derating effect of non-ventilated enclosures.

3. Salt spray, excessive moisture, dripping, etc.

Drip shields in equipment rooms and space heaters in indoor switchgear, or outdoor weatherproof enclosures, may be indicated, depending upon the severity of the conditions.

4. Excessively high or low ambient temperatures.

For ambient temperatures exceeding 40°C, and based on a standard temperature rise of 65°C, the continuous current ratings of breaker frame sizes, and also buses, current transformers, etc., will be subject to a derating factor calculated from the following formula:

$$\sqrt{\frac{105^{\circ}\text{C Total} - \text{Special Ambient, }^{\circ}\text{C}}{105^{\circ}\text{C Total} - 40^{\circ}\text{C Standard Ambient}}}$$

Circuit breakers are not adversely affected by very low outdoor ambient temperatures, particularly when energized and carrying load currents. The standard space heaters in weatherproof switchgear will raise the temperature slightly and prevent condensation.

Electrical components such as relays and instruments, however, must be applied within the manufacturer's specified limits.

5. Exposure to seismic shock.

DSII assemblies and breakers have been certified for applications through UBC Zone 4 and for the California Building Code. Assembly modifications are required, so such conditions must be specified.

6. Abnormally high frequency of operation.

In line with above, a lesser number of operations between servicing, and more frequent replacement of parts, may be indicated.

## Application

### Feeder Breakers — General

Circuit breakers for feeder circuit protection may be manually or electrically operated, with long and short delay or long delay and instantaneous type trip devices, and trip settings, as required for the specific circuit and load requirements.

General purpose feeder breakers, such as for lighting circuits, are usually equipped with long delay and instantaneous trip devices, with the long delay pickup set for the maximum load demand in the circuit. Where arcing fault protection is required, the instantaneous trip setting should be as low as practicable consistent with inrush requirements.

### Motor Starting Feeder Breakers

These breakers are usually electrically operated, with long delay and instantaneous tripping characteristics for motor running, locked rotor and fault protection. The breaker sensor rating should be chosen so that the long delay pickup can be set at 125% of motor full load current for motors with a 1.15 service factor, or at 115% for all other motors. Contactors are recommended for this application when there are a number of daily operations involved.

When system short circuits are less than 40 times the motor full load current, the motor breaker tripping characteristic should include a short delay characteristic for greater fault protection.

### Repetitive Duty

Repetitive breaker opening and closing, such as in frequent motor starting and stopping, are covered by ANSI standards C37.13 and C37.16. These standards list the number of operations between servicing (adjusting, cleaning, lubrication, tightening, etc.) and the total numbers of operations under various conditions without requiring replacement of parts, for the various breaker frame sizes.

For motor starting duty, with closing starting currents up to 600% and opening running currents up to 100% of the breaker frame size, at 80% power factor or higher, the endurance or total operations (not requiring parts replacement) will be as follows:

800 A Frame: 1400 operations  
 1600 A Frame: 400 operations

The frequency of operation should not exceed 20 starts in 10 minutes or 30 in one hour.

### Group Motor Feeder Breakers

Typical loads for such circuits are motor control centers. The feeder breakers may be either manually or electrically operated as preferred, and are usually equipped with long and short delay trip protection only for coordination with the individual motor circuit devices. The minimum long delay pickup setting should be 115% of the running current of the largest motor in the group, plus the sum of the running currents of all other motors.

### Zone Selective Interlocking

By definition, a selectively coordinated system is one where by adjusting trip unit pickup and time delay settings, the circuit breaker closest to the fault trips first. The upstream breaker serves two functions: (1) back-up protection to the downstream breaker and (2) protection of the conductors between the upstream and downstream breakers. These elements are provided for on Digitrip trip units.

For faults which occur on the conductors between the upstream and downstream breakers it is ideally desirable for the upstream breaker to trip with no time delay. This is the feature provided by zone selective interlocking. Digitrip trip units may be specified to utilize this option.

Zone selective interlocking is a communication signal between trip units applied on upstream and downstream breakers. Each trip unit must be applied as if zone selective interlocking were not employed, and set for selective coordination.

During fault conditions, each trip unit which senses the fault sends a restraining signal to all upstream trip units. This restraining signal results in causing the upstream trip to continue timing as it is set. In the absence of a restraining signal, the trip unit trips the associated breaker with no intentional time delay, minimizing damage to the fault point. This restraining signal is a very low level. To minimize the potential for induced noise, and provide a low impedance interface between trip units, a special secondary connector is added to the Eaton's Cutler-Hammer Magnum DS breaker, and twisted pair conductors are utilized for interconnection. For this reason, zone selective interlocking must be specified.

Ground fault and short delay pickup on Digitrip Trip Units may be specified with zone selective interlocking. Since most system faults start as arcing ground faults, zone selective interlocking on ground fault pickup only is usually adequate. Zone selective interlocking on short delay pickup may be utilized where no ground fault protection is provided.

Zone selective interlocking may be applied as a type of bus differential protection. It must be recognized, however, that one must accept the minimum pickup of the trip unit for sensitivity.

It must also be recognized that not all systems may be equipped with zone selective interlocking. Systems containing multiple sources, or where the direction of power flow varies, require special considerations, or may not be suitable for this feature. Digitrip zone interlocking has been tested with up to three levels with up to 20 trip units per level.



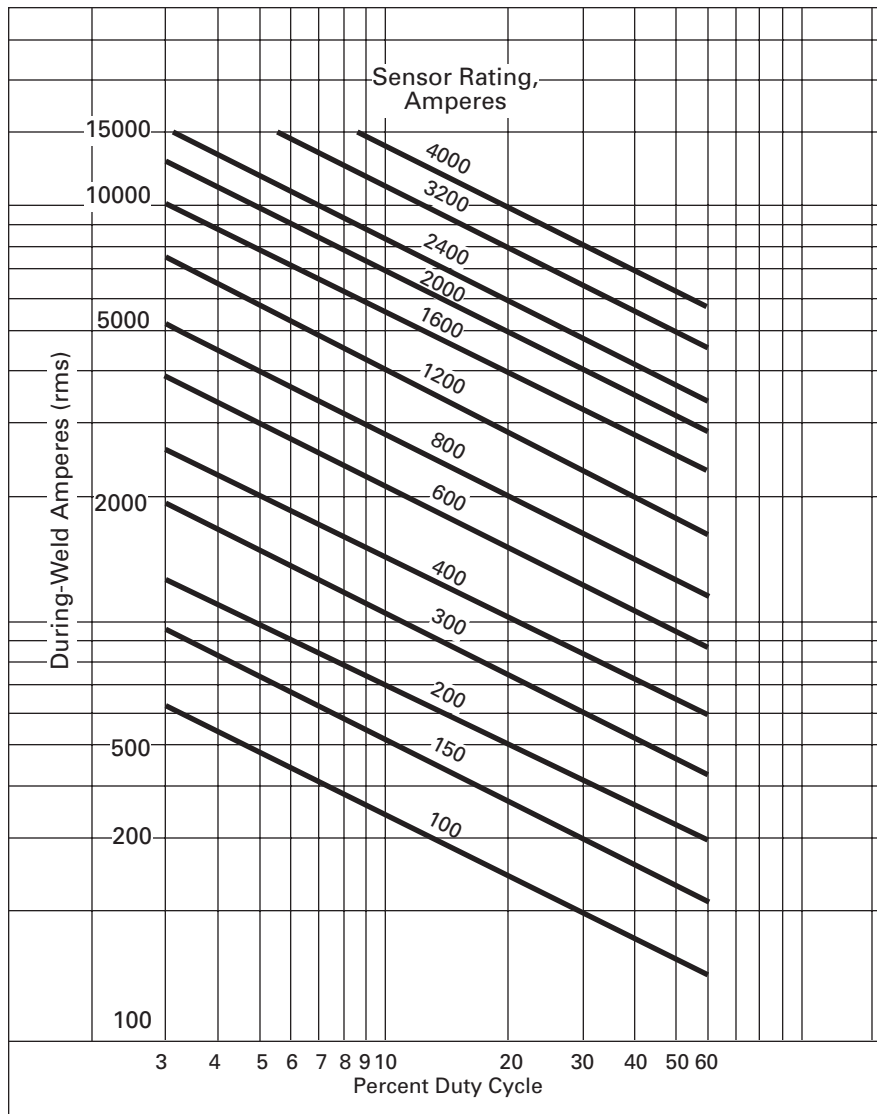


Figure 21.2-9. Type DSII Breaker Sensor Selection Guide for Resistance Welding Applications

### Resistance Welding

The application of Eaton’s Cutler-Hammer DSII circuit breakers to resistance welding circuits is shown in **Figure 21.2-9** of the Sensor Selection Guide. Sensor ratings only are given; the breaker frame must be selected as required for interrupting ratings.

The DSII Digitrip microprocessor-based true rms sensing devices have a thermal memory and are well suited for this service. The thermal memory functions to prevent exceeding the breaker and cable maximum permissible thermal energy level. The circuit also replicates time dissipation of thermal energy.

The size of the thermal memory is  $30 T (I_n / I_n)^2$  unit Amperes<sup>2</sup> seconds. It fills at a rate of  $(i_w / I_n)^2$  unit Amperes<sup>2</sup> seconds/second, trips at 30T seconds, and empties at the rate of  $(I_n / I_n)^2$  unit Amperes<sup>2</sup> seconds/second, where

T = Long Time Delay Setting in seconds (range is 2 – 24 seconds)

$i_w$  = rms value of the welding current in amperes

$I_n$  = Rating plug current value in amperes

The memory is filled during the weld and empties during the non-welding period of the duty cycle.

These welding applications are based on long delay and instantaneous trip devices with the following settings. The long time delay setting is based on the weld amperes and duty cycle. Instantaneous trip setting is two times the average weld amperes (weld amperes times percent duty cycle) or higher.

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## Molded Case Circuit Breakers



Molded Case Circuit Breakers

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## General Description

**General Circuit Breaker Information**

Eaton's Cutler-Hammer molded case circuit breakers are designed to provide circuit protection for low voltage distribution systems. They are described by NEMA as, "... a device for closing and interrupting a circuit between separable contacts under both normal and abnormal conditions," and furthermore as, "... a breaker assembled as an integral unit in a supporting and enclosing housing of insulating material." The NEC describes them as, "A device designed to open and close a circuit by non-automatic means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating."

So designed, Cutler-Hammer circuit breakers protect conductors against overloads and conductors and connected apparatus, such as motors and motor starters, against short circuits.

**Circuit Breaker Components and Functions**

Being essentially a high interrupting capacity switch with repetitive elements, Cutler-Hammer circuit breakers are comprised of three main functional components. These are: trip elements, operating mechanism and arc extinguishers.

**Trip Elements**

The function of the trip element is to trip the operating mechanism in the event of a prolonged overload or short circuit current. To accomplish this, a thermal-magnetic trip action is provided.

**Thermal-Magnetic Breakers**

Thermal trip action is achieved through the use of a bimetal heated by the load current. On a sustained overload, the bimetal will deflect, causing the operating mechanism to trip. Because bimetals are responsive to the heat emitted by the current flow, they allow a long time delay on light overloads, yet they have a fast response on heavier overloads.

Magnetic trip action is achieved through the use of an electromagnet in series with the load current. This provides an instantaneous tripping action when the current reaches a predetermined value. Front adjustable magnetic trip elements are supplied as standard on 250 ampere frame circuit breakers and above (except 100 and 150 ampere magnetic only breakers), all other thermal-magnetic breakers have non-adjustable magnetic trip elements.

**Electronic rms Trip Breakers**

Both the overload trip action and the short circuit trip action of breakers with Digitrip electronic trip units are achieved by the use of current transformers and solid-state circuitry that monitors the current and initiates tripping through a flux shunt trip when an overload or short circuit is present. All multiple pole circuit breakers have trip elements in each pole and a common trip bar. An abnormal circuit condition in any one pole will cause all poles to open simultaneously.

Electronic rms trip breakers can include trip features such as:

- Adjustable long-time pickup.
- Adjustable short-time pickup.
- Adjustable long delay time.
- Adjustable short delay time.
- Adjustable instantaneous pickup.
- Adjustable ground fault pickup.
- Adjustable ground fault delay time.
- Zone selective interlocking.
- Communications.

Trip unit adjustments are made by setting switches on the front of the trip unit or by programming the trip unit electronically.

All electronic rms trip breakers are equipped with a manual push-to-trip mechanism.

**Operating Mechanism**

The function of the operating mechanism is to provide a means of opening and closing the breaker contacts. All mechanisms are of the quick-make, quick-break type and are "trip free." "Trip free" mechanisms are designed so that the contacts cannot be held closed against an abnormal circuit condition and are sometimes referred to as an "overcenter toggle mechanism." In addition to indicating whether the breaker is "on" or "off," the operating mechanism handle indicates when the breaker is "tripped" by moving to a position midway between the extremes. This distinct trip point is particularly advantageous where breakers are grouped, as in panelboard applications, because it clearly indicates the faulty circuit. The operating mechanism contains a positive on feature. In the normal switching operation, the handle of the circuit breaker shall not be capable of being left readily at or near the off position when the main contacts are closed.

**Arc Extinguishers**

The function of the DE-ION arc extinguisher is to confine, divide and extinguish the arc drawn between opening breaker contacts. It consists of specially shaped steel grids isolated from each other and supported by an insulating housing. When the contacts are opened, the arc drawn induces a magnetic field in the grids, which in turn draws the arc from the contacts and into the grids. The arc is thus split into a series of smaller arcs and the heat generated is quickly dissipated through the metal. These two actions result in a rapid removal of ions from the arc, which hastens dielectric build-up between the contacts and results in rapid extinction of the arc.

## General Description

**Cutler-Hammer Family Molded Case Circuit Breakers**

In low voltage distribution systems, there are many varied applications of molded case circuit breakers. Eaton offers the most comprehensive family of molded case circuit breakers in the industry.

This family of circuit breakers includes:

- Thermal-magnetic trip breakers.
- Electronic rms trip breakers.
- Molded case switches.
- Motor circuit protectors.
- Earth leakage breakers.
- Current limiting breakers.
- Special application breakers.
- World breakers.

**Interrupting Ratings**

Molded case circuit breakers are available in various interrupting capacities. Standard interrupting capacity breakers are available in both industrial and replacement circuit breaker lines. These breakers have interrupting capacities up to 35 kA at 480 Vac.

High interrupting capacity breakers are similar to standard interrupting capacity breakers, but the improved performance makes these breakers suited for use in today's network systems where higher fault currents exist. These breakers have interrupting capacities up to 65 kA at 480 Vac.

For applications that call for very high interrupting ratings, current limiting high interrupting capacity breakers are available. These breakers offer true current limiting characteristics in the same physical frame size as the high interrupting capacity version and have interrupting capacities of 100 kA at 480 Vac.

**Thermal-Magnetic Trip Breaker**

Cutler-Hammer thermal-magnetic breakers are general purpose devices suitable for the majority of breaker applications and are considered the industry standard. Available from 15 through 800 amperes, thermal-magnetic breakers provide accurate reliable overload and short circuit protection for conductors and connected apparatus.

**Electronic Trip Breakers**

Cutler-Hammer electronic trip breakers are generally applied for applications where high levels of system coordination are called for. Available from 70 through 2500 amperes, today's electronic trip breakers can provide superior protection and coordination as well as system alarms and diagnostics, monitoring and communications.

**Molded Case Switches**

Cutler-Hammer molded case switches are UL 1087 devices that have no thermal protection but do have a self protecting high magnetic trip setting. Molded case switches are applied when a compact high capacity disconnect device is called for. Accessories that can be installed in molded case circuit breakers are also available for molded case switches. The most common application for a molded case switch would be as a main disconnect for a panelboard or a loadcenter. Available from 100 through 2500 amperes, molded case switches provide a compact disconnect device along with the added benefits of a molded case circuit breaker without the thermal protection.

**Motor Circuit Protectors**

Application flexibility of Cutler-Hammer motor circuit protectors (Type GMCP/HMCP/HMCPE) is enhanced by the higher interrupting ratings and current limiting characteristics designed into the line. These devices are available from 3 – 600 amperes in 63, 100, 150, 250, 400 and 600 A frame sizes.

The motor circuit protectors are designed for application in individual motor circuits in combination motor starter units. Motor circuit protectors operate on the magnetic principle with a current sensing element in each pole to provide short circuit protection.

The motor circuit protector design permits the most effective protection possible against low-level faults while offering circuit breaker convenience, quick-make quick-break action, deadfront safety, and prevention of single phasing.

**Earth Leakage Circuit Breakers**

Cutler-Hammer Earth Leakage Breakers offer Class 1 ground fault protection and improved ground fault coordination capability. A Class 1 device can open at high levels of fault current, while a Class 2 device prevents opening beyond the contact rating of its interrupting device.

Earth Leakage Breakers are factory supplied with a single sensor and ground fault relay built-in. The ground fault pickup setting is adjustable from 0.03 to 30 amperes in eight steps, and the ground fault time delay setting is adjustable from instantaneous to 2.0 seconds.

## General Description

**Current Limiting Circuit Breakers**

Eaton offers one of the most complete lines of both fusible and non-fused current limiting breakers in the industry. The industrial breakers are available in current limiting versions with interrupting capacities up to 100 kA at 480 V without fuses in the same physical size as standard and high interrupting capacity breakers. Eaton also manufactures both fused and non-fused current limiting devices with interrupting capacities up to 200 kA at 600 Vac.

The current limiting breakers utilize a reverse loop stationary contact. When current is flowing through the contacts of these breakers, the positions of the reverse loop and moving contact arm induce opposing magnetic fields. The resulting flux lines cause rapid contact blow-apart under these conditions, resulting in very high interrupting capacities and provide current limiting characteristics.

Current limiting breakers are available from 15 through 2500 amperes and have an interrupting rating of 100 kA at 480 V. These breakers are most commonly applied when very high (up to 100 kA) fault levels are available and in series rating applications where the current limiting capability of these breakers are used upstream in series combinations.

Circuit breakers 600 amperes and below which are current limiting have frame catalog numbers which end with the letter "C." For example, the F-frame model which is current limiting has a catalog number FDC. In accordance with UL circuit breaker marking requirements, the nameplate on the breaker is also labeled "current limiting."

**Current Limit-R Breakers**

The Current Limit-R molded case circuit breaker was developed with interrupting ratings up to 200,000 amperes at 480 Vac to provide complete system protection against faults, including:

1. Overloads, by using inverse time current tripping characteristics.
2. Low-level short circuits, by using instantaneous and/or short-time delay tripping characteristics.
3. High-level short circuits, by using ultra high-speed, blow-apart, current limiting contacts.

Current Limit-R<sup>®</sup> circuit breakers can be used in series with Cutler-Hammer standard molded case circuit breakers with listed interrupting ratings as low as 10,000 amperes in systems capable of delivering fault currents as high as 200,000 amperes. The excellent current limiting properties of the Current Limit-R breakers completely protect all Cutler-Hammer downstream series circuit breakers applied within their voltage ratings.

The high level current-limiting action is achieved by the use of special design, blow-apart contacts. The opening speed of the contacts is amplified by the repulsion force in the patented slot motor to effectively separate the contacts under high level fault conditions in less than one millisecond. The rapid rise of arc voltage introduces impedance into the system, thus limiting the amount of the otherwise available fault current.

The Current Limit-R current limiting circuit breakers incorporate all the advantages and features of conventional molded case circuit breakers. They are available in 2- and 3-pole versions in two physical frame sizes and three continuous current frame ratings.

The Type FCL has a maximum continuous current frame rating of 100 amperes. It is equipped with a conventional, non-interchangeable, thermal-magnetic-type trip unit with individual ampere ratings. The Type LCL is available with frames having maximum continuous current ratings of either 250 or 400 amperes. Overload and low level short circuit protection is provided by a SELTRONIC<sup>™</sup> electronic trip unit which uses the individual rating plug concept for determining the continuous rating of the breaker. Rating plugs are available with either fixed or adjustable ampere ratings.

**TRI-PAC Breakers**

The increase in demand for electrical power in modern commercial and industrial buildings has resulted in electrical services becoming substantially larger. In some low voltage distribution systems, available short circuit currents can exceed 100,000 symmetrical rms amperes. Fault currents of this intensity may exceed the interrupting ratings of molded case breakers. As a result, larger expensive circuit interrupting devices which could withstand the thermal and magnetic stresses associated with currents of this value have had to be used. High interrupting capacity current limiting devices have been developed which will restrict short circuit current. If applied correctly, they may be used in conjunction with the molded case circuit breakers to provide adequate and economical protection.

The TRI-PAC<sup>®</sup> breaker was developed for this application and so named because it affords TRiple-PACkage protection with (1) time delay thermal trip, (2) instantaneous magnetic trip and (3) current limiting protection, combined and coordinated in a compact and economical device. These protective actions are so coordinated that over-currents and low magnitude faults are cleared by the thermal action; normal short circuits are cleared by the magnetic action; and abnormal short circuits, above an established value, are cleared by the current limiting device. Thus, unless a severe short circuit occurs, the current limiter is unaffected and its replacement is held to a minimum.

TRI-PAC breakers are available in ratings from 15 through 1600 amperes and have a UL listed interrupting capacity of 200,000 amperes at up to 600 Vac and also have an interrupting capacity of 100,000 amperes at up to 250 Vdc.

The TRI-PAC breaker offers all of the advantages of the economical molded case breaker and the current limiter is retained, while the disadvantages of separately mounted devices are eliminated.

## General Description

**Special Application Breakers**

Eaton offers a wide range of special application molded case circuit breakers. Special application breakers are breakers built with special features to meet the unique requirements of the special application as follows. See the application data section for further information.

**DC Rated Breakers**

Breakers are available for use with ungrounded applications where all three poles are connected in series. Rated for up to 600 Vdc, breakers are available from 15 – 2500 ampere trip ranges with thermal magnetic trip units or special low magnetic only trip devices. Their compact size and increased interrupting performance give Eaton the most complete range of dc breakers in the industry.

**Mining Breakers**

Cutler-Hammer Mining Circuit Breakers have a tradition of proven dependability and reliability in harsh mine environments, consistently combining strength and reliability with safe, efficient operation. The E<sup>2</sup>G mining breaker is available in 225 and 400 ampere frames and is designed for trailing cable applications per MSHA 30 CFR 75. With interrupting ratings of 14 kA at 1000/577 Vac and rms sensing electronic trip unit, the E<sup>2</sup>G mining breaker can be applied to all mining circuit breaker applications.

**Navy/Marine Circuit Breakers**

Molded Case Navy Circuit Breakers provide both overload protection for conductors and short circuit protection for all circuit elements such as conductors, motors and starters. They also serve as manual disconnecting means as well as circuit protectors. All Cutler-Hammer Navy breakers meet applicable Navy/Marine specifications for “hi-shock” and “vibration” requirements.

These manually operated breakers are rated from 5 to 1600 amperes with interrupting ratings from 1500 to 100,000 amperes.

**AFCI Circuit Breakers**

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.

Eaton offers 125 Vac AFCI single-pole, 15 and 20 ampere breakers, plug-in and bolt-on, to meet Article 210-12 of the 2002 NEC.

**Lighting and Industrial Breakers**

Recognizing the growing need for high interrupting requirements on 240V applications such as loadcenters, metercenters, metering switchboards, distribution switchboards and panelboards, etc., the Cutler-Hammer family of lighting and industrial circuit breakers is designed to meet all applications. The Cutler-Hammer family of QUICKLAG miniature circuit breakers is available in bolt-on, plug-in and cable-in cable-out configurations. For molded case circuit breakers, Eaton offers the GB/GC design up through 100 amperes and the ED/EDH/EDC design up through 225 amperes up to 200 kA at 240 volts.

**HACR Listed Circuit Breakers**

HACR listed circuit breakers are circuit breakers that have been tested per UL for use in heating, air conditioning and refrigeration applications. HACR type circuit breakers are typically applied as the protection device for multimotor or combination loads in a group installation configuration. Eaton has its family of QUICKLAG QC miniature breakers and Series C<sup>®</sup> molded case breaker frames G, F, J and K listed for HACR applications.

**Engine Generator Circuit Breakers**

Engine generator circuit breakers are designed specifically for application on diesel engine powered standby generator systems. Generator breakers are equipped with a special trip unit that provides standard overload protection with low magnetic short circuit protection to suit generator applications that call for close short circuit protection at low interrupting ratings.

Eaton offers a family of engine generator circuit breakers in six frames from 15 to 1200 amperes that conform to UL, CSA and IEC standards.

**100% Rated Circuit Breakers**

100% rated circuit breakers are tested inside a minimum size enclosure to UL 489 for application at 100% of the breakers continuous current rating. 100% rated circuit breakers are equipped with electronic trip units and applied with 90°C cable rated at 75°C ampacity. To apply 100% rated breakers in switchboards and panelboards, additional tests are required to meet UL 67 and UL 891. Cutler-Hammer molded

case circuit breaker frames K-, L-, N- and R-, 70 through 2000 amperes can be applied at 100% of their rated continuous current as long as the breaker is installed in its minimum size enclosure including ventilation. 100% rated breakers are applied to distribution system to provide installation cost savings. The amount of savings that can be realized is dependent on the application.

**Series Rating Circuit Breakers**

Series rating is a short circuit interrupting rating assigned to a combination of two or more overcurrent devices connected in series. The short circuit interrupting rating of the upstream device must be equal to or greater than the available fault current. Downstream breakers, however, are not fully rated for the system's available fault current. Series combinations must be tested to UL 489. Series ratings are applied to distribution systems where short circuit coordination is not required. The Cutler-Hammer listing of available series rating combinations are shown in the applications section of this document.

**World Standard Circuit Breakers (IEC 947-2)**

Molded case circuit breakers meet all major electrical standards of the world. There are two branches of the family tree. One meets applicable UL, NEMA, CSA and IEC standards and employs a fixed thermal and fixed or adjustable magnetic trip. The second meets IEC 947-2 and has been assigned ultimate and service interrupting ratings, and employs adjustable thermal and adjustable magnetic trips. The frame ratings of both types of breakers are physically interchangeable with each other. Eaton is the first manufacturer in the industry to have a true family of world circuit breakers.

**Standards**

- Canadian Standards Association Standard C22.2 No. 5, Service Entrance and Branch Circuit Breakers.
- National Electrical Manufacturers Association Standards Publication Number AB1, Molded Case Circuit Breakers.
- Underwriters Laboratories Standard UL 489, Molded Case Circuit Breakers and Circuit Breaker Enclosures, including Marine Circuit Breakers File E7819.
- Underwriters Laboratories Standard UL 1087, Molded Case Switches.

General Description

**Time-Current Trip Curve Characteristics**

Time-current trip curve characteristics are available in the Molded Case Circuit Breaker CD-ROM (available on request) and on the Eaton Web site.

The band curves shown for each breaker type represent current tripping limits for the breaker and are within limits established by Underwriters Laboratories. For a given current, at rated ambient, a breaker will clear the circuit automatically at some total time within the two extreme values defined by "maximum" and "minimum" curves. For example, a 1-pole, 15-ampere QUICKLAG would trip in no less than 10 seconds and in no more than 150 seconds on a 30-ampere current.

Because of this allowed spread, users should not specify exact tripping times.

The upper left portions of these curves show the inverse time delay tripping of the breakers due to thermal action. The lower right segments for these curves portray the magnetic tripping action of the breakers. In the case of the front adjustable thermal-magnetic breakers, the magnetic tripping elements may be adjusted to trip at values within a specific current range. This adjustment is shown their respective characteristic tripping curves. When these breakers leave the factory, their magnetic trip elements are set at the high side of their tripping range. Adjustment downward may be made to fit the requirements of the installation. Currents equal to or greater than these

magnetic settings will cause instant tripping. Curves can be family curves and are suitable for most applications; for more accurate applications, a detailed curve of the particular type and ampere rating of the breaker should be requested.

The total time taken by a breaker to clear a fault consists of the mechanical operating time plus the time of actual current interruption. Characteristic time/current curves show total clearing times. Magnetic only breakers have no time delay in tripping. The tripping characteristics of these breakers are similar to the right-hand portion of the standard breakers, except with the vertical lines extended to the top of the curve.

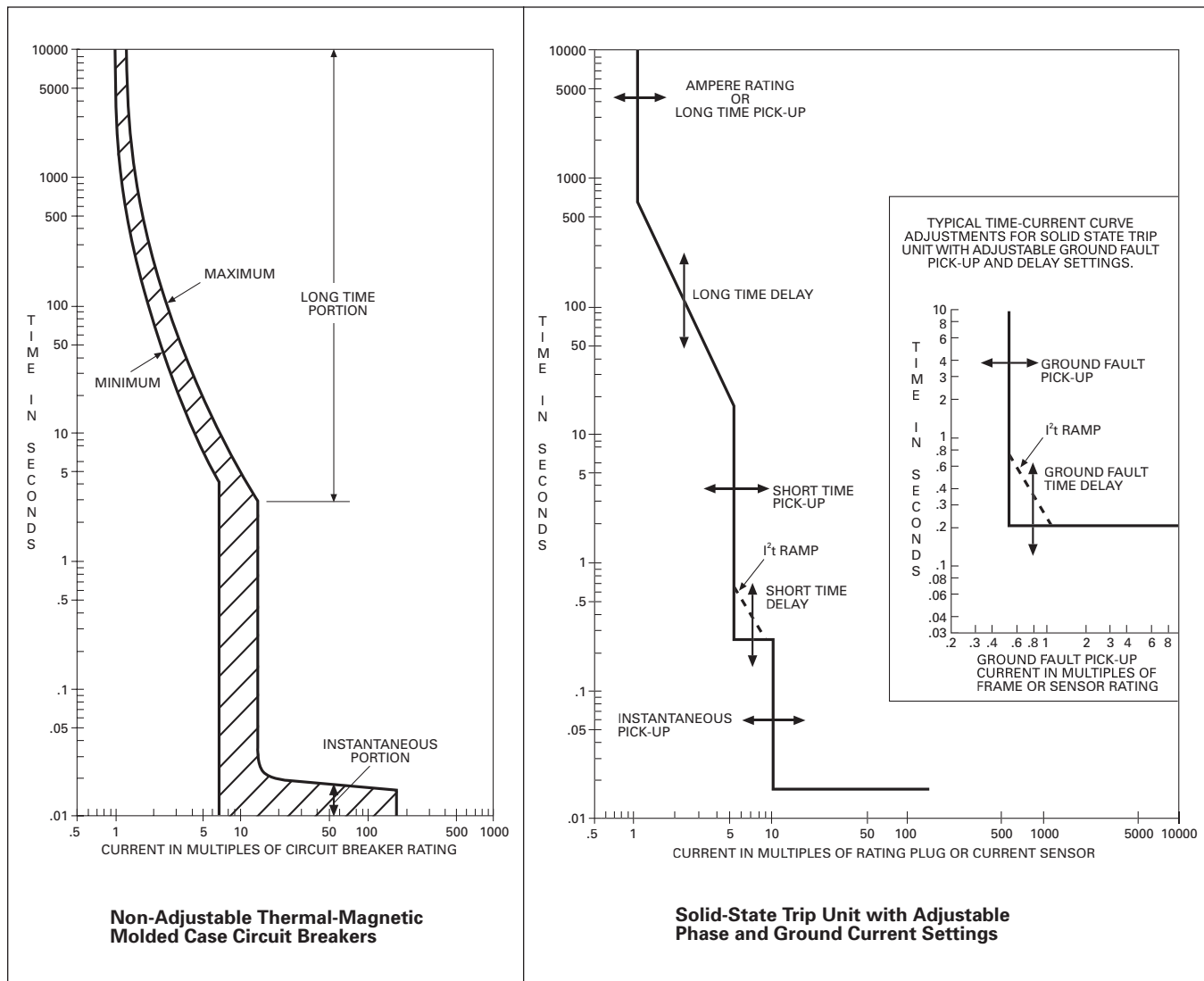


Figure 21.3-1. Typical Time-Current Curves



Table 21.3-1. Circuit Breaker Frame Reference Guide

Frame	Nominal Size Amperes	Circuit Breaker Types
Q or B	5 – 125	HQP, QPHW, QHPX, QHPW, QPGF, QPHGF, QPGFEP, QPHGFEP, BAB, QBHW, HBAX, HBAW, QBGF, QBHGF, QBGFEP, QBHGFEP, QC, QCD, QCF, QCR, QCHW, QHCX, QHCW, QCGF, QCHGF, QCGFEP, QCHGFEP
G E EG F	15 – 100 100 – 225 15 – 125 15 – 150	GHB, HGHB, GHBS, GHC, HGHC, GD ED, EDH, EDC, EHD (100 ampere) EGB, EGE, EGS, EGH FDB, FD, HFD, FDC
JG J K L LG	63 – 250 70 – 250 70 – 400 300 – 600 100 – 600	JGE, JGS, JGH JDB, JD, HJD, JDC KDB, KD, CKD, HKD, CHKD, KDC LDB, LD, CLD, HLD, CHLD, LDC, CLDC LGE, LGS, LGH, LGC
M N R	400 – 800 600 – 1200 800 – 2500	MDLB, MDL, CMDL, HMDLB, HMDL, CHMDL ND, CND, HND, CHND, NDC, CNDC RD, CRD, RDC, CRDC

Table 21.3-2. Industrial Circuit Breakers

Circuit Breaker Type	Continuous Ampere Rating at 40°C	No. of Poles	Volts		Type of Trip ①	Federal Specification W-C-375b	UL Listed Interrupting Ratings (rms Symmetrical Amperes)									
			ac	dc			ac Ratings Volts						dc ②			
							120	120/240	240	277	480	600	125	250	125/250	
<b>G-Frame</b>																
GHB	15 – 100	1	120	125	N.I.T.	11a	65,000	—	—	—	—	—	14,000	—	—	—
GHB	15 – 100	2, 3	240	125/250	N.I.T.	10b, 11b, 12b, 14b, 15b	—	—	65,000	—	—	—	14,000	—	—	14,000
GHB	15 – 100	1	277	125	N.I.T.	12c, 13a, 13b	—	—	—	14,000	—	—	14,000	—	—	—
GHB	15 – 100	2, 3	277/480	125/250	N.I.T.	12c, 13a, 13b	—	—	—	14,000	14,000	—	—	—	—	14,000
HGHB	15 – 30	1	277	125	N.I.T.	12c, 13a, 13b	65,000	—	—	—	—	—	14,000	—	—	—
GQ	15 – 20	1	277	—	N.I.T.	12c, 13a, 13b	65,000	—	—	—	—	—	14,000	—	—	—
GHBS	15 – 30	1, 2	277/480	—	—	—	65,000	65,000	—	14,000	—	—	—	—	—	—
GBHS	15 – 20	1, 2	347/600	—	N.I.T.	—	—	—	—	—	10,000	—	—	—	—	—
GD	15 – 50	2	480	125/250	N.I.T.	13b	—	—	65,000	—	14,000	—	—	—	—	10,000
GD	15 – 100	3	480	250	N.I.T.	13b	—	—	65,000	—	22,000	—	—	10,000	—	—
GHC	15 – 100	1	120	125	N.I.T.	12c, 13a	65,000	—	—	—	—	—	14,000	—	—	—
GHC	15 – 100	2, 3	240	125/250	N.I.T.	13b	—	—	65,000	—	—	—	—	—	—	14,000
GHC	15 – 100	1	277	125	N.I.T.	12c, 13a	—	—	—	14,000	—	—	14,000	—	—	—
GHC	15 – 100	2, 3	277/480	125/250	N.I.T.	13b	—	—	—	14,000	14,000	—	—	—	—	14,000
HGHC	15 – 30	1	277	125	N.I.T.	13b	65,000	—	—	25,000	—	—	14,000	—	—	—
<b>EG Frame ③</b>																
EGB	15 – 125	1 2, 3, 4	277 480	250	N.I.T.	—	35,000	—	—	25,000	18,000	—	—	10,000	—	—
EGE	15 – 125	2, 3, 4	600Y/347	250	N.I.T.	—	—	—	35,000	—	25,000	18,000	10,000	10,000	—	—
EGS	15 – 125	1 2, 3, 4	347 600Y/347	250	N.I.T. N.I.T.	—	100,000	—	—	85,000	35,000	—	—	35,000	—	—
EGH	15 – 125	1 2, 3, 4	347 600Y/347	250	N.I.T.	—	200,000	—	—	100,000	65,000	—	—	42,000	—	—
<b>F-Frame</b>																
EDB	100 – 225	2, 3	240	125	N.I.T.	12b	—	—	22,000	—	—	—	10,000	—	—	—
EDS	100 – 225	2, 3	240	125	N.I.T.	12b	—	—	42,000	—	—	—	10,000	—	—	—
ED	100 – 225	2, 3	240	125	N.I.T.	12b	—	—	65,000	—	—	—	10,000	—	—	—
EDH	100 – 225	2, 3	240	125	N.I.T.	14b	—	—	100,000	—	—	—	10,000	—	—	—
EDC ④	100 – 225	2, 3	240	125	—	1	—	—	200,000	—	—	—	10,000	—	—	—
EHD	15 – 100	1	277	125	N.I.T.	13a	—	—	—	14,000	—	—	10,000	—	—	—
EHD	15 – 100	2, 3	480	250	N.I.T.	13b	—	—	18,000	—	14,000	—	—	10,000	—	—
FDB	15 – 150	2, 3	600	250	N.I.T.	18a	—	—	18,000	—	14,000	14,000	—	10,000	—	—
FDB	15 – 150	4	600	250	—	⑤	—	—	18,000	—	14,000	14,000	—	10,000	—	—
FD	15 – 225	1	277	125	N.I.T.	13a	—	—	—	35,000	—	—	10,000	—	—	—
FD	15 – 225	2, 3	600	250	—	22a	—	—	65,000	—	35,000	18,000	—	10,000	—	—
FD	15 – 225	4	600	250	—	⑤	—	—	65,000	—	35,000	18,000	—	10,000	—	—
HFD	15 – 225	1	277	125	N.I.T.	13a	—	—	—	65,000	—	—	10,000	—	—	—
HFD	15 – 225	2, 3	600	250	—	22a	—	—	100,000	—	65,000	25,000	—	22,000	—	—
HFD	15 – 225	4	600	250	—	⑤	—	—	100,000	—	65,000	25,000	—	22,000	—	—
FDC ④	15 – 225	2, 3	600	250	N.I.T.	24a	—	—	200,000	—	100,000	35,000	—	22,000	—	—
FDC ④	15 – 225	4	600	250	—	⑤	—	—	200,000	—	100,000	35,000	—	22,000	—	—

① N.I.T. is non-interchangeable trip unit and I.T. is interchangeable trip unit.  
 ② Two-pole circuit breaker, or two poles of three-pole circuit breaker at 250 Vdc.  
 ③ Not presently available for panelboard or switchboard mounting.  
 ④ Current limiting.  
 ⑤ Not defined in W-C-375b.

## Circuit Breaker Selection Guide and Interrupting Ratings

Table 21.3-2. Industrial Circuit Breakers (Continued)

Circuit Breaker Type	Continuous Ampere Rating at 40°C	No. of Poles	Volts		Type of Trip ①	Federal Specification W-C-375b	UL Listed Interrupting Ratings (rms Symmetrical Amperes)								
			ac	dc			ac Ratings Volts						dc ②		
							120	120/240	240	277	480	600	125	250	125/250
<b>JG Frame ③</b>															
JGE	63 – 250	2, 3, 4	600	250	I.T.	—	—	—	65,000	—	25,000	18,000	—	10,000	—
JGS	63 – 250	2, 3, 4	600	250	I.T.	—	—	—	85,000	—	35,000	18,000	—	22,000	—
JGH	63 – 250	2, 3, 4	600	250	I.T.	—	—	—	100,000	—	65,000	25,000	—	22,000	—
<b>J-Frame</b>															
JDB	70 – 250	2, 3	600	250	N.I.T.	22a	—	—	65,000	—	35,000	18,000	—	10,000	—
JD	70 – 250	2, 3, 4	600	250	I.T.	22a	—	—	65,000	—	35,000	18,000	—	10,000	—
HJD	70 – 250	2, 3, 4	600	250	I.T.	22a	—	—	100,000	—	65,000	25,000	—	22,000	—
JDC ④	70 – 250	2, 3, 4	600	250	I.T.	22a	—	—	200,000	—	100,000	35,000	—	22,000	—
<b>K-Frame</b>															
DK	250 – 400	2, 3	240	250	N.I.T.	14b	—	—	65,000	—	—	—	—	10,000	—
KDB	100 – 400	2, 3	600	250	N.I.T.	23a	—	—	65,000	—	35,000	25,000	—	10,000	—
KD	100 – 400	2, 3, 4	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	10,000	—
CKD ⑤	100 – 400	2, 3, 4	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	10,000	—
HKD	100 – 400	2, 3, 4	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	22,000	—
CHKD ⑤	100 – 400	2, 3, 4	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	22,000	—
KDC ④	100 – 400	2, 3, 4	600	250	I.T.	23a	—	—	200,000	—	100,000	50,000	—	22,000	—
<b>L-Frame</b>															
LGE	100 – 600	3, 4	600	250	I.T.	23a	—	—	65,000	—	35,000	18,000	—	22,000	—
LGS	100 – 600	3, 4	600	250	I.T.	23a	—	—	85,000	—	50,000	25,000	—	22,000	—
LGH	100 – 600	3, 4	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	42,000	—
LGC	100 – 600	3, 4	600	250	I.T.	23a	—	—	200,000	—	100,000	50,000	—	42,000	—
LDB	300 – 600	2, 3	600	250	N.I.T.	23a	—	—	65,000	—	35,000	25,000	—	22,000	—
LD	300 – 600	2, 3, 4	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	22,000	—
CLD ⑤	300 – 600	2, 3, 4	600	250	I.T.	23a	—	—	65,000	—	35,000	25,000	—	22,000	—
HLD	300 – 600	2, 3, 4	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	25,000	—
CHLD ⑤	300 – 600	2, 3, 4	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	25,000	—
LDC ④	300 – 600	2, 3, 4	600	250	I.T.	23a	—	—	—	—	100,000	50,000	—	25,000	—
CLDC ④⑤	300 – 600	2, 3, 4	600	250	I.T.	23a	—	—	200,000	—	100,000	50,000	—	25,000	—
<b>M-Frame</b>															
MDL	300 – 800	2, 3	600	250	I.T.	23a	—	—	65,000	—	50,000	25,000	—	22,000	—
CMDL ⑤	300 – 800	2, 3	600	250	I.T.	23a	—	—	65,000	—	50,000	25,000	—	22,000	—
HMDL	300 – 800	2, 3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	25,000	—
CHMDL ⑤	300 – 800	2, 3	600	250	I.T.	23a	—	—	100,000	—	65,000	35,000	—	25,000	—
<b>N-Frame</b>															
ND	600 – 1200	3, 4	600	—	N.I.T.	23A	—	—	65,000	—	50,000	25,000	—	—	—
CND ⑤	600 – 1200	3, 4	600	—	N.I.T.	23A	—	—	65,000	—	50,000	25,000	—	—	—
HND	600 – 1200	3, 4	600	—	N.I.T.	23A	—	—	100,000	—	65,000	35,000	—	—	—
CHND ⑤	600 – 1200	3, 4	600	—	N.I.T.	23A	—	—	100,000	—	65,000	35,000	—	—	—
NDC	600 – 1200	3, 4	600	—	N.I.T.	23A	—	—	200,000	—	100,000	50,000	—	—	—
CNDC ⑤	600 – 1200	3, 4	600	—	N.I.T.	23A	—	—	200,000	—	100,000	50,000	—	—	—
<b>R-Frame</b>															
RD 1600	800 – 1600	3, 4	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
CRD 1600 ⑤	800 – 1600	3, 4	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
RD 2000	1000 – 2000	3, 4	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
RD 2500	1000 – 2500	3, 4	600	—	N.I.T.	24a	—	—	200,000	—	65,000	50,000	—	—	—
CRD 2000 ⑤	1000 – 2000	3, 4	600	—	N.I.T.	24a	—	—	125,000	—	65,000	50,000	—	—	—
RDC 1600	800 – 1600	3, 4	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
CRDC 1600 ⑤	800 – 1600	3, 4	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
RDC 2000	1000 – 2000	3, 4	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
RDC 2500	1000 – 2500	3, 4	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—
CRDC 2000 ⑤	1000 – 2000	3, 4	600	—	N.I.T.	25a	—	—	200,000	—	100,000	65,000	—	—	—

① N.I.T. is non-interchangeable trip unit and I.T. is interchangeable trip unit.

② Two-pole circuit breaker, or two poles of three-pole circuit breaker at 250 Vdc.

③ Not presently available for panelboard or switchboard mounting.

④ Current limiting.

⑤ 100% rated.

**Table 21.3-2. Industrial Circuit Breakers (Continued)**

Circuit Breaker Type	Continuous Ampere Rating at 40°C	No. of Poles	Volts		Type of Trip ①	Federal Specification W-C-375b	UL Listed Interrupting Ratings (rms Symmetrical Amperes)								
			ac	dc			ac Ratings Volts						dc ②		
							120	120/240	240	277	480	600	125	250	125/250
<b>Current Limit-R Current Limiting Circuit Breakers — Non-Fused Type</b>															
FCL	15 – 100	2, 3	480	—	N.I.T.	—	—	—	200,000	—	150,000	—	—	—	
LCL	125 – 400	2, 3	600	—	N.I.T.	—	—	—	200,000	—	200,000	100,000	—	—	
<b>TRI-PAC Current Limiting Circuit Breakers — Fused Type</b>															
FB	15 – 100	2, 3	600	250	N.I.T.	16a, 16b, 17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000
LA	70 – 400	2, 3	600	250	I.T.	16a, 16b, 17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000
NB	300 – 800	2, 3	600	250	I.T.	16b, 17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000
PB	600 – 1600	2, 3	600	250	I.T.	17a, 26a	—	—	200,000	—	200,000	200,000	—	—	100,000

① N.I.T. is non-interchangeable trip unit and I.T. is interchangeable trip unit.  
② Two-pole circuit breaker, or two poles of three-pole circuit breaker at 250 Vdc.

Circuit Breaker Selection Guide and Interrupting Ratings

**QUICKLAG Industrial Circuit Breakers** ①

Table 21.3-3. Plug-in, Bolt-on, Cable-in/Cable-out

Circuit Breaker Type	Circuit Breaker Type Code	Continuous Ampere Rating at 40°C	Number of Poles	Volts		Federal Specification W-C-375b	Interrupting Ratings (rms Symmetrical Amperes)					
				ac	dc		ac Ratings Volts			dc ②		
							120	120/240	240	24 – 48	62.5	80
HQP	P	10 – 70	1	120/240	24, 48, 62.5	10a, 11a, 12a	—	10,000	—	5,000	③	—
HQP		10 – 125	2	120/240	24, 48, 80	10a, 12a	—	10,000	—	5,000	5,000	5,000
HQP		10 – 100	2, 3	240	—	10b, 11b, 12b	—	—	10,000	—	—	—
QPHW	P	15 – 70	1	120/240	24, 48, 62.5	14a	—	22,000	—	5,000	③	—
QPHW		15 – 125	2	120/240	24, 48, 80	14a	—	22,000	—	5,000	5,000	5,000
QPHW		15 – 100	2, 3	240	—	14b	—	—	22,000	—	—	—
QHPX	P	15 – 70	1	120/240	24, 48, 62.5	—	—	42,000	—	5,000	③	—
QHPX		15 – 100	2	120/240	24, 48, 80	—	—	42,000	—	5,000	5,000	5,000
QHPX		15 – 100	3	240	—	—	—	—	42,000	—	—	—
QHPW	P	15 – 30	1	120/240	24, 48, 62.5	15a	—	65,000	—	5,000	③	—
QHPW		15 – 30	2	120/240	24, 48, 80	15a	—	65,000	—	5,000	5,000	5,000
QHPW		15 – 20	3	240	—	15b	—	—	65,000	—	—	—
QPGF	P, GF	15 – 40	1	120	—	10a, 11a, 12a	10,000	—	—	—	—	—
QPGF		15 – 50	2	120/240	—	10a, 11a, 12a	—	10,000	—	—	—	—
QPHGF	P, GF	15 – 30	1	120	—	10a, 11a, 12a	22,000	—	—	—	—	—
QPHGF		15 – 50	2	120/240	—	10a, 11a, 12a	—	22,000	—	—	—	—
QPGFEP	P, GFEP	15 – 40	1	120	—	—	10,000	—	—	—	—	—
QPGFEP		15 – 50	2	120/240	—	—	—	10,000	—	—	—	—
QPHGFEP	P, GFEP	15 – 30	1	120	—	—	22,000	—	—	—	—	—
QPHGFEP		15 – 30	2	120/240	—	—	22,000	22,000	—	—	—	—
BAB	B	10 – 70	1	120/240	24, 48, 62.5	10a, 11a, 12a	—	10,000	—	5,000	③	—
BAB		10 – 125	2	120/240	24, 48, 80	10a, 12a	—	10,000	—	5,000	5,000	5,000
BAB		10 – 100	2, 3	240	—	10b, 11b, 12b	—	—	10,000	—	—	—
BABR, BABRS	B	15 – 30	1	120	—	—	—	10,000	—	—	—	—
BABR, BABRS		15 – 30	2	120/240	—	—	—	10,000	—	—	—	—
QBHW	B	15 – 70	1	120/240	24, 48, 62.5	14a	—	22,000	—	5,000	③	—
QBHW		15 – 125	2	120/240	24, 48, 80	14a	—	22,000	—	5,000	5,000	5,000
QBHW		15 – 100	2, 3	240	—	14b	—	—	22,000	—	—	—
HBAX	B	15 – 70	1	120/240	24, 48, 62.5	—	—	42,000	—	5,000	③	—
HBAX		15 – 100	2	120/240	24, 48, 80	—	—	42,000	—	5,000	5,000	5,000
HBAX		15 – 100	3	240	—	—	—	—	42,000	—	—	—
HBAW	B	15 – 30	1	120/240	24, 48, 62.5	15a	—	65,000	—	5,000	③	—
HBAW		15 – 30	2	120/240	24, 48, 80	15a	—	65,000	—	5,000	5,000	5,000
HBAW		15 – 20	3	240	—	15b	—	—	65,000	—	—	—

① QUICKLAG circuit breakers are suitable for application in relative humidity 0 – 95% noncondensing.  
 ② Two-pole dc interrupting ratings based on 2 poles connected in series.  
 ③ 62.5 Vac interrupting rating is 3800 AIC 10 – 50 amperes and 2500 AIC 55 – 100 amperes continuous.

**Circuit Breaker Selection Guide and Interrupting Ratings**

**Table 21.3-3. Plug-in, Bolt-on, Cable-in/Cable-out (Continued)**

Circuit Breaker Type	Circuit Breaker Type Code	Continuous Ampere Rating at 40°C	Number of Poles	Volts		Federal Specification W-C-375b	Interrupting Ratings (rms Symmetrical Amperes)					
				ac	dc		ac Ratings Volts			dc <sup>①</sup>		
							120	120/240	240	24 – 48	62.5	80
QBGF QBGF	B, GF	15 – 40 15 – 50	1 2	120 120/240	— —	10a, 11a, 12a 10a, 11a, 12a	10,000 —	— 10,000	— —	— —	— —	— —
QBHGF QBHGF	B, GF	15 – 30 15 – 30	1 2	120 120/240	— —	10a, 11a, 12a 10a, 11a, 12a	22,000 —	— 22,000	— —	— —	— —	— —
QBGFEP QBGFEP	B, GFEP	15 – 40 15 – 50	1 2	120 120/240	— —	— —	10,000 —	— 10,000	— —	— —	— —	— —
QBHGFEP QBHGFEP	B, GFEP	15 – 30 15 – 30	1 2	120 120/240	— —	— —	22,000 22,000	— 22,000	— —	— —	— —	— —
QC QC QC	C	10 – 70 10 – 100 10 – 100	1 2 2, 3, 4	120/240 120/240 240	— 24, 48, 62.5 —	10a, 11a, 12a 10a, 12a 10b, 11b, 12b	— — —	10,000 10,000 —	— — 10,000	5,000 5,000 —	② 5,000 —	— 5,000 —
QCD QCD QCD	C	10 – 100 10 – 100 15 – 100	1 2 3	120 120/240 240	— — —	— — —	— — —	10,000 10,000 —	— — 10,000	— — —	— — —	— — —
QCF QCF QCF QCR QCR QCR	C	10 – 60 15 – 20 15 – 30 10 – 60 15 – 20 15 – 30	1, 2 1, 2 2, 3 1, 2 1, 2 2, 3	120/240 120/240 240 120/240 120/240 240	24, 48, 62.5 24, 48, 62.5 24, 48, 62.5 24, 48, 62.5 24, 48, 62.5 24, 48, 62.5	— — — — — —	10,000 22,000 — 10,000 22,000 —	10,000 — 10,000 10,000 — 10,000	— — — — — —	3,000 3,000 3,000 3,000 3,000 3,000	② 3,000 3,000 2,000 3,000 3,000 3,000	— — — — — —
QCHW QCHW QCHW	C	15 – 70 15 – 100 15 – 100	1 2 2, 3	120/240 120/240 240	24, 48, 62.5 24, 48, 80 —	14a 14a 14b	— — —	22,000 22,000 —	— — 22,000	5,000 5,000 —	② 5,000 —	— 5,000 —
QHXC QHXC QHXC	C	15 – 70 15 – 100 15 – 100	1 2 3	120/240 120/240 240	24, 48, 62.5 24, 48, 80 —	— — —	— — —	42,000 42,000 —	— — 42,000	5,000 5,000 —	② 5,000 —	— 5,000 —
QHCW QHCW QHCW	C	15 – 30 15 – 30 15 – 20	1 2 3	120/240 120/240 240	24, 48, 62.5 24, 48, 80 —	15a 15a 15b	— — —	65,000 65,000 —	— — 65,000	5,000 5,000 —	② 5,000 —	— 5,000 —
QCGF QCGF	C, GF	15 – 40 15 – 50	1 2	120 120/240	— —	— —	10,000 —	— 10,000	— —	— —	— —	— —
QCHGF QCHGF	C, GF	15 – 30 15 – 30	1 2	120 120/240	— —	— —	22,000 —	— 22,000	— —	— —	— —	— —
QCGFEP QCGFEP	C, GFEP	15 – 40 15 – 50	1 2	120 120/240	— —	— —	10,000 —	— 10,000	— —	— —	— —	— —
QCHGFEP QCHGFEP	C, GFEP	15 – 30 15 – 30	1 2	120 120/240	— —	— —	22,000 —	— 22,000	— —	— —	— —	— —

① Two-pole dc interrupting ratings based on 2 poles connected in series.  
② 62.5 Vac interrupting rating is 3800 AIC 10 – 50 amperes and 2500 AIC 55 – 100 amperes continuous.

Selection Data — QUICKLAG Industrial Breakers

QUICKLAG Industrial Circuit Breakers

21



HQP, QPHW, QHPX



QHPW



QPGF, QPHGF,  
QPGFEP, QPHGFEP



BAB, QBHW, HBAX



HBAW

Table 21.3-4. QUICKLAG Industrial Circuit Breakers

Type of Breaker Mounting/Electrical Connections																	
Plug-on												Bolt-on					
Thermal-Magnetic HQP, QPHW, QHPX				Thermal-Magnetic QHPW				Thermal-Magnetic QPGF, QPHGF, QPGFEP, QPHGFEP				Thermal-Magnetic BAB, QBHW, HBAX			Thermal-Magnetic HBAW		

Circuit Breaker Ratings — Continuous Current Rating at 40°C and 0 – 95% Humidity (Noncondensing)

Amperes	Poles	Volts	Amperes	Poles	Volts	Amperes	Poles	Volts	Amperes	Poles	Volts	Amperes	Poles	Volts
HQP			QHPW			QPGF			BAB			HBAW		
5 – 70	1	120/240	15 – 30	1-2	120/240	15 – 40	1	120	5 – 70	1	120/240	15 – 30	1-2	120/240
10 – 150	2	120/240	15 – 20	3	240	15 – 50	2	120/240	10 – 150	2	120/240	15 – 20	3	240
10 – 100	2-3	240							10 – 100	2-3	240			
QPHW						QPHGF			QBHW					
15 – 70	1	120/240				15 – 30	1	120	15 – 70	1	120/240			
15 – 125	2	120/240				15 – 30	2	120/240	15 – 125	2	120/240			
15 – 100	2-3	240							15 – 100	2-3	240			
QHPX						QPGFEP			HBAX					
15 – 70	1	120/240				15 – 40	1	120	15 – 70	1	120/240			
15 – 100	2	120/240				15 – 50	2	120/240	15 – 100	2	120/240			
15 – 100	2-3	240							15 – 100	3	240			
						QPHGFEP								
						15 – 30	1	120						
						15 – 30	2	120/240						

Dimensions in Inches (mm) Per Single-Pole Breaker

W	H	D	W	H	D	W	H	D	W	H	D	W	H	D
1.00 (25.4)	2.94 (74.6)	2.38 (60.3)	1.00 (25.4)	2.94 (74.6)	2.38 (60.3)	1.00 (25.4)	3.19 (81.0)	2.38 (60.3)	1.00 (25.4)	2.94 (74.6)	2.38 (60.3)	1.00 (25.4)	2.94 (74.6)	2.38 (60.3)

ac Interrupting Ratings — UL Listed Interrupting Ratings Shown (rms Symmetrical Amperes)

Volts	Amps I.R.	Volts	Amps I.R.	Volts	Amps I.R.	Volts	Amps I.R.	Volts	Amps I.R.
HQP		QHPW		QPGF, QPGFEP		BAB		HBAW	
120/240, 240	10,000	120/240, 240	65,000	120, 120/240	10,000	120/240, 240	10,000	120/240, 240	65,000
QPHW				QPHGF, QPHGFEP		QBHW			
120/240, 240	22,000			120, 120/240	22,000	120/240, 240	22,000		
QHPX						HBAX			
120/240, 240	42,000					120/240, 240	42,000		

dc Interrupting Ratings ①

Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.
48	1-2	5,000	48	1-2	5,000	—	—	—	48	1-2	5,000	48	1-2	5,000
62.5	1	2,500	62.5	1	2,500	—	—	—	62.5	1	2,500	62.5	1	2,500
80	2	5,000	80	2	5,000	—	—	—	80	2	5,000	80	2	5,000

Accessories and Modifications — See MCCB CD-ROM for Description and UL Installation Status

Moisture-Fungus Treatment Handle Lock Devices Shunt Trip Special Calibration Shock Tested Dummy Breaker Optional Terminals	Moisture-Fungus Treatment Handle Lock Devices Shunt Trip Special Calibration Shock Tested Dummy Breaker Optional Terminals	Moisture-Fungus Treatment Bell Alarm Contacts Auxiliary Switch Contacts	Moisture-Fungus Treatment Handle Lock Devices Shunt Trip Special Calibration Shock Tested Panelboard Accessories Dummy Breaker Optional Terminals	Moisture-Fungus Treatment Handle Lock Devices Shunt Trip Special Calibration Shock Tested Panelboard Accessories Optional Terminals
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① Two-pole interrupting ratings based on two poles connected in series. Not UL listed.

QUICKLAG Industrial Circuit Breakers



QBGF, QBHGF,  
QBGFEP, QBHGFEP



QCR, QCF



QC, QCHW, QHCX



QHCW



QCGF, QCHGF,  
QCGFEP, QCHGFEP

Table 21.3-5. QUICKLAG Industrial Circuit Breakers

Type of Breaker Mounting/Electrical Connections																
Bolt-on					Cable-in/Cable-out											
Thermal-Magnetic QBGF, QBHGF, QBGFEP, QBHGFEP					Thermal-Magnetic QCR, QCF			Thermal-Magnetic QC, QCHW, QHCX			Thermal-Magnetic QCD			Thermal-Magnetic QCGF, QCHGF, QCGFEP, QCHGFEP		

Circuit Breaker Ratings — Continuous Current Rating at 40°C and 0 – 95% Humidity (Noncondensing)

Amperes	Poles	Volts	Amperes	Poles	Volts	Amperes	Poles	Volts	Amperes	Poles	Volts	Amperes	Poles	Volts
QBGF			QCR, QCF			QC			QCD			QCGF		
15 – 40	1	120	10 – 60	1	120	5 – 70	1	120/240	10 – 100	1-2	120/240	15 – 40	1	120
15 – 50	2	120/240	10 – 60	2	120/240	10 – 125	2	120/240	10 – 100	3	240	15 – 50	2	120/240
—	—	—	15 – 30	2-3	240	10 – 100	2-3	240	—	—	—	—	—	—
QBHGF			QCHW			QCHGF			QCHGFEP			QCHGFEP		
15 – 30	1	120	15 – 70	1	120/240	15 – 30	1	120	15 – 30	1	120	15 – 30	1	120
15 – 30	2	120/240	15 – 100	2	120/240	15 – 50	2	120/240	15 – 50	2	120/240	15 – 50	2	120/240
—	—	—	15 – 100	2-3	240	—	—	—	—	—	—	—	—	—
QBGFEP			QHCX			QCGFEP			QCHGFEP			QCHGFEP		
15 – 40	1	120	15 – 70	1	120/240	15 – 30	1	120	15 – 30	1	120	15 – 30	1	120
15 – 50	2	120/240	15 – 100	2	120/240	15 – 50	2	120/240	15 – 50	2	120/240	15 – 50	2	120/240
—	—	—	15 – 100	2-3	240	—	—	—	—	—	—	—	—	—
QBHGFEP			QHCW			QCHGFEP			QCHGFEP			QCHGFEP		
15 – 30	1	120	15 – 30	1-2	120/240	15 – 50	1	120	15 – 50	1	120	15 – 50	1	120
15 – 30	2	120/240	15 – 20	3	240	15 – 30	2	120/240	15 – 30	2	120/240	15 – 30	2	120/240

Dimensions in Inches (mm) Per Single-Pole Breaker

W	H	D	W	H	D	W	H	D	W	H	D	W	H	D
1.00 (25.4)	3.19 (81.0)	2.38 (60.3)	.50 (12.7)	3.94 (74.6)	2.63 (66.7)	1.00 (25.4)	3.75 (95.3)	2.44 (61.9)	1.00 (25.4)	3.75 (95.3)	2.63 (66.7)	1.00 (25.4)	3.75 (95.3)	2.44 (61.9)

ac Interrupting Ratings — UL Listed Interrupting Ratings Shown (rms Symmetrical Amperes)

Volts	Amps I.R.	Volts	Amps I.R.	Volts	Amps I.R.	Volts	Amps I.R.	Volts	Amps I.R.
QBGF, QBGFEP		QCR, QCF		QC		QCD		QCGF, QCGFEP	
120, 120/240	10,000	120/240	10,000	120/240, 240	10,000	120/240, 240	10,000	120/240	10,000
QBHGF, QBHGFEP		QCHW		QCHGF, QCHGFEP		QCHGF, QCHGFEP		QCHGF, QCHGFEP	
120, 120/240	22,000	120/240, 240	22,000	120	22,000	120	22,000	120	22,000
		QHCX		QHCW					
		120/240, 240	42,000	120/240, 240	65,000				

dc Interrupting Ratings ①

Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.	Volts	Poles	Amps I.R.
—	—	—	62.5	1	3,000	48	1-2	5,000	48	1-2	5,000	—	—	—
—	—	—	125	2	3,000	62.5	1	2,500	62.5	1	2,500	—	—	—
—	—	—	—	—	—	80	2	5,000	80	2	5,000	—	—	—

Accessories and Modifications — See MCCB CD-ROM for Description and UL Installation Status

Moisture-Fungus Treatment Handle Lock Devices Bell Alarm Contacts Auxiliary Switch Contacts Ring Terminals	Moisture-Fungus Treatment Handle Lock Devices QCR Mounting Clips Ring Terminals Quick Connect Terminals Shunt Trip Shock Tested DIN Rail Mounting Clip	Moisture-Fungus Treatment Handle Lock Devices Shunt Trip Special Calibration Shock Tested Face Mounting Plate Base Mounting Hardware Optional Terminals Dummy Breaker DIN Rail Mounting Clip	Moisture-Fungus Treatment Handle Lock Devices Shunt Trip Special Calibration Shock Tested Face Mounting Plate Base Mounting Hardware Optional Terminals Dummy Breaker DIN Rail Mounting Clip	Moisture-Fungus Treatment Handle Lock Devices Bell Alarm Contacts Auxiliary Switch Contacts DIN Rail Mounting Clip
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① Two-pole dc interrupting ratings based on two poles connected in series. Not UL listed.

Selection Data — QUICKLAG Industrial Breakers

**QUICKLAG Industrial Circuit Breaker  
Catalog Numbering System**

Table 21.3-6. Catalog Numbering System — QUICKLAG

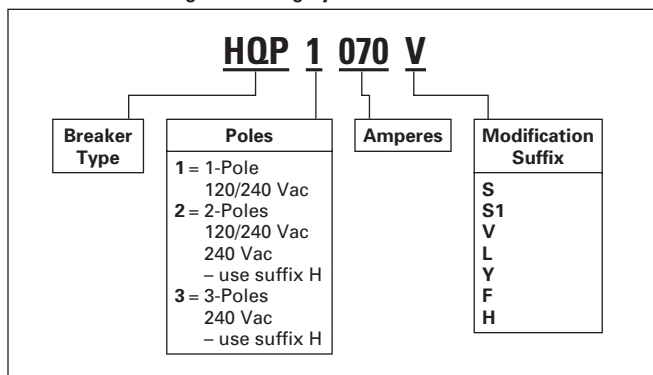


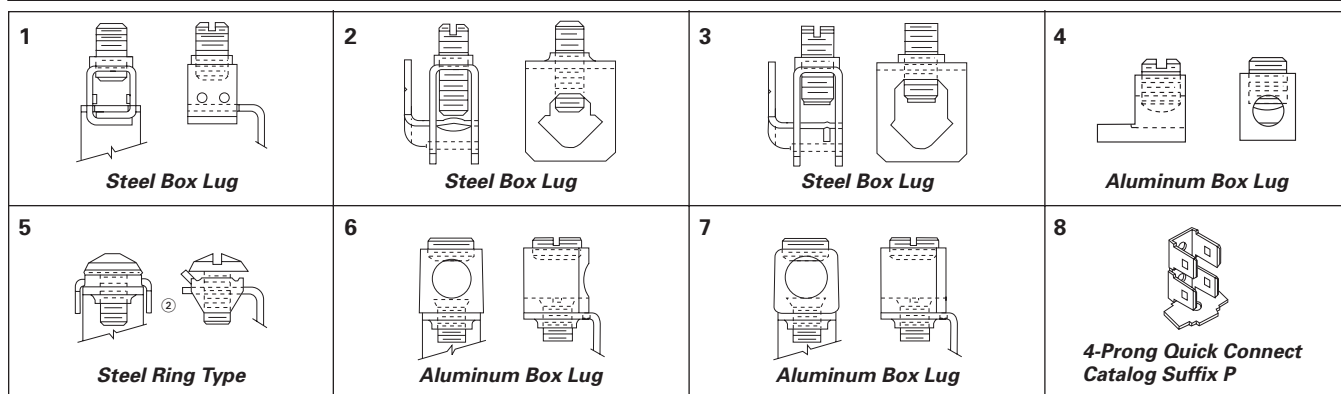
Table 21.3-7. Factory Modifications ①

Type of Modification	Breaker Types	Catalog Suffix
Shunt Trip (Requires 1 extra pole space on right side) 120, 208, 240 Vac 12, 24, 48 Vac/dc Draws 2.6A at 120 V Draws 11A at 24 Vdc	QUICKLAG Types P, B and C QUICKLAG Types P, B and C	S S1
Special Calibration (50°C) Shock Testing Freeze Testing	QUICKLAG Types P, B and C QUICKLAG Types P, B and C QUICKLAG Types P, B and C	V L Y
Moisture-Fungus Treatment	QUICKLAG Types P, B, C and Ground Fault	F
Marine Duty Naval Duty 400 Hz Calibration Specific dc Ratings (Breaker marked with a Maximum Vdc rating)	QUICKLAG Types P, B, C QUICKLAG Types P, B, C QUICKLAG Types P, B, C QUICKLAG Types P, B, C	H08 H09 G Q thru Q9

① Contact the Eaton factory for modifications available for QCR and QCF breakers.

Table 21.3-8. Factory Installed Breaker Terminals

Breaker Type	Continuous Ampere Rating	Standard Line Terminal			Standard Load Terminal			Optional Terminals	
		Term Type	Wire Type	Wire Range (AWG)	Term Type	Wire Type	Wire Range (AWG)	Line	Load
QUICKLAG Type P HQP, QPHW, QHPX, QHPW	10 to 30 35 to 50 55 to 125	Plug-on female clips which mate with the bus stabs			1 2 3	Cu/Al Cu/Al Cu/Al	14 – 4 14 – 4 8 – 1/0	N/A	3 3 —
QUICKLAG Ground Fault QPGF, QPHGF, QPGFEP, QPHGFEP	10 to 30 40	Plug-on female clips which mate with the bus stabs			1 (1-pole) 4 (2-pole) 4	Cu/Al Cu/Al Cu	14 – 4 14 – 8 14 – 8	N/A	3 3 —
QUICKLAG Type B BAB, QBHW, HBAX, HBAW	10 to 30 35 to 50 55 to 125	Extended tangs which bolt directly to the bus			1 (1- and 2-pole) 2 (3-pole) 3	Cu/Al Cu/Al Cu/Al	14 – 4 14 – 4 8 – 1/0	N/A	3 3 —
QUICKLAG Ground Fault QBGF, QBHGF, QBGFEP, QBHGFEP	10 to 30 40	Extended tangs which bolt directly to the bus			1 (1-pole) 4 (2-pole) 4	Cu/Al Cu/Al Cu	14 – 4 14 – 8 14 – 8	N/A	N/A
QUICKLAG Type C QC, QCHW, QHCX, QHCW	10 to 20 25 to 60 70 to 100	5 6 7	Cu/Al Cu/Al Cu/Al	14 – 10 14 – 10 14 – 10	5 2 3	Cu/Al Cu/Al Cu/Al	14 – 10 14 – 4 8 – 1/0	6, 7 5, 7 5	6, 7, 8 5, 6, 7, 8 5, 7, 8
QUICKLAG QCR, QCF	10 to 55 60	1 1	Cu/Al Cu	14 – 4 14 – 4	1 1	Cu/Al Cu	14 – 4 14 – 4	N/A	N/A
QUICKLAG Ground Fault QCGF, QCHGF, QCGFEP, QCHGFEP	10 to 20 25 to 50	5 6	Cu/Al Cu/Al	14 – 10 14 – 10	1 1	Cu/Al Cu/Al	14 – 4 14 – 4	6, 7 5, 7	5 5



② Clamp on line side only.



**Types BABR and BABRS  
Solenoid-Operated,  
Remote-Controlled**



**BABR Breaker**

**Description**

BABR and BABRS circuit breakers are bolt-on branch circuit breakers designed for use in panelboards and are ideally suited for lighting control or energy management applications. In addition to providing conventional branch circuit protection, they include a unique solenoid-operated mechanism that provides for efficient breaker pulse-on and pulse-off operation when used with a suitable controller like the Eaton's Cutler-Hammer Pow-R-Command™ lighting control system. BABR and BABRS breakers can also be operated by pushbuttons, relays or PLCs. A breaker status feature is included on the BABRS version.

**Note:** The BABR breaker has monitoring only of the status of the remote controlled contact, while the BABRS has monitoring only of the status of the breaker contacts.

**Product Features**

- Bolt-on line-side terminal.
- Cable connected load-side terminal.
- 3- or 4-wire (BABR) control terminal.
- Status switch.
- Bi-metal assembly for thermal overload protection.
- Fast acting short circuit protection.
- Arc-runner and arc-chute assembly for fast acting arc extinction.
- Three-position handle: OFF, TRIP (Center), ON.
- Handle permits manual switching when control power is lost.
- Mechanical trip indicator.
- 15 and 20 ampere breakers SWD (switching duty) rated.
- HID ratings for HID (high intensity discharge) lighting.

**Note:** For use in lighting control applications, see Pow-R-Command Section 28.

**Table 21.3-9. BABR and BABRS UL 489 and CSA 22.2 Interrupting Ratings and Catalog Numbers**

Circuit Breaker Type	Number of Poles	Interrupting Capacity (Symmetrical Amperes)		
		Ampere Rating ①	Volts ac (50/60 Hz)	
			120	120/240
BABR1015, BABRS1015	1	15	10,000	—
BABR1020, BABRS1020	1	20	10,000	—
BABR1025, BABRS1025	1	25	10,000	—
BABR1030, BABRS1030	1	30	10,000	—
BABR2015, BABRS2015	2	15	—	10,000
BABR2020, BABRS2020	2	20	—	10,000
BABR2025, BABRS2025	2	25	—	10,000
BABR2030, BABRS2030	2	30	—	10,000

① Continuous current rating at 40°C.

**Table 21.3-10. BABR Wire Harness**

Description	Catalog Number
This 60-inch (1219.2 mm) wire pigtail provides a connection from a single BABR or BABRS control plug to a customer's pushbutton, relay or PLC. Each box contains 12 pigtails. Wires are 22 AWG, 600 V. Order in multiples of 12.	SLBKRPTL1
Same as SLBKRPTL1 except 72 inches (1828.8 mm) long and connects up to four BABR or BABRS breakers on the same pigtail. Each box contains 4 pigtails. Order in multiples of 4.	SLBKRPTL4
Same as SLBKRPTL4 except it connects up to six BABR or BABRS breakers on the same pigtail. Each box contains 4 pigtails. Order in multiples of 4.	SLBKRPTL6

Selection Data — Solenoid-Operated

Types GHBS and GBHS  
Solenoid-Operated, Remote-Controlled

21



1-Pole



2-Pole

Description

GHBS and GBHS circuit breakers are bolt-on branch circuit breakers designed for use in panelboards and are ideally suited for lighting control or energy management applications. In addition to providing conventional branch circuit protection, they include a unique solenoid-operated mechanism that provides for efficient breaker pulse-on and pulse-off operation when used with a suitable controller like the Eaton's Cutler-Hammer Pow-R-Command lighting control system.

Table 21.3-11. GHBS UL 489 Interrupting Ratings

Circuit Breaker Type <sup>①</sup>	Number of Poles	Interrupting Capacity (Symmetrical Amperes)			
		Ampere Rating <sup>②</sup>	Volts ac (50/60 Hz)		
			120	240	277/480
GHBS1015D	1	15	65,000	—	14,000
GHBS1020D	1	20	65,000	—	14,000
GHBS1030D	1	30	65,000	—	14,000
GHBS2015D	2	15	—	65,000	14,000
GHBS2020D	2	20	—	65,000	14,000
GHBS2030D	2	30	—	65,000	14,000

<sup>①</sup> All UL listed circuit breakers are HID (High Intensity Discharge) rated.  
<sup>②</sup> Continuous current rating at 40°C.

Table 21.3-12. GBHS CSA 22.2 Interrupting Ratings

Circuit Breaker Type	Number of Poles	Interrupting Capacity (Symmetrical Amperes)	
		Ampere Rating <sup>③</sup>	Volts ac (50/60 Hz)
			347/600
GBHS1015D	1	15	10,000
GBHS1020D	1	20	10,000
GBHS2015D	2	15	10,000
GBHS2020D	2	20	10,000

<sup>③</sup> Continuous current rating at 40°C.

Table 21.3-13. Terminal Type

Item	Circuit Breaker Amperes	Terminal Type	Screw Head Type	Wire Type	AWG Wire Range
GHBS	15 – 20	Clamp	Slotted	Cu/Al	14 – 10
GBHS	15 – 20	Clamp	Slotted	Cu/Al	14 – 10
GHBS	30	Box	Slotted	Cu/Al	14 – 2
GBHS	30	Box	Slotted	Cu/Al	14 – 2
BABRS	15 – 30	Box	Slotted	Cu/Al	14 – 6

**Note:** For load-side. Terminals are UL listed as suitable for wire type and size given below.

Table 21.3-14. Dimensions Per Pole in Inches (mm)

Item	Width	Height	Depth
GHBS	1.00 (25.4)	4.12 (104.8)	2.81 (71.4)
GBHS	1.00 (25.4)	4.12 (104.8)	2.81 (71.4)
BABR BABRS	1.00 (25.4)	4.08 (104.8)	2.91 (74.0)

Types GHBS, GBHS, BABR and BABRS Solenoid-Operated, Remote-Controlled

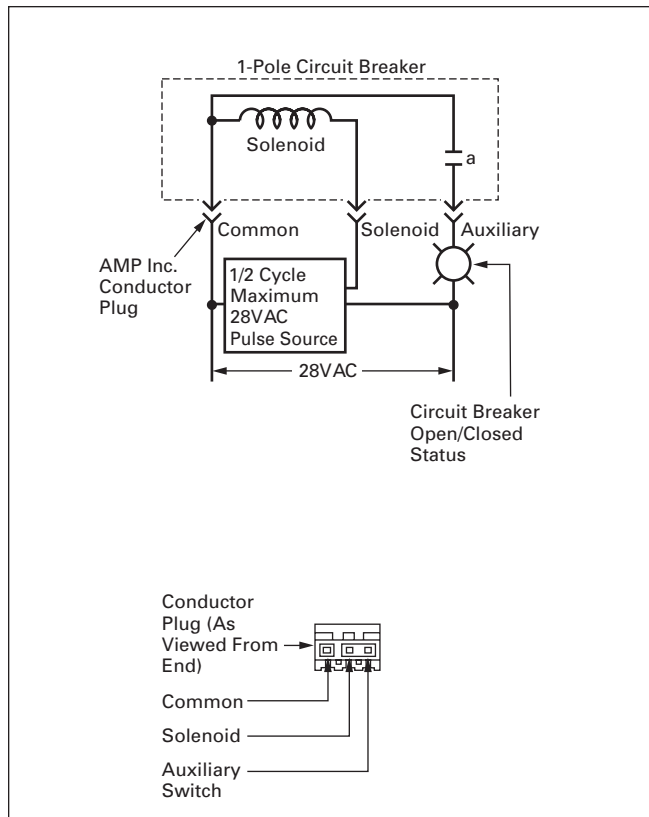


Figure 21.3-2. Typical GHBS or GBHS Single-Pole Circuit Breaker Schematic Diagram and Conductor Plug Wiring Connections

Note: 2-pole breakers have two solenoids.

Remote Control Operation

The remote-control capability of the breaker is “armed” when the breaker handle is manually switched to the “ON” position. Once armed, the breaker can be pulsed “ON” and “OFF” by a controller device which provides an ac pulse of specified magnitude and duration to the solenoid operated mechanism. Control connections to the breaker are provided through a conductor plug (supplied by others). A normally open (a) auxiliary contact provides for “ON”/“OFF” status indication to the remote controller and/or indicating lamp.

In the event the breaker automatically trips, the breaker must be reset manually.

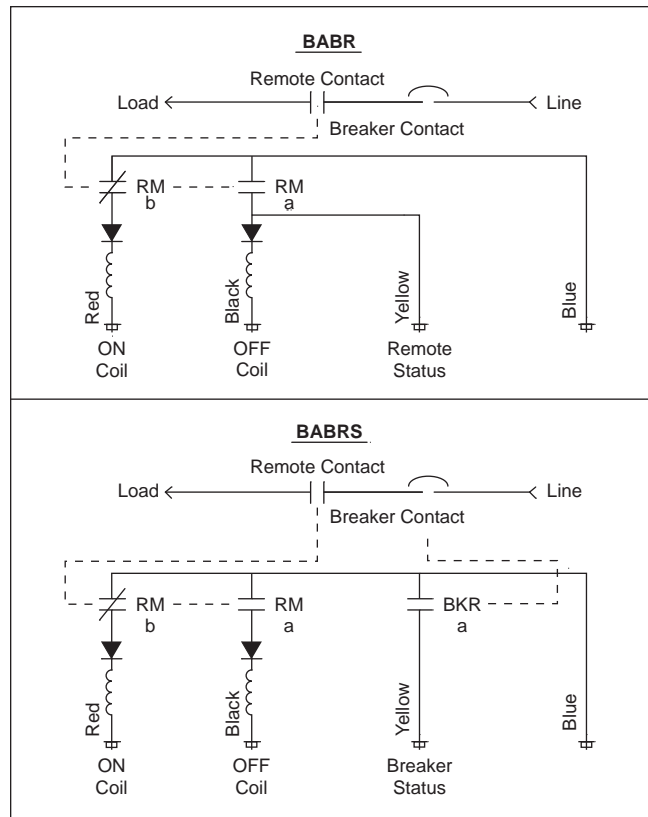


Figure 21.3-3. Circuit Breaker Schematic Diagram for the BABR and BABRS Breakers

Note: 2-pole breakers have two solenoids.

Breaker Solenoid and Operating Data

- Ambient temperature: 0°C – 40°C.
- Nominal pulse magnitude: 28 Vac rms, 24 Vac (BABR).
- Tolerance: +10% to -15% of nominal voltage.
- Pulse duration: 1/2 cycle (8 – 10 ms).
- Minimum recommended pulse current at nominal voltage:
  - GHBS
    - 1-Pole: 4.9 amperes peak, 3.5 amperes rms
    - 2-Pole: 7.84 amperes peak, 5.6 amperes rms
  - BABR and BABRS
    - 1-Pole: 1.0 amperes peak
    - 2-Pole: 2.0 amperes peak
- Breaker operating time: 20 – 40 ms.
- Maximum breaker cycling: six operations per minute.
- Humidity: 0 – 95% non-condensing.
- The GHBS and GBHS are rated for 25,000 operations while the BABR and BABRS are rated for 250,000 operations.

Selection Data — Industrial G-Frame

## G-Frame, Thermal-Magnetic, 15 – 100 Amperes



GHB Breaker

Table 21.3-15. G-Frame —  
Dimensions in Inches (mm)

Number of Poles	Width	Height	Depth
1P G-Frame	1.00 (25.4)	4.00 (101.6)	2.81 (71.4)
2P G-Frame	2.00 (50.8)	4.00 (101.6)	2.81 (71.4)
3P G-Frame	3.00 (76.2)	4.00 (101.6)	2.81 (71.4)
GHCGFEP	2.00 (50.8)	4.88 (124.0)	2.81 (71.4)
GHBGFEP	2.00 (50.8)	4.00 (101.6)	2.81 (71.4)

Table 21.3-16. Thermal-Magnetic Trip Ratings

Frame	Ratings
GHB, GHC	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100
GHCGFEP, GHBGFEP	15, 20, 30, 40, 50, 60



GHCGFEP, GHBGFEP  
277 Volt 30 mA GF Breaker

### Application Notes

- On all 3-phase Delta (240 V) Grounded B phase applications, refer to Eaton.
- 480Y/277 V, circuit breakers (Type GHB) not suitable for 3-phase Delta (480 V) Grounded B phase applications.
- All 2- and 3-pole circuit breakers are of the common trip type.
- Single-pole circuit breakers, 15 and 20 ampere. Switching duty rated (SWD) for fluorescent lighting applications.
- Suitable for reverse feed applications.
- HACR rated.
- GHCGFEP and GHBGFEP are earth leakage breakers, rated for 30 mA ground fault protection.
- Type GHB are bolt-on panelboard breakers while type GHC is a cable-in and cable-out breaker for stand-alone mounting typically in a control panel or separate enclosure.

### Terminals

Line side (on GHC) and load side (on GHC and GHB) terminals are UL listed as suitable for wire type and size listed below. When used with aluminum conductors, use joint compound.

Table 21.3-19. Terminals

Breaker Amperes	Terminal Type	Wire Type	Wire Range
15 – 20	Clamp	Cu/Al	#14 – #10 AWG
25 – 60	Pressure	Cu/Al	#10 – 1/0 AWG

Table 21.3-17. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Number of Poles	Type of Trip ①	Interrupting Capacity (Symmetrical Amperes)					
			Volts ac (50/60 Hz)				Volts dc	
			120	240	277	480	125	250 ②③
GHB, GHC	1	N.I.T.	65,000	—	14,000	—	14,000 ③	—
GHB, GHC	2, 3	N.I.T.	—	65,000	—	14,000	—	14,000
GHCGFEP, GHBGFEP	1	—	—	65,000	14,000	—	—	—

- ① N.I.T. is non-interchangeable trip unit.
- ② Two poles of 3-pole circuit breaker.
- ③ Time constant is 8 milliseconds minimum.

Table 21.3-18. Terminal Types

Circuit Breaker Amperes	Terminal Body Material ④	Wire Type	AWG Wire Range
15 – 20	Clamp (Plated Steel)	Cu/Al	(1) #14 – 10
25 – 100	Pressure (Aluminum Body)	Cu/Al	(1) #10 – 1/0
15 – 20	Clamp	Cu/Al	(1) #14 – #10 AWG
25 – 60	Pressure	Cu/Al	(1) #10 – 1/0 AWG

- ④ UL listed for use with copper or aluminum conductors as noted.

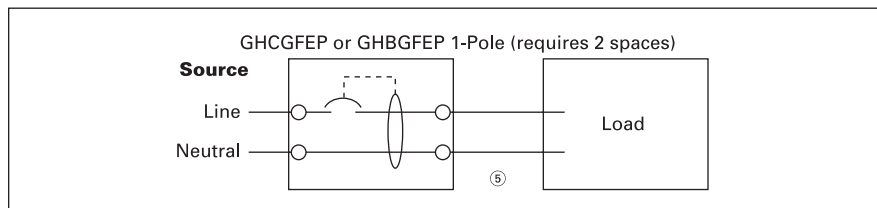
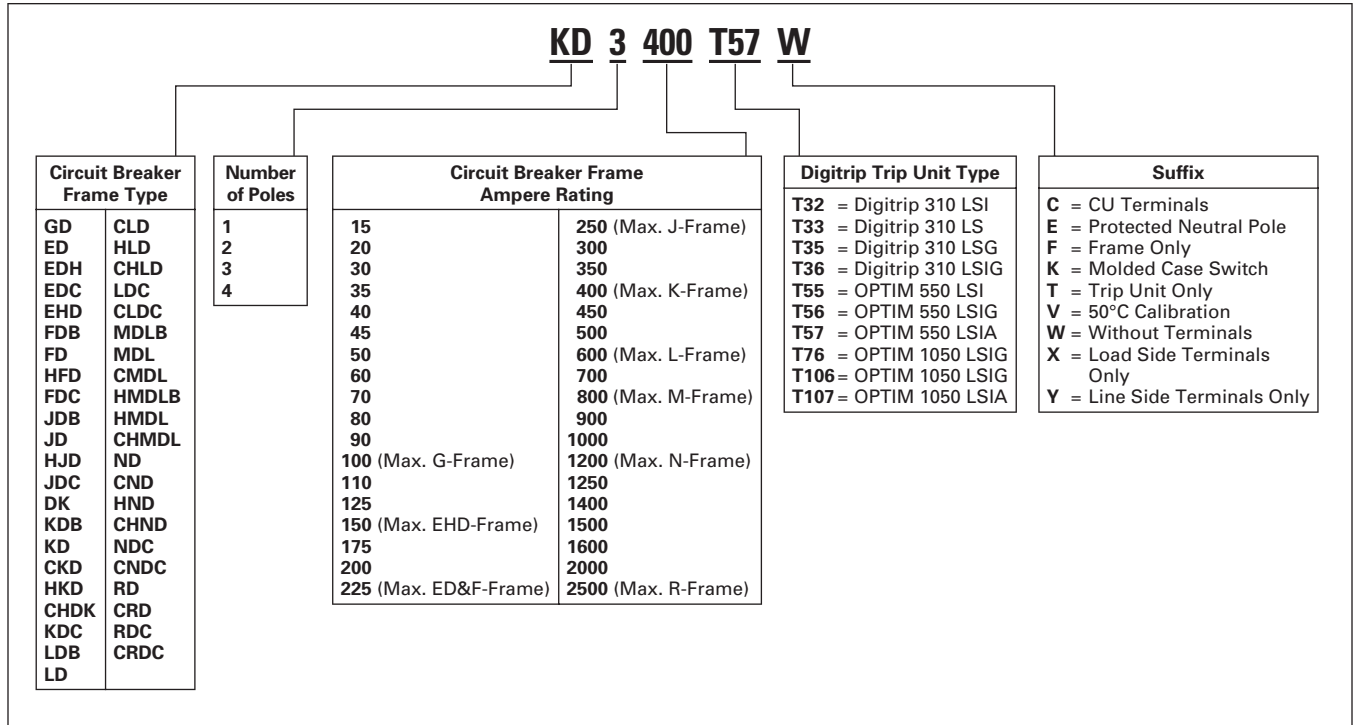


Figure 21.3-4. Electrical Schematic

- ⑤ Do not ground neutral anywhere on load side of breaker.

**Circuit Breaker/Frame Catalog Numbering System**

Table 21.3-20. Catalog Numbering System — Molded Case Circuit Breakers



**Note:** This chart is for interpretation of Cutler-Hammer catalog numbers and not for the creation of catalog numbers.

Selection Data — G-Frame

G-Frame  
Thermal-Magnetic  
15 – 100 Amperes

21



G-Frame Breaker

Table 21.3-21. Dimensions in Inches (mm)

Number of Poles	Width	Height	Depth
2	2.00 (50.8)	4.88 (124.0)	2.81 (71.4)
3	3.00 (76.2)	4.88 (124.0)	2.81 (71.4)

Table 21.3-22. Thermal-Magnetic Trip Ratings

Frame	Ratings
GD	15, 20, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100

Table 21.3-23. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Number of Poles	Type of Trip <sup>①</sup>	Interrupting Capacity (Symmetrical Amperes)					
			Volts ac (50/60 Hz)				Volts dc	
			120	240	277	480	125	250 <sup>②③</sup>
GD	2, 3	N.I.T.	—	65,000	—	22,000	—	10,000

- ① N.I.T. is non-interchangeable trip unit.
- ② Two poles of 3-pole circuit breaker.
- ③ Time constant is 8 milliseconds minimum.

Table 21.3-24. Line and Load Terminals

Circuit Breaker Amperes	Terminal Body Material <sup>④</sup>	Wire Type	AWG Wire Range	Metric Wire Range (mm <sup>2</sup> ) <sup>⑤</sup>
15 – 20	Clamp (Plated Steel)	Cu/Al	(1) #14 – 10	2.5 – 4
25 – 100	Pressure (Aluminum Body)	Cu/Al	(1) #10 – 1/0	4 – 50

- ④ UL listed for use with copper or aluminum conductors as noted.
- ⑤ Not UL listed sizes.

**EG-Frame  
Thermal-Magnetic  
15 – 125 Amperes**



*E125-Frame Breaker*

**Table 21.3-27. UL 489/IEC 60947-2 Interrupting Capacity Ratings**

Circuit Breaker Type	Number of Poles	Interrupting Capacity (Symmetrical Amperes) (kA)													
		Volts ac (50/60 Hz)										Volts dc <sup>②</sup>			
		120	220 – 240		277	347		380 – 415		480	600Y/347	125	250 <sup>③④</sup>		
	I <sub>cu</sub>	I <sub>cs</sub>		I <sub>cu</sub>	I <sub>cs</sub>	I <sub>cu</sub>	I <sub>cs</sub>				I <sub>cu</sub>	I <sub>cs</sub>			
EGB	1	35	25	25	18	—	—	—	—	—	—	10	10	—	—
	2, 3, 4	—	25	25	—	—	—	18	18	18	—	—	—	10	10
EGE	2, 3, 4	—	35	35	—	—	—	25	25	25	18	—	—	10	10
	1	100	85	43	35	22	22	—	—	—	—	35	35	—	—
EGS	2, 3, 4	—	85	43	—	—	—	40	30	35	22	—	—	35	35
	1	200	100	50	65	30	30	—	—	—	—	42	42	—	—
EGH	2, 3, 4	—	100	50	—	—	—	70	35	65	25	—	—	42	42

<sup>②</sup> dc ratings apply to substantially non-inductive circuits.  
<sup>③</sup> 2-pole circuit breaker, or two poles of 3-pole circuit breaker.  
<sup>④</sup> Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 42 kA.  
**Note:** Contact Eaton for availability of E125 frame breakers in panelboards and switchboards.

**Table 21.3-25. Dimensions in Inches (mm)**

Number of Poles	Width	Height	Depth
1	1.00 (25.4)	5.50 (139.7)	2.99 (75.9)
2	2.00 (50.8)	5.50 (139.7)	2.99 (75.9)
3	3.00 (76.2)	5.50 (139.7)	2.99 (75.9)
4	4.00 (101.6)	5.50 (139.7)	2.99 (75.9)

**Table 21.3-26. Thermal-Magnetic Trip Ratings**

Frame	Ratings
EG	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125
EG <sup>①</sup>	16, 32, 63

<sup>①</sup> Not UL listed.

Selection Data — F-Frame

F-Frame  
Thermal-Magnetic  
10 – 225 Amperes



F-Frame Breaker

Table 21.3-28. Dimensions in Inches (mm)

Number of Poles	Width	Height	Depth
1	1.38 (34.8)	6.00 (152.4)	3.38 (85.7)
2	2.75 (69.9)	6.00 (152.4)	3.38 (85.7)
3	4.13 (104.8)	6.00 (152.4)	3.38 (85.7)
4	5.50 (139.7)	6.00 (152.4)	3.38 (85.7)

Table 21.3-29. Thermal-Magnetic Trip Ratings

Frame	Ratings
ED, EDH, EDC	100, 125, 150, 175, 200, 225
EHD, FDB, FD, HFD, FDC, HFDDC	10, 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150
FD, HFD, FDC	175, 200, 225

Table 21.3-30. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Number of Poles	Type of Trip ①	Interrupting Capacity (Symmetrical Amperes)					
			Volts ac (50/60 Hz)				Volts dc	
			240	277	480	600	125	250 ②③
EDB	2, 3	N.I.T.	22,000	—	—	—	10,000	—
EDS	2, 3	N.I.T.	42,000	—	—	—	10,000	—
ED	2, 3	N.I.T.	65,000	—	—	—	10,000	—
EDH	2, 3	N.I.T.	100,000	—	—	—	10,000	—
EDC ④	2, 3	N.I.T.	200,000	—	—	—	10,000	—
EHD	1	N.I.T.	—	14,000	—	—	10,000	—
	2, 3	N.I.T.	18,000	—	14,000	—	—	10,000
FDB	2, 3, 4	N.I.T.	18,000	—	14,000	14,000	—	10,000
FD	1	N.I.T.	—	35,000	—	—	10,000	—
	2, 3, 4	N.I.T.	65,000	—	35,000	18,000	—	10,000
HFD	1	N.I.T.	—	65,000	—	—	10,000	—
	2, 3, 4	N.I.T.	100,000	—	65,000	25,000	—	22,000
FDC ④	2, 3, 4	N.I.T.	200,000	—	100,000	35,000	—	22,000
HFDDC ⑤	3	N.I.T.	—	—	—	—	—	42,000 ⑥

- ① N.I.T. is non-interchangeable trip unit.
- ② 2-pole circuit breaker, or two poles of 3-pole circuit breaker.
- ③ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.
- ④ Current limiting.
- ⑤ HFDDC is UL only and is not tested to other standards.
- ⑥ Interrupting rating is 35,000 amperes at 600 Vdc with three poles in series, for ungrounded systems only.

Table 21.3-31. Line and Load Terminals

Maximum Breaker Amperes	Terminal Body Material ⑦	Wire Type	AWG Wire Range	Metric Wire Range (mm <sup>2</sup> )	Catalog Number Package of 3 Terminals
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Standard Pressure Type Terminals

20 (EHD)	Steel	Cu/Al	(1) #14 – #10	2.5 – 4	3T20FB ⑧
100	Steel	Cu/Al	(1) #14 – 1/0	2.5 – 50	3T100FB
150	Aluminum	Cu/Al	(1) #4 – 4/0	25 – 95	3TA150FB
225	Aluminum	Cu/Al	(1) #4 – 4/0	25 – 95	3TA225FD

Optional Pressure Terminals

50	Aluminum	Cu/Al	(1) #14 – #4	2.5 – 16	3TA50FB ⑧
100	Aluminum	Cu/Al	(1) #14 – 1/0	2.5 – 50	3TA100FD
150	Stainless Steel	Cu	(1) #4 – 4/0	25 – 95	3T150FB
225	Aluminum	Cu/Al	(1) #6 – 300 kcmil	16 – 150	3TA225FDK

- ⑦ UL listed for use with copper or aluminum conductors as noted.
- ⑧ Not for use with ED, EDH, EDC breakers.



**JG-Frame**  
**Electronic RMS, 20 – 250 Amperes**  
**Thermal-Magnetic, 63 – 250 Amperes**



JG250-Frame Breaker

**Table 21.3-32. Dimensions in Inches (mm)**

Number of Poles	Width	Height	Depth
2, 3	4.13 (104.9)	7.00 (177.8)	3.57 (90.7)
4	5.34 (135.6)	7.00 (177.8)	3.57 (90.7)

**Table 21.3-33. Thermal-Magnetic Trip Ratings**

Frame	Ratings
JG	70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250
JG ①	63, 160

① Not UL listed.

**Table 21.3-34. Digitrip 310 Electronic Trip Units**

Frame	Ratings
JG250	100, 125, 150, 160, 175, 200, 225, 250
JG160	63, 80, 90, 100, 110, 125, 150, 160
JG100	40, 45, 50, 63, 70, 80, 90, 100
JG50	20, 25, 30, 32, 40, 45, 50

**Table 21.3-35. UL 489/IEC 60947-2 Interrupting Capacity Ratings**

Circuit Breaker Type	Number of Poles	Interrupting Capacity (kA Symmetrical Amperes)										
		Volts ac (50/60 Hz)									Volts dc ②	
		220 – 240		380 – 415		480	600	690		250 ③④		
		I <sub>cu</sub>	I <sub>cs</sub>	I <sub>cu</sub>	I <sub>cs</sub>			I <sub>cu</sub>	I <sub>cs</sub>	I <sub>cu</sub>	I <sub>cs</sub>	
JGE	2, 3, 4	65	65	25	25	25	18	12	6	10	10	
JGS	2, 3, 4	85	85	40	40	35	18	12	6	22	22	
JGH	2, 3, 4	100	100	70	70	65	25	14	7	22	22	
JGC	2, 3, 4	200	150	100	75	100	50	20	10	42	42	

② dc ratings apply to substantially non-inductive circuits.

③ 2-pole circuit breaker, or two poles of 3-pole circuit breaker.

④ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.

**Note:** Contact Eaton for availability of J250 frame breakers in panelboards and switchboards.

Selection Data — J-Frame

J-Frame  
Thermal-Magnetic, 70 – 250 Amperes



J-Frame Breaker

Table 21.3-36. Dimensions in Inches (mm)

Number of Poles	Width	Height	Depth
2, 3	4.13 (104.8)	10.00 (254.0)	4.06 (103.2)
4	5.50 (139.7)	10.00 (254.0)	4.06 (103.2)

Table 21.3-37. Thermal-Magnetic Trip Ratings

Frame	Ratings
JDB, JD, HJD JDC, HJDDC	70, 90, 100, 125, 150, 175, 200, 225, 250

Table 21.3-38. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Number of Poles	Type of Trip <sup>①</sup>	Interrupting Capacity (Symmetrical Amperes)				
			Volts ac (50/60 Hz)			Volts dc	
			240	480	600	250 <sup>②③</sup>	600 <sup>④</sup>
JDB	2, 3	N.I.T.	65,000	35,000	18,000	10,000	—
JD	2, 3, 4	I.T.	65,000	35,000	18,000	10,000	—
HJD	2, 3, 4	I.T.	100,000	65,000	25,000	22,000	—
JDC <sup>⑤</sup>	2, 3, 4	I.T.	200,000	100,000	35,000	22,000	—
HJDDC	3 <sup>⑥</sup>	I.T.	—	—	—	42,000 <sup>⑦</sup>	35,000 <sup>⑧</sup>

- ① N.I.T. is non-interchangeable trip; I.T. is interchangeable trip.
- ② 2-pole circuit breaker or two outside poles of 3-pole circuit breaker.
- ③ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.
- ④ 8 milliseconds time constant.
- ⑤ Current limiting.
- ⑥ Three poles in series.
- ⑦ Two poles in series.

Table 21.3-39. Line and Load Terminals

Maximum Breaker Amperes	Terminal Body Material <sup>⑧</sup>	Wire Type	AWG Wire Range	Metric Wire Range (mm <sup>2</sup> )	Catalog Number
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Standard Cu/Al Pressure Terminals

250	Aluminum	Cu/Al	(1) #4 – 350 kcmil	25 – 185	TA250KB
250	Stainless Steel	Cu	(1) #4 – 350 kcmil	25 – 185	T250KB

- ⑧ UL listed for use with copper or aluminum conductors as noted.

**K-Frame**  
**Electronic RMS, 70 – 400 Amperes**  
**Thermal-Magnetic, 100 – 400 Amperes**



*K-Frame Breaker*

**Table 21.3-40. Dimensions in Inches (mm)**

Number of Poles	Width	Height	Depth
2, 3	5.50 (139.7)	10.13 (257.2)	4.06 (103.2)
4	7.22 (183.4)	10.13 (257.2)	4.06 (103.2)

**Table 21.3-41. Thermal-Magnetic Trip Ratings**

Frame	Ratings
DK, FDB, KD, HKD, KDC, HKDDC, CKD, CHKD	100, 125, 150, 175, 200, 225, 250, 300, 350, 400

**Table 21.3-42. Digitrip 310 and OPTIM Electronic Trip Unit Rating Plugs**

Frame	Rating Plugs ①
KD, HKD, KDC, CKD, CHKD	70, 90, 100, 110, 125 ②, 150, 160, 175, 200, 225, 250 ②, 300, 350, 400 ②

① 160 ampere is only available on Digitrip 310.  
② Adjustable rating plug available on Digitrip 310.

**Table 21.3-43. NEMA/UL 489/CSA Interrupting Capacity Ratings**

Circuit Breaker Type	Number of Poles	Type of Trip ③	Interrupting Capacity (Symmetrical Amperes)				
			Volts ac (50/60 Hz)			Volts dc	
			240	480	600	250 ④⑤	600 ⑥
DK	2, 3	N.I.T.	65,000	—	—	10,000	—
KDB	2, 3, 4	N.I.T.	65,000	35,000	25,000	10,000	—
KD	2, 3, 4	I.T.	65,000	35,000	25,000	10,000	—
HKD	2, 3, 4	I.T.	100,000	65,000	35,000	22,000	—
KDC ⑦	2, 3, 4	I.T.	200,000	100,000	50,000	22,000	—
HKDDC	3	I.T.	—	—	—	42,000 ⑧	35,000 ⑩
CKD ⑨	3	I.T.	65,000	35,000	25,000	10,000	—
CHKD ⑨	3	I.T.	100,000	65,000	35,000	22,000	—

③ N.I.T. is non-interchangeable trip; I.T. is interchangeable trip.  
④ 2-pole circuit breaker or two outside poles of 3-pole circuit breaker.  
⑤ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.  
⑥ 8 milliseconds time constant.  
⑦ Current limiting.  
⑧ 100% rated.  
⑨ Two poles in series.  
⑩ Three poles in series.

**Table 21.3-44. Line and Load Terminals**

Maximum Breaker Amperes	Terminal Body Material ①	Wire Type	AWG/kcmil Wire Range/Number of Conductors	Metric Wire Range (mm <sup>2</sup> )	Catalog Number
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**Standard Cu/Al Pressure Terminals**

225	Aluminum	Cu/Al	(1) 3 – 350 kcmil	35 – 185	<b>TA300K</b>
350	Aluminum	Cu/Al	(1) 250 – 500 kcmil	120 – 240	<b>TA350K</b>
400	Aluminum	Cu/Al	(2) 3/0 – 250 kcmil	95 – 120	<b>2TA400K</b> – 2-Pole Kit ② <b>3TA400K</b> – 3-Pole Kit ② <b>4TA400K</b> – 4-Pole Kit ②

**Optional Copper and Cu/Al Pressure Type Terminals**

225	Copper	Cu	(1) 3 – 350 kcmil	35 – 185	<b>T300K</b>
350	Copper	Cu	(1) 250 – 500 kcmil	120 – 240	<b>T350K</b>
400	Copper	Cu	(2) 3/0 – 250 kcmil	95 – 120	<b>2T400K</b> – 2-Pole Kit ② <b>3T400K</b> – 3-Pole Kit ② <b>4T400K</b> – 4-Pole Kit ②
400	Aluminum	Cu/Al	(2) 2/0 – 250 kcmil or (1) 2/0 – 500 kcmil	70 – 120 70 – 240 70 – 240	<b>2TA401K</b> – 2-Pole Kit ② <b>3TA401K</b> – 3-Pole Kit ② <b>4TA401K</b> – 4-Pole Kit ②

① UL listed for use with copper or aluminum conductors as noted.  
② TA400K, T400K and TA401K terminal kits contain one terminal for each pole and one terminal cover.

Selection Data — L-Frame

**L-Frame**  
**Electronic RMS, 70 – 600 Amperes**  
**Thermal-Magnetic, 300 – 600 Amperes**



L-Frame Breaker

Table 21.3-45. Dimensions in Inches (mm)

Number of Poles	Width	Height	Depth
2, 3	8.25 (209.6)	10.75 (273.1)	4.06 (103.2)
4	11.00 (279.4)	10.75 (273.1)	4.06 (103.2)

Table 21.3-46. Thermal-Magnetic Trip Ratings

Frame	Ratings
LDB, LD, CLD, HLD, CHLD, LDC, CLDC, HLDDC	300, 350, 400, 450, 500, 600

Table 21.3-47. Digitrip 310 Electronic Trip Unit Rating Plugs

Frame	Rating Plugs
LDB, LD, CLD, HLD, CHLD, LDC, CLDC	300, 350, 400, 500, 600 300/600 Adjustable

Table 21.3-48. Digitrip OPTIM Electronic Trip Unit Rating Plugs

Frame	Rating Plugs
LD, CLD, HLD, CHLD, LDC, CLDC	70, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 500, 600

Table 21.3-49. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Number of Poles	Type of Trip ①	Interrupting Capacity (rms Symmetrical Amperes)				
			Volts ac (50/60 Hz)			Volts dc	
			240	480	600	250 ②③	600
LDB	2, 3	N.I.T.	65,000	35,000	25,000	22,000	—
LD, CLD ④	2, 3, 4	I.T.	65,000	35,000	25,000	22,000	—
HLD	2, 3, 4	I.T.	100,000	65,000	35,000	25,000	—
CHLD ④	2, 3, 4	I.T.	100,000	65,000	35,000	25,000	—
LDC ⑤	2, 3, 4	I.T.	200,000	100,000	50,000	30,000	—
CLDC ④⑤	2, 3, 4	I.T.	200,000	100,000	50,000	30,000	—
HLDDC	3	I.T.	—	—	—	42,000 ⑥	35,000 ⑦

① N.I.T. is non-interchangeable trip; I.T. is interchangeable trip.

② L/R = 8 milliseconds minimum.

③ 2-pole circuit breaker or two poles of 3-pole circuit breaker. Incorporating T/M trip unit only.

④ 100% rated.

⑤ Current limiting.

⑥ 2-poles in series.

⑦ 3-poles in series.

Table 21.3-50. Line and Load Terminals

Maximum Breaker Amperes	Terminal Body Material ⑧	Wire Type	AWG/kcmil Wire Range/Number of Conductors	Metric Wire Range (mm <sup>2</sup> )	Catalog Number
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Standard Cu/Al Pressure Terminals

400	Aluminum	Cu/Al	(1) 4/0 – 600 kcmil	120 – 300	2TA401LDK – 2-Pole Kit ⑨ 3TA401LDK – 3-Pole Kit ⑨ 4TA401LDK – 4-Pole Kit ⑨
500	Aluminum	Cu/Al	(2) 250 – 350 kcmil	120 – 150	TA602LD
600	Aluminum	Cu/Al	(2) 400 – 500 kcmil	185 – 240	2TA603LDK – 2-Pole Kit ⑨ 3TA603LDK – 3-Pole Kit ⑨ 4TA603LDK – 4-Pole Kit ⑨

Optional Copper Pressure Type Terminals

600	Copper	Cu	(2) 250 – 350 kcmil	120 – 150	T602LD
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⑧ UL listed for use with copper or aluminum conductors as noted.

⑨ Terminal kits contain one terminal for each pole and one terminal cover.

**Selection Data — M-Frame**

**M-Frame  
Electronic RMS, 400 – 800 Amperes  
Thermal-Magnetic, 300 – 800 Amperes**



*M-Frame Breaker*

**Table 21.3-51. Dimensions in Inches (mm)**

Width	Height	Depth
8.25 (209.6)	16.00 (406.4)	4.06 (103.2)

**Table 21.3-52. Thermal-Magnetic Trip Ratings**

Frame	Ratings
MDL	300, 400, 450, 500, 600, 700, 800

**Table 21.3-53. Digitrip 310 Electronic Trip Unit Rating Plugs**

Frame	Rating Plugs
MDL	400, 500, 600, 700, 800, 400/800 Adjustable

**Table 21.3-54. UL 489 Interrupting Capacity Ratings**

Circuit Breaker Type	Number of Poles	Type of Trip ①	Interrupting Capacity (rms Symmetrical Amperes)			
			Volts ac (50/60 Hz)			Volts dc ②③
			240	480	600	250
MDL, CMDL ④	2, 3	N.I.T.	65,000	50,000	25,000	22,000
HMDL, CHMDL ④	2, 3	N.I.T.	100,000	65,000	35,000	25,000

- ① N.I.T. is non-interchangeable trip unit.
- ② Two poles or two poles of 3-pole circuit breaker. Thermal-magnetic trip units only, MDL, HMDL breakers with electronic trip unit are not dc rated.
- ③ Time constant is 3 milliseconds minimum at 10 kA and 8 milliseconds minimum at 22 kA.
- ④ 100% rated. Not for use on dc.

**Table 21.3-55. Line and Load Terminals**

Maximum Breaker Amperes	Terminal Body Material ⑤	Wire Type	AWG/kcmil Wire Range/Number of Conductors	Catalog Number
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**Standard Cu/Al Pressure Terminals**

600	Aluminum	Cu/Al	(2) #1 – 500 kcmil	TA700MA1
800	Aluminum	Cu/Al	(3) 3/0 – 400 kcmil	TA800MA2
800	Aluminum	Cu/Al	(2) 500 – 750 kcmil	TA801MA

**Optional Copper and Cu/Al Pressure Type Terminals**

600	Copper	Cu	(2) 2/0 – 500 kcmil	T600MA1
800	Copper	Cu	(3) 3/0 – 300 kcmil	T800MA1

⑤ UL listed for use with copper or aluminum conductors as noted.

Selection Data — N-Frame

**N-Frame**  
**Electronic RMS, 400 – 1200 Amperes**



*N-Frame Breaker*

**Table 21.3-56. Dimensions in Inches (mm)**

Number of Poles	Width	Height	Depth
2, 3	8.25 (209.6)	16.00 (406.4)	5.50 (139.7)
4	11.13 (282.6)	16.00 (406.4)	5.50 (139.7)

**Table 21.3-57. Digitrip 310 Electronic Trip Unit Rating Plugs**

Frame	Rating Plugs
800	400, 450, 500, 600, 700, 800 ①
1200	600, 700, 800, 900, 1000, 1100, 1200 ①

① Adjustable rating plug available.

**Table 21.3-58. Digitrip OPTIM Electronic Trip Unit Rating Plugs**

Frame	Ratings
800	400, 450, 500, 550, 600, 700, 800
1200	600, 700, 800, 1000, 1200

**Table 21.3-59. UL 489 Interrupting Capacity Ratings**

Circuit Breaker Type	Number of Poles	Type of Trip ②	Interrupting Capacity (Symmetrical Amperes)			
			Volts ac (50/60 Hz)			
			240	277	480	600
ND, CND ③	2, 3, 4	N.I.T.	65,000	—	50,000	25,000
HND	2, 3, 4	N.I.T.	100,000	—	65,000	35,000
CHND ③	2, 3, 4	N.I.T.	100,000	—	65,000	35,000
NDC	2, 3, 4	N.I.T.	200,000	—	100,000	50,000
CNDC ③	2, 3, 4	N.I.T.	200,000	—	100,000	50,000

② N.I.T. is non-interchangeable trip unit.

③ 100% rated.

**Table 21.3-60. Line and Load Terminals**

Maximum Breaker Amperes	Terminal Body Material ④	Wire Type	AWG/kcmil Wire Range/Number of Conductors	Metric Wire Range (mm <sup>2</sup> )	Catalog Number
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**Standard Cu/Al Pressure Terminals**

700	Aluminum	Cu/Al	(2) 1 – 500 kcmil	50 – 300	TA700NB1
1000	Aluminum	Cu/Al	(3) 3/0 – 400 kcmil	95 – 185	TA1000NB1
1200	Aluminum	Cu/Al	(4) 4/0 – 500 kcmil	120 – 300	TA1200NB1
1200	Aluminum	Cu/Al	(3) 500 – 750 kcmil	300 – 400	TA1201NB1

**Optional Copper and Cu/Al Pressure Type Terminals**

700	Copper	Cu	(2) 2/0 – 500 kcmil	70 – 300	T700NB1
1000	Copper	Cu	(3) 3/0 – 500 kcmil	95 – 300	T1000NB1
1200	Copper	Cu	(4) 3/0 – 400 kcmil	95 – 185	T1200NB3

④ UL listed for use with copper or aluminum conductors as noted.

**Selection Data — R-Frame**

**R-Frame  
Electronic RMS, 800 – 2500 Amperes**



*R-Frame Breaker*

**Table 21.3-64. UL 489 Interrupting Capacity Ratings**

Circuit Breaker Frame	Number of Poles	Type of Trip ②	Interrupting Capacity (Symmetrical Amperes)			
			Volts ac (50/60 Hz)			
			240	277	480	600
RD	3, 4	N.I.T.	125	—	65	50
CRD ③	3, 4	N.I.T.	125	—	65	50
RDC	3, 4	N.I.T.	200	—	100	65
CRDC ③	3, 4	N.I.T.	200	—	100	65

② N.I.T. is non-interchangeable trip unit.

③ 100% rated versions.

**Table 21.3-65. Line and Load Terminals**

Maximum Breaker Amperes	Terminal Body Material ④	Wire Type	Hardware	AWG/kcmil Wire Range/Number of Conductors	Metric Wire Range (mm <sup>2</sup> )	Catalog Number
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**Wire Terminal**

1600	Aluminum	Cu/Al	English	(4) 500 – 1000 kcmil	300 – 500	<b>TA1600RD</b>
1600	Copper	Cu	English	(4) 1 – 600 kcmil	50 – 300	<b>T1600RD</b>
2000	Aluminum	Cu/Al	English	(6) 2 – 600 kcmil	35 – 300	<b>TA2000RD</b>

④ UL listed for use with copper or aluminum conductors as noted.

**Table 21.3-61. Dimensions in Inches (mm)**

Number of Poles	Width	Height	Depth
3	15.50 (393.7)	16.00 (406.4)	9.75 (247.7)
4	20.00 (508.0)	16.00 (406.4)	9.75 (247.7)

**Table 21.3-62. Digitrip 310 Electronic Trip Unit Rating Plugs**

Frame	Rating Plugs
1600	800, 1000, 1200, 1250, 1400, 1500, 1600 ①
2000	1000, 1200, 1250, 1400, 1600, 2000 ①
2500	1200, 1250, 1600, 2000, 2500 ①

① Adjustable rating plug available.

**Table 21.3-63. Digitrip RMS and Digitrip OPTIM Electronic Trip Unit Rating Plugs**

Frame	Rating Plugs
1600	800, 1000, 1200, 1600
2000	1000, 1200, 1600, 2000
2500	1600, 2000, 2500

Selection Data — Current Limiting

Current Limiting FCL Frame 15 – 100 Amperes, LCL Frame 125 – 400 Amperes

FCL Frame

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FCL Frame Breaker

LCL Frame



LCL Frame Breaker

Interrupting Capacity Ratings

Table 21.3-66. FCL Interrupting Capacity Ratings

Volts ac (50/60 Hz)	Type of Trip ①	Interrupting Capacity (Symmetrical Amperes)
240	N.I.T.	200,000
480	N.I.T.	150,000

① N.I.T. is non-interchangeable trip unit.

Note: On all 3-phase Delta, Ground B phase applications, refer to Eaton.

Terminals

Breakers listed include line and load terminals. Terminals are Underwriters Laboratories listed for wire sizes and types listed below. When used with aluminum cable, use joint compound. To order optional aluminum terminals, add suffix "Z" to breaker catalog number listed.

Table 21.3-67. FCL Terminals

Maximum Breaker Amperes	Wire Type	AWG Wire Range
100	Al/Cu	#14 – 1/0

Standard Pressure Terminals

100	Al/Cu	#14 – 1/0
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Optional Al/Cu Pressure Terminals

50	Al/Cu	#14 – #4
100	Al/Cu	#4 – 4/0

Table 21.3-68. Dimensions in Inches (mm)

Frame	Number of Poles	Width	Height	Depth
FCL	2, 3	4.13 (104.8)	8.75 (222.3)	3.50 (88.9)
LCL, LCLG ②	2, 3	8.25 (209.6)	16.00 (406.4)	4.00 (101.6)

② Breaker with built-in ground fault protection.

Table 21.3-69. Thermal-Magnetic Trip Ratings

Frame	Ratings
FCL	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100

Table 21.3-70. SELTRONIC Electronic Trip Unit Rating Plug

Frame	Ratings
LCL, LCLG ③	125, 150, 175, 200, 225, 250, 275, 300, 350, 400

③ Breaker with built-in ground fault protection.

Listed with Underwriters Laboratories Except as Noted

Type LCL breakers are not defined in Federal Specifications W-C-375-b.

Interrupting Capacity Ratings

Table 21.3-71. LCL Interrupting Capacity Ratings

Volts ac (50/60 Hz)	Type of Trip ④	Interrupting Capacity (Symmetrical Amperes)
240	N.I.T.	200,000
480	N.I.T.	200,000
600	N.I.T.	100,000

④ N.I.T. is non-interchangeable trip unit.

Note: On all 3-phase Delta, Ground B phase applications, refer to Eaton.

Terminals

Two terminals are required per pole. Terminals are Underwriters Laboratories listed for wire type and range listed below. When used with aluminum cable, use joint compound.

Table 21.3-72. LCL Terminals

Maximum Breaker Amperes	AWG/kcmil Wire Range/Number of Conductors	Terminal Catalog Number
225	(1) #6 – 350 kcmil Cu, or (1) #4 – 350 kcmil Al	TA225LA1
400	(1) #4 – 250 kcmil Al/Cu, plus (1) 3/0 – 600 kcmil Cu	TA400LA1

Standard Copper Pressure Terminals

225	(1) #6 – 350 kcmil Cu, or (1) #4 – 350 kcmil Al	TA225LA1
400	(1) #4 – 250 kcmil Al/Cu, plus (1) 3/0 – 600 kcmil Al/Cu	TA400LA1

Optional Al/Cu Pressure Terminals

225	(1) #6 – 350 kcmil Cu, or (1) #4 – 350 kcmil Al	TA225LA1
400	(1) #4 – 250 kcmil Al/Cu, plus (1) 3/0 – 600 kcmil Al/Cu	TA400LA1



**Current Limiting FB TRI-PAC 15-100 Amperes, LA TRI-PAC 70 – 400 Amperes**

**FB TRI-PAC**



**FB TRI-PAC Breaker**

**Listed with Underwriters Laboratories Except as Noted**

TRI-PAC FB breakers meet the requirements for Class 16a, 16b, 17a and 26a circuit breakers as defined in Federal Specification W-C-375b.

**Interrupting Capacity Ratings**

**Underwriters Laboratories Listed**

600 Vac maximum: 200,000 amperes symmetrical.

**Based on NEMA Test Procedures**

250 Vdc maximum: 100,000 amperes.

**Note:** On all 3-phase Delta, Ground B phase applications, refer to Eaton.

**Terminals**

Breakers listed include line and load terminals. Terminals are Underwriters Laboratories listed for wire sizes and types listed below. When used with aluminum cable, use joint compound. To order optional aluminum terminals, add suffix "Z" to breaker catalog number listed.

**Table 21.3-73. FB TRI-PAC Terminals**

Maximum Breaker Amperes	Wire Type	AWG Wire Range
100	Al/Cu	(1) #14 – 1/0

**Standard Pressure Terminals**

100	Al/Cu	(1) #14 – 1/0
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**Optional Al/Cu Pressure Terminals**

50	Al/Cu	(1) #14 – #4
100	Al/Cu	(1) #4 – 4/0

**LA TRI-PAC**



**LA TRI-PAC Breaker**

**Listed with Underwriters Laboratories Except as Noted**

TRI-PAC LA breakers meet the requirements for Class 16a, 16b, 17a and 26a circuit breakers as defined in Federal Specification W-C-375b.

**Interrupting Capacity Ratings**

**Underwriters Laboratories Listed**

600 Vac maximum: 200,000 amperes symmetrical.

**Based on NEMA Test Procedures**

250 Vdc maximum: 100,000 amperes.

**Note:** On all 3-phase Delta, Grounded B phase applications, refer to Eaton.

**Terminals**

Two terminals are required per pole. Terminals are Underwriters Laboratories listed for wire size and type listed below. When used with aluminum conductors, use joint compound. To order optional aluminum terminals, add suffix "Z" to complete breaker catalog number.

**Table 21.3-76. LA TRI-PAC Terminals**

Maximum Breaker Amperes	AWG/kcmil Wire Range/Number of Conductors	Terminal Catalog Number
225	(1) #6 – 350 kcmil Cu	T225LA
225	(1) #6 – 250 kcmil Cu	T225LBF
400	(1) #4 – 250 kcmil Cu, plus (1) 3/0 – 600 kcmil Cu	T401LA

**Standard Copper Pressure Terminals**

225	(1) #6 – 350 kcmil Cu, or (1) #4 – 350 kcmil Al/Cu	TA225LA1
400	(1) #4 – 250 kcmil Al/Cu, plus (1) 3/0 – 600 kcmil Al/Cu	TA400LA1

**Optional Al/Cu Pressure Terminals**

225	(1) #6 – 350 kcmil Cu, or (1) #4 – 350 kcmil Al/Cu	TA225LA1
400	(1) #4 – 250 kcmil Al/Cu, plus (1) 3/0 – 600 kcmil Al/Cu	TA400LA1

**Table 21.3-74. Dimensions in Inches (mm)**

Frame	Number of Poles	Width	Height	Depth
FB	2, 3	4.13 (104.8)	8.75 (222.3)	3.50 (88.9)
LA	2, 3	8.13 (206.4)	16.00 (406.4)	7.75 (196.9)

**Table 21.3-75. Thermal-Magnetic Trip Ratings**

Frame	Ratings
FB TRI-PAC	15, 20, 30, 40, 50, 60, 70, 90, 100
LA TRI-PAC	70, 90, 100, 125, 150, 175, 200, 225, 250, 300, 350, 400

Selection Data — Current Limiting

Current Limiting NB TRI-PAC 300 – 800 Amperes, PB TRI-PAC 600 – 1600 Amperes

NB TRI-PAC

PB TRI-PAC

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NB TRI-PAC Breaker



PB TRI-PAC Breaker

Listed with Underwriters Laboratories Except as Noted

TRI-PAC NB breakers meet the requirements for Class 16b, 17a and 26a circuit breakers as defined in Federal Specification W-C-375b.

Interrupting Capacity Ratings

Underwriters Laboratories Listed

600 Vac maximum: 200,000 amperes symmetrical.

Based on NEMA Test Procedures

250 Vdc maximum: 100,000 amperes.

Note: On all 3-phase Delta, Grounded B phase applications, refer to Eaton.

Terminals

Two terminals are required per pole. Terminals are Underwriters Laboratories listed for wire size and type listed below. When used with aluminum conductors, use joint compound. To order optional aluminum terminals, add suffix "Z" to complete breaker catalog number.

Table 21.3-77. NB TRI-PAC Terminals

Maximum Ampere Rating	AWG/kcmil Wire Range/Number of Conductors	Terminal Catalog Number
350	1 #1 – 600 kcmil Cu	T350NB
700	2 2/0 – 500 kcmil Cu	T700NB1
800	3 3/0 – 500 kcmil Cu	T1000NB1

Standard Copper Pressure Terminals

350	1 #1 – 600 kcmil Cu	T350NB
700	2 2/0 – 500 kcmil Cu	T700NB1
800	3 3/0 – 500 kcmil Cu	T1000NB1

Optional Al/Cu Pressure Terminals

700	2 #1 – 500 kcmil Al/Cu	TA700NB1
800	3 3/0 – 400 kcmil Al/Cu	TA1000NB1
800	3 500 – 750 kcmil Al/Cu	TA1201NB1

Table 21.3-78. Dimensions in Inches (mm)

Frame	Number of Poles	Width	Height	Depth
NB	2, 3	8.25 (209.6)	22.00 (558.8)	5.50 (139.7)
PB	2, 3	12.06 (306.4)	22.13 (562.0)	9.06 (230.2)

Table 21.3-79. Thermal-Magnetic Trip Ratings

Frame	Ratings
NB TRI-PAC	300, 350, 400, 500, 600, 700, 800
PB TRI-PAC	600, 700, 800, 900, 1000, 1200, 1400, 1600

Listed with Underwriters Laboratories Except as Noted

TRI-PAC PB breakers meet the requirements for Class 17a and 26a circuit breakers as defined in Federal Specification W-C-375b.

Interrupting Capacity Ratings

Underwriters Laboratories Listed

600 Vac maximum: 200,000 amperes symmetrical.

Based on NEMA Test Procedures

250 Vdc maximum: 100,000 amperes.

Note: On all 3-phase Delta, Ground B phase applications, refer to Eaton.

Bus Bar Connectors

"T" Connector for Cu/Al Bus

Two required per pole. For rear bus connection. Accepts up to four bus bolts. May be rotated 90°.



"T" Connector for Cu/Al Bus

Cable Connector (Optional)

For "T" Connector. Accepts four 600 kcmil copper cables.



Optional Cable Connector

Selection Data — Earth Leakage

Earth Leakage Circuit Breakers  
F-, J- and K- Frame, Thermal-  
Magnetic, 15 – 400 Amperes



Earth Leakage Circuit Breaker

Table 21.3-80. Dimensions in Inches (mm)

Frame	Width	Height	Depth
<b>3-Pole</b>			
F	4.13 (105.0)	11.20 (284.5)	4.14 (105.2)
J	4.13 (105.0)	13.70 (348.0)	4.94 (125.5)
K	5.51 (140.0)	13.84 (351.5)	4.91 (124.7)
<b>4-Pole</b>			
F	5.51 (140.0)	11.20 (284.5)	4.14 (105.2)
J	5.51 (140.0)	13.70 (348.0)	4.94 (125.5)
K	7.20 (183.0)	13.84 (351.5)	4.91 (124.7)

**Note:** All dimensions are provided for guidance and should not be used for construction purposes unless approved.

Table 21.3-81. Thermal-Magnetic Trip Ratings

Frame	Ratings
F	15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150
J	100, 125, 150, 175, 200, 225, 250
K	200, 225, 250, 300, 350, 400

Table 21.3-82. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	No. of Poles	Type of Trip ①	Interrupting Capacity (kA Symmetrical Amperes)	
			Volts ac (50/60 Hz)	
			240	480
ELFD	3, 4	N.I.T.	65	25
ELHFD	3, 4	N.I.T.	100	65
ELFDC ②	3, 4	N.I.T.	200	100
ELJD	3, 4	N.I.T.	65	35
ELHJD	3, 4	N.I.T.	100	65
ELJDC ②	3, 4	N.I.T.	200	100
ELKD	3, 4	N.I.T.	65	35
ELHKD	3, 4	N.I.T.	100	65
ELKDC ②	3, 4	N.I.T.	200	100

① N.I.T. is non-interchangeable trip unit and breaker is factory sealed.  
② Current limiting.

Table 21.3-83. Standard Line and Load Terminals — Included with Breakers

Frame	Amperes	Terminal Body Material ③	Wire Type	AWG/kcmil Wire Range/Number of Conductors	Poles
F	15 – 100	Steel	Cu/Al	(1) #14 – 1/0	3, 4
F	110 – 150	Stainless Steel	Cu/Al	(1) #4 – 4/0	3, 4
J	100 – 250	Aluminum	Cu/Al	(1) #4 – 250 kcmil	3, 4
K	200 – 350	Aluminum	Cu/Al	(1) 250 – 250 kcmil	3, 4
K	400	Aluminum	Cu/Al	(1) 3/0 – 250 kcmil	3, 4

③ UL listed for use with copper or aluminum conductors as noted.

Table 21.3-84. Optional K-Frame Line and Load Terminals

Terminal Body Material ④	Wire Type	AWG/kcmil Wire Range/Number of Conductors	Number of Poles	Kit Quantity	Catalog Number
Aluminum	Cu/Al	(2) 250 kcmil	3	2	3TA401K
Aluminum	Cu/Al	(1) 500 kcmil	3	2	3TA401K
Aluminum	Cu/Al	(2) 250 kcmil	4	2	4TA401K
Aluminum	Cu/Al	(1) 500 kcmil	4	2	4TA401K
Copper	Cu	(1) 3 – 350 kcmil	3	6	T300K
Copper	Cu	(1) 3 – 350 kcmil	4	8	T300K
Copper	Cu	(1) 250 – 500 kcmil	3	6	T350K
Copper	Cu	(1) 250 – 500 kcmil	4	8	T350K
Copper	Cu	(1) 3/0 – 250 kcmil	3	2	3T400K
Copper	Cu	(1) 3/0 – 250 kcmil	4	2	3T400K

④ UL listed for use with copper or aluminum conductors as noted.

Application Notes

Eaton's Cutler-Hammer Earth Leakage Breakers offer superior Class 1 ground fault protection and improved ground fault coordination capability.

Earth leakage ground fault protection differs from other types of systems in its level of sensitivity. The sensitivity of traditional devices is limited by the cumulative error of the residual current sensors and the placement of the phase and neutral conductors inside the current sensor.

Leakage breakers are zero sequence sensing devices. They are factory supplied with a single sensor and ground fault relay built-in. This technique allows for protection sensitivities down to the 30 milliamper level.

Leakage breakers are provided with a full complement of easy adjustments. The ground fault pickup setting is adjustable from .03 to 30 amperes in eight steps, and the ground fault time delay setting is adjustable from instantaneous to 2.0 seconds in six steps. When the pickup is set to 30 mA, the time delay setting defaults internally to instantaneous only. Increased selectivity provides for improved coordination with upstream and downstream ground fault devices, as well as the flexibility to adjust for transient currents.

Three-Phase, Four-Wire Loads

For 3-phase applications with line-to-neutral loads, select 4-pole earth leakage breakers and wire the neutral through the fourth (right) pole.

Three-Phase, Three-Wire Loads

For applications with only 3-phase, 3-wire, line-to-line connected loads, select 3-pole earth leakage breakers.

Single-Phase Loads

For single-phase, 2-wire or 3-wire applications, use a 3-pole earth leakage breaker and connect all conductors through the breaker.

Motor Circuit Protectors, 3 – 1200 Amperes

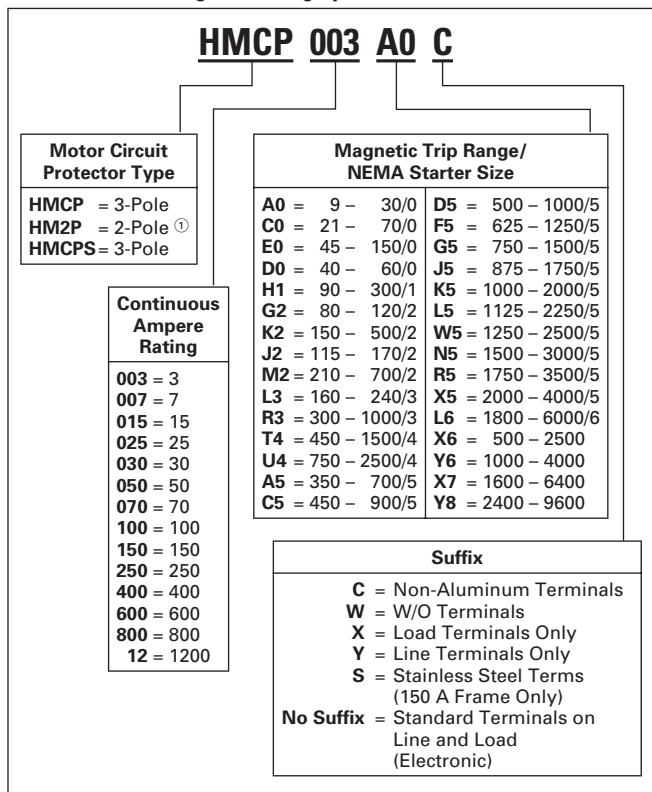


Motor Circuit Protectors 3 – 1200 Amperes

Catalog Numbering System

Note: This information is presented only as an aid to understanding catalog numbers. It is not to be used to build catalog numbers for circuit breakers or trip units.

Table 21.3-85. Catalog Numbering System — HMCP



① On J- and K-Frame HMCPs only.

Table 21.3-86. Catalog Numbering System — GMCP/HMCPPE

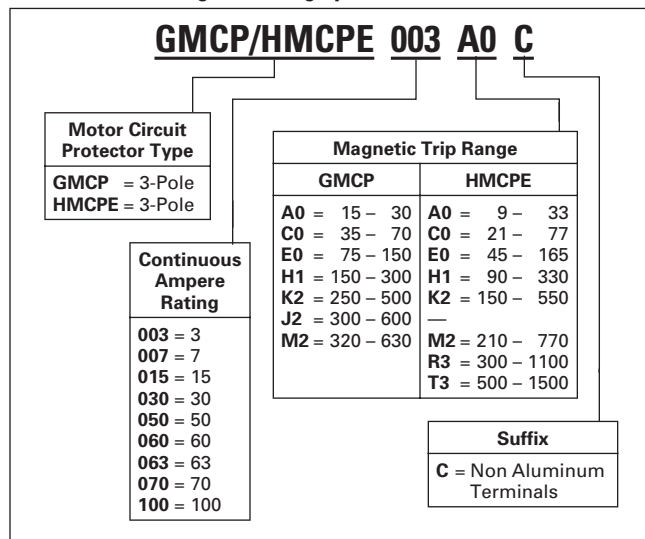


Table 21.3-87. 600 Vac Maximum, 250 Vdc Minimum

Continuous Amperes	MCP Trip Range (Amperes)	MCP Catalog Number
<b>JG-Frame ①</b>		
250	500 – 1000 625 – 1250 750 – 1500	HMCPJ250D5L HMCPJ250F5L HMCPJ250G5L
	875 – 1750 1000 – 2000 1125 – 2250 1250 – 2500	HMCPJ250J5L HMCPJ250K5L HMCPJ250L5L HMCPJ250W5L
<b>LG-Frame ①②</b>		
600	1125 – 2250 1500 – 3000 1750 – 3500	HMCPJ600L HMCPJ600N HMCPJ600R
	2000 – 4000 2250 – 4500 2500 – 5000 3000 – 6000	HMCPJ600X HMCPJ600Y HMCPJ600P HMCPJ600M

① UL listed for use with Cutler-Hammer Motor Starters.

② Equipped with an electronic trip device.

## General Information

Designated as the Eaton's Cutler-Hammer Types GMCP, HMCPE and HMCP are instantaneous-only motor circuit protectors. The GMCP and HMCPE are 480V devices rated between 3 – 100 amperes. The HMCP is a 600V device available in four frames and rated between 3 – 600 amperes. The MCP is designed to comply with the applicable requirements of Underwriters Laboratories Standard UL 489, Canadian Standards Association Standard C22.2 No. 5, and International Electrotechnical Commission Recommendations IEC 157-1.

An innovative design of internal components allows higher MCP-starter combination interrupting ratings. The MCP is marked to permit proper electrical application within the assigned equipment ratings.

The MCP is a recognized component (UL File E7819) and complies with the applicable requirements of Underwriters Laboratories Standard UL 489. It is also designed to comply with the applicable requirements of Canadian Standards Association Standard C22.2 No. 5, and International Electrotechnical Commission Recommendations IEC 157-1. The interrupting rating is defined on the assembled equipment nameplate.

## Accessories

### Termination Accessories

- Line and load terminals.
- Keeper nut/plug nut.
- Control wire terminal kit.
- Base mounting hardware.
- Terminal shields.
- Terminal end covers.
- Interphase barriers.
- ELC current limiter.
- Multiwire connector.

### Internal Accessories

- Only one internal accessory per pole maximum.
- Alarm lockout (Make/Break).
- Alarm lockout (2Make/2Break).
- Auxiliary switch (1A, 1B).
- Auxiliary switch (2A, 2B).
- Auxiliary switch/alarm lockout.
- Shunt Trip — standard.
- Shunt Trip — low energy.
- Undervoltage release mechanism.

### External Accessories

- Non-padlockable handle block.
- Padlockable handle block.
- Padlockable handle lock hasp.
- Key interlock kit.
- Sliding bar interlock — requires two breakers.
- Electrical (solenoid) operator.
- Handle mechanism.
- Door hardware/accessories.
- DIN rail adapter (GMCP only).

### Modifications

- Moisture fungus treatment.
- Freeze test.

**Selection Data — Motor Circuit Protectors**

**Motor Protection**

**Note:** These recommendations are based on previous code interpretations. See the current NEC for exact up-to-date information.

In line with NEC 430-6(a), circuit breaker, HMCP and fuse rating selections are based on full-load currents for induction motors running at speeds normal for belted motors and motors with normal torque characteristics using data shown taken from NEC table 430-150 (3-phase). Actual motor nameplate ratings shall be used for selecting motor running overload protection. Motors built special for low speeds, high torque characteristics, special starting conditions and applications will require other considerations as defined in the application section of the NEC.

Circuit breaker, HMCP and fuse ampere rating selections are in line with maximum rules given in NEC 430-52 and Table 430-152. Based on known characteristics of Eaton's Cutler-Hammer type breakers, specific units are recommended. The current ratings are no more than the maximum limits set by the NEC rules for motors with code letters F to V or without code letters. Motors with lower code letters will require further considerations.

In general, these selections were based on:

1. Ambient — outside enclosure not more than 40°C (104°F).
2. Motor starting — infrequent starting, stopping or reversing.
3. Motor accelerating time — 10 seconds or less.
4. Locked rotor — maximum six times motor FLA.
5. Type HMCP motor circuit protector may not set at more than 1300% of the motor full-load current, to comply with the NEC, Sec. 430-52. (Except for new E rated motor which can be set up to 1700%.)

Circuit breaker selections are based on types with standard interrupting ratings. Higher interrupting rating types may be required to satisfy specific system application requirements.

For motor full load currents of 208 and 200 volts, increase the corresponding 230-volt motor values by 10 and 15% respectively.

**Table 21.3-88. Motor Circuit Protector (MCP), Circuit Breaker and Fusible Switch Selection Guide**

Hp	Full Load Amperes (NEC) FLA	Fuse Size NEC 430-152 Maximum Amperes <sup>①</sup>		Recommended Cutler-Hammer MCPs & Circuit Breakers			
		Time Delay	Non-Time Delay	Circuit Breaker <sup>②</sup>		Motor Circuit Protector Type HMCP <sup>③</sup>	
				Amperes	Type	Amperes	Adj. Range
<b>230 Volts, 3-Phase</b>							
1	3.6	10	15	15	HFD	7	21 – 70
1-1/2	5.2	10	20	15	HFD	7	21 – 70
2	6.8	15	25	15	HFD	15	45 – 150
3	9.6	20	30	20	HFD	15	45 – 150
5	15.2	30	50	30	HFD	30	90 – 300
7-1/2	22	40	70	50	HFD	30	90 – 300
10	28	50	90	60	HFD	50	150 – 500
15	42	80	150	90	HFD	70	210 – 700
20	54	100	175	100	HFD	100	300 – 1000
25	68	125	225	125	HFD	100	300 – 1000
30	80	150	250	150	HFD	150	450 – 1500
40	104	200	350	150	HFD	150	450 – 1500
50	130	250	400	200	HFD	150	750 – 2500
60	154	300	500	225	HFD	250	1250 – 2500
75	192	350	600	300	HKD	400	2000 – 4000
100	248	450	800	400	HKD	600	1800 – 6000
125	312	600	1000	500	HLD	600	1800 – 6000
150	360	700	1200	600	HLD	—	—
200	480	1000	1600	700	HND	—	—
<b>460 Volts, 3-Phase</b>							
1	1.8	6	6	15	HFD	3	9 – 30
1-1/2	2.6	6	10	15	HFD	7	21 – 70
2	3.4	6	15	15	HFD	7	21 – 70
3	4.8	10	15	15	HFD	7	21 – 70
5	7.6	15	25	15	HFD	15	45 – 150
7-1/2	11	20	35	25	HFD	15	45 – 150
10	14	25	45	35	HFD	30	90 – 300
15	21	40	70	45	HFD	30	90 – 300
20	27	50	90	50	HFD	50	150 – 500
25	34	60	110	70	HFD	50	150 – 500
30	40	70	125	70	HFD	70	210 – 700
40	52	100	175	100	HFD	100	300 – 1000
50	65	125	200	110	HFD	100	300 – 1000
60	77	150	150	250	HFD	150	450 – 1500
75	96	175	300	150	HJD	150	450 – 1500
100	124	225	400	175	HJD	150	750 – 2500
125	156	300	500	225	HJD	250	1250 – 2500
150	180	350	600	250	HJD	250	1250 – 2500
200	240	450	800	350	HKD	400	2000 – 4000
<b>575 Volts, 3-Phase</b>							
1	1.4	3	6	15	HFD	3	9 – 30
1-1/2	2.1	6	10	15	HFD	3	9 – 30
2	2.7	6	10	15	HFD	7	21 – 70
3	3.9	10	15	15	HFD	7	21 – 70
5	6.1	15	20	15	HFD	15	45 – 150
7-1/2	9	20	30	20	HFD	15	45 – 150
10	11	20	35	25	HFD	15	45 – 150
15	17	30	60	40	HFD	30	90 – 300
20	22	40	70	50	HFD	50	150 – 500
25	27	50	90	60	HFD	50	150 – 500
30	32	60	100	60	HFD	50	150 – 500
40	41	80	125	80	HFD	70	210 – 700
50	52	100	175	100	HFD	100	300 – 1000
60	62	110	200	125	HFD	100	300 – 1000
75	77	150	250	150	HFD	150	450 – 1500
100	99	175	300	175	HJD	150	450 – 1500
125	125	225	400	200	HJD	250	875 – 1750
150	144	300	450	225	HJD	250	1250 – 2500
200	192	350	600	300	HKD	400	2000 – 4000

① Consult fuse manufacturer's catalog for smaller fuse ratings.

② Types are for minimum interrupting capacity breakers. Ensure that the fault duty does not exceed breakers I.C.

③ Designers should verify and specify motor inrush currents to fall within the magnetic pick-up range, or use a higher range product.

**Motor Circuit Protector Catalog Numbers and Ranges**

The following tables provide specific catalog numbers and application ranges for the G-Frame (GMCP), E-Frame (HMCPE), J-Frame (HMCP) and K-Frame (HMCP) motor circuit protectors. Motor circuit protector models are available with earth leakage ground fault protection. Models are also available for motor starters provided with electronic overload relays rather than thermal overload relays, such as the Eaton's Cutler-Hammer Advantage™ motor starter.

Similar tables for the selection of the settings are provided with motor control products which use motor circuit protectors. As required by the NEC, the HMCP setting is selected by using the actual full load ampere data from the motor nameplate. The corresponding trip settings provided are within 13 times the minimum full load amperes of the motor as required by the NEC. The NEC allows a higher setting for Design E motors.

**Table 21.3-89. G-Frame**

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes ①	MCP Trip Setting
GMCP003A0C	0, 1	3	A	1.1 – 1.2	15
			B	1.3 – 1.5	18
			C	1.6 – 1.7	21
			D	1.8 – 1.9	24
			E	2.0 – 2.2	27
			F	2.3 – 2.5	30
GMCP007C0C	0, 1	7	A	2.6 – 3.1	35
			B	3.2 – 3.6	42
			C	3.7 – 3.9	49
			D	4.3 – 4.7	56
			E	4.8 – 5.2	63
			F	5.3 – 5.7	70
GMCP015E0C	0, 1	15	A	5.7 – 6.8	75
			B	6.9 – 7.9	90
			C	8.0 – 9.1	105
			D	9.2 – 10.3	120
			E	10.4 – 11.4	135
			F	11.5 – 12.6	150
GMCP030H1C	1	30	A	12.7 – 13.7	150
			B	13.8 – 16.0	180
			C	16.1 – 18.3	210
			D	18.4 – 20.6	240
			E	20.7 – 22.9	270
			F	23.0 – 25.2	300
GMCP050K2C	2	50	A	19.3 – 22.9	250
			B	23.0 – 26.8	300
			C	26.9 – 30.6	350
			D	30.7 – 34.5	400
			E	34.6 – 38.3	450
			F	38.4 – 42.1	500
GMCP060J2C	3	60	A	23.1 – 27.5	300
			B	27.7 – 32.2	360
			C	32.3 – 36.7	420
			D	36.9 – 41.4	480
			E	41.5 – 46.0	540
			F	46.2 – 50.5	600
GMCP063M2C	3	63	A	24.2 – 32.1	320
			B	29.1 – 34.8	380
			C	33.9 – 39.4	440
			D	38.8 – 46.4	500
			E	43.6 – 48.9	570
			F	48.5 – 53.7	630

① Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.

**Table 21.3-90. E-Frame**

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes ②	MCP Trip Setting ③
HMCPE003A0C	0	3	A	.69 – .91	9
			B	1.1 – 1.3	15
			C	1.6 – 1.7	21
			D	2.0 – 2.2	27
			E	2.3 – 2.5	30
			F	2.3 – 2.6	33
HMCPE007C0C	0	7	A	1.5 – 2.0	21
			B	2.6 – 3.1	35
			C	3.7 – 3.9	49
			D	4.8 – 5.2	63
			E	5.3 – 5.7	70
			F	5.8 – 6.1	77
HMCPE015E0C	0	15	A	3.4 – 4.5	45
			B	5.7 – 6.8	75
			C	8.0 – 9.1	105
			D	10.4 – 11.4	135
			E	11.5 – 12.6	150
			F	12.7 – 13.0	165
HMCPE030H1C	1	30	A	3.9 – 9.1	90
			B	11.5 – 13.7	150
			C	16.1 – 18.3	210
			D	20.7 – 22.9	270
			E	23.0 – 25.2	300
			F	25.3 – 26.1	330
HMCPE050K2C	2	50	A	11.5 – 15.2	150
			B	19.2 – 22.9	250
			C	26.9 – 30.6	350
			D	34.6 – 38.3	450
			E	38.4 – 42.1	500
			F	42.2 – 43.5	550
HMCPE070M2C	2	70	A	16.1 – 30.6	210
			B	26.9 – 32.2	350
			C	37.6 – 42.9	490
			D	48.4 – 53.7	630
			E	53.8 – 59.1	700
			F	59.2 – 60.9	770
HMCPE100R3C	3	10 0	A	23.0 – 30.6	300
			B	38.4 – 46.0	500
			C	53.8 – 61.4	700
			D	69.2 – 76.8	900
			E	76.9 – 84.5	1000
			F	84.6 – 87.0	1100
HMCPE100T3C	3	10 0	A	38.4 – 46.0	500
			B	53.8 – 61.4	700
			C	69.2 – 76.8	900
			D	84.6 – 76.8	110
			E	④	1300
			F	④	1500

② Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.

③ For dc applications, actual trip levels are approximately 40% higher than values shown.

④ Settings above 10x I<sub>N</sub> are for special applications. NEC Article 430-110(a) requires the ampere rating of the disconnecting means to be no less than 115% of the motor full load ampere rating.

Selection Data — Motor Circuit Protectors

Table 21.3-91. F-Frame (Also Available with Earth Leakage Ground Fault)

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes <sup>①</sup>	MCP Trip Setting <sup>②</sup>
HMCP003A0	0, 1	3	A	.69 – .91	9
			B	.92 – 1.0	12
			C	1.1 – 1.2	15
			D	1.3 – 1.5	18
			E	1.6 – 1.7	21
			F	1.8 – 1.9	24
			G	2.0 – 2.2	27
			H	2.3 – 2.5	30
HMCP007C0	0, 1	7	A	1.5 – 2.0	21
			B	2.1 – 2.5	28
			C	2.6 – 3.1	35
			D	3.2 – 3.6	42
			E	3.7 – 3.9	49
			F	4.3 – 4.7	56
			G	4.8 – 5.2	63
			H	5.3 – 5.7	70
HMCP015E0	0, 1	15	A	3.4 – 4.5	45
			B	4.6 – 5.6	60
			C	5.7 – 6.8	75
			D	6.9 – 7.9	90
			E	8.0 – 9.1	105
			F	9.2 – 10.3	120
			G	10.4 – 11.4	135
			H	11.5 – 12.6	150
HMCP030H1	1	30	A	6.9 – 9.1	90
			B	9.2 – 11.4	120
			C	11.5 – 13.7	150
			D	13.8 – 16.0	180
			E	16.1 – 18.3	210
			F	18.4 – 20.6	240
			G	20.7 – 22.9	270
			H	23.0 – 25.2	300
HMCP050K2	2	50	A	11.5 – 15.2	150
			B	15.3 – 19.1	200
			C	19.2 – 22.9	250
			D	23.0 – 26.8	300
			E	26.9 – 30.6	350
			F	30.7 – 34.5	400
			G	34.6 – 38.3	450
			H	38.4 – 42.1	500

① Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.

② For dc applications, actual trip levels are approximately 40% higher than values shown.

(Continued)

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes <sup>③</sup>	MCP Trip Setting <sup>③</sup>
HMCP070M2	2	70	A	16.1 – 21.4	210
			B	21.5 – 26.8	280
			C	26.9 – 32.2	350
			D	32.3 – 37.5	420
			E	37.6 – 42.9	490
			F	43.0 – 48.3	560
			G	48.4 – 53.7	630
			H	53.8 – 59.1	700
HMCP100R3	3	100	A	23.0 – 30.6	300
			B	30.7 – 38.3	400
			C	38.4 – 46.0	500
			D	46.1 – 53.7	600
			E	53.8 – 61.4	700
			F	61.5 – 69.1	800
			G	69.2 – 76.8	900
			H	76.9 – 84.5	1000
HMCP150T4	4	150	A	34.6 – 46.0	450
			B	46.1 – 57.5	600
			C	57.6 – 69.1	750
			D	69.2 – 80.6	900
			E	80.7 – 92.2	1050
			F	92.3 – 103.7	1200
			G	103.8 – 115.2	1350
			H	115.3 – 126.7	1500
HMCP150U4	4	150	A	57.0 – 75.0	750
			B	76.0 – 95.0	1000
			C	96.0 – 114.0	1250
			D	115.0 – 130.7	1500
			E	④	1750
			F	④	2000
			G	④	2250
			H	④	2500

③ Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.

④ For dc applications, actual trip levels are approximately 40% higher than values shown.



**Selection Data — Motor Circuit Protectors**

**Table 21.3-92. MCPs for Application with Motor Starters Equipped with Electronic Overload Relays (Also available with Earth Leakage Ground Fault)**

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes <sup>①</sup>	MCP Trip Setting <sup>②</sup>
HMCP5003A0	0, 1	3	A	.69 – .91	9
			B	.92 – 1.0	12
			C	1.1 – 1.2	15
			D	1.3 – 1.5	18
			E	1.6 – 1.7	21
			F	1.8 – 1.9	24
			G	2.0 – 2.2	27
			H	2.3 – 2.5	30
HMCP5007C0	0, 1	7	A	1.5 – 2.0	21
			B	2.1 – 2.5	28
			C	2.6 – 3.1	35
			D	3.2 – 3.6	42
			E	3.7 – 3.9	49
			F	4.3 – 4.7	56
			G	4.8 – 5.2	63
			H	5.3 – 5.7	70
HMCP5015E0C	0, 1	15	A	3.4 – 4.5	45
			B	4.6 – 5.6	60
			C	5.7 – 6.8	75
			D	6.9 – 7.9	90
			E	8.0 – 9.1	105
			F	9.2 – 10.3	120
			G	10.4 – 11.4	135
			H	11.5 – 12.6	150
HMCP5030H1C	1	30	A	6.9 – 9.1	90
			B	9.2 – 11.4	120
			C	11.5 – 13.7	150
			D	13.8 – 16.0	180
			E	16.1 – 18.3	210
			F	18.4 – 20.6	240
			G	20.7 – 22.9	270
			H	23.0 – 25.2	300

<sup>①</sup> Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.  
<sup>②</sup> For dc applications, actual trip levels are approximately 40% higher than values shown.

(Continued)

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes <sup>③</sup>	MCP Trip Setting <sup>④</sup>
HMCP5050K2C	2	50	A	11.5 – 15.2	150
			B	15.3 – 19.1	200
			C	19.2 – 22.9	250
			D	23.0 – 26.8	300
			E	26.9 – 30.6	350
			F	30.7 – 34.5	400
			G	34.6 – 38.3	450
			H	38.4 – 42.1	500
HMCP5100R3C	3	100	A	23.0 – 30.6	300
			B	30.7 – 38.3	400
			C	38.4 – 46.0	500
			D	46.1 – 53.7	600
			E	53.8 – 61.4	700
			F	61.5 – 69.1	800
			G	69.2 – 76.8	900
			H	76.9 – 84.5	1000
HMCP5150T4C	4	150	A	34.6 – 46.0	450
			B	46.1 – 57.5	600
			C	57.6 – 69.1	750
			D	69.2 – 80.6	900
			E	80.7 – 92.2	1050
			F	92.3 – 103.7	1200
			G	103.8 – 115.2	1350
			H	115.3 – 126.7	1500
HMCP5150U4C	4	150	A	57.0 – 75.0	750
			B	76.0 – 95.0	1000
			C	96.0 – 114.0	1250
			D	115.0 – 130.7	1500
			E	<sup>⑤</sup>	1750
			F	<sup>⑤</sup>	2000
			G	<sup>⑤</sup>	2250
			H	<sup>⑤</sup>	2500

<sup>③</sup> Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.  
<sup>④</sup> For dc applications, actual trip levels are approximately 40% higher than values shown.  
<sup>⑤</sup> Settings above 130 amperes are for special applications. NEC Article 430-110(a) requires the ampere rating of the disconnecting means to be not less than 115% of the motor full load ampere rating.

Selection Data — Motor Circuit Protectors

Table 21.3-93. J-Frame (Also available with Earth Leakage Ground Fault)

MCP Catalog Number ①	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes ②	MCP Trip Setting ③
HMCP250A5	4	250	A	27.0 – 30.7	350
			B	30.8 – 33.8	400
			C	33.9 – 36.9	440
	5		D	37.0 – 40.3	480
			E	40.4 – 43.8	525
			F	43.9 – 46.9	570
	5		G	47.0 – 50.7	610
			H	50.8 – 53.8	660
			I	53.9 – 57.2	700
HMCP250C5	5	250	A	34.7 – 38.8	450
			B	38.9 – 43.4	505
			C	43.5 – 47.6	565
	5		D	47.7 – 52.2	620
			E	52.3 – 56.5	680
			F	56.6 – 60.7	735
	5		G	60.8 – 64.9	790
			H	65.0 – 69.2	845
			I	69.3 – 73.5	900
HMCP250D5	5	250	A	38.5 – 43.4	500
			B	43.5 – 48.0	565
			C	48.1 – 53.0	625
	5		D	53.1 – 57.6	690
			E	57.7 – 62.3	750
			F	62.4 – 67.3	810
	5		G	67.4 – 71.9	875
			H	72.0 – 76.9	935
			I	77.0 – 81.6	1000
HMCP250F5	5	250	A	48.1 – 53.8	625
			B	53.9 – 59.9	700
			C	60.0 – 66.1	780
	5		D	66.2 – 72.3	860
			E	72.4 – 78.4	940
			F	78.5 – 83.8	1020
	5		G	83.9 – 89.9	1090
			H	90.0 – 96.1	1170
			I	96.2 – 102.0	1250
HMCP250G5	5	250	A	57.7 – 64.6	750
			B	64.7 – 71.9	840
			C	72.0 – 79.2	935
	5		D	79.3 – 86.5	1030
			E	86.6 – 93.8	1125
			F	93.9 – 101.1	1220
	5		G	101.2 – 108.4	1315
			H	108.5 – 115.3	1410
			I	115.4 – 122.4	1500

- ① Three-pole catalog numbers shown. Two-pole catalog numbers begin with "HM2P" in place of "HMCP."
- ② Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.
- ③ For dc applications, actual trip levels are approximately 40% higher than values shown.

(Continued)

MCP Catalog Number ④	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes ⑤	MCP Trip Setting ⑥
HMCP250J5	5	250	A	67.4 – 75.3	875
			B	75.4 – 83.8	980
			C	83.9 – 92.3	1090
	5		D	92.4 – 100.7	1200
			E	100.8 – 109.2	1310
			F	109.3 – 117.6	1420
	5		G	117.7 – 126.1	1530
			H	126.2 – 134.6	1640
			I	134.7 – 142.8	1750
HMCP250K5	5	250	A	77.0 – 86.5	1000
			B	86.6 – 96.1	1125
			C	96.2 – 105.7	1250
	5		D	105.8 – 115.3	1375
			E	115.4 – 124.9	1500
			F	125.0 – 134.6	1625
	5		G	134.7 – 144.2	1750
			H	144.3 – 153.8	1875
			I	153.9 – 163.3	2000
HMCP250L5	5	250	A	86.6 – 97.3	1125
			B	97.4 – 108.4	1265
			C	108.5 – 118.8	1410
	5		D	118.9 – 129.9	1545
			E	130.0 – 140.7	1690
			F	140.8 – 151.5	1830
	5		G	151.6 – 162.3	1970
			H	162.4 – 173.0	2110
			I	173.1 – 183.6	2250
HMCP250W5	5	250	A	96.2 – 108.0	1250
			B	108.1 – 119.9	1405
			C	120.0 – 132.3	1560
	5		D	132.4 – 144.2	1720
			E	144.3 – 156.1	1875
			F	156.2 – 168.0	2030
	5		G	168.1 – 179.9	2185
			H	180.0 – 192.3	2340
			I	192.4 – 204.0	2500

- ④ Three-pole catalog numbers shown. Two-pole catalog numbers begin with "HM2P" in place of "HMCP."
- ⑤ Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.
- ⑥ For dc applications, actual trip levels are approximately 40% higher than values shown.

Table 21.3-94. JG-Frame 600 Vac Maximum, 250 Vdc Minimum ⑦

Continuous Amperes	MCP Trip Range (Amperes)	MCP Catalog Number
250	500 – 1000 625 – 1250 750 – 1500	HMCPJ250D5L HMCPJ250F5L HMCPJ250G5L
	875 – 1750 1000 – 2000 1125 – 2250 1250 – 2500	HMCPJ250J5L HMCPJ250K5L HMCPJ250L5L HMCPJ250W5L

- ⑦ UL listed for use with Cutler-Hammer Motor Starters.

Selection Data — Motor Circuit Protectors

Table 21.3-95. K-Frame

MCP Catalog Number <sup>①</sup>	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes <sup>②</sup>	MCP Trip Setting <sup>③</sup>
HMCP400D5	5	400	A	38.5 – 43.4	500
			B	43.5 – 48.0	565
			C	48.1 – 53.0	625
	5		D	53.1 – 57.6	690
			E	57.7 – 62.3	750
			F	62.4 – 67.3	810
	5		G	67.4 – 71.9	875
			H	72.0 – 76.9	935
			I	77.0 – 81.6	1000
HMCP400F5	5	400	A	48.1 – 53.8	625
			B	53.9 – 59.9	700
			C	60.0 – 66.1	780
	5		D	66.2 – 72.3	860
			E	72.4 – 78.4	940
			F	78.5 – 83.8	1020
	5		G	83.9 – 89.9	1090
			H	90.0 – 96.1	1170
			I	96.2 – 102.0	1250
HMCP400G5	5	400	A	57.7 – 64.6	750
			B	64.7 – 71.9	840
			C	72.0 – 79.2	935
	5		D	79.3 – 86.5	1030
			E	86.6 – 93.8	1125
			F	93.9 – 101.1	1220
	5		G	101.2 – 108.4	1315
			H	108.5 – 115.3	1410
			I	115.4 – 122.4	1500
HMCP400J5	5	400	A	67.4 – 75.3	875
			B	75.4 – 83.8	980
			C	83.9 – 92.3	1090
	5		D	92.4 – 100.7	1200
			E	100.8 – 109.2	1310
			F	109.3 – 117.6	1420
	5		G	117.7 – 126.1	1530
			H	126.2 – 134.6	1640
			I	134.7 – 142.8	1750
HMCP400K5	5	400	A	77.0 – 86.5	1000
			B	86.6 – 96.1	1125
			C	96.2 – 105.7	1250
	5		D	105.8 – 115.3	1375
			E	115.4 – 124.9	1500
			F	125.0 – 134.6	1625
	5		G	134.7 – 144.2	1750
			H	144.3 – 153.8	1875
			I	153.9 – 163.3	2000
HMCP400L5	5	400	A	86.6 – 97.3	1125
			B	97.4 – 108.4	1265
			C	108.5 – 118.8	1410
	5		D	118.9 – 129.9	1545
			E	130.0 – 140.7	1690
			F	140.8 – 151.5	1830
	5		G	151.6 – 162.3	1970
			H	162.4 – 173.0	2110
			I	173.1 – 183.6	2250

- ① Three-pole catalog numbers shown. Two-pole catalog numbers begin with "HM2P" in place of "HMCP."
- ② Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.
- ③ For dc applications, actual trip levels are approximately 40% higher than values shown.

(Continued)

MCP Catalog Number <sup>④</sup>	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes <sup>⑤</sup>	MCP Trip Setting <sup>⑥</sup>
HMCP400W5	5	400	A	96.2 – 108.0	1250
			B	108.1 – 119.9	1405
			C	120.0 – 132.3	1560
	5		D	132.4 – 144.2	1720
			E	144.3 – 156.1	1875
			F	156.2 – 168.0	2030
	5		G	168.1 – 179.9	2185
			H	180.0 – 192.3	2340
			I	192.4 – 204.0	2500
HMCP400N5	5	400	A	115.4 – 129.9	1500
			B	130.0 – 144.2	1690
			C	144.3 – 158.4	1875
	5		D	158.5 – 173.0	2060
			E	173.1 – 187.6	2250
			F	187.7 – 201.9	2440
	5		G	202.0 – 216.1	2625
			H	216.2 – 230.7	2810
			I	230.8 – 244.9	3000
HMCP400R5	5	400	A	134.7 – 151.5	1750
			B	151.6 – 168.4	1970
			C	168.5 – 185.3	2190
	5		D	185.4 – 201.9	2410
			E	202.0 – 218.8	2625
			F	218.9 – 235.7	2845
	5		G	235.8 – 252.6	3065
			H	252.7 – 269.2	3285
			I	269.3 – 285.7	3500
HMCP400X5	5	400	A	153.9 – 173.0	2000
			B	173.1 – 192.3	2250
			C	192.4 – 211.5	2500
	5		D	211.6 – 230.7	2750
			E	230.8 – 249.9	3000
			F	250.0 – 269.2	3250
	5		G	269.3 – 288.4	3500
			H	288.5 – 307.6	3750
			I	307.7 – 326.9	4000

- ④ Three-pole catalog numbers shown. Two-pole catalog numbers begin with "HM2P" in place of "HMCP."
- ⑤ Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.
- ⑥ For dc applications, actual trip levels are approximately 40% higher than values shown.

Selection Data — Motor Circuit Protectors

Table 21.3-96. L-Frame ①

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes ②	MCP Trip Setting
HMCP600L6W	6 6 6	600	A	138.5 – 184.5	1800
			B	184.6 – 230.7	2400
			C	230.8 – 276.8	3000
	6 6 6		D	276.9 – 323.0	3600
			E	323.1 – 369.1	4200
			F	369.2 – 415.3	4800
	6 6 6		G	415.4 – 461.4	5400
			H	461.5 – 507.7	6000
HMCP600L6W		6 6 6	A	138.5 – 184.5	1800
	B		184.6 – 230.7	2400	
	C		230.8 – 276.8	3000	
	6 6 6	D	276.9 – 323.0	3600	
		E	323.1 – 369.1	4200	
		F	369.2 – 415.3	4800	
	6 6 6	G	415.4 – 461.4	5400	
		H	461.5 – 507.7	6000	
HMCP600X6W		6 6 6	A	38.5 – 46.1	500
	B		46.2 – 61.4	600	
	C		61.5 – 76.8	800	
	6 6 6	D	76.9 – 96.1	1000	
		E	96.2 – 115.3	1250	
		F	115.4 – 153.7	1500	
	6 6 6	G	153.8 – 192.2	2000	
		H	192.3 – 230.7	2500	
HMCP600Y6W		6 6 6	A	76.9 – 96.1	1000
	B		96.2 – 115.3	1250	
	C		115.4 – 153.7	1500	
	6 6 6	D	153.8 – 192.2	2000	
		E	192.3 – 230.7	2500	
		F	230.8 – 269.1	3000	
	6 6	G	269.2 – 307.6	3500	
		H	307.7 – 346.1	4000	

- ① Equipped with electronic trip device.
- ② Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used. In accordance with the requirements of the NEC, a setting of 17 times FLA is permitted for Design E motors.

Table 21.3-97. N-Frame ③

MCP Catalog Number	NEMA Starter Size	Continuous Amperes	Cam Setting	Motor Full Load Current Amperes ④	MCP Trip Setting
HMCP800X7W	7 7 7	800	A	123.1 – 184.5	1600
			B	184.6 – 246.1	2400
			C	246.2 – 307.6	3200
	7 7 7 7		D	307.7 – 369.1	4000
			E	369.2 – 430.7	4800
			F	430.8 – 492.2	5600
			G	492.3 – 553.7	6400
HMCP12Y8W	7 7 7	1200	A	184.6 – 276.8	2400
			B	276.9 – 369.1	3600
			C	369.2 – 461.4	4800
	7 7 7 7		D	461.5 – 553.7	6000
			E	553.8 – 646.1	7200
			F	646.2 – 738.4	8400
			G	738.5 – 830.7	9600

- ③ Equipped with electronic trip device.
- ④ Motor FLA ranges are typical. The corresponding trip setting is at 13 times the minimum FLA value shown. Where a 13 times setting is required for an intermediate FLA value, alternate cam settings and/or MCP ratings should be used.

Table 21.3-98. LG-Frame 600 Vac Maximum, 250 Vdc Minimum ⑤⑥

Continuous Amperes	MCP Trip Range (Amperes)	MCP Catalog Number
250	1125 – 2250 1500 – 3000 1750 – 3500	HMCP600L HMCP600N HMCP600R
	2000 – 4000 2250 – 4500 2500 – 5000 3000 – 6000	HMCP600X HMCP600Y HMCP600P HMCP600M

- ⑤ UL listed for use with Cutler-Hammer Motor Starters.
- ⑥ Equipped with an electronic trip device.

**Electronic RMS Trip Unit**

**General**

Eaton offers the most comprehensive range of electronic trip units in the industry for Molded Case Circuit Breakers. All electronic trip units are rms sensing and can be applied from 70 amperes up through 2500 amperes. Eaton offers electronic trip units as standard for circuit breakers rated 800 amperes and above and offers electronic trip units as optional for circuit breakers 70 amperes up through 600 amperes.

Digitrip electronic trip units are ac devices that employ microprocessor-based technology that provides a true rms current sensing means for proper correlation with thermal characteristics of conductors and equipment. The primary function of the Digitrip electronic trip unit is to provide circuit protection. This is achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker shunt trip when pre-set current levels and time delay settings are exceeded.

Electronic trip units are applied to distribution systems when high standards of protection and coordination are called for. In addition, electronic trip units can provide further enhanced features such as alarming, diagnostics, system monitoring and communications.

Cutler-Hammer rms sensing trip units fall into two main categories:

- Front adjustable trip units (Digitrip RMS 310, 310+, 510, 610, 810 and 910).
- Programmable trip units (Digitrip OPTIM 550 and 1050).

**Front Adjustable Trip Units**

Front adjustable trip units are electronic trip units that have up to nine time-current setting options that are set by switches mounted on the front of the trip unit. The application for front adjustable trip units would be distribution systems that can be coordinated within the range of settings available and that do not require sophisticated coordination strategies to be applied down through the distribution system to small rated breakers.




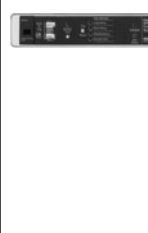




**Programmable Trip Units (OPTIM)**

Programmable trip units are electronic trip units that have up to ten time-current setting options that are programmed electronically by the use of a programming device. The application for programmable trip units would be high integrity distribution systems that require superior levels of system coordination coupled with system alarming, diagnostics and monitoring.

**Rating Plugs**

Rating plugs provide a means to establish the breaker's continuous current rating. Rating plugs are color-coded and interchangeable to make it easy to match the correct rating plug with the correct trip unit. The same rating plug can be applied to both 50 and 60 Hz distribution systems. In general, most rating plugs are of the fixed ampere rating type. Eaton does offer an adjustable rating plug as an option for the Digitrip RMS 310 trip unit.

**Table 21.3-99. The Digitrip Family of Low Voltage Electronic Trip Units**

RMS 310	RMS 310+	RMS 510	OPTIM 550	RMS 610	RMS 810	RMS 910	OPTIM 1050
							
rms Sensing — 5 Functions — Front Adjustable	rms Sensing — 6 Functions — Front Adjustable	rms Sensing — 9 Functions — Front Adjustable — Zone Selective Interlocking	rms Sensing — 10 Functions — Programmable — Load Monitoring — Diagnostics — Zone Selective Interlocking ① — Communications ①	rms Sensing — 9 Functions — Front Adjustable — Zone Selective Interlocking — Load Monitoring — Diagnostics	rms Sensing — 9 Functions — Front Adjustable — Zone Selective Interlocking — Load Monitoring — Diagnostics — Communications — Power and Energy Monitoring	rms Sensing — 9 Functions — Front Adjustable — Zone Selective Interlocking — Load Monitoring — Diagnostics — Communications — Power and Energy Monitoring — Harmonics	rms Sensing — 10 Functions — Programmable — Zone Selective Interlocking — Load Monitoring — Diagnostics — Communications — Power and Energy Monitoring — Harmonics

① Optional features.

Selection Data — Electronic Trip Units

Molded Case Circuit Breaker Digitrip Selection Guide

Table 21.3-100. Molded Case Circuit Breaker Digitrip Selection Guide

Trip Unit Type	Digitrip RMS 310	Digitrip RMS 310+	Digitrip RMS 510	Digitrip OPTIM 550	Digitrip RMS 610	Digitrip RMS 810	Digitrip RMS 910	Digitrip OPTIM 1050
rms Sensing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Breaker Type</b>								
Frame	K, L, N, R	JG, LG	R	K, L, N	R	R	R	K, L, N, R
Ampere Range	70 – 2500 A	20 – 600 A	800 – 2500 A	70 – 2500 A	800 – 2500 A	800 – 2500 A	800 – 2500 A	70 – 2500 A
Interrupting Rating at 480 V	35, 65, 100 (kA)	35, 65, 100 (kA)	65, 100 (kA)	35, 65, 100 (kA)	65, 100 (kA)	65, 100 (kA)	65, 100 (kA)	35, 65, 100 (kA)
<b>Protection</b>								
Ordering Options	LS LSG	LSI LSIG	LS LSG	LSI, LSI(A), LSIG	LI, LS, LSI, LSG, LSIG	LI, LS, LSI, LSG, LSIG	LI, LS, LSI, LIG, LSG, LSIG	LSI(A), LISG
Fixed Rated Plug (I <sub>N</sub> )	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Overtemperature Trip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Long Delay Protection (L)</b>								
Adjustable Rating Plug (I <sub>N</sub> )	Yes	No	No	No	No	No	No	No
Long Delay Pickup	0.5 – 1.0(I <sub>N</sub> ) <sup>①</sup>	40 – 100% Frame	0.5 – 1.0 x (I <sub>N</sub> )	0.4 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.4 – 1.0 x (I <sub>N</sub> )
Long Delay Time I <sup>2</sup> t	12 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds
Long Delay Time I <sup>4</sup> t	No	No	No	1 – 5 Seconds	No	No	No	1 – 5 Seconds
Long Delay Thermal Memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High Load Alarm	No	Yes	No	0.5 – 1.0 x I <sub>r</sub>	0.85 x I <sub>r</sub>	0.85 x I <sub>r</sub>	0.85 x I <sub>r</sub>	0.5 – 1.0 x I <sub>r</sub>
<b>Short Delay Protection (S)</b>								
Short Delay Pickup	200 – 800% x (I <sub>N</sub> )	—	200 – 600% S1&S2 x (I <sub>r</sub> )	150 – 800% x (I <sub>r</sub> )	200 – 600% S1&S2 x (I <sub>r</sub> )	200 – 600% S1&S2 x (I <sub>r</sub> )	200 – 600% S1&S2 x (I <sub>r</sub> )	150 – 800% x (I <sub>r</sub> )
Short Delay Time I <sup>2</sup> t	100 ms	No	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Short Delay Time Flat	No	Inst – 300 ms	No	Inst – 300 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Short Delay Time Z.S.I.	No	No	Yes	Optional <sup>②</sup>	Yes	Yes	Yes	Yes
<b>Instantaneous Protection (I)</b>								
Instantaneous Pickup	No	200 – 800% x (I <sub>N</sub> )	No	200 – 600% M1&M2 x (I <sub>N</sub> )	200 – 800% x (I <sub>N</sub> )	200 – 600% M1&M2 x (I <sub>N</sub> )	200 – 600% M1&M2 x (I <sub>N</sub> )	200 – 800% x (I <sub>N</sub> )
Discriminator	No	No	Yes <sup>③</sup>	Yes	Yes <sup>③</sup>	Yes <sup>③</sup>	Yes <sup>③</sup>	Yes
Instantaneous Override	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Ground Fault Protection (G)</b>								
Ground Fault Alarm	No	No	No	20/25 – 100% <sup>②③</sup>	No	No	No	20/25 – 100% <sup>④⑤</sup>
Ground Fault Pickup	var/Frame <sup>④</sup>	20 – 100% Frame	25 – 100% x I <sub>N</sub> <sup>④</sup>	20/25 – 100% <sup>④</sup>	25 – 100% x I <sub>N</sub> <sup>④</sup>	25 – 100% x I <sub>N</sub> <sup>④</sup>	25 – 100% x I <sub>N</sub> <sup>④</sup>	20/25 – 100% <sup>④⑤</sup>
Ground Fault Delay I <sup>2</sup> t	No	No	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Ground Fault Delay Flat	Ins – 500 ms	—	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Ground Fault Z.S.I.	No	No	Yes	Optional <sup>②</sup>	Yes	Yes	Yes	Yes
Ground Fault Thermal Memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>System Diagnostics</b>								
Cause of Trip LEDs	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Magnitude of Trip Information	No	No	No	Yes	Yes	Yes	Yes	Yes
Remote Signal Contacts	No	No	No	Optional <sup>②</sup>	Yes	Yes	Yes	Yes
<b>System Monitoring</b>								
Digital Display	No	No	No	Yes <sup>⑥</sup>	Yes	Yes	Yes	Yes <sup>⑥</sup>
Current	No	No	No	Yes	Yes	Yes	Yes	Yes
Voltage	No	No	No	No	No	No	No	No
Power and Energy	No <sup>⑦</sup>	No	No	No	No	Yes	Yes	Yes
Power Quality-Harmonics	No	No	No	No	No	No	Yes	Yes
Power Factor	No	No	No	No	No	Yes (Over PowerNet Only)	Yes	Yes
<b>Communications</b>								
PowerNet	No	No	No	Optional <sup>②</sup>	No	Yes	Yes	Yes
<b>Testing</b>								
Testing Method	Test Set	Test Kit	Integral	OPTIMizer, BIM, PowerNet <sup>②</sup>	Integral	Integral	Integral	OPTIMizer, BIM, PowerNet

① Adjust by rating plug.  
 ② Must install as field upgrade, or factory option.  
 ③ LS/LSG only.  
 ④ Not to exceed 1200 amperes.  
 ⑤ L and N Frames \*20-100% x I<sub>S</sub>, R Frame \*25-100% x I<sub>N</sub>.  
 ⑥ By OPTIMizer/BIM.  
 ⑦ Yes with addition of Energy Sentinel.

BIM = Breaker Interface Module  
 I<sub>S</sub> = Sensor Rating  
 I<sub>N</sub> = Rating Plug  
 I<sub>r</sub> = LDPU Setting x I<sub>N</sub>  
 (A) = GF Alarm

## Accessories and Modifications

## Internal Accessories

**Note:** Some UL listings pending; refer to Eaton.

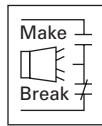
All internal accessories are of the plug-in type and are listed for field installation under UL File E64983. Internal accessories for sealed circuit breakers are listed under UL File E7819 for factory installation only. The available plug-in accessories include the following:

- Alarm (signal)/lockout switch.
- Auxiliary switch.
- Shunt trip.
- Low energy shunt trip.
- Undervoltage release mechanism.



**Typical Internal Plug-in Accessory Installed in K-Frame Circuit Breaker**

Different accessory wiring options are available to satisfy most circuit breaker mounting applications. The standard wiring configuration is pigtail leads exiting the rear of the base directly behind the accessory. Optional configurations include a terminal block mounted on the same side of the base as the accessory, leads exiting the side of the base where the accessory is mounted, and leads exiting the rear of the base on the side opposite the accessory. If accessory leads longer than 18 inches (457.2) are required, side-mounted terminal blocks should be used.



**Alarm (Signal)/Lockout Switch**

## Alarm (Signal)/Lockout Switch

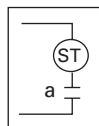
The alarm (signal)/lockout switch monitors circuit breaker trip status and provides remote signaling and interlocking capabilities when the circuit breaker trips. For 2-, 3- and 4-pole circuit breakers, the alarm (signal)/lockout switch consists of one or two SPDT switches assembled to a plug-in module mounted in retaining slots in the top of the trip unit. The SPDT switch contacts are identified as make and break contacts. When the circuit breaker trips, the make contact closes and the break contact opens.



**Auxiliary Switch**

## Auxiliary Switch

The auxiliary switch provides circuit breaker contact status information by monitoring the position of the molded crossbar containing the moving contact arms. The auxiliary switch is used for remote signaling and interlocking purposes, and consists of one or two SPDT switches assembled to a plug-in module mounted in retaining slots in the top of the trip unit. Each SPDT switch has one "a" and one "b" contact. When the circuit breaker contacts are open, the "a" contact is open and the "b" contact is closed.



**Shunt Trip**

## Shunt Trip

The shunt trip provides remote controlled tripping of the circuit breaker. The shunt trip consists of an intermittent rated solenoid with a tripping plunger and a cutoff switch assembled to a plug-in module. When required for ground fault protection applications, certain ac rated shunt trips are suitable for operation at 55% of rated voltage.

Available in most ac and dc voltages.

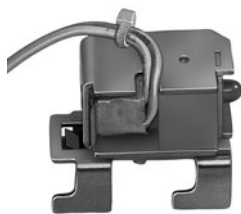
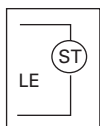
**Note:** Approximate unlatching time — 6 milliseconds. Approximate total circuit breaker contact opening time — 18 milliseconds. Endurance — 4000 electrical operations plus 1000 mechanical operations. Supply voltages suitable for use with Class 1 GFP devices. Marking label included with accessory kits.



**PowerNet Communications Kit**

## PowerNet Communications Kit

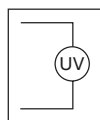
Eaton's Cutler-Hammer PowerNet Communications Kit provides the option to field install PowerNet communications into a K-, L- or N-Frame OPTIM 550 breaker.



**Low Energy Shunt Trip**

Low energy shunt trip devices are designed to operate from low energy output signals from dedicated current sensors typically applied in ground fault protection schemes. However, with a proper control voltage source, they may be applied in place of conventional trip devices for special applications. Flux paths surrounding permanent magnets used in the shunt trip assembly hold a charged spring poised in readiness to operate the circuit breaker trip

mechanism. When a 100 microfarad capacitor charged to 28 Vdc is discharged through the shunt trip coil, the resultant flux opposes the permanent magnet flux field, which releases the stored energy in the spring to trip the circuit breaker. As the circuit breaker resets, the reset arm is actuated by the circuit breaker handle, resetting the shunt trip. The plug-in module is mounted in retaining slots in the top of the trip unit. Coil is intermittent-rated only. Cutoff provisions required in control circuit.



**Undervoltage Release Mechanism**

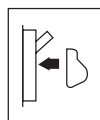
The undervoltage release mechanism monitors a voltage (typically a line voltage) and trips the circuit breaker when the voltage falls to between 70 and 35% of the solenoid coil rating.

**Note:** Undervoltage release mechanism accessories are not designed for, and should not be used as, circuit interlocks.

The undervoltage release mechanism consists of a continuous rated solenoid with a plunger and tripping lever assembled to a plug-in module.

The tab on the tripping lever resets the undervoltage release mechanism when normal voltage has been restored and the circuit breaker handle is moved to the reset (OFF) position.

With no voltage applied to the undervoltage release mechanism, the circuit breaker contacts will not touch when a closing operation is attempted.



**Non-Padlockable Handle Block**

The nonlockable handle block secures the circuit breaker handle in either the ON or OFF position. (Trip-free operation allows the circuit breaker to trip when the handle block holds the circuit breaker

handle in the ON position.) The device is positioned over the circuit breaker handle and secured by a setscrew to deter accidental operation of the circuit breaker handle. (Field installation only.)



**Padlockable Handle Lock Hasp**

The padlockable handle lock hasp allows the handle to be locked in the ON or OFF position. (Trip-free operation allows the circuit breaker to trip when the handle lock holds the circuit breaker handle in the ON position.) The hasp mounts on the circuit breaker cover within the

trimline. The cover is predrilled on both sides of the operating handle so that the hasp can be mounted on either side of the handle. The hasp will accommodate up to three padlocks with 1/4-inch (6.4 mm) shackles. One per circuit breaker. (Field installation only.)



**Key Interlock Kit (Lock Not Included)**

The key interlock is used to externally lock the circuit breaker handle in the OFF position. When the key interlock is locked, an extended deadbolt blocks movement of the circuit breaker handle. Uniquely coded keys are removable only with the deadbolt extended. Each coded key controls a group of circuit breakers for a given specific customer installation.

The key interlock assembly consists of a mounting kit and a purchaser supplied deadbolt lock. The mounting kit comprises a mounting plate, which is secured to the circuit breaker cover in either the left- or right-pole position; key interlock mounting hardware; and a wire seal. Specific mounting kits are required for individual key interlock types. (Field installation only.)



**Padlockable Handle Block**

The device is positioned in the cover opening to prevent handle movement. Will accommodate one 5/16-inch (8.0 mm) padlock.



**Accessories and Modifications**

**Table 21.3-101. Breaker Accessories and Modifications**

Breaker Frame	G	F	J	K	L	M	N	R
<b>Termination Accessories</b>								
Line and Load Terminals	●	●	●	●	●	●	●	●
Plug Nut		●	●					
Control Wire Terminal Kit		●	●	●				
Base Mounting Hardware	●	●	●	●	●	●	●	●
Terminal Shields		●	●	●	●	●		
Interphase Barriers		●	●	●	●		●	
Multewire Connectors		●	●	●	●	●		
<b>Internal Accessories</b>								
Alarm Lockout (1 Make/1 Break)	●	● <sup>①</sup>	●	●	●	●	●	●
Alarm Lockout (2 Make/2 Break)		●		●	●		●	●
Auxiliary Switch (1A, 1B)	●	●	●	●	●	●	●	
Auxiliary Switch (2A, 2B)	●	●	●	●	●	●	●	●
Auxiliary Switch (3A, 3B)			●	●	●		●	
Auxiliary Switch (4A, 4B)								●
Auxiliary Switch (1A, 1B)/Alarm Lockout	●	●	●	●	●	●	●	
Auxiliary Switch (2A, 2B)/Alarm Lockout					●		●	
Auxiliary Switch (3A, 3B)/Alarm Lockout					●			
Standard Shunt Trip	●	●	●	●	●	●	●	●
Low Energy Shunt Trip		●	●	●	●		●	●
Undervoltage Release Mechanism	●	●	●	●	●	●	●	●
<b>External Accessories</b>								
Non-Padlockable Handle Block	●	●	●	●	●	●	●	
Padlockable Handle Block		●	●	●	●	●	●	
Padlockable Handle Lock Hasp	●	●	●	●				●
Cylinder Lock		●	●	●				
Key Interlock Kit		●	●	●	●	●	●	●
Sliding Bar Interlock <sup>②</sup>		●	●	●	●	●	●	
Walking Beam Interlock <sup>②</sup>		●		●	●	●	●	
Electrical (Solenoid) Operator		●	●	●	●	●	●	
Electrical (Motor) Operator								●
IQ Energy Sentinel		●	●	●				
LFD Current Limiter		●						
Plug-in Adapters		●	●	●	●	●	●	
Drawout Cassette								●
Rear Connecting Studs		●	●	●	●	●	●	
Panelboard Connecting Straps		●	●	●	●	●	●	
Handle Mechanisms	●	●	●	●	●	●	●	●
Door Hardware/Accessories		●	●	●	●	●		
Solid-State (Electronic) Test Kit				●	●	●	●	●
Handle Extension			●	●	●	●	●	●
<b>Modifications<sup>③</sup></b>								
Special Calibration		●	●	●	●	●	●	●
Moisture Fungus Treatment		●	●	●	●	●	●	●
Freeze-Tested Circuit Breakers		●	●	●	●	●	●	●
Marine Application		●	●	●	●	●	●	●

① Make only (one pole).  
② Requires two breakers.  
③ Refer to the Eaton.

**Accessories and Modifications**

**EG-Frame Allowable Accessory Combinations**

Different combinations of accessories can be supplied, depending on the types of accessories and the number of poles in the circuit breaker.

**Table 21.3-102. Accessories**

Description	1-Pole	2-Pole		3-Pole			4-Pole			
	Center	Left	Right	Left	Center	Right	Left	Center	Right	Neu.
<b>Internal Accessories (Only one internal accessory per pole)</b>										
Alarm Lockout Switch (Make Only)										
Alarm Lockout (Make/Break)			■			■			■	
Alarm Lockout (2Make/2Break)			■			■			■	
Auxiliary Switch (1A, 1B)			■			■			■	
Auxiliary Switch (2A, 2B)			■			■			■	
Auxiliary Switch and Alarm Switch Combination			■			■			■	
Shunt Trip — Standard				■			■			
Shunt Trip — Low Energy				■			■			
Undervoltage Release Mechanism				■			■			
<b>External Accessories</b>										
End Cap Kit			●			●				●
Control Wire Terminal Kit	●		●			●				●
Multewire Connectors	●		●			●				●
Base Mounting Hardware	●		●			●				●
Terminal Shields	●		●			●				●
Terminal End Covers						●				
Interphase Barriers			●			●				●
Non-padlockable Handle Block	■	■			■			■		
Snap-On Padlockable Handle Lock Hasp	■	■			■			■		
Padlockable Handle Lock Hasp			■	□		□	□		□	
Walking Beam Interlock — Requires Two Breakers					●				●	
Plug-In Adapters			●		●				●	
Rear Connecting Studs	●		●		●				●	
Handle Mechanisms					●					●
<b>Modifications (Refer to Eaton)</b>										
Moisture Fungus Treatment	●		●		●				●	
Freeze-Tested Circuit Breakers	●		●		●				●	
Marine Application	●		●		●				●	

- Applicable in indicated pole position
- May be mounted on left or right pole — not both
- Accessory available/Modification available

**JG-Frame Allowable Accessory Combinations**

Different combinations of accessories can be supplied, depending on the types of accessories and the number of poles in the circuit breaker.

**Table 21.3-103. Accessories**

Description	2- and 3-Pole			4-Pole			
	Left	Center	Right	Left	Center	Right	Neu.
<b>Internal Accessories (Only one internal accessory per pole)</b>							
Alarm Lockout (Make/Break)			■			■	
Auxiliary Switch (1A, 1B)			■			■	
Auxiliary Switch (2A, 2B)			■			■	
Auxiliary Switch and Alarm Switch Combination			■			■	
Shunt Trip — Standard	■			■			
Shunt Trip — Low Energy	■			■			
Undervoltage Release Mechanism	■			■			
<b>External Accessories</b>							
End Cap Kit		●				●	
Plug Nut		●				●	
Control Wire Terminal Kit		●				●	
Multewire Connectors		●				●	
Base Mounting Hardware		●				●	
Terminal Shields		●				●	
Interphase Barriers		●				●	
Non-padlockable Handle Block		■			■		
Padlockable Handle Block		■			■		
Padlockable Handle Lock Hasp	□		□	□		□	
Cylinder Lock	□		□				
Key Interlock Kit	□		□	□		□	
Sliding Bar Interlock — Requires Two Breakers		●					
Electrical Operator		●				●	
Plug-In Adapters		●				●	
Rear Connecting Studs		●				●	
Panelboard Connecting Straps		●				●	
Handle Mechanisms		●				●	
Handle Extension		●				●	
IQ Energy Sentinel		●					
<b>Modifications (Refer to Eaton)</b>							
Special Calibration	●			●			
Moisture Fungus Treatment	●			●			
Freeze-Tested Circuit Breakers	●			●			
Marine/Naval Application	●			●			

■ Applicable in indicated pole position      □ May be mounted on left or right pole — not both      ● Accessory available/Modification available

**Application Information**

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**Circuit Voltage**

Molded case circuit breakers are rated by voltage class and should be applied only to system voltages within their rating. The voltage rating is determined by the maximum voltage that can be applied across its terminals, the type of distribution system and how the breaker is applied in the system.

Circuit breakers listed for use at 120/240 volts may be applied on 120/240 volt grounded systems. For applications on 240 volt ungrounded systems apply only circuit breakers rated 240 volts (with no “slash” rating) or higher.

Circuit breakers rated 277/480 volts are suitable for application on 277/480 volt grounded wye systems and are not for application on 480 volt ungrounded delta systems. Apply circuit breakers rated 480 volts (with no “slash” rating) or higher on 480 volt ungrounded delta systems.

UL 489 provides standards for testing the individual poles of 2-pole and 3-pole MCCBs. The test current is generally lower than the interrupting rating of the MCCB. This capability is necessary for breakers applied on corner-grounded delta systems where single line-to-ground faults may be interrupted by only a single pole of a circuit breaker with full line-to-line voltage across that single interrupting pole. MCCBs should not be used on circuits where the available fault current exceeds the level at which individual poles were short circuit tested at line-to-line voltage.

**Note:** On all three-phase Delta, grounded B Phase applications, refer to Eaton.

**Circuit Frequency**

The tripping characteristics of most molded case circuit breakers remain virtually constant when applied to frequencies of 50 and 60 hertz. On higher frequency applications, molded case circuit breakers must usually be specially calibrated and/or derated. The amount of derating depends upon the frame size and ampere rating as well as the current frequency. In general, the higher the ampere rating in a given frame size, the greater the derating required.

Thermal-magnetic molded case circuit breakers applied at frequencies above 60 hertz could require that individual consideration be given to thermal performance, magnetic performance and interrupting capabilities.

Electronic trip units are usually calibrated for 50/60 hertz, although operation at higher frequencies is achievable with the use of special derating factors and specially sized cable or bus.

Avoid making circuit breaker performance assumptions on applications above 60 hertz. Consult Eaton for any Cutler-Hammer molded case circuit breaker above 60 hertz.

**Continuous Ampere Rating**

Molded case circuit breakers are rated in rms amperes at a specific ambient. This ampere rating is the continuous current they will carry in the ambient temperature for which they are calibrated. Cutler-Hammer thermal-magnetic breakers are calibrated for an ambient temperature 40°C (104°F) which is the average temperature within an enclosure; thus, they minimize the need for derating. If the enclosure ambient is known to exceed 40°C, the breaker used should either be especially calibrated for that ambient, or be derated accordingly.

The selection of a specific ampere rating for a given application is dependent upon the type of load and duty cycle, and is governed by the National Electrical Code. In general, the NEC requires overcurrent protection at the supply and at points where wire sizes are reduced. It further states that the conductors be protected in accordance with their current carrying capacity, but lists exceptions for applications such as motor circuits where a larger rating is often required to override motor inrush currents.

**Cable Selection**

UL listed circuit breakers rated 125 A or less shall be marked as being suitable for 60°C (140°F), 75°C (167°F) only or 60/75°C (140/167°F) wire. All Cutler-Hammer listed breakers rated 125 A or less are marked 60/75°C. All UL listed circuit breakers rated over 125 A are suitable for 75°C conductors. Conductors rated for higher temperatures may be used, but must not be loaded to carry more current than the 75°C ampacity of that size conductor for equipment marked or rated 75°C or the 60°C ampacity of that size conductor for equipment marked or rated 60°C. However, the full 90°C (194°F) ampacity may be used when applying derated factors, so long as the actual load does not exceed the lower of the derated ampacity or the 75°C or 60°C ampacity that applies.

## Circuit Breaker Sizing Considerations

The following paragraphs outline pertinent information from the NEC according to the type of load and duty cycle.

### A. Service

A service includes the conductors and equipment for delivering electrical energy from the supply system to the wiring system of the premises served.

NEC Article 230 contains the many requirements for services of 600 volts or less including the sizing, location and overcurrent protection of conductors, disconnect means, permissible number of disconnects, grounding of conductors, and ground fault protection requirements of service equipment.

### B. Feeder Circuits

A feeder is composed of the conductors of a wiring system between the service equipment or the generator switchboard of an isolated plant and the branch circuit overcurrent device.

NEC Article 220: Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125% of the continuous load.

Exception: Where the assembly including the overcurrent devices protecting the feeder(s) are listed for operation at 100% of their rating, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the sum of the continuous load plus the noncontinuous load.

Only breakers listed for 100% application, and so labeled, can be applied under the exception (for example, type CKD). Breakers without 100% application listing and label are applied under (B) above, or at 80% of rating.

NEC Article 430: Breakers for feeders having mixed loads; i.e., heating (lighting and heat appliances) and motors, should have ratings suitable for carrying the heating loads plus the capacity required by the motor loads.

NEC Article 430: Breakers for motor feeders shall have a rating not greater than the sum of the highest breaker rating of any of its branches and the full load currents of all other motors served by the feeder.

### C. Branch Circuits

A branch circuit is the portion of a wiring system extending beyond the final overcurrent device protecting the circuit.

#### (1) Lighting Circuits (NEC Article 310)

These are protected in accordance with the conductor ratings as given. High wattage incandescent lamp loads may result in abnormally high inrush currents that must be taken into account to avoid nuisance tripping. The lamp manufacturer should be consulted for data relative to the inrush currents.

#### (2) Motor Circuits (NEC Article 430)

Breakers are primarily intended for the protection of conductors, motor control apparatus and motors against short circuits and ground fault conditions.

On motor overloads, the motor overcurrent device will open the circuit before the correctly applied breaker. Currents higher than the locked rotor value will be interrupted by the breakers, protecting the circuit from these heavy fault currents. The breaker must not trip on normal starting.

While breakers may be applied for motor running overcurrent protection when the requirements of Article 430 of the NEC are met, these applications are not recommended for Eaton's Cutler-Hammer breakers and, therefore, this discussion is confined to the use of a breaker as a circuit protector.

For many applications, particularly those where starting behavior of the motor is unknown, the NEC maximum rules are followed. Usually, lower rated breakers can be used successfully. This is further discussed under motor circuit application and motor application tables.

Motor Circuit Application (NEC Article 430): The breaker must have a continuous rating of not less than 115% of the motor full load current. Before applying a breaker, one should check to determine the effect of any of the following conditions: High ambient temperature, heating within breaker enclosure due to grouping of current consuming devices, frequent motor starting, and lengthy motor acceleration period.

Breaker Rating or Setting (NEC Article 430): The motor branch circuit overcurrent device shall be capable of the motor. The required protection shall be considered as being obtained when the overcurrent device has a rating or setting not exceeding the values given in **Table 21.3-104**, reference NEC Article 430).

An instantaneous trip circuit breaker (without time delay) shall be used only if adjustable and if part of a combination controller having overcurrent protection in each conductor and the combination is especially approved for the purpose. In the event a breaker chosen on this basis still does not allow motor starting, a higher rating is permitted by the code. See Exceptions listed with **Table 21.3-104**.

Due to the infinite number of motor-and-load combinations and because comparable breakers of different manufacture have different tripping characteristics, NEC motor circuit breaker rules are of a general nature and are set up as maximum boundaries. Protection is considered satisfactory if the breaker rating does not exceed the figure allowed by the NEC requirements. Although Cutler-Hammer breakers rated less than the NEC maximum values may be applied in most cases. Many operating engineers select breakers on the basis of the NEC maximum rules simply because consideration of other factors is not usually necessary, or to ensure motor starting when the starting behavior of the motor is not known. **Tables 21.3-104** and **21.3-105** are adapted from Article 430 of NEC.

When a certain motor is standard for a given job, as on a volume produced machine tool, it is practical (and often more economical) to select a breaker for closer protection than one chosen on the basis of NEC maximum rules.

**Application Information**

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**Table 21.3-104. Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground Fault Protective Devices — NEC Table 430-152**

Type of Motor	Percent of Full Load Current ①	
	Instantaneous Trip Breaker	Inverse Time Breaker
Single-Phase Motors	800	250
ac Polyphase Motors other than Wound Rotor Squirrel Cage:		
Other than Design E	800	250
Design E	1100	250
Synchronous Wound Rotor	800	250
Direct-Current (Constant Voltage)	800	150
	250	150

① For certain exceptions to the values specified, see Sections 430-52 through 430-54. The values given in the last column also cover the ratings of nonadjustable inverse time types of circuit breakers that may be modified as in Section 430-52. Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as are used to drive reciprocating compressors, pumps, etc., that start unloaded, do not require a fuse rating or circuit breaker setting in excess of 200 percent of full load current.

**Table 21.3-105. Full-Load Current Three-Phase Alternating-Current Motors — NEC Table 430-150 ②**

Hp	Induction Type Squirrel-Cage and Wound-Rotor Amperes							Synchronous Type Unity Power Factor ③ Amperes			
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
1/2	4.4	2.5	2.4	2.2	1.1	0.9	—	—	—	—	—
3/4	6.4	3.7	3.5	3.2	1.6	1.3	—	—	—	—	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	—	—	—	—
1-1/2	12.0	6.9	6.6	6.0	3.0	2.4	—	—	—	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—	—	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—	—	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—	—	—	—
7-12	—	25.3	24.2	22	11	9	—	—	—	—	—
10	—	32.2	30.8	28	14	11	—	—	—	—	—
15	—	48.3	46.2	42	21	17	—	—	—	—	—
20	—	62.1	59.4	54	27	22	—	—	—	—	—
25	—	78.2	74.8	68	34	27	—	53	26	21	—
30	—	92	88	80	40	32	—	63	32	26	—
40	—	120	114	104	52	41	—	83	41	33	—
50	—	150	143	130	65	52	—	104	52	42	—
60	—	177	169	154	77	62	16	123	61	49	12
75	—	221	211	192	96	77	20	155	78	62	15
100	—	285	273	248	124	99	26	202	101	81	20
125	—	359	343	312	156	125	31	253	126	101	25
150	—	414	396	360	180	144	37	302	151	121	30
200	—	552	528	480	240	192	49	400	201	161	40
250	—	—	—	—	302	242	60	—	—	—	—
300	—	—	—	—	361	289	72	—	—	—	—
350	—	—	—	—	414	336	83	—	—	—	—
400	—	—	—	—	477	382	95	—	—	—	—
450	—	—	—	—	515	412	103	—	—	—	—
500	—	—	—	—	590	472	118	—	—	—	—

② The following values of full load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for low speeds (1200 RPM or less) or high torques may require more running current, and multispeed motors will have full-load current varying with speed. In these cases the nameplate current rating shall be used. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

③ For 90 and 80 percent power factor, the above figures shall be multiplied by 1.1 and 1.25 respectively.

**C. Capacitor Protection (NEC Article 460)**

In normal applications, breakers rated about 150% of capacitor rated currents are recommended. This factor allows for switching surges, and possible overcurrent due to overvoltage and harmonic currents. Such selection fully meets the NEC requirements in 460-8 for a conductor and disconnect to be rated not less than 135% capacitor rating. Where the operating currents exceed 135% of rated current due to harmonic components, service conditions may require the selection of a breaker with a higher current rating.

For application in ambients higher than the rated ambient of the breaker, the breaker derating table should be checked to determine the rating of the breaker required to meet the minimum of 135% capacitor rating.

Circuit breakers and switches for use with capacitor must have a current rating in excess of rated capacitor current to provide for overcurrent from overvoltages at fundamental frequency and harmonic currents. The following percent of the capacitor-rated current should be used:

- Fused and unfused switches . . . 165%
- Enclosed Molded Case Circuit Breaker (Includes additional de-rating for enclosures) . . . . . 150%
- Air circuit breakers . . . . . 135%
- Contactors:
- Open type . . . . . 135%
- Enclosed type . . . . . 150%

**Table 21.3-106. Recommended Switching Devices Enclosed ①**

Capacitor Rating		Amperes			
Volts	kvar	Capacitor Rating Current	Safety Switch Fuse Rating	MCCB Trip Rating	Air Breaker Trip Rating
240	2-1/2	6	15	15	15
	5	12	20	20	20
	7-1/2	18	30	30	30
	10	24.1	40	40	40
	15	36.1	60	70	50
	20	48.1	80	90	70
	25	60	100	100	90
	30	72.2	125	125	100
	45	108	200	175	150
	50	120	200	200	175
	60	144	250	225	200
	75	180	300	275	250
	90	217	400	350	300
	100	240	400	400	350
	120	289	500	500	400
	125	301	500	500	450
	135	325	600	500	500
	150	361	600	600	500
180	433	800	700	600	
200	480	800	800	700	
225	541	900	900	800	
240	578	1000	900	800	
250	602	1000	900	900	
270	650	1200	1000	1000	
300	720	1200	—	1200	
360	866	1600	—	1200	
375	903	1500	—	1200	
480	2	2.41	15	15	15
	5	6.01	15	15	15
	7-1/2	9	15	15	15
	10	12	20	20	20
	15	18	30	30	30
	20	24	40	40	40
	25	30	50	50	50
	30	36.1	60	70	50
	35	42	70	70	60
	40	48.1	80	100	70
	45	54	90	100	80
	5	60.1	10	100	90
	60	72.2	125	125	100
	75	90.2	150	150	125
	80	96.2	175	150	150
	90	108	200	175	150
	100	120	200	200	175
	120	144	250	225	200
	125	150	250	225	200
	150	180	300	300	25
	160	192	350	300	300
	180	216	400	350	300
	200	241	400	400	350
	225	271	500	500	400
240	289	500	500	400	
250	301	500	500	400	
300	361	600	600	500	
320	385	700	600	600	
360	433	800	700	600	
375	451	800	700	600	
400	481	800	800	800	
450	541	900	900	800	

① Switching device ratings are based on percentage of capacitor-rated current as indicated. The interrupting rating of the switch must be selected to match the system fault current available at the point of capacitor application. Whenever a capacitor bank is purchased with less than the ultimate kvar capacity of the rack or enclosure, the switch rating should be selected based on the ultimate kvar capacity — not the initial installed capacity.

**Application Information — Transformer Protection**

**E. Transformer Protection  
 (NEC Article 450) Primary**

Each transformer 600 volts or less shall be protected by an individual overcurrent device on the primary side. Rated or set at not more than 125% of the rated primary current of the transformer.

Exception No. 1: Where the rated primary currents of a transformer is 9 amperes or more and 125% of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, the next higher standard rating described in Section 240 shall be permitted. Where the rated primary current is less than 9 amperes, an overcurrent device rated or set at not more than 167% of the primary current shall be permitted.

Where the rated primary current is less than 2 amperes, an overcurrent device rated or set at not more than 300% shall be permitted.

Exception No. 2: An individual overcurrent device shall not be required where the primary circuit overcurrent device provides the protection specified in this Section.

Exception No. 3: As provided in (b) (2) below.

(2) Primary and Secondary

A transformer 600 volts or less having an overcurrent device on the secondary side rated or set at not more than 125% of the rated secondary current on the transformer shall not be required to have an individual overcurrent device on the primary side if the primary feeder overcurrent device is rated or set at a current value not more than 250% of the rated primary current of the transformer.

A transformer 600 volts or less, equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current, shall not be required to have an individual overcurrent device on the primary side if the primary feeder overcurrent device is rated or set at a current value not more than 6 times the rated current of the transformer for transformers having more than 6% impedance and not more than 4 times the rated current of the transformer for transformers having more than 6 but not more than 10% impedance.

Exception 4: Where the rated secondary current of a transformer is 9 amperes or more and 125% of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, the next higher standard rating described in Section 240 shall be permitted.

Where the rated secondary current is less than 9 amperes, an overcurrent device rated or set at not more than 167% of the rated secondary current shall be permitted. Closer protection can be provided by breakers having shunt trips actuated by a temperature sensing device imbedded in transformer windings.

**Table 21.3-107. Single-Phase Primary Protection When Secondary Protection Provided**

kVA	208 V		240 V		277 V		480 V		600 V	
	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip
2	10	20	8	20	7	15	5	10	4	—
3	14	30	13	30	11	20	6	15	5	10
5	24	50	21	50	18	40	10	20	8	20
7.5	36	70	31	60	27	50	16	30	13	30
10	48	100	42	80	36	70	21	40	17	40
15	72	150	63	125	54	100	31	60	25	50
25	120	225	104	200	90	175	52	100	42	100
37.5	180	350	156	300	135	250	78	150	63	150
50	240	450	208	400	181	350	104	200	83	150
75	361	700	313	600	271	500	156	300	125	250
100	481	1000	417	800	361	700	208	400	167	350
167	803	1600	696	1200	603	1200	348	700	278	600
250	1202	2000	1042	1600	903	1600	521	800	417	800
333	1601	3000	1388	2000	1202	2000	694	1200	555	800
500	2404	3200	2083	3000	1805	2500	1042	1600	833	1200

**Table 21.3-108. Single-Phase Secondary Protection When Primary Protection Provided**

kVA	208 V		240 V		277 V		480 V	
	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip
2	10	15	8	15	—	—	—	—
3	14	20	13	20	11	15	—	—
5	24	30	21	30	18	25	10	15
7.5	36	45	31	40	27	35	16	20
10	48	60	42	60	36	50	21	30
15	72	90	63	80	54	70	31	40
25	120	150	104	150	90	150	52	70
37.5	180	225	156	200	135	175	78	100
50	240	300	208	300	181	225	104	150
75	361	450	313	400	271	350	156	200
100	481	600	417	600	361	450	208	300
167	803	1000	696	900	603	800	348	450
250	1202	1600	1042	1400	903	1200	521	700
333	1601	2000	1388	1800	1202	1600	694	900
500	2404	3000	2083	3000	1805	2500	1042	1400



Application Information

Table 21.3-109. Three-Phase Primary Protection When Secondary Protection Provided

kVA	240 V		480 V		600 V	
	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip
3	7	15	—	—	—	—
6	14	30	7	15	6	15
9	22	40	11	25	9	20
15	36	70	18	40	14	30
30	72	150	36	70	29	60
37.5	90	200	45	90	36	70
45	108	200	54	110	43	90
50	120	225	60	120	48	100
75	180	350	90	200	72	150
112.5	271	500	135	250	108	200
150	361	700	180	350	144	300
225	541	1000	271	500	217	400
300	722	1000	361	600	289	500
500	1203	2000	601	800	481	700
7550	1804	2500	902	1200	722	1000
1000	2406	4000	1203	2000	962	1600

Table 21.3-110. Three-Phase Secondary Protection When Primary Protection Provided

kVA	208 V		240 V		480 V		600 V	
	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip	FLA	Breaker Trip
3	8	10	7	10	—	—	—	—
6	17	20	14	20	7	10	—	—
9	25	35	22	30	11	15	9	10
15	42	60	36	45	18	25	14	20
30	83	110	72	100	36	45	29	40
37.5	104	150	90	125	45	60	36	50
45	125	175	108	150	54	70	43	60
50	139	175	120	175	60	80	48	60
75	208	300	180	225	90	125	72	90
112.5	312	400	271	350	135	175	108	150
150	416	600	361	500	180	225	144	200
225	652	800	541	700	271	350	217	300
300	833	1200	722	900	361	500	289	400
500	1388	1800	1203	1500	601	800	481	600
750	2082	3000	1804	2500	902	1200	722	900
1000	2776	3500	2406	3000	1203	1600	962	1200

Interrupting Rating

The maximum amount of fault current supplied by a system can be calculated at any point in that system. One rule must be followed for applying the correct circuit breaker.

The interrupting rating of the breaker must be equal to or greater than the amount of fault current that can be delivered at that point in the system where the breaker is applied.

The interrupting rating of the breaker is the maximum amount of fault current it can safely interrupt without damaging itself. A breaker's interrupting rating always decreases as the voltage increases. Interrupting rating is one of the most critical factors in the breaker selection process.

Number of Poles

The number of poles in the breaker is determined by the type of distribution system. A pole is required for each hot conductor, but usually not for the neutral conductor, except in certain special applications.

In general, a 1-pole breaker may be used on grounded neutral systems for single-phase applications and a 3-pole breaker on 3-phase applications. There are instances, however, where 2-pole breakers are necessary on single-phase systems and 4-pole breakers on 3-phase systems to interrupt the neutral. Certain dc voltage applications also use special multi-pole configurations.

Fixed or Interchangeable Trip Unit

Reverse Feed Applications (Power Supply to Load Side)

Often due to physical equipment arrangements in panelboards and switchboards, it is desirable to reverse feed a molded case circuit breaker. For this application, circuit breakers must be tested and listed accordingly. For safety reasons, thermal-magnetic circuit breakers having interchangeable trip units are not acceptable for this application, and are, therefore, marked "Line" and "Load" on the cover. Where circuit breakers are so marked, the power source conductors must be connected to the "Line" end terminations.

Circuit breakers suitable for reverse feed application generally have sealed covers and not marked "Line" and "Load" and are UL listed.

**Application Information — Unusual Operating Conditions**

**Unusual Operating Conditions**

**Trip Unit Temperatures**

Eaton's Cutler-Hammer Thermal-magnetic circuit breakers are temperature sensitive. At ambient temperatures below 40°C (104°F), circuit breakers carry more current than their continuous current rating. Nuisance tripping is not a problem under these lower temperature conditions, although consideration should be given to closer protection coordination to compensate for the additional current carrying capability. In addition, the actual mechanical operation of the breaker could be affected if the ambient temperature is significantly below the 40°C standard.

For ambient temperatures above 40°C, breakers will carry less current than their continuous current rating. This condition promotes nuisance tripping and can create unacceptable temperature conditions at the terminals. Under this condition, the circuit breaker should be recalibrated for the higher ambient temperature.

Electronic trip units are insensitive to ambient temperatures within a certain temperature range. The temperature range for most Cutler-Hammer electronic trip units is -20°C to +55°C (-4°F to 131°F). However, at very low ambient temperatures, the mechanical parts of the breaker could require special treatment, such as the use of special lubricants. If the ambient temperature exceeds 40°C significantly, damage to the electronic circuitry and other components could result. Eaton includes temperature protective circuits in its designs to initiate a tripping operation and provide self-protection, should the internal temperature rise to an unsafe level.

**Circuit Breaker Temperatures**

The temperature of the air surrounding a circuit breaker is the ambient temperature. For some years, all molded case circuit breakers were calibrated for 25°C (77°F). This ambient temperature was not very representative of the conditions in which most molded case circuit breakers were applied, namely in an enclosure. In the mid-1960s, industry standards were changed to make all standard breakers calibrated to a 40°C ambient temperature. For any ambient temperature application above or below 40°C, it is recommended that the breaker manufacturer be consulted as to any possible rerating, recalibration or special procedures, before the circuit breaker is selected and applied.

**Table 21.3-111. Derating Chart for Non-Compensated Thermal-Magnetic Breakers Calibrated for 40°C**

Breaker Ampere Rating at 40°C	Ampere Rating		
	25°C (77°F)	50°C (122°F)	60°C (140°F)
<b>F-Frame/E125-Frame</b>			
15	17	13	11
20	22	18	16
25	32	21	16
30	33	27	24
35	41	32	27
40	45	34	29
50	55	46	42
60	66	56	52
70	77	65	60
90	99	84	78
100	110	94	87
125	137	116	105
150	165	138	125
<b>J-Frame/J250-Frame</b>			
70	79	63	55
90	102	81	71
100	115	89	76
125	140	114	102
150	171	134	116
175	200	156	134
200	230	178	153
225	252	205	183
250	281	227	201
<b>K-Frame</b>			
100	121	90	79
125	145	116	106
150	188	132	111
175	210	159	141
200	243	180	157
225	255	212	198
250	294	230	208
300	364	270	236
350	412	322	291
400	471	368	333
<b>L-Frame</b>			
300	330	276	252
350	385	325	301
400	440	372	340
500	550	468	435
600	660	564	525
<b>M-Frame</b>			
300	332	277	252
350	388	322	292
400	444	368	334
450	495	418	383
500	550	468	435
600	660	564	525
700	770	658	613
800	880	754	704

**Moisture — Corrosion**

High moisture content and/or the presence of corrosive elements can result in damage to key operating components and/or severely compromise the breaker's operational integrity. As is the case with all electrical equipment, this type of condition or environment should be avoided. Good electrical practice dictates that electrical equipment always be applied in a clean environment, free of moisture and corrosion. If such operating conditions cannot be avoided, special treatment of the circuit breaker should be considered to minimize the possibility of operational problems. Most Cutler-Hammer molded case circuit breaker cases are molded from glass polyester which does not support the growth of fungus. In addition, a special moisture and fungus-resisting treatment is recommended for any parts that are susceptible to the growth of fungus. In areas where daily temperature changes have a tendency to cause condensation, the inclusion of space heaters in the enclosure is the best preventative measure. The manufacturer should be consulted if either one of these operational environments is likely to exist. Consider the addition of a Cutler-Hammer C799 series oxidation inhibiting capsule in the assembly.

**Altitude**

Low voltage circuit breakers must be progressively derated for voltage, current carrying and interrupting rating at altitudes above 6,000 feet (1,829 m). The thinner air at higher altitudes reduces cooling and dielectric characteristics compared to the denser air found at lower altitudes. Refer to Eaton for additional application details.

**Shock/Vibration**

Where high shock is an anticipated condition, hi-shock Navy type breakers are recommended. Molded case circuit breakers can be supplied to meet the following marine specifications: U.S. Coast Guard CFR 46, ABS – American Bureau of Shipping, IEEE 45, UL 489 Supplement SA Marine, and UL 489 Supplemental SB Naval.

## Special Applications

### Molded Case Breakers for Application on Resistance Welding Circuits

Short circuit protection for resistance welding devices can be obtained by properly applying instantaneous trip molded case circuit breakers.

**Note:** Instantaneous only breakers for welding application are intended for application within the welding equipment not as feeder breakers to welding machines.

These breakers permit normally high welding currents, but trip instantaneously if a short circuit develops. These breakers include standard molded case circuit breaker features such as trip-free operation, deadfront and single-phase protection. Because the breakers are resettable after tripping, replacement costs and downtime are minimized.

Duty Cycle is based on the one minute averaging time of the breaker, and can be determined as follows:

$$\text{Duty Cycle} = \frac{\text{Weld Time} \times 100}{\text{Weld Time} + \text{Off Time}}$$

“During-weld” amperes can be obtained from the welder manufacturer, or as follows:

$$\text{During-weld Amperes} = \frac{\text{During-weld kVA} \times 1000}{\text{Voltage}}$$

Interrupting capacity of the breaker should be within the maximum available at the point of application. Refer to Eaton for additional application details.

### Mining Service Circuit Breakers

The full line of mining service circuit breakers includes Standard “Classic” Mining Service, Series C and E<sup>2</sup>G Mining Breaker, including 1000Y/577 Vac ratings. Mining breakers are available with a full line of accessories. These special purpose circuit breakers are designed specifically for underground trailing cable application per MSHA 30 CFR 75.

### Engine Generator Circuit Breakers

Engine generator molded case circuit breakers are designed specifically for application on diesel engine powered standby generators where high interrupting circuit breakers are not required. Engine generator circuit breakers conform to UL 489, CSA and IEC 947-2.

### Molded Case Switches

The molded case switch is used when a compact, high capacity disconnect switch is required. It provides no over-current protection, overload or low level fault. The MCS is equipped with a high instantaneous magnetic fixed trip unit. The fixed magnetic trip is factory preset to interrupt high fault currents at or above its preset level. MCS is self protecting within its withstand rating. The molded case switch accepts the same accessories as the equivalent thermal-magnetic circuit breaker. See **Table 21.3-112**.

### Application and Replacement of Breakers

Apply and replace breakers prudently, within the design and operating parameters of the power system. Use the following tables to select the size and type of Series C<sup>®</sup> Circuit Breaker needed to fit virtually any application in series connected and other protective systems. Series C Breakers are highly compatible across ratings, capacities and characteristic; prudent replacements are as important as initial selection.

### Unusual Mounting Configurations

Generally, circuit breakers may be mounted in any position, up or down, horizontal or vertical, without affecting the tripping characteristics or interrupting rating. However, mounting circuit breakers in a vertical position with the “ON” position other than “UP” will be in violation of Article 240-81 of the National Electrical Code.

**Application Information — Molded Case Switch Ratings**

**Table 21.3-112. Molded Case Switch Short Circuit Current Ratings at 60 Hz Only (Maximum Fault Current at Which Device can be Applied in kAIC)**

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MCS Catalog Number	Short Circuit Current Rating			
	240 V	480 V	600 V	250 Vdc
GD3060K	65	22	—	10
GD3100K	65	22	—	10
EHD2100K	18	14	—	10
EHD3100K	18	14	—	10
FD2100KL	65	25	18	10
FD2150KL	65	25	18	10
FD3100KL	65	25	18	10
FD3150KL	65	25	18	10
FD4100KL	65	25	18	10
FD4150KL	65	25	18	10
HFD2100KL	100	65	25	22
HFD2150KL	100	65	25	22
HFD3100KL	100	65	25	22
HFD3150KL	100	65	25	22
HFD4100KL	100	65	25	22
HFD4150KL	100	65	25	22
JD2250KW	65	25	18	10
JDB2250KW	65	25	18	10
JD4250KW	65	25	18	10
JDB4250KW	65	25	18	10
HJD2250KW	100	65	25	22
HJDB2250KW	100	65	25	22
HJD3250KW	100	65	25	22
HJDB3250KW	100	65	25	22
HJD4250KW	100	65	25	22
HJDB4250KW	100	65	25	22
DK2400KW	65	—	—	10
DK3400KW	65	—	—	10
KD2400KW	65	35	25	10
KDB2400KW	65	35	25	10
KD3400KW	65	35	25	10
KDB3400KW	65	35	25	10
KD4400KW	65	35	25	10

(Continued)

MCS Catalog Number	Short Circuit Current Rating			
	240 V	480 V	600 V	250 Vdc
KDB4400KW	65	35	25	10
HKD2400KW	100	65	35	22
HKDB2400KW	100	65	35	22
HKD3400KW	100	65	35	22
HKDB3400KW	100	65	35	22
HKD4400KW	100	65	35	22
HKDB4400KW	100	65	35	22
LD2600WK	65	35	25	10
LDB2600WK	65	35	25	10
LD3600WK	65	35	25	10
LDB3600WK	65	35	25	10
LD4600WK	65	35	25	10
LDB4600WK	65	35	25	10
HLD2600WK	100	65	35	25
HLDB2600WK	100	65	35	25
HLD3600WK	100	65	35	25
HLDB3600WK	100	65	35	25
HLD4600WK	100	65	35	25
HLDB4600WK	100	65	35	25
MDL2800WK	42	35	22	20
MDL3800WK	42	35	22	20
MDL4800WK	42	35	22	20
MDLS2800WK	42	35	22	20
MDLS3800WK	42	35	22	20
MDLS4800WK	65	50	25	—
ND312WK	65	50	25	—
ND412WK	65	50	25	—
HND312WK	100	65	35	—
HND412WK	100	65	35	—
RD316WK	125	65	50	—
RD320WK	125	65	50	—
RD420WK	125	65	50	—
—	125	65	50	—

### DC Circuit Breakers

UL listed Eaton's Cutler-Hammer DC Molded Case Circuit Breakers are for use in general dc circuits. They are also used in ungrounded battery supply circuits of UPS systems which provide continuous reliable ac power to computer-controlled applications for financial institutions and telecommunications. These devices are an excellent alternative to molded case switches and fuses because they are easier to install and require less maintenance.

All DC breakers are designed specifically for use in ungrounded dc circuits. The various dc voltage ratings are obtained by connecting one, two, three, or four poles in series as noted. Connection diagrams are shown on the breaker nameplate. The DC breakers use the same internal and external accessories as the standard breakers for ac application. Shorting straps for series connecting poles are available.

Molded case circuit breakers for transportation application requiring 750 Vdc are available 15 through 2500 amperes with 20 kA interrupting capacity at 750 Vdc. Breakers require 4 poles in series for 750 Vdc application. However, 750 V is not a UL rating. Dimensions are the same as the standard thermal-magnetic equivalent.

### Interrupting Capacity Ratings

Table 21.3-113. UL 489 Interrupting Capacity Ratings

Circuit Breaker Type	Frame	Interrupting Capacity (Symmetrical kA)			
		Volts dc <sup>①</sup>			
		125 <sup>②</sup>	250 <sup>③</sup>	600 <sup>④</sup>	750 <sup>⑤</sup>
HFDDC	150	42	42	35	42
HJDDC	250	42	42	35	20
HKDDC	400	42	42	35	20
HLDDC	600	42	42	35	20
NBDC	1200	42	50	50	20
PBDC	2500	42	75	75	20

① dc ratings apply to substantially non-inductive circuits. 8 millisecond time constant.

② 1-pole in series.

③ 2-poles in series.

④ 3-poles in series.

⑤ 4 poles in series. Not a UL listed voltage rating.

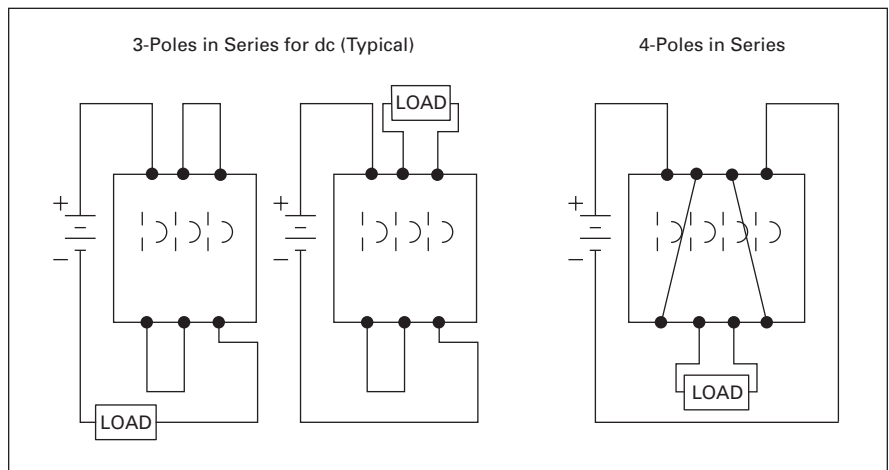


Figure 21.3-5. Series Connection Diagrams for 600 Volts dc Application

Note: Use rated cable per NEC. Connect to terminals as per breaker nameplate.

**Application of Cutler-Hammer  
 Molded Case Circuit Breakers to  
 400 – 415 Hz Systems**

Eaton's Cutler-Hammer molded case circuit breakers, including breakers with electronic trip units, can be applied for overcurrent protection on 400 – 415 Hz systems. Commonly used to power computer installations, 400 – 415 Hz systems are also employed in conjunction with certain aircraft, military and other specialty equipment.

This publication contains guidelines to applying Cutler-Hammer molded case circuit breakers on 400 – 415 Hz systems.

**Circuit Breaker Derating Required**

**Table 21.3-114**, lists the maximum continuous current carrying capacity at 400 – 415 Hz of Cutler-Hammer molded case circuit breakers. Due to the increased resistance of the copper sections resulting from the skin effect produced by eddy currents at 400 – 415 Hz, circuit breakers in many cases require derating.

The thermal derating on these devices is based upon 100%, 3-phase application in open air in a maximum of 40°C (104°F) with 4 feet (1.2 m) of the specified cable 75°C (167°F) of bus at the line and load side. Additional derating of not less than 20% will be required if the circuit breaker is to be utilized in an enclosure. Further derating may be required if the enclosure contains other heat generating devices or if the ambient temperatures exceed 40°C.

**Table 21.3-114. Continuous Current of 400 Hz Breakers**

Breaker Frame Series	Maximum Continuous Amperes at 60 Hz	400 – 415 Hz Application ①			
		Maximum Continuous Amperes	Cable/Bus Bar (Per Phase)	Terminals (Fixed Front) Catalog or Style Number	
EHD, FDB, FD	15	15	1 #12 Cu	624B100G02	
	20	20	1 #12 Cu	624B100G02	
	25	25	1 #12 Cu	624B100G02	
	30	30	1 #10 Cu	624B100G02	
	35	35	1 #10 Cu	624B100G02	
	40	40	1 #8 Cu	624B100G02	
	50	45	1 #6 Cu	624B100G02	
	70	65	1 #4 Cu	624B100G02	
	90	85	1 #2 Cu	624B100G02	
	100	95	1 #1 Cu	624B100G17	
	125 ②	115	1 – 1/0 Cu	624B100G17	
	150 ②	135	1 – 1/0 Cu	624B100G17	
	JDB, JD, HJD	70	60	1 #4 Cu	T250KB
		90	80	1 #2 Cu	T250KB
100		90	1 #1 Cu	T250KB	
	125	100	1 – 1/0 Cu	T250KB	
	150	125	1 – 1/0 Cu	T250KB	
	175	150	1 – 2/0 Cu	T250KB	
	200	160	1 – 3/0 Cu	T250KB	
	225	200	1 – 4/0 Cu	T250KB	
	250	200	1 – 250 kcmil Cu	T250KB	
KDB, KD, HKD	125	100	1 – 1/0 Cu	T300K	
	150	125	1 – 1/0 Cu	T300K	
	175	150	1 – 2/0 Cu	T300K	
	200	160	1 – 3/0 Cu	T300K	
	225	180	1 – 4/0 Cu	T300K	
	250	200	1 – 250 kcmil Cu	T300K	
	300	225	1 – 350 kcmil Cu	T300K	
	350	275	1 – 500 kcmil Cu	T350K	
	400	300	2 – 3/0 Cu	T400K	
LDB, LD, HLD	250	210	1 – 250 kcmil Cu	T600LA	
	300	240	1 – 350 kcmil Cu	T600LA	
	350	275	1 – 500 kcmil Cu	T600LA	
	400	310	2 – 250 kcmil Cu	T600LA	
	500	370	2 – 350 kcmil Cu	T600LA	
	600	425	2 – 500 kcmil Cu	T600LA	
LD with Digitrip RMS 310	300	300	2 – 250 kcmil Cu	T401LA	
	600	500	2 – 350 kcmil Cu	T401LA	
MD with Digitrip RMS 310	400	340	2 – 3/0 Cu	601MA	
	500	405	2 – 300 kcmil Cu	T601MA	
	600	470	2 – 350 kcmil Cu	T601MA	
	700	355	2 – 4/0 Cu	T601MA	
	800	400	2 – 300 kcmil Cu	T601MA	
ND with Digitrip RMS 310	1200	700	3 – 300 kcmil Cu	T1000 NBI	
		750	3 – 350 kcmil Cu	T1000 NBI	
		85	4 – 350 kcmil Cu	T1200 NBI	
RD with Digitrip RMS 310	2000	1500	4-1/2 x 4 Cu	Rear Connected Cu T-Bar	

① The calibration of these breakers and the tolerance percentages of the time-current curves are the same as at 60 Hz.

② FD and HFD only.

**Cable and Bus Sizing**

The cable and bus sizes to be utilized at 400 – 415 Hz are not based on standard National Electrical Code tables for 60 Hz application. Larger cross sections are necessary at 400 – 415 Hz to avoid exceeding component temperature limits. All bus bars specified are based upon mounting the bars in the vertical plane to allow maximum air flow. All bus bars are spaced at a minimum of 1/4-inch (6.35 mm) apart. Mounting of bus bars in the horizontal plane will necessitate additional drafting. Edgewise orientation of the bus may change the maximum ratings indicated. If additional information is required for other connections of cable or bus, contact the Eaton Customer Support Center.

**Interrupting Capacity**

400 – 415 Hz interrupting capacities of the Cutler-Hammer molded case circuit breakers found in **Table 21.3-115**.

**Application Recommendations**

It is recommended that thermal indicating devices such as “temp plates” be placed on the line and load terminals or T-connectors of the center pole. These are usually the hottest terminals with a balanced load. A maximum temperature of 90°C (50°C over a maximum ambient of 40°C) would verify the maximum rating for the particular application. Temperature profiles taken on these breakers can be correlated to insure that the hottest points within the breaker case are within the required temperature limits. A thermal cutoff switch can also be used to actuate a shunt trip to open the breaker if the thermal limits are exceeded. Consult the Customer Support Center for further information on special applications.

**400 – 415 Hz Breakers**

When required, molded case circuit breakers may be factory calibrated for 400 – 415 Hz application. These breakers are specially labeled for 400 – 415 Hz usage and their nameplate current rating will include the necessary derating factor. The highest “Maximum Continuous Amperes” rating at 400 – 415 Hz found in Tables

A and B is approximately equal to the highest specially calibrated 400 – 415 Hz nameplate amperes rating available for a given frame size. The EHD, FDB and FD frames have style numbers designated for breakers calibrated at 400 – 415 Hz. Contact Eaton for ordering information on other Cutler-Hammer breakers to be applied in 400 – 415 Hz systems.

**Table 21.3-115. Interrupting Capacities of 400 Hz Breakers**

Breaker Frame Series	Estimated 400 – 415 Hz Interrupting Capacities <sup>①②</sup> (rms Symmetrical Amperes)		
	240 V	480 V	600 V
<b>Thermal Magnetic</b>			
EHD	3,600	2,800	—
FDB	3,600	2,800	2,800
FD	13,000	5,000	3,600
JDB, JD	8,000	7,000	7,000
HJD	14,000	10,000	7,000
KDB, KD, HKD	21,000	11,000	8,000
LDB, LD	14,000	10,000	7,000
HLD	21,000	11,000	8,000
MD	14,000	10,000	7,000
<b>Electronic Trip Units</b>			
LD, MD, ND	14,000	10,000	7,000
HLD	21,000	11,000	8,000
HND	21,000	16,000	8,000
RD	40,000	33,000	33,000

① The above interrupting ratings are estimates based on the design parameters and operating characteristics of each breaker as well as on the limited amount of test data thus far available for circuit breakers applied to 400 – 415 Hz systems.

② Not UL listed.

## 100% Rated Circuit Breakers

The amount of protection designed into a distribution system is often based on economics. However, each project should be furnished with a reliable distribution system that delivers the most effective protection possible for each investment dollar.

Reliable and economic system design can be usually achieved with Eaton's Cutler-Hammer circuit breakers that are UL listed for application at 100% of their ratings — instead of standard breakers that in actual use are applied at 80% of their frame ratings in an enclosure.

The concept between a system design using standard breakers and that using 100% rated breakers is uncomplicated — but there are no shortcut methods for determining which design (and devices) is the best choice for a given system. Good engineering practice requires a careful system analysis beginning with the lowest feeder and concluding with the main device.

Also included in the system analysis must be all present and future factors that could affect the size and/or quantity of the breakers and associated hardware, such as switchboard bus, busway, cable and conduit. Other factors to consider are loads (continuous and noncontinuous) and system expansions and transformers with provisions for forced air cooling.

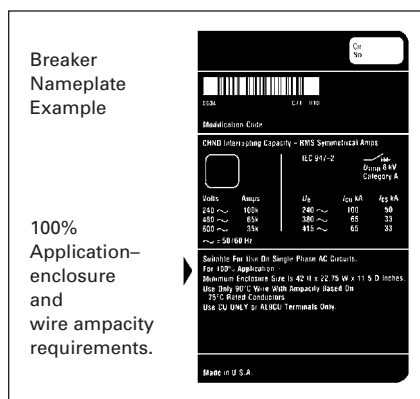


Figure 21.3-6. Breaker Nameplate

**A 100% rated breaker receives its UL listing based on tests conducted in a minimum size enclosure with minimum ventilation (if required) and minimum cable sizes, as stated on this nameplate example. All Cutler-Hammer 100% rated breakers have standard electronic trip units.**

## The NEC

The rules and intent of the National Electrical Code governing the use of standard or 100% rated breakers must be understood before recommending or applying such devices.

Section 220-10(b) Continuous and Noncontinuous Loads of the National Electrical Code addresses differences between applications of standard rated breakers and 100% rated breakers. (Significant sections are in bold face type.)

“Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than **the noncontinuous load plus 125% of the continuous load.**”

The minimum circuit conductor size without the application of any ampacity adjustment or correction factors shall have an allowable ampacity equal to or greater than the noncontinuous load plus 125% of the continuous load.

“Exception: Where the assembly including the overcurrent devices protecting the feeder(s) are listed for operation at 100% of their rating, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the **sum of the continuous load plus the noncontinuous load.**”




Figure 21.3-7. NEC Reference

Section 220-10(b) covers standard breakers, and the exception 100% rated breakers. NEC Section 220-10(b) and the Section 220-10(b) exception can be expressed by these formulas:

### Standard 80% Rated Design

$$\text{Noncontinuous Load} + 125\% \text{ of the Continuous Load} = \text{Total Minimum Load}$$

### Special 100% Rated Design

$$\text{Noncontinuous Load} + \text{Continuous Load} = \text{Total Minimum Load}$$

The necessity for these NEC requirements results from circuit breaker testing procedures.

A molded case circuit breaker is tested in open air to verify its nameplate ampere rating. The nameplate specifies a value of current the circuit breaker is rated to carry continuously without tripping within specific operating temperature guidelines.

In most instances, a breaker is applied in an enclosure and performance could be adversely affected by slow heat dissipation and temperature rise. These factors must be considered regarding the ability of the breaker to comply with its nameplate ampere rating.



**Testing Conditions and Operating Conditions**

There are distinct differences between these conditions that are addressed in the NEC Section 220-10(b) by introducing an overcurrent device and associated hardware sizing factor. The sizing factor ensures reliable equipment performance under realistic conditions. Section 220-10(b) is the key to making the best system design choice.

For feeders, Section 220-20(b) addresses the rating of all overcurrent devices that have been tested in open air but are applied in an enclosure. The thermal response of an overcurrent device applied in an enclosure will usually be faster than in open air, thus dictating the 125% requirement.

The exception allows for properly tested and listed overcurrent devices to be applied at 100% of their nameplate rating.

**There is a Difference Between 100% Rated Breakers and 100% Rated Assemblies**

Special attention should be given to the word “assembly” in the NEC Exception. Normally, an assembly is listed for 100% operation only after being successfully tested as an assembly per UL requirements.

For an assembly to receive a 100% rated UL listing, it must be tested separately by UL project engineers. Panelboards are tested to UL 67, switchboards tested to UL 891.

Installing 100% rated breakers in an assembly does not automatically make it acceptable for a 100% rating.

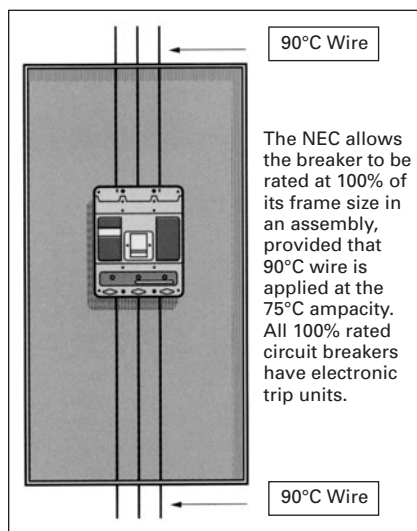


Figure 21.3-8. Conductor Requirements

**Table 21.3-116. The Application — These Examples Illustrate the Cost Savings when the 100% Rated Approach is Utilized** ①

A visual comparison of breaker, bus and cable sizes in the Three-Phase Distribution System examples (line diagrams) reveals how a 100% rated system design can provide cost savings.

Load	Feeder #1	Feeder #2	Feeder #3	Main	Description
Continuous	400 A	800 A	0	1200 A	Three-Phase Distribution System Line Diagrams
Noncontinuous	200 A	0	1000 A	1200 A	

① Selection of either a 100% rated design or standard design must result from a system analysis beginning with the lowest feeder and concluding with the system’s main device. For these system examples, assume that all assembly testing has been successfully completed and either the 100% rated design or standard design can be selected. Each system is hypothetical and either approach will meet safety requirements. Loads were arbitrarily selected. The load table includes the calculations for minimum total loads in conformance with NEC Section 22-10(b).

**Table 21.3-117. Available 100% Rated Circuit Breakers**

Frames	Rating at 480 V	Trip Units
K-Frame 125/250/400 A Minimum Enclosure Size 24 x 15 x 6-inches (609.6 x 381.0 x 152.4 mm)	CKD 35 kA CHKD 65 kA	Digitrip 310
L-Frame 125/250/400/600 A Minimum Enclosure Size with Ventilation 24 x 15 x 6-inches (609.6 x 381.0 x 152.4 mm)	CLD 35 kA CHLD 65 kA CLDC 100 kA	Digitrip OPTIM
L-Frame 600 A Minimum Enclosure Size with Ventilation 24 x 15 x 6-inches (609.6 x 381.0 x 152.4 mm)	CLD 35 kA CHLD 65 kA CLDC 100 kA	Digitrip 310
M-Frame 800 A Minimum Enclosure Size with Ventilation 42 x 18 x 7.5-inches (1066.8 x 457.2 x 190.5 mm)	CMDL 50 kA CHMDL 65 kA	Digitrip 310
N-Frame 800/1200 A Minimum Enclosure Size with Ventilation 42 x 22.75 x 11.5-inches (1066.8 x 577.9 x 292.1 mm)	CND 50 kA CHND 65 kA CNDC 100 kA	Digitrip OPTIM
N-Frame 800/1200 A Minimum Enclosure Size with Ventilation 42 x 22.75 x 11.5-inches (1066.8 x 577.9 x 292.1 mm)	CND 50 kA CHND 65 kA CNDC 100 kA	Digitrip 310
R-Frame 1600/2000 A Minimum Enclosure Size with Ventilation 21.5 x 18 x 13-inches (546.1 x 457.2 x 330.2 mm) ②	CRD 65 kA CRDC 100 kA	Digitrip OPTIM
R-Frame 1600/2000 A Minimum Enclosure Size with Ventilation 21.5 x 18 x 13-inches (546.1 x 457.2 x 330.2 mm) ②	CRD 65 kA CRDC 100 kA	Digitrip 510/610/810/910
R-Frame 1600/2000 A Minimum Enclosure Size with Ventilation 21.5 x 18 x 13-inches (546.1 x 457.2 x 330.2 mm) ②	CRD 65 kA CRDC 100 kA	Digitrip 310

② Use with 9-inch (228.6 mm) Tee connector.

**Application Information — 100% Rated Circuit Breakers**

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**Table 21.3-118. Standard 80% Rated Design**

Noncontinuous Load + 125% of the Continuous Load = Total Minimum Load					Line Diagram
Calculation per NEC of Minimum Total Load ①	$200 + (1.25)(400) = 700 \text{ A}$	$0 + (1.25)(800) = 1000 \text{ A}$	$1000 + 0 = 1000 \text{ A}$	$2700 \text{ A}$ ①	
Breaker Frame (F) Trip (T) Rating	(F) (T) 800 A ②/700 A	(F) (T) 1200 A ②/1000 A	(F) (T) 1200A ②/1000 A	(F) (T) 3000 A ②/3000 A	
Bus/Cable Rating	800 A ②	1000 A	1000 A	3000 A ②	

① (Noncontinuous Load) + (125%) (Continuous Load) per NEC Section 220-10(b).  
 ② Nearest standard size, not less than calculated value.

**Table 21.3-119. Standard 100% Rated Design**

Noncontinuous Load + Continuous Load = Total Minimum Load					Line Diagram
Calculation per NEC of Minimum Total Load ③	$200 + 400 = 600 \text{ A}$	$0 + 800 = 800 \text{ A}$	$1000 + 0 = 1000 \text{ A}$	$2400 \text{ A}$ ④	
Breaker Frame (F) Trip (T) Rating	(F) (T) 600 A/600 A	(F) (T) 800 A/800 A	(F) (T) 1200 A ⑤/1000 A	(F) (T) 2500 A ⑤/2500 A	
Bus/Cable Rating	600 A	800 A	1000 A	2500 A ⑤	

③ (Noncontinuous Load) + (Continuous Load) per NEC Section 220-10(b) Exception.  
 ④ Sum of all NEC calculated minimum feeder loads.  
 ⑤ Nearest standard size, not less than calculated value.

**Table 21.3-120. The Result — Savings in Both Switchboard and Cable Costs**

Design	Minimum Total Load (Amperes)				Rated Breaker
Standard	700	1000	1000	2700	<b>100% Rated Breaker Systems Save Money:</b> Significant economic advantages — in lower rated and sized breakers, less cable, and significant reductions in equipment floor and wall space — can be realized when the results of a systems analysis favor the 100% rated design approach.
100% Rated	600	800	1000	2400	
Results	The standard design requires higher rated, more expensive breaker and bus. Although the minimum total load is 700 amperes, most breakers and hardware are available only in standard sizes requiring even more expensive “nearest standard size” breakers and hardware.	Dramatic economic advantages are achieved by using the 100% rated design. Substantial savings result from using an 800 ampere busway and significant savings are also provided by the smaller breaker frame and cable size.	Calculations indicate either approach results in the same size breaker and hardware. A 100% rated breaker would be more expensive although the final decision could rest on whether or not future load growth is anticipated.	The 100% approach provides significant economic advantages. It not only permits use of the smaller size 2500 ampere breaker (nearest standard size) and main bus. Eaton offers a 2500 ampere frame breaker which further enhances the economic value of the 100% rated design.	

## Series Rated Systems

Under most circumstances, selection of a series rated system will reduce initial cost and size, since downstream breakers are not fully rated for the prospective short circuit fault current at their point of application. The interrupting rating of the upstream breaker must always be equal to or greater than the available fault current at its line terminals. In addition, downstream breakers must have been tested in combination with the upstream breaker and shown to be protected by the upstream breaker at the assigned series rated interrupting rating. The net result is that the system can be assigned a "series rated" or "integrated" rating higher than the rating of the downstream breaker when it is tested or applied alone. Design of the system and selection of breakers is based on short circuit interruption test specified and witnessed by UL.

Because of their blow-open design, most molded case circuit breakers are current limiting to some degree. In a series rated application and in the event of a major fault, both upstream and downstream breakers open, protecting the lower-rated downstream devices by limiting the let-through current.

To develop a series rated protective system, it is suggested that the design engineer, after completing preliminary steps:

- Define available fault current at the line side terminals of the upstream breaker.
- Select an upstream breaker with an interrupting rating equal to or greater than the available fault current.
- Verify the series tested interrupting ratings of the selected combination of breakers by referring to the tables in this section.
- Confirm, during installation, that the correct breakers have been selected by checking the nameplates appearing on the end-use equipment.

## Evaluating the Protection Systems

Designed properly, all three systems protect electrical equipment with equal effectiveness. But initial cost and continuity of service can vary widely depending on the inherent characteristics of the system, and on the design philosophy adopted.

### Fully Rated System

A fully rated system is typically less costly than a selectively coordinated system and more costly than a series rated system. All breakers are rated for full fault current at their point of application in accordance with the National Electrical Code. The continuity of service provided by the system is less than with a selectively coordinated system, and can be more than a series rated system.

### Selectively Coordinated System

A selectively coordinated system is the most costly of the three. All breakers are fully rated and upstream breakers must have adequate short-time delay adjusting capabilities. Continuity of service is the highest possible.

### Series Rated System

A series rated system is the least costly. The upstream breaker is always fully rated, but the interrupting ratings of downstream breakers are normally lower. Service continuity can be acceptable after initial start-up, since the lower-level arcing faults most likely occur after that time can be cleared by the downstream breaker alone. However, under high fault conditions, both the upstream and downstream breakers would open, eliminating service to the affected portion of the system.

### National Electrical Code Requirements

Requirements of the National Electrical Code for short circuit ratings may now be met by equipment that is marked with ratings adequate for the available fault current at their point of application in the electrical system. Refer to the current NEC for specific requirements.

## General Discussion

### Available Short Circuit Current.

Service equipment shall be suitable for the short circuit current available at its supply terminal.

**Approval.** The conductors and equipment required or permitted by the Code shall be acceptable only if approved. See Examination of Equipment for Safety and Examination, Identification, Installation and Use of Equipment. See definitions of "Approved," "Identified," "Labeled" and "Listed."

### Examination, Identification, Installation and Use of Equipment

1. Examination: In judging equipment, considerations such as the following should be evaluated.
  - a. Suitability for installation and use in conformity with the provisions of this Code. Suitability of equipment use may be identified by a description marked on or provided with a product to identify the suitability of the product for a specific purpose, environment or application. Suitability of equipment may be evidenced by listing or labeling.
  - b. Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.
  - c. Wire-ending and connection space.
  - d. Electrical insulation.
  - e. Heating effects under normal conditions of use and also under abnormal conditions likely to arise in service.
  - f. Arcing effects.
  - g. Classification by type, size, voltage, current capacity and specific use.
  - h. Other factors which contribute to the practical safeguarding of persons using or likely to come in contact with the equipment.
2. Installation and Use: Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.

**Interrupting Rating**

Equipment intended to break current at fault levels shall have an interrupting rating sufficient for the system voltage and the current which is available at the terminals of the equipment. Equipment intended to break current at other than fault levels shall have an interrupting rating at system voltage sufficient for the current that must be interrupted.

**Circuit Impedance and Other Characteristics**

The overcurrent protective devices, the total impedance, the component short circuit withstanding ratings, and other characteristics of the circuit to be protected shall be so selected and coordinated as to permit the circuit protective devices used to clear a fault without the occurrence of extensive damage to the electrical components of the circuit. This fault shall be assumed to be either two or more of the circuit conductors, or between any circuit conductor and the grounding conductor or enclosing metal raceway.

**Motor Contribution**

The fault current contribution of motors connected between series rated breakers must be considered. Article 240-86(b) in the 1999 edition of the National Electrical Code states that for series ratings the sum of the motor, full-load currents cannot exceed 1% of the interrupting rating of the lower-rated circuit breaker. The actual fault current contribution from induction motors is about 4 times their full-load current (impedance value of 25%). For example, if the downstream branch circuit breakers used in a series rated combination have an interrupting rating of 14,000 amperes rms symmetrical for a 480 volt system, the maximum full-load current of motors connected to that panel from the branch circuit breakers is 140 amperes (1%). For typical induction motors this is equivalent to a total horsepower at 480 volts of approximately 115 horsepower.

**Design/Test Considerations for Series Coordinated Circuit Breakers**

Test Procedures for all Cutler-Hammer molded case circuit breakers intended for application in series connected systems are in full compliance with all applicable paragraphs of the latest edition of UL 489.

**Note:** For further information, see IEEE Standards 141, 242 and 446.

The entire system is tested, since such tests are the only way to correctly verify the performance of overcurrent devices under short circuit conditions.

Calibration, interruption, trip-out and dielectric withstand tests are performed. Breakers in their as-received condition are used for the interrupting and intermediate interrupting capability tests. If agreeable to concerned parties, previously tested samples may be used. The interrupting rating of the line-side circuit breaker is equal to or greater than the maximum available fault current on the distribution system at its point of intended application.

Tests comply also with the intent of the proposed revisions to applicable IEC documents.

Tests are completed in a well-defined sequence:

- Interrupting tests.
- Intermediate interrupting tests.
- Trip-out tests.
- Dielectric voltage-withstand tests.

Eaton's Cutler-Hammer Series C Circuit Breakers intended for application in series rated systems are subjected, in the following sequence, to interrupting ability, intermediate interrupting ability, trip-out, and dielectric voltage-withstand tests.

During testing of the series rated circuit breakers, each breaker is mounted in the smallest enclosure in which it is to be used; openings in the enclosure do not exceed 10% of its total external area, and there are no openings directly opposite a vent in a circuit breaker case. The two enclosures are connected by a 12-inch (304.8 mm) conduit of any diameter. Each lead from test terminals to the line-side breaker is less than 4 feet (1.2 m) per breaker(s), and each load shorting the load-side breaker(s) is sized based on the rating of the load-side breaker. The combined length of the lead from the line-side overcurrent protective device of the load-side breaker and from the load-side breaker to the shorting point, is less than 4 feet (1.2 m) per pole.

Exception: the breakers may be mounted in the end-use equipment that will contain them and is marked for use with the series combination. The load-side breaker is positioned as close as possible to the line-side breaker(s). Line and load leads are less than 4 feet (1.2 m).

A fuse is connected between the enclosure and line terminal of the pole least likely to arc to the enclosure, or the neutral, if the breaker is rated 120/240 or 480Y/277 Vac. The connection to the load-side of the limiting impedance is #10 AWG copper wire less than 6 feet (1.8 m) long. The fuse is a 30 A non-renewable type acceptable for branch circuit protection; its voltage rating is not less than the rating of the device, and its interrupting rating is not less than the available current.

1. Interrupting tests:
    - a. The test circuit is closed on the series combination with all breakers fully closed; and
    - b. The load-side breaker is closed on the circuit while the line-side breaker is fully closed.
- Note:** Random closing is used in all 3-phase tests. When the circuit is closed on the combination, closing is controlled in single-phase tests so that closing occurs within ten electrical degrees of the zero-point of the supply voltage wave.
2. *Intermediate interrupting tests* at the specified available current and maximum voltage. Procedures are identical to those described in 1a and 1b (above) but at the maximum current level that causes the load-side breaker to open, but not the line-side breaker. If the line-side breaker is current-limiting, the series combination shall be evaluated in the region below its current-limiting threshold. (There is no need for these tests if the current is less than the interrupting rating on the load-side breaker.)
  3. *Trip-out tests* of the load-side breaker at 250% of the marked ampere rating.
  4. *Dielectric voltage-withstand tests* verify that the breaker can withstand, without breakdown, a 60 (48 – 62) Hz essentially sinusoidal potential for one minute.

**Circuit Breaker Identification**

Marking of all Eaton's Cutler-Hammer circuit breakers is clear for easy identification of type, rating and operating status. Nameplates are color-coded for immediate identification of rating, and a color-coded bar identifies the type and interrupting rating at common application voltages. Operating status is indicated clearly by the position of the handle and color-coded flags. On and off positions are identified by English words and international symbols.

Scientists and engineers at the Eaton Testing Laboratory ensure that Cutler-Hammer circuit breakers are the most reliable and develop new concepts and improvements in breaker design. Designs and reliability are verified, products are improved continuously and qualified to meet UL, NEMA and other standards. In addition, engineers from any breaker or panelboard manufacturer can work along-side their peers from Eaton to test their products in the lab.

The consolidated nameplate on all breakers provides complete identification and rating information in a format that is easy to read and understand.

The interrupting rating of the series combination is never permitted to be marked on the downstream breaker. However, the series rating may be marked on panelboards in which the combination has been tested and listed if:

- The upstream breaker is installed in the panelboard as a main breaker.
- The panelboard is a main-lug-only type and is specifically marked to indicate the type and rating of the upstream listed series tested breaker that must be applied with the panelboard.

**Marking of Panelboards**

Marking of panelboards conforms to the latest edition of UL 67. Markings are clear and understandable, and include the short circuit rating in rms amperes; maximum voltage rating for each short circuit rating; a statement indicating that additional or replacement devices shall be of the same type and of equal or greater interrupting capacity; and, when applicable, the identity of combinations of integral and branch circuit overcurrent devices that are required when applying the marked short circuit current rating.

**Fuses**

Fuses can be used instead of circuit breakers in fully rated, selectively coordinated and series connected protection systems. See the tables in the back of this brochure for fuse breakout data applied to series connected designs.

Don't apply fuses using the up-over-down method, which has been recommended by some fuse manufacturers for sizing a current-limiting fuse that protects a downstream molded case circuit breaker with a specified rms symmetrical interrupting rating. The method can lead to erroneous and unsafe conclusions, and should not be used.

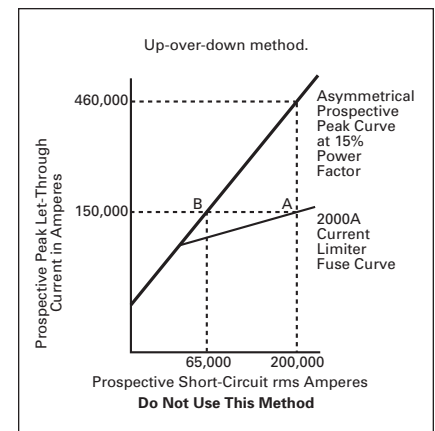
Example: Assume a specific type of current-limiting fuse rated 2000 A. Then using the figure below:

1. Draw a vertical line from the prospective short circuit current of 200 kA to intersect the "typical peak let-through curve at "A."
2. Draw a horizontal line left from Point "A" to intersect the "prospective peak" curve at "B."
3. Drop a vertical line from "B" to intersect the horizontal axis and read the recommended rating, 65 kA rms, concluding that a circuit breaker with a 65 kA interrupting capacity will be protected by a specified 2000 A current-limiting fuse.

This conclusion is wrong when the downstream service has a blow-open contact assembly, as does a molded case circuit breaker or similar device. It may be valid when the current-limiting fuse is sized to protect a passive bus bar system.

The reason: The up-over-down method ignores dynamic impedance (the inherent current-limiting of the downstream molded case circuit breaker). Such impedance is developed directly by the forces of the let-through current created when the contacts are blown open.

For proper application of current-limiting fuses, always refer to recommendations by the manufacturer of the circuit breaker, which are based on actual test data.



**Figure 21.3-9. Up-Over-Down Misapplication**

**Application and Replacement of Breakers**

Apply and replace breakers prudently, within the design and operating parameters of the power system. Use the following tables to select the size and type of circuit breaker needed to fit virtually any application in series rated and other protective systems. Breakers are highly-compatible across ratings, capacities and characteristic; prudent replacements are as important as initial selection.

**Breakers for Series Connected Protection of Power Distribution Systems**

**Table 21.3-121. Index for Series Rating Tables**

Devices – Upstream/Downstream	System Voltage	Pages
Circuit Breaker/Circuit Breaker	600 V 480 V 480Y/277 V 240 V 120/240 V	21.3-68, 21.3-69 21.3-70, 21.3-71 21.3-72, 21.3-73 21.3-74 to 21.3-76 21.3-77 to 21.3-80
Fuse/Circuit Breaker	600, 480, 480/277 240, 120/240 V	21.3-81, 21.3-82

**Series Connected Ratings: Cutler-Hammer Circuit Breakers**

A wide range of breakers and combinations in the Eaton’s Cutler-Hammer line is available that has been tested in accordance with UL procedures for series connected ratings: individually

enclosed breakers in series with main lug panelboards, main breakers integral with branch breakers in panelboards, in switchboards, and in meter centers. You can rely on the enclosed data for

applications with other undefined distribution equipment where series application ratings can be an advantage.

**Table 21.3-122. Circuit Breaker/Circuit Breaker Series Combinations ①② — 600 Volt System**

Upstream Breaker	Type	FD, FDB, HFD	FD, FDB, HFD	LCL	LCL	KDC	KDC	HLD, HLDB	HKD	JDC
	Amperes, Maximum	150	70	400	250	400	400	600	400	250
	Limiter Type	LFD3150R	LFD3070R	—	—	—	—	—	—	—
System kA		200	200	100	100	50	42	35	35	35
System Volts		600	600	600	600	600	600	600	600	600
Downstream Breaker	Range Amperes	Poles								
FDB	15 – 70	2, 3		●	●	●		●		●
FD	15 – 70	2, 3		●	●	●		●		●
HFD	15 – 70	2, 3		●	●	●		●		●
FDC	15 – 70	2, 3		●	●	●				
FDB	80 – 150	2, 3	●		●	●		●		●
FD	80 – 150	2, 3	●		●	●		●		●
HFD	80 – 150	2, 3	●		●	●		●		●
FDC	80 – 150	2, 3	●		●	●				
JD	70 – 250	2, 3			●	●	●			●
JDB	70 – 250	2, 3			●	●	●			●
HJD	70 – 250	2, 3			●	●	●			●
JDC	70 – 250	2, 3			●					
KD	100 – 400	2, 3			●		●		●	
KDB	100 – 400	2, 3			●		●		●	
HKD	100 – 400	2, 3			●		●			
KDC	100 – 400	2, 3			●					
LD, LDB	300 – 600	2, 3						●		
LC, LCG, LCA, LCGA	75 – 400	2, 3			●		●			●
HLC, HLCG, HLCA, HLCGA	75 – 400	2, 3			●		●			●

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under “Circuit Breakers — Series Connected.”

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

**The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.**

Table 21.3-122. Circuit Breaker/Circuit Breaker Series Combinations <sup>①②</sup> — 600 Volt System (Continued)

Upstream Breaker	Type	FDC	FDC	HLD, HLDB	KD, KDB	HJD	HFD	HFD	JD, JDB	FD	FD
	Amperes, Maximum	225	150	600	400	250	225	150	250	225	150
	Limiter Type	—	—	—	—	—	—	—	—	—	—
System kA		35	35	25	25	25	25	25	18	18	18
System Volts		600	600	600	600	600	600	600	600	600	600
Downstream Breaker	Range Amperes	Poles									
FDB	15 – 70	2, 3	●	●		●	●	●	●	●	●
FD	15 – 70	2, 3	●	●	●	●	●	●	●	●	
HFD	15 – 70	2, 3		●							
FDC	15 – 70	2, 3									
FDB	80 – 150	2, 3	●	●		●	●	●	●	●	●
FD	80 – 150	2, 3	●	●	●	●	●	●		●	
HFD	80 – 150	2, 3		●							
FDC	80 – 150	2, 3									
JD	70 – 250	2, 3			●	●	●				
JDB	70 – 250	2, 3			●	●	●				
HJD	70 – 250	2, 3									
JDC	70 – 250	2, 3									
KD	100 – 400	2, 3									
KDB	100 – 400	2, 3									
HKD	100 – 400	2, 3									
KDC	100 – 400	2, 3									
LD, LDB	300 – 600	2, 3									
LC, LCG, LCA, LCGA	75 – 400	2, 3				●					
HLC, HLCG, HLCA, HLCGA	75 – 400	2, 3									

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

- A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

**Breakers for Series Connected Protection of Power Distribution Systems**

**Table 21.3-123. Circuit Breaker/Circuit Breaker Series Combinations ①② — 480 Volt System**

Upstream Breaker	Type		FDB, FD, HFD	FDB, FD, HFD	LCL	LCL	FCL	NB TRI-PAC	NB TRI-PAC	KDC	JDC	LA TRI-PAC
	Amperes, Maximum		150	70	400	250	100	800	500	400	250	400
	Limiter Type		LFD3150R	LFD3070R	—	—	—	P20	P12	—	—	P10
System kA			200	200	150	150	150	100	100	100	100	100
System Volts			480	480	480	480	480	480	480	480	480	480
Downstream Breaker	Range Amperes	Poles										
EHD	15 – 100	2, 3	● (80 – 100)	● (15 – 70)	●	●	●			●	●	
FDB	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●	● (15 – 100)			●	●	
FD	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●	● (15 – 100)			●	●	
HFD	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●	● (15 – 100)			●	●	
FDC	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●						
JD, JDB	70 – 250	2, 3			●	●		●	●	●	●	
HJD	70 – 250	2, 3			●	●		●	●	●	●	
KD, KDB	100 – 400	2, 3			●			●	●		●	
HKD	100 – 400	2, 3			●			●	●		●	
LD, LDB	300 – 600	2, 3										
LC, LCG, LCA, LCGA	75 – 600	2, 3			● (75 – 400)			●	● (75 – 500)	● (75 – 400)		
HLC, HLCG, HLCA, HLCGA	75 – 600	2, 3			● (75 – 400)					● (75 – 400)		
LA, LAB, HLA	125 – 600	2, 3						●	● (125 – 500)			
MA	125 – 800	2, 3						●	● (125 – 500)			
MC, MCA, MCG, MCGA	400 – 800	2, 3						●	● (400 – 500)			
NB	700 – 800	2, 3						●			●	

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

**The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.**



Table 21.3-123. Circuit Breaker/Circuit Breaker Series Combinations ①② — 480 Volt System (Continued)

Upstream Breaker	Type		LA TRI-PAC	FDC	FDC	FB TRI-PAC	HLD, HLDB	HKD	HJD	HFD	HFD	KD, KDB	JD, JDB	FD	FD
	Amperes, Maximum		200	225	150	100	600	400	250	225	150	400	250	225	150
	Limiter Type		P08	—	—	P06	—	—	—	—	—	—	—	—	—
System kA			100	100	100	100	65	65	65	65	65	35	25	25	25
System Volts			480	480	480	480	480	480	480	480	480	480	480	480	480
Downstream Breaker	Range Amperes	Poles													
EHD	15 – 100	2, 3	●	●	●	●		●	●	●	●	●	●	●	●
FDB	15 – 150	2, 3	● (15 – 100)	●	●	● (15 – 100)		●	●	●	●	●	●	●	●
FD	15 – 150	2, 3	● (15 – 100)		●	● (15 – 100)		●	●		●	●			
HFD	15 – 150	2, 3	● (15 – 100)		●	● (15 – 100)									
FDC	15 – 150	2, 3													
JD, JDB	70 – 250	2, 3	● (70 – 200)					●	●						
HJD	70 – 250	2, 3	● (70 – 200)												
KD, KDB	100 – 400	2, 3						●							
HKD	100 – 400	2, 3													
LD, LDB	300 – 600	2, 3					●								
LC, LCG, LCA, LCGA	75 – 600	2, 3						● (75 – 400)				● (75 – 400)			
HLC, HLCG, HLCA, HLCGA	75 – 600	2, 3													
LA, LAB, HLA	125 – 600	2, 3						● (125 – 400)							
MA	125 – 800	2, 3													
MC, MCA, MCG, MCGA	400 – 800	2, 3													
NB	700 – 800	2, 3													

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

- A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

**Breakers for Series Connected Protection of Power Distribution Systems**

**Table 21.3-124. Circuit Breaker/Circuit Breaker Series Combinations ①② — 480Y/277 Volt System**

Upstream Breaker	Type	FD, FDB, HFD	FD, FDB, HFD	LCL	LCL	FCL	KDC	JDC	FDC	FDC	LA TRI-PAC	
	Amperes, Maximum	150	70	400	250	100	400	250	225	150	200	
	Limiter Type	LFD3150R	LFD3070R	—	—	—	—	—	—	—	P08	
System kA		200	200	150	150	150	100	100	100	100	100	
System Volts		480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	
Downstream Breaker	Range Amperes	Poles										
EHD	15 – 100	1			●	●	●	●	●		●	●
EHD	15 – 100	2, 3	● (80 – 100)	● (15 – 70)	●	●	●	●	●		●	●
FDB	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●	●	●	●		●	● (15 – 100)
FD	15 – 150	1			●	●	●	●	●		●	● (15 – 100)
FD	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●	●	●	●		●	● (15 – 100)
HFD	15 – 150	1			●	●	●	●	●		●	● (15 – 100)
HFD	15 – 150	2, 3	● (80 – 150)	● (15 – 70)	●	●	●	●	●		●	● (15 – 100)
GHB, GHC	15 – 100	1			●	●	●	●	●	●	●	
GHB, GHC	15 – 100	2, 3	● (80 – 100)	● (15 – 70)	●	●	●	● (15 – 50)	● (15 – 50)	●	●	

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

**The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.**

Table 21.3-124. Circuit Breaker/Circuit Breaker Series Combinations ①② — 480Y/277 Volt System (Continued)

Upstream Breaker	Type	FB TRI-PAC	HKD	HJD	HFD	HFD	KD, KDB	KDC	HKD	JDC	HJD	JD, JDB	FD	FD	KD, KDB	JD, JDB
	Amperes, Maximum	100	400	250	225	150	400	400	400	250	250	250	225	150	400	250
	Limiting Type	P06	—	—	—	—	—	—	—	—	—	—	—	—	—	—
System kA		100	65	65	65	65	35	25	25	25	25	25	25	25	22	22
System Volts		480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277	480Y/277
Downstream Breaker	Range Amperes	Poles														
EHD	15 – 100	1	●	●	●		●	●	●	●	●	●		●	●	●
EHD	15 – 100	2, 3	●	●	●		●	●	●	●	●	●		●	●	●
FDB	15 – 150	2, 3	● (15 – 100)	●	●		●	●	●	●	●	●		●	●	
FD	15 – 150	1	● (15 – 100)	●	●		●	●	●	●	●	●			●	
FD	15 – 150	2, 3	● (15 – 100)	●	●		●	●	●	●	●	●			●	
HFD	15 – 150	1	● (15 – 100)						●							
HFD	15 – 150	2, 3	● (15 – 100)						●							
GHB, GHC	15 – 100	1		●	●	●	●	●	●	●	●	●	●	●	●	●
GHB, GHC	15 – 100	2, 3		● (15 – 50)	● (15 – 50)	●	●	● (15 – 50)	●	●	●	●	● (15 – 50)	●	●	●

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

- A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

**Breakers for Series Connected Protection of Power Distribution Systems**

**Table 21.3-125. Circuit Breaker/Circuit Breaker Series Combinations <sup>①②</sup> — 240 Volt System**

Upstream Breaker	Type		LCL	KDC	LCL	JDC	FDC	FCL	FD, FDB, HFD	FD, FDB, HFD	HLD, HLDB
	Amperes, Maximum		400	400	250	250	150	100	150	70	600
	Limiter Type		—	—	—	—	—	—	LFD 3150R	LFD 3070R	—
System kA			200	200	200	200	200	200	200	200	100
System Volts			240	240	240	240	240	240	240	240	240
Downstream Breaker	Range Amperes	Poles									
BA, BR, HQP, QC	15 – 100	2, 3	●		●			●	● (80 – 100)	● (15 – 70)	
QBHW, BRH, QPHW, QCHW	15 – 100	2, 3	●		●			●	● (80 – 100)	● (15 – 70)	
HBAX, QHPX, QHCX	15 – 100	3	●		●			●	● (80 – 100)	● (15 – 70)	
HBAW, QHPW, QHCW	15 – 20	3	●		●			●		●	
GB, GHB	15 – 100	2, 3	●	●	●	●	●	●	● (80 – 100)	● (15 – 70)	●
GC, GHC	15 – 100	2, 3	●	●	●	●	●	●	● (80 – 100)	● (15 – 70)	●
CA, CAH, HC	100 – 225	2, 3	●	●	●	●					
BJ, BJH	100 – 225	2, 3	●	●	●	●					
ED	100 – 225	2, 3	●	●	●	●			●	●	●
EDH	100 – 225	2, 3	●	●	●	●					
EHD	15 – 100	2, 3	●	●	●	●	●	●	● (80 – 100)	● (15 – 70)	
FD, FDB	15 – 150	2, 3	●	●	●	●	●	● (15 – 100)	● (80 – 150)	● (15 – 70)	●
HFD	15 – 150	2, 3	●	●	●	●	●	● (15 – 100)	● (80 – 150)	● (15 – 70)	
JD, JDB	70 – 250	2, 3	●	●	●	●					●
HJD	70 – 250	2, 3	●	●	●	●					
DK	250 – 400	2, 3	●	●							●
KD, KDB	100 – 400	2, 3	●	●							●
HKD	100 – 400	2, 3	●	●							
LD, LDB	300 – 600	2, 3									●
HLD	300 – 600	2, 3									
LC, LCG, LCA, LCGA	75 – 400	2, 3	●	●							
HLC, HLCG, HLCA, HLCGA	75 – 400	2, 3	●	●							

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

**The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.**

Table 21.3-125. Circuit Breaker/Circuit Breaker Series Combinations ①② — 240 Volt System (Continued)

Upstream Breaker	Type		NB TRI-PAC	NB TRI-PAC	LA TRI-PAC	FB TRI-PAC	KDC	HKD	JDC	HJD	EDH	FDC	HFD	KDC	HKD
	Amperes, Maximum		800	500	200	100	400	400	250	250	225	150	150	400	400
	Limiting Type		P20	P12	P08	P06	—	—	—	—	—	—	—	—	—
System kA			100	100	100	100	100	100	100	100	100	100	100	65	65
System Volts			240	240	240	240	240	240	240	240	240	240	240	240	240
Downstream Breaker	Range Amperes	Poles													
BA, BR, HQP, QC	15 – 100	2, 3			●	●			●		●	●	●	●	●
QBHW, BRH, QPHW, QCHW	15 – 100	2, 3			●	●	●	●	●			●	●	●	●
HBAX, QHPX, QHCX	15 – 100	3			●	●	●		●			●		●	●
HBAW, QHPW, QHCW	15 – 20	3			●	●	●					●		●	
GB, GHB	15 – 100	2, 3					●	●	●	●		●	●	●	●
GC, GHC	15 – 100	2, 3					●	●	●	●		●	●	●	●
CA, CAH, HCA	100 – 225	2, 3			●		●	●	●	●			●	●	●
BJ, BJH	100 – 225	2, 3						●		●			●		
ED	100 – 225	2, 3						●		●					
EDH	100 – 225	2, 3													
EHD	15 – 100	2, 3			●	●	●	●	●	●		●	●	●	●
FD, FDB	15 – 150	2, 3			● (15 – 100)	● (15 – 100)	●	●	●	●		●	●	●	●
HFD	15 – 150	2, 3					●	●	●			●		●	
JD, JDB	70 – 250	2, 3		●	●		●	●	●	●				●	●
HJD	70 – 250	2, 3					●		●					●	
DK	250 – 400	2, 3	●	●			●	●						●	
KD, KDB	100 – 400	2, 3	●	●			●	●						●	
HKD	100 – 400	2, 3					●							●	
LD, LDB	300 – 600	2, 3													
HLD	300 – 600	2, 3													
LC, LCG, LCA, LCGA	75 – 400	2, 3					●	●						●	
HLC, HLCG, HLCA, HLCGA	75 – 400	2, 3					●	●						●	

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

- A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

**Breakers for Series Connected Protection of Power Distribution Systems**

**Table 21.3-125. Circuit Breaker/Circuit Breaker Series Combinations ①② — 240 Volt System (Continued)**

Upstream Breaker	Type	KD, KDB, DK	HJD	JD, JDB	ED	HFD	FD	GB, GC	KD, KDB, DK	KD, KDB, DK	CAH	BJH	QBHW, QPHW, QCHW, BRH	FDB	EHD
	Amperes, Maximum	400	250	250	225	150	150	100	400	400	225	225	100	150	100
	Limiter Type	—	—	—	—	—	—	—	—	—	—	—	—	—	—
System kA		65	65	65	65	65	65	65	42	22	22	22	22	18	18
System Volts		240	240	240	240	240	240	240	240	240	240	240	240	240	240
Downstream Breaker	Range Amperes	Poles													
BA, BR, HQP, QC	15 – 100	2, 3	●	● (15 – 70)	● (15 – 70)	●	● (15 – 70)	●	●	● (15 – 70)	●	●	●	● (15 – 70)	● (15 – 70)
QBHW, BRH, QPHW, QCHW	15 – 100	2, 3	●	●	●	●	●	●	●						
HBAX, QHOX, QHCX	15 – 100	3		●	●		●	●	●						
HBAW, QHPW, QHCW	15 – 20	3													
GB, GHB	15 – 100	2, 3		●			●								
GC, GHC	15 – 100	2, 3		●			●								
CA, CAH, HCA	100 – 225	2, 3	●	●	●		●	●							
BJ, BJH	100 – 225	2, 3	●		●			●							
ED	100 – 225	2, 3													
EDH	100 – 225	2, 3													
EHD	15 – 100	2, 3	●	●	●		●	●							
FD, FDB	15 – 150	2, 3	●	●	●		●	●							
HFD	15 – 150	2, 3													
JD, JDB	70 – 250	2, 3		●											
HJD	70 – 250	2, 3													
DK	250 – 400	2, 3													
KD, KDB	100 – 400	2, 3													
HKD	100 – 400	2, 3													
LD, LDB	300 – 600	2, 3													
HLD	300 – 600	2, 3													
LC, LCG, LCA, LCGA	75 – 400	2, 3													
HLC, HLCG, HLCA, HLCGA	75 – 400	2, 3		●											

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

**The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.**

Table 21.3-126. Circuit Breaker/Circuit Breaker Series Combinations ①② — 120/240 Volt System

Upstream Breaker	Type	LCL	KDC	LCL	JDC	FDC	FCL	FD, FDB, HFD	FD, FDB, HFD	KDC	
	Amperes, Maximum	400	400	250	250	225	100	150	70	400	
	Limiting Type	—	—	—	—	—	—	LFD3150R	LFD3070R	—	
System kA		200	200	200	200	200	200	200	200	100	
System Volts		120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240	
Downstream Breaker	Range Amperes	Poles									
BA, BR, HQP, QC	15 – 70	1	●		●		●	●		●	
BA, BR, HQP, QC	15 – 125	2	● (15 – 100)		● (15 – 100)		● (15 – 70)	● (15 – 100)	● (80 – 100)	● (15 – 70)	
QBHW, BRH, QPHW, QCHW	15 – 70	1	●		●		●	●		●	●
QBHW, BRH, QPHW, QCHW	15 – 125	2	● (15 – 100)		● (15 – 100)		● (15 – 100)	● (15 – 100)	● (80 – 100)	● (15 – 70)	●
HBAX, QHPX, QHCX	15 – 70	1	●		●		●	●		●	●
HBAX, QHPX, QHCX	15 – 100	2	●		●		●	●	● (80 – 100)	● (15 – 70)	●
QHPW, HBAW, QHCW	15 – 30	1, 2	●		●		●	●			●
QBGF, QPGF, QHCB	15 – 30	1, 2	●		●		●	●		●	
GB, GHB	15 – 100	1, 2	●	●	●	●	●	●	● (80 – 100)	● (15 – 70)	●
GC, GHC	15 – 100	1, 2	●	●	●	●	●	●	● (80 – 100)	● (15 – 70)	●
EHD	15 – 100	1, 2	●	●	●	●	●	●	● (80 – 100)	● (15 – 70)	●
FD	15 – 150	1, 2	●	●	●	●	●	●	● (15 – 100)	● (80 – 150)	● (15 – 70)
HFD	15 – 150	1, 2	●	●	●	●	●	●	● (15 – 100)	● (80 – 150)	● (15 – 70)

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under “Circuit Breakers — Series Connected.”

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

**Breakers for Series Connected Protection of Power Distribution Systems**

**Table 21.3-126. Circuit Breaker/Circuit Breaker Series Combinations ①② — 120/240 Volt System (Continued)**

Upstream Breaker	Type	HKD	JDC	HJD	EDH	FDC	HFD	FB TRI-PAC	LA TRI-PAC	KDC
	Amperes, Maximum	400	250	250	225	150	225	100	100	400
	Limiter Type	—	—	—	—	—	—	P06	P08	—
<b>System kA</b>		100	100	100	100	100	100	100	100	65
<b>System Volts</b>		120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240
Downstream Breaker	Range Amperes	Poles								
BA, BR, HQP, QC	15 – 70	1		●		●	●	●	●	●
BA, BR, HQP, QC	15 – 125	2		●		●	●	(15 – 70)	(15 – 100)	(15 – 100)
QBHW, BRH, QPHW, QCHW	15 – 70	1		●		●	●	●	●	
QBHW, BRH, QPHW, QCHW	15 – 125	2		●		●	●	(15 – 100)	(15 – 100)	(15 – 100)
HBAX, QHPX, QHCX	15 – 70	1		●		●	●	●	●	
HBAX, QHPX, QHCX	15 – 100	2		●		●	●	●	●	
QHPW, HBAW, QHCW	15 – 30	1, 2								
QBGF, QPGF, QHCB	15 – 30	1, 2				●		(15 – 40)	●	
GB, GHB	15 – 100	1, 2	●	●	●		●	●		
GC, GHC	15 – 100	1, 2	●	●	●		●	●		
EHD	15 – 100	1, 2	●	●	●		●	●	●	
FD	15 – 150	1, 2	●	●	●		●	●	●	
HFD	15 – 150	1, 2	●	●			●			

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under “Circuit Breakers — Series Connected.”

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

**The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.**



Table 21.3-126. Circuit Breaker/Circuit Breaker Series Combinations ①② — 120/240 Volt System (Continued)

Upstream Breaker	Type	JDC	FDC	HKD	KD, KDB, DK	HJD	JD, JDB	ED	HFD	FD	GB, GC	
	Amperes, Maximum	250	150	400	400	250	250	225	150	225	100	
	Limiter Type	—	—	—	—	—	—	—	—	—	—	
System kA		65	65	65	65	65	65	65	65	65	65	
System Volts		120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240	
Downstream Breaker	Range Amperes	Poles										
BA, BR, HQP, QC	15 – 70	1	● (15 – 100)	●	●	●	●	●	●	●	●	
BA, BR, HQP, QC	15 – 125	2	●	●	●	●	●	●	●	● (15 – 100)	● (15 – 100)	
QBHW, BRH, QPHW, QCHW	15 – 70	1	●	●	●	●	●	●	●	●	●	
QBHW, BRH, QPHW, QCHW	15 – 125	2	●	●	●	●	●	● (15 – 100)	● (15 – 100)	● (15 – 100)	● (15 – 100)	
HBAX, QHPX, QHCX	15 – 70	1	●	●	●	●	●	●	●	●	●	
HBAX, QHPX, QHCX	15 – 100	2	●	●	●	●	●	●	●	●	●	
QHPW, HBAW, QHCW	15 – 30	1, 2										
QBGF, QPGF, GFCB	15 – 30	1, 2	● (15 – 20)	● (15 – 20)				● (15 – 20)		● (15 – 40)	●	
GB, GHB	15 – 100	1, 2	●	●	●	●	●	●	●	●	●	
GC, GHC	15 – 100	1, 2	●	●	●	●	●	●	●	●	●	
EHD	15 – 100	1, 2	●	●	●	●	●	●	●	●	●	
FD	15 – 150	1, 2	●	●	●	●	●	●	●	●	●	
HFD	15 – 150	1, 2	●	●	●	●	●	●	●	●	●	

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

- A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

Breakers for Series Connected Protection of Power Distribution Systems

Table 21.3-126. Circuit Breaker/Circuit Breaker Series Combinations ①② — 120/240 Volt System (Continued)

Upstream Breaker	Type		KD, KDB, DK	KD, KDB, DK	CAH	QBHW, QPHW, QCHW	BWH	BJH	FDB	EHD
	Amperes, Maximum		400	400	225	100	225	225	150	100
	Limiter Type		—	—	—	—	—	—	—	—
System kA			42	22	22	22	25	22	18	18
System Volts			120/240	120/240	120/240	120/240	120/240	120/240	120/240	120/240
Downstream Breaker	Range Amperes	Poles								
BA, BR, HQP, QC	15 – 70	1	●	●	●	●	●	●	●	●
BA, BR, HQP, QC	15 – 125	2	●	● (15 – 70)	●	● (15 – 100)	● (15 – 100)	● (15 – 100)	●	●
QBHW, BRH, QPHW, QCHW	15 – 70	1	●	●						
QBHW, BRH, QPHW, QCHW	15 – 125	2	●	●						
HBAX, QHPX, QHCX	15 – 70	1								
HBAX, QHPX, QHCX	15 – 100	2								
QHPW, HBAW, QHCW	15 – 30	1, 2								
QBGF, QPGF, GFCB	15 – 30	1, 2		●	●	●		●		
GB, GHB	15 – 100	1, 2								
GC, GHC	15 – 100	1, 2								
EHD	15 – 100	1, 2	●							
FD	15 – 150	1, 2								
HFD	15 – 150	1, 2								

① Circuit Breaker/Circuit Breaker series rated combinations shown in above tabulations by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."

② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.

● A solid circle in the row of a particular downstream breaker indicates that the upstream device associated with the column provides a Series Rating for the parameter values of the column heading. If the solid circle is accompanied by numbers in parentheses, then only the breaker ampacities listed in the parentheses have the Series Rating.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

Table 21.3-127. Fuse/Circuit Breaker Series Combinations ①② — Active Circuit Breakers

Upstream Fuse ③	Type	J, T	RK	J, T	J, T	RK	RK	J, T	J, T	RK	J, T	J, T	RK	J, T	J, T	RK	J, T	RK
	Amperes, Maximum	200	100	400	600	400	200	400	200	100	400	200	100	400	200	100	200	100
System kA		100	100	100	100	100	100	200	200	200	100	200	100	200	100	100	100	100
System Volts		600	600	600	600	600	600	600	120/240	120/240	120/240	240	240	240	480	480	277	277
Downstream Breaker	Range Amperes	Poles																
FD, HFD, FDC, FDB	15 – 150	2, 3, 4	●	●														
JD, HJD, JDC, JDB	70 – 250	2, 3, 4			●		●											
KD, HKD, KDC, KDB	100 – 400	2, 3, 4			●	●	●		●									
BA, BR, HQP, QC, QBHW, BRH, QPHW, HBAX, QHPX, QHCX	15 – 70	1							●	●	●							
BA, BR, HQP, QC, QBHW, BRH, QPHW, QCHW, HBAX, QHPX, QHCX	15 – 100	2							●	●	●							
QHPW, HBAW, QHCW	15 – 30	1, 2							●	●	●							
BA, BR, HQP, QC, QBHW, BRH, QPHW, QCHW	15 – 100	2, 3										●	●	●				
HBAX, QHPX, QHCX	15 – 100	3										●	●	●				
HBAW, QHPW, QHCW	15 – 20	3										●	●	●				
EHD	15 – 100	2, 3, 4													●	●		
EHD	15 – 100	1															●	●
FD, HFD	15 – 150	1															●	●

① Fuse/Circuit Breaker and Fuse/Motor Circuit Protector series connected combinations shown in above tabulations listed by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."  
 ② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.  
 ③ RK ratings shown are applicable for both RK1 and RK5 fuses. RK1 fuses in higher ampere ratings may also provide series protection.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

Breakers for Series Connected Protection of Power Distribution Systems

Table 21.3-128. Fuse/Circuit Breaker Series Combinations ①② — Active Circuit Breakers

Upstream Fuse ③	Type	J, T	RK	J, T	RK	J, T	RK	J, T	J, T	J, T	J	L	RK	L
	Amperes, Maximum	400	200	200	200	400	200	400	600	200	100	800	600	2000
System kA		200	100	200	200	100	100	200	100	65	100	200	200	200
System Volts		480/277	480/277	240	240	240	240	240	240	277	277	480	600	480
Downstream Breaker	Range Amperes	Poles												
GHBS	15 – 20	1									●	●		
GHB, GHC	15 – 100	2, 3	●	●										
CA	125 – 225	2, 3					●	●						
CAH, HCA	125 – 225	2, 3			●	●	●	●	●	●				
MA, HMA, MC, MCAM MCG, MCGA, HMCA, HMCGA, HMCG, MDL, HMDL, ND, HND	125 – 800	2, 3										●	●	
PC, PCG, PCA, PCGA	1000 – 3000	2, 3												●

① Fuse/Circuit Breaker and Fuse/Motor Circuit Protector series connected combinations shown in above tabulations listed by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."  
 ② Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.  
 ③ RK ratings shown are applicable for both RK1 and RK5 fuses. RK1 fuses in higher ampere ratings may also provide series protection.

Table 21.3-129. Fuse/Circuit Breaker Series Combinations ④⑤ — Active Circuit Breakers

Upstream Fuse ⑥	Type	J, T	RK	L	RK	J, T	RK	L	RK	J, T	RK	RK	RK	J, T	RK	J, T	RK
	Amperes, Maximum	600	400	1200	600	600	400	1200	600	400	100	200	200	400	100	400	100
System kA		200	200	100	100	200	200	100	100	200	200	100	100	100	200	200	200
System Volts		600	600	600	600	480	480	480	240	120/240	120/240	120/240	277	277	240	240	480/277
Downstream Breaker	Range Amperes	Poles															
LC, LCA, LCG, LCGA, HLC, HLCA, HLCG, HLCGA	125 – 600	2, 3	●	●	●	●											
LC, LCA, LCG, LCAG, HLC, HLCA, HLCG, HLCGA	74 – 400	2, 3					●	●	●	●							
GB, GC, GHB, GHC	15 – 100	1								●	●	●					
GHB, GHC	15 – 100	1											●	●			
GB, GC, GHB, GHC	15 – 100	2, 3													●	●	
GHB, GHC	15 – 100	2, 3															●
MA, HMA, MC, MCA, MCG, MCGA, HMCA, HMCGA, HMCG, MDL, HMDL, ND, HND	125 – 800	2, 3	●						●								
NB, NC, NCA, NCG, NCGA, HNB, HNC, HNCA, HNCG, HNCGA, MDL, HMDL, ND, HND	600 – 1200	2, 3							●								

④ Fuse/Circuit Breaker and Fuse/Motor Circuit Protector series connected combinations shown in above tabulations listed by Underwriters Laboratories in their *Component Directory* (Yellow Book) under "Circuit Breakers — Series Connected."  
 ⑤ Only active Circuit Breaker types are included in the above tabulations. For additional information on inactive styles, consult the UL Yellow Book or contact Eaton.  
 ⑥ RK ratings shown are applicable for both RK1 and RK5 fuses. RK1 fuses in higher ampere ratings may also provide series protection.

The series combinations shown are UL recognized component ratings only. Consult the equipment manufacturer for applicable UL recognized assembly combinations.

**Panelboard Replacement Breaker Selection Guide**

Panelboard Replacement Breakers are generally for use as replacement for out-of-production panelboard circuit breakers where both physical and electrical interchangeability is

required. Where possible, consideration should be given to application of either Eaton’s Cutler-Hammer or original Westinghouse circuit breakers

For additional information on replacement circuit breakers and accessories refer to the *Cutler-Hammer YES Catalog*.

**Table 21.3-130. Replacement Breakers**

Breaker Type	Amperes	Panelboard Replacement Breaker Interrupting Ampere Rating											
		120 Vac		240 Vac		277 V (1-Pole)		480 Vac		600 Vac		125 V (1-Pole)	250 Vdc
		Sym.	Asym.	Sym.	Asym.	Sym.	Asym.	Sym.	Asym.	Sym.	Asym.		
RE	15 – 20	—	—	—	—	10,000	10,000	—	—	—	—	—	—
RE	15 – 100	7,500	7,500	7,500	7,500	—	—	—	—	—	—	5,000	5,000
REA	15 – 20	—	—	—	—	10,000	10,000	—	—	—	—	—	—
REA	15 – 100	7,500	7,500	7,500	7,500	—	—	—	—	—	—	5,000	5,000
REH	15 – 100	—	—	18,000	20,000	10,000	10,000	14,000	15,000	—	—	—	10,000
RF	15 – 100	—	—	18,000	20,000	—	—	14,000	15,000	14,000	15,000	—	10,000
RFA	15 – 150	—	—	18,000	20,000	—	—	14,000	15,000	14,000	15,000	—	10,000
RHF	15 – 100	—	—	65,000	75,000	—	—	25,000	30,000	18,000	20,000	—	20,000
RHFA	15 – 150	—	—	65,000	75,000	—	—	25,000	30,000	18,000	20,000	—	20,000
RJ	70 – 225	—	—	22,000	25,000	—	—	18,000	20,000	14,000	15,000	—	10,000
LA	70 – 225	—	—	42,000	50,000	—	—	30,000	35,000	22,000	25,000	—	20,000
LA	125 – 400	—	—	42,000	50,000	—	—	30,000	35,000	22,000	25,000	—	20,000
RK	70 – 225	—	—	25,000	30,000	—	—	22,000	25,000	22,000	25,000	—	10,000
RKL	125 – 400	—	—	42,000	50,000	—	—	30,000	35,000	22,000	25,000	—	20,000
RLM	125 – 800	—	—	42,000	50,000	—	—	30,000	35,000	22,000	25,000	—	20,000
RHK	70 – 225	—	—	65,000	75,000	—	—	35,000	40,000	25,000	30,000	—	20,000
RHKL	125 – 400	—	—	65,000	75,000	—	—	35,000	40,000	25,000	30,000	—	20,000
RHLM	125 – 800	—	—	65,000	75,000	—	—	35,000	40,000	25,000	30,000	—	20,000

**Table 21.3-131. Replacement Breakers**

Current Panelboard Circuit Breaker Type	Out-of-Production Circuit Breaker Type	Volts ac (50/60 Hz)		
		240	480	600
RE	E ①	●		
REA	EA ①	●		
REH	EH ①		●	
RFA	FA ①			●
RHFA	HFA ①			●
RF	F ①			●
RHF	HF ①			●
RJ	J ②			●
RK	K ②			●
RHK	HK ②			●
RKL	KL ②			●
RHKL	HKL ②			●
RLM	LM ②			●
RHLM	HLM ②			●
LA	JK ②			●
LA	JKL ②			●

① Last manufacture date — 1974.  
② Last manufacture date — 1967.

Replacement of all out-of-production panelboard circuit breakers other than the “JK” and “JKL” types are designated by the easily identifiable addition of an “R” prefix to the out-of-production circuit breaker catalog number that they replace.

**An Example:**

**RF3100** is a newly manufactured, 3-Pole, 100 Ampere Trip Panelboard Replacement Breaker for an out-of-production F3100.

**R** Designates new panelboard replacement breaker

**F** Identifies the out-of-production circuit breaker frame

**3** Number of poles

**100** Trip ampere rating

**Notes:**

1. Panelboard Replacement Circuit Breakers have non-interchangeable trip units and the same interrupting capacity as the out-of-production circuit breakers that they replace.
2. The RE breaker has off-center terminals just like the E breaker it is replacing.
3. For out-of-production breakers, the “B” suffix denotes 277 Vac rating for the Panelboard Replacement Breaker. (Example: RE3020B)

4. Some Panelboard Replacement Breakers do not have the same physical dimensions or mounting holes as the breakers that they replace. For example, the types REH, RFA and RHFA are 6 inches (152.4 mm) in length and the breakers they replace, EH, FA and HFA are 6-1/2 inches (165.1 mm) in length. Mounting hardware is provided with each breaker to resolve these differences, and must be installed to ensure a proper fit.

5. Panelboard Replacement Breakers can be installed in the following style of out-of-production Westinghouse panelboards:

ABH	NEB
A2B	NHDP
CDP	NHEB
NAB	NH1B
NA1B	NLAB-AB
NA1B-LX	NLAB-ABH
NDP	

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**General Description**

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Trip Units (Digitrip and OPTIM)**

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*Circuit Breakers with Microprocessor Trip Units*

**Table 21.4-1. Digitrip RMS Circuit Breaker Trip Unit Selection Chart**

Description	Digitrip 310	Digitrip 310+	Digitrip 510	OPTIM 550	Digitrip 610	Digitrip 810	OPTIM 750	Digitrip 910	OPTIM 1050	Digitrip 520	Digitrip 520M	Digitrip 520MC	Digitrip 1150
<b>Circuit Breaker Type</b>													
Molded Case J250-Frame 250 Ampere	X	X	—	—	—	—	—	—	—	—	—	—	—
Molded Case K-Frame 400 Ampere	X	—	—	X	—	—	—	—	X	—	—	—	—
Molded Case L-Frame 600 Ampere	X	X	—	X	—	—	—	—	X	—	—	—	—
Molded Case M-Frame 800 Ampere	X	—	—	—	—	—	—	—	—	—	—	—	—
Molded Case N-Frame 1200 Ampere	X	—	—	X	—	—	—	—	X	—	—	—	—
Molded Case R-Frame 2500 Ampere	X	—	X	—	X	X	—	X	X	—	—	—	—
Insulated Case SPB	—	—	X	—	X	X	X	X	X	—	—	—	—
Power Breaker DSII/DSLII	—	—	X	—	X	X	X	X	X	—	—	—	—
Power Breaker Magnum DS	—	—	—	—	—	—	—	—	—	X	X	X	X
<b>Features</b>													
Curve Shaping Functions	5	5	9	10	9	9	10	9	10	9	9	9	10
Front Adjustable	X	X	X	—	X	X	—	X	—	X	X	X	—
Programmable	—	—	—	X	—	—	X	—	X	—	—	—	X
Zone Selective Interlocking	—	—	X	X <sup>①</sup>	X	X	X	X	X	X	X	X	X
Load Monitoring	—	—	—	X	X	X	X	X	X	—	X	X	X
Diagnostics	—	—	X	X	X	X	X	X	X	X	X	X	X
Power/Energy Monitoring	—	—	—	—	—	X	—	X	X	—	—	—	X
Harmonics	—	—	—	—	—	—	—	X	X	—	—	—	X
Waveform Capture	—	—	—	—	—	—	—	X	X	—	—	—	X
Communications	—	—	—	X <sup>①</sup>	—	X	X	X	X	—	—	X	X
Ground Fault Alarm	X <sup>②③</sup>	—	—	X <sup>①②</sup>	—	—	—	—	X <sup>②</sup>	—	X	X	X

① Optional feature.  
 ② Requires auxiliary alarm module below R-Frames.  
 ③ Not available in J250-Frame yet.

**Note:** For time current curves for the trip units, see the Cutler-Hammer Circuit Breaker CD-ROM SA.73A.01.T.E.

**General Description — Molded Case, SPB and DSII Trip Units**

**Digitrip and OPTIM Trip Units**

The Eaton Corporation offers the most comprehensive range of electronic trip units in the industry for Cutler-Hammer Molded Case Circuit Breakers, SPB Insulated Case Circuit Breakers, and DSII Power Circuit Breakers. All electronic trip units are rms sensing and can be applied from 70 amperes up through 5000 amperes.

Eaton offers electronic trip units as standard for molded case circuit breakers rated 1000 amperes and above and offers electronic trip units as optional for molded case circuit breakers 70 amperes up through 800 amperes.

Digitrip electronic trip units are ac devices that employ microprocessor-based technology that provides a true rms current sensing means for proper correlation with thermal characteristics of conductors and equipment. The primary function of the Digitrip electronic trip unit is to provide circuit protection. This is achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker shunt trip when pre-set current levels and time delay settings are exceeded.

Electronic trip units are applied to distribution systems when high standards of protection and coordination are called for. In addition, electronic trip units can provide further enhanced features such as alarming, diagnostics, system monitoring and communications.

Cutler-Hammer rms sensing trip units fall into two main categories:

- Front adjustable trip units (Digitrip RMS 310, 310+, 510, 610, 810 and 910).
- Programmable trip units (Digitrip OPTIM 550, 750 and 1050).

**Note:** OPTIM 750 programmable trip units not available in molded case circuit breakers.

**Front Adjustable Trip Units**

Front adjustable trip units are electronic trip units that have up to nine time-current setting options that are set by switches mounted on the front of the trip unit. The application for front adjustable trip units would be distribution systems that can be coordinated within the range of settings available and that do not require sophisticated coordination strategies to be applied down through the distribution system to small rated breakers.

**Programmable Trip Units**

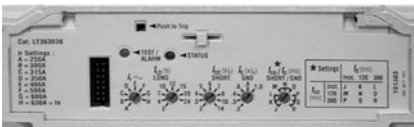
Programmable trip units are electronic trip units that have up to ten time-current setting options that are programmed electronically by the use of a programming device. The application for programmable trip units would be high integrity distribution systems that require superior levels of system coordination coupled with system alarming, diagnostics and monitoring.

**Rating Plugs**

Rating plugs provide a means to establish the breaker's continuous current rating. Rating plugs are color-coded and interchangeable to make it easy to match the correct rating plug with the correct trip unit. The same rating plug can be applied to both 50 and 60 Hz distribution systems. In general, most rating plugs are of the fixed ampere rating type. Eaton offers an adjustable rating plug as an option for the Digitrip RMS 310 trip unit.



*Digitrip 310*



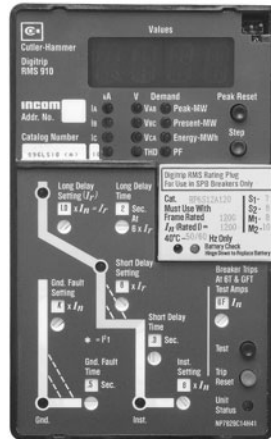
*Digitrip 310+*



*OPTIM 550*



*OPTIM 1050*



*Digitrip 910*



*Digitrip 1050*



### Additional Protection Features

Eaton's Cutler-Hammer Digitrip RMS Electronic trip units are designed and built with safety and reliability in mind, both to protect the user and the equipment as well as making sure the trip functions within its design parameters. By providing a SURE Start discriminator circuit to Digitrip RMS 510, 610, 810 and 910 trip units as well as to Digitrip OPTIM 550, 750 and 1050 trip units that do not have an instantaneous setting, the user is protected should a faulted circuit exist. The discriminator (or making current releases as it is often called) is set at 11 times the rating plug ampere rating and is enabled for approximately the first 10 cycles of current flow. Should a fault condition exist, the breaker will trip with no intentional time delay on closing, protecting the user from a potentially unsafe condition.

In addition to a discriminator, an instantaneous override is present in all molded case and insulated case circuit breakers to provide additional protection for the breaker. The instantaneous override is factory set nominally just below the breaker withstand rating.

Digitrip electronic trip units can operate reliably in ambient temperatures that range from -20°C to +85°C. In the unlikely event that temperatures exceed this ambient, the trip unit has a built-in overtemperature trip to protect the trip unit should the temperature exceed these design parameters.

### Thermal Memory

Digitrip RMS and Digitrip OPTIM electronic trip units incorporate powered thermal memory, i.e., the units remember recent overcurrent events which may have initiated the trip timing sequence, and then returned to nominal levels, halting the sequence prior to trip initiation. In the event that the current levels again exceed the pickup set point within a few cycles of the original pickup, the unit's memory recalls the previous near trip and automatically imposes a shorter delay time. In effect, the unit treats multiple time related events as a single continuous event thereby preventing system damage due to cumulative overheating.

As a further enhancement, the trip units incorporate an unpowered thermal memory feature. In the event that current levels cause the breaker to trip and the breaker is immediately reclosed, the trip unit remembers the previous overcurrent trip and again imposes a shorter delay time should a further overcurrent occur before a sufficient cooldown period has elapsed.

Thermal memory protects the distribution system from cumulative overheating caused by repeated overcurrent conditions. OPTIM trip units allow this to be turned ON or OFF.

### System Alarms

Digitrip RMS 610, 810 and 910 electronic trip units incorporate a high load alarm capability. Set at 85% of  $I_r$ , the alarm will be initiated once the load current exceeds 85% for 40 seconds. Once this occurs, the HILD message will flash in the display window and the power/relay module will operate to send a remote signal.

Digitrip OPTIM electronic trip units also offer a high load alarm capability but with more flexibility. OPTIM trip units have a high load alarm that can be programmed to operate between 50% and 100% of  $I_r$ .

Digitrip OPTIM electronic trip units incorporate a ground fault alarm capability. Settings available for ground fault alarm are the same as for ground fault trip. Once a ground fault alarm occurs, both local and remote signal indication is available. (OPTIM 550 is remote only.)

Peak demand exceeded alarms are available with Digitrip RMS 810 and 910 as well as Digitrip OPTIM 1050.

Power quality and total harmonic distortion levels can be set with Digitrip RMS 910 and Digitrip OPTIM 1050 and an alarming feature can be initiated should these levels be exceeded.

### System Diagnostics

Whenever a circuit breaker trips, it is normally imperative that the cause of trip be determined quickly, the faulty conditions rectified, and the breaker put back into service. Digitrip RMS 510, 610, 810, 910, and Digitrip OPTIM electronic trip units incorporate a complete package of systems diagnostics to meet this challenge.

Four cause-of-trip LEDs are embedded in the front of the trip unit case, indicating that the cause-of-trip was either a long delay, short delay, instantaneous or ground fault. Remote signal indication for cause of trip as well as magnitude of trip information is also available.

### Systems Monitoring

Digitrip RMS and Digitrip OPTIM electronic trip units offer a complete menu of monitoring capability to include current, power and energy, power factor, power quality harmonics, and other related parameters with a high level of accuracy.

### Digital Display

Digitrip RMS 610, 810 and 910 have a large, easy-to-read 4-digit alphanumeric display mounted on the trip unit. The display is supported by LEDs that indicate which parameter is being displayed along with the unit the value is displayed in, e.g., kA etc.

### Current Monitoring

Digitrip RMS 610, 810 and 910 trip units are capable of monitoring currents in individual phases (A, B, C) as well as ground currents. Digitrip OPTIM 550, 750 and 1050 trip units are capable of monitoring currents in individual phases (A, B, C) as well as neutral and ground currents.

Values are displayed in the digital display window in kA. Accuracy of the current monitored values is  $\pm 2$  percent of full scale sensor rating.

### Power and Energy Monitoring

For the trip unit to calculate true power and energy values, a Potential Transformer Module is required. This PTM is mounted internally (R frame and larger) or externally (N frame or smaller) to the breaker, and provides voltage to the trip unit.

Digitrip RMS 810 and 910 trip units are capable of monitoring peak power demand, present power demand, and reverse power flow in MW. Additionally, both forward and reverse energy consumption in MWh can be monitored. Digitrip OPTIM 1050 trip units can also monitor the same power and energy parameters but the units are displayed in kW and kWh.

The accuracy of power monitored values is  $\pm 4$  percent of full scale sensor/frame rating.

The accuracy of energy monitored values is  $\pm 5$  percent of full scale sensor/frame rating.

Both the RMS 910 and OPTIM 1050 report power factor. Digitrip RMS 910 trip units have the additional capability of monitoring line-to-line voltage.

### Harmonics Monitoring

Digitrip RMS 910 and Digitrip OPTIM 1050 trip units are capable of monitoring values of current harmonics. Percentage of total harmonic content can be monitored for each level of harmonic content up to the 27th harmonic. Additionally, a total harmonic distortion (THD) value can be calculated and displayed providing the user with total system current harmonic monitoring capability.

## General Description — Molded Case, SPB and DSII Trip Units

**System Communications**

The Eaton's Cutler-Hammer PowerNet monitoring, protection, and control communications system is the most highly reliable, cost-effective communications system available. Digitrip RMS 810 and 910 as well as Digitrip OPTIM 550, 750 and 1050 electronic trip units include a capability to communicate within a PowerNet System.

**Note:** Communications is an optional accessory on the Digitrip OPTIM 550.

PowerNet system communications are over a shielded twisted pair communications cable that connects devices daisychain style.

PowerNet system communications with Digitrip electronic trip units can be applied for variable levels of sophistication as described as follows:

**Display**

Digitrip RMS 610, 810 and 910 electronic trip units are front adjustable trip units where all settings and display information is accessible from the front of the trip unit. Digitrip OPTIM 550, 750 and 1050 electronic trip units are programmable by the use of a hand-held programmer called a Digitrip OPTIMizer. The Digitrip OPTIMizer accesses, displays and configures trip settings and information.

**Sub-Network Displays**

Digitrip RMS 810 and 910 electronic trip units can be connected as part of a sub-network system to a panel-mounted user interface device known as an Assemblies Electronic Monitor (AEMII). All trip units connected to the sub-network can have their settings and monitoring information displayed on the AEMII which is normally mounted on the front of the switchgear or switchboard.

Digitrip OPTIM 550, 750 and 1050 electronic trip units can also be connected as part of a sub-network system to a panel-mounted user interface device called a Breaker Interface Module II (BIMII). A Breaker Interface Module accesses, configures and displays OPTIM trip unit information as well as for Digitrip RMS 810 and 910 trip units as well as Energy Sentinels. The BIMII, like the AEMII, is normally mounted on the front of an electrical assembly. (See **Section 4** for more information on the BIMII.)

**PowerNet Network**

Digitrip RMS 810, 910, and Digitrip OPTIM 550, 750 and 1050 electronic trip units can be connected into a field bus system which is called PowerNet. All control, monitoring and configuration of the trip units can be carried out from a central personal computer. Please see **Section 2** of this catalog for more information on PowerNet.



**Breaker Interface Module (BIM)**

Control and monitoring features provided by Digitrip RMS 810 or 910 and Digitrip OPTIM 550, 750 or 1050 trip units include:

- Breaker status (open, closed, tripped).
- Address and baud rate.
- Trip event time.
- Trip event counter.
- View protection settings.
- Change protection settings. ①
- Load current values.
- Power and energy values. ②
- Power factor. ②
- Line-to-line voltage. ③
- Power quality current harmonic values. ②
- Waveform capture. ②
- Remote status messages.
- Remote control-trip/close/reset.
- Reset demand/energy/trip event.

① Digitrip OPTIM only.

② Digitrip RMS 910 and Digitrip OPTIM 1050 only.

③ Digitrip RMS 910 only.

**Field Testing**

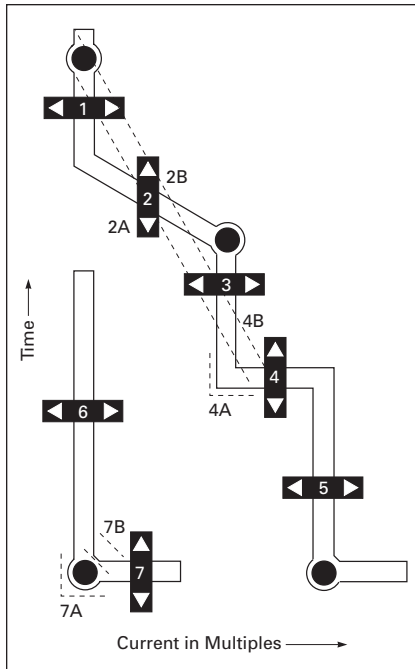
System maintenance is an extremely important part of any distribution system and the capability to test electronic trip units is an essential requirement.

Digitrip RMS 310 and 310+ electronic trip units can be tested using a test set to perform long delay, short delay, and ground fault functional testing. The test set is connected to the trip unit via a built-in test receptacle.

Digitrip RMS 510, 610, 810 and 910 as well as Digitrip OPTIM 550, 750 and 1050 electronic trip units have an integral test capability and do not require an external test set. Both phase and ground, trip and no trip, testing can be carried out with the breaker in the connected cell position.

An Auxiliary Power Module can be provided for bench testing Digitrip RMS 510, 610, 810, 910, and Digitrip OPTIM 550, 750 and 1050 electronic trip units, or when the breaker is disconnected from the cell. The Auxiliary Power Module operates from a 120 Vac supply and provides control power to test the trip unit.

## Time-Current Curve Shaping



**Figure 21.4-1. Time-Current Curve Shaping**

**Note:** See selection guide charts for availability of adjustments.

## Long Delay (L)

1. Long Delay Pickup  
Determines the continuous ampere rating of the breaker.
2. Long Delay Time  
Determines the amount of time the breaker will carry a low level overload before tripping.
  - a.  $I^2t$  Response  
 $I^2t$  in: For coordination with other circuit breakers with electronic trip devices and for coordination with thermal-magnetic circuit breakers.
  - b.  $I^4t$  Response  
 $I^4t$  in: For coordination with fuses and upstream transformer damage curves.

## Short Delay (S)

3. Short Delay Pickup  
Determine or set the level of fault current at which the short time trip delay countdown is actuated.
4. Short Delay  
Sets the amount of time the breaker will carry both a low level and high fault currents before tripping.
  - a. Flat Response  
 $I^2t$  out: For coordination with other circuit breakers with electronic trip devices.
  - b.  $I^2t$  Response  
 $I^2t$  in: For coordination with fuses and thermal-magnetic breakers.

## Instantaneous (I)

5. Instantaneous Pickup  
Determines the level of fault current which will actuate a trip with no time delay.

## Ground Fault (G)

6. Ground Fault Pickup  
Determines the level of fault current at which the ground fault trip delay countdown is actuated.
7. Ground Fault Delay  
Determines the amount of time the breaker will carry a ground fault before tripping.
  - a. Flat Response  
 $I^2t$  out: For coordination with other circuit breakers with electronic ground fault settings.
  - b.  $I^2t$  Response  
 $I^2t$  in: For coordination with zero sequence ground fault relays, fuses, and thermal-magnetic breakers.

## Curve Shaping Economy

Eaton's Cutler-Hammer Digitrip RMS 310 trip units are available with up to five phase and ground adjustments on the front of the trip unit. Selective system coordination with both upstream and downstream devices can be achieved to provide an economic solution for less sophisticated distribution systems.

## Dependent Curve Shaping

For more sophisticated selective coordination systems Digitrip RMS 510, 610, 810 and 910 trip units are available with up to nine curve shaping choices via switches on the front of the unit. Curve shaping flexibility is provided by dependent long and short delay adjustments that are based on continuous amperes ( $I_r$ ) selection.

Dependent curve shaping offers the user additional system coordination possibilities as well as closer thermal protection of the system. Dependent curve shaping adjustments are shown by the blue portion of the graphic time-current curve on the front of the trip unit.

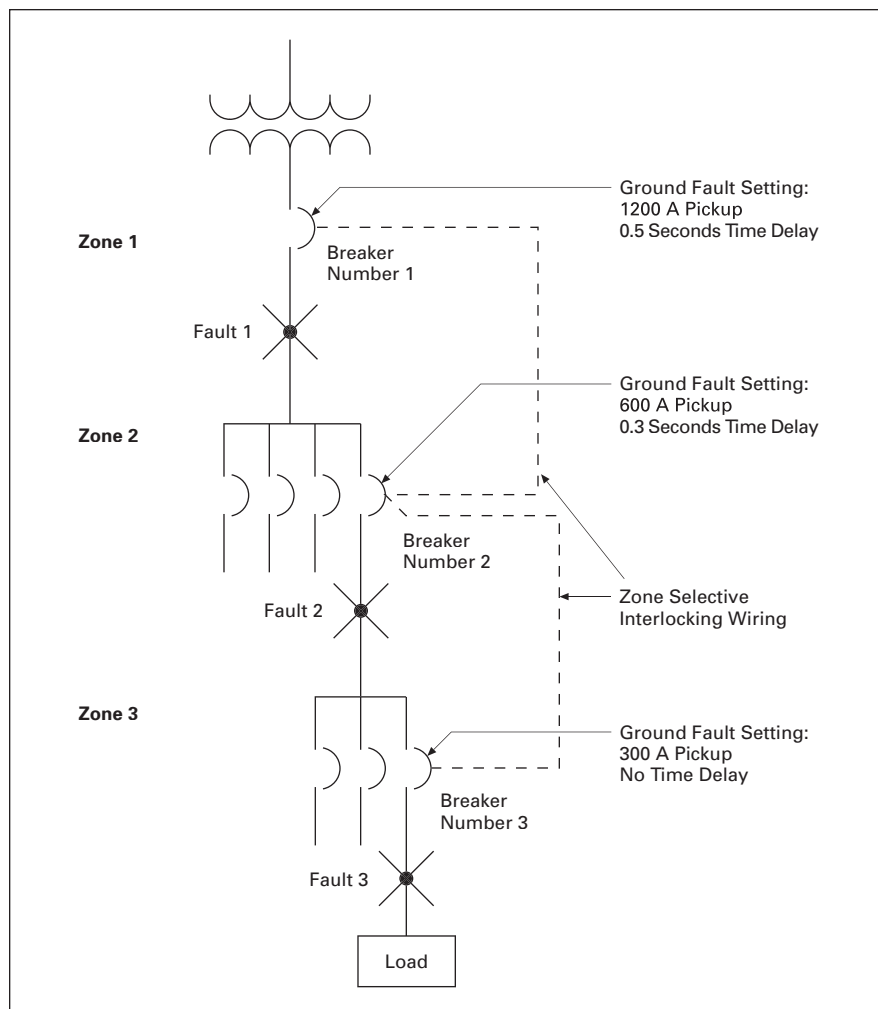
Digitrip OPTIM 550, 750 and 1050 trip units offer programmable dependent curve shaping via ten curve shaping choices that are programmed electronically into the trip unit. OPTIM also offers virtual infinite settings to allow the user to optimize coordination for a selectively coordinated distribution system. In addition, time-current set points can be downloaded via a communication system from a central personal computer. Digitrip OPTIM is normally applied to systems where system integrity is very important.

### Zone Selective Interlocking

Zone selective interlocking capabilities are available with Digitrip RMS 510, 610, 810 and 910 trip units as well as Digitrip OPTIM 550, 750 and 1050 trip units.

**Note:** Optional accessory on the OPTIM 550.

Zone selective interlocking provides positive system coordination by allowing the breaker closest to the fault to trip without any preset time delays. This is achieved by setting up the distribution system as shown in the adjacent diagram. The hardwired connection between the trip units sends a restraining signal upstream allowing the breaker closest to the fault to act instantaneously. Zone selective interlocking also reduces stress on the distribution system by isolating faults without time delays.



**Figure 21.4-2. Zone Selective Interlocking**

#### Fault 1

There are no interlocking signals. The main breaker trip unit will initiate the trip instantaneously.

#### Fault 2

The feeder breaker trip unit will initiate the trip instantaneously to clear the fault; and Zone 2 will send an interlocking signal to the Zone 1 trip unit. The Zone 1 trip unit will begin to time out, and in the event that the feeder breaker in Zone 2 would not clear the fault, the main breaker in Zone 1 will clear the fault in 0.5 seconds.

#### Fault 3

The branch breaker trip unit will initiate the trip instantaneously to clear the fault; and Zone 3 will send an interlocking signal to the Zone 2 trip unit; and Zone 2 will send an interlocking signal to Zone 1.

Zone 1 and Zone 2 trip units will begin to time out, and in the event that the branch breaker in Zone 3 would not clear the fault, the feeder breaker in Zone 2 will clear the fault in 0.3 seconds. Similarly, in the event that the feeder breaker in Zone 2 would not clear the fault, the main breaker in Zone 1 will clear the fault in 0.5 seconds.

## Digitrip OPTIM

### Description

Digitrip OPTIM is a programmable communicating microprocessor-based low voltage electronic trip unit system for Eaton's Cutler-Hammer Molded Case Circuit Breakers and Low Voltage DSII Power Breakers. Digitrip OPTIM trip units are available in three models: Digitrip OPTIM 550 and 1050, for the K-, L-, N- and R-Frames (70 through 2500 amperes), as well as Digitrip OPTIM 550, Digitrip OPTIM 750 and Digitrip OPTIM 1050 for the SPB Insulated Case Circuit Breakers and DSII Power Circuit Breakers.

Digitrip OPTIM trip units are fully programmable and can be applied as a standalone breaker with a hand-held Digitrip OPTIMizer programmer for configuring the trip unit, displaying information and testing. In addition, OPTIM can be applied as a low voltage assembly with a panel-mounted Breaker Interface Module (BIM) to configure, display and test. Alternatively, OPTIM can be applied as part of a fully integrated IMPACC/PowerNet system. (See **Section 2**).

### Features

- Fully programmable, rms sensing trip unit.
- Available in K, L, N and R Series C breakers and DSII power breakers.
- Available in 80% and 100% rated breakers.
- Available in LSI, LSIG or LSIA configurations.
- Note:** Ground fault alarm only.
- Available in three models OPTIM 550, OPTIM 750 and OPTIM 1050.
- 10 function time-current curve shaping options, including a new 1<sup>1</sup>/<sub>4</sub> long delay time or slope.
- Short delay and ground delay Zone Selective Interlocking (Optional on 550).
- Additional programmable protection features including thermal memory and discriminator functions.
- Advanced warning systems including high load alarm, ground fault alarm.
- Full system diagnostics capability.
- System monitoring features including:
  - Load current
  - Power and energy
  - Power factor
  - Power quality — harmonics
- PowerNet communications saves individual wiring of breakers.



*Circuit Breaker Trip Units and Accessories*

### Hand-Held Programmer

The Digitrip OPTIMizer hand-held programmer accesses, displays and configures information from OPTIM Trip Units. The OPTIMizer plugs into the front of the trip unit and is powered by a nine-volt battery, or an auxiliary power module.

An operator can use the OPTIMizer to:

- Complete Initial System Setup:
  - Select breaker address
  - Select system frequency (50/60 Hz)
  - Set system baud rate
  - Set system password
- Configure the System:
  - Change time-current set points
  - Select protection options
  - Select alarm levels
- Display Information:
  - Breaker information
  - Time-current set points
  - Metered values
  - Trip event information
- Test Trip Unit Performance:
  - Phase and ground
  - Trip/no trip

### Panel Mounted User Interface

The Breaker Interface Module can be mounted directly on the assembly or at a remote location and can be used to access, configure and display information from OPTIM Trip Units.

An operator can use the Breaker Interface Module to:

- Complete Initial System Setup:
  - Select system frequency (50/60 Hz)
  - Set system password

- Configure the System:
  - Change time-current set points
  - Select protection options
  - Select alarm levels
- Display Information:
  - Breaker information
  - Time-current set points
  - Metered values
  - Trip event information
- Test Trip Unit Performance:
  - Phase and ground
  - Trip/no trip
- Expanded Energy Monitoring:
  - Set addresses for group energy monitoring
  - Group energy readings
- Common Alarm Contacts:
  - Three Form C contacts
  - Saves wiring to each breaker
- Local and Remote Indication:
  - Remote indication/alarming
  - Breaker status LED indication
- Expanded Communications:
  - Communicate with:
    - OPTIM Trip Units
    - Digitrip RMS 810 and 910 Trip Units
    - IQ Energy Sentinels and Universal
    - IQ Energy Sentinels
    - A total of 50 devices

Technical Data — Molded Case, SPB, and DSII Trip Units Selection Guide

Table 21.4-2. Molded Case and DSII Digitrip Selection Guide

Trip Unit Type	Digitrip RMS 310	Digitrip RMS 310+	Digitrip RMS 510	Digitrip OPTIM 550	Digitrip RMS 610	Digitrip OPTIM 750	Digitrip RMS 810	Digitrip RMS 910	Digitrip OPTIM 1050
rms Sensing	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Breaker Type</b>									
Frame	J250 ①, K, L, M, N, R	JG, LG	R, SPB, DSII, DSLII	K, L, N	R, SPB, DSII, DSLII	SPB, DSII, DSLII ①	R, SPB, DSII, DSLII	R, SPB, DSII, DSLII	K, L, N, R, DSII, DSLII
Ampere Range	15 – 2500 A	20 – 600 A	800 – 5000 A	70 – 1200 A	800 – 5000 A	800 – 2500 A	800 – 5000 A	800 – 5000 A	70 – 5000 A
Interrupting Rating at 480 V	35, 65, 100 (kA)	35, 65, 100 (kA)	65, 100 (kA)	35, 65, 100 (kA)	65, 100 (kA)	35, 65, 100 (kA)	65, 100 (kA)	65, 100 (kA)	35, 65, 100 (kA)
<b>Protection</b>									
Ordering Options	LS LSG	LS LSIG	LI, LS, LSI, LIG, LSG, LSIG	LSI, LSI (A), LSIG	LI, LS, LSI, LIG, LSG, LSIG	LSI(A), LSIG	LI, LS, LSI, LIG, LSG, LSIG	LI, LS, LSI, LIG, LSG, LSIG	LSI (A), LSIG
Fixed Rated Plug (I <sub>N</sub> )	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Overtemperature Trip	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Long Delay Protection (L)</b>									
Adjustable Rating Plug (I <sub>N</sub> )	Yes	No	No	No	No	No	No	No	No
Long Delay Pickup	0.5 – 1.0(I <sub>N</sub> ) ②	40 – 100% Frame	0.5 – 1.0 x (I <sub>N</sub> )	0.4 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.5 – 1.0 x (I <sub>N</sub> )	0.4 – 1.0 x (I <sub>N</sub> )
Long Delay Time I <sup>2</sup> t	10 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds	2 – 24 Seconds
Long Delay Time I <sup>4</sup> t	No	No	No	1 – 5 Seconds	No	1 – 5 Seconds	No	No	1 – 5 Seconds
Long Delay Thermal Memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High Load Alarm	No	Yes	No	0.5 – 1.0 x I <sub>r</sub>	0.85 x I <sub>r</sub>	0.5 – 1.0 x I <sub>r</sub>	0.85 x I <sub>r</sub>	0.85 x I <sub>r</sub>	0.5-1.0 x I <sub>r</sub>
<b>Short Delay Protection (S)</b>									
Short Delay Pickup	200 – 800% x (I <sub>N</sub> )	—	200 – 600% S1&S2 x (I <sub>r</sub> )	150 – 800% x (I <sub>r</sub> )	200 – 600% S1&S2 x (I <sub>r</sub> )	150 – 800% x (I <sub>r</sub> )	200 – 600% S1&S2 x (I <sub>r</sub> )	200 – 600% S1&S2 x (I <sub>r</sub> )	150 – 800% x (I <sub>r</sub> )
Short Delay Time I <sup>2</sup> t	100 ms	No	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Short Delay Time Flat	No	Inst – 300 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Short Delay Time Z.S.I.	No	No	Yes	Optional	Yes	Yes	Yes	Yes	Yes
<b>Instantaneous Protection (I)</b>									
Instantaneous Pickup	No	200 – 800% x (I <sub>N</sub> )	No	200 – 800% x (I <sub>N</sub> )	200 – 600% M1&M2 x (I <sub>N</sub> )	200 – 800% x (I <sub>N</sub> )	200 – 600% M1&M2 x (I <sub>N</sub> )	200 – 600% M1&M2 x (I <sub>N</sub> )	200 – 800% x (I <sub>N</sub> )
Discriminator	No	No	Yes ③	Yes	Yes ③	Yes	Yes ③	Yes ③	Yes
Instantaneous Override	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>Ground Fault Protection (G)</b>									
Ground Fault Alarm	Yes	No	No	20/25 – 100% ④	No	20/25 – 100% ④⑤	No	No	20/25 – 100% ⑤⑥
Ground Fault Pickup	Var/Frame ④	20 – 100% Frame	25 – 100% x I <sub>N</sub> ④	20/25 – 100% ④	25 – 100% x I <sub>N</sub> ④	20/25 – 100% ④⑤	25 – 100% x I <sub>N</sub> ④	25 – 100% x I <sub>N</sub> ④	20/25 – 100% ⑤⑥
Ground Fault Delay I <sup>2</sup> t	No	No	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Ground Fault Delay Flat	Inst – 500 ms	—	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms	100 – 500 ms
Ground Fault Z.S.I.	No	No	Yes	Optional	Yes	Yes	Yes	Yes	Yes
Ground Fault Thermal Memory	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<b>System Diagnostics</b>									
Cause of Trip LEDs	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Magnitude of Trip Information	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Remote Signal Contacts	No	No	No	No	Yes	Yes	Yes	Yes	Yes
<b>System Monitoring</b>									
Digital Display	No	No	No	Yes ⑥	Yes	Yes ⑥	Yes	Yes	Yes ⑥
Current	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Voltage	No	No	No	No	No	No	No	Yes	No
Power and Energy	No ⑦	No	No	No	No	No	Yes	Yes	Yes
Power Quality-Harmonics	No	No	No	No	No	No	No	Yes	Yes
Power Factor	No	No	No	No	No	No	Yes (Over PowerNet Only)	Yes	Yes
<b>Communications</b>									
PowerNet	No	No	No	Optional	No	Yes	Yes	Yes	Yes
<b>Testing</b>									
Testing Method	Test Set	Test Kit	Integral	OPTIMizer, BIM, PowerNet (Optional)	Integral	OPTIMizer, BIM, PowerNet	Integral	Integral	OPTIMizer, BIM, PowerNet

① J250 Frame adjustments are not by rating plug. Ground fault version not available yet.  
 ② Adjust by rating plug.  
 ③ LS/LSG only.  
 ④ Not to exceed 1200 amperes.  
 ⑤ L and N Frames \*20 – 100% x I<sub>S</sub>.  
 R-Frame \*25 – 100% x I<sub>N</sub>.  
 ⑥ By OPTIMizer/BIM.  
 ⑦ Yes with addition of Energy Sentinel.

BIM = Breaker Interface Module  
 I<sub>S</sub> = Sensor Rating  
 I<sub>N</sub> = Rating Plug  
 I<sub>r</sub> = LDPU Setting x I<sub>N</sub>

## Magnum DS Digitrip Trip Units

The next generation of proven Eaton's Cutler-Hammer Digitrip RMS trip units is available exclusively on Cutler-Hammer Magnum DS breakers. These true rms sensing trip units provide accurate coordination with the conductors and equipment the breaker is designed to protect.

Eaton introduced the first microprocessor-based trip unit and has advanced the technology into a new family of UL and CSA listed Digitrip RMS Electronic and Programmable Trip Units designed and engineered exclusively for Magnum DS Breakers.

- **Digitrip RMS 520** enables the user as many as nine phase and ground current protection settings for maximum flexibility in trip-curve shaping and multi-unit coordination, and adds ground current protection settings.
- **Digitrip RMS 520M** adds metering for phase, neutral and ground current...with a four-character LCD display window.
- **Digitrip RMS 520MC** adds communication of trip values and breaker status (open, closed and tripped).

- **Digitrip RMS 1150** provides programmability for more sophisticated distribution systems.
  - Increased protection and coordination capabilities.
  - Systems monitoring information including voltage, current, power, energy, power factor, and harmonic distortion values, viewed on a three-line LED display.
  - Two programmable contacts for customer use.
  - Time stamping of trip events for improved troubleshooting and diagnostics.
  - Accuracy of 1% on voltage and current metered values, and 2% on energy and power.
  - Systems diagnostic information.
  - PowerNet communications.
  - Waveform capture.

### Zone Selective Interlocking

The Digitrip RMS Zone Selective Interlocking capability provides positive system coordination without time delays. Zone Selective Interlocking (ZSI) allows the breaker closest to the fault to trip without any preset time delay. The breaker closest to the fault trips first, while the remainder of the distribution system remains online, thus avoiding unnecessary and costly downtime.







**Digitrip RMS 1150 Programmable Trip Unit**

This state-of-the-art trip unit with true rms sensing can be programmed at the faceplate or remotely with a PC using the PowerNet communications system. All system parameters as well as programming information can be viewed on the easy-to-read three-line digital display window.

Technical Data — Magnum DS Digitrip Selection Guide

Table 21.4-3. Magnum DS Digitrip Selection Guide

Magnum DS Digitrip Trip Units The next generation of proven Digitrip RMS Trip Units is available exclusively on Magnum DS Breakers. These true rms sensing trip units provide accurate coordination with the conductors and equipment the breaker is designed to protect.					
<b>Trip Unit Type</b>		<b>Digitrip 520</b>	<b>Digitrip 520M</b>	<b>Digitrip 520MC</b>	<b>Digitrip 1150</b>
<b>Ampere Range</b>		200 – 5000 A	200 – 5000 A	200 – 5000 A	200 – 5000 A
<b>rms Sensing</b>		Yes	Yes	Yes	Yes
<b>Protection and Coordination</b>					
<b>Protection</b>	<b>Ordering Options</b> Fixed Rating Plug ( $I_N$ ) Overtemperature Trip	LSI, LSIG <sup>①</sup> Yes Yes	LSI, LSIG, LSIA <sup>①</sup> Yes Yes	LSI, LSIG, LSIA <sup>①</sup> Yes Yes	LSI, LSIG, LSIA <sup>①</sup> Yes Yes
<b>Long Delay Protection</b>	Adjustable Rating Plug ( $I_N$ ) Long Delay Setting Long Delay Time $I^2t$ at $6 \times I_r$	No 0.4 – 1.0 $\times (I_N)$ 2 – 24 Seconds	No 0.4 – 1.0 $\times (I_N)$ 2 – 24 Seconds	No 0.4 – 1.0 $\times (I_N)$ 2 – 24 Seconds	No 0.4 – 1.0 $\times (I_N)$ 2 – 24 Seconds
	Long Delay Time $I^4t$ Long Delay Thermal Memory High Load Alarm	No Yes No	No Yes No	No Yes No	1-5 Seconds Yes 0.5-1.0 $\times I_r$
<b>Short Delay Protection</b>	Short Delay Pick-Up Short Delay Time $I^2t$ at $8 \times I_r$ Short Delay Time Flat Short Delay Time ZSI	200 – 1000% $M1 \times (I_r)$ 100 – 500 ms 100 – 500 ms Yes	200 – 1000% $M1 \times (I_r)$ 100 – 500 ms 100 – 500 ms Yes	200 – 1000% $M1 \times (I_r)$ 100 – 500 ms 100 – 500 ms Yes	150% – 1000% $\times (I_r)$ 100 – 500 ms 100 – 500 ms Yes
	<b>Instantaneous Protection</b>	Instantaneous Pick-Up Making Current Release Off Position	200 – 1000% $M1 \times (I_N)$ Yes Yes	200 – 1000% $M1 \times (I_N)$ Yes Yes	200 – 1000% $M1 \times (I_N)$ Yes Yes
<b>Ground Fault Protection</b>	Ground Fault Alarm Ground Fault Pick-Up Ground Fault Delay $I^2t$ at $.625 \times I_N$	No 0.25 – 100% $\times (I_N)$ <sup>①</sup> 100 – 500 ms	Yes 0.25 – 100% $\times (I_N)$ <sup>①</sup> 100 – 500 ms	Yes 0.25 – 100% $\times (I_N)$ <sup>①</sup> 100 – 500 ms	Yes 0.25 – 100% $\times (I_N)$ <sup>①</sup> 100 – 500 ms
	Ground Fault Delay Flat Ground Fault ZSI Ground Fault Thermal Memory	100 – 500 ms Yes Yes	100 – 500 ms Yes Yes	100 – 500 ms Yes Yes	100 – 500 ms Yes Yes
<b>System Diagnostics</b>					
<b>Cause of Trip LEDs</b>		Yes <sup>②</sup>	Yes <sup>②</sup>	Yes <sup>②</sup>	Yes <sup>②</sup>
<b>Magnitude of Trip Information</b>		No	No	No	Yes
<b>Trip Log (3 Events)</b>		No	No	No	Yes
<b>Remote Signal Contacts</b>		No	Yes <sup>③</sup>	Yes <sup>③</sup>	Yes
<b>Programmable Contacts</b>		No	No	No	2
<b>System Monitoring</b>					
<b>Digital Display</b>		No	4-Character LCD	4-Character LCD	24-Character LED
<b>Electronic Operations Counter</b>		No	No	No	Yes
<b>Current (Accuracy — % FS Sensor)</b>		No	Yes (2%)	Yes (2%)	Yes (1%)
<b>Voltage (Accuracy — %) L to L</b>		No	No	No	Yes (1%)
<b>Power and Energy (Accuracy — %)</b>		No	No	No	Yes (2%)
<b>Apparent Power kVA and Demand</b>		No	No	No	Yes
<b>Reactive Power kvar</b>		No	No	No	Yes
<b>Power Factor</b>		No	No	No	Yes
<b>Crest Factor</b>		No	No	No	Yes
<b>Power Quality — Harmonics</b>		No	No	No	Yes
<b>% THD</b>		No	No	No	Yes
<b>Waveform Capture</b>		No	No	No	Yes
<b>System Communications</b>					
<b>IMPACC/PowerNet</b>		No	No	Yes <sup>⑤</sup>	Yes <sup>⑤</sup>
<b>Testing Method</b>		Test Set <sup>④</sup>	Test Set <sup>④</sup>	Test Set <sup>④</sup>	Integral and Test Set <sup>④</sup>
<b>Triplink</b>		No	No	No	Yes

① Not to exceed 1200 amperes on ground.

② Cause of trip — L, S, I, G, and making current release.

③ Optional GF only.

④ Tester for secondary injection.

⑤ Must utilize NT-based PowerNet software to enable communications.

$I_N$  = Sensor and plug rating.  
 $I_r$  = LDPU setting.



## General Description

**NEMA 1 General Purpose****Surface or Flush Mounting**  
15 – 1200 A, 600 Vac, 500 Vdc**NEMA 1**

Eaton's Cutler-Hammer NEMA 1 enclosed breakers are designed for indoor use in commercial buildings, apartment buildings and other areas where a general purpose enclosure is applicable. The breaker is front operable and is capable of being padlocked in the OFF position. (Padlocking not available on enclosures for QUICKLAG breakers.) Ratings through 1200 amperes are listed with Underwriters Laboratories as suitable for service entrance application. Both surface and flush mounted enclosures are available.

**UL File Number E7819**  
**CSA File Number LR84319****NEMA 3R Rainproof**  
**Surface Mounting****Interchangeable Hubs**  
(through 400 amperes)  
15 – 1200 A, 600 Vac, 500 Vdc**NEMA 3R**

This general purpose outdoor service center employs a circuit breaker inside a weatherproof sheet steel enclosure to serve as a main disconnect and protective device for feeder circuits. The operating handle can be padlocked in the OFF position, and is interlocked to prevent the door from opening when the breaker is ON. Ratings through 1200 amperes are listed by Underwriters Laboratories as suitable for service entrance application.

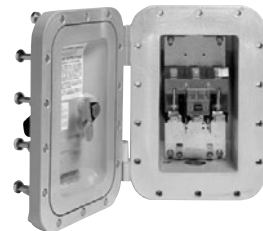
**UL File Number E7819**  
**CSA File Number LR84319****NEMA 4/4X, 5 Water and Dustproof****Stainless Steel — Type 304,**  
**Surface Mounting**  
15 – 1200 A, 600 Vac, 500 Vdc**NEMA 4/4X, 5**

This enclosure meets NEMA 4/4X and 5 requirements for water and dustproof applications and has no knockouts or other openings. It is particularly well suited for use in dairies, borax mines, breweries, paper mills and other process industries. The operating handle can be padlocked in the OFF position, and is interlocked to prevent the door from opening when the breaker is ON. Ratings through 1200 amperes are Underwriters Laboratories listed as suitable for service entrance application.

**UL File Number E7819**  
**CSA File Number LR84319****NEMA 12 Dustproof**  
**Surface Mounting****No Knockouts or Other Openings**  
15 – 1200 A, 600 Vac, 500 Vdc**NEMA 12 Dustproof**

The Cutler-Hammer Type 12 enclosure is designed in line with specifications for special industry application where unusually severe conditions involving oil, coolant, dust and other foreign materials exist in the operating atmosphere. The handle padlocks in the OFF position and the cover is interlocked with the handle mechanism to prevent opening the cover with the circuit breaker in the ON position. Ratings through 1200 amperes are listed by Underwriters Laboratories as suitable

for service entrance application. A NEMA 12 semi-dust-tight design which includes knockouts is available. These units are rated 15 – 400 A, 600 Vac, 500 Vdc.

**UL File Number E7819**  
**CSA File Number LR84319****NEMA 7/9 Hazardous Location****Cast Aluminum, Explosion-proof**  
**Surface Mounting**  
15 – 1200 A, 600 Vac, 250 Vdc**NEMA 7/9 Hazardous Location**

Hazardous location, Class I, Groups B, C, D, Divisions 1, 2; Class II, Groups E, F, G, Divisions 1, 2. This special service cast aluminum enclosure is supplied with a wide, machined flanged cover to prevent igniting outside atmospheres by arcing from inside the enclosure. Front operable, the handle padlocks in the OFF position. Enclosures rated 600 amperes and above have lift-off hinges for ease of assembly.

**Note:** XF DN050 is not Group B compliant.**UL File Number E84577 Enclosed**  
**Circuit Breakers**

## General Description — Enclosures Only

Table 21.5-1. Enclosure Only Catalog Numbers Selection Guide

Breaker Frame	Breaker Ampere Range	Enclosure	
		NEMA Class	Catalog Number
<b>Series C Breakers</b>			
GC, GHC, GD 2- and 3-Pole only GHCGFEP 1-Pole Only	15 – 100	1 Surface 3R 12 12K 4/4X, 5 St. Steel	SGDN100 ① RGDN100 JGDN100 DGDN100 WGDN100
EHD, FD, FDB, HFD, FDC	15 – 100	1 Surface 1 Flush 3R 12 12K 4/4X, 5 St. Steel	SFDN100 FFDN100 RFDN100 JFDN100 DFDN100 WFDN100
EHD, FD, FDB HFD, FDC	15 – 50 60 – 225 ②	7/9 Cast Alum. 7/9 Cast Alum.	XFDN050B XFDN225B
FD, FDB, HFD, FDC, ED, EDH, EDC	125 – 225	1 Surface 1 Flush 3R 12 12K 4/4X, 5 St. Steel	SFDN225 FFDN225 RFDN225 JFDN225 DFDN225 WFDN225
JD, JDB, HJD, JDC	125 – 250	1 Surface 1 Flush 3R 12 12K 4/4X, 5 St. Steel	SJDN250 FJDN250 RJDN250 JJDN250 DJDN250 WJDN250
JD, JDB, HJD, JDC	125 – 250	7/9 Cast Alum.	XJDN250B
KD, KDB, HKD, KDC, DK	125 – 400	1 Surface 1 Flush 3R 12 12K 4/4X, 5 St. Steel	SKDN400 FKDN400 RKDN400 JKDN400 DKDN400 WKDN400
KD, KDB, HKD, KDC, DK	125 – 400	7/9 Cast Alum.	XKDN400B
LD, LDB, HLD, LDC	300 – 600	1 Surface 3R 12 4/4X, 5 St. Steel	SLDN600 RLDN600 JLDN600 WLDN600
LD, LDB, HLD, LDC MDL, HMDL	300 – 600 400 – 800	7/9 Cast Alum.	XMCN800B
MDL, HMDL, ND, NDC, HND	400 – 1200	1 Surface 3R 12 4/4X, 5 St. Steel	SNDN1200 RNDN1200 JNDN1200 WNDN1200
ND, HND, NDC	400 – 1200	7/9 Cast Alum.	XNDN1200B

① Suitable for use with one-pole breaker base mounting plate kit. QCCBP required.

② Maximum wire size: 4/0.

Table 21.5-2. Neutral Kits, Insulated and Groundable

Maximum Enclosure Rating (Amperes)	Main Lug Size Cu/Al	Ground Lug Size Cu/Al	Catalog Number
100 (RFDN100 and SFDN100)	(1) 14 – 1/0	(1) 14 – 2	DH100NK
100 (All Others)	(1) 14 – 1/0	(1) 14 – 1/0	INK100
250	(1) 6 – 350 kcmil	(1) 4 – 300 kcmil	INK250
400	(1) 4 – 750 kcmil or (2) 1/0 – 250 kcmil	(1) 4 – 300 kcmil	INK400
600	(2) 250 – 500 kcmil	(1) 4 – 300 kcmil	INK600
1200	(3) 1/0 to 750 kcmil or (4) 1/0 to 750 kcmil	(1) #6 – 250 kcmil	INK1200

Enclosure Only Catalog Numbers Selection Guide (Continued)

Breaker Frame	Breaker Ampere Range	Enclosure	
		NEMA Class	Catalog Number
<b>Earth Leakage Breakers</b>			
ELFD, ELHFD & ELFDC (3-Pole Only)	15 – 100	1 Surface 1 Flush 3R 12 12K 4/4X	SFD100E FFD100E RFDN100E JFDN100E DFDN100E WFDN100E
<b>Current Limit-R Breakers</b>			
FCL	15 – 100	3R 12 12K 4/4X, 5 St. Steel	RFDN150 JFDN150 DFDN150 WFDN150
LCL ③	125 – 400	1 Surface 3R 12 4/4X, 5 St. Steel	SNDN1200 RNDN1200 JNDN1200 WNDN1200
<b>TRI-PAC Breakers</b>			
FB-P	15 – 100	3R 12 12K 4/4X, 5 St. Steel	RFDN150 JFDN150 DFDN150 WFDN150
LA-P ③	70 – 400	1 Surface 3R 12 4/4X	SNDN1200 RNDN1200 JNDN1200 WNDN1200
NB-P	500 – 800	12 4/4X, 5 St. Steel	JNDPN800 WNDPN800

③ Requires additional adapter plate.

Table 21.5-3. Raintight Hubs — Dimensions in Inches (mm)


Hub Diameter in Inches (mm)	Catalog Number		
	Small Hubs	Large Hubs	
 <p>All rainproof enclosures 30 through 400 A are shipped with plate over cutout. Hubs are not supplied with screws on 30 through 400 A enclosures. Use screws from plate.</p>	For use with RGDN and RFDN	.75 (19.1) 1.00 (25.4) 1.25 (31.8) 1.50 (38.1) 2.00 (50.8)	DS075H1 DS100H1 DS125H1 DS150H1 DS200H1
	For use with RJDN, RKDN has two cutouts	2.00 (50.8) 2.50 (63.5) 3.00 (76.2)	R1H200 R1H250 R1H300
	Required if using Type DS hubs on RJDN and RKDN enclosures.		R1HA

Table 21.5-4. Breather and Drain, Hazardous Enclosures — Dimensions in Inches (mm)

Description	Compliance	Conduit Opening	Catalog Number
A Universal Breather/Drain Fitting is installed in the top of an enclosure to provide ventilation to minimize condensation and in the bottom to allow drainage of accumulated condensation while maintaining explosion-proof integrity.	Type BD: NEMA 7 – Class I, Groups C, D; Class I, Zone 1, Group IIB NEMA 9 – Class II, Groups F, G	.50 (12.7)	XPBD2
	Type DBB: NEMA 7 – Class I, Groups B, C, D; Class I, Zone 1, Group IIB + Hydrogen NEMA 9 – Class II, Groups E, F, G	.50 (12.7)	XPDBB50

Dimensions and Weights — Enclosure Only

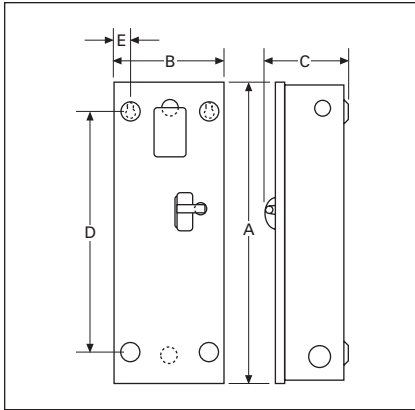


Figure 21.5-1. NEMA 1 Surface Mounted

Table 21.5-5. NEMA 1 Surface Mounted — Dimensions in Inches (mm)

Catalog Number	Approximate <sup>①</sup> Weight Lbs. (kg)	Maximum Amperes	Box Dimensions				
			A	B	C	D	E
SGDN100	12 (5)	100	17.50 (444.5)	8.41 (213.5)	6.28 (159.5)	13.03 (331.0)	1.20 (30.6)
SFDN100	12 (5)	100	19.12 (485.6)	9.13 <sup>②</sup> (231.9)	5.20 (132.1)	17.00 (431.8)	N/A <sup>③</sup>
SFDN150	15 (7)	150	23.25 (590.6)	8.41 (213.5)	6.28 (159.5)	18.75 (476.2)	1.20 (30.6)
SFDN225	15 (7)	225	23.25 (590.6)	8.41 (213.5)	6.28 (159.5)	18.75 (476.2)	1.20 (30.6)
SJDN250	31 (14)	250	34.70 (881.5)	10.92 (277.4)	7.20 (183.0)	30.00 (762.0)	1.88 (47.6)
SKDN400	53 (24)	400	38.81 (985.9)	11.01 (281.0)	10.94 (277.8)	34.00 (863.6)	2.28 (57.9)
SLDN600	81 (37)	600	45.88 (1165.2)	14.31 (363.6)	12.38 (314.3)	46.56 (1182.7)	1.91 (48.4)
SNDN1200	178 (81)	1200	61.22 (1555.0)	21.44 (544.5)	15.41 (391.3)	61.84 (1570.8)	1.97 (50.0)

<sup>①</sup> Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.

<sup>②</sup> Total width, due to door clip is 9.95 (252.7).

<sup>③</sup> Single centered mounting hole provided.

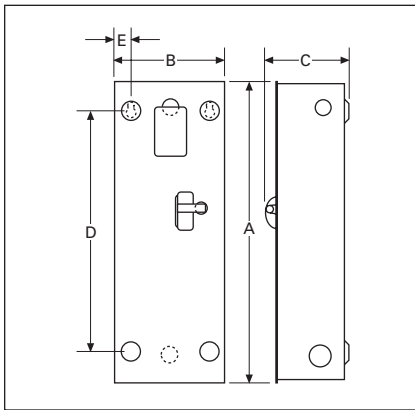


Figure 21.5-2. NEMA 1 Flush Mounted

Table 21.5-6. NEMA 1 Flush Mounted — Dimensions in Inches (mm)

Catalog Number	Approximate <sup>④</sup> Weight Lbs. (kg)	Maximum Amperes	Box Dimensions				
			A	B	C	D	E
FFDN100	12 (5)	100	18.81 (477.9)	9.72 (246.9)	6.28 (159.5)	13.03 (331.0)	1.86 (47.2)
FFDN150	15 (7)	150	24.56 (623.9)	9.72 (246.9)	6.28 (159.5)	18.75 (476.2)	1.86 (47.2)
FFDN225	15 (7)	225	24.56 (623.9)	9.72 (246.9)	6.28 (159.5)	18.75 (476.2)	1.86 (47.2)
FJDN250	32 (15)	250	36.02 (914.8)	12.23 (310.7)	7.20 (183.0)	30.00 (762.0)	1.88 (47.6)
FKDN400	53 (24)	400	40.13 (1019.2)	12.38 (314.3)	10.94 (277.8)	34.00 (863.6)	2.94 (74.6)

<sup>④</sup> Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.

Not to be used for construction purposes unless approved.

## Dimensions and Weights — Enclosures Only

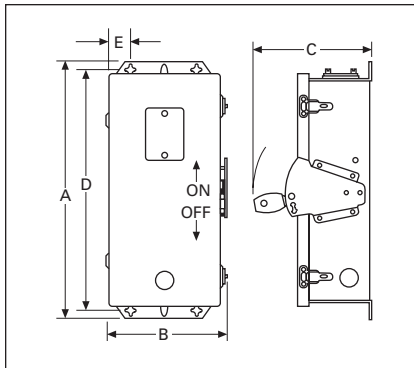


Figure 21.5-3. NEMA 12, 12K Dustproof

Table 21.5-7. NEMA 12, 12K Dustproof — Dimensions in Inches (mm)

Catalog Number	Approximate <sup>①</sup> Weight Lbs. (kg)	Maximum Amperes	Box Dimensions				
			A	B	C	D	E
JGDN100	14 (6)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	18.53 (470.7)	1.70 (43.3)
JFDN100	14 (6)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	18.53 (470.7)	1.70 (43.3)
JFDN150	18 (8)	150	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	24.28 (616.7)	1.70 (43.3)
JFDN225	18 (8)	225	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	24.28 (616.7)	1.70 (43.3)
JJDN250	37 (17)	250	37.53 (953.3)	11.56 (293.7)	10.22 (259.6)	35.77 (908.5)	1.94 (49.2)
JKDN400	58 (26)	400	41.69 (1058.9)	11.75 (298.4)	14.06 (357.2)	39.94 (1014.4)	1.97 (50.0)
JLDN600	81 (37)	600	48.31 (1227.2)	14.91 (378.6)	15.50 (393.7)	46.56 (1182.7)	1.92 (48.8)
JNDPN800	110 (50)	800	63.59 (1615.3)	22.00 (558.8)	17.63 (447.7)	—	1.97 (50.0)
JNDN1200	170 (77)	1200	63.59 (1615.3)	22.00 (558.8)	17.63 (447.7)	61.84 (1570.8)	—
DGDN100	16 (7)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	—	—
DFDN100	16 (7)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	—	—
DFDN150	19 (9)	150	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	—	—
DFDN225	19 (9)	225	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	—	—
DJDN250	36 (16)	250	37.53 (953.3)	11.56 (293.7)	10.22 (259.6)	—	—
DKDN400	53 (24)	400	41.69 (1058.9)	11.75 (298.4)	14.06 (357.2)	—	—

<sup>①</sup> Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.

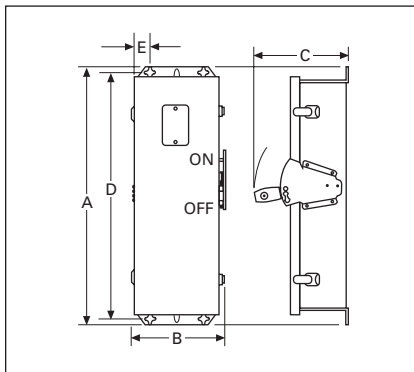


Figure 21.5-4. NEMA 3R Rainproof

Table 21.5-8. NEMA 3R Rainproof — Dimensions in Inches (mm)

Catalog Number	Approximate <sup>②</sup> Weight Lbs. (kg)	Maximum Amperes	Dimensions in Inches (mm)				
			A	B	C	D	E
RGDN100	14 (6)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	18.53 (470.7)	1.70 (43.3)
RFDN100	14 (6)	100	19.12 (485.6)	9.95 (252.8)	5.14 (130.6)	17.00 (431.8)	N/A <sup>③</sup>
RFDN150	19 (9)	150	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	24.28 (616.7)	1.70 (43.3)
RFDN225	19 (9)	225	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	24.28 (616.7)	1.70 (43.3)
RJDN250	40 (18)	250	37.50 (952.5)	11.56 (293.7)	10.22 (259.6)	35.77 (908.5)	1.94 (49.2)
RKDN400	60 (27)	400	41.69 (1058.9)	11.75 (298.4)	14.06 (357.2)	39.94 (1014.4)	1.97 (50.0)
RLDN600	84 (38)	600	48.31 (1227.2)	14.91 (378.6)	15.50 (393.7)	46.56 (1182.7)	1.92 (48.8)
RNDN1200	175 (79)	1200	63.59 (1615.3)	22.00 (558.8)	17.63 (447.7)	61.84 (1570.8)	1.97 (50.0)

<sup>②</sup> Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.

<sup>③</sup> Single centered mounting hole provided.

**Not to be used for construction purposes unless approved.**

Dimensions and Weights — Enclosures Only

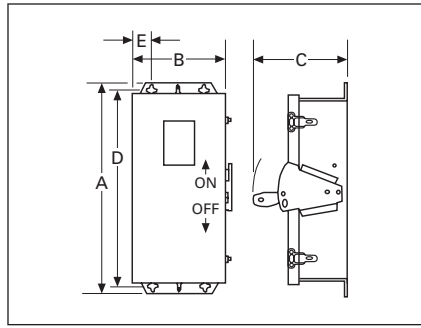


Figure 21.5-5. NEMA 4/4X, 5 Stainless Steel

Table 21.5-9. NEMA 4/4X, 5 Stainless Steel — Dimensions in Inches (mm)

Catalog Number	Approximate <sup>①</sup> Weight Lbs. (kg)	Maximum Amperes	Dimensions in Inches (mm)				
			A	B	C	D	E
WGDN100	16 (7)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	18.53 (470.7)	1.70 (43.3)
WFDN100	16 (7)	100	19.91 (505.6)	8.84 (224.6)	9.31 (236.6)	18.53 (470.7)	1.70 (43.3)
WFDN150	20 (9)	150	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	24.28 (616.7)	1.70 (43.3)
WFDN225	20 (9)	225	25.66 (651.7)	8.84 (224.6)	9.31 (236.6)	24.28 (616.7)	1.70 (43.3)
WJDN250	39 (18)	250	37.50 (952.5)	11.56 (293.7)	10.22 (259.6)	35.77 (908.5)	1.94 (49.2)
WKDN400	60 (27)	400	41.69 (1058.9)	11.75 (298.4)	14.06 (357.2)	39.94 (1014.4)	1.97 (50.0)
WLDN600	88 (40)	600	48.31 (1227.2)	14.91 (378.6)	15.50 (393.7)	46.56 (1182.7)	1.92 (48.8)
WNDN1200	185 (84)	1200	63.59 (1615.3)	22.00 (558.8)	17.63 (447.7)	61.84 (1570.8)	1.97 (50.0)

<sup>①</sup> Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.

Table 21.5-10. NEMA 7/9Cast Aluminum with Weather Resistant Seals — 15 – 250 Amperes

Catalog Number	Breaker Size Amperes	Number of Outlets	Dimensions in Inches (mm)											Approximate Weight <sup>②</sup>		
			Mounting			Inside				Outside			K Dim	Standard Conduit Size	Lbs.	kg
			A	B	J	C	D	E	F	G	H					
XFDN050B	15 – 50	4	5.50 (139.7)	13.13 (333.5)	14.13 (358.9)	6.13 (155.7)	10.75 (273.1)	5.25 (133.4)	10.63 (270.0)	15.25 (387.4)	8.88 (225.6)	2.00 (50.8)	1.50 (38.1)	38	17.3	
XFDN100B <sup>③</sup>	60 – 100	4	6.00 (152.4)	18.00 (457.2)	19.00 (482.6)	6.50 (165.1)	16.00 (406.4)	5.50 (139.7)	11.00 (279.4)	20.50 (520.7)	9.00 (228.6)	2.31 (58.7)	2.00 (50.8)	57	25.9	
XFDN225B <sup>③</sup>	125 – 225	4	10.25 (260.4)	22.63 (574.8)	—	11.38 (289.1)	20.00 (508.0)	6.38 (162.1)	16.38 (416.1)	25.13 (638.3)	9.63 (244.6)	3.50 (88.9)	2.50 (63.5)	104	47.2	
XJDN225B	70 – 225	4	8.50 (215.9)	27.13 (689.1)	—	11.25 (285.8)	29.88 (759.0)	7.38 (187.5)	16.00 (406.4)	29.50 (749.3)	12.31 (312.7)	4.00 (101.6)	3.00 (76.2)	145	65.8	
XJDN250B	250	4	9.50 (241.3)	27.25 (692.2)	—	11.25 (285.8)	29.88 (759.0)	8.06 (204.7)	16.38 (416.1)	35.00 (889.0)	12.38 (314.5)	4.19 (106.4)	4.00 (101.6)	170	77.2	

<sup>②</sup> Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.

<sup>③</sup> Maximum wire size: 4/0.

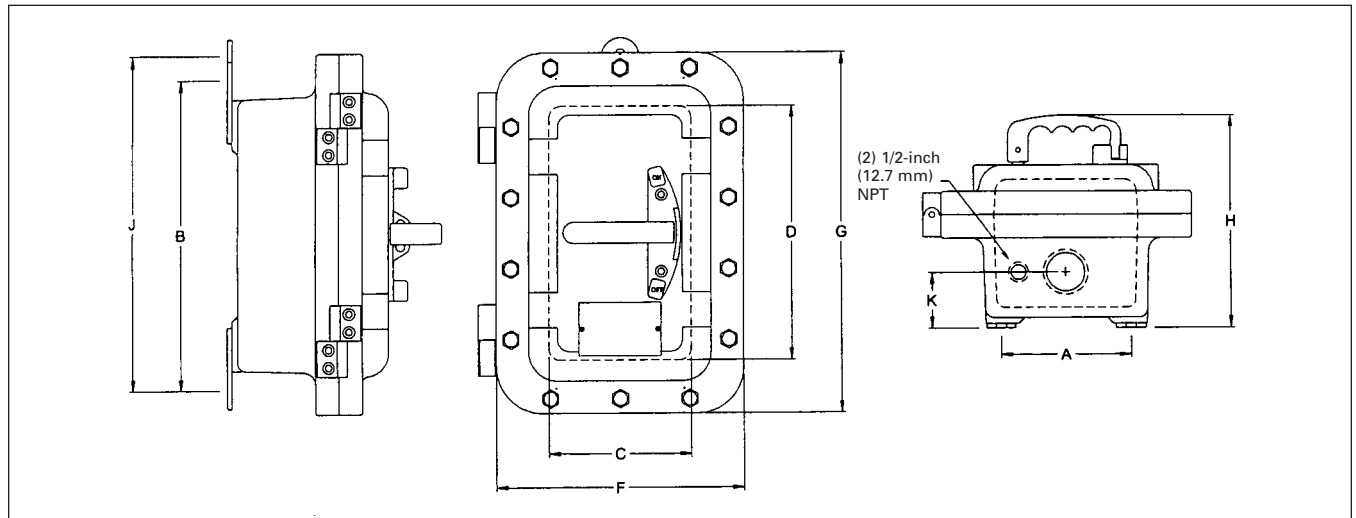


Figure 21.5-6. NEMA 7/9 Cast Aluminum with Weather Resistant Seals — Dual 3 and 4 Point Mounting Available as Standard on F-Frame 100 A and Below

Dimensions and Weights/Technical Data — Enclosures and Breakers

Table 21.5-11. NEMA 7/9 Cast Aluminum with Weather Resistant Seals — 400 – 1200 Amperes

Catalog Number	Breaker Size Amperes	Dimensions in Inches (mm)										Weight ①	
		Overall Enclosure			Enclosure Mounting		Conduit		Standard Conduit				
		A	B	C	E	F	H	I	Size	Location	Lbs.	kg	
XKDN400B ②	400	35.00 (889.0)	16.38 (416.1)	12.63 (320.8)	9.50 (241.3)	27.25 (692.2)	3.00 (76.2)	4.19 (106.4)	4.00 (101.6)	1, 3 & 6, 8	170	77	
XLDN600B	600	37.88 (962.2)	23.88 (606.6)	14.25 (362.0)	16.00 (406.4)	45.38 (1152.7)	4.00 (101.6)	5.00 (127.0)	4.00 (101.6)	1, 3 & 6, 8	419	191	
XKCN800B	800	47.88 (1216.2)	13.63 (346.2)	12.81 (325.4)	16.13 (409.7)	40.75 (1035.1)	4.00 (101.6)	4.00 (101.6)	4.00 (101.6)	1, 3 & 6, 8	228	104	
XNDN1200B ③	1200	64.00 (1625.6)	26.00 (660.4)	21.38 (543.1)	27.56 (700.0)	38.63 (981.2)	6.50 (165.1)	4.38 (111.3)	4.00 (101.6)	1, 3 & 6, 8	567	257	

- ① Weight values are for the enclosure only. See Table 21.5-12 for breaker weights.
- ② Maximum wire size: 500 kcmil.
- ③ Power cables must enter and leave from opposite ends (through-feed).

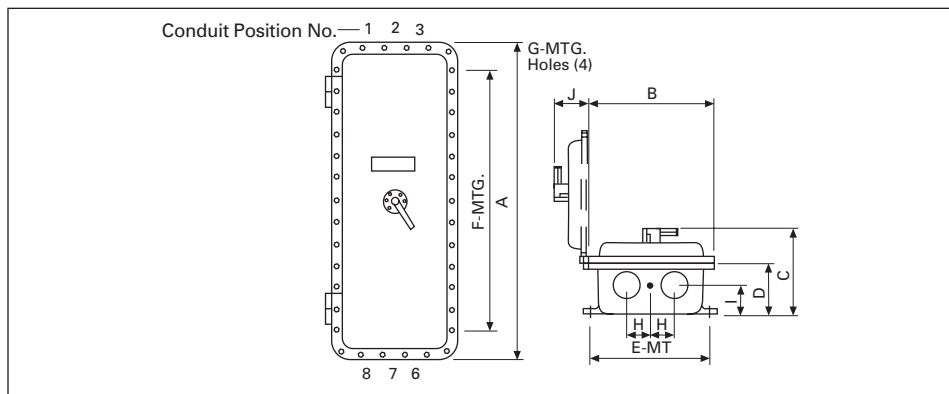


Figure 21.5-7. NEMA 7/9 Cast Aluminum with Weather Resistant Seals

Table 21.5-12. Typical Breaker Weights

Frame	Lbs.	kg
G	2	0.9
E	3	1.4
F	5	2.3
J	12	5.4
K	13	5.9
L	20	9.1
M	30	13.6
N	45	20.4

Table 21.5-13. Circuit Breaker Enclosure Interpretation Data

1st Field Enclosure Type	2nd Field Breaker Family	3rd Field Maximum Ampacity	NEMA Enclosure Type	Definitions NEMA Standard
NEMA 1 Flush Surface	F S	50 100	1	Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment.
NEMA 3R	R	150	3R	Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain, sleet, and external ice formation.
NEMA 12	J	225	12	Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.
NEMA 12K	D	250	12K	Type 12K enclosures with knockouts are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids other than at knockouts.
NEMA 4/4X, 5	W V	400	4/4X	Type 4 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose-directed water, and corrosion; and will be undamaged by the external formation of ice on the enclosure.
NEMA 7/9	X	600 1200	5	Type 5 enclosures are used for indoor use primarily to provide a degree of protection against dust and falling dirt.
			7	Type 7 enclosures are for use indoors in locations classified as Class I, Groups B, C or D as defined in the National Electrical Code. ⑤
			9	Type 9 enclosures are for use in indoor locations classified as Class II, Groups E, F or G as defined in the National Electrical Code.

1st Field	2nd Field	3rd Field
R	FD	N ④
NEMA Enclosure	Breaker Frame	NEMA Enclosure
		150

- ④ "N" in this position indicates enclosure complies with NEC gutter space requirement.
- ⑤ XFNDN050 is not Group B compliant.

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