

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Introduction

PowerPact™ M-, P-, and R-frame and Compact™ NS630b–NS3200 electronic trip molded case circuit breakers are designed to protect electrical systems from damage caused by overloads, short circuits, and ground faults. All circuit breakers are designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent. Electronic trip molded case circuit breakers use an electronic trip system to signal the circuit breaker to open automatically.

The PowerPact M-frame (800 A frame size), P-frame (1200 A frame size) and R-frame (3000 A frame size) circuit breakers are dual rated to UL489 and IEC 60947-2. The Compact NS630b–NS1600 (1600 A frame size) and NS1600b–NS3200 (3200 A frame) circuit breakers are rated to IEC 60947-2 only.

M-frame molded case circuit breakers are equipped with a basic ET1.0 electronic trip system, which has a fixed long-time (overload) setting and an adjustable instantaneous (short-circuit) trip setting. P-frame, R-frame and NS630b–NS3200 molded case circuit breakers are available with either a basic ET 1.0I electronic trip system or with a more advanced Micrologic™ trip system. Electronic trip motor circuit protectors (trip system ET 1.0M), which trip on short circuit only, and automatic molded case switches, which trip at a predetermined self-protection level only, are also available for special applications. All of these circuit breakers are available labeled as Square D™ or Schneider Electric™ (formerly Merlin Gerin™, Federal Pioneer™, or Federal Pacific™).

For information on other Square D brand PowerPact molded case circuit breakers, see the Class 611 catalog: *PowerPact H-, J-, and L-Frame Circuit Breakers*.

Features and Benefits

M-frame, P-frame, R-frame and NS630b–NS3200 electronic trip circuit breakers:

- Provide overload and short-circuit protection
- Are true RMS sensing devices
- Provide means to manually disconnect power to the circuit
- Provide enhanced coordination by their adjustability
- Provide high interrupting ratings and withstand ratings

Circuit breakers with Micrologic trip units can also:

- Provide integral equipment ground-fault protection or alarm
- Provide communications
- Provide power monitoring
- Provide protective relaying functions
- Provide zone-selective interlocking (ZSI), which can reduce damage in the event of a fault

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Specifications

Electronic trip molded case circuit breakers have a molded case made of a glass-reinforced insulating material (thermal set composite resin) that provides high dielectric strength. These circuit breakers:

- Are available in either dual-rated Underwriters Laboratory® (UL®) / International Electrotechnical Commission® (IEC®) or IEC-only constructions
- Are also Canadian Standard Association® (CSA®) and Association of the Electrical Sector® (ANCE®) certified (dual-rated UL/IEC circuit breakers only)
- Are manufactured in unit-mount, I-Line™ and drawout (P-frame and NS630b–NS1600) constructions
- Are available with either type ET or Micrologic electronic tripping systems
- Provide optional power monitoring, communications, protective relaying, integral ground-fault protection for equipment and zone-selective interlocking functions
- Share common tripping of all poles
- Can be mounted and operated in any position¹
- Are equipped with an externally-accessible test port for use with hand-held and full-function test sets
- Are available in motor circuit protector and automatic molded case switch constructions
- Can be reverse connected, without restrictive LINE and LOAD markings
- Meet the requirements of National Electrical Code® (NEC®) Sections 240.6 by providing a means to seal the rating plug and trip unit adjustments

Codes and Standards

M-, P- and R-frame, and NS630b–NS3200 electronic trip circuit breakers and switches are manufactured and tested in accordance with the following standards:

Table 1: Standards

M-Frame, P-Frame and R-Frame Circuit Breakers	P- and R-Frame Switches	NS630b–NS3200 Circuit Breakers	NS630b–NS3200 Switches
UL 489 ¹ IEC Standard 60947-2 CSA C22.2 No 5 Federal Specification W-C-375B/GEN NEMA AB1 NMX J-266 UTE, VDE, BS, CEI, UNE, CCC	UL 489 ² IEC Standard 60947-3 CSA C22.2 No 5 Federal Specification W-C-375B/GEN NEMA AB1 NMX J-266 UTE, VDE, BS, CEI, UNE	IEC Standard 60947-2 Federal Specification W-C-375B/GEN NEMA AB1 UTE, VDE, BS, CEI, UNE	IEC Standard 60947-3 Federal Specification W-C-375B/GEN NEMA AB1 UTE, VDE, BS, CEI, UNE

¹ PowerPact M-frame circuit breaker is in UL File E10027.
PowerPact P-frame circuit breaker is in UL File E63335.
PowerPact R-frame circuit breaker is in UL File E10027.

² PowerPact P-frame switch is in UL File E103740.
PowerPact R-frame switch is in UL File E33117.

Circuit breakers should be applied according to guidelines detailed in the NEC and other local wiring codes.

¹ Compact NW circuit breakers are not available with I-Line terminations. (They cannot be mounted horizontally, only vertically.)

Circuit Breaker Ratings

Interrupting Rating

The interrupting rating is the highest current at rated voltage the circuit breaker is designed to safely interrupt under standard test conditions. Circuit breakers must be selected with interrupting ratings equal to or greater than the available short-circuit current at the point where the circuit breaker is applied to the system (unless it is a branch device in a series rated combination). Interrupting ratings are shown on the front of the circuit breaker. For grounded B phase interrupting ratings, see Data Bulletin 2700DB0202.

Table 2: UL/IEC Circuit Breaker Interrupting Ratings

Circuit Breaker ¹	UL/CSA Rating (60 Hz)				IEC 60947-2 Rating (50/60 Hz)			
	3 Phase			Grounded B Phase (1Ø-3Ø)	240 Vac		380/415 Vac	
	240 Vac	480 Vac	600 Vac	240 Vac 2P	Icu	Ics	Icu	Ics
MG	65 kA	35 kA	18 kA	65 kA	50 kA	25 kA	35 kA	20 kA
MJ	100 kA	65 kA	25 kA	65 kA	65 kA	35 kA	50 kA	25 kA
PG	65 kA	35 kA	18 kA	65 kA	50 kA	25 kA	35 kA	20 kA
PJ	100 kA	65 kA	25 kA	65 kA	65 kA	35 kA	50 kA	25 kA
PK	65 kA	50 kA	50 kA	65 kA	50 kA	25 kA	50 kA	25 kA
PL	125 kA	100 kA	25 kA	65 kA	125 kA	65 kA	85 kA	45 kA
RG	65 kA	35 kA	18 kA	35 kA	50 kA	25 kA	35 kA	20 kA
RJ	100 kA	65 kA	25 kA	100 kA	65 kA	35 kA	50 kA	25 kA
RK	65 kA	65 kA	65 kA	65 kA	85 kA	65 kA	70 kA	55 kA
RL	125 kA	100 kA	50 kA	125 kA	125 kA	65 kA	85 kA	45 kA

¹ The K interrupting rating is recommended for applications having high inrush and/or non-linear loads such as large motors, transformers, motors with soft starts, etc.

Table 3: IEC Only Circuit Breaker Interrupting Ratings (50/60 Hz)

Circuit Breaker	Interrupting Rating	220/240 Vac		380/415 Vac		440 Vac		500/525 Vac		660/690 Vac	
		Icu	Ics	Icu	Ics	Icu	Ics	Icu	Ics	Icu	Ics
Electrically Operated											
NS630b–NS1600	N Interrupting Rating	50 kA	37 kA	50 kA	37 kA	50 kA	37 kA	40 kA	30 kA	30 kA	22 kA
NS630b–NS1600	H Interrupting Rating	70 kA	35 kA	70 kA	35 kA	65 kA	32 kA	50 kA	25 kA	42 kA	21 kA
NS630b–NS1000	L Interrupting Rating	150 kA	150 kA	150 kA	150 kA	130 kA	130 kA	100 kA	100 kA	—	—
Manually Operated											
NS630b–NS1600	N Interrupting Rating	85 kA	50 kA	50 kA	50 kA	50 kA	50 kA	40 kA	40 kA	30 kA	30 kA
NS630b–NS1600	H Interrupting Rating	85 kA	52 kA	70 kA	52 kA	65 kA	48 kA	50 kA	37 kA	42 kA	31 kA
NS630b–NS1000	L Interrupting Rating	150 kA	150 kA	150 kA	150 kA	130 kA	130 kA	100 kA	100 kA	—	—
NS630b–NS800	R Interrupting Rating	200 kA	200 kA	200 kA	200 kA	200 kA	200 kA	100 kA	100 kA	75 kA	75 kA
NS1600b–NS3200	N Interrupting Rating	85 kA	65 kA	70 kA	52 kA	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA
NS1600b–NS3200	H Interrupting Rating	125 kA	94 kA	85 kA	64 kA	85 kA	64 kA	—	—	—	—

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Application Ratings

The voltage rating is the highest voltage for the electrical system on which the circuit breaker can be applied. The frequency rating indicates the system frequency for which the circuit breaker is intended. The withstand rating is used to improve system coordination by maximizing the current level at which the circuit breaker trips with no intentional delay. The withstand rating is the level of RMS symmetrical current that a circuit breaker can carry in a closed position for a stated period of time.

Table 4: Voltage, Frequency and Withstand Ratings

Circuit Breaker	Voltage Rating	Frequency Rating	Withstand Rating at 480 Vac ¹
MG, MJ	600 Vac	60 Hz (UL), 50/60 Hz (IEC)	10 kA (0.5 sec)
PG, PK	600 Vac	60 Hz (UL), 50/60 Hz (IEC)	25 kA (0.5 sec)
PJ	600 Vac	60 Hz (UL), 50/60 Hz (IEC)	10 kA (0.5 sec)
PL	480 Vac	60 Hz (UL), 50/60 Hz (IEC)	10 kA (0.5 sec)
R-frame (RG, RJ, RK, RL)	600 Vac	60 Hz (UL), 50/60 Hz (IEC)	32 kA (3 sec)
NS630b–NS1600 N Interrupting Rating	690 Vac	50/60 Hz (IEC)	19.2 kA (1 sec)
NS630b–NS1600 H Interrupting Rating	690 Vac	50/60 Hz (IEC)	19.2 kA (1 sec)
NS630b–NS1000 L Interrupting Rating	690 Vac	50/60 Hz (IEC)	N/A
NS630b–NS1000 R Interrupting Rating	690 Vac	50/60 Hz (IEC)	N/A
NS1600b–NS3200 N Interrupting Rating	690 Vac	50/60 Hz (IEC)	32 kA (3 sec)
NS1600b–NS3200 H Interrupting Rating	440 Vac	50/60 Hz (IEC)	32 kA (3 sec)

¹ A system coordination study should be done for optimum circuit breaker coordination.

Ampere Rating (Continuous Current Rating)

The ampere rating (or continuous current rating) (I_r) is the maximum current that a circuit breaker can carry. The sensor size (I_n) is the maximum ampere rating for a specific circuit breaker and is based on the size of the sensor plug inside the circuit breaker. This value is printed below the trip unit on the sensor plug. See Sensor Plugs (page 109) for more information.

NOTE: The maximum ampere rating a circuit breaker family can carry is called the frame size. Sensor size is less than or equal to frame size.

The ampere rating of a type ET electronic trip circuit breaker is equal to the current sensor size (I_n).

The ampere rating of a Micrologic™ electronic trip circuit breaker is determined by the mathematical equation:

$$\text{Ampere Rating} = \text{Sensor Size} \times \text{Rating Plug Setting} \quad (I_r = I_n \times \text{Rating Plug Setting})$$

The rating plug varies the circuit breaker ampere rating as a function of its sensor size. Rating plugs have nine dial settings; the multiplier values corresponding with each setting are printed on the rating plug. The maximum setting range is 0.4–1.0 $\times I_n$.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Enclosure Sizes

All type ET electronic trip UL/IEC M-frame, P-frame and R-frame circuit breakers are available as standard rated circuit breakers. Micrologic electronic trip UL/IEC circuit breakers are also available in 100% rated constructions. Because the additional heat generated when applying circuit breakers at 100% of continuous current rating, the use of specially designed enclosures and 194° F (90°C) rated wire sized per the 167° F (75°C) NEC chart is required.

Circuit breakers with 100% rating can also be used in applications requiring only 80% continuous loading.

Table 5: Minimum Enclosure Sizes for Fixed-Mounted Circuit Breakers

Circuit Breaker Rating	Enclosure Dimensions (h x w x d) in./ (mm)		Ventilation Area			
	3P Circuit Breaker	4P Circuit Breaker	Top		Bottom	
M-Frame, ≤ 800 A, Standard Rated	51.9 x 20.25 x 7.75 (1318.3 x 514.4 x 196.9)	51.9 x 23.01 x 7.75 (1318.3 x 584.4 x 196.9)	—	—	—	—
P-Frame, ≤ 800 A, 100% Rated	51.9 x 20.25 x 7.75 (1318.3 x 514.4 x 196.9)	51.9 x 23.01 x 7.75 (1318.3 x 584.4 x 196.9)	—	—	—	—
P-Frame, ≤ 1200 A, Standard Rated	62.25 x 23 x 14.75 (1581.2 x 584.2 x 374.7)	62.25 x 25.76 x 14.75 (1581.2 x 654.2 x 374.7)	16.5 in.	10,645 mm	16.5 in.	10,645 mm
P-Frame, ≤ 1200 A, 100% Rated	62.25 x 23 x 14.75 (1581.2 x 584.2 x 374.7)	62.25 x 25.76 x 14.75 (1581.2 x 654.2 x 374.7)	16.5 in.	10,645 mm	16.5 in.	10,645 mm
R-Frame, Standard Rated ¹	30 x 21 x 7 (762 x 533 x 178)	30 x 25.5 x 7 (762 x 648 x 178)	—	—	—	—
R-Frame, 100% Rated ¹	30 x 21 x 7 (762 x 533 x 178)	30 x 25.5 x 7 (762 x 648 x 178)	40.25 in.	26,000 mm	40.25 in.	26,000 mm

¹ RLTB or RL3TB kits may extend beyond end of enclosure when using minimum enclosure size.

Operating Conditions

Temperature

To meet the requirements of the UL489 Standard, molded case circuit breakers are designed, built and calibrated for use on 50/60 Hz ac systems in a 40°C (104°F) ambient environment. Electronic trip circuit breakers, however, are designed to react only to the magnitude of the current flowing through the circuit breaker and are inherently ambient insensitive. Both UL/IEC and IEC-only circuit breakers may be operated at temperatures between -25°C and +70°C (-13°F and 158°F). For temperatures other than 40°C (104°F), the circuit breakers must be re-rated as shown.

Table 6: Temperature Re-rating Values

Maximum Ambient Temperature													
°F	158	140	122	104	86	77	68	50	32	14	-4	-13	-22
°C	70	60	50	40	30	25	20	10	0	-10	-20	-25	-30
Current	0.75	0.83	0.92	1.00	1.07	1.11	1.14	1.21	1.27	1.33	1.39	1.42	1.44

Altitude

Circuit breakers are suitable for use at altitudes up to 13,100 ft. (4000 m). For altitudes higher than 6560 ft. (2000 m), circuit breakers must be derated as shown.

Table 7: Altitude Derating Values Per ANSI C37.20.1 Table 10

Altitude	≤ 6,600 ft. (≤ 2,000 m)	8,500 ft. (2,600 m)	13,000 ft. (3,900 m)
Voltage	1.00	0.95	0.80
Current	1.00	0.99	0.96

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Extreme Atmospheric Conditions

PowerPact circuit breakers have successfully passed the tests defined below for extreme atmospheric conditions.

Dry cold and dry heat:

- IEC 68-2-1—Dry cold at -67°F (-55°C)
- IEC 68-2-2—Dry heat at 185°F (+85°C)

Damp heat (tropicalization)

- IEC 68-2-30—Damp heat (temperature 131°F (55°C) and relative humidity of 95%, condensing)
- IEC 68-2-52 level 2—Salt mist

The materials used in the PowerPact circuit breakers will not support the growth of fungus and mold.

Vibration

PowerPact circuit breakers meet IEC 60068-2-6 Standards for vibration.

- 2 to 13.2 Hz and amplitude 0.039 in. (1 mm)
- 13.2 to 100 Hz constant acceleration

Storage Temperature

Circuit breakers with trip units without LCD displays may be stored in the original packaging at temperatures between -58°F (-50°C) and 185°F (85°C). For circuit breakers with trip units with LCD displays, this range is -40°F (-40°C) to 185°F (85°C).

Trip System

The trip system causes the circuit breaker to open automatically under overload, short-circuit or equipment ground-fault conditions. Electronic trip circuit breakers give the customer more versatility to achieve coordination with features such as adjustable instantaneous pickup and high withstand ratings.

The type ET and the Micrologic trip systems consist of current sensors, a microprocessor-based trip unit, and a tripping coil. The tripping coil is a flux transfer solenoid that requires no external power source. All type ET and Micrologic protective functions are completely fault powered.

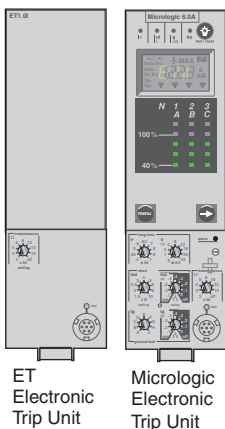
Micrologic Trip System

Features found in Micrologic™ electronic trip circuit breakers, such as universally interchangeable rating plugs, adjustable long-time pickups and 100% ratings also provide capacity for future growth.

The integral equipment ground-fault sensing capabilities available with Micrologic trip systems mean that there are fewer parts and pieces to purchase, mount and wire. These capabilities include integral ground-fault protection for equipment, which causes the circuit breaker to trip when a ground fault is detected, as well as integral ground-fault alarm, which does not trip the circuit breaker but sends an alarm when a ground fault is detected.

Certain Micrologic trip systems also offer the customer true power management system solutions through communication. These trip units can communicate with other circuit breakers in the system and also with a power monitoring system. Communication is by Modbus® and does not require proprietary software.

Communication between trip units allows zone-selective interlocking (ZSI) between circuit breakers at different levels in the system. ZSI reduces fault stress by allowing the upstream circuit breaker closest to the fault to ignore its preset delay time and trip without any intentional delay on a short circuit or ground fault. For more information on ZSI, see data bulletin *Reducing Fault Stress with Zone-Selective Interlocking*.



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Communication with a power monitoring system through a communications network allows a ground fault to be reported without interrupting power to the system. It also allows the power monitoring system to remotely report power usage, current flow, and trip history.

Instantaneous OFF Feature

Micrologic™ 5.0 and 6.0 Standard, A, P, and H electronic trip units provide the unique ability to turn the instantaneous tripping function OFF. Turning off the instantaneous trip function increases the current level at which the circuit breaker will trip with no intentional delay to the level of the short-time withstand rating. This current level is typically much higher than any of the pickup levels provided by the adjustable instantaneous feature. Therefore, using the instantaneous OFF feature improves coordination by allowing the user to take advantage of the circuit breaker withstand rating.

Motor Circuit Protectors

An instantaneous trip version of the electronic trip circuit breaker is also available for motor circuit protection. These motor circuit protectors comply with NEC requirements for providing short-circuit protection when installed as part of a Listed combination controller having motor overload protection.

Electronic trip motor circuit protectors are similar in construction to type ET electronic trip circuit breakers. They are designed as disconnect devices for use in combination with motor starters. These motor circuit protectors provide short-circuit protection only and have an adjustable amperage pickup so they can be set to open instantaneously at current values slightly above the motor starting inrush current. This setting coordinates the pickup time-current response of the motor circuit protector with the overload relay of the motor starter to give the best possible protection.

Current interrupting ratings for these UL Recognized components are established in combination with motor starters and properly-sized overload relays and contactors.

Automatic Molded Case Switches

P-frame, R-frame and NS630b–NS3200 circuit breakers are also available in automatic molded case switch construction. Automatic switches are similar in construction to electronic trip circuit breakers, except that the switches open instantaneously at a factory-set non-adjustable trip point calibrated to protect only the molded case switch itself. Because of their molded case construction, they are more compact than conventional disconnect switches and accept electrical accessories for added flexibility.

Molded case switches are intended for use as disconnect devices only. UL489 requires molded case switches to be protected by a circuit breaker or fuse of equivalent rating. Molded case switches are labeled with their appropriate withstand ratings. The withstand rating of a switch is defined as the maximum current at rated voltage that the molded case switch will withstand without damage when protected by a circuit breaker with an equal continuous current rating.

Table 8: P- and R-Frame Withstand Ratings¹

Voltage	Withstand Rating					
	P-Frame Circuit Breakers			R-Frame Circuit Breakers		
	J	K	L	J	K	L
240 Vac	100 kA	65 kA	125 kA	—	65 kA	125 kA
480 Vac	65 kA	50 kA	100 kA	—	50 kA	100 kA
600 Vac	25 kA	50 kA	25 kA	—	50 kA	50 kA

¹ The withstand rating is the fault current at rated voltage that the molded case switch will withstand without damage when protected by a circuit breaker with an equal continuous current rating.

Internal Operating Mechanism

Manually-Operated Circuit Breakers

M-frame, P-frame, R-frame and NS630b–NS3200 manually-operated circuit breakers have a single operating handle that acts directly through the operating mechanism against the contact blades. Multi-pole circuit breakers have a common trip bar for positive action of all poles on manual and automatic operation. These circuit breakers have a trip-free mechanism that allows them to trip even though the operating handle may be restricted (by a handle operating mechanism or padlock attachment) in the I/ON position. If not restricted, the operating handle moves to a position between I/ON and O/OFF when the circuit breaker is tripped.

The face of the manually-operated circuit breaker is marked with standard ON/OFF and international I/O markings to indicate handle position. In addition, the O/OFF portion of the circuit breaker handle is color coded green.

Electrically-Operated Circuit Breakers

P-frame and NS630b–NS1600 circuit breakers are also available with a two-step stored-energy mechanism which can be charged manually or using a motor. The closing time is less than five cycles. Closing and opening operations can be initiated by remote control or by push buttons on the front cover. An O-C-O (open-close-open) cycle is possible without recharging. Electrically-operated circuit breakers include a motor, shunt trip, and shunt close of the same voltage plus an overcurrent trip switch (SDE).

The face of electrically-operated circuit breakers is also marked ON/OFF and I/O, and equipped with a position indicator to show contact position.

Push-to-Trip Button

The push-to-trip button located on the face of each manually-operated circuit breaker is a standard feature on these circuit breakers. This allows the user to manually trip the circuit breaker without risking exposure to live parts. During normal on-off operation, the handle opens and closes the circuit breaker contact but does not exercise the tripping mechanism.

Use the push-to-trip button to:

- Exercise the circuit breaker mechanism
- Check the auxiliary and alarm switch circuits

Circuit Breaker Mounting and Connections

Table 9: Circuit Breaker Mounting and Connections

Circuit Breaker	Unit-Mount Construction		I-Line Construction	Drawout Construction
	Cable Connection	Bus Connection		
M-Frame	X	X	X	—
P-Frame	X	X	X	X
R-Frame	X ¹	X	X ²	—
NS630b–NS1250	X	X	—	X
NS1600–NS3200	—	X	—	—

¹ Must use RLTB or RL3TB terminal pad kit.

² Through 1200 A, 100% rated only.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Unit-Mount Circuit Breakers

Unit-mount M-frame, P-frame, R-frame and NS630b–NS3200 circuit breakers are individually-mounted using supplied mounting screws. The four mounting screws are inserted through mounting holes molded into the circuit breaker case and threaded into the circuit breaker mounting enclosure. To properly support the circuit breaker, all four mounting screws must be used.

Unit-mount M-frame, P-frame and NS630b–NS1250 circuit breakers can be ordered with mechanical line and load side lugs. The standard lugs can be removed for the installation of compression-type lugs or bus connections. All lugs are UL Listed for their proper application and marked for use with aluminum and copper (Al/Cu) or copper only (Cu) conductors. Lugs suitable for copper and aluminum conductors are made of tin-plated aluminum. Lugs suitable for use with copper conductors only are made of copper.

See individual frame sections for frame-specific connection information.



M-Frame Unit-Mount



P-Frame Unit-Mount



Electrically Operated
P-Frame Unit-Mount



R-Frame Unit-Mount

I-Line Circuit Breakers

M-frame circuit breakers through 800 A and P-frame and R-frame circuit breakers through 1200 A are available in I-Line construction for easy installation and removal in I-Line panelboards and switchboards. I-Line circuit breakers use “blow-on” type line side connectors. In case of a short circuit, increased magnetic flux causes the plug-on connectors of the circuit breaker to tighten their grasp on the panelboard or switchboard bus bars. The I-Line connectors and circuit breaker mounting bracket are integral parts of I-Line circuit breakers and cannot be removed or replaced. I-Line circuit breakers come with mechanical load side lugs.



M-Frame I-Line



P-Frame I-Line



R-Frame I-Line

Drawout Circuit Breakers

P-frame manually-operated circuit breakers and switches are also available in drawout construction. The drawout assembly mechanism allows the circuit breaker to be racked in four positions (connected, test, disconnect or withdrawn).

P-frame cradles are ordered separately and are available with factory and field-installed accessories. See Section 10—P-Frame Cradles and Cradle Accessories for details.



P-Frame Drawout

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Catalog Numbering System

The M-frame, P-frame, R-frame and NS630b–NS3200 circuit breakers and cradles follow a “smart” catalog numbering system. The following tables are intended as a tool to decipher existing catalog numbers. **They are not intended for use in building catalog numbers, as some combinations may not be available.** To build a catalog number, please see the *Digest*, the *Product Selector* or contact the local field office.

M-Frame, P-Frame and R-Frame Circuit Breaker Catalog Numbers

NOTE: Not all options are available on all frames.

Table 10: Catalog Number for M-, P- and R-Frame (UL/IEC Dual-Rated) Circuit Breakers

Field Position	Field Description	Options	Description
1	Brand Name	(blank)	Square D
		N	Schneider Electric (Formerly Merlin Gerin brand)
2	Circuit Breaker Frame	M	800 A Max.
		P	1200 A Max.
		R	3000 A Max.
3	Interrupting Rating	G	35 kA @ 480 Vac
		J	65 kA @ 480 Vac
		K	P-Frame: 50 kA @ 600 Vac R-Frame: 65 kA @ 600 Vac
		L	100 kA @ 480 Vac
4	Connection	F	No Lugs
		L	Lugs on Both Ends
		M	Lugs on I/ON End
		P	Lugs on O/OFF End
		A	I-Line
		D	Drawout (Not Available on M and R Frames)
5	Poles	2	2P
		3	3P
		4	4P
6	Voltage Rating	4	480 V
		6	600 V
7–9	Ampere Rating	###	Circuit Breaker Rating (120 = 1200 A)
		000	Automatic Switch Value
10	Standard or 100% Rated	(none)	Standard Rated
		C	100% rated

Continued on next page

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Table 10: Catalog Number for M-, P- and R-Frame (UL/IEC Dual-Rated) Circuit Breakers

Field Position	Field Description	Options	Description
11–14	Circuit Breaker Trip System	(none)	ET1.0 (M-Frame)
		(none)	ET1.0I (P-Frame, R-Frame)
		U31	Micrologic™ 3.0 Trip Unit
		U33	Micrologic 5.0 Trip Unit
		U41	Micrologic 3.0A Trip Unit
		U43	Micrologic 5.0A Trip Unit
		U44	Micrologic 6.0A Trip Unit
		U63	Micrologic 5.0P Trip Unit
		U64	Micrologic 6.0P Trip Unit
		U73	Micrologic 5.0H Trip Unit
		U74	Micrologic 6.0H Trip Unit
	Automatic Switch Trip System ¹	S60	600 A ²
		S80	800 A ²
		S10	1000 A ²
		S12	1200 A
		S16	1600 A
		S20	2000 A
		S25	2500 A
		S30	3000 A
	Motor Circuit Protector Trip System	M68	1200–10000 A ²
		M69	1500–10000 A ²
		M70	1800–10000 A ²
15	Rating Plug	A–H	See Table 81
16-17	Modbus® Communication	E1	Modbus BCM
18	I-Line™ Phasing	See <i>Digest</i> , <i>Product Selector</i>	

For Factory-Installed Accessories, See *Product Selector*

¹ For more information on P-frame switches, see page 78. For more information on R-frame switches, see page 89.

² Not available on R-frame.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

NS630b–NS3200 Circuit Breaker Catalog Numbers

Table 11: Catalog Number for NS630b–NS3200 (IEC-Rated) Circuit Breakers

Field Position	Field Description	Options	Description
1	Brand Name	(Blank)	Square D
		N	Schneider Electric
2	Circuit Breaker Frame	R	3200 A Max.
		P	1600 A Max.
3	Interrupting Rating	N	Standard Interrupting Rating
		H	High Interrupting Rating
		L	Current Limiting
		R ¹	200 kA Interrupting
4	Connection	F	No lugs
		L	Lugs on Both Ends
		M	Lugs on I/ON End
		P	Lugs on O/OFF End
		D	Drawout
		S	Rear Connected
5	Certification	E	IEC
6	Poles	3	3P
		4	4P
7	Voltage Rating	4	440 Vac
		6	690 Vac
8–10	Ampere Rating	###	Circuit Breaker Rating (120 = 1200 A)
		000	Automatic Switch Value
11–14	Circuit Breaker Trip System	U32	Micrologic™ 2.0 Trip Unit
		U33	Micrologic 5.0 Trip Unit
		U42	Micrologic 2.0A Trip Unit
		U43	Micrologic 5.0A Trip Unit
		U44	Micrologic 6.0A Trip Unit
		U63	Micrologic 5.0P Trip Unit
		U64	Micrologic 6.0P Trip Unit
		U73	Micrologic 5.0H Trip Unit
		U74	Micrologic 6.0H Trip Unit
	Automatic Switch Trip System	S63	630 A
		S80	800 A
		S10	1000 A
		S12	1250 A
		S16	1600 A
		S20	2000 A
		S25	2500 A
		S32	3200 A
	Non-Automatic Switch Trip System	Z63	630 A
		Z80	800 A
		Z10	1000 A
		Z12	1250 A
		Z16	1600 A
15	Rating Plug	R–T	See Table 80
16–17	Modbus® Communications	E1	Modbus BCM

For Accessories, See *Product Selector*

¹ R interruption only valid with rear-connected (S) termination.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

Cradle Catalog Numbers

P-frame and NS630b–NS1600 manually-operated circuit breakers and switches are available in drawout construction (factory installed only). The circuit breakers may be ordered using the circuit breaker catalog numbering systems described above. The cradles must be ordered separately.

Table 12: Cradle Catalog Number

Field Position	Field Description	Options	Description
1	Cradle	C	Cradle
2	Frame Size	S	P-Frame 3P
		D	P-Frame 4P
3	Brand/Certification	L	Square D Brand UL/IEC Dual-Rated
		G	Schneider Electric IEC Rated Only
4	Circuit Breaker Interruption Rating	E	P-Frame "G", "J", "K", or "L" Interrupting Rating
5	Cradle Connections Top Terminals	V	Rear-Connected T Vertical (RCTV)
		H	Rear-Connected T horizontal (RCTH)
		E	Front-Connected Flat (FCF)
6	Cradle Connections Bottom Terminals	V	Rear-Connected T Vertical (RCTV)
		H	Rear-Connected T Horizontal (RCTH)
		E	Front-Connected Flat (FCF)
7	Shutters and Associated Options	9	None (Standard for P-Frame Circuit Breakers)
		3	Shutters with Padlocking Provision
8	Circuit Breaker Mismatch and Cradle Interlock	A	See <i>Product Selector</i>
9	Metering CT	X	Not Applicable on P-Frame Cradle
10	Cradle Secondary Disconnects Wiring	X	See <i>Product Selector</i>
11–18	Miscellaneous Cradle Options	X	See <i>Product Selector</i>

Testing Requirements

UL, NEMA, CSA, and NMX requirements

The UL, NEMA, CSA and NMX labels on a circuit breaker indicate that the circuit breaker meets the requirements of UL Standard 489, NEMA Standard AB-1, CSA Standard C22.2 No. 5 and NMX standard J266. The labels also mean that the production procedure is monitored by UL, CSA and ANCE inspectors to ensure continued compliance to these standards. These requirements include the following tests:

- **200% Overload Calibration**—each pole of the circuit breaker must trip within a specified time limit when carrying 200% of its continuous current rating.
- **135% Overload Calibration**—with all poles connected in series, the circuit breaker must trip within a specified time limit while carrying 135% of its continuous current rating.
- **Overload**—the circuit breaker must make and break 600% of its continuous current rating at rated voltage. Circuit breaker frame sizes 125–1600 A must perform 50 operations at 600%. Circuit breaker frame sizes 2000–2500 A must perform 25 operations at 600%.
- **Temperature Rise**—while carrying 100% of rated current and mounted in open air, temperature rise on a wiring terminal must be within specified limits. For 100% rating, the circuit breaker is mounted in an enclosure.
- **Endurance**—UL489 requires that the circuit breaker must complete, at minimum, the following number of operations:

Table 13: Endurance Operations

Frame Size	Operations	
	With Current ¹	Without Current
1200–2500	500	2000

¹ UL requires the circuit breaker to operate 10% of the “with current” operations with a shunt trip.

- **Calibration**—both the 200% and 135% overload calibration tests are repeated after endurance testing.
- **Short Circuit**—the circuit breaker shall be subjected to test currents based on voltage rating and frame size, with the type and number of operations based on the number of poles, frame rating and voltage rating. Example: a 3P, 600 Vac, 2500 A frame circuit breaker is subjected to one 20 kA single-phase closing of the circuit on the circuit breaker per pole and one 30 kA three-phase closing of the circuit on the circuit breaker for a total of seven short circuit tests.
- **Trip Out**—the 200% thermal calibration test is repeated following the short-circuit tests.
- **Dielectric**—the circuit breaker must withstand, for one minute, twice its rated voltage plus 1000 V:
 - Between line and load terminals with the circuit breaker in the open, tripped and OFF positions.
 - Between terminals of opposite polarity with the circuit breaker closed.
 - Between live parts and the overall enclosure with the circuit breaker both open and closed.

No conditioning of the circuit breaker can take place during or between tests. There can be no failure of functional parts at the conclusion of the sequences.

After qualifying a set of circuit breakers to the standard tests, a manufacturer can have additional circuit breaker samples tested on higher than standard available fault currents. The following performance requirements apply:

- **200% Overload Calibration**—each pole of the circuit breaker must trip within a specified time limit when carrying 200% of its continuous current rating.
- **Short-Circuit Test**—with the load side terminals connected by 10-inch lengths of specified cable (or a shorting bar), the circuit breaker is exposed to a short-circuit current for a set time interval. After safe interruption, the circuit breaker is reset and closed again on the short circuit.
- **250% Overload Calibration**—each pole of the circuit breaker must trip within a specified time limit when carrying 250% of its continuous current rating.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 1—General Information

- **Dielectric Withstand**—the circuit breaker is subjected to twice the voltage rating at which the interrupting test was conducted, but not less than 900 V.
 - Between line and load terminals with the circuit breaker in the tripped and in the OFF positions.
 - Between terminals of opposite polarity with the circuit breaker closed.
 - Between live parts and the overall enclosure with the circuit breaker both open and closed.

When the sample circuit breakers pass these tests, circuit breakers of the same construction can be marked or labeled with the current interrupting rating for the higher fault currents.

IEC Requirements

The IEC markings on a circuit breaker indicates that the circuit breaker meets the requirements of IEC Standard 60947-2 for circuit breakers and 60947-3 for automatic switches. These requirements include the following tests:

Table 14: IEC Test Sequence

Sequence	Category of Devices	Tests
General Performance Characteristics (Sequence 1)	All Circuit Breakers	• Tripping Limits and Characteristics • Dielectric Properties • Mechanical and Electrical Endurance • Overload • Dielectric Voltage Withstand • Temperature Rise • 145% Calibration (3 Poles in Series or 3-Phase Test)
Rated Service Short-circuit Breaking Capacity (Ics) (Sequence 2)	All Circuit Breakers	• Rated service short circuit breaking capacity (O-t-CO-t-CO) • Electrical Endurance (5% of with Current Operations of Sequence 1) • Dielectric Voltage Withstand • Temperature Rise • 145% Calibration (3 poles in series or 3-phase test)
Rated Ultimate Short-circuit Breaking Capacity (Icu) (Sequence 3)	Circuit Breakers of Utilization Category A Circuit Breakers of Utilization Category B	• 200% Calibration (Each Pole Separately) • Rated Ultimate Short Circuit Breaking Capacity (O-t-CO) • Dielectric Voltage Withstand • 250% Calibration (Each Pole Separately)
Rated Short-time Withstand Current (Icw) (Sequence 4)	Circuit Breakers of Utilization Category B	• 200% Calibration (Each Pole Separately) • Rated Short-Time Withstand Current • Temperature Rise • Short-Circuit Breaking Capacity at Maximum Short-Time Withstand Current (O-t-CO) • Dielectric Voltage Withstand • 200% Calibration (Each Pole Separately)
Combined Sequence	Circuit Breakers of Utilization Category B: When Icw = Ics Replaces Sequences 2 and 4 When Icw = Ics = Icu Replaces Sequences 2, 3 and 4	• 200% Calibration (Each Pole Separately) • Rated Short-Time Withstand Current Icw • Rated Service Short-Circuit Breaking Capacity at Ics (O-CO-CO) at Maximum Relay Temp. • 145% Calibration (3 Poles in Series or 3-Phase Test) • Dielectric Voltage Withstand • Temperature Rise • 200% Calibration (Each Pole Separately)
Individual Pole Short-Circuit Test Sequence (Annex H)	Circuit Breakers for Use in IT Systems	• Individual Pole Short-Circuit Breaking Capacity • Dielectric Voltage Withstand • 250% Calibration (Each Pole Separately)

Section 2—Energy Management

Energy Management Using the Enerlin'X System

Use the Enerlin'X communication system to connect your building to real savings in three steps:

- A. Measure
 - Embedded and stand-alone metering and control
- B. Connect
 - Integrated communication interfaces
 - Ready to connect to energy management platforms
- C. Save
 - Data-driven energy efficiency actions
 - Real-time monitoring and control
 - Access to energy and site information through on-line services



Measure

Enerlin'X communication systems mean visible information.

Grouping most of the electrical protection, command and metering components, the switchboards are now significant sources of data locally displayed and sent via communication networks.

Connect

Enerlin'X communication systems use reliable, simple-to-install-and-use displays, and Ethernet and Modbus interfaces.

Information is safely transmitted through the most efficient networks:

- Modbus SL inside switchboards, between components,
- Ethernet, on cable or WiFi, inside the building and connecting switchboards and computers,
- Ethernet or GPRS, for access to on-line services by Schneider Electric.

Energy experts, no matter where they are located, can now provide advice based on the updated data of the building.

Save



On-Site Real-Time Monitoring and Control

The FDM128 touch screen display connected to the Ethernet:

- shows essential electrical information and alarms concerning the electrical network,
- allows control (open, close, reset...) of various equipment.

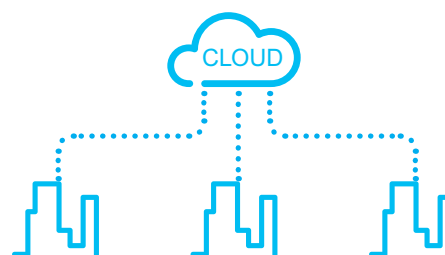
The FDM128 touch screen provides real-time value checking and control, directly on the front panel of the main switchboard.

On a PC display with common browser:

- shows monitoring web pages hosted into the local Ethernet interface,
- alarm events generate automatic email notifications,
- allows control (open, close, reset...) of various equipment.

The data is displayed graphically or recorded into files for optimizing the use of energy in the building.

As an example, the data can help validate the change of temperature settings, time scheduling in a Building Management System or other automated devices.



On-Line Energy Management Services

StruXureWare Energy Operation automates data collection using an open, scalable, and secure energy management information system.

With the help of the Schneider Electric energy management services team, data is turned into information to enable customers to understand their facilities' performance on an ongoing basis.

Energy Operation leverages companies' current investments in their existing systems, and can be used to communicate advanced results and performance to a broad audience for a shared understanding throughout an organization.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 2—Energy Management

Enerlin'X Communication System Components

PowerPact and Compact Circuit Breakers with Micrologic Trip Units

Ammeter A

- 2.0 basic protection (IEC)
- 3.0 basic protection (UL)
- 5.0 selective protection
- 6.0 selective + ground-fault protection

Power Meter P

- 5.0 selective protection
- 6.0 selective + ground-fault protection

Harmonic Meter H

- 5.0 selective protection
- 6.0 selective + ground-fault protection

See page 40 for more information.



Power Meter

Displays

FDM121

- One-to-one front display module
- See page 25 for more information

FDM128

- One-to-eight front display module
- See page 25 for more information



Operating Assistance Functions

Communication

- PowerPact and Compact circuit breakers in a communication network
- I/O application module
- IFE: Ethernet interface module
- IFM: Modbus interface module



Communication



I/O Module



IFE Module



IFM Module

See page 54 for more information.

Power Meter Functions

In addition to protection functions, Micrologic A/P/H trip units offer all the functions of Power Meter products as well as operating assistance for the circuit breaker.

Micrologic A/P/H trip unit measurement functions are made possible by the Micrologic trip unit's intelligence and the accuracy of the sensors. They are handled by a microprocessor that operates independent of protection functions.

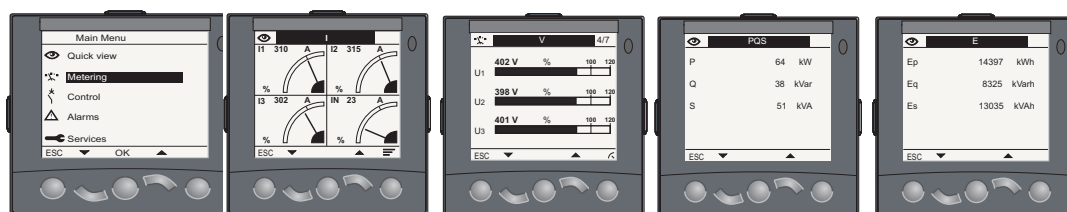
Display Function



Display Function

FDM121 Display Unit (One to One)

The FDM121 switchboard display unit can be connected to a communication (COM) option (Breaker Communication Module [BCM ULP]) using a circuit breaker ULP cord to display all measurements on a screen. The LCD screen is 3.78 x 3.78 in. (96 x 96 mm). The FMD121 display unit requires a 24 Vdc power supply. The COM option (BCM ULP) unit is supplied by the same power supply via the circuit breaker ULP cord connecting it to the FDM121. See page 30 for more information.



FDM121 Display
Navigation

FDM121 Display
Current

FDM121 Display:
Voltage

FDM121 Display:
Power

FDM121 Display:
Consumption

FDM128 Display Unit (One to Eight)

The FDM128 display unit uses an IFE Ethernet interface for low-voltage circuit breakers.



FDM128 Display
Navigation

FDM128 Display
Current

FDM128 Display:
Voltage

FDM128 Display:
Power

FDM128 Display:
Consumption

For all FDM, in addition to the information displayed on the Micrologic trip unit LCD, the FDM screen shows demand, power quality, and maximum/minimum ammeter values along with histories and maintenance indicators.



Measurement Function

Measurement Function

Instantaneous RMS Measurements

The Micrologic trip unit continuously displays the RMS value of the highest current of the three phases and neutral (I_{max}). The navigation buttons can be used to scroll through the main measurements.

In the event of a fault trip, the trip cause is displayed.

The Micrologic A trip unit measures phase, neutral, and ground fault currents.

Micrologic P/H trip units offer voltage, power, power factor, frequency, and $\cos \phi$ in addition to the measurements provided by Micrologic A trip units.

Maximum / Minimum Ammeter

Every instantaneous measurement provided by Micrologic A trip units can be associated with a maximum/minimum ammeter. The maximum for the highest current of the three phases, neutral, and demand current can be reset using the FDM display unit or the communication system.

Energy Metering

The Micrologic P/H trip units also measures the energy consumed since the last reset of the meter. The active energy meter can be reset using the Micrologic trip unit keypad, the FDM display unit, or the communication system.

Demand and Maximum Demand Values

Micrologic P/H trip units also calculate demand current and power values. These calculations can be made using a block or sliding interval that can be set from five to sixty minutes in steps of one minute. The window can be synchronised with a signal sent through the communication system. Whatever the calculation method, the calculated values can be recovered on a PC through the communication network.

Ordinary spreadsheet software can be used to provide trend curves and forecasts based on this data. They provide a basis for load shedding and reconnection operations used to adjust consumption to the subscribed power.

Power Quality

The Micrologic H trip unit calculates power quality indicators taking into account the presence of harmonics up to the fifteenth harmonic, including the total harmonic distortion (THD) of current and voltage.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 2—Energy Management



Table 15: Micrologic A/P/H Trip Units Integrated Power Meter Functions

Micrologic A/P/H Integrated Power Meter Functions			Type	Display	
				Micrologic LCD	FDM Display
Display of protection settings					
Pick-ups (A) and delays	All settings can be displayed	I _r , t _r , I _{sd} , t _{sd} , I _i , I _g , t _g	A/P/H	X	—
Measurements					
Instantaneous rms measurements					
Currents (A)	Phases and neutral	I _A , I _B , I _C , I _N	A/P/H	X	X
	Average of phases	I _{avg} = (I _A + I _B + I _C) / 3	A/P/H	—	X
	Highest current of the 3 phases and neutral	I _{max} of I _A , I _B , I _C , I _N	A/P/H	X	X
	Ground fault (Micrologic 6)	% I _g (pick-up setting)	A/P/H	X	X
	Current unbalance between phases	% I _{avg}	P/H	—	X
Voltages (V)	Phase-to-phase	V _{AB} , V _{BC} , V _{CA}	P/H	X	X
	Phase-to-neutral	V _{AN} , V _{BN} , V _{CN}	P/H	X	X
	Average of phase-to-phase voltages	V _{avg} = (V _{AB} + V _{BC} + V _{CA}) / 3	P/H	—	X
	Average of phase-to-neutral voltages	V _{avg} = (V _{AN} + V _{BN} + V _{CN}) / 3	P/H	—	X
	Ph-Ph and Ph-N voltage unbalance	% V _{avg}	P/H	—	X
	Phase sequence	ABC, ACB	P/H	X	X ¹
Frequency (Hz)	Power system	f	P/H	X	X
Power	Active (kW)	P, total	P/H	X	X
		P, per phase	P/H	X	X
	Reactive (kVAR)	Q, total	P/H	X	X
		Q, per phase	P/H	X	X
	Apparent (kVA)	S, total	P/H	X	X
		S, per phase	P/H	X	X
	Power Factor	PF, total	P/H	X	X
		PF, per phase	P/H	X	X
	cos φ	Cos φ, total	P/H	X	X
		Cos φ, per phase	P/H	X	X
Maximum/Minimum Ammeter	Associated with instantaneous rms measurements	Reset using the FDM display unit and Micrologic keypad	A/P/H	X	X
Energy Metering					
Energy	Energy Active (kW), reactive (kVARh), apparent (kVAh)	Total since last reset	P/H	X	X
Demand and Maximum Demand Values					
Demand Current (A)	Phases and neutral P	Present value on the selected window	P/H	X	X
		Maximum demand since last reset	P/H	X	X
Demand Power	Active (kWh), reactive (kVAR), apparent (kVA)	Present value on the selected window	P/H	X	X
		Maximum demand since last reset	P/H	X	X
Calculation Window	Sliding, fixed or com-synchronised	Adjustable from 5 to 60 minutes in 1 minute steps ²	P/H	—	—
Power Quality					
Total Harmonic Distortion (%)	Of voltage with respect to rms value	THDU, THDV of the Ph-Ph and Ph-N voltage	H	X	X
	Of current with respect to rms value	THDI of the phase current	H	X	X

¹ FDM121 only.

² Available via the communication system only.

Histories



- Trip indications in clear text in a number of user-selectable languages
- Time-stamping: date and time of trip.

Maintenance Indicators



Micrologic trip units have indicators for, among other items, the number of operating cycles, load profile, and operating times (operating hours counter).

It is possible to assign an alarm to the operating cycle counter to plan maintenance.

The various indicators can be used together with the trip histories to analyze the level of stresses the device has been subjected to.

Contact Wear

Contact wear algorithms only function on Masterpact circuit breakers, and contact wear cannot be selected for PowerPact or Compact circuit breakers.

Each time a Masterpact circuit breaker opens, the Micrologic P/H trip unit measures the interrupted current and increments the contact-wear indicator as a function of the interrupted current, according to test results stored in memory. Breaking under normal load conditions results in a very slight increment. The indicator value may be read on the FDM display.

It provides an estimation of contact wear calculated on the basis of the cumulative forces affecting the circuit breaker. When the indicator reaches 100%, it is advised to visually inspect the contacts per the instructions in the circuit breaker user guide.

Circuit Breaker Load Profile

Micrologic A/P/H trip units calculate the load profile of the circuit breaker protecting a load circuit. The profile indicates the percentage of the total operating time at four current levels (% of circuit breaker I_n):

- 0 to 49% I_n
- 50 to 79% I_n
- 80 to 89% I_n
- $\geq 90\%$ I_n .

This information can be used to optimize use of the protected equipment or to plan ahead for maintenance interval extensions.

Management of Installed Devices

Each circuit breaker equipped with a COM option (BCM ULP) can be identified using the communication system:

- serial number
- firmware version
- hardware version
- device name assigned by the user.

This information together with the previously described indications provides a clear description of the installed devices.



Table 16: Micrologic A/P/H Trip Units Operating Assistance Functions

Micrologic A/P/H Operating Assistance Functions			Type	Display	
				Micrologic LCD	FDM Display
Operating Assistance					
Trip History					
Trips	Cause of tripping	I _r , I _{sd} , I _i , I _g , I _{Dn}	A/P/H	X	X
Maintenance Indicators					
Counter	Mechanical cycles	Assignable to an alarm	A/P/H	—	X
	Electrical cycles	Assignable to an alarm	A/P/H	—	X
	Hours	Total operating time (hours) ¹	A/P/H	—	—
Indicator	Contact wear	%	P/H	X	X
Load Profile	Hours at different load levels	% of hours in four current ranges: 0-49% I _n , 50-79% I _n , 80-89% I _n and ≥ 90% I _n	P/H	—	X

¹ Available through the communication system only.

FDM121 Display

Micrologic trip unit measurement capabilities come into full play with the FDM121 display. It connects to the COM option (BCM ULP) with a circuit breaker ULP cord and displays the Micrologic trip unit information. The result is a true integrated unit combining a circuit breaker and a power meter. Additional operating assistance functions can also be displayed.

An FDM121 display unit can be connected to ULP communication devices using a prefabricated cord to display all measurements, alarms, histories and event tables, maintenance indicators, and management of installed devices on a screen.

The FMD121 display unit requires a 24 Vdc power supply.

The FDM121 is a display that can be integrated with the PowerPact H/J/L/P/R or Masterpact NW/NT circuit breaker systems. It uses the sensors and processing capacity of the Micrologic trip unit. It is easy to use and requires no special software or settings. It is immediately operational when connected to the circuit breaker by a ULP cord.

It also provides monitoring and control with the use of the I/O application module, the motor mechanism module, or the circuit breaker communication module (BCM ULP).

The FDM121 has a large display, but requires very little depth. The anti-glare graphic screen is backlit for very easy reading even under poor ambient lighting and at sharp angles.

Display of Micrologic Trip Unit Measurements and Alarms

The FDM121 is intended to display Micrologic trip unit measurements, alarms and operating information. It cannot be used to modify the protection settings.

Measurements can be easily accessed using a menu. All user-defined alarms are automatically displayed. The display mode depends on the priority level selected during alarm set-up:

- high priority: a pop-up window displays the time-stamped description of the alarm and the orange Alarm LED flashes;
- medium priority: the orange Alarm LED goes continuously on;
- low priority: no display on the screen.

All faults resulting in a trip automatically produce a high-priority alarm, without any special settings required. In all cases, the alarm history is updated. The Micrologic trip unit saves the information in its non-volatile memory in the event of an FDM121 power loss.

Status Indications and Remote Control

When the circuit breaker is equipped with the Breaker Communications Module (BCM ULP), the FDM121 display can also be used to view circuit breaker status conditions:

- O/F: ON/OFF
- SD: trip indication
- SDE: fault-trip indication (overload, short-circuit, or ground fault).

When the circuit breaker system is equipped with the I/O application module, the FDM121 can monitor and control:

- cradle management
- circuit breaker operation
- light and load control
- custom applications.

When the circuit breaker is equipped with the COM option (BCM ULP) (including connection to shunt close [XF] and shunt trip [MX1] communication voltage releases), the FDM121 display can also be used to control (open/close) the circuit breaker.

Two operating mode are available:

- local mode: open/close commands are enabled from the FDM121 while disabled from the communication network;
- remote mode: open/close commands are disabled from the FDM121 while enabled from the communication network.

Main Characteristics

- A 3.78 x 3.78 x 1.18 in. (96 x 96 x 30 mm) screen requiring 0.39 in. (10 mm) behind the door (or 0.79 in. [20 mm] when the 24 V power supply connector is used).
- White backlighting.
- Wide viewing angle: vertical $\pm 60^\circ$, horizontal $\pm 30^\circ$.
- High resolution: excellent reading of graphic symbols.
- Alarm LED: flashing orange for alarm pick-up, steady orange after operator reset if the alarm condition persists.
- Operating temperature range: +14°F (-10°C) to +131°F (+55°C).
- CE / UL / CSA marking.
- 24 Vdc power supply, with tolerances 24 V -20% (19.2 V) to 24 V +10% (26.4 V).

When the FDM121 is connected to the communication network, the 24 Vdc can be supplied by the communication system wiring system. Consumption is 40 mA.

Mounting

The FDM121 is easily installed in a switchboard.

- Standard door cut-out is 3.6 x 3.6 in. (92 x 92 mm).
- Attached using clips.

To avoid a cut-out in the door, an accessory is available for surface mounting by drilling only two 0.87 in. (22 mm) diameter holes.



FDM121 Display



Surface Mount
Accessory



Connection with FDM121
Display Unit

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Connection

The FDM121 is equipped with a 24 Vdc terminal block:

- A plug-in type terminal block with two wire inputs per point for easy daisy-chaining.
- A power supply range of 24 Vdc -20% (19.2 V) to 24 Vdc +10% (26.4 V).
A 24 Vdc type auxiliary power supply must be connected to a single point on the ULP system. The FDM121 display has a two-point screw connector on the rear panel of the module for this purpose. The ULP module to which the auxiliary power supply is connected distributes the supply via the ULP cable to all the ULP modules connected to the system and therefore also to Micrologic trip unit.
- Two RJ45 jacks.

The Micrologic trip unit connects to the internal communication terminal block on the PowerPact or Compact circuit breaker with the circuit breaker ULP cord. Connection to one of the RJ45 connectors on the FDM121 automatically establishes communication between the Micrologic trip unit and the FDM121 and supplies power to the Micrologic trip unit measurement functions.

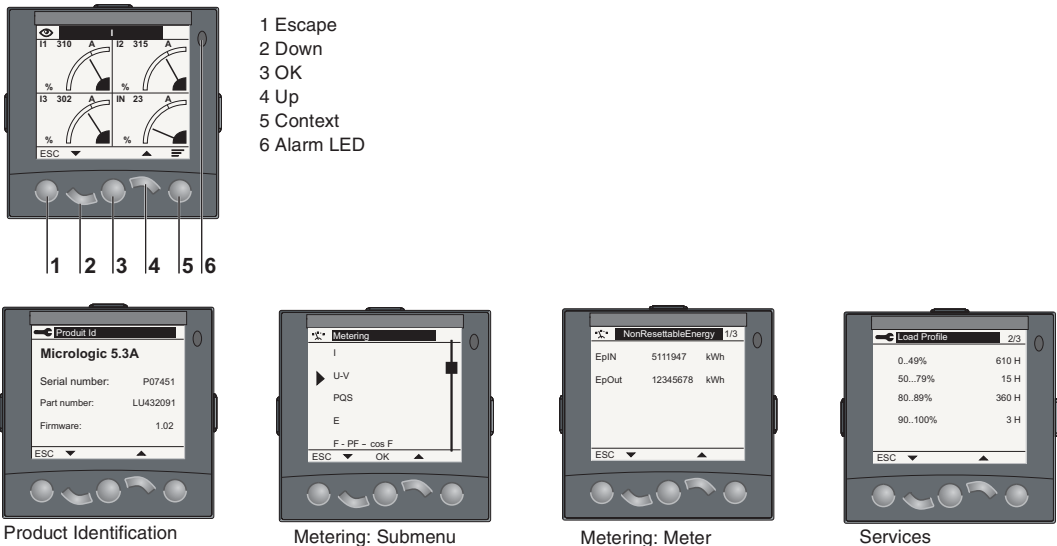
When the second connector is not used, it must be fitted with a line terminator.

Navigation

Five buttons are used for intuitive and fast navigation.

The “Context” button may be used to select the type of display (digital, bargraph, analogue).

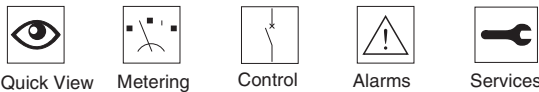
The user can select the display language (Chinese, English, French, German, Italian, Portuguese, Spanish, etc.).



Screens

Main Menu

When powered up, the FDM121 screen automatically displays the ON/OFF status of the device.



When not in use, the screen is not backlit. Backlighting can be activated by pressing one of the buttons. It goes off after three minutes.

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Fast Access to Essential Information

- “Quick view” provides access to five screens that display a summary of essential operating information (I, U-V, f, P, E, THD, circuit breaker ON/OFF).

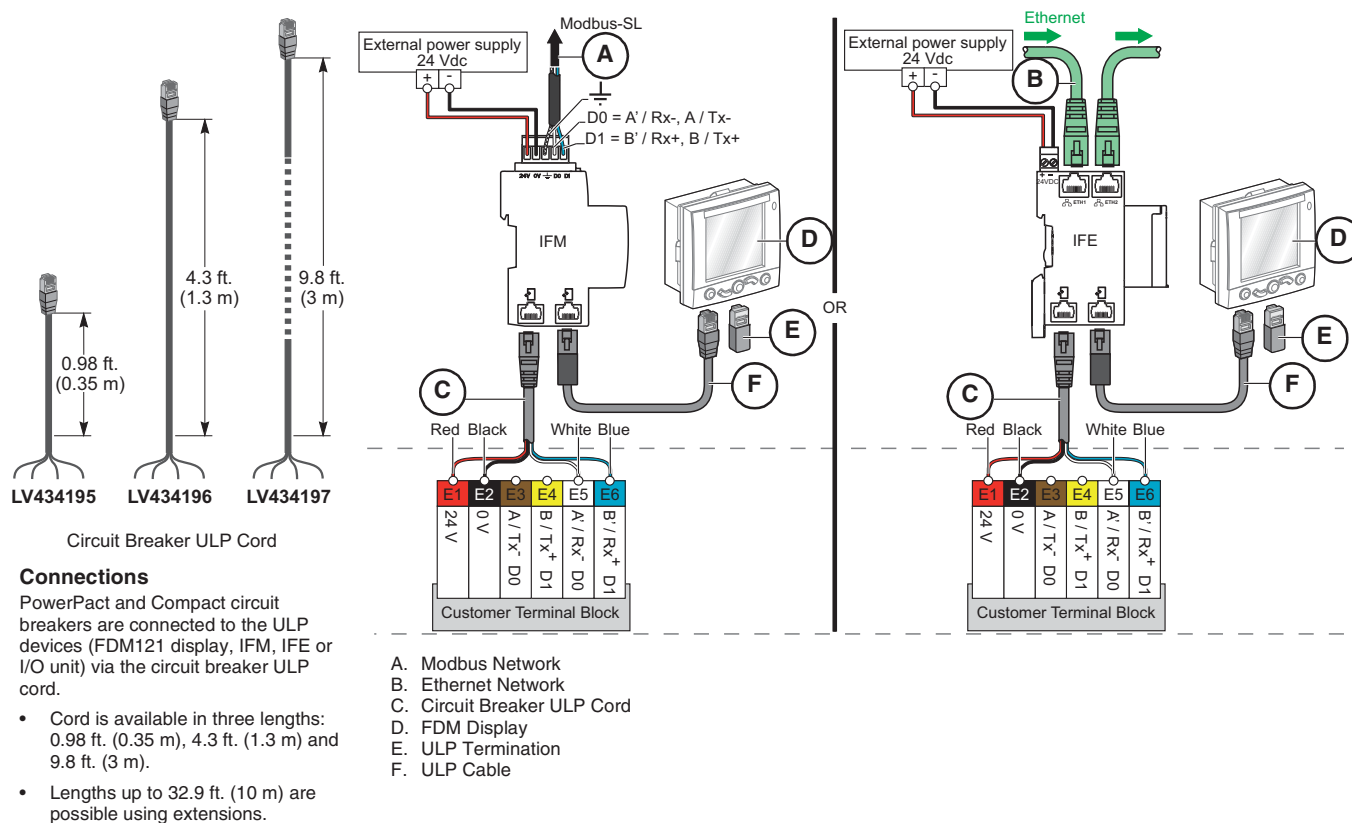
Access to Detailed Information

- “Metering” can be used to display the measurement data (I, U-V, f, P, Q, S, E, THD, PF) with the corresponding min/max values.
- “Alarms” displays active alarms and the alarm history.
- “Services” provides access to the operation counters, energy and maximum ammeter reset function, maintenance indicators, identification of modules connected to the internal bus, and FDM121 internal settings (language, contrast, etc.).

Communication Components and FDM121 Connections

The FDM121 degree of protection is IP54 in front. IP54 is maintained after switchboard mounting by using the supplied gasket during installation.

Figure 1: FDM121 Connections



FDM128 Display

The Micrologic trip unit measurement capabilities are fully utilized with the FDM128 display. The FDM128 display connects to Ethernet communication using the RJ45 port and displays Micrologic trip unit information. The result is an integrated unit combining a circuit breaker with a power meter. Additional operating assistance functions can also be displayed.

The FDM128 display unit can be connected to a Micrologic COM option (BCM ULP through an IFE). It uses the sensors and processing capacity of the Micrologic trip unit and requires no special software or settings. The FDM128 is a large display, but requires very little depth. The anti-glare graphic screen is backlit for easy reading even under poor ambient lighting and at sharp angles.

The FDM128 display is designed to manage up to eight devices (PowerPact H/J/L/P/R or Masterpact NW/NT circuit breakers).

Display of Micrologic Trip Unit Measurements and Trips

The FDM128 is intended to display Micrologic A/P/H trip unit measurements, trips, and operating information. It cannot be used to modify the protection settings.

- Measurements may be easily accessed using a menu.
- Trips are automatically displayed.
- A pop-up window displays the time-stamped description of the trip.

Status Indications

When the circuit breaker is equipped with the COM option (BCM ULP) (including its set of sensors) the FDM128 display can also be used to view circuit breaker status conditions:

- O/F: ON/OFF
- SDE: Fault-trip indication (overload, short-circuit, ground fault)
- PF: ready to close
- CH: charged (spring loaded).
- CE, CD, CT cradle management with I/O application module.

Remote Control

When the circuit breaker is equipped with the COM option (BCM ULP) (including connection to shunt close [XF] and shunt trip [MX1] communication voltage releases), the FDM128 display can also be used to operate (open/close) the circuit breaker.

Two operating mode are available:

- Local mode: open/close commands are enabled from the FDM128 while disabled from the communication network.
- Remote mode: open/close commands are disabled from the FDM128 while enabled from the communication network.

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Section 2—Energy Management

Main Characteristics

- 4.54 x 3.40 in. (115.2 x 86.4 mm) with 5.7 in. (145 mm) QVGA display 320 x 240 pixels.
- Color TFT LCD, with LED backlight.
- Wide viewing angle: vertical $\pm 80^\circ$, horizontal $\pm 70^\circ$.
- High resolution: excellent reading of graphic symbols.
- Operating temperature range: +14°F (-10°C) to +131°F (+55°C).
- CE / UL / CSA marking.
- 24 Vdc power supply, -10%/+20% (limit 20.4 - 28.8 Vdc).
- Consumption 6.8 W.



FDM128 Display



Surface Mount Accessory



Connection with Display Unit

Mounting

The FDM128 is easily installed in a switchboard.

- Standard door hole $\varnothing$ 0.87 in. (22 mm).
- The FDM128 degree of protection is IP65 at the touch screen cover. IP54 is maintained after installation by using the supplied gasket.

Connection

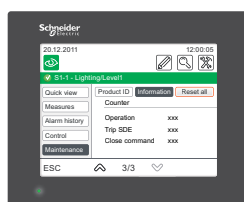
The FDM128 is equipped with:

- a 24 Vdc terminal block:
 - power supply range of 24 Vdc (limit 20.4 - 28.8 Vdc).
 - The FDM128 display unit has a 2-point screw connector on the rear panel of the module for this purpose.
- One RJ45 Ethernet jacks.

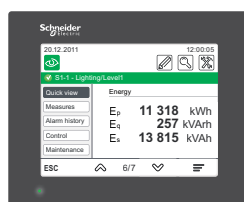
The Micrologic trip unit connects to the internal communication terminal block on the Masterpact circuit breakers through the circuit breaker ULP cord and Ethernet connection through the IFE.

Navigation

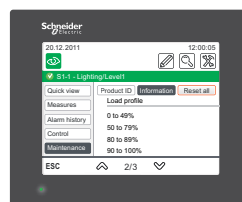
- A touch screen is used for intuitive and fast navigation.
- The user can select the display language (Chinese, English, French, German, Italian, Portuguese, Spanish, etc.).



Product Identification



Metering: Meter



Services

Screens

Main Menu



Quick View



Metering



Control



Alarms



Services

When not in use, the screen is automatically shifted to low back-lighting.

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Section 2—Energy Management

Fast Access to Essential Information

- “Quick view” provides access to five screens that display a summary of essential operating information (I, U-V, f, P, E, THD, circuit breaker On / Off).

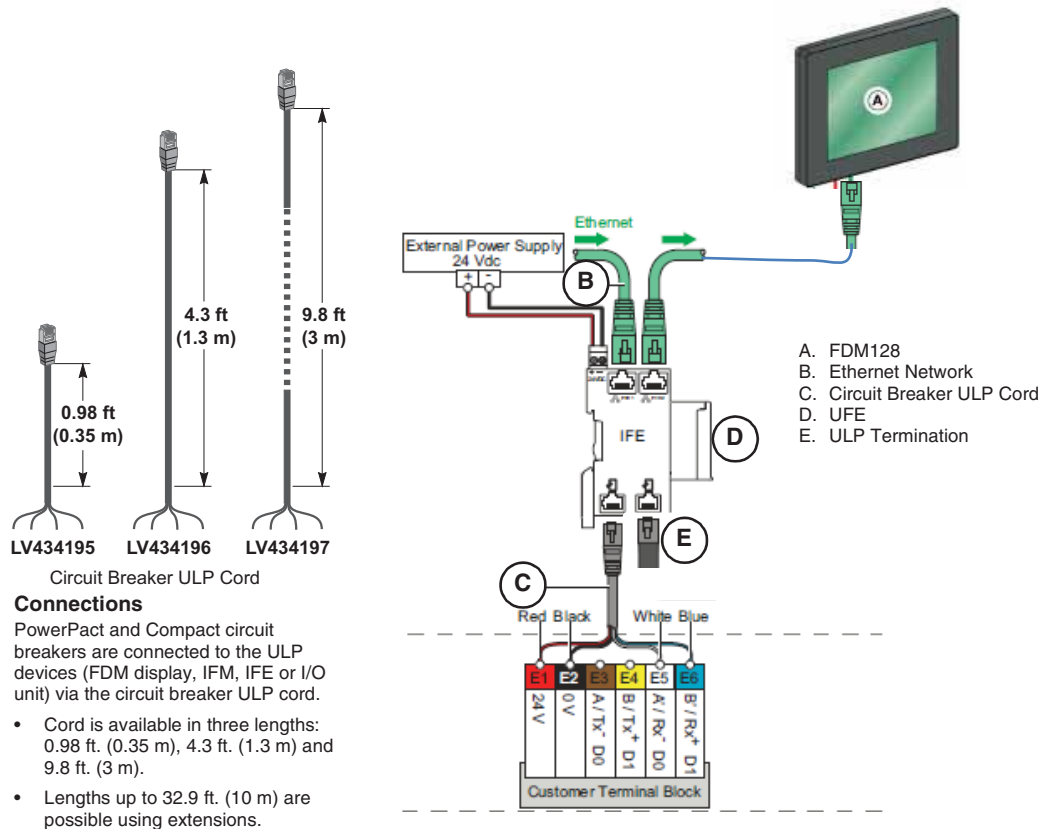
Access to Detailed Information

- “Metering” can be used to display the measurement data (I, U-V, f, P, Q, S, E, THD, PF) with the corresponding min/max values.
- “Alarms” displays the trip history.
- “Services” provides access to the operation counters, energy and maximum ammeter reset function, maintenance indicators, identification of modules connected to the internal bus and FDM128 internal settings (language, contrast, etc.).

Communication Components and FDM128 Connections

The FDM128 degree of protection is IP65 at the touch screen cover. IP54 is maintained after installation by using the supplied gasket.

Figure 2: FDM128 Connections



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Section 2—Energy Management

Figure 3: Panelboard and Switchboard Connections

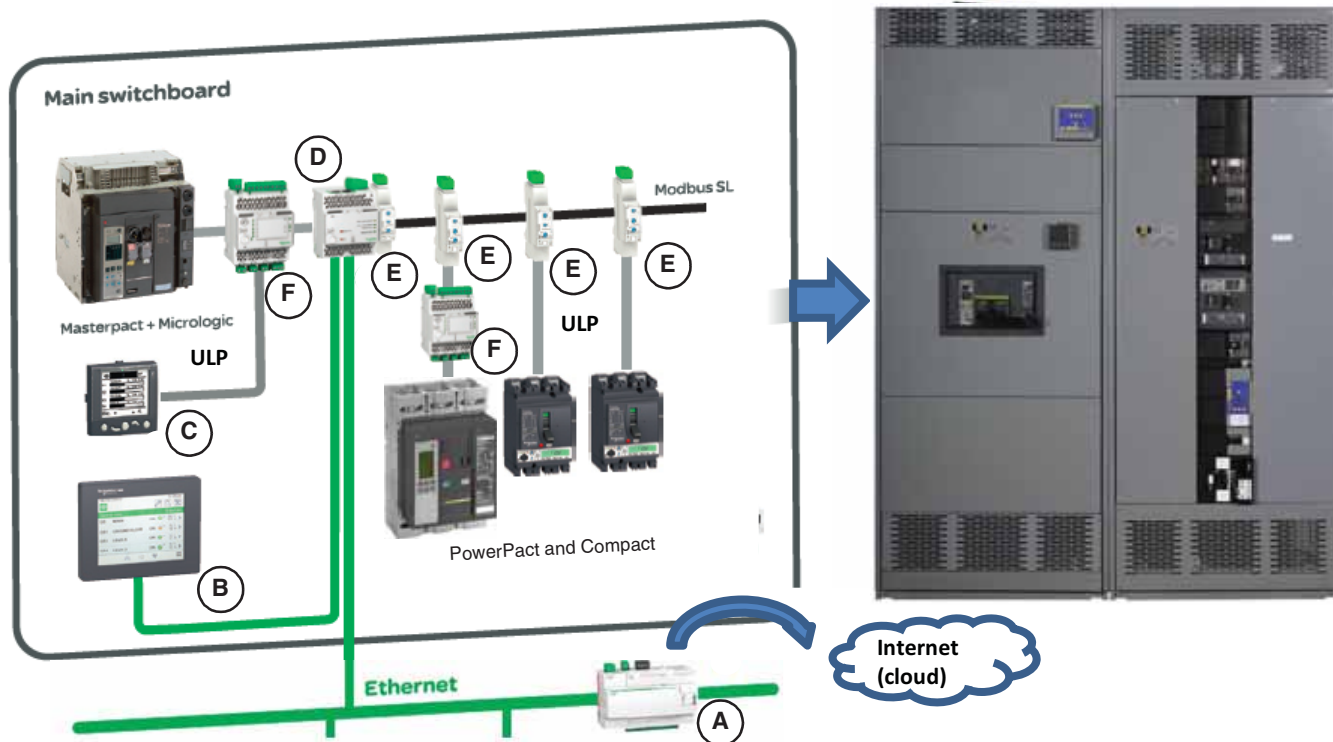


Table 17: Enerlin'X Communication Devices and Displays

		Name	Function	Port To Device	To Server	Bin. Input	Analog. Input	Bin. Output
A		Com'X 200	Energy Server with Ethernet Gateway® Function	Modbus Master	Ethernet Cable + WiFi	6	2	—
B		FDM128	Ethernet LCD Color Touch Screen	—	Ethernet	—	—	—
C		FDM121	LCD Display for Circuit Breaker	ULP	—	—	—	—

Continued on next page

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 2—Energy Management

Table 17: Enerlin'X Communication Devices and Displays *(continued)*

		Name	Function	Port		Bin. Input	Analog. Input	Bin. Output
				To Device	To Server			
D		IFE Interface + Gateway	Ethernet Interface & Gateway	Modbus Master & ULP	Ethernet	—	—	—
		IFE Interface	Ethernet Interface for Circuit Breakers	ULP	Ethernet	—	—	—
E		IFM	Modbus Interface for Circuit Breakers	ULP	Modbus Slave	—	—	—
F		I/O	Input/Output Application Module for Circuit Breakers	ULP	ULP	6	1	1

Section 3—Electronic Trip Systems

M-frame circuit breakers are available with the type ET 1.0 electronic trip system. P-frame and R-frame circuit breakers are available with either the ET1.0I basic electronic trip system or the Micrologic™ electronic trip system. The NS630b–NS3200 circuit breakers are available with the Micrologic electronic trip system. The sensing system responds to the flow of current through the circuit breaker.

Thermal Imaging

The thermal imaging function protects the cables or bus bars from overheating in case of low amplitude repetitive faults. Such overheating can be due to repetitive motor startings, fluctuating load, intermittent ground faults, or subsequent closing after a fault. Traditional electronic protection does not protect against repetitive faults because the duration of each overload above the pickup setting is too short to achieve effective tripping. Nevertheless, each overload involves a temperature rise in the installation, the cumulative effect of which could lead to overheating of the system.

The thermal imaging function remembers and integrates the thermal heating caused by each pickup setting overrun. Before tripping, the integrated heating value will reduce the associated time delay and, therefore, the reaction of the trip unit will be closer to the real heating of the power network system. After tripping, the function will also reduce the time delay when closing the circuit breaker on an overload.

True RMS Current Sensing

The sensing system responds to the flow of current through the circuit breaker. The trip unit samples the current waveform to provide true RMS protection through the fifteenth harmonic. This true RMS sensing gives accurate values for the magnitude of a non-sinusoidal waveform. Therefore, the heating effects of harmonically distorted waveforms are accurately evaluated.

The Micrologic H trip unit provides additional sampling of the waveforms to measure and provide waveform capture of harmonic distortion to the thirty-first harmonic.

Type ET Electronic Trip System

Type ET trip units are available with M-frame, P-frame and R-frame UL/IEC circuit breakers. Circuit breakers with type ET trip units have a fixed ampere rating. The trip units are not field-interchangeable and will not accept any communications or other trip unit accessories. The trip system uses a set of current transformers (called CTs or sensors) to sense current, a trip unit to evaluate the current, and a tripping solenoid to trip the circuit breaker.

ET1.0 (M-Frame only)

The ET1.0 trip system is available on M-frame circuit breakers and is equipped with fixed long-time and adjustable instantaneous tripping functions only. The long-time pickup is fixed at $1.0 \times$ sensor rating (I_n), while the instantaneous pickup is adjustable (dial settings from $2\text{--}10 \times I_n$) with no intentional time delay.

ET1.0I (P-Frame and R-Frame only)

The ET1.0I trip system is available on both P-frame and R-frame circuit breakers and is equipped with fixed long-time and adjustable instantaneous tripping functions only. The long-time pickup is fixed at $1.0 \times$ sensor rating (I_n), while the instantaneous pickup is adjustable (dial settings from $1.5\text{--}12 \times I_n$) with no intentional time delay.

ET1.0M (P-Frame only)

The ET1.0M trip system is only available on P-frame motor circuit protectors and provides protection for short circuit conditions only. The trip unit has a single adjustment for instantaneous pickup that, if

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

exceeded, will trip the circuit breaker with no intentional delay. Instantaneous trip dial settings are $2-16 \times I_n$ for 600 A circuit breakers and $1.5-12 \times I_n$ for 800–1200 A circuit breakers.

Micrologic™ Electronic Trip Systems

The P-frame, R-frame and NS630b–NS3200 electronic trip circuit breakers can be equipped with the optional Micrologic trip systems listed below:

Table 18: Micrologic Trip Systems

Model	(LS0) Long-time + Short-time + Zero delay (IEC Rated Only)	(LI) Long-time + Instantaneous Protection (UL Listed, IEC Rated)	(LSI) Long-time + Short-time + Instantaneous Protection (UL Listed, IEC Rated)	(LSIG) Long-time + Short-time + Instantaneous Protection + Equipment Ground-fault Protection (UL Listed, IEC Rated)
Micrologic Basic Trip Unit	2.0	3.0	5.0	—
Micrologic A Trip Unit	2.0A	3.0A	5.0A	6.0A
Micrologic P Trip Unit	—	—	5.0P	6.0P
Micrologic H Trip Unit	—	—	5.0H	6.0H

Trip units are designed to protect power circuits and loads. Micrologic trip systems use a set of current transformers (called CTs or sensors) to sense current, a trip unit to evaluate the current, and a tripping solenoid to trip the circuit breaker. Adjustable rotary switches on the trip unit allow the user to set the proper overcurrent or equipment ground-fault current protection required in the electrical system. If current exceeds a set value for longer than its set time delay, the trip system opens the circuit breaker. Alarms may be programmed for remote indications. Measurements of current, voltage, frequency, power, and power quality optimize continuity of service and energy management.

Integration of protection functions in the Application Specific Integrated Circuit (ASIC) electronic component used in all Micrologic trip units guarantees a high degree of reliability and immunity to conducted or radiated disturbances. On Micrologic P and H trip units, advanced functions are managed by an independent microprocessor.

Circuit breakers are shipped with the trip unit long-time pickup switch set at 1.0 and all other trip unit adjustments set at their lowest settings. Actual settings required for a specific application must be determined by a qualified consultant or plant engineer. A coordination study is recommended to provide coordination between all circuit breakers in the distribution system.

Table 19: Micrologic™ Trip Unit Features

Feature	Micrologic Trip Unit (X = Standard Feature O = Available Option)										
	Standard			Ammeter				Power		Harmonics	
	2.0	3.0	5.0	2.0A	3.0A	5.0A	6.0A	5.0P	6.0P	5.0H	6.0H
Field-Installable	X	X	X	X	X	X	X	X	X	X	X
LI		X			X						
LS0	X			X							
LSI			X			X		X		X	
LSIG/Ground-Fault Trip ¹							X		X		X
Ground-Fault Alarm/No Trip ^{1, 2}								X		X	
Ground-Fault Alarm and Trip ^{1, 2}									X		X
Adjustable Rating Plugs	X	X	X	X	X	X	X	X	X	X	X
True RMS Sensing	X	X	X	X	X	X	X	X	X	X	X
UL Listed		X	X		X	X	X	X	X	X	X
Thermal Imaging	X	X	X	X	X	X	X	X	X	X	X
Phase-Loading Bar Graph				X	X	X	X	X	X	X	X

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

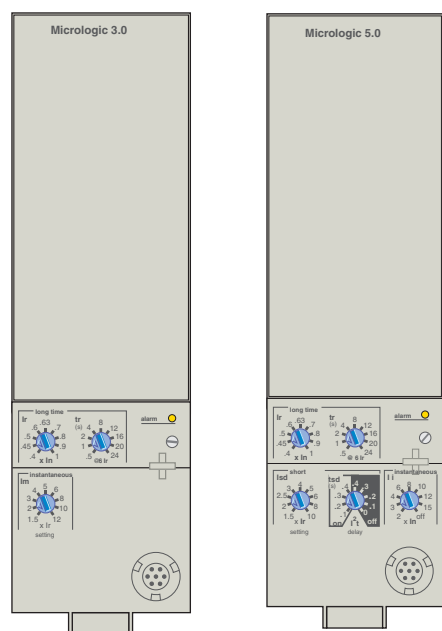
Table 19: Micrologic™ Trip Unit Features (continued)

Feature	Micrologic Trip Unit (X = Standard Feature O = Available Option)										
	Standard			Ammeter				Power		Harmonics	
	2.0	3.0	5.0	2.0A	3.0A	5.0A	6.0A	5.0P	6.0P	5.0H	6.0H
LED for Long-Time Pick-Up	X	X	X	X	X	X	X	X	X	X	X
LED for Trip Indication				X	X	X	X	X	X	X	X
Digital Ammeter				X	X	X	X	X	X	X	X
Zone-Selective Interlocking ³				X		X	X	X	X	X	X
Communications				O	O	O	O	X	X	X	X
LCD Dot Matrix Display								X	X	X	X
Advanced User Interface								X	X	X	X
Protective Relay Functions								X	X	X	X
Neutral Protection ¹								X	X	X	X
Contact Wear Indication								X	X	X	X
Incremental Fine Tuning of Settings								X	X	X	X
Selectable Long-Time Delay Bands								X	X	X	X
Power Measurement								X	X	X	X
Power Quality Measurements										X	X
Waveform Capture										X	X

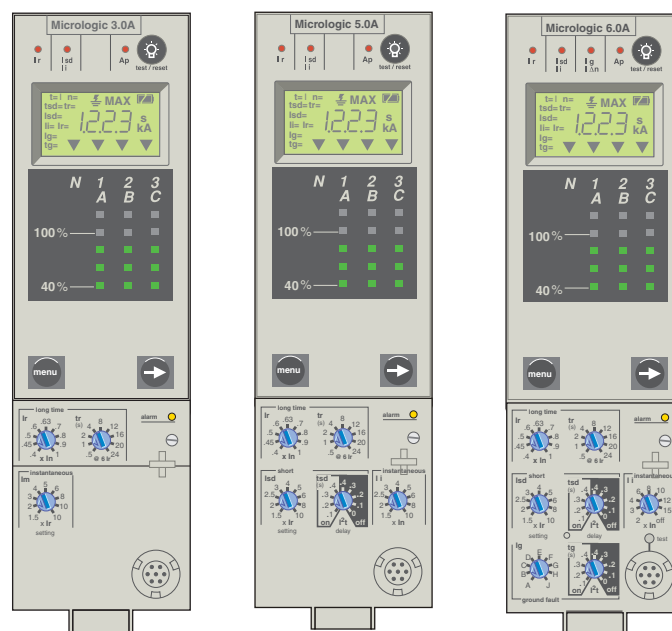
¹ 3Ø, 4W circuits require either a neutral current transformer or a 4-pole breaker.

² Requires M6C Programmable Contact Module.

³ Not available for 2.0A trip units as upstream devices.



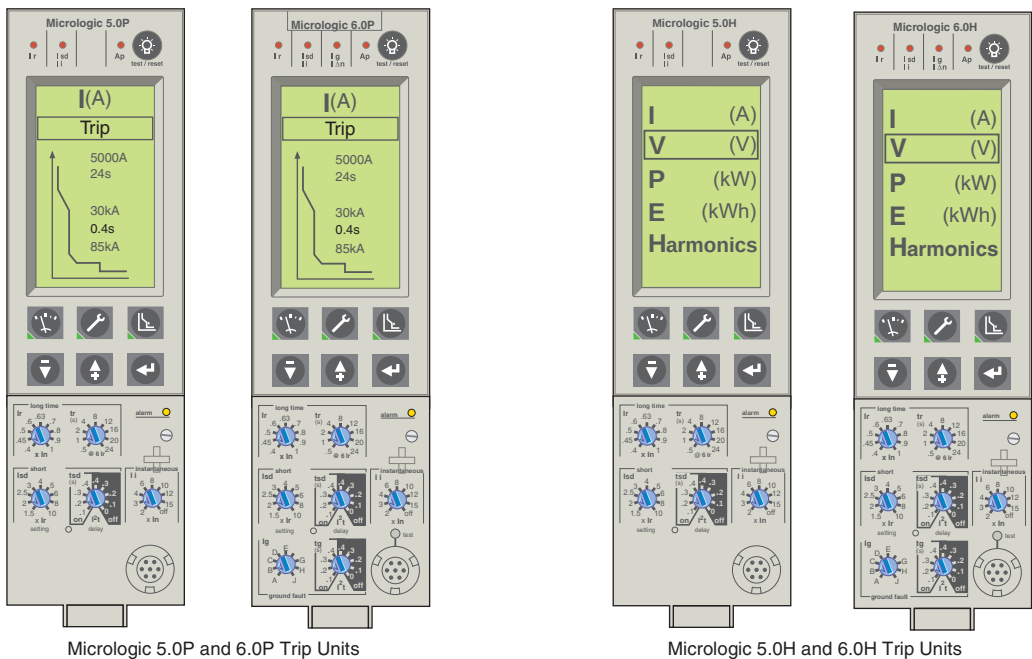
Micrologic 3.0 and 5.0 Basic Trip Units



Micrologic 3.0A, 5.0A and 6.0A Trip Units

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems



Micrologic 5.0P and 6.0P Trip Units

Micrologic 5.0H and 6.0H Trip Units

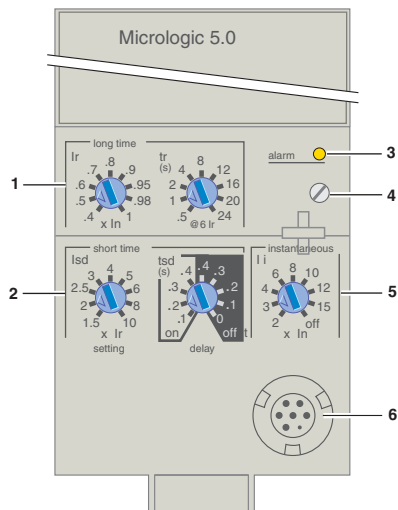
Micrologic™ 2.0, 3.0 and 5.0 Basic Trip Units

The Micrologic 2.0, 3.0, and 5.0 basic trip units protect power circuits.

Protection Settings

Protection thresholds and delays are set using the rotary switches. A full-range of long-time settings are available via field-installable adjustable rating plugs.

- Overload protection
 - True RMS long-time protection
 - Thermal imaging: Active thermal imaging before and after tripping
- Short-circuit protection
 - Short-time RMS
 - Selection of I^2t type (ON or OFF) for short-time delay
- Instantaneous protection
- Neutral protection on four-pole circuit breakers



- 1—Long-time current setting and tripping delay
- 2—Short-time pickup and tripping delay
- 3—Overload signal (LED)
- 4—Long-time rating plug screw
- 5—Instantaneous pickup
- 6—Test connector

Table 20: Micrologic 2.0 and 3.0 Basic Trip Unit Settings

Long-Time Protection	Current Setting (A) Tripping between 1.05 and 1.20 x I_r	$I_r = I_n \times \dots$	2.0:	0.40	0.50	0.60	0.70	0.80	0.90	0.95	0.98	1.00
			3.0:	0.40	0.45	0.50	0.60	0.63	0.70	0.80	0.90	1.00
			Other ranges are available by changing rating plug									
	Maximum Time Delay (s) Accuracy: 0 to -20%	t_r at 1.5 x I_r t_r at 6 x I_r t_r at 7.2 x I_r	12.5	25	50	100	200	300	400	500	600	
Short-Time Protection	Current Setting (A) Accuracy: $\pm 10\%$ No delay	$I_{sd} = I_r \times \dots$	2.0:	1.5	2	2.5	3	4	5	6	8	10
			3.0:	1.5	2	3	4	5	6	8	10	12
Instantaneous Protection	Current Setting (A) Accuracy: $\pm 10\%$	$I_i = I_n \times \dots$	3.0:	1.5	2	3	4	5	6	8	10	12

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

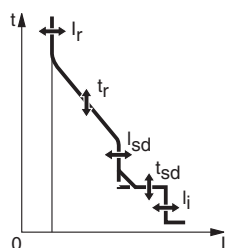


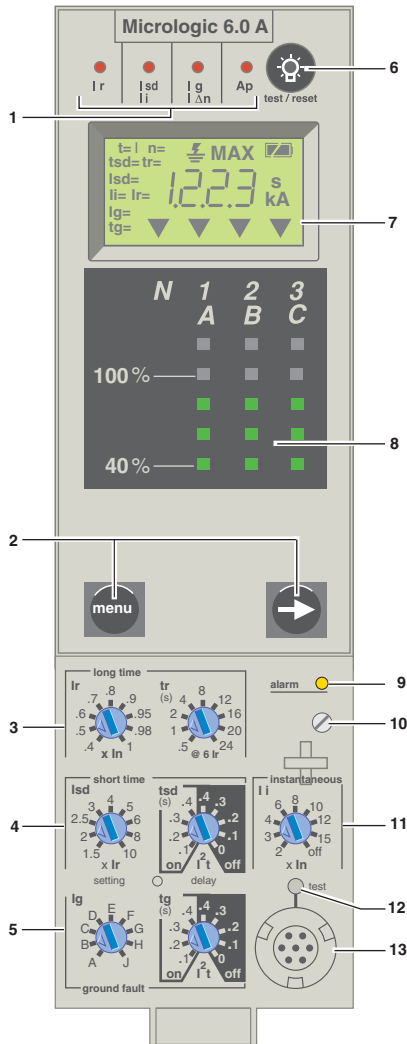
Table 21: Micrologic 5.0 Basic Trip Unit Settings

Long-Time Protection	Current Setting (A) Tripping Between 1.05 and 1.20 x I _r	I _r = I _n x ...	IEC:	0.40	0.50	0.60	0.70	0.80	0.90	0.95	0.98	1.00
			UL:	0.40	0.45	0.50	0.60	0.63	0.70	0.80	0.90	1.00
			Other Ranges are Available by Changing Rating Plug									
	Maximum Time Delay (s) Accuracy: 0 to –20%	t _r at 1.5 x I _r t _r at 6 x I _r t _r at 7.2 x I _r		12.5	25	50	100	200	300	400	500	600
Thermal Imaging			20 Minutes Before or After Tripping									
Short-Time Protection	Current Setting (A) Accuracy: ±10%	I _{sd} = I _r x ...		1.5	2	2.5	3	4	5	6	8	10
	Maximum Time Delay (s) at 10 x I _r	Settings	I ² t OFF	0	0.1	0.2	0.3	0.4				
			I ² t ON		0.1	0.2	0.3	0.4				
			Min. Trip Time (ms)	20	80	140	230	350				
Instantaneous Protection	Current Setting (A) Accuracy: ±10%	I _i = I _n x ...	Max. Trip Time (ms)	80	140	200	320	500				

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

Micrologic™ 2.0A, 3.0A, 5.0A and 6.0A Trip Units with Ammeter



- 1—Indication of tripping cause
- 2—Navigation buttons
- 3—Long-time current setting and tripping delay
- 4—Short-time pickup and tripping delay
- 5—Ground-fault pickup and tripping delay
- 6—Test lamp and reset
- 7—Digital display
- 8—Three-phase bar graph and ammeter
- 9—Overload signal (LED)
- 10—Long-time rating plug screw
- 11—Instantaneous pickup
- 12—Electronic push-to-trip
- 13—Test connector

Micrologic A trip units protect power circuits and provide current measurements, overload protection, and short-circuit protection. In addition, the 6.0A trip units also provide ground-fault protection for equipment.

Protection Settings

Protection thresholds and delays are set using the rotary switches. The selected values are momentarily displayed in amperes and in seconds. A full-range of long-time settings are available via the field-installable rating plug:

- Overload protection (true RMS long-time protection)
- Thermal imaging (active thermal imaging before and after tripping)
- Short-circuit protection:
 - Short-time RMS
 - I^2t ON or OFF for short-time delay
- Instantaneous protection
- Ground-fault protection for equipment:
 - Residual ground-fault protection for equipment
 - Source ground-return ground-fault protection for equipment
 - Modified differential ground-fault protection (MDGF) for equipment
- Neutral protection on four-pole circuit breakers
- ZSI: Zone-selective interlocking:
 - ZSI terminal block may be used to interconnect a number of trip units to provide total discrimination for short-time and equipment ground-fault protection, without delay for tripping).
 - Not available for 3.0A trip units or for 2.0A trip units installed as upstream devices.

Ammeter Measurements

Micrologic A trip units measure the true RMS value of currents. They provide continuous current measurement from 0.2 to $20 \times I_n$ with an accuracy of 1.5% (including sensors). No auxiliary source is needed where $I > 0.2 \times I_n$. The optional external power supply (24 Vdc) makes it possible to display currents where $I < 0.2 \times I_n$ and to store values of the interrupted current.

A digital LCD screen continuously displays the most heavily loaded phase (I_{max}) or displays the I_A , I_B , I_C , I_g , and (on 4P circuit breakers only) I_N stored current and setting values by successively pressing the navigation button.

Communication Network

In conjunction with an optional communication network, the trip unit transmits the following parameters:

- Setting values
- All ammeter measurements
- Tripping causes

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

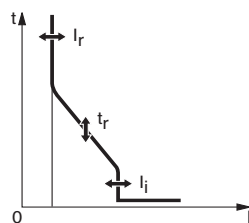


Table 22: Micrologic 2.0A and 3.0A Trip Unit Settings

Long-Time Protection	Current Setting (A)		2.0A: 0.40 0.50 0.60 0.70 0.80 0.90 0.95 0.98 1.00
	Tripping Between 1.05 and 1.20 x I _r	I _r = I _n x...	3.0A: 0.40 0.45 0.50 0.60 0.63 0.70 0.80 0.90 1.00
			Other Ranges are Available by Changing Rating Plug
	Maximum Time Delay (s)	t _r at 1.5 x I _r	12.5 25 50 100 200 300 400 500 600
Short-Time Protection	Accuracy: ±10%, No delay	t _r at 6 x I _r	0.5 1 2 4 8 12 16 20 24
		t _r at 7.2 x I _r	0.34 0.69 1.38 2.7 5.5 8.3 11 13.8 16.6
Instantaneous Protection	Accuracy: ±10%	Thermal Imaging	
		20 Minutes Before or After Tripping	
Short-Time Protection	Current Setting (A)	I _{sd} = I _r x...	2.0A: 1.5 2 2.5 3 4 5 6 8 10
			3.0A: 1.5 2 3 4 5 6 8 10 12

Table 23: Micrologic 5.0A and 6.0A Trip Unit Settings

Long-Time Protection	Current Setting (A)		IEC: 0.40 0.50 0.60 0.70 0.80 0.90 0.95 0.98 1.00
	Tripping Between 1.05 and 1.20 x I _r	I _r = I _n x...	UL: 0.40 0.45 0.50 0.60 0.63 0.70 0.80 0.90 1.00
			Other ranges are available by changing rating plug
	Maximum Time Delay (s)	t _r at 1.5 x I _r	12.5 25 50 100 200 300 400 500 600
Short-Time Protection	Accuracy: 0–20%	t _r at 6 x I _r	0.5 1 2 4 8 12 16 20 24
		t _r at 7.2 x I _r	0.34 0.69 1.38 2.7 5.5 8.3 11 13.8 16.6
Instantaneous Protection	Accuracy: ±10%	Thermal Imaging	
		20 minutes before or after tripping	
Short-Time Protection	Current Setting (A)	I _{sd} = I _r x...	1.5 2 2.5 3 4 5 6 8 10
Short-Time Protection	Maximum Time Delay (s) at 10 x I _r	Settings	I ² t OFF 0 0.1 0.2 0.3 0.4
			I ² t ON 0.1 0.2 0.3 0.4
		t _{sd}	Min. trip time (ms) 20 80 140 230 350
			Max. trip time (ms) 80 140 200 320 500
Instantaneous Protection	Current Setting (A)	I _i = I _n x...	2 3 4 6 8 10 12 15 off

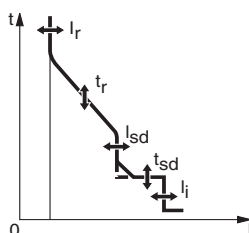
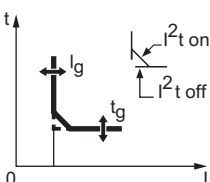


Table 24: Micrologic 6.0A Trip Unit Ground-Fault Settings

Ground-Fault Pickup (A)	I _g = I _n x...	A B C D E F G H J
	I _n ≤ 400 A	0.3 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
	400 A < I _n ≤ 1200 A	0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
	I _n > 1200 A	500 640 720 800 880 960 1040 1120 1200
Maximum Time Delay (s) at 1 x I _g	Settings	I ² t OFF 0 0.1 0.2 0.3 0.4
		I ² t ON 0.1 0.2 0.3 0.4
	t _g	Minimum Trip Time (ms) 20 80 140 230 350
		Maximum Trip Time (ms) 80 140 200 320 500



External Power Supplies for Micrologic Trip Units

Current-based protection functions require no auxiliary power source.

Table 25: Micrologic A Use of External 24 Vdc Power Supply

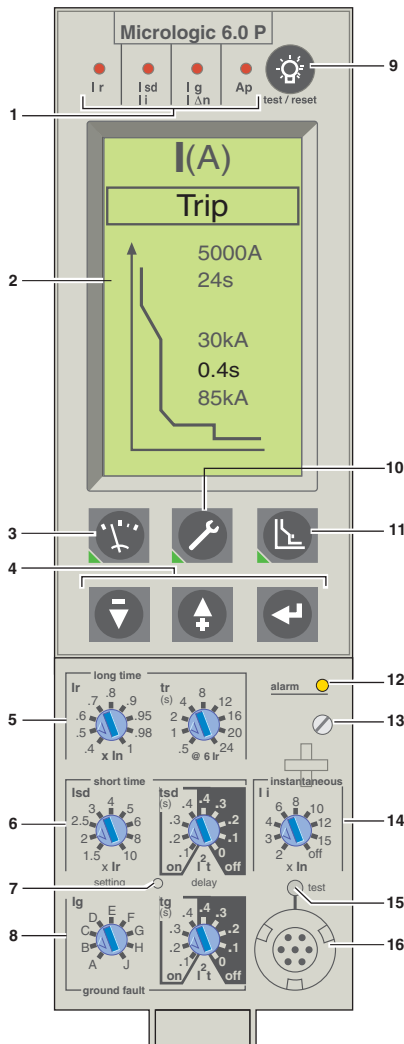
Function	Without 24 Vdc Power Supply at F1 and F2	With 24 Vdc Power Supply at F1 and F2
Fault Protection for LSIG Functions	Yes	Yes
LED Trip Indication	Yes	Yes
Ammeter and bar graph displays	Yes	Yes
Trip Setting and Max. Current Readings Can Be Accessed on the Display by Using Navigation Buttons	Yes, If Current Flow on One Phase is Equal To or Greater Than:	
	Sensor Plug Value (I _n)	Minimum Ground-fault Pickup
	100–250 A	30% of sensor rating
	400–1200 A	20% of sensor rating
Ground-Fault Push-to-Trip Button Works for Testing Ground Fault ¹	1600–6300 A	500 A
Modbus® Communications (Optional)	No	Yes, with separate 24 Vdc power supply for the circuit breaker communication module
Back-lit Display	No	Yes

¹ Ground fault Push-to-trip button will also be functional if hand-held test kit or full-function test kit is powering the trip unit.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

Micrologic™ 5.0P and 6.0P Trip Units with Power Metering



- 1—Indication of tripping cause
- 2—High resolution screen
- 3—Measurement display
- 4—Navigation buttons
- 5—Long-time current setting and tripping delay
- 6—Short-time pickup and tripping delay
- 7—Hole for settings lockout pin
- 8—Ground-fault pickup and tripping delay
- 9—Test lamp and indication reset
- 10—Maintenance indicators
- 11—Protection settings
- 12—Overload signal (LED)
- 13—Long-time rating plug screw
- 14—Instantaneous pickup
- 15—Electronic push-to-trip
- 16—Test connector

Micrologic P trip units provide power metering and extended protection in addition to the adjustable protection functions of the Micrologic A trip unit.

Protection Settings

The adjustable protection functions of the 5.0P and 6.0P trip units are identical to those of Micrologic A trip unit (overloads, short circuits, equipment ground-fault protection; see page 44). These units also feature:

- Fine adjustment
Within the range below the rotary switch setting, fine adjustments of pickups/delays in steps of 1 A/s (except for short-time and ground-fault) are possible on the keypad or remotely by the communication network.
- Inverse definite minimum time lag (IDMTL) setting.
Coordination with fuse-type or medium-voltage protection systems is optimized by adjusting the long-time delay curve around $6 \times I_r$ axis. This setting ensures better coordination with certain loads.
- Neutral protection
On three-pole circuit breakers, neutral protection may be set using the keypad or remotely using the communication network to one of four positions: OFF, $1/2N$ ($1/2 \times I_n$), $1N$ ($1 \times I_n$), or $1.6N$ ($2 \times I_n$).

NOTE: Neutral protection is disabled if long-time curve is set to one of the IDMTL protection settings.

Configuring Alarms and Other Protection Functions

When the cover is closed, the keypad may no longer be used to change the protection settings, but it still provides access to the displays for measurements, histories, indicators, etc. Depending on the thresholds and time delays set, the Micrologic P trip unit monitors current, voltage, power, frequency, and phase sequence. Each threshold overrun may be signalled remotely via the communication network.

Each threshold overrun may be combined with tripping (protection) or an indication carried out by an optional M6C programmable contact (alarm), or both (protection and alarm).

Maintenance Record

The maintenance record can be consulted using the full-function test kit or remotely via the communication network. It can be used as an aid in troubleshooting and to assist scheduling for device maintenance operations. Recorded indications include:

- Highest current measured
- Operation counter (cumulative total and total since last reset)
- Number of test kit connections
- Number of trips in operating mode

Load Shedding and Reconnection Parameters

Load shedding and reconnection parameters can be set according to the power or the current flowing through the circuit breaker. Load shedding is carried out by a remote computer via the communication network or by an M6C programmable contact.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

Indication Option Via Programmable Contacts

The M6C programmable contact may be used to signal threshold overruns or status changes. It can be programmed using the keypad on the Micrologic P trip unit or remotely using the communication network. The contact is required to obtain data from the protective relay functions on Type P and Type H trip units.

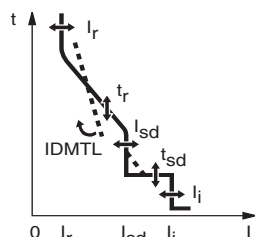


Table 26: Micrologic 5.0P and 6.0P Trip Unit Settings

Long-Time (RMS) Protection	Current Setting (A)	$I_r = I_n \times \dots$	IEC	0.40	0.50	0.60	0.70	0.80	0.90	0.95	0.98	1.00	
	Tripping Between 1.05 and 1.20 x I_r	$I_r = I_n \times \dots$	UL	0.40	0.45	0.50	0.60	0.63	0.70	0.80	0.90	1.00	
	Other Ranges are Available by Changing Rating Plug												
	Maximum Time Delay (s)	t_r at 1.5 x I_r		12.5	25	50	100	200	300	400	500	600	
	Accuracy: 0 to -20%	t_r at 6 x I_r		0.5	1	2	4	8	12	16	20	24	
	t_r at 7.2 x I_r		0.34	0.69	1.38	2.7	5.5	8.3	11	13.8	16.6		
	IDMTL Setting	Curve slope		SIT	VIT		EIT		HV Fuse		DT		
	Thermal Imaging	20 Minutes Before or After Tripping											
Short-Time (RMS) Protection	Current Setting (A)	$I_{sd} = I_r \times \dots$		1.5	2	2.5	3	4	5	6	8	10	
	Maximum Time Delay (s)	Settings	I^2t OFF	0	0.1	0.2	0.3	0.4					
			I^2t ON		0.1	0.2	0.3	0.4					
		t_{sd}	Min. Trip Time (ms)	20	80	140	230	350					
		Max. Trip Time (ms)	80	140	200	320	500						
Instantaneous Protection	Current Setting (A)	$I_i = I_N \times \dots$		2	3	4	6	8	10	12	15	off	
	Accuracy: $\pm 10\%$												

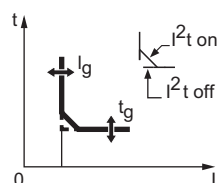


Table 27: Micrologic 6.0P Trip Unit Ground-Fault Settings

Ground-Fault Pickup (A) Accuracy: ±10%		I _g = I _n x...	A	B	C	D	E	F	G	H	J	
		I _n ≤ 400 A	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
		400 A < I _n ≤ 1200 A	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	
		I _n > 1200 A	500	640	720	800	880	960	1040	1120	1200	
Time Delay (s) at 1 x I _n	Settings	I ² t OFF	0	0.1	0.2	0.3	0.4					
		I ² t ON		0.1	0.2	0.3	0.4					
	t _g	Min. Trip Time (ms)	20	80	140	230	350					
		Max. Trip Time (ms)	80	140	200	320	500					

Table 28: Micrologic 5.0P and 6.0P Trip Unit Settings for Protection Functions

			Threshold	Time Delay
Current	Current Imbalance		0.05 to 0.6 x I_{max}	1 to 40 s
	Maximum Current	$I_{max}: I_A, I_B, I_C, I_N, I_g$	0.2 to 1.0 x I_n	15 to 1500 s
Voltage	Voltage Imbalance		0.02 to 0.3 x V_n	1 to 40 s
	Minimum Voltage	V_{min}	100 to 725 V (Phase Total)	0.25 to 0.5 s
Power	Maximum Power	P_{max}	100 to 1200 V (Between Phases)	0.20 to 5.0 s
	Reverse Power	P_r	5 to 500 kW	0.2 to 20 s
Frequency	Minimum Frequency	F_{min}	0.02 to 0.2 x P_n	0.5 to 20 s
	Maximum Frequency	F_{max}	45 to 65 Hz	0.2 to 5 s
Phase	Sequence	$\Delta \emptyset$	45 to 540 Hz	0.2 to 5 s
			$\emptyset A-\emptyset B-\emptyset C$ or $\emptyset A-\emptyset C-\emptyset B$	Instantaneous

Table 29: Micrologic 5.0P and 6.0P Trip Unit Settings for Current and Power Load-Shedding

		Pickup	Drop-out
		Threshold	Time Delay
Current	I	0.5 to 1.0 x I_r Per Phase	20% to 80% x t_r
Power	P	200 kW to 10 MW	10 to 3600 s

Micrologic P trip units are designed to be used with an external 24 Vdc power supply. Current-based protection functions require no auxiliary power source.

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Section 3—Electronic Trip Systems

Table 30: Micrologic P Use of External 24 Vdc Power Supply

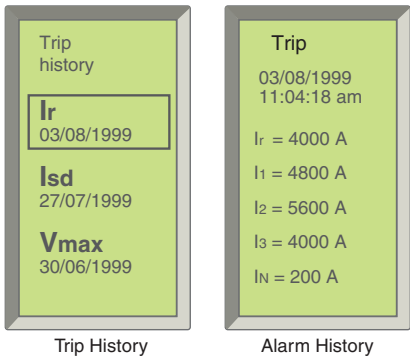
Function	Without 24 Vdc Power Supply at F1 and F2	With 24 Vdc Power Supply at F1 and F2
Fault Protection for LSIG Functions	Yes	Yes
LED Trip Indication	Yes	Yes
LCD Display and Backlight are Functional	Yes ¹	Yes
Ground-Fault Push-to-Trip Button Works for Testing Ground Fault ²	Yes ¹	Yes
Metering, Monitoring, and History Logs are Functional	Yes ¹	Yes
Communications Between Trip Unit and M2C and M6C Programmable Contact Modules	No	Yes
Operation of M6C Programmable Contact Module	No	Yes, with separate 24 Vdc power supply for the module
Modbus Communications	No	Yes, with separate 24 Vdc power supply for the circuit breaker communication module

¹ If circuit breaker has 100 Vac or more between two phases or phase to neutral and is bottom fed or closed in a top fed application.

² Ground-fault push-to-trip button will also be functional if hand-held test kit or full-function test kit is powering the trip unit.

Tripping and Alarm Histories

The last ten trips and ten alarms are recorded in two separate history files that can be displayed on the screen (sample displays are shown).



The following information is contained in these files:

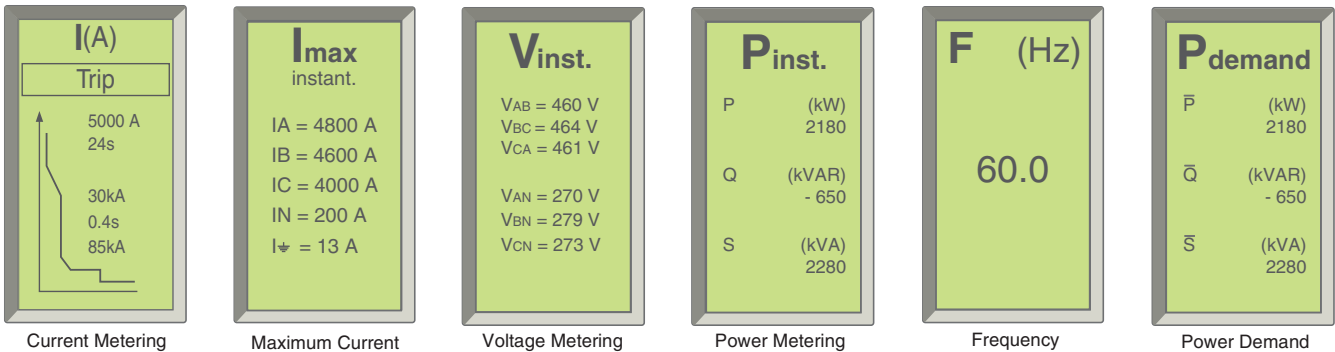
- Trip History**

 - Type of fault
 - Date and time of fault
 - Interrupted current
- Alarm History**

 - Type of alarm
 - Date and time of alarm
 - Values measured at time of alarm

Metering

The Micrologic P trip unit calculates in real time the electrical values V, A, W, VAR, VA, Wh, VARh, VAh, Hz, power factor and crest factor. It also calculates demand current and power over an adjustable time period.



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Section 3—Electronic Trip Systems

Real-Time Metering

The value displayed on the screen is refreshed every second. Minimum and maximum measurement values are stored in memory.

Table 31: Real-Time Metering

Type of Measurement		Unit of Measurement	Measurement Source
Current	I_{RMS}	A	$\phi A, \phi B, \phi C$ or N
	$I_{AVERAGE}$	A	$(\phi A + \phi B + \phi C) / 3$
	$I_{PEAK}/\sqrt{2}$	A	$\phi A, \phi B, \phi C$ or N
Voltage	V_{RMS}	V	$(\phi A-\phi B), (\phi B-\phi C)$ and $(\phi C-\phi A)$
	V_{RMS}	V	$(\phi A-N), (\phi B-N)$ and $(\phi C-N)$
	$\Delta V_{IMBALANCE}$	%	V_{RMS}
Power	P, Q and S	W, VAR, VA	Total
	EP, EQ and ES	Wh, VARh, VAh	Total
	Power factor		Total
Frequency	F	Hz	50/60

Demand Metering

The demand is calculated over a fixed or sliding time window that can be programmed from five to sixty minutes. Depending on the contract signed with the power supplier, specific programming makes it possible to avoid or minimize the cost of overrunning the subscribed power. Maximum demand values are systematically stored and time stamped.

Table 32: Demand Metering

Type of Measurement		Unit of Measurement	Measurement Source
Current	I_{DEMAND}	A	$\phi A, \phi B, \phi C$ or N
Power	P, Q and S_{DEMAND}	W, VAR, VA	Total

Communication Network

The communication network may be used to:

- Remotely read parameters for the protection functions.
- Transmit all the measurements and calculated values.
- Signal the causes of tripping and alarms.
- Consult the history files and the maintenance indicator record.

In addition, an event log of the last 100 events and a maintenance record, which is stored in the trip unit memory but not available locally, may be accessed via the communication network.

This Modbus communication system is compatible with the Powerlogic™ System Manager™ software (SMS).

Event Log

The event log may be accessed by a remote computer via the communication network. All events are time stamped and include:

- Trips
- Beginning and end of alarms
- Modifications to settings and parameters
- Loss of time
- Test kit connections
- Counter resets
- System faults (thermal self-protection, major fault and minor fault alarms)

Micrologic™ 5.0H and 6.0H Trip Units with Harmonic Metering



In addition to the P functions, the Micrologic H trip units offer:

- In-depth analysis of power quality including calculation of harmonics and the fundamentals.
- Diagnostics aid and event analysis through waveform capture.
- Customized alarm programming to analyze and track down a disturbance on the ac power system.
- Systematic time stamping of all events and creation of logs.

Metering

The Micrologic H trip unit offers all the measurements carried out by the Micrologic P trip unit, with the addition of phase-by-phase measurements of power and energy as well as calculation of:

- Current and voltage total harmonic distortion (THD, thd)
- Current, voltage and power fundamentals (50/60 Hz)
- Harmonic components (amplitude and phase) up to the 31st current and voltage harmonic
- Real-time metering: The value displayed on the screen is refreshed every second. The table below shows what is measured in real-time metering

Table 33: Measurements

Type of Measurement		Unit of Measurement	Measurement Source
Current	I _{RMS}	A	ØA, ØB, ØC or N
	I _{AVERAGE}	A	(ØA + ØB + ØC) / 3
	I _{PEAK} /√2	A	ØA, ØB, ØC or N
	ΔI _{IMBALANCE}	%	ØA, ØB, ØC or N
Voltage	V _{RMS}	V	(ØA–ØB), (ØB–ØC) and (ØC–ØA)
	V _{RMS}	V	(ØA–N), (ØB–N) and (ØC–N)
	ΔV _{IMBALANCE}	%	V _{RMS}
Power	P, Q and S	W, VAR, VA	Total
	EP, EQ and ES	Wh, VARh, VAh	Total
	Power factor		Total
Frequency	F	Hz	ØA, ØB, or ØC
Power Quality Indicators	Fundamentals	50/60 Hz component	V, I, P, Q, and S
	THD	%	V/I
	V and I harmonics	Amplitude to phase	1, 2, 3, 4...50

- Demand Metering: Similar to the Micrologic P trip unit, demand values are calculated over a fixed or sliding time window that can be set from five to sixty minutes.

Table 34: Demand Metering

Type of Measurement	Unit of Measurement	Measurement Source
Current	I _{DEMAND}	A
Power	P, Q and S _{DEMAND}	W, VAR, VA
		ØA, ØB, ØC or N
		Total

Waveform Capture

The Micrologic H trip units can capture and store current and voltage waveforms using digital sampling techniques similar to those used in oscilloscopes. Using the information available in the captured waveform, it is possible to determine the level of harmonics as well as the direction and amplitude of the flow of harmonic power.

The Micrologic™ H trip unit can record manually via the keypad the following waveforms:

- Currents I_A, I_B, I_C and I_N
- Phase-to-phase voltages $V_{AB}, V_{BC},$ and V_{CA}

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Section 3—Electronic Trip Systems

Waveforms may be displayed on the graphic screen of the control unit or communicated over a networked system. The recording takes place over one cycle with a measurement range of 1 to 1.5 I_n for current and 0 to 690 volts for voltage. Resolution is 64 points per cycle.

Customized Alarm Programming

The instantaneous value of each measurement can be compared to user-set high and low thresholds. Overrun of a threshold generates an alarm. Programmable action can be linked to each alarm, including circuit breaker opening, activation of an M6C contact, recording of measurements in a log, etc.

Event Logs

Each event is recorded with:

- The date, time, and name of the event
- The event characteristics

Micrologic H trip units are designed to be used with an external 24 Vdc power supply. Current-based protection functions require no auxiliary power source.

Table 35: Micrologic H Use of External 24 Vdc Power Supply

Function	Without 24 Vdc Power Supply at F1 and F2	With 24 Vdc Power Supply at F1 and F2
Fault Protection for LSIG Functions	Yes	Yes
LED Trip Indication	Yes	Yes
LCD Display and Backlight are Functional	Yes ¹	Yes
Ground-Fault Push-to-Trip Button Works for Testing Ground Fault ²	Yes ¹	Yes
Metering, Monitoring, and History Logs are Functional	Yes ¹	Yes
Communications Between Trip Unit and M2C and M6C Programmable Contact Modules	No	Yes
Operation of M6C Programmable Contact Module	No	Yes, with Separate 24 Vdc Power Supply for the Module
Modbus™ Communications	No	Yes, with Separate 24 Vdc Power Supply for the Circuit Breaker Communication Module

¹ If circuit breaker has 100 Vac or more between two phases or phase to neutral and is bottom fed or closed in a top fed application.

² Ground-fault push-to-trip button will also be functional if hand-held test kit or full-function test kit is powering the trip unit.

Additional Characteristics for Type P and H Trip Units

- Setting the display language: System messages can be displayed in six different languages (English - US, English - UK, French, German, Spanish, and Italian). The desired language is selected via the keypad.
- Protection functions: All current-based protection functions require no auxiliary source. Voltage-based protection functions are connected to ac power via a voltage measurement input built into the circuit breaker on the bottom side. (Optional external voltage measurement is available as a factory-installed option.)
- Accuracy of measurements (including sensors):
 - Voltage (V) 1%
 - Current (A) 1.5% (higher accuracy [1%] may be achieved with special calibration on the current transformer [CT characterization option])
 - Frequency (Hz) 0.1 Hz
 - Power (W) and energy (Wh) 2.5%

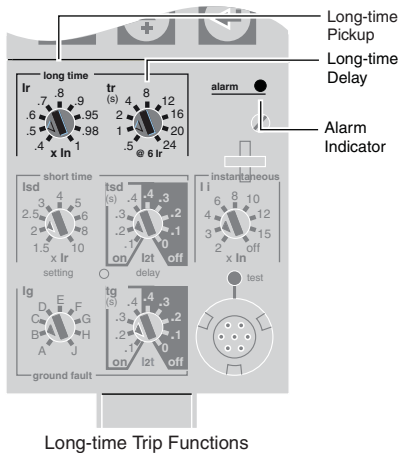
The Micrologic H trip unit uses a dedicated metering data chain separate from the protection data chain so that a greater number of data samples can be used for metering. This increases the number of samples taken per time period, which in turn gives the H trip unit a higher degree of metering accuracy.

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Section 3—Electronic Trip Systems

- **Stored information:** The fine setting adjustments, the last 100 events and the maintenance record remain in the trip unit memory even when power is lost.
- **Reset:** An individual reset, via the keypad or remotely, will reset alarms, minimum and maximum data, peak values, counters and indicators.

Micrologic™ Trip Unit Functions

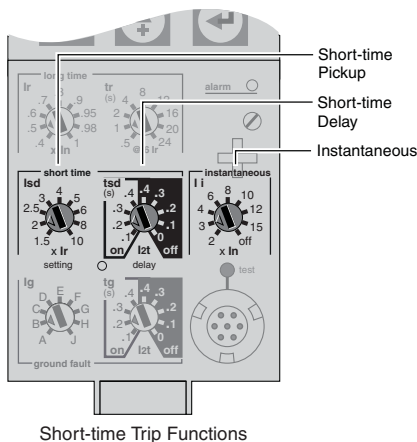


Long-Time Trip Functions

The *long-time pickup* switch sets the maximum current level the circuit breaker will carry continuously. The maximum current level (I_r) is the long-time pickup setting multiplied by the sensor plug amperage (I_n). If the current exceeds this value for longer than the long-time delay time, the circuit breaker will trip.

The *long-time delay* switch sets the length of time that the circuit breaker will carry a sustained overload before tripping. Delay bands are labeled in seconds of overcurrent at six times the ampere rating. For maximum coordination, there are eight delay bands. Long-time delay is an “inverse time” characteristic in that the delay time decreases as the current increases.

The trip unit includes an *alarm indicator* that will be lit continuously when the current is above 100% of the pickup setting.



Short-Time Trip Functions

The *short-time pickup* switch sets the short-circuit current level at which the circuit breaker will trip after the set short-time delay. The short-time current (I_{sd}) equals the short-time pickup setting multiplied by the long-time pickup (I_r).

The *short-time delay* switch sets the length of time the circuit breaker will carry a short circuit within the short-time pickup range. The delay (based on 10 times the ampere rating I_r) can be adjusted to four positions of I^2t ramp operation (I^2t ON) or five positions of fixed time delays (I^2t OFF). I^2t ON delay is an “inverse time” characteristic in that the delay time decreases as the current increases. Short-time delay for the 2.0 trip unit is fixed at a delay band of 20 to 80 ms.

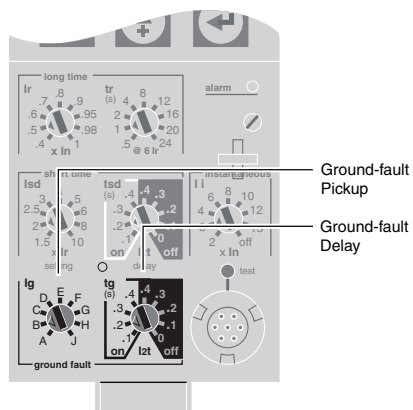
Instantaneous Trip Function

The *instantaneous pickup* switch sets the short-circuit current level at which the circuit breaker will trip with no intentional time delay. The instantaneous current (I_i) is equal to the instantaneous pickup setting multiplied by the sensor plug amperage (I_n).

The instantaneous function will override the short-time function if the instantaneous pickup is adjusted at the same or lower setting than the short-time pickup. In trip units with both adjustable short-time and instantaneous trip functions, the adjustable instantaneous trip can be disabled by setting Instantaneous pickup to OFF.

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Section 3—Electronic Trip Systems



Ground-Fault Trip Functions

The *ground-fault pickup* switch sets the current level at which the circuit breaker will trip after the set ground-fault delay. Ground-fault pickup values (I_g) are based on circuit breaker sensor plug (I_n) only, not on the rating plug multiplier (I_r). Changing the rating plug multiplier has no effect on ground-fault pickup values.

The *ground-fault delay* switch sets the length of time the circuit breaker will carry ground-fault current which exceeds the ground-fault pickup level before tripping. The delay, based on the sensor plug amperage (I_n), can be adjusted to four positions of I^2t ramp operation (I^2t ON) or five positions of fixed time delays (I^2t OFF). I^2t ON delay is an “inverse time” characteristic in that the delay time decreases as the current increases.

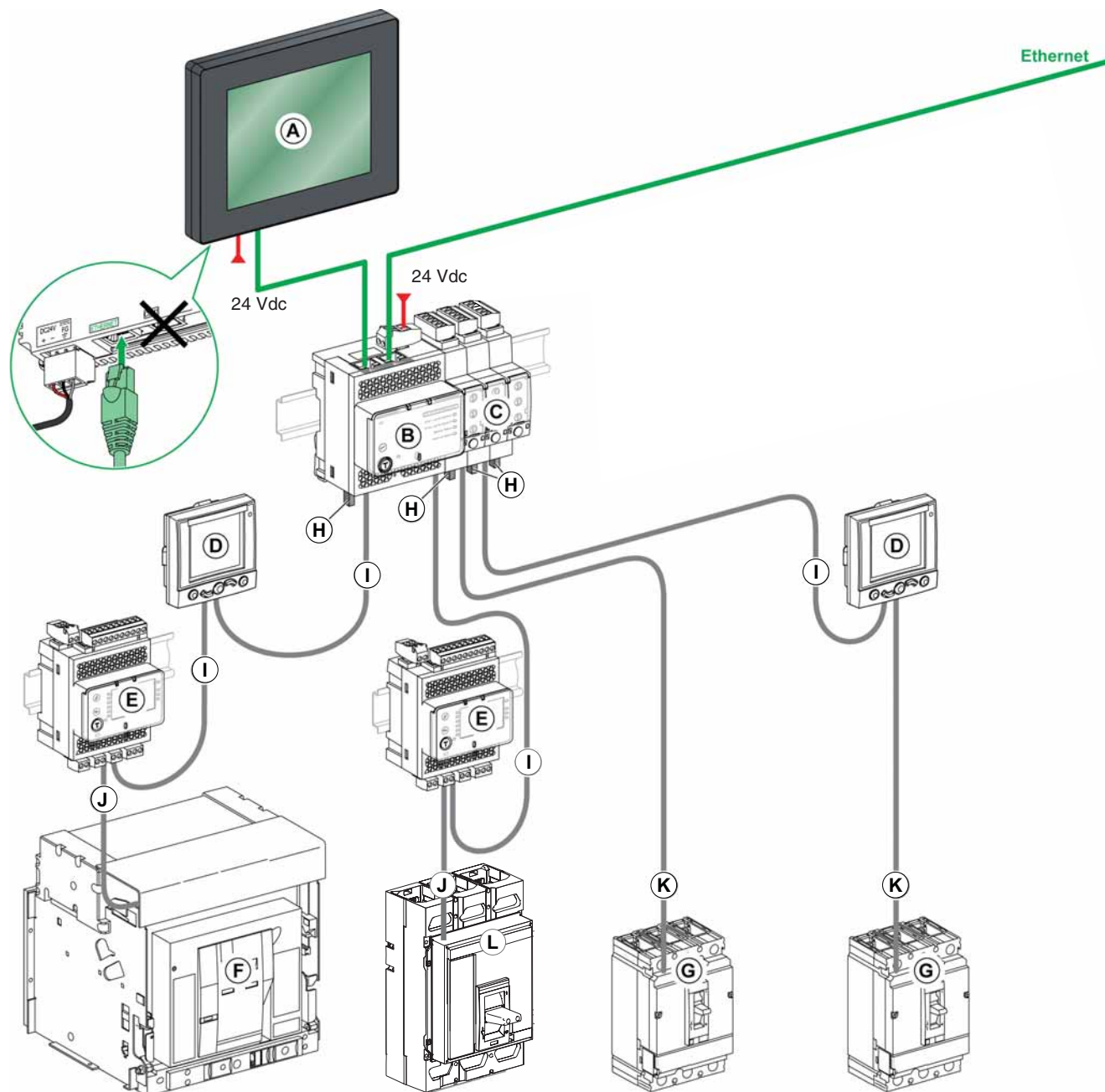
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Section 3—Electronic Trip Systems

Enerlin'X Communication Wiring System

Wiring System ULP

The wiring system is designed for low-voltage power switchboards. Installation does not require special tools or training. The prefabricated wiring ensures both data transmission (Modbus protocol) and 24 Vdc power distribution for the communications modules on the Micrologic trip units.



- A. FDM128 display for 8 LV devices
- B. IFE Ethernet interface for LV circuit breaker and gateway
- C. IFM Modbus-SL interface for LV circuit breaker
- D. FDM121 display for LV circuit breaker
- E. IO input/output interface module for LV circuit breaker
- F. Masterpact NT/NW circuit breaker

- G. PowerPact H-, J-, or L-frame circuit breaker
- H. ULP line terminator
- I. ULP cable
- J. Breaker ULP cord
- K. NSX cord
- L. PowerPact P/R or Compact NS

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Section 3—Electronic Trip Systems

Four Functional Levels

The PowerPact and Compact devices can be integrated into Ethernet and Modbus communication environment.

There are four possible functional levels that can be combined.

Functional Level	Switch	Circuit Breaker		
Status Indications				
ON/OFF (O/F) \	X	A	P	H
Spring charged	X	A	P	H
Ready to close	X	A	P	H
Fault-trip SDE	X	A	P	H
Connected / disconnected / test position CE/CD/CT (CCM only)	—	A	P	H
Controls				
MX1 shunt trip	X	A	P	H
XF shunt close	X	A	P	H
Measurements				
Instantaneous measurement information	—	A	P	H
Averaged measurement information	—	—	P	H
Maximum / minimum Ammeter	—	A	P	H
Energy metering	—	—	P	H
Demand for current and power	—	—	P	H
Power quality	—	—	—	H
Operating Assistance				
Protection and alarm settings	—	—	P	H
Histories	—	—	P	H
Time stamped event tables	—	—	P	H
Maintenance indicators	—	A	P	H



A: Micrologic trip unit with ammeter

P: Micrologic trip unit "Power"

H: Micrologic trip unit "Harmonics"

NOTE: See the section on the Micrologic trip units for details about the trip units.

Modbus Principle

The Modbus RS 485 (RTU protocol) system is an open bus on which communicating Modbus devices (Masterpact NW with Modbus COM, Power Meter PM700, PM800, PowerPact P/R-frame, etc.) are installed. All types of PLCs and microcomputers may be connected to the bus.

Addresses

The Modbus communication parameters (address, baud rate, parity) are entered using the keypad on the Micrologic A, P, or H trip unit. For a switch, it is necessary to use the Electrical Asset Manager or RSU (Remote Setting Utility) Micrologic utility.

Number of Devices

The maximum number of devices that may be connected to the Modbus bus depends on the type of device (PowerPact circuit breaker with Modbus COM, PM700, PM800, Masterpact circuit breaker, etc.), the baud rate (19200 is recommended), the volume of data exchanged and the desired response time. The RS 485 physical layer offers up to thirty-two connection points on the bus (one master, thirty-one slaves).

Length of Bus

The maximum recommended length for the Modbus bus is 3940 feet (1200 meters).

Bus Power Source

A 24 Vdc power supply is required (less than 20% ripple, insulation class II).

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Ethernet Principle

Ethernet is a data link and physical layer protocol defined by IEEE 802.10 and 100 Mbps specifications that connects computer or other Ethernet devices. Ethernet is an asynchronous Carrier Sense Multiple Access with Collision detection (referred as CSMA/CD) protocol. Carrier Sense means that the hosts can detect whether the medium (coaxial cable) is idle or busy.

Multiple Access means that multiple hosts can be connected to the common medium. Collision Detection means a host detects whether its transmission has collided with the transmission of another host (or hosts).

IFE Ethernet interface can be connected to a PC or a laptop over Ethernet. The maximum length of Ethernet cable is 325 feet (100 meters). IFE Ethernet interface + gateway provides a Modbus TCP/IP gateway over Ethernet to enable Modbus TCP communication from a Modbus TCP master to any Modbus slave devices connected to it. The maximum active Modbus TCP client connection is twelve.

IFE Ethernet interface has an embedded web server (web page).

COM Option in PowerPact and Compact Circuit Breakers

All PowerPact and Compact devices can be fitted with the communication function thanks to the COM option. PowerPact and Compact uses the Ethernet or Modbus communications protocol for full compatibility with the supervision management systems.

For fixed and drawout devices, the common communication option is made up of:



BCM ULP Module

- A BCM ULP module, installed behind the Micrologic trip unit and supplied with a set of switches (OF, SDE, PF and CH switches), a kit for connection to shunt close (XF) and shunt trip (MX1) communicating voltage releases (for electrically operated devices), and a COM terminal block (inputs E1 to E6).

This module is independent of the trip unit and receives and transmits information on the communication network. An infra-red link transmits data between the trip unit and the communication module.

Consumption: 30 mA, 24 V.

and

- The IFM module, the Modbus interface for connection to the network, contains the Modbus address (1 to 99) declared by the user using the two dials in front. It automatically adapts (baud rate, parity) to the Modbus network in which it is installed.

or

- The IFE module, the Ethernet interface for low-voltage circuit breakers, enables an intelligent modular unit (IMU) such as a Masterpact NT/NW or PowerPact circuit breaker to be connected to an Ethernet network. Each circuit breaker has its own IFE and a corresponding IP address.

For drawout device the Cradle Management option must be added:

The I/O (Input/Output) application module for low-voltage circuit breakers is delivered with the drawout devices ordered with the COM option for cradle management. It must be installed on a steel DIN rail that is properly grounded near the device. The I/O module must be connected to the ULP system and to the cradle position contacts (CD, CT, CE) that transmit the position of the circuit breaker in the cradle.

For communicating remote control for electrically operated devices, shunt close (XF) and shunt trip (MX1) communicating voltage releases must be added:

The shunt close (XF) and shunt trip (MX1) communicating voltage releases are equipped for connection to the communication module.

The remote-tripping function shunt trip (MX2) and undervoltage release (MN) are independent of the communication option. They are not equipped for connection to the communication module.



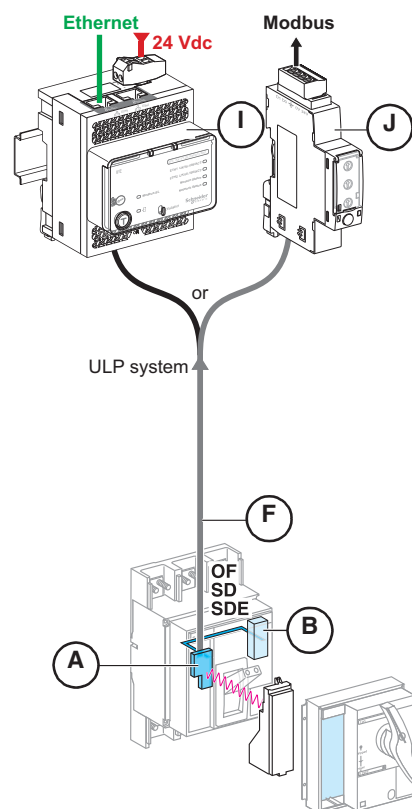
I/O Application Module

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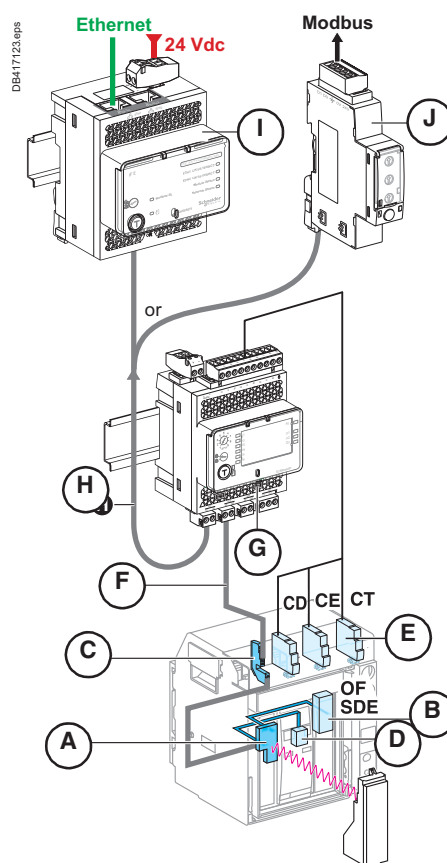
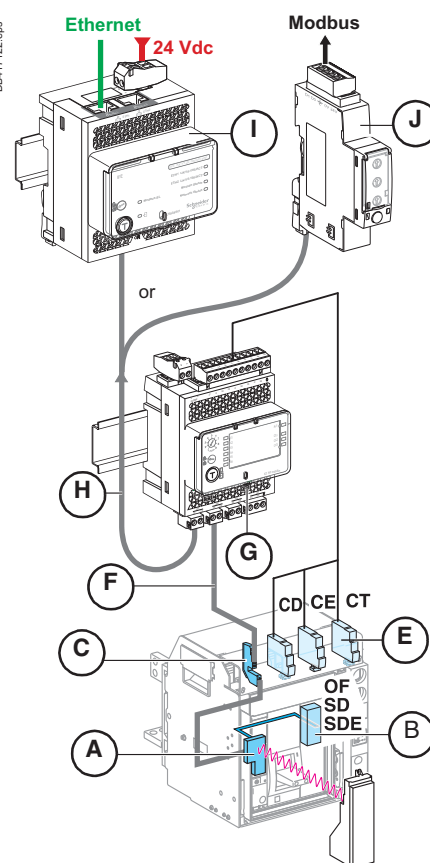
Section 3—Electronic Trip Systems

Figure 4: Communication Connections

Fixed Devices



Drawout Devices



- A. BCM ULP
- B. OF, SDE, SD, PF, CH (tripped, Open/closed, overcurrent trip, ready to close, charged Switches
- C. COM Terminal Block (E1 to E6)
- D. Shunt Trip (MX1) and Shunt Close (XF)
- E. CE, CD, and CT (connected, disconnected, test) Contacts
- F. Circuit Breaker ULP Cord
- G. I/O Application Module
- H. ULP Cable
- I. IFE Module
- J. IFM Module

IFE Ethernet Interface

IFE Interface, IFE Interface + Gateway Description

Introduction

The IFE interface and IFE interface + gateway enable low-voltage circuit breakers such as Masterpact NT/NW or PowerPact P/R-frame to be connected to an Ethernet network.

IFE Interface

Provides Ethernet access to a single low-voltage circuit breaker.

Function: Interface - one circuit breaker is connected to the IFE interface using its ULP port.

IFE Interface + Gateway

Provides Ethernet access to one or several low-voltage circuit breakers.

Functions:

- Interface - one circuit breaker is connected to the IFE interface using its ULP port.
- Gateway: several circuit breakers on a Modbus network are connected using the IFE interface + gateway master Modbus port.

IFE Interface, IFE Interface + Gateway Features

- Dual 10/100 Mbps Ethernet port for simple daisy chain connection.
- Device profile web service for discovery of the IFE interface, IFE interface + gateway on the LAN.
- Ethernet interface for Masterpact and PowerPact circuit breakers.
- Gateway for Modbus-SL connected devices (IFE interface + gateway only).
- Embedded set-up web pages.
- Embedded monitoring web pages.
- Embedded control web pages.
- Built-in e-mail alarm notification.

Figure 5: IFE Interface, IFE Interface + Gateway Screen



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Mounting

The IFE interface and IFE interface + gateway are DIN rail mounting devices. A stacking accessory enables the user to connect several IFMs (ULP to Modbus interfaces) to an IFE interface + gateway without additional wiring.

24 Vdc Power Supply

The IFE interface and the IFE interface + gateway must always be supplied with 24 Vdc.

The IFMs stacked to an IFE interface + gateway have power supplied by the IFE interface + gateway, thus it is not necessary to supply them separately. It is recommended to use a UL listed and recognized limited voltage/limited current or a class 2 power supply with a 24 Vdc, 3 A maximum.

Required Circuit Breaker Communication Modules

The connection to an IFE interface or IFE interface + gateway requires a communication module embedded into the circuit breaker:

- PowerPact and Compact circuit breakers: BCM ULP communication module
- Drawout PowerPact and Compact circuit breakers: BCM ULP and its respective I/O (Input/Output) application module.

All connection configurations for the circuit breakers require the circuit breaker ULP cord. The insulated NSX cord is mandatory for system voltages greater than 480 Vac. When the second ULP RJ45 connector is not used, it must be closed with a ULP terminator (TRV00880).

Table 36: Network Communication Interface

Characteristic		Value
Type of interface module		Modbus RTU, RS485 serial connection Modbus TCP/IP Ethernet
Transmission	Modbus RS485	• Transfer rate: 9,600–19,200 Baud • Medium Double shielded twisted pair • Impedance 120 Ω
	Ethernet	Transfer rate: 10/100 Mbps Medium STP, Cat5e, straight cable
Structure	Type	Modbus, Ethernet
	Method	Master/Slave
Device type	Modbus	Master
	Ethernet	Server
Turnaround time	Modbus	10 ms
	Ethernet	1 ms
Maximum length of cable	Modbus	1000 m
	Ethernet	100 m
Type of bus connector	Modbus	4-pin connector
	Ethernet	RJ45 (Shielded)

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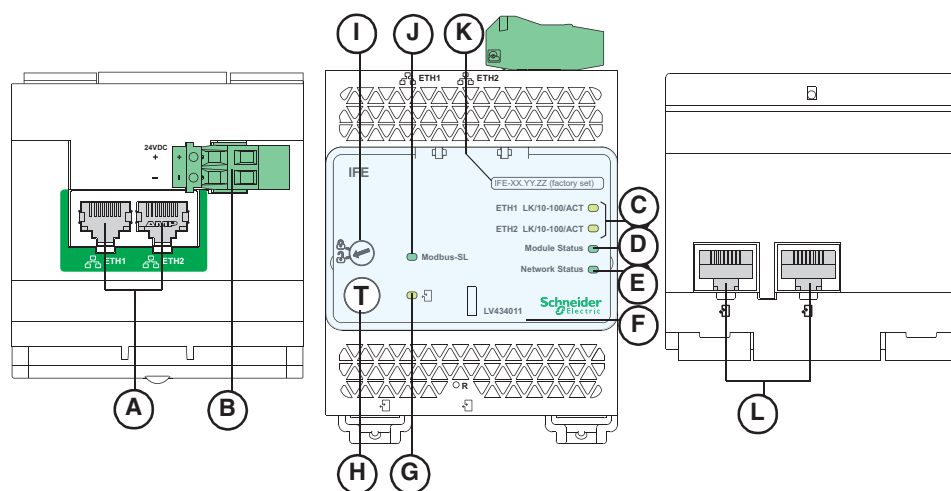
Section 3—Electronic Trip Systems

Table 37: Characteristics

General Characteristics	
Environmental Characteristics	
Conforming to standards	UL 508, UL 60950, IEC 60950, 60947-6-2
Certification	cUIUs, FCC, CE
Ambient temperature	Storage: -40 to +185°F (-40 to +85°C) Operation: -13 to +158°F (-25 to +70°C)
Protective Treatment	ULVO, conforming to IEC 60068-2-30
Pollution	Level 3
Mechanical Characteristics	
Shock resistance	Conforming to IEC 60068-2-27 15g/11ms, 1/2 sinusoidal
Resistance to sinusoidal vibrations	Conforming to IEC 60068-2-6
Electrical Characteristics	
Power Supply	24 Vdc, -20%/+10% (19.2 to 26.4 Vdc)
Consumption	Typical: 4 Vdc, 120 mA at 68°F (20°C) Maximum with gateway: 26.4 Vdc, 3 A at 140°F (60°C)
Physical Characteristics	
Dimensions	2.83 x 4.13 x 2.79 in. (72 x 105 x 71 mm)
Mounting	Mounting DIN rail
Weight	182.5 g (0.41 lb)
Degree of protection of the installed module	On the front panel (wall mounted enclosure): IP4x Connectors: IP2x Other parts: IP3x
Connections	Screw type terminal blocks
Technical Characteristics - 24 Vdc Power Supply	
Power supply type	Regulated switch type
Rated power	72 W
Input voltage	100–120 Vac for single phase 200–500 Vac phase-to-phase
PFC filter	With IEC 61000-3-2
Output voltage	24 Vdc
Power supply out current	3 A

IFE Web Page Description	
Monitoring Web Page	
Real time data	X
Device logging	X
Control Web Page	
Single device control	X
Diagnostics Web Page	
Statistics	X
Device information	X
IMU (circuit breaker) information	X
Read device registers	X
Communication check	X
Maintenance Web Page	
Maintenance log	X
Maintenance counters	X
Setup Web Page	
Device localization/name	X
Ethernet configuration (dual port)	X
IP configuration	X
Modbus TCP/IP filtering	X
Serial port	X
Date and time	X
E-mail server configuration	X
Alarms to be e-mailed	X
Device list	X
Device logging	X
Device log export	X
SNMP parameters	X
Documentation links	X
Preferences	X
Advanced services control	X
User accounts	X

NOTE: Use a UL Listed/UL Recognized limited voltage/limited current or a Class 2 power supply with a 24 Vdc, 3 A maximum.



- A. Ethernet 1 and Ethernet 2 communication port
- B. 24 Vdc power supply terminal block
- C. Ethernet communication LEDs:
 - yellow: 10 Mb
 - green: 100 Mb
- D. Module status LED:
 - steady off: no power
 - steady green: device operational
 - steady red: major fault
 - flashing green: standby
 - flashing red: minor fault
 - flashing green/red: self-test
- E. Network status LED:
 - steady off: no power/no valid IP address
 - steady green: connected, valid IP address
 - steady orange: default IP address
 - steady red: duplicated IP address
 - flashing green/red: self-test
- F. Sealable transparent cover
- G. ULP status LED
- H. Test button (accessible closed cover)
- I. Locking pad
- J. Modbus traffic status LED (IFE Interface + Gateway only)
- K. Device name label
- L. ULP ports

IFM Modbus Communication Interface

Function

An IFM Modbus communication interface is required for connection of a Masterpact or PowerPact circuit breaker to a Modbus network as long as this circuit breaker is provided with a ULP (Universal Logic Plug) port. The port is available on the BCM ULP.

Once connected, the circuit breaker is considered as a slave by the Modbus master. Its electrical values, alarm status, open/close signals can be monitored or controlled by a Programmable Logic Controller or any other system.

Characteristics

ULP Port

Two RJ45 sockets, internal parallel wiring.

- Connection of a single circuit breaker.
- A ULP line terminator or an FDM121 display unit must be connected to the second RJ45 ULP socket.
- The RJ45 sockets deliver a 24 Vdc supply fed from the Modbus socket.
- Built-in test function, for checking the correct connection to the circuit breaker and FDM121 display unit.

Modbus Slave Port

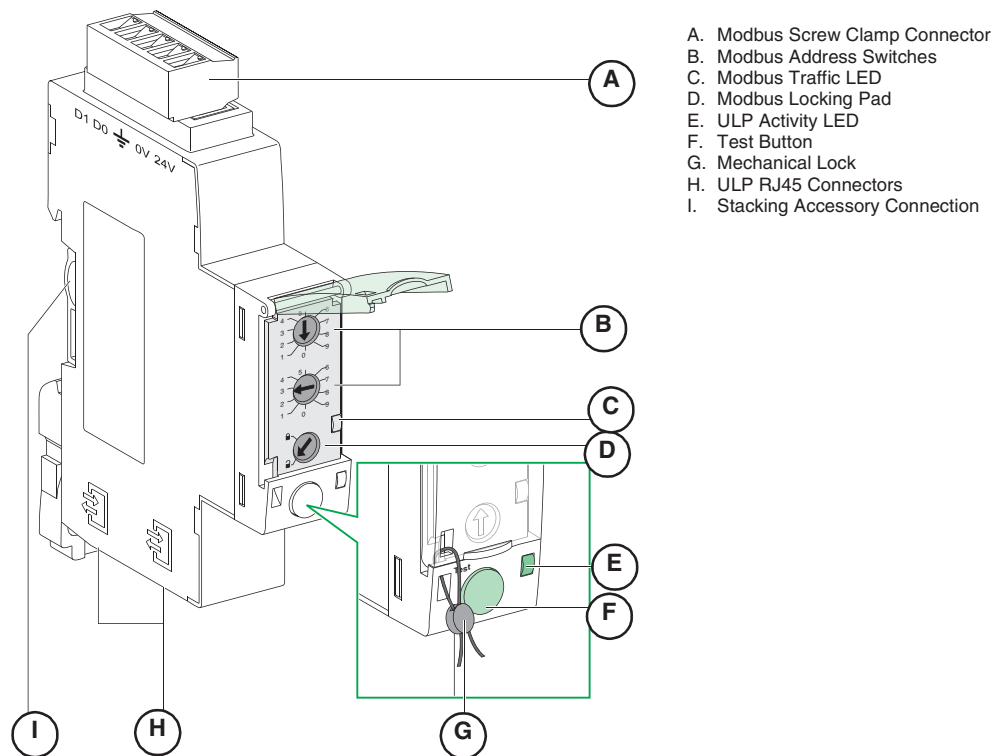
- Top socket for screw-clamp connector, providing terminals for:
 - 24 Vdc input supply (0 V, +24 V)
 - Modbus line (D1, D2, Gnd) 2-wire Modbus system.
- Lateral socket, for DIN-rail stackable connector. Both top and lateral sockets are internally parallel wired.
- Multiple IFMs can be stacked, thus sharing a common power supply and Modbus line without individual wiring.
- On the front face:
 - Modbus address setting (1 to 99): two coded rotary switches
 - Modbus locking pad: enables or disable the circuit breaker remote control and modification of IFM parameters.
- Self-adjusting communication format (Baud rate, parity).



IFM Modbus
Communication Interface.
Ref.: TRV00210

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Section 3—Electronic Trip Systems



Technical Characteristics

Table 38: IFM Modbus Communication Interface

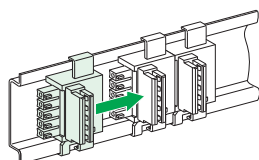
Dimensions		0.71 x 2.83 x 3.78 in. (18 x 72 x 96 mm)
Maximum number of stacked IFM		12
Degree of protection of the installed module	Part projecting beyond the escutcheon	IP4x
	Other module parts	IP3x
	Connectors	IP2x
Operating temperature		-25 to +70°C
Power supply voltage		24 Vdc -20%/+10% (19.2–26.4 Vdc)
Consumption	Typical	21 mA/24 Vdc at 68°F (20°C)
	Maximum	30 mA/19.2 Vdc at 140°F (60°C)
Certification	CE	IEC/EN 60947-1
	UL	UL 508 - Industrial Control Equipment
	CSA	No. 142-M1987 - Process Control Equipment
		• CAN/CSA C22.2 No. 0-M91 - General requirements - Canadian Electrical Code Part • CAN/CSA C22.2 No. 14-05 - Industrial Control Equipment

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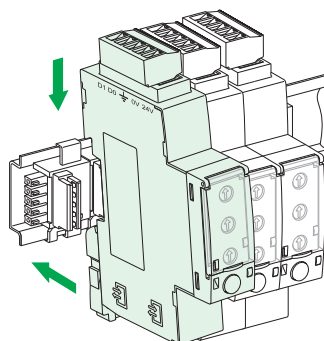
Section 3—Electronic Trip Systems

Simplified IFM Installation

Stacking an IFM

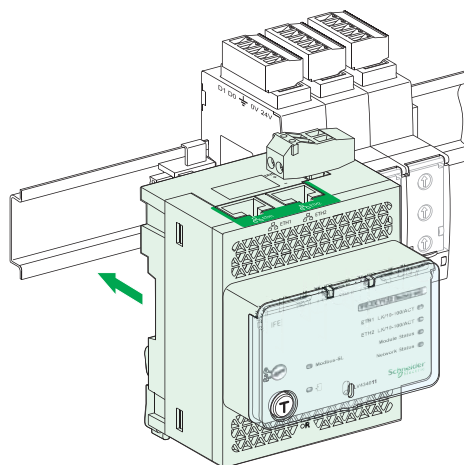
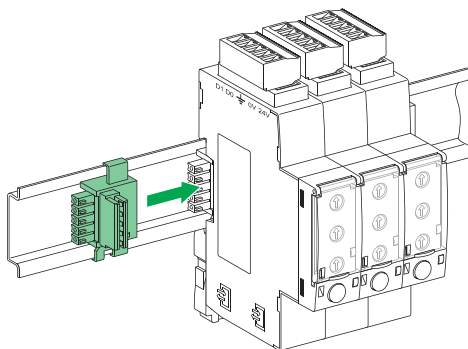


Stacking Accessories



Up to 12 Stacked IFM

Stacking an IFE Interface + Gateway with IFMs



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Section 3—Electronic Trip Systems

I/O Application Module

Description



I/O Application Module

The I/O (Input/Output) application module for an low-voltage circuit breaker is part of an ULP system with built-in functions and applications to enhance the application needs. The ULP system architecture can be built without any restrictions using the wide range of circuit breakers.

The I/O application module is compliant with the ULP system specifications.

Two I/O application modules can be connected in the same ULP network.

The ranges of low-voltage circuit breakers enhanced by the I/O application module are:

- Masterpact NW
- Masterpact NT
- PowerPact R-Frame
- PowerPact P-Frame
- Compact NS

I/O (Input/Output) Application Module for Low-Voltage Circuit Breaker Resources

The I/O application module resources are:

- Six digital inputs that are self powered for either NO and NC dry contact or pulse counter.
- Three digital outputs that are a bistable relay (5 A maximum).
- One analog input for PT100 temperature sensor.

Pre-Defined Application

The pre-defined application adds new functions to the I/O application module by:

- Selection by the application rotary switch on the I/O application module, defining the application with pre-defined input/output assignment and wiring diagram.
- No additional setting with the customer engineering tool required.

The resources not assigned to the pre-defined application are free for additional user-defined applications:

- cradle management
- circuit breaker operation
- cradle management + ERMS (Energy Reduction Maintenance Setting)

NOTE: Use only Micrologic P or H trip units with the blue ERMS label for energy reduction maintenance setting systems. Review the I/O module user guide 0613IB1317 and ERMS installation instructions NHA67346 for details on installation, testing, and operation of the ERMS system.

- light and load control
- custom.

User-Defined Applications

User-defined applications are processed by the I/O application module in addition to the pre-defined application selected.

The user-defined applications are available depending on:

- the pre-defined application selected
- the I/O application module resources (inputs and outputs) not used by the application.

The resources required by user-defined applications are assigned using the customer engineering tool:

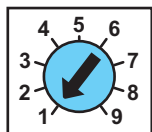
- protection
- control
- energy management
- monitoring.

Mounting

The I/O application module is a DIN rail mounted device. Install on a steel DIN rail that is properly grounded near the device.

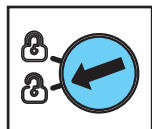
Application Rotary Switch

The application rotary switch enables the selection of the pre-defined application. It has nine positions and each position is assigned to a pre-defined application. The factory set position of the switch is pre-defined application one.



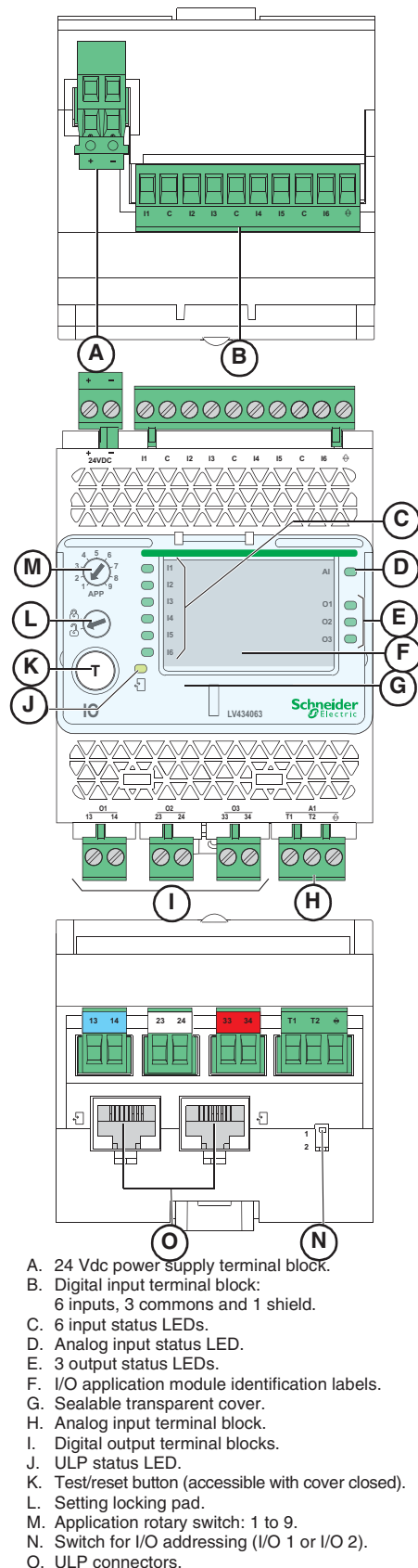
Setting Locking Pad

The setting locking pad on the front panel of the I/O application module enables the setting of the I/O application module by the customer engineering tool.



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems



General Characteristics

Environmental Characteristics	Conforming to standards	UL 508, UL 60950, IEC 60950, 60947-6-2
	Certification	cULus, EAC, FCC, CE
	Ambient temperature	Storage: -40 to +185°F (-40 to +85°C) Operation: -13 to +158°F (-25 to +70°C)
	Protective Treatment	ULVO, conforming to IEC 60068-2-30
	Pollution	Level 3
Mechanical Characteristics	Shock resistance	Conforming to IEC 60068-2-27 15g/11ms, 1/2 sinusoidal
	Resistance to sinusoidal vibrations	Conforming to IEC 60068-2-6
Electrical Characteristics	Power Supply	24 Vdc, -20%/+10% (19.2 to 26.4 Vdc)
	Consumption	Typical: 24 Vdc, 165 mA at 20°C Maximum with gateway: 26.4 Vdc, 420 mA at 60°C
Physical Characteristics	Dimensions	2.83 x 4.52 X 2.79 in. (72 x 115 x 71 mm)
	Mounting	DIN rail
	Weight	0.51 lb. (229.5 g)
	Degree of protection of the installed I/O application module	- On the front panel (wall mounted enclosure): IP4x - I/O parts: IP3x - Connectors: IP2x
	Connections	Screw type terminal blocks
Technical Characteristics	Power supply type	Regulated switch type
	Rated power	72 W
	Input voltage	100–120 Vac for single phase 200–500 Vac phase-to-phase maximum
	PFC filter	With IEC 61000-3-2
	Output voltage	24 Vdc
	Power supply out current	3 A
	NOTE: It is recommended to use an UL listed/UL listed recognized limited voltage/limited current or a class 2 power supply with a 24 Vdc, 3 A maximum.	
	24 Vdc power supply	
Digital Inputs	Digital input type	Self powered digital input with current limitations as per IEC 61131-2 type 2 standards (7 mA)
	Input limit values at state 1 (close)	19.8–25.2 Vdc, 6.1–8.8 mA
	Input limit values at state 0 (open)	0–19.8 Vdc, 0 mA
	Maximum cable length	33 ft (10 m)
	NOTE: For a length greater than 10 m (33 ft) and up to 300 m (1,000 ft), it is mandatory to use a shielded twisted cable. The shield cable is connected to the I/O functional ground of the I/O application module.	
Digital Outputs	Digital output type	Bistable relay
	Rated load	5 A at 250 Vac
	Rated carry current	5 A
	Maximum switching voltage	380 Vac, 125 Vdc
	Maximum switch current	5 A
	Maximum switching power	1250 VA, 150 W
	Minimum permissible load	10 mA at 5 Vdc
	Contact resistance	30 mΩ
	Maximum operating frequency	18000 operations/hr (Mechanical) 1800 operations/hr (Electrical)
	Digital output relay protection by an external fuse	External fuse of 5 A or less
Analog Inputs	Maximum cable length	10 m (33 ft)
	The I/O application module analog input can be connected to a Pt100 temperature sensor	
	Range	-22 to 392°F (-30 to 200°C)
	Accuracy	-22 to 68°F (-30 to 20°C): ±3.6°F (2°C) 68 to 284°F (20 to 140°C): ±1.8°F (1°C) 284 to 392°F (140 to 200°C): ±3.6°F (2°C)
	Refresh interval	5 s

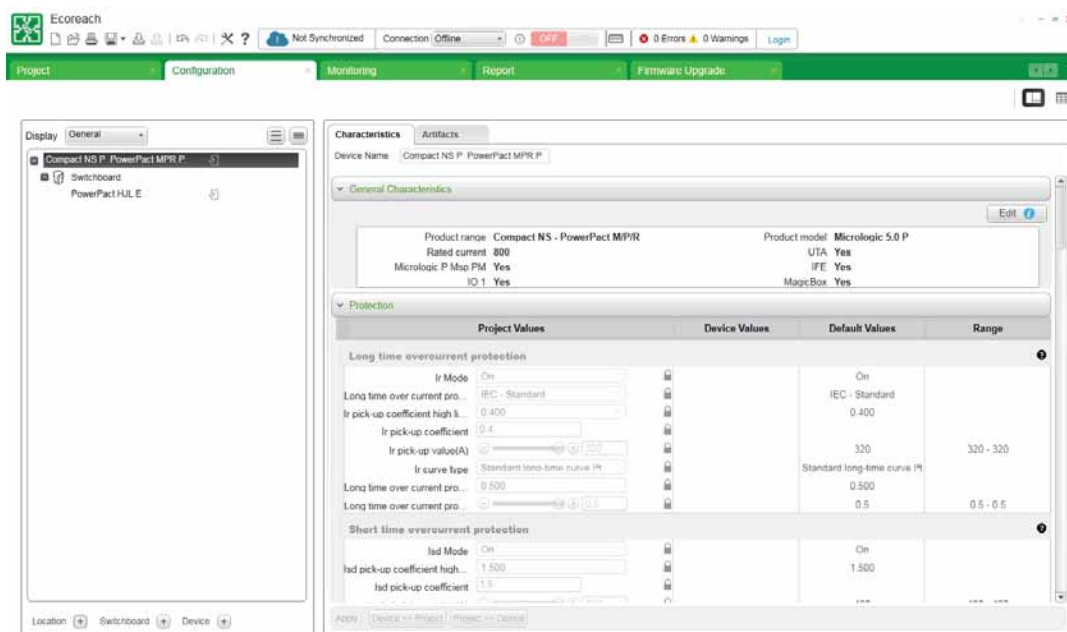
PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

Electrical Asset Manager Configuration Engineering Tool (Ecoreach™)

Introduction

The Ecoreach engineering tool is a software application that helps the user to manage a project as part of designing, testing, site commissioning, and maintenance of the project life cycle. It enables the user to prepare the settings of the devices offline (without connecting to the device) and configure them when connected with the devices. It also provides other value-added features for the user to manage the project such as: safe repository in cloud, attach artifacts to each device or at the project level, organize devices in switchboard, manage a hierarchical structure of the installation, etc.



Compatible Devices (Configuration and Device Management)

The Ecoreach engineering tool is compatible with the following devices:

- Compact NSX100-630 (IEC) circuit breakers
- PowerPact (UL) circuit breakers
- Compact NS630b-3200 (IEC) circuit breakers
- Masterpact NT/NW (IEC and UL) circuit breakers
- Compatible devices (Device Management in the project)
- Switches (Compact NSX, Masterpact & PowerPact Family)
- Third party devices.

References:

The Ecoreach software package can be downloaded from our website:

www.schneider-electric.com

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 3—Electronic Trip Systems

Features

The Ecoreach engineering tool includes the Schneider Electric customer engineering tools such as the Remote Setting Utility (RSU) and Remote Control Utility (RCU) with additional features.

The Ecoreach engineering tool supports the connection of Schneider Electric communicable devices to:

- create projects by device discovery, selection of devices, and importing a Bill of Material (BOM)
- monitor the status of protection and I/O status
- read information (alarms, measurements, parameters)
- check protection discrimination between two devices
- upload and download of configuration or settings in batch mode to multiple devices.
- carry out commands and tests
- generate and print a device settings report and communication test report
- manage multiple devices with a electrical and communication hierarchy model
- manage artifacts (project documents)
- check consistency in settings between devices on a communication network
- compare configuration settings between PC and device (online)
- download latest firmware.

The Ecoreach engineering tool enables the user to access the advanced features of the software once the project is saved in the Schneider Electric cloud.

Section 4—PowerPact M-Frame Molded Case Circuit Breakers

Performance

PowerPact M-frame molded case circuit breakers provide improved performance and a compact solution for applications up to 800 A. They complement the existing PowerPact P- and R-frame circuit breakers, and replace the traditional MA/MH circuit breakers with a smaller footprint and competitive cost.

- Available in 300, 350, 400, 450, 500, 600, 700, and 800 A ratings.
- Available in two- and three-pole unit-mount and I-Line versions

Table 39: Termination Options

Frame	Termination Letter	Termination Option
M-Frame	F	No Lugs
	L	Lugs both ends
	M	Lugs ON end Terminal Nut Kit Off end
	P	Lugs OFF end Terminal Nut Kit On end

For factory-installed termination, place termination letter in the third block of the circuit breaker catalog number.

M, G, L, 3, 6, 4, 0, 0 or **D, G, L, 3, 6, 4, 0, 0, E, 2, 0**
Termination Letter

- Built-in electronic trip unit type ET 1.0 provides better accuracy than standard thermal-magnetic trip units. The ET 1.0 trip unit cannot be field replaced, nor does it allow adjustment of the trip point setting. (It is considered an electronic equivalent of a thermal-magnetic circuit breaker.)
- Fixed long-time and adjustable instantaneous protection (2 to 10 times nominal ampere rating) is standard.
- Same dimensions, common mounting, bussing, cabling and door cut-out as PowerPact P-frame circuit breakers.
- Approximately 15% smaller installed volume than the MA/MH circuit breakers.
- A full range of electrical accessories are available:
 - Shunt trip (various AC and DC voltages are available)
 - Undervoltage trip (various AC and DC voltages are available)
 - Time delayed undervoltage trip (various AC and DC voltages are available)
 - Auxiliary switches (up to 3A/3B); low-level switches are also available (voltage and amperage)
 - Alarm switch (1A/1B); low-level switches are also available (voltage and amperage)
 - Overcurrent trip switch (SDE)
- A full range of mechanical accessories are available:
 - Standard mechanical lugs (aluminum or copper)
 - Crimp (compression) lugs (aluminum or copper)
 - Power distribution lugs (aluminum only)
 - Bus connector kit
 - Inter-phase barriers
 - Door escutcheons (for toggle or accessory cover)
 - Padlocking device (removable or fixed version), complies with OSHA requirements
 - Key-lock device (Kirk® or Schneider Electric™ keylocks)



M-Frame Unit-Mount



M-Frame I-Line

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 4—PowerPact M-Frame Molded Case Circuit Breakers

Catalog Numbers

Table 40: UL/IEC Rated, Unit-Mount, Manually-Operated, Standard-Rated Electronic Trip Circuit Breakers with Non-Interchangeable 1.0 Electronic Trip (Fixed Long-Time and Adjustable Instantaneous Trip Settings)

Type	Poles	Current Rating							
		300 A	350 A	400 A	450 A	500 A	600 A	700 A	800 A
MG	2	MGL26300	MGL26350	MGL26400	MGL26450	MGL26500	MGL26600	MGL26700	MGL26800
MJ	2	MJL26300	MJL26350	MJL26400	MJL26450	MJL26500	MJL26600	MJL26700	MJL26800
MG	3	MGL36300	MGL36350	MGL36400	MGL36450	MGL36500	MGL36600	MGL36700	MGL36800
MJ	3	MJL36300	MJL36350	MJL36400	MJL36450	MJL36500	MJL36600	MJL36700	MJL36800

Table 41: UL/IEC Rated, I-Line™, Manually-Operated, Standard-Rated Electronic Trip Circuit Breakers with Non-Interchangeable 1.0 Electronic Trip (Fixed Long-Time and Adjustable Instantaneous Trip Settings)

Type	Poles	Current Rating							
		300 A	350 A	400 A	450 A	500 A	600 A	700 A	800 A
MG ¹	2	MGA263002	MGA263502	MGA264002	MGA264502	MGA265002	MGA266002	MGA267002	MGA268002
MJ ¹	2	MJA263002	MJA263502	MJA264002	MJA264502	MJA265002	MJA266002	MJA267002	MJA268002
MG ²	3	MGA36300	MGA36350	MGA36400	MGA36450	MGA36500	MGA36600	MGA36700	MGA36800
MJ ²	3	MJA36300	MJA36350	MJA36400	MJA36450	MJA36500	MJA36600	MJA36700	MJA36800

¹ Suffix 2 is for AC phasing (standard offer), or use 5 for CA phasing (option).

² No suffix is for ABC phasing (standard offer), or use 6 for CBA phasing (option).

Interrupting Ratings

Table 42: Interrupting Ratings

Mounting	Circuit Breaker	Interrupting Ratings						
		UL/CSA/NMX			IEC 60947-2			
					240 Vac		380/415 Vac	
		240 Vac	480 Vac	600 Vac	Icu	Ics	Icu	Ics
Individually-Mounted	MG	65 kA	35 kA	18 kA	50 kA	25 kA	35 kA	20 kA
	MJ	100 kA	65 kA	25 kA	65 kA	35 kA	50 kA	25 kA
I-Line	MG	65 kA	35 kA	18 kA	50 kA	25 kA	35 kA	20 kA
	MJ	100 kA	65 kA	25 kA	65 kA	35 kA	50 kA	25 kA



M-Frame Unit-Mount



M-Frame I-Line

Termination Information

Unit-mount circuit breakers have mechanical lugs standard on both ends. I-Line circuit breakers have lugs standard on the O/OFF end. These lugs accept aluminum or copper wire. See Table 92 on page 115 for more lug options.

Accessories

Accessories are available either factory- or field-installed. They can be installed in accessory compartments behind the circuit breaker accessory cover. See Table 68 on page 101 for available accessories.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 4—PowerPact M-Frame Molded Case Circuit Breakers

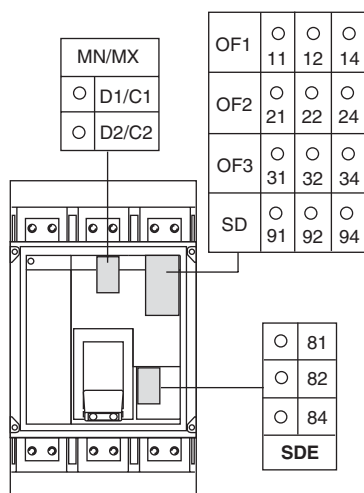
Control Wiring

Control wiring is connected to terminals located under the circuit breaker accessory cover.

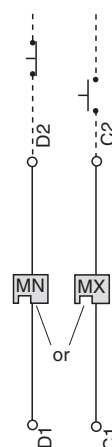
NOTE: All diagrams show circuit breaker in open position

Figure 6: Accessory Control Wiring Diagrams

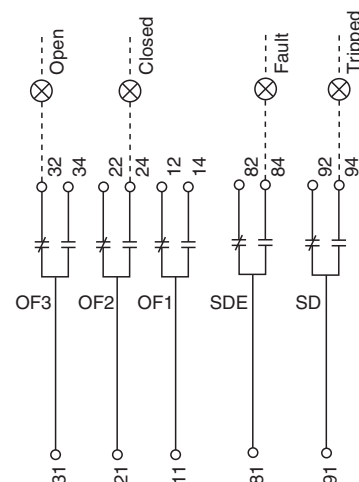
Function	Connector	Description
Auxiliary Contacts	OF	Open/Closed Circuit Breaker Position Contacts
	SD	Bell Alarm
Remote Operation	MN	Undervoltage Trip Device
	MX	Shunt Trip



Remote Operation



Alarm Contacts



Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Performance

Providing unparalleled performance and control, the P-frame circuit breakers features the exclusive Micrologic electronic trip units, which allow for a range of sophisticated applications for metering and monitoring. In addition, trip units can be interchanged in the field to allow for maximum flexibility.

The compact size and small footprint of the P-frame circuit breaker permits high density installations in I-Line panelboards and switchboards. These circuit breakers are available in 100% rated construction for all unit-mount circuit breakers and up to 800 A in I-Line circuit breakers to meet a broad range of commercial and industrial application needs.

- Both standard (80%) and 100% rated construction circuit breakers are available in 1200 A with a sensor size range of 250–1200 A.
- Interrupting ratings (AIR):

Voltage	G	J	K	L
240 Vac	65 kA	100 kA	65 kA	125 kA
480 Vac	35 kA	65 kA	50 kA	100 kA
600 Vac	18 kA	25 kA	50 kA	25 kA

- The P-frame circuit breakers with K interrupting rating are recommended for applications having high inrush and/or non-linear loads such as large motors, transformers, motors with soft starts, etc.
- Compact circuit breaker size allows for small footprint installations using I-Line panelboards and switchboards. Nine inch width provides increased density installation.
- Most field-installable accessories are common to all frame sizes for easier stocking and installation
- Selection of four interchangeable Micrologic trip units available, with Powerlogic power metering and monitoring capabilities available in advanced trip units.
- Field-installable sensor plugs (after January 2007). See Table 80 on page 109.
- Compatible with Powerlogic systems and high amperage power circuit breakers.
- Built-in Modbus protocol provides an open communications platform and eliminates the need to purchase additional, proprietary network solutions.
- Connection options include bus, cable or I-Line for installation flexibility.
- Additional options are available for 5-cycle closing, stored energy mechanisms and drawout-mounting.



P-Frame Unit-Mount



P-Frame I-Line



P-Frame Drawout

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Catalog Numbers

Table 43: UL/IEC Rated, Unit-Mount¹, Manually-Operated, Standard-Rated Electronic Trip Circuit Breakers with Basic Electronic Trip and Micrologic™ Electronic Trip Unit

Trip Unit		Circuit Breaker Catalog Number ²					
		Current Rating (Sensor Rating)					
	Type	250 A ³	400 A	600 A	800 A	1000 A	1200 A
Basic Electronic Trip Unit (Not Interchangeable)	ET1.0I	—	—	PGL36060	PGL36080	PGL36100	PGL36120
	2P ⁴ , 3P	—	—	PJL36060	PJL36080	PJL36100	PJL36120
	Fixed	—	—	PKL36060	PKL36080	PKL36100	PKL36120
	Long-time	—	—	PLL34060	PLL34080	PLL34100	PLL34120
Micrologic Interchangeable Standard Trip Unit	3.0 (LI) 3P, 4P ⁵ (G & K only)	PGL36025U31A	PGL36040U31A	PGL36060U31A	PGL36080U31A	PGL36100U31A	PGL36120U31A
		PJL36025U31A	PJL36040U31A	PJL36060U31A	PJL36080U31A	PJL36100U31A	PJL36120U31A
		PKL36025U31A	PKL36040U31A	PKL36060U31A	PKL36080U31A	PKL36100U31A	PKL36120U31A
		PLL34025U31A	PLL34040U31A	PLL34060U31A	PLL34080U31A	PLL34100U31A	PLL34120U31A
	5.0 (LSI) 3P 4P ⁵ (G & K only)	PGL36025U33A	PGL36040U33A	PGL36060U33A	PGL36080U33A	PGL36100U33A	PGL36120U33A
		PJL36025U33A	PJL36040U33A	PJL36060U33A	PJL36080U33A	PJL36100U33A	PJL36120U33A
		PKL36025U33A	PKL36040U33A	PKL36060U33A	PKL36080U33A	PKL36100U33A	PKL36120U33A
		PLL34025U33A	PLL34040U33A	PLL34060U33A	PLL34080U33A	PLL34100U33A	PLL34120U33A
	3.0A (LI) 3P 4P ⁵ (G & K only)	PGL36025U41A	PGL36040U41A	PGL36060U41A	PGL36080U41A	PGL36100U41A	PGL36120U41A
		PJL36025U41A	PJL36040U41A	PJL36060U41A	PJL36080U41A	PJL36100U41A	PJL36120U41A
		PKL36025U41A	PKL36040U41A	PKL36060U41A	PKL36080U41A	PKL36100U41A	PKL36120U41A
		PLL34025U41A	PLL34040U41A	PLL34060U41A	PLL34080U41A	PLL34100U41A	PLL34120U41A
	5.0A (LSI) 3P 4P ⁵ (G & K only)	PGL36025U43A	PGL36040U43A	PGL36060U43A	PGL36080U43A	PGL36100U43A	PGL36120U43A
		PJL36025U43A	PJL36040U43A	PJL36060U43A	PJL36080U43A	PJL36100U43A	PJL36120U43A
		PKL36025U43A	PKL36040U43A	PKL36060U43A	PKL36080U43A	PKL36100U43A	PKL36120U43A
		PLL34025U43A	PLL34040U43A	PLL34060U43A	PLL34080U43A	PLL34100U43A	PLL34120U43A
	6.0A (LSIG) 3P 4P ⁵ (G & K only)	PGL36025U44A	PGL36040U44A	PGL36060U44A	PGL36080U44A	PGL36100U44A	PGL36120U44A
		PJL36025U44A	PJL36040U44A	PJL36060U44A	PJL36080U44A	PJL36100U44A	PJL36120U44A
		PKL36025U44A	PKL36040U44A	PKL36060U44A	PKL36080U44A	PKL36100U44A	PKL36120U44A
		PLL34025U44A	PLL34040U44A	PLL34060U44A	PLL34080U44A	PLL34100U44A	PLL34120U44A
Micrologic Interchangeable Power Trip Unit with Modbus [®] Communications	5.0P (LSI) 3P 4P ⁵ (G & K only)	PGL36025U63AE1	PGL36040U63AE1	PGL36060U63AE1	PGL36080U63AE1	PGL36100U63AE1	PGL36120U63AE1
		PJL36025U63AE1	PJL36040U63AE1	PJL36060U63AE1	PJL36080U63AE1	PJL36100U63AE1	PJL36120U63AE1
		PKL36025U63AE1	PKL36040U63AE1	PKL36060U63AE1	PKL36080U63AE1	PKL36100U63AE1	PKL36120U63AE1
		PLL34025U63AE1	PLL34040U63AE1	PLL34060U63AE1	PLL34080U63AE1	PLL34100U63AE1	PLL34120U63AE1
	6.0P (LSIG) 3P 4P ⁵ (G & K only)	PGL36025U64AE1	PGL36040U64AE1	PGL36060U64AE1	PGL36080U64AE1	PGL36100U64AE1	PGL36120U64AE1
		PJL36025U64AE1	PJL36040U64AE1	PJL36060U64AE1	PJL36080U64AE1	PJL36100U64AE1	PJL36120U64AE1
		PKL36025U64AE1	PKL36040U64AE1	PKL36060U64AE1	PKL36080U64AE1	PKL36100U64AE1	PKL36120U64AE1
		PLL34025U64AE1	PLL34040U64AE1	PLL34060U64AE1	PLL34080U64AE1	PLL34100U64AE1	PLL34120U64AE1
	5.0H (LSI) 3P 4P ⁵ (G & K only)	PGL36025U73AE1	PGL36040U73AE1	PGL36060U73AE1	PGL36080U73AE1	PGL36100U73AE1	PGL36120U73AE1
		PJL36025U73AE1	PJL36040U73AE1	PJL36060U73AE1	PJL36080U73AE1	PJL36100U73AE1	PJL36120U73AE1
		PKL36025U73AE1	PKL36040U73AE1	PKL36060U73AE1	PKL36080U73AE1	PKL36100U73AE1	PKL36120U73AE1
		PLL34025U73AE1	PLL34040U73AE1	PLL34060U73AE1	PLL34080U73AE1	PLL34100U73AE1	PLL34120U73AE1
	6.0H (LSIG) 3P 4P ⁵ (G & K only)	PGL36025U74AE1	PGL36040U74AE1	PGL36060U74AE1	PGL36080U74AE1	PGL36100U74AE1	PGL36120U74AE1
		PJL36025U74AE1	PJL36040U74AE1	PJL36060U74AE1	PJL36080U74AE1	PJL36100U74AE1	PJL36120U74AE1
		PKL36025U74AE1	PKL36040U74AE1	PKL36060U74AE1	PKL36080U74AE1	PKL36100U74AE1	PKL36120U74AE1
		PLL34025U74AE1	PLL34040U74AE1	PLL34060U74AE1	PLL34080U74AE1	PLL34100U74AE1	PLL34120U74AE1

- Catalog numbers are for circuit breakers with lugs on line and load ends. Consult the *Product Selector* for catalog numbers for circuit breakers with alternate terminations.
- The L interrupting rating at 600 Vac is 25 kA.
- 250 A is not available as a four pole circuit breaker.
- For 2P, replace the leading 3 in the catalog number following the prefix with a 2 (PGL36025 becomes PGL26025).
- For 4P (available in G and K interrupting levels only), replace the leading 3 in the catalog number following the prefix with a 4 (PGL36040U31A becomes PGL46040U31A).
- Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Table 44: UL/IEC Rated, Unit-Mount¹, Manually-Operated, 100%-Rated Electronic Trip Circuit Breakers with Micrologic™ Electronic Trip Units

Trip Unit, Interchangeable 3P, 4P	Circuit Breaker Catalog Number ²					
	Current Rating (Sensor Rating)					
Type	250 A ³	400 A	600 A	800 A	1000 A	1200 A
Micrologic Interchangeable Standard Trip Unit						
3.0 (LI) 3P 4P ⁴ (G & K only)	PGL36025CU31A	PGL36040CU31A	PGL36060CU31A	PGL36080CU31A	PGL36100CU31A	PGL36120CU31A
	PJL36025CU31A	PJL36040CU31A	PJL36060CU31A	PJL36080CU31A	PJL36100CU31A	PJL36120CU31A
	PKL36025CU31A	PKL36040CU31A	PKL36060CU31A	PKL36080CU31A	PKL36100CU31A	PKL36120CU31A
	PLL34025CU31A	PLL34040CU31A	PLL34060CU31A	PLL34080CU31A	PLL34100CU31A	PLL34120CU31A
5.0 (LSI) 3P 4P ⁴ (G & K only)	PGL36025CU33A	PGL36040CU33A	PGL36060CU33A	PGL36080CU33A	PGL36100CU33A	PGL36120CU33A
	PJL36025CU33A	PJL36040CU33A	PJL36060CU33A	PJL36080CU33A	PJL36100CU33A	PJL36120CU33A
	PKL36025CU33A	PKL36040CU33A	PKL36060CU33A	PKL36080CU33A	PKL36100CU33A	PKL36120CU33A
	PLL34025CU33A	PLL34040CU33A	PLL34060CU33A	PLL34080CU33A	PLL34100CU33A	PLL34120CU33A
Micrologic Interchangeable Ammeter Trip Unit⁵						
3.0A (LI) 3P 4P ⁴ (G & K only)	PGL36025CU41A	PGL36040CU41A	PGL36060CU41A	PGL36080CU41A	PGL36100CU41A	PGL36120CU41A
	PJL36025CU41A	PJL36040CU41A	PJL36060CU41A	PJL36080CU41A	PJL36100CU41A	PJL36120CU41A
	PKL36025CU41A	PKL36040CU41A	PKL36060CU41A	PKL36080CU41A	PKL36100CU41A	PKL36120CU41A
	PLL34025CU41A	PLL34040CU41A	PLL34060CU41A	PLL34080CU41A	PLL34100CU41A	PLL34120CU41A
5.0A (LSI) 3P 4P ⁴ (G & K only)	PGL36025CU43A	PGL36040CU43A	PGL36060CU43A	PGL36080CU43A	PGL36100CU43A	PGL36120CU43A
	PJL36025CU43A	PJL36040CU43A	PJL36060CU43A	PJL36080CU43A	PJL36100CU43A	PJL36120CU43A
	PKL36025CU43A	PKL36040CU43A	PKL36060CU43A	PKL36080CU43A	PKL36100CU43A	PKL36120CU43A
	PLL34025CU43A	PLL34040CU43A	PLL34060CU43A	PLL34080CU43A	PLL34100CU43A	PLL34120CU43A
6.0A (LSIG) 3P 4P ⁴ (G & K only)	PGL36025CU44A	PGL36040CU44A	PGL36060CU44A	PGL36080CU44A	PGL36100CU44A	PGL36120CU44A
	PJL36025CU44A	PJL36040CU44A	PJL36060CU44A	PJL36080CU44A	PJL36100CU44A	PJL36120CU44A
	PKL36025CU44A	PKL36040CU44A	PKL36060CU44A	PKL36080CU44A	PKL36100CU44A	PKL36120CU44A
	PLL34025CU44A	PLL34040CU44A	PLL34060CU44A	PLL34080CU44A	PLL34100CU44A	PLL34120CU44A
Micrologic Interchangeable Power Trip Unit with Modbus® Communications						
5.0P (LSI) 3P 4P ⁴ (G & K only)	PGL36025CU63AE1	PGL36040CU63AE1	PGL36060CU63AE1	PGL36080CU63AE1	PGL36100CU63AE1	PGL36120CU63AE1
	PJL36025CU63AE1	PJL36040CU63AE1	PJL36060CU63AE1	PJL36080CU63AE1	PJL36100CU63AE1	PJL36120CU63AE1
	PKL36025CU63AE1	PKL36040CU63AE1	PKL36060CU63AE1	PKL36080CU63AE1	PKL36100CU63AE1	PKL36120CU63AE1
	PLL34025CU63AE1	PLL34040CU63AE1	PLL34060CU63AE1	PLL34080CU63AE1	PLL34100CU63AE1	PLL34120CU63AE1
6.0P (LSIG) 3P 4P ⁴ (G & K only)	PGL36025CU64AE1	PGL36040CU64AE1	PGL36060CU64AE1	PGL36080CU64AE1	PGL36100CU64AE1	PGL36120CU64AE1
	PJL36025CU64AE1	PJL36040CU64AE1	PJL36060CU64AE1	PJL36080CU64AE1	PJL36100CU64AE1	PJL36120CU64AE1
	PKL36025CU64AE1	PKL36040CU64AE1	PKL36060CU64AE1	PKL36080CU64AE1	PKL36100CU64AE1	PKL36120CU64AE1
	PLL34025CU64AE1	PLL34040CU64AE1	PLL34060CU64AE1	PLL34080CU64AE1	PLL34100CU64AE1	PLL34120CU64AE1
Micrologic Interchangeable Harmonic Trip Unit with Modbus Communications						
5.0H (LSI) 3P 4P ⁴ (G & K only)	PGL36025CU73AE1	PGL36040CU73AE1	PGL36060CU73AE1	PGL36080CU73AE1	PGL36100CU73AE1	PGL36120CU73AE1
	PJL36025CU73AE1	PJL36040CU73AE1	PJL36060CU73AE1	PJL36080CU73AE1	PJL36100CU73AE1	PJL36120CU73AE1
	PKL36025CU73AE1	PKL36040CU73AE1	PKL36060CU73AE1	PKL36080CU73AE1	PKL36100CU73AE1	PKL36120CU73AE1
	PLL34025CU73AE1	PLL34040CU73AE1	PLL34060CU73AE1	PLL34080CU73AE1	PLL34100CU73AE1	PLL34120CU73AE1
6.0H (LSIG) 3P 4P ⁴ (G & K only)	PGL36025CU74AE1	PGL36040CU74AE1	PGL36060CU74AE1	PGL36080CU74AE1	PGL36100CU74AE1	PGL36120CU74AE1
	PJL36025CU74AE1	PJL36040CU74AE1	PJL36060CU74AE1	PJL36080CU74AE1	PJL36100CU74AE1	PJL36120CU74AE1
	PKL36025CU74AE1	PKL36040CU74AE1	PKL36060CU74AE1	PKL36080CU74AE1	PKL36100CU74AE1	PKL36120CU74AE1
	PLL34025CU74AE1	PLL34040CU74AE1	PLL34060CU74AE1	PLL34080CU74AE1	PLL34100CU74AE1	PLL34120CU74AE1

¹ Catalog numbers are for circuit breakers with lugs on line and load ends. Consult the product selector for catalog numbers for circuit breakers with alternate terminations.

² The L interrupting rating at 600 Vac is 25 kA.

³ 250 A is not available as a four pole circuit breaker.

⁴ For 4P (available in G and K interrupting levels only), replace the leading 3 in the catalog number following the prefix with a 4 (PGL36040CU31A becomes PGL46040CU31A).

⁵ Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Table 45: UL/IEC Rated, I-Line, Manually-Operated, Standard-Rated Electronic Trip Circuit Breakers with Basic Electronic Trip and Micrologic™ Electronic Trip Units

Trip Unit		Circuit Breaker Catalog Number ¹					
		Current Rating (Sensor Rating)					
	Type ²	250 A	400 A	600 A	800 A	1000 A	1200 A
Basic Electronic Trip Unit Not Interchangeable	ET1.0I	—	—	PGA36060	PGA36080	PGA36100	PGA36120
	2P ³ , 3P	—	—	PJA36060	PJA36080	PJA36100	PJA36120
	Fixed	—	—	PKA36060	PKA36080	PKA36100	PKA36120
	Long-time	—	—	PLA34060	PLA34080	PLA34100	PLA34120
Micrologic Interchangeable Standard Trip Unit	3.0 (LI) 3P	PGA36025U31A	PGA36040U31A	PGA36060U31A	PGA36080U31A	PGA36100U31A	PGA36120U31A
		PJA36025U31A	PJA36040U31A	PJA36060U31A	PJA36080U31A	PJA36100U31A	PJA36120U31A
		PKA36025U31A	PKA36040U31A	PKA36060U31A	PKA36080U31A	PKA36100U31A	PKA36120U31A
		PLA34025U31A	PLA34040U31A	PLA34060U31A	PLA34080U31A	PLA34100U31A	PLA34120U31A
	5.0 (LSI) 3P	PGA36025U33A	PGA36040U33A	PGA36060U33A	PGA36080U33A	PGA36100U33A	PGA36120U33A
		PJA36025U33A	PJA36040U33A	PJA36060U33A	PJA36080U33A	PJA36100U33A	PJA36120U33A
		PKA36025U33A	PKA36040U33A	PKA36060U33A	PKA36080U33A	PKA36100U33A	PKA36120U33A
		PLA34025U33A	PLA34040U33A	PLA34060U33A	PLA34080U33A	PLA34100U33A	PLA34120U33A
	3.0A (LI) 3P	PGA36025U41A	PGA36040U41A	PGA36060U41A	PGA36080U41A	PGA36100U41A	PGA36120U41A
		PJA36025U41A	PJA36040U41A	PJA36060U41A	PJA36080U41A	PJA36100U41A	PJA36120U41A
		PKA36025U41A	PKA36040U41A	PKA36060U41A	PKA36080U41A	PKA36100U41A	PKA36120U41A
		PLA34025U41A	PLA34040U41A	PLA34060U41A	PLA34080U41A	PLA34100U41A	PLA34120U41A
	5.0A (LSI) 3P	PGA36025U43A	PGA36040U43A	PGA36060U43A	PGA36080U43A	PGA36100U43A	PGA36120U43A
		PJA36025U43A	PJA36040U43A	PJA36060U43A	PJA36080U43A	PJA36100U43A	PJA36120U43A
		PKA36025U43A	PKA36040U43A	PKA36060U43A	PKA36080U43A	PKA36100U43A	PKA36120U43A
		PLA34025U43A	PLA34040U43A	PLA34060U43A	PLA34080U43A	PLA34100U43A	PLA34120U43A
	6.0A (LSIG) 3P	PGA36025U44A	PGA36040U44A	PGA36060U44A	PGA36080U44A	PGA36100U44A	PGA36120U44A
		PJA36025U44A	PJA36040U44A	PJA36060U44A	PJA36080U44A	PJA36100U44A	PJA36120U44A
		PKA36025U44A	PKA36040U44A	PKA36060U44A	PKA36080U44A	PKA36100U44A	PKA36120U44A
		PLA34025U44A	PLA34040U44A	PLA34060U44A	PLA34080U44A	PLA34100U44A	PLA34120U44A
Micrologic Interchangeable Power Trip Unit with Modbus® Communications	5.0P (LSI) 3P	PGA36025U63AE1	PGA36040U63AE1	PGA36060U63AE1	PGA36080U63AE1	PGA36100U63AE1	PGA36120U63AE1
		PJA36025U63AE1	PJA36040U63AE1	PJA36060U63AE1	PJA36080U63AE1	PJA36100U63AE1	PJA36120U63AE1
		PKA36025U63AE1	PKA36040U63AE1	PKA36060U63AE1	PKA36080U63AE1	PKA36100U63AE1	PKA36120U63AE1
		PLA34025U63AE1	PLA34040U63AE1	PLA34060U63AE1	PLA34080U63AE1	PLA34100U63AE1	PLA34120U63AE1
	6.0P (LSIG) 3P	PGA36025U64AE1	PGA36040U64AE1	PGA36060U64AE1	PGA36080U64AE1	PGA36100U64AE1	PGA36120U64AE1
		PJA36025U64AE1	PJA36040U64AE1	PJA36060U64AE1	PJA36080U64AE1	PJA36100U64AE1	PJA36120U64AE1
		PKA36025U64AE1	PKA36040U64AE1	PKA36060U64AE1	PKA36080U64AE1	PKA36100U64AE1	PKA36120U64AE1
		PLA34025U64AE1	PLA34040U64AE1	PLA34060U64AE1	PLA34080U64AE1	PLA34100U64AE1	PLA34120U64AE1
Micrologic Interchangeable Harmonic Trip Unit with Modbus Communications	5.0H (LSI) 3P	PGA36025U73AE1	PGA36040U73AE1	PGA36060U73AE1	PGA36080U73AE1	PGA36100U73AE1	PGA36120U73AE1
		PJA36025U73AE1	PJA36040U73AE1	PJA36060U73AE1	PJA36080U73AE1	PJA36100U73AE1	PJA36120U73AE1
		PKA36025U73AE1	PKA36040U73AE1	PKA36060U73AE1	PKA36080U73AE1	PKA36100U73AE1	PKA36120U73AE1
		PLA34025U73AE1	PLA34040U73AE1	PLA34060U73AE1	PLA34080U73AE1	PLA34100U73AE1	PLA34120U73AE1
	6.0H (LSIG) 3P	PGA36025U74AE1	PGA36040U74AE1	PGA36060U74AE1	PGA36080U74AE1	PGA36100U74AE1	PGA36120U74AE1
		PJA36025U74AE1	PJA36040U74AE1	PJA36060U74AE1	PJA36080U74AE1	PJA36100U74AE1	PJA36120U74AE1
		PKA36025U74AE1	PKA36040U74AE1	PKA36060U74AE1	PKA36080U74AE1	PKA36100U74AE1	PKA36120U74AE1
		PLA34025U74AE1	PLA34040U74AE1	PLA34060U74AE1	PLA34080U74AE1	PLA34100U74AE1	PLA34120U74AE1

¹ The L interrupting rating at 600 Vac is 25 kA.

² For 3P, no suffix is for ABC phasing (standard offer), or use 6 for CBA phasing (option).

³ For 2P, replace the leading 3 in the catalog number following the prefix with a 2 (PGA36025 becomes PGA26025). Add the suffix 2 for AC phasing (standard offer), or use 5 for CA phasing (option).

⁴ Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Table 46: UL/IEC Rated, I-Line, Manually-Operated, 100%-Rated Electronic Trip Circuit Breakers with Micrologic™ Electronic Trip Units

Trip Unit, Interchangeable		Circuit Breaker ¹			
		Current Rating (Sensor Rating)			
	Type ²	250 A	400 A	600 A	800 A
Micrologic Interchangeable Standard Trip Unit	3.0 (LI) 3P	PGA36025CU31A	PGA36040CU31A	PGA36060CU31A	PGA36080CU31A
		PJA36025CU31A	PJA36040CU31A	PJA36060CU31A	PJA36080CU31A
		PKA36025CU31A	PKA36040CU31A	PKA36060CU31A	PKA36080CU31A
		PLA34025CU31A	PLA34040CU31A	PLA34060CU31A	PLA34080CU31A
	5.0 (LSI) 3P	PGA36025CU33A	PGA36040CU33A	PGA36060CU33A	PGA36080CU33A
		PJA36025CU33A	PJA36040CU33A	PJA36060CU33A	PJA36080CU33A
		PKA36025CU33A	PKA36040CU33A	PKA36060CU33A	PKA36080CU33A
		PLA34025CU33A	PLA34040CU33A	PLA34060CU33A	PLA34080CU33A
Micrologic Interchangeable Ammeter Trip Unit ³	3.0A (LI) 3P	PGA36025CU41A	PGA36040CU41A	PGA36060CU41A	PGA36080CU41A
		PJA36025CU41A	PJA36040CU41A	PJA36060CU41A	PJA36080CU41A
		PKA36025CU41A	PKA36040CU41A	PKA36060CU41A	PKA36080CU41A
		PLA34025CU41A	PLA34040CU41A	PLA34060CU41A	PLA34080CU41A
	5.0A (LSI) 3P	PGA36025CU43A	PGA36040CU43A	PGA36060CU43A	PGA36080CU43A
		PJA36025CU43A	PJA36040CU43A	PJA36060CU43A	PJA36080CU43A
		PKA36025CU43A	PKA36040CU43A	PKA36060CU43A	PKA36080CU43A
		PLA34025CU43A	PLA34040CU43A	PLA34060CU43A	PLA34080CU43A
	6.0A (LSIG) 3P	PGA36025CU44A	PGA36040CU44A	PGA36060CU44A	PGA36080CU44A
		PJA36025CU44A	PJA36040CU44A	PJA36060CU44A	PJA36080CU44A
		PKA36025CU44A	PKA36040CU44A	PKA36060CU44A	PKA36080CU44A
		PLA34025CU44A	PLA34040CU44A	PLA34060CU44A	PLA34080CU44A
Micrologic Interchangeable Power Trip Unit with Modbus® Communications	5.0P (LSI) 3P	PGA36025CU63AE1	PGA36040CU63AE1	PGA36060CU63AE1	PGA36080CU63AE1
		PJA36025CU63AE1	PJA36040CU63AE1	PJA36060CU63AE1	PJA36080CU63AE1
		PKA36025CU63AE1	PKA36040CU63AE1	PKA36060CU63AE1	PKA36080CU63AE1
		PLA34025CU63AE1	PLA34040CU63AE1	PLA34060CU63AE1	PLA34080CU63AE1
	6.0P (LSIG) 3P	PGA36025CU64AE1	PGA36040CU64AE1	PGA36060CU64AE1	PGA36080CU64AE1
		PJA36025CU64AE1	PJA36040CU64AE1	PJA36060CU64AE1	PJA36080CU64AE1
		PKA36025CU64AE1	PKA36040CU64AE1	PKA36060CU64AE1	PKA36080CU64AE1
		PLA34025CU64AE1	PLA34040CU64AE1	PLA34060CU64AE1	PLA34080CU64AE1
Micrologic Interchangeable Harmonic Trip Unit with Modbus Communications	5.0H (LSI) 3P	PGA36025CU73AE1	PGA36040CU73AE1	PGA36060CU73AE1	PGA36080CU73AE1
		PJA36025CU73AE1	PJA36040CU73AE1	PJA36060CU73AE1	PJA36080CU73AE1
		PKA36025CU73AE1	PKA36040CU73AE1	PKA36060CU73AE1	PKA36080CU73AE1
		PLA34025CU73AE1	PLA34040CU73AE1	PLA34060CU73AE1	PLA34080CU73AE1
	6.0H (LSIG) 3P	PGA36025CU74AE1	PGA36040CU74AE1	PGA36060CU74AE1	PGA36080CU74AE1
		PJA36025CU74AE1	PJA36040CU74AE1	PJA36060CU74AE1	PJA36080CU74AE1
		PKA36025CU74AE1	PKA36040CU74AE1	PKA36060CU74AE1	PKA36080CU74AE1
		PLA34025CU74AE1	PLA34040CU74AE1	PLA34060CU74AE1	PLA34080CU74AE1

¹ The L interrupting rating at 600 Vac is 25 kA.

² No suffix is for ABC phasing (standard offer), or use 6 for CBA phasing (option).

³ Add E1 suffix for Modbus communications.

Table 47: P-Frame Termination Options

F = No Lugs (Includes terminal nut kit on both ends)
L = Lugs both ends
M = Lugs I/ON end, terminal nut kit O/OFF end
P = Lugs O/OFF end, terminal nut kit I/ON end
D = Drawout
A = I-Line

For factory-installed termination, place termination letter in the third block of the circuit breaker catalog number.

P G L 3 6 0 4 0 U 4 1 A
Termination Letter

Table 48: P-Frame Interrupting Ratings

Voltage	P-Frame Interrupting Rating			
	G	J	K	L
240 Vac	65 kA	100 kA	65 kA	125 kA
480 Vac	35 kA	65 kA	50 kA	100 kA
600 Vac	18 kA	25 kA	50 kA	25 kA

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Continuous Current Rating

All circuit breakers marked as 100% rated can be continuously loaded to 100% of their rating.

Because of additional heat generated when applying circuit breakers at 100% of continuous current rating, the use of specially-designed enclosures and 90°C (194°F) wire is required. The 90°C (194°F) wire must be sized according to the ampacity of the 75°C (167°F) wire column in the NEC. Minimum enclosure size and ventilation specifications are indicated on the circuit breaker and in its instruction bulletin and in Table 5 on page 11.

Circuit breakers with 100% rating can also be used in applications requiring only 80% continuous loading.

Interrupting Ratings

Table 49: Interrupting Ratings

Mounting	Circuit Breaker	Ampere Rating (A)		Interrupting Ratings						
		Basic Electronic Trip Units	Micrologic™ Trip Units	UL/CSA/NMX			IEC 60947-2			
				240 Vac	480 Vac	600 Vac	240 Vac		380/415 Vac	
							Icu	Ics	Icu	Ics
Individually-Mounted	PG	600, 800, 1000, 1200	250, 400, 600, 800, 1000, 1200	65 kA	35 kA	18 kA	50 kA	25 kA	35 kA	20 kA
	PJ			100 kA	65 kA	25 kA	65 kA	35 kA	50 kA	25 kA
	PK			65 kA	50 kA	50 kA	50 kA	25 kA	50 kA	25 kA
	PL			125 kA	100 kA	25 kA ¹	125 kA	65 kA	85 kA	45 kA
I-Line™	PG	600, 800, 1000, 1200	250, 400, 600, 800, 1000, 1200	65 kA	35 kA	18 kA	50 kA	25 kA	35 kA	20 kA
	PJ			100 kA	65 kA	25 kA	65 kA	35 kA	50 kA	25 kA
	PK			65 kA	50 kA	50 kA	50 kA	25 kA	50 kA	25 kA
	PL			125 kA	100 kA	25 kA ¹	125 kA	65 kA	85 kA	45 kA

¹ Non-standard AIR.

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Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Automatic Molded Case Switches¹

Automatic molded case switches are available in individually-mounted and I-Line constructions from 600–1200 A. Automatic switches are similar in construction to electronic trip circuit breakers except that long-time tripping is not present. The switches open instantaneously at a non-adjustable magnetic trip point calibrated to protect only the molded case switch itself. They must be used in conjunction with a circuit breaker or fuse of equivalent rating.

Table 50: Automatic Switch Information

Circuit Breaker	Ampere Rating	Voltage Rating	Catalog Number	Withstand Rating			Trip Point (±10%)
				240 Vac	480 Vac	600 Vac	
PJ 2P ¹ , 3P	600	600 Vac	PJL36000S60	100 kA	65 kA	25 kA	10 kA
	800	600 Vac	PJL36000S80	100 kA	65 kA	25 kA	10 kA
	1000	600 Vac	PJL36000S10	100 kA	65 kA	25 kA	10 kA
	1200	600 Vac	PJL36000S12	100 kA	65 kA	25 kA	10 kA
PK 2P, 3P, 4P ²	600	600 Vac	PKL36000S60	65 kA	50 kA	50 kA	24 kA
	800	600 Vac	PKL36000S80	65 kA	50 kA	50 kA	24 kA
	1000	600 Vac	PKL36000S10	65 kA	50 kA	50 kA	24 kA
	1200	600 Vac	PKL36000S12	65 kA	50 kA	50 kA	24 kA
PL 2P, 3P	600	480 Vac	PLL34000S60	125 kA	100 kA	—	10 kA
	800	480 Vac	PLL34000S80	125 kA	100 kA	—	10 kA
	1000	480 Vac	PLL34000S10	125 kA	100 kA	—	10 kA
	1200	480 Vac	PLL34000S12	125 kA	100 kA	—	10 kA

¹ For 2P, replace the leading 3 in the catalog number following the prefix with a 2 (PJL36000S60 becomes PJL26000S60). Add the suffix 2 for AC phasing (standard offer), or use 5 for CA phasing (option).

² For 4P, replace the leading 3 in the catalog number following the prefix with a 4 (PKL36000S60 becomes PKL46000S60).

¹ Catalog numbers for automatic switches are designated by "000" in positions 7–9 (ampere rating) and S60, S80, S10, or S12 in positions 11–14 (trip system). See Table 10.

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Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Motor Circuit Protectors²

Motor circuit protectors are similar in construction to thermal-magnetic circuit breakers, but have only instantaneous trip functions provided by the ET1.0M trip unit. These motor circuit protectors comply with NEC requirements for providing short-circuit protection when installed as part of a listed combination controller having motor overload protection. Interrupting ratings are determined by testing the motor circuit protector in combination with a contactor and overload relay.

Motor circuit protectors are available in PJ and PL individually-mounted and I-Line™ construction. According to the NEC, the instantaneous trip of the motor circuit protector may be set to a maximum of 8 to 17 times motor Full Load Amps (FLA), but a setting as close as possible to inrush current (without nuisance tripping) results in the best protection. The instantaneous trip pickup level is adjustable within the ranges shown below.

Table 51: Motor Circuit Protector Trip Range

Ampere Rating	Adjustable Trip Range	Catalog Number	
		J-Interrupting—600 Vac	L-Interrupting—480 Vac
600 A	1200–10,000 A	PJL36060M68	PLL34060M68
800 A	1200–10,000 A	PJL36080M68	PLL34080M68
1000 A	1500–10,000 A	PJL36100M69	PLL34100M69
1200 A	1800–10,000 A	PJL36120M70	PLL34120M70

NOTE: Continuous currents larger than the ampere rating can damage the motor circuit protector.

Select motor circuit protectors as follows:

1. Determine motor horsepower (hp) rating from the motor nameplate. The selection table is suitable for motors with locked-rotor indicating code letters per NEC Table 430-7 (b) as follows:

Horsepower	Motor Code Letters
30–150	A–G
150 or More	A–F

For other motors contact the field office.

2. Select a motor circuit protector with an ampere rating recommended for the hp and voltage involved.
3. Select an adjustable trip setting of at least 800% but not to exceed 1300% (1700% for high-efficiency motors) of the motor full load amperes (FLA).
4. The NEC 1300% maximum setting (1700% for high-efficiency motors) may be inadequate for motor circuit protectors to withstand current surges typical of the magnetization current of auto-transformer type reduced voltage starters or open transition wye-delta starters during transfer from “start” to “run,” constant hp multi-speed motors and motors labeled “high efficiency”.
5. Part-winding motors, per NEC 430-3, should have two motor circuit protectors selected from the above at not more than one-half the allowable trip setting for the horsepower rating. The two circuit protectors should operate simultaneously as a disconnecting means per NEC 430-103.

² Catalog numbers for motor circuit protectors are designated by M68, M69, or M70 in positions 11–14 (trip system). See Table 10.

Electrically-Operated Circuit Breakers

Electrically-operated P-frame circuit breakers are available in I-Line and unit-mount construction up to 1200 A and are denoted in the catalog number by an “M_” suffix. These come equipped with a two-step stored energy mechanism and come standard with a motor assembly. These are available factory-installed only.

Motor assemblies provide on and off control from remote locations. The assemblies contain a spring-charging motor (MCH), a shunt trip (MX) and a shunt close (XF) and are available in standard or communicating versions. An SDE overcurrent trip switch is also included for trip indication. When remote indication of the circuit breaker status is required, use of a circuit breaker with an OF auxiliary switch for on-off indication. See Table 75 on page 106 for details.

Table 52: Motors Assembly Voltage Ratings (Vn)

Voltage Type	Voltage Ratings (Vn)
Vac 50/60 Hz	48, 100–130, 220–240, 380–415
Vdc	24–30, 48–60, 110–130, 200–250

Termination Information

Unit-mount circuit breakers and switches have mechanical lugs standard on both ends. I-Line circuit breakers have lugs standard on the O/OFF end. These lugs accept aluminum or copper wire. Manually-operated P-frame circuit breakers are also available in drawout construction. See Table 92 on page 115 for more lug options.

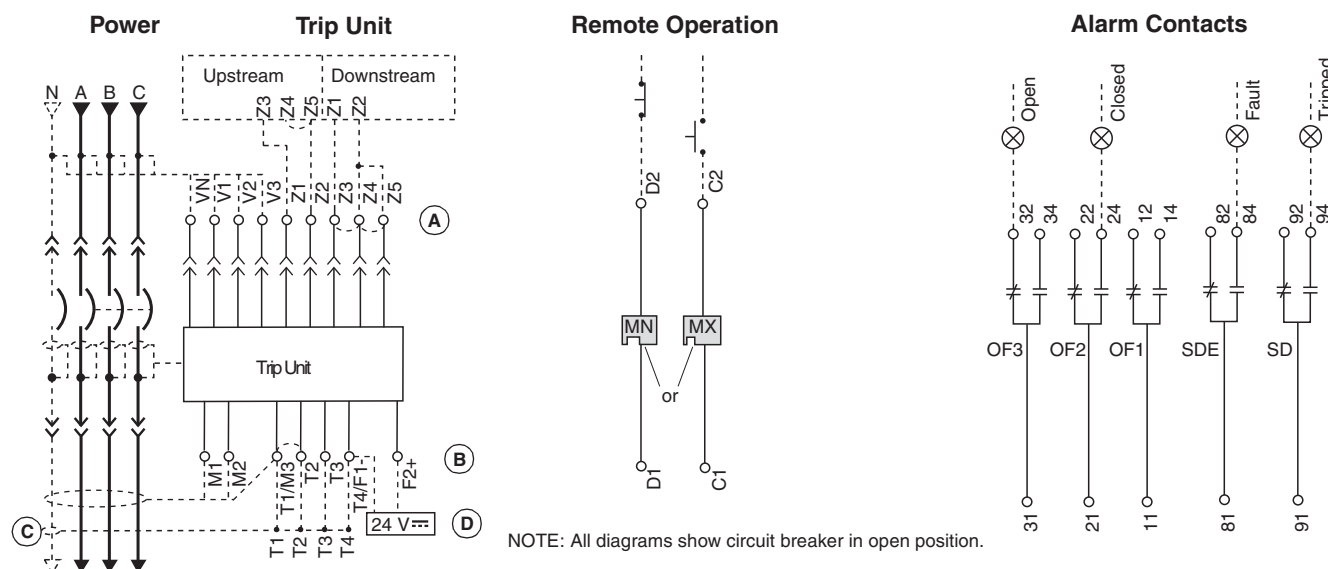
Control Wiring

Control wiring for unit-mount and I-Line construction is connected to terminals located under the circuit breaker accessory cover. Control wiring for drawout construction is connected to terminals located on the cradle.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Figure 7: Accessory Control Wiring Diagrams for Manually-Operated Circuit Breakers

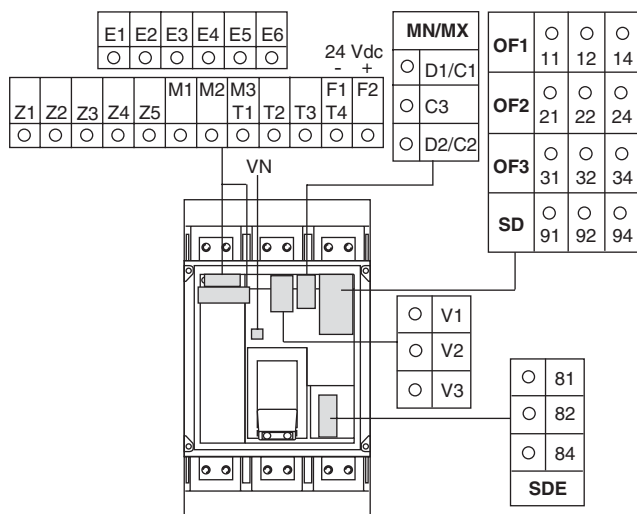


A—Do not remove factory-installed jumpers between Z3, Z4 and Z5 unless ZSI is connected.

B—Do not remove factory-installed jumper between T1 and T2 unless neutral CT is connected. Do not install jumper between T3 and T4.

C—For proper wiring of neutral CT, refer to Instruction Bulletin 48041-082-01 shipped with it.

D—24 Vdc power supply for trip unit must be separate and isolated from 24 Vdc power supply for communication modules.



Connector	Recommended Wire Size
V1, V2, V3, Vn	22–16 AWG (0.3–1.5 mm ²)
E1–E2	22 AWG (0.3 mm ²) MIN shielded pair cable or twisted pair copper wires
T	22 AWG (0.3 mm ²) stranded shielded cable
M	Refer to MDGF instructions
E3–E6, Q1, Q2, Q3	22 AWG (0.3 mm ²) shielded twisted pairs with drain (Belden 8723 or equal) ³
OF, SD, SDE	18–16 AWG (0.8–1.5 mm ²)
MN, MX	18–14 AWG (0.8–2.5 mm ²)
F	Size per aux 24 Vdc power supply
Z1–Z5	22–18 AWG (0.3–0.8 mm ²)

Trip Unit Type				Connector	Description
Basic	A	P	H		
—	•	•	•	Com: E1–E6	Circuit breaker communication module E1 = +24 Vdc E2 = Common E3 = A/Tx- D0 E4 = B/Tx+ D1 E5 = A/Rx- D0 E6 = B/Rx+ D1
—	•	•	•	Z	Zone-selective interlocking (ZSI) Z1 = ZSI OUT signal Z2 = ZSI OUT Z3 = ZSI IN signal Z4 = ZSI IN short-time delay Z5 = ZSI IN ground fault
—	•	•	•	T	External neutral sensor
—	•	•	•	F	24 Vdc external power supply
—	—	•	•	Vn ¹	External neutral voltage takeoff
—	—	•	•	V1, V2, V3	External phase voltage takeoff
—	—	•	•	M6C ² : Q1, Q2, Q3	6 programmable contacts 24 Vdc external power supply required
Function				Connector	Description
Auxiliary Contacts				OF	Open/Closed circuit breaker or switch position contacts
				SD	Bell alarm
				SDE	Electrical fault alarm contact
Remote Operation				MN	Undervoltage trip device
				MX	Shunt trip

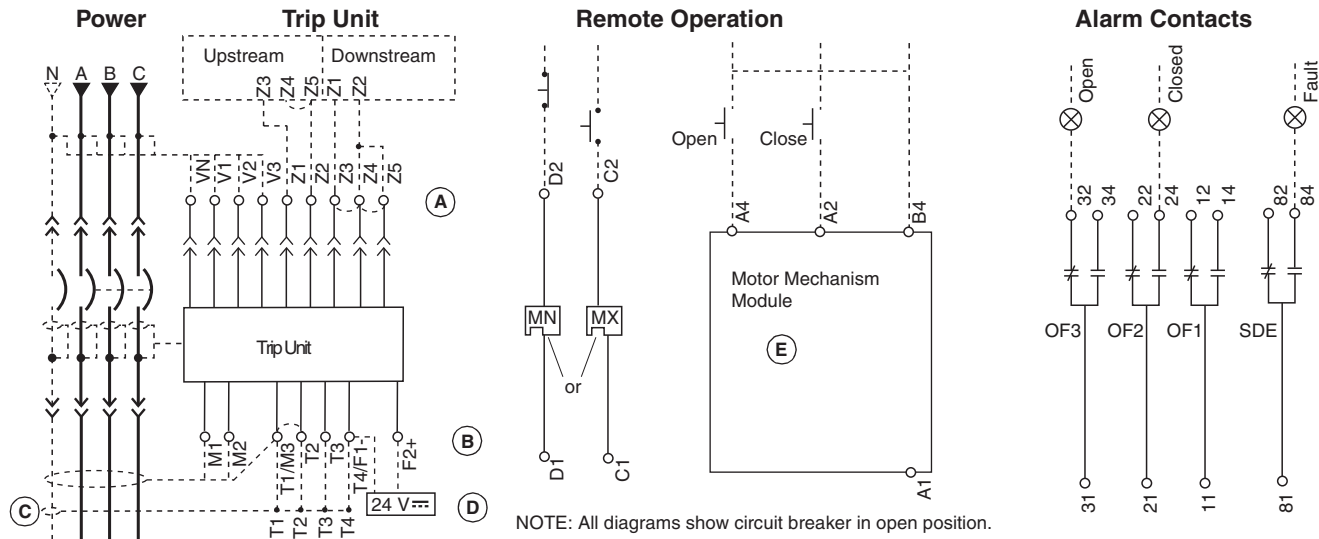
¹ Neutral voltage supplied with flying leads.

² Optional M6C programmable contacts are supplied with flying leads.

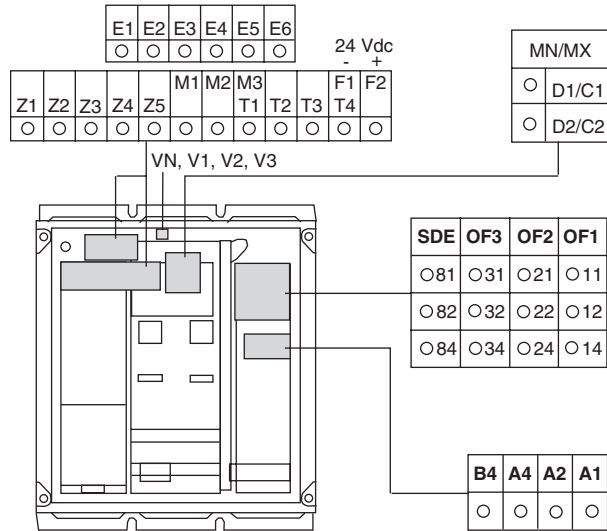
PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 5—PowerPact P-Frame Molded Case Circuit Breakers

Figure 8: Accessory Control Wiring Diagrams for Electrically-operated Circuit Breakers



- A—Do not remove factory-installed jumpers between Z3, Z4 and Z5 unless ZSI is connected.
 B—Do not remove factory-installed jumper between T1 and T2 unless neutral CT is connected. Do not install jumper between T3 and T4.
 C—For proper wiring of neutral CT, refer to Instruction Bulletin 48041-082-01 shipped with it.
 D—24 Vdc power supply for trip unit must be separate and isolated from 24 Vdc power supply for communication modules.
 E—Motor mechanism includes opening and closing coils.



Connector	Recommended Wire Size
E1–E2	22 AWG (0.3 mm ²) MIN shielded pair cable or twisted pair copper wires
V1, V2, V3, Vn	22–16 AWG (0.3–1.5 mm ²)
T	22 AWG (0.3 mm ²) stranded shielded cable
E3–E6, Q1, Q2, Q3	22 AWG (0.3 mm ²) shielded twisted pairs with drain (Belden 8723 or equal) ³
M	Refer to MDGF instructions
OF, SD, SDE	18–16 AWG (0.8–1.5 mm ²)
MN, MX	18–14 AWG (0.8–2.5 mm ²)
F	Size per aux 24 Vdc power supply
Z1–Z5	22–18 AWG (0.3–0.8 mm ²)

Trip Unit Type				Connector	Description
Basic	A	P	H		
–	•	•	•	Com: E1–E6	Circuit breaker communication module E1 = +24 Vdc E2 = Common E3 = A/Tx- D0 E4 = B/Tx+ D1 E5 = A/Rx- D0 E6 = B/Rx+ D1
–	•	•	•	Z	Zone-selective interlocking (ZSI) Z1 = ZSI OUT signal Z2 = ZSI OUT Z3 = ZSI IN signal Z4 = ZSI IN short-time delay Z5 = ZSI IN ground fault
–	•	•	•	T	External neutral sensor
–	•	•	•	F	24 Vdc external power supply
–	–	•	•	Vn ¹	External voltage takeoff
–	–	•	•	V1, V2, V3 ¹	External phase voltage takeoff
–	–	•	•	M6C ¹ : Q1, Q2, Q3	6 programmable contacts 24 Vdc external power supply required
Function		Connector		Description	
Auxiliary Contacts		OF		Open/Closed circuit breaker or switch position contacts	
		SDE		Electrical fault alarm contact	
Remote Operation		MN		Undervoltage trip device	
		MX		Shunt trip	
Motor Mech Module		A4		Electrical opening	
		A2		Electrical closing	
		B4, A1		Power supply for control devices and gear motor	

¹ Optional M6C and external voltage takeoff are supplied with flying leads.

Section 6—PowerPact R-Frame Circuit Breakers

Performance

Providing unparalleled performance and control, the R-frame circuit breakers features the exclusive Micrologic electronic trip units, which allow for a range of sophisticated applications for metering and monitoring. In addition, trip units can be interchanged in the field to allow for maximum flexibility.

The compact size and smaller footprint of the R-frame circuit breaker permits higher density installations using I-Line panelboards and switchboards. These circuit breakers are available in 100% rated construction up to 3000 A to meet a broad range of commercial and industrial application needs.

- Both standard and 100% rated construction circuit breakers are available in 3000 A with a sensor size range of 600–3000 A.
- Interrupting ratings (AIR):

Voltage	G	J	K	L
240 Vac	65 kA	100 kA	65 kA	125 kA
480 Vac	35 kA	65 kA	65 kA	100 kA
600 Vac	18 kA	25 kA	65 kA	50 kA

- The K interrupting rating is recommended for applications having high inrush and/or non-linear loads such as large motors, transformers, motors with soft starts, etc.
- Compact circuit breaker size allows for smaller footprint installations using I-Line panelboards and switchboards. Fifteen-inch width provides increased density installation.
- Most field-installable accessories are common to all frame sizes for easier stocking and installation
- Selection of four interchangeable Micrologic trip units available, with Powerlogic power metering and monitoring capabilities available in advanced trip units.
- Compatible with Powerlogic systems and high amperage power circuit breakers.
- Built-in Modbus protocol provides an open communications platform and eliminates the need to purchase additional, proprietary network solutions.
- Connection options include bus, cable or I-Line for installation flexibility.



R-Frame Unit-Mount



R-Frame I-Line

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Catalog Numbers

Table 53: UL/IEC Rated, Unit-Mount, Manually-Operated, Standard-Rated Electronic Trip Circuit Breakers with Basic Electronic Trip and Micrologic™ Electronic Trip Units—600A to 1200A

Trip Unit Type	Circuit Breaker Catalog Number			
	Current Rating (Sensor Rating)			
	600 A	800 A	1000 A	1200 A
Basic Electronic Trip Unit Not interchangeable				
ET1.0I 2P ¹ , 3P Fixed Long-time	RGF36060	RGF36080	RGF36100	RGF36120
	RJF36060	RJF36080	RJF36100	RJF36120
	RKF36060	RKF36080	RKF36100	RKF36120
	RLF36060	RLF36080	RLF36100	RLF36120
Micrologic Interchangeable Standard Trip Unit				
3.0 (LI) 3P, 4P ²	RGF36060U31A	RGF36080U31A	RGF36100U31A	RGF36120U31A
	RJF36060U31A	RJF36080U31A	RJF36100U31A	RJF36120U31A
	RKF36060U31A	RKF36080U31A	RKF36100U31A	RKF36120U31A
	RLF36060U31A	RLF36080U31A	RLF36100U31A	RLF36120U31A
5.0 (LSI) 3P, 4P ²	RGF36060U33A	RGF36080U33A	RGF36100U33A	RGF36120U33A
	RJF36060U33A	RJF36080U33A	RJF36100U33A	RJF36120U33A
	RKF36060U33A	RKF36080U33A	RKF36100U33A	RKF36120U33A
	RLF36060U33A	RLF36080U33A	RLF36100U33A	RLF36120U33A
Micrologic Interchangeable Ammeter Trip Unit³				
3.0A (LI) 3P, 4P ²	RGF36060U41A	RGF36080U41A	RGF36100U41A	RGF36120U41A
	RJF36060U41A	RJF36080U41A	RJF36100U41A	RJF36120U41A
	RKF36060U41A	RKF36080U41A	RKF36100U41A	RKF36120U41A
	RLF36060U41A	RLF36080U41A	RLF36100U41A	RLF36120U41A
5.0A (LSI) 3P, 4P ²	RGF36060U43A	RGF36080U43A	RGF36100U43A	RGF36120U43A
	RJF36060U43A	RJF36080U43A	RJF36100U43A	RJF36120U43A
	RKF36060U43A	RKF36080U43A	RKF36100U43A	RKF36120U43A
	RLF36060U43A	RLF36080U43A	RLF36100U43A	RLF36120U43A
6.0A (LSIG) 3P, 4P ²	RGF36060U44A	RGF36080U44A	RGF36100U44A	RGF36120U44A
	RJF36060U44A	RJF36080U44A	RJF36100U44A	RJF36120U44A
	RKF36060U44A	RKF36080U44A	RKF36100U44A	RKF36120U44A
	RLF36060U44A	RLF36080U44A	RLF36100U44A	RLF36120U44A
Micrologic Interchangeable Power Trip Unit with Modbus® Communications				
5.0P (LSI) 3P, 4P ²	RGF36060U63AE1	RGF36080U63AE1	RGF36100U63AE1	RGF36120U63AE1
	RJF36060U63AE1	RJF36080U63AE1	RJF36100U63AE1	RJF36120U63AE1
	RKF36060U63AE1	RKF36080U63AE1	RKF36100U63AE1	RKF36120U63AE1
	RLF36060U63AE1	RLF36080U63AE1	RLF36100U63AE1	RLF36120U63AE1
6.0P (LSIG) 3P, 4P ²	RGF36060U64AE1	RGF36080U64AE1	RGF36100U64AE1	RGF36120U64AE1
	RJF36060U64AE1	RJF36080U64AE1	RJF36100U64AE1	RJF36120U64AE1
	RKF36060U64AE1	RKF36080U64AE1	RKF36100U64AE1	RKF36120U64AE1
	RLF36060U64AE1	RLF36080U64AE1	RLF36100U64AE1	RLF36120U64AE1
Micrologic Interchangeable Harmonic Trip Unit with Modbus Communications				
5.0H (LSI) 3P, 4P ²	RGF36060U73AE1	RGF36080U73AE1	RGF36100U73AE1	RGF36120U73AE1
	RJF36060U73AE1	RJF36080U73AE1	RJF36100U73AE1	RJF36120U73AE1
	RKF36060U73AE1	RKF36080U73AE1	RKF36100U73AE1	RKF36120U73AE1
	RLF36060U73AE1	RLF36080U73AE1	RLF36100U73AE1	RLF36120U73AE1
6.0H (LSIG) 3P, 4P ²	RGF36060U74AE1	RGF36080U74AE1	RGF36100U74AE1	RGF36120U74AE1
	RJF36060U74AE1	RJF36080U74AE1	RJF36100U74AE1	RJF36120U74AE1
	RKF36060U74AE1	RKF36080U74AE1	RKF36100U74AE1	RKF36120U74AE1
	RLF36060U74AE1	RLF36080U74AE1	RLF36100U74AE1	RLF36120U74AE1

¹ For 2P, replace the leading 3 in the catalog number following the prefix with a 2 (RGF36060 becomes RGF26060.)

² For 4P, replace the leading 3 in the catalog number following the prefix with a 4 (RPF36060U31A becomes RGF46060U31A).

³ Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Table 54: UL/IEC Rated, Unit-Mount, Manually-Operated, Standard-Rated Electronic Trip Circuit Breakers with Basic Electronic Trip and Micrologic™ Electronic Trip Units—1600A to 3000A

Trip Unit Type	Circuit Breaker Catalog Number			
	Current Rating (Sensor Rating)			
	1600 A	2000 A	2500 A	3000 A
Basic Electronic Trip Unit Not interchangeable				
ET1.0I 2P ¹ , 3P Fixed Long-time	RGF36160	RGF36200	RGF36250	—
	RJF36160	RJF36200	RJF36250	—
	RKF36160	RKF36200	RKF36250	—
	RLF36160	RLF36200	RLF36250	—
Micrologic Interchangeable Standard Trip Unit				
3.0 (LI) 3P, 4P ²	RGF36160U31A	RGF36200U31A	RGF36250U31A	RGF36300U31A
	RJF36160U31A	RJF36200U31A	RJF36250U31A	RJF36300U31A
	RKF36160U31A	RKF36200U31A	RKF36250U31A	RKF36300U31A
	RLF36160U31A	RLF36200U31A	RLF36250U31A	RLF36300U31A
5.0 (LSI) 3P, 4P ²	RGF36160U33A	RGF36200U33A	RGF36250U33A	RGF36300U33A
	RJF36160U33A	RJF36200U33A	RJF36250U33A	RJF36300U33A
	RKF36160U33A	RKF36200U33A	RKF36250U33A	RKF36300U33A
	RLF36160U33A	RLF36200U33A	RLF36250U33A	RLF36300U33A
Micrologic Interchangeable Ammeter Trip Unit³				
3.0A (LI) 3P, 4P ²	RGF36160U41A	RGF36200U41A	RGF36250U41A	RGF36300U41A
	RJF36160U41A	RJF36200U41A	RJF36250U41A	RJF36300U41A
	RKF36160U41A	RKF36200U41A	RKF36250U41A	RKF36300U41A
	RLF36160U41A	RLF36200U41A	RLF36250U41A	RLF36300U41A
5.0A (LSI) 3P, 4P ²	RGF36160U43A	RGF36200U43A	RGF36250U43A	RGF36300U43A
	RJF36160U43A	RJF36200U43A	RJF36250U43A	RJF36300U43A
	RKF36160U43A	RKF36200U43A	RKF36250U43A	RKF36300U43A
	RLF36160U43A	RLF36200U43A	RLF36250U43A	RLF36300U43A
6.0A (LSIG) 3P, 4P ²	RGF36160U44A	RGF36200U44A	RGF36250U44A	RGF36300U44A
	RJF36160U44A	RJF36200U44A	RJF36250U44A	RJF36300U44A
	RKF36160U44A	RKF36200U44A	RKF36250U44A	RKF36300U44A
	RLF36160U44A	RLF36200U44A	RLF36250U44A	RLF36300U44A
Micrologic Interchangeable Power Trip Unit with Modbus® Communications				
5.0P (LSI) 3P, 4P ²	RGF36160U63AE1	RGF36200U63AE1	RGF36250U63AE1	RGF36300U63AE1
	RJF36160U63AE1	RJF36200U63AE1	RJF36250U63AE1	RJF36300U63AE1
	RKF36160U63AE1	RKF36200U63AE1	RKF36250U63AE1	RKF36300U63AE1
	RLF36160U63AE1	RLF36200U63AE1	RLF36250U63AE1	RLF36300U63AE1
6.0P (LSIG) 3P, 4P ²	RGF36160U64AE1	RGF36200U64AE1	RGF36250U64AE1	RGF36300U64AE1
	RJF36160U64AE1	RJF36200U64AE1	RJF36250U64AE1	RJF36300U64AE1
	RKF36160U64AE1	RKF36200U64AE1	RKF36250U64AE1	RKF36300U64AE1
	RLF36160U64AE1	RLF36200U64AE1	RLF36250U64AE1	RLF36200U64AE1
Micrologic Interchangeable Harmonic Trip Unit with Modbus Communications				
5.0H (LSI) 3P, 4P ²	RGF36160U73AE1	RGF36200U73AE1	RGF36250U73AE1	RGF36300U73AE1
	RJF36160U73AE1	RJF36200U73AE1	RJF36250U73AE1	RJF36300U73AE1
	RKF36160U73AE1	RKF36200U73AE1	RKF36250U73AE1	RKF36300U73AE1
	RLF36160U73AE1	RLF36200U73AE1	RLF36250U73AE1	RLF36300U73AE1
6.0H (LSIG) 3P, 4P ²	RGF36160U74AE1	RGF36200U74AE1	RGF36250U74AE1	RGF36300U74AE1
	RJF36160U74AE1	RJF36200U74AE1	RJF36250U74AE1	RJF36300U74AE1
	RKF36160U74AE1	RKF36200U74AE1	RKF36250U74AE1	RKF36300U74AE1
	RLF36160U74AE1	RLF36200U74AE1	RLF36250U74AE1	RLF36300U74AE1

¹ For 2P, replace the leading 3 in the catalog number following the prefix with a 2 (RGF36060 becomes RGF26060.)

² For 4P, replace the leading 3 in the catalog number following the prefix with a 4 (RPF36060U31A becomes RGF46060U31A).

³ Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Table 55: UL/IEC Rated, Unit-Mount, Manually-Operated, 100%-Rated Electronic Trip Circuit Breakers with Micrologic™ Electronic Trip Units—600 A to 1200 A

Trip Unit Type	Circuit Breaker Catalog Number ¹			
	Current Rating (Sensor Rating)			
	600 A	800 A	1000 A	1200 A
Micrologic Standard Trip Unit Interchangeable, 3P, 4P				
3.0 (LI)	RGF36060CU31A	RGF36080CU31A	RGF36100CU31A	RGF36120CU31A
	RJF36060CU31A	RJF36080CU31A	RJF36100CU31A	RJF36120CU31A
	RKF36060CU31A	RKF36080CU31A	RKF36100CU31A	RKF36120CU31A
	RLF36060CU31A	RLF36080CU31A	RLF36100CU31A	RLF36120CU31A
5.0 (LSI)	RGF36060CU33A	RGF36080CU33A	RGF36100CU33A	RGF36120CU33A
	RJF36060CU33A	RJF36080CU33A	RJF36100CU33A	RJF36120CU33A
	RKF36060CU33A	RKF36080CU33A	RKF36100CU33A	RKF36120CU33A
	RLF36060CU33A	RLF36080CU33A	RLF36100CU33A	RLF36120CU33A
Micrologic Ammeter Trip Unit² Interchangeable, 3P, 4P				
3.0A (LI)	RGF36060CU41A	RGF36080CU41A	RGF36100CU41A	RGF36120CU41A
	RJF36060CU41A	RJF36080CU41A	RJF36100CU41A	RJF36120CU41A
	RKF36060CU41A	RKF36080CU41A	RKF36100CU41A	RKF36120CU41A
	RLF36060CU41A	RLF36080CU41A	RLF36100CU41A	RLF36120CU41A
5.0A (LSI)	RGF36060CU43A	RGF36080CU43A	RGF36100CU43A	RGF36120CU43A
	RJF36060CU43A	RJF36080CU43A	RJF36100CU43A	RJF36120CU43A
	RKF36060CU43A	RKF36080CU43A	RKF36100CU43A	RKF36120CU43A
	RLF36060CU43A	RLF36080CU43A	RLF36100CU43A	RLF36120CU43A
6.0A (LSIG)	RGF36060CU44A	RGF36080CU44A	RGF36100CU44A	RGF36120CU44A
	RJF36060CU44A	RJF36080CU44A	RJF36100CU44A	RJF36120CU44A
	RKF36060CU44A	RKF36080CU44A	RKF36100CU44A	RKF36120CU44A
	RLF36060CU44A	RLF36080CU44A	RLF36100CU44A	RLF36120CU44A
Micrologic Power Trip Unit with Modbus® Communications Interchangeable, 3P, 4P				
5.0P (LSI)	RGF36060CU63AE1	RGF36080CU63AE1	RGF36100CU63AE1	RGF36120CU63AE1
	RJF36060CU63AE1	RJF36080CU63AE1	RJF36100CU63AE1	RJF36120CU63AE1
	RKF36060CU63AE1	RKF36080CU63AE1	RKF36100CU63AE1	RKF36120CU63AE1
	RLF36060CU63AE1	RLF36080CU63AE1	RLF36100CU63AE1	RLF36120CU63AE1
6.0P (LSIG)	RGF36060CU64AE1	RGF36080CU64AE1	RGF36100CU64AE1	RGF36120CU64AE1
	RJF36060CU64AE1	RJF36080CU64AE1	RJF36100CU64AE1	RJF36120CU64AE1
	RKF36060CU64AE1	RKF36080CU64AE1	RKF36100CU64AE1	RKF36120CU64AE1
	RLF36060CU64AE1	RLF36080CU64AE1	RLF36100CU64AE1	RLF36120CU64AE1
Micrologic Harmonic Trip Unit with Modbus Communications Interchangeable, 3P, 4P				
5.0H (LSI)	RGF36060CU73AE1	RGF36080CU73AE1	RGF36100CU73AE1	RGF36120CU73AE1
	RJF36060CU73AE1	RJF36080CU73AE1	RJF36100CU73AE1	RJF36120CU73AE1
	RKF36060CU73AE1	RKF36080CU73AE1	RKF36100CU73AE1	RKF36120CU73AE1
	RLF36060CU73AE1	RLF36080CU73AE1	RLF36100CU73AE1	RLF36120CU73AE1
6.0H (LSIG)	RGF36060CU74AE1	RGF36080CU74AE1	RGF36100CU74AE1	RGF36120CU74AE1
	RJF36060CU74AE1	RJF36080CU74AE1	RJF36100CU74AE1	RJF36120CU74AE1
	RKF36060CU74AE1	RKF36080CU74AE1	RKF36100CU74AE1	RKF36120CU74AE1
	RLF36060CU74AE1	RLF36080CU74AE1	RLF36100CU74AE1	RLF36120CU74AE1

¹ For 4P, replace the leading 3 in the catalog number following the prefix with a 4 (RPF36060CU31A becomes RGF46060CU31A).

² Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Table 56: UL/IEC Rated, Unit-Mount, Manually-Operated, 100%-Rated Electronic Trip Circuit Breakers with Micrologic™ Electronic Trip Units—1600 A to 3000 A

Trip Unit Type	Circuit Breaker Catalog Number ¹			
	Current Rating (Sensor Rating)			
	1600 A	2000 A	2500 A	3000 A
Micrologic Standard Trip Unit Interchangeable, 3P, 4P				
3.0 (LI)	RGF36160CU31A	RGF36200CU31A	RGF36250CU31A	RGF36300CU31A
	RJF36160CU31A	RJF36200CU31A	RJF36250CU31A	RJF36300CU31A
	RKF36160CU31A	RKF36200CU31A	RKF36250CU31A	RKF36300CU31A
	RLF36160CU31A	RLF36200CU31A	RLF36250CU31A	RLF36300CU31A
5.0 (LSI)	RGF36160CU33A	RGF36200CU33A	RGF36250CU33A	RGF36300CU33A
	RJF36160CU33A	RJF36200CU33A	RJF36250CU33A	RJF36300CU33A
	RKF36160CU33A	RKF36200CU33A	RKF36250CU33A	RKF36300CU33A
	RLF36160CU33A	RLF36200CU33A	RLF36250CU33A	RLF36300CU33A
Micrologic Ammeter Trip Unit ² Interchangeable, 3P, 4P				
3.0A (LI)	RGF36160CU41A	RGF36200CU41A	RGF36250CU41A	RGF36300CU41A
	RJF36160CU41A	RJF36200CU41A	RJF36250CU41A	RJF36300CU41A
	RKF36160CU41A	RKF36200CU41A	RKF36250CU41A	RKF36300CU41A
	RLF36160CU41A	RLF36200CU41A	RLF36250CU41A	RLF36300CU41A
5.0A (LSI)	RGF36160CU43A	RGF36200CU43A	RGF36250CU43A	RGF36300CU43A
	RJF36160CU43A	RJF36200CU43A	RJF36250CU43A	RJF36300CU43A
	RKF36160CU43A	RKF36200CU43A	RKF36250CU43A	RKF36300CU43A
	RLF36160CU43A	RLF36200CU43A	RLF36250CU43A	RLF36300CU43A
6.0A (LSIG)	RGF36160CU44A	RGF36200CU44A	RGF36250CU44A	RGF36300CU44A
	RJF36160CU44A	RJF36200CU44A	RJF36250CU44A	RJF36300CU44A
	RKF36160CU44A	RKF36200CU44A	RKF36250CU44A	RKF36300CU44A
	RLF36160CU44A	RLF36200CU44A	RLF36250CU44A	RLF36300CU44A
Micrologic Power Trip Unit with Modbus® Communications Interchangeable, 3P, 4P				
5.0P (LSI)	RGF36160CU63AE1	RGF36200CU63AE1	RGF36250CU63AE1	RGF36300CU63AE1
	RJF36160CU63AE1	RJF36200CU63AE1	RJF36250CU63AE1	RJF36300CU63AE1
	RKF36160CU63AE1	RKF36200CU63AE1	RKF36250CU63AE1	RKF36300CU63AE1
	RLF36160CU63AE1	RLF36200CU63AE1	RLF36250CU63AE1	RLF36300CU63AE1
6.0P (LSIG)	RGF36160CU64AE1	RGF36200CU64AE1	RGF36250CU64AE1	RGF36300CU64AE1
	RJF36160CU64AE1	RJF36200CU64AE1	RJF36250CU64AE1	RJF36300CU64AE1
	RKF36160CU64AE1	RKF36200CU64AE1	RKF36250CU64AE1	RKF36300CU64AE1
	RLF36160CU64AE1	RLF36200CU64AE1	RLF36250CU64AE1	RLF36300CU64AE1
Micrologic Harmonic Trip Unit with Modbus Communications Interchangeable, 3P, 4P				
5.0H (LSI)	RGF36160CU73AE1	RGF36200CU73AE1	RGF36250CU73AE1	RGF36300CU73AE1
	RJF36160CU73AE1	RJF36200CU73AE1	RJF36250CU73AE1	RJF36300CU73AE1
	RKF36160CU73AE1	RKF36200CU73AE1	RKF36250CU73AE1	RKF36300CU73AE1
	RLF36160CU73AE1	RLF36200CU73AE1	RLF36250CU73AE1	RLF36300CU73AE1
6.0H (LSIG)	RGF36160CU74AE1	RGF36200CU74AE1	RGF36250CU74AE1	RGF36300CU74AE1
	RJF36160CU74AE1	RJF36200CU74AE1	RJF36250CU74AE1	RJF36300CU74AE1
	RKF36160CU74AE1	RKF36200CU74AE1	RKF36250CU74AE1	RKF36300CU74AE1
	RLF36160CU74AE1	RLF36200CU74AE1	RLF36250CU74AE1	RLF36300CU74AE1

¹ For 4P, replace the leading 3 in the catalog number following the prefix with a 4 (RPF36060CU31A becomes RGF46060CU31A).

² Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Table 57: UL/IEC Rated, I-Line, Manually-Operated, 100%-Rated Electronic Trip Circuit Breakers with Micrologic™ Electronic Trip Units

Trip Unit, Interchangeable		Circuit Breaker Catalog Number	
		Current Rating	
	Type	1000 A	1200 A
Micrologic Standard Trip Unit	3.0 (LI)	RGA36100CU31A	RGA36120CU31A
		RJA36100CU31A	RJA36120CU31A
		RKA36100CU31A	RKA36120CU31A
		RLA36100CU31A	RLA36120CU31A
	5.0 (LSI)	RGA36100CU33A	RGA36120CU33A
		RJA36100CU33A	RJA36120CU33A
		RKA36100CU33A	RKA36120CU33A
		RLA36100CU33A	RLA36120CU33A
Micrologic Ammeter Trip Unit ¹	3.0A (LI)	RGA36100CU41A	RGA36120CU41A
		RJA36100CU41A	RJA36120CU41A
		RKA36100CU41A	RKA36120CU41A
		RLA36100CU41A	RLA36120CU41A
	5.0A (LSI)	RGA36100CU43A	RGA36120CU43A
		RJA36100CU43A	RJA36120CU43A
		RKA36100CU43A	RKA36120CU43A
		RLA36100CU43A	RLA36120CU43A
	6.0A (LSIG)	RGA36100CU44A	RGA36120CU44A
		RJA36100CU44A	RJA36120CU44A
		RKA36100CU44A	RKA36120CU44A
		RLA36100CU44A	RLA36120CU44A
Micrologic Power Trip Unit with Modbus® Communications	5.0P (LSI)	RGA36100CU63AE1	RGA36120CU63AE1
		RJA36100CU63AE1	RJA36120CU63AE1
		RKA36100CU63AE1	RKA36120CU63AE1
		RLA36100CU63AE1	RLA36120CU63AE1
	6.0P (LSIG)	RGA36100CU64AE1	RGA36120CU64AE1
		RJA36100CU64AE1	RJA36120CU64AE1
		RKA36100CU64AE1	RKA36120CU64AE1
		RLA36100CU64AE1	RLA36120CU64AE1
Micrologic Harmonic Trip Unit with Modbus Communications	5.0H (LSI)	RGA36100CU73AE1	RGA36120CU73AE1
		RJA36100CU73AE1	RJA36120CU73AE1
		RKA36100CU73AE1	RKA36120CU73AE1
		RLA36100CU73AE1	RLA36120CU73AE1
	6.0H (LSIG)	RGA36100CU74AE1	RGA36120CU74AE1
		RJA36100CU74AE1	RJA36120CU74AE1
		RKA36100CU74AE1	RKA36120CU74AE1
		RLA36100CU74AE1	RLA36120CU74AE1

¹ Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Interrupting Ratings

Table 58: Interrupting Ratings

Mounting	Circuit Breaker	Ampere Rating (A)		Interrupting Ratings						
		Basic Electronic Trip Units	Micrologic Trip Units	UL/CSA/NMX			IEC 60947-2			
							240 Vac		380/415 Vac	
				240 Vac	480 Vac	600 Vac	Icu	Ics	Icu	Ics
Individually-Mounted	RG	1200, 1600, 2000, 2500	600, 800, 1000, 1200, 1600, 2000, 2500, 3000	65 kA	35 kA	18 kA	50 kA	25 kA	35 kA	20 kA
	RJ			100 kA	65 kA	25 kA	65 kA	35 kA	50 kA	25 kA
	RK			65 kA	65 kA	65 kA	85 kA	65 kA	70 kA	55 kA
	RL			125 kA	100 kA	50 kA	125 kA	65 kA	85 kA	45 kA
I-Line™	RG	NA	1000, 1200	65 kA	35 kA	18 kA	50 kA	25 kA	35 kA	20 kA
	RJ			100 kA	65 kA	25 kA	65 kA	35 kA	50 kA	25 kA
	RK			65 kA	65 kA	65 kA	85 kA	65 kA	70 kA	55 kA
	RL			125 kA	100 kA	50 kA	125 kA	65 kA	85 kA	45 kA

Automatic Molded Case Switches

Automatic molded case switches are available in unit-mount construction from 1200–3000 A. Automatic switches are similar in construction to electronic trip circuit breakers except that long-time protection is not present. The switches open instantaneously at a non-adjustable magnetic trip point calibrated to protect only the molded case switch itself. They must be used in conjunction with a circuit breaker or fuse of equivalent rating.

NOTE: Catalog numbers for automatic switches are designated by “000” in positions 7–9 (ampere rating) and S12, S16, S20, S25, or S30 in positions 11–14 (trip system). See Table 10.

Table 59: Automatic Switch Information

Circuit Breaker	Ampere Rating	Catalog Number ¹	Withstand Rating			Trip Point (±10%)
			240 Vac	480 Vac	600 Vac	
RK 2P ¹ , 3P	1200	RKF36000S12	65 kA	65 kA	65 kA	57 kA
	1600	RKF36000S16	65 kA	65 kA	65 kA	57 kA
	2000	RKF36000S20	65 kA	65 kA	65 kA	57 kA
	2500	RKF36000S25	65 kA	65 kA	65 kA	57 kA
	3000	RKF36000S30	65 kA	65 kA	65 kA	57 kA
RL 2P, 3P	1200	RLF36000S12	125 kA	100 kA	50 kA	39 kA
	1600	RLF36000S16	125 kA	100 kA	50 kA	39 kA
	2000	RLF36000S20	125 kA	100 kA	50 kA	39 kA
	2500	RLF36000S25	125 kA	100 kA	50 kA	39 kA
	3000	RLF36000S30	125 kA	100 kA	50 kA	39 kA

¹ For 2P, replace the leading 3 in the catalog number following the prefix with a 2 (RKP36000S12 becomes RKP26000S12).

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Termination Information

I-Line circuit breakers have lugs standard on the O/OFF end. Unit-mount circuit breakers and switches are equipped for direct bus connection. For certain circuit breaker ratings and to connect cable to R-frame circuit breakers, an RLTB terminal pad kit may be required. Refer to Section 11—Circuit Breaker Dimensional Drawings for terminal pad kit dimensions.

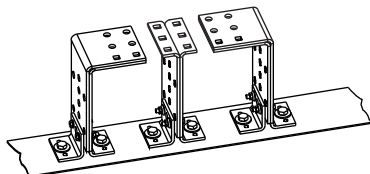


Table 60: RLTB Terminal Pad Kit

Table 61: Terminal Pad Kits for R-Frame Circuit Breakers

R-Frame Circuit Breaker	Terminal Pad Kit	Lugs per Phase	Field-Installable Kits	
	Usage		3P (One End Only)	4P (One End Only)
3000 A, 100% Rated	Required for Cable or Bus	9	RL3TB ¹	RL3TB4
3000 A, Standard (80% Rated)	Required for Cable or Bus	8	RLTB ¹	RLTB4
2500 A, 100% Rated	Required for Cable or Bus	8	RLTB ¹	RLTB4
2500 A, Standard (80% Rated)	Required for Cable, Optional for Bus	8	RLTB	RLTB4
All Other R-Frame Circuit Breakers	Required for Cable, Optional for Bus	8	RLTB	RLTB4

¹ Supplied as standard with the R-frame circuit breaker.

For cable connection to RLTB, use AL2500RK lug. See page 115.

Continuous Current Rating

All circuit breakers marked as 100% rated can be continuously loaded to 100% of their rating. 100%-rated circuit breakers are available in unit-mount construction up to 3000 A and in I-Line construction up to 1200 A.

Because of the additional heat generated when applying circuit breakers at 100% of continuous current rating, the use of specially-designed enclosures and 90°C (194°F) wire is required. The 90°C (194°F) wire must be sized according to the ampacity of the 75°C (167°F) wire column in the NEC. Minimum enclosure size and ventilation specifications are indicated on a label on the circuit breaker, in the circuit breaker instruction bulletin and in Table 5 on page 11.

Circuit breakers with 100% rating can also be used in applications requiring only 80% continuous loading.

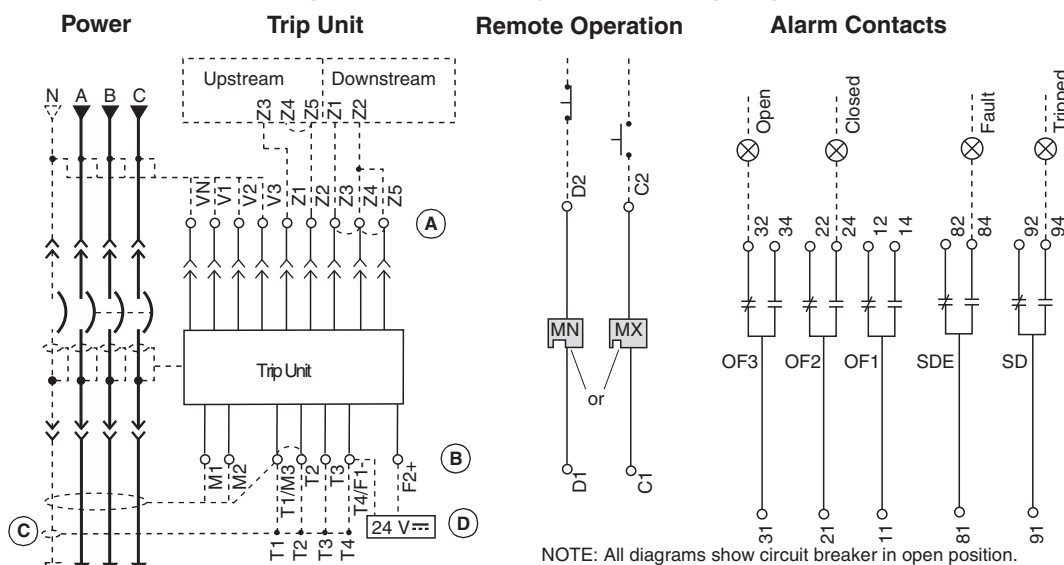
Control Wiring

Control wiring is connected to terminals located under the circuit breaker accessory cover.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 6—PowerPact R-Frame Circuit Breakers

Figure 9: Accessory Control Wiring Diagrams

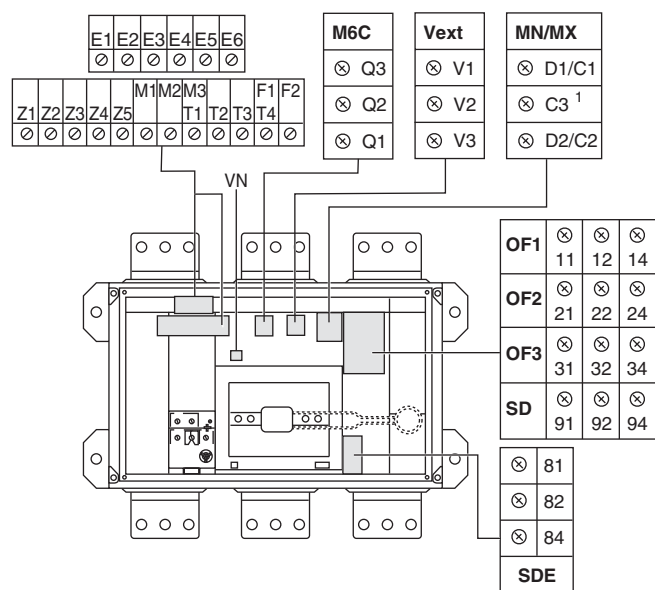


A—Do not remove factory-installed jumpers between Z3, Z4 and Z5 unless ZSI is connected.

B—Do not remove factory-installed jumper between T1 and T2 unless neutral CT is connected. Do not install jumper between T3 and T4.

C—For proper wiring of neutral CT, refer to Instruction Bulletin 48041-082-01 shipped with it.

D—24 Vdc power supply for trip unit must be separate and isolated from 24 Vdc power supply for communication modules.



Connector	Recommended Wire Size
V1, V2, V3, Vn	22–16 AWG (0.3–1.5 mm ²)
E1–E2	22 AWG (0.3 mm ²) MIN shielded pair cable or twisted pair copper wires
T	22 AWG (0.3 mm ²) stranded shielded cable
M	Refer to MDGF instructions
Z1–Z5	22–18 AWG (0.3–0.8 mm ²)
OF, SD, SDE	18–16 AWG (0.8–1.5 mm ²)
MN, MX	18–14 AWG (0.8–2.5 mm ²)
F	Size per aux 24 Vdc power supply
E3–E6, Q1, Q2, Q3	22 AWG (0.3 mm ²) shielded twisted pairs with drain (Belden 8723 or equal) ³

¹ C3 terminal is not used.

² Neutral voltage takeoff supplied as flying lead.

Trip Unit Type				Connector	Description
Basic	A	P	H		
—	•	•	•	Com: E1–E6	Circuit breaker communication module E1 = +24 Vdc E2 = Common E3 = A/Tx- D0 E4 = B/Tx+ D1 E5 = A/Rx- D0 E6 = B/Rx+ D1
—	•	•	•	Z	Zone-selective interlocking Z1 = ZSI OUT signal Z2 = ZSI OUT Z3 = ZSI IN signal Z4 = ZSI IN short-time delay Z5 = ZSI IN ground fault
—	•	•	•	T	External neutral sensor
—	•	•	•	M	Modified differential ground fault (MDGF)
—	•	•	•	F	24 Vdc external power supply
—	—	•	•	Vn ²	External neutral voltage takeoff
—	—	•	•	M6C:	6 programmable contacts
—	—	•	•	Q1, Q2, Q3	24 Vdc external power supply required
—	—	•	•	V1, V2, V3	External phase voltage takeoff
Function		Connector		Description	
Auxiliary Contacts	OF			Open/Closed circuit breaker or switch position contacts	
	SD			Bell alarm	
	SDE			Electrical fault alarm contact	
Remote Operation	MN			Undervoltage trip device	
	MX			Shunt trip	

Section 7—Compact NS630b–NS1600 Circuit Breakers

Performance

The Compact NS630b–NS1600 circuit breakers feature the exclusive Micrologic electronic trip units, which allow for a range of sophisticated applications for metering and monitoring. In addition, trip units can be interchanged in the field to allow for maximum flexibility.

The compact size and small footprint of the NS circuit breakers permit higher density installations. These circuit breakers are available in ratings up to 1600 A to meet a broad range of commercial and industrial application needs.

- Circuit breakers are available in 1600 A construction with a sensor size range of 250–1600 A.
- Interrupting ratings (AIR):

Circuit Breaker	Interrupting Rating	220/240 Vac		380/415 Vac		440 Vac		500/525 Vac		660/690 Vac	
		Icu	Ics	Icu	Ics	Icu	Ics	Icu	Ics	Icu	Ics
Electrically Operated											
NS630b–NS1600	N	50 kA	37 kA	50 kA	37 kA	50 kA	37 kA	40 kA	30 kA	30 kA	22 kA
NS630b–NS1600	H	70 kA	35 kA	70 kA	35 kA	65 kA	32 kA	50 kA	25 kA	42 kA	21 kA
NS630b–NS1000	L	150 kA	150 kA	150 kA	150 kA	130 kA	130 kA	100 kA	100 kA	—	—
Manually Operated											
NS630b–NS1600	N	85 kA	50 kA	50 kA	50 kA	50 kA	50 kA	40 kA	40 kA	30 kA	30 kA
NS630b–NS1600	H	85 kA	52 kA	70 kA	52 kA	65 kA	48 kA	50 kA	37 kA	42 kA	31 kA
NS630b–NS1000	L	150 kA	150 kA	150 kA	150 kA	130 kA	130 kA	100 kA	100 kA	—	—
NS630b–NS800	R	200 kA	200 kA	200 kA	200 kA	200 kA	200 kA	100 kA	100 kA	75 kA	75 kA

- Compact circuit breaker size allows for smaller footprint installations. Nine inch width provides increased density installation.
- Most field-installable accessories are common to all frame sizes for easier stocking and installation
- Selection of four interchangeable Micrologic trip units available, with Powerlogic power metering and monitoring capabilities available in advanced trip units.
- Compatible with Powerlogic systems and high amperage power circuit breakers.
- Built-in Modbus protocol provides an open communications platform and eliminates the need to purchase additional, proprietary network solutions.
- Connection options include bus or cable for installation flexibility.
- Additional options are available for five-cycle closing, stored energy mechanisms and drawout-mounting.



Compact NS630b–NS1600

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

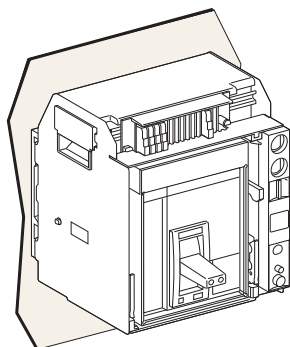
Section 7—Compact NS630b–NS1600 Circuit Breakers

Drawout Configuration

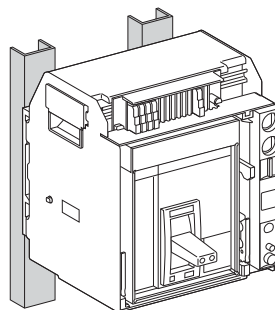
The drawout configuration makes it possible to:

- extract and/or rapidly replace the circuit breaker without having to touch connectors
- allow for the addition of circuits at a later date

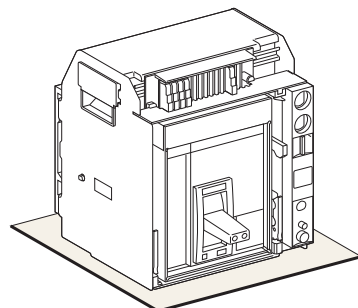
Compact NS630b to NS1600 circuit breakers should be installed vertically only.



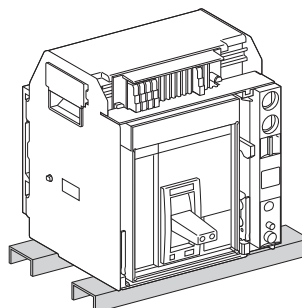
Mounting on a backplate.



Rear mounting on rails.



Device on mounting plate.



Device on rails.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 7—Compact NS630b–NS1600 Circuit Breakers

Catalog Numbers

Table 62: IEC-Rated, Unit-Mount, Manually-Operated, 3P Electronic Trip Circuit Breakers with Micrologic Electronic Trip Units¹

Trip Unit		Circuit Breaker				
		Current Rating				
		630 A	800 A	1000 A	1250 A	1600 A
Micrologic Standard Trip Unit	2.0 (LSO)	NPNLE36063U32R	NPNLE36080U32R	NPNLE36100U32R	NPNLE36125U32R	NPNFE36160U32R
		NPHLE36063U32R	NPHLE36080U32R	NPHLE36100U32R	NPHLE36125U32R	NPHFE36160U32R
		NPLLE34063U32R	NPLLE34080U32R	NPLLE34100U32R	—	—
		NPRLE34063U32R	NPRLE34080U32R	—	—	—
	5.0 (LSI)	NPNLE36063U33R	NPNLE36080U33R	NPNLE36100U33R	NPNLE36125U33R	NPNFE36160U33R
		NPHLE36063U33R	NPHLE36080U33R	NPHLE36100U33R	NPHLE36125U33R	NPHFE36160U33R
		NPLLE34063U33R	NPLLE34080U33R	NPLLE34100U33R	—	—
		NPRLE34063U33R	NPRLE34080U33R	—	—	—
Micrologic Ammeter Trip Unit ²	2.0A (LSO)	NPNLE36063U42R	NPNLE36080U42R	NPNLE36100U42R	NPNLE36125U42R	NPNFE36160U42R
		NPHLE36063U42R	NPHLE36080U42R	NPHLE36100U42R	NPHLE36125U42R	NPHFE36160U42R
		NPLLE34063U42R	NPLLE34080U42R	NPLLE34100U42R	—	—
		NPRLE34063U42R	NPRLE34080U42R	—	—	—
	5.0A (LSI)	NPNLE36063U43R	NPNLE36080U43R	NPNLE36100U43R	NPNLE36125U43R	NPNFE36160U43R
		NPHLE36063U43R	NPHLE36080U43R	NPHLE36100U43R	NPHLE36125U43R	NPHFE36160U43R
		NPLLE34063U43R	NPLLE34080U43R	NPLLE34100U43R	—	—
		NPRLE34063U43R	NPRLE34080U43R	—	—	—
	6.0A (LSIG)	NPNLE36063U44R	NPNLE36080U44R	NPNLE36100U44R	NPNLE36125U44R	NPNFE36160U44R
		NPHLE36063U44R	NPHLE36080U44R	NPHLE36100U44R	NPHLE36125U44R	NPHFE36160U44R
		NPLLE34063U44R	NPLLE34080U44R	NPLLE34100U44R	—	—
		NPRLE34063U44R	NPRLE34080U44R	—	—	—
Micrologic Power Trip Unit with Modbus Communications	5.0P (LSI)	NPNLE36063U63RE1	NPNLE36080U63RE1	NPNLE36100U63RE1	NPNLE36125U63RE1	NPNFE36160U63RE1
		NPHLE36063U63RE1	NPHLE36080U63RE1	NPHLE36100U63RE1	NPHLE36125U63RE1	NPHFE36160U63RE1
		NPLLE34063U63RE1	NPLLE34080U63RE1	NPLLE34100U63RE1	—	—
		NPRLE34063U63RE1	NPRLE34080U63RE1	—	—	—
	6.0P (LSIG)	NPNLE36063U64RE1	NPNLE36080U64RE1	NPNLE36100U64RE1	NPNLE36125U64RE1	NPNFE36160U64RE1
		NPHLE36063U64RE1	NPHLE36080U64RE1	NPHLE36100U64RE1	NPHLE36125U64RE1	NPHFE36160U64RE1
		NPLLE34063U64RE1	NPLLE34080U64RE1	NPLLE34100U64RE1	—	—
		NPRLE34063U64RE1	NPRLE34080U64RE1	—	—	—
Micrologic Harmonic Trip Unit with Modbus Communications	5.0H (LSI)	NPNLE36063U73RE1	NPNLE36080U73RE1	NPNLE36100U73RE1	NPNLE36125U73RE1	NPNFE36160U73RE1
		NPHLE36063U73RE1	NPHLE36080U73RE1	NPHLE36100U73RE1	NPHLE36125U73RE1	NPHFE36160U73RE1
		NPLLE34063U73RE1	NPLLE34080U73RE1	NPLLE34100U73RE1	—	—
		NPRLE34063U73RE1	NPRLE34080U73RE1	—	—	—
	6.0H (LSIG)	NPNLE36063U74RE1	NPNLE36080U74RE1	NPNLE36100U74RE1	NPNLE36125U74RE1	NPNFE36160U74RE1
		NPHLE36063U74RE1	NPHLE36080U74RE1	NPHLE36100U74RE1	NPHLE36125U74RE1	NPHFE36160U74RE1
		NPLLE34063U74RE1	NPLLE34080U74RE1	NPLLE34100U74RE1	—	—
		NPRLE34063U74RE1	NPRLE34080U74RE1	—	—	—

¹ For 4P, replace the 3 in the catalog number following the prefix with a 4 (NPNLE35053U43R becomes NPNLE46063U43R).

² Add E1 suffix for Modbus communications.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 7—Compact NS630b–NS1600 Circuit Breakers

Table 63: Compact Non-Automatic Switch

Compact Switch-Catalog Number ¹			NPNLE36000Z63	NPNLE36000Z80	NPNLE36000Z10	NPNLE36000Z12	NPNFE36000Z16 ²
Amperage			630 A	800 A	1000 A	1200 A	1600 A
Number of Poles			3, 4	3, 4	3, 4	3, 4	3, 4
Control	Manual	Toggle	X	X	X	X	X
		Direct or extended rotary handle	X	X	X	X	X
	Electric		X	X	X	X	X
Connections	Fixed	Front connection	X	X	X	X	X
		Rear connection	X	X	X	X	X
	Drawout (on cradle)	Front connection	X	X	X	X	X
		Rear connection	X	X	X	X	X
Electrical Characteristics as per IEC 60947-3							
Conventional thermal current (A)	I _{th}	60°C	630	800	1000	1250	1600
Rated insulation voltage (V)	U _i		800	800	800	800	800
Rated impulse withstand voltage (V)	U _{imp}		8	8	8	8	8
Rated operation voltage (V)	U _e	AC 50/60 Hz	690	690	690	690	690
		220/240 V 380/415V 440/480 V ³ 500/525 V 660/690 V	630	800	1000	1250	1600
Short-circuit making capacity	I _{cm}	(kA peak)	52	52	52	52	52
Short-time withstand current	I _{cw}	(A 0.5s rms) 20s	19.2 4	19.2 4	19.2 4	19.2 4	19.2 4
Suitability for isolation			X	X	X	X	X
Durability (C-O cycles)	Mechanical		1000	1000	1000	1000	1000
	Electrical	AC	2000	2000	2000	2000	1000
Positive contact indication			X	X	X	X	X
Pollution degree			3	3	3	3	3
Protections							
Add-on earth-leakage protection		Combination with Vigirex relay	X				
Additional indication and control auxiliaries							
Indication contacts			X				
Voltage releases	MX shunt release		X				
	MN undervoltage release		X				
Remote communication by bus							
Device status indication (communicating auxiliary contacts)			X				
Device remote operation (communicating motor operator)			X				
Installation							
Accessories	Terminal extensions and spreaders		X				
	Terminal shields and interphase barriers		X				
	Escutcheons		X				
Dimensions (mm) W x H x D	Fixed	3P	327 x 210 x 147				
		4P	327 x 280 x 147				
Weight (kg)	Fixed	3P	14				
		4P	18				

¹ Installation standards require upstream protection.

² Not available on 1600 A circuit breaker with "L" termination.

³ Suitable for 480 V NEMA.

Interrupting Ratings

See page 92.

Electrically-Operated Circuit Breakers

Electrically-operated NS630b–NS1600 circuit breakers are available in unit-mount construction up to 1600 A and are denoted in the catalog number by an “M_” suffix. These come equipped with a two-step stored energy mechanism and come standard with a motor assembly.

Motor assemblies provide on and off control from remote locations. The assemblies contain a spring-charging motor (MCH), a shunt trip (MX) and a shunt close (XF) and are available in standard or communicating versions. An SDE overcurrent trip switch is also included for trip indication. When remote indication of the circuit breaker status is required, use of a circuit breaker with an OF auxiliary switch (for on-off indication).

Table 64: Motor Assembly Voltage Ratings (Vn)

Voltage Type	Voltage Ratings (Vn)
Vac 50/60 Hz	48, 100–130, 220–240, 380–415
Vdc	24–30, 48–60, 100–130, 200–250

For catalog numbers, see Table 76 on page 106.

Automatic Molded Case Switches

Automatic molded case switches are available in unit-mount constructions from 630–1600 A.

Automatic switches are similar in construction to electronic trip circuit breakers except that long-time protection is not present. The switches open instantaneously at a non-adjustable magnetic trip point calibrated to protect only the molded case switch itself. They must be used in conjunction with a circuit breaker or fuse of equivalent rating.

Termination Information

Unit-mount circuit breakers and switches have mechanical lugs standard on both ends. These lugs accept aluminum or copper wire. Manually operated circuit breakers are also available in drawout construction.

Other terminations are available as accessories for non-standard applications. See Table 92 on page 115 for more lug options.

Accessories

Accessories are available either factory-installed or field-installable. They can be installed in accessory compartments behind the circuit breaker accessory cover. See Table 68 on page 101 for available accessories.

Control Wiring

Control wiring is connected to terminals located under the circuit breaker accessory cover.

Accessory Control Wiring Diagrams for Manually-Operated Circuit Breakers

See Figure 7 on page 81. (Same as PowerPact P-frame circuit breaker.)

Accessory Control Wiring Diagrams for Electrically-Operated Circuit Breakers

See Figure 8 on page 82. (Same as PowerPact P-frame circuit breaker.)

Section 8—Compact NS1600b–NS3200 Circuit Breaker



Compact NS1600b–NS3200

Performance

The Compact NS1600b–NS3200 circuit breakers feature the exclusive Micrologic electronic trip units, which allow for a range of sophisticated applications for metering and monitoring. In addition, trip units can be interchanged in the field to allow for maximum flexibility.

The compact size and smaller footprint of the NS circuit breaker permits higher density installations. These circuit breakers are available in up to 3200 A construction to meet a broad range of commercial and industrial application needs.

- Circuit breakers are available in 3200 A construction with a sensor size range of 600–3200 A.
- Interrupting ratings (AIR):

Interrupting Rating	220/240 Vac		380/415 Vac		440 Vac		500/525 Vac		660/690 Vac	
	Icu	Ics	Icu	Ics	Icu	Ics	Icu	Ics	Icu	Ics
N	85 kA	65 kA	70 kA	52 kA	65 kA	65 kA	65 kA	65 kA	65 kA	65 kA
H	125 kA	94 kA	85 kA	64 kA	85 kA	64 kA	—	—	—	—

- The N interrupting rating is recommended for applications having high inrush and/or non-linear loads such as large motors, transformers, motors with soft starts, etc.
- Compact circuit breaker size allows for smaller footprint installations. Fifteen-inch width provides increased density installation.
- Most field-installable accessories are common to all frame sizes for easier stocking and installation.
- Selection of four interchangeable Micrologic trip units available, with Powerlogic power metering and monitoring capabilities available in advanced trip units.
- Compatible with Powerlogic systems and high amperage power circuit breakers.
- Built-in Modbus protocol provides an open communications platform and eliminates the need to purchase additional, proprietary network solutions.
- Connection options include bus or cable for installation flexibility.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 8—Compact NS1600b–NS3200 Circuit Breaker

Catalog Numbers

Table 65: IEC-Rated, Unit-Mount, Manually-Operated, 3P Electronic Trip Circuit Breakers with Micrologic Electronic Trip Units

Trip Unit		Circuit Breaker			
		Current Rating ¹			
		1600 A	2000 A	2500 A	3200 A
Micrologic Standard Trip Unit	2.0 (LS0)	NRNFE36160U32R	NRNFE36200U32R	NRNFE36250U32R	NRNFE36320U32R
		NRHFE36160U32R	NRHFE36200U32R	NRHFE36250U32R	NRHFE36320U32R
	5.0 (LSI)	NRNFE36160U33R	NRNFE36200U33R	NRNFE36250U33R	NRNFE36320U33R
		NRHFE36160U33R	NRHFE36200U33R	NRHFE36250U33R	NRHFE36320U33R
Micrologic Ammeter Trip Unit ²	2.0A (LS0)	NRNFE36160U42R	NRNFE36200U42R	NRNFE36250U42R	NRNFE36320U42R
		NRHFE36160U42R	NRHFE36200U42R	NRHFE36250U42R	NRHFE36320U42R
	5.0A (LSI)	NRNFE36160U43R	NRNFE36200U43R	NRNFE36250U43R	NRNFE36320U43R
		NRHFE36160U43R	NRHFE36200U43R	NRHFE36250U43R	NRHFE36320U43R
	6.0A (LSIG)	NRNFE36160U44R	NRNFE36200U44R	NRNFE36250U44R	NRNFE36320U44R
		NRHFE36160U44R	NRHFE36200U44R	NRHFE36250U44R	NRHFE36320U44R
Micrologic Power Trip Unit with Modbus Communications	5.0P (LSI)	NRNFE36160U63RE1	NRNFE36200U63RE1	NRNFE36250U63RE1	NRNFE36320U63RE1
		NRHFE36160U63RE1	NRHFE36200U63RE1	NRHFE36250U63RE1	NRHFE36320U63RE1
	6.0P (LSIG)	NRNFE36160U64RE1	NRNFE36200U64RE1	NRNFE36250U64RE1	NRNFE36320U64RE1
		NRHFE36160U64RE1	NRHFE36200U64RE1	NRHFE36250U64RE1	NRHFE36320U64RE1

¹ For 4P, replace the leading 3 in the catalog number following the prefix with a 4 (NRHFE36200U74RE1 becomes NRHFE46200U74RE1).

² Add E1 suffix for Modbus Communications.

Interrupting Ratings

See page 97.

Automatic Molded Case Switches

Automatic molded case switches are available in unit-mount constructions from 1600–3200 A. Automatic switches are similar in construction to electronic trip circuit breakers except that long-time protection is not present. The switches open instantaneously at a non-adjustable magnetic trip point calibrated to protect only the molded case switch itself. They must be used in conjunction with a circuit breaker or fuse of equivalent rating.

Table 66: Automatic Switch Information

Ampere Rating	Icw	Trip Point
1600	32 kA	57 kA
2000	32 kA	57 kA
2500	32 kA	57 kA
3200	32 kA	57 kA

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 8—Compact NS1600b–NS3200 Circuit Breaker

Termination Information

NS1600b–NS3200 circuit breakers and switches are equipped for bus connection only. For certain amperages, an RLTBE terminal pad kit may be required. (Same kit as the PowerPact R-frame circuit breaker.) Refer to Section 11—Circuit Breaker Dimensional Drawings for terminal pad kit dimensions.

Table 67: Terminal Pad Kits for Compact NS1600b–NS3200 Circuit Breakers

Circuit Breaker	Terminal Pad Kit (One End Only)		
	Usage	3P Kit	4P Kit
3200 A	Required	Provided	Provided
All Other Circuit Breakers	Optional	RLTBE	RLTBE4

Accessories

Accessories are available either factory-installed or field-installable. They can be installed in accessory compartments behind the circuit breaker accessory cover. (Same accessories as the R-frame circuit breaker.)

Control Wiring

Control wiring is connected to terminals located under the circuit breaker accessory cover.

Accessory Control Wiring Diagrams

Refer to Wiring Diagrams on page 91. (Same as the R-frame circuit breaker.)

Section 9—Accessories

Accessories

M-frame, P-frame, R-frame and NS630b–NS3200 circuit breakers can be used with a variety of internal and external accessories to increase application versatility and meet the demands of modern electrical distribution systems.

Circuit breaker internal accessories are available either factory installed or field installable. They can be installed in accessory compartments behind the circuit breaker accessory cover.

Factory-Installed Accessories

Factory-installed accessories are internally mounted by the factory. Accessories only available factory installed cannot be removed or repaired in the field. Order factory-installed accessories by adding the correct two-letter suffix to the standard circuit breaker catalog number. To build a catalog number, refer to the product selector or contact a field office.

Field-Installable Accessories

Field-installable accessories can be installed or replaced in the field without affecting the circuit breaker ratings. Field-installable accessories are shipped separately from the circuit breakers. Install and wire field-installable accessories according to the instructions supplied with the circuit breaker and particular accessory. Order field-installable accessories by the catalog number found in the *Schneider Electric Digest*.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 9—Accessories

Table 68: Field/Factory-Installed Accessories

Accessory	M-Frame Manually-Operated Circuit Breakers		P-Frame and NS630b–NS1600				R-Frame and NS1600b–NS3200 Circuit Breakers		Page No.
	Field Installable	Factory Installed	Field Installable	Factory Installed	Field Installable	Factory Installed	Field Installable	Factory Installed	
Shunt Trip (MX)	Y	Y	Y	Y	Y	Y	Y	Y	102
Undervoltage Trip (MN)	Y	Y	Y	Y	Y	Y	Y	Y	103
Adjustable Time Delay Module for Undervoltage Trip	Y	N	Y	N	Y	N	Y	N	104
Auxiliary Switch (OF)	Y	Y	Y	Y	Y	Y	Y	Y	104
Alarm Switch (SD)	Y	Y	Y	Y	N/A	N/A	Y	Y	104
Overcurrent Trip Switch (SDE)	N	N	Y	Y	Y	Y	Y	Y	104
Spring-Charging Motor	N/A	N/A	N/A	N/A	Y	Y	N/A	N/A	106
Trip Unit Replacement Covers	N	N	Y	N	Y	N	Y	N	107
Neutral Current Transformer	N	N/A	Y	N	Y	N	Y	N	108
Ground-Fault Interface Module	N	N/A	Y	Y	Y	Y	Y	Y	108
External Sensor for SGR or MDGF Protection	N	N/A	Y	Y	Y	Y	Y	Y	108
Sensor Plugs	N	N	Y	Y	Y	Y	Y	Y	109
Rating Plugs	N	N	Y	Y	Y	Y	Y	Y	109
M2C and M6C Programmable Contacts	N/A	N/A	Y	Y	Y	Y	Y	Y	110
Circuit Breaker Communication Module	N/A	N/A	Y	Y	Y	Y	Y	Y	110
Restraint Interface Module	N/A	N/A	Y	N	Y	N	Y	N	112
External Power Supply Module	N	N/A	Y	Y	Y	Y	Y	Y	112
External Battery Backup Module	N	N/A	Y	Y	Y	Y	Y	Y	112
Hand-Held Test Kit	N	N/A	Y	Y	Y	Y	Y	Y	113
Full-Function Test Kit	Y	N/A	Y	Y	Y	Y	Y	Y	113
Mechanical Lug	Y	Y	Y	Y	Y	Y	Y	Y	114
Compression Lug	Y	Y	Y	Y	Y	Y	Y	Y	114
Terminal Pad	Y	Y	Y	Y	Y	Y	Y	Y	114
I-Line Jaws	Y	Y	Y	Y	Y	Y	Y	Y	114
Power Distribution Connectors	Y	Y	Y	Y	Y	Y	Y	Y	115
Control Wire Terminations	Y	Y	Y	Y	Y	Y	Y	Y	115
Phase Barriers	Y	N	Y	N	Y	N	Y	N	117
Electric Joint Compound	Y	Y	Y	Y	Y	Y	Y	Y	117
Door-Mounted Operating Mechanism	Y	Y	Y	Y	Y	Y	N/A	N/A	117
Rotary Handle	N/A	N/A	N	Y	N/A	N/A	N/A	N/A	118
Replacement Handles	Y	Y	Y	Y	Y	Y	Y	Y	118
Long Handle Extension	Y	Y	Y	Y	N/A	N/A	N/A	N/A	118
Accessory Cover Door Escutcheons	Y	N	Y	N	Y	N	Y	N	118
Padlock Attachment	Y	Y	Y	Y	Y	Y	Y	Y	118
Keylock	N	Y	N	Y	N	Y	N	Y	118
Keylock Provision	N	Y	N	Y	N	Y	N	Y	118
Sub-Feed Lugs	Y	Y	Y	Y	Y	Y	Y	Y	119

Y = Yes

N = No

N/A = Not Available

Electrical Accessories

Maximum Wire Length

Maximum Wire Length—The inrush currents for these devices are approximately 200 VA. When low supply voltages (12, 24 or 48 V) are used, the maximum allowable wire length is dependent on the voltage and the wire size.

Table 69: Maximum Wire Length¹

Device	Percent of Source Voltage	Source Voltage					
		12 Vdc		24 Vdc		48 Vdc	
Wire Size		14 AWG (2.08 mm ²)	16 AWG (1.31 mm ²)	14 AWG (2.08 mm ²)	16 AWG (1.31 mm ²)	14 AWG (2.08 mm ²)	16 AWG (1.31 mm ²)
UVR (MN)	100%	—	—	159 ft (48.5 m)	100 ft (30.5 m)	765 ft (233.2 m)	472 ft (143.9 m)
	85%	—	—	44 ft (13.4 m)	29 ft (8.8 m)	205 ft (62.5 m)	129 ft (39.3 m)
Shunt Trip (MX) and Shunt Close (XF)	100%	57 ft (17.4 m)	34 ft (10.4 m)	314 ft (95.7 m)	200 ft (61.0 m)	1503 ft (457.8 m)	944 ft (287.7 m)
	85%	27 ft (8.2 m)	17 ft (5.2 m)	205 ft (62.5 m)	126 ft (38.4 m)	957 ft (291.7 m)	601 ft (183.2 m)

¹ The length shown in the table is for each of the two supply wires.

Shunt Trip (MX1) and Shunt Close (XF)



Shunt Trip (MX1) and Shunt Close (XF)

Shunt Trip (MX1): When energized, the shunt trip instantaneously opens the circuit breaker. The shunt trip may be energized continuously or intermittently.

Shunt Close (XF): Remotely closes the circuit breaker if the spring mechanism is charged. The shunt close may be energized continuously or intermittently. This accessory is for electrically-operated P-frame circuit breaker only.

Communication versions of the MX1 and XF are available for direct connection via the circuit breaker communication module (BCM).

Table 70: Shunt Trip and Shunt Close Characteristics

Characteristics		MX1	XF	Min	Max
Voltage Ratings (V _n)	Vac 50/60 Hz	24 Vac		17 Vac	26 Vac
		48 Vac		34 Vac	52 Vac
		120 Vac		60 Vac	132 Vac
		240 Vac		168 Vac	264 Vac
		277 Vac		194 Vac	304 Vac
		380 Vac		266 Vac	418 Vac
		480 Vac		336 Vac	528 Vac
	Vdc	12 Vdc		8 Vdc	13 Vdc
		24 Vdc		17 Vdc	26 Vdc
		48 Vdc		34 Vdc	52 Vdc
		125 Vdc		88 Vdc	137 Vdc
		250 Vdc		175 Vdc	275 Vdc
Operating Threshold		0.7 to 1.1 V _n	0.85 to 1.1 V _n		
Power Consumption (VA or W)	Steady-State/Inrush	4.5/200			
Circuit Breaker Response Time at V _n ¹		50 ms ±10	70 ms ±10 (NW ≤ 4000 A) 80 ms ±10 (NW > 4000 A) 55 ms (NT)		

¹ Shunt trip (MX1) and shunt close (XF) circuits must be energized for minimum of 200 ms.

Undervoltage Trip (MN)

This function opens the circuit breaker via an electrical order.

It is made up of:

- Instantaneous trip
- Fixed undervoltage trip (time delayed) or,
- Adjustable undervoltage trip (time delayed)

As shown in the wiring diagram for the remote tripping function below, the delay unit (installed outside the circuit breaker) may be disabled by an emergency off button to obtain non-delayed opening of the circuit breaker.

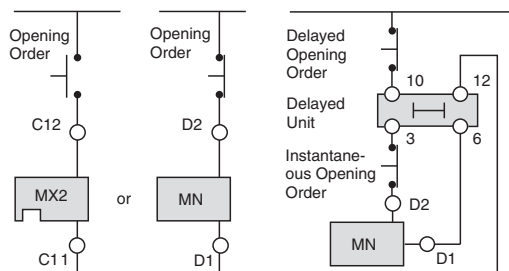
The undervoltage trip (MN) instantaneously opens the circuit breaker when its supply voltage drops to a value between 35% and 70% of its rated voltage.

If the undervoltage trip is not energized, it is impossible to close the circuit breaker, either manually or electrically. An attempt to close the circuit breaker produces no movement of the main contacts. Closing is allowed when the supply voltage of the undervoltage trip reaches 85% of rated voltage.

Table 71: Undervoltage Trip Characteristics

Characteristics	MN	
Voltage Ratings (V_n)	Vac 50/60 Hz	24 Vac
		48 Vac
		120 Vac
		240 Vac
		277 Vac
		380 Vac
	Vdc	480 Vac
		12 Vdc
		24 Vdc
		48 Vdc
Power Consumption (VA or W)	Constant/Inrush	4.5/200
Operating Threshold	Opening	0.35 to 0.70 V_n
	Closing	0.35 V_n
Circuit Breaker Response Time at V_n		90 ms ± 5

Figure 10: Wire Diagram for the Remote Tripping Function



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Time-Delay Module for Undervoltage Trip

To eliminate circuit breaker nuisance tripping during temporary voltage dips (micro-breaks), operation of the undervoltage trip (MN) can be delayed by adding an external time-delay module to the undervoltage trip circuit. Available as adjustable and non-adjustable module.

Table 72: Time-Delay Module Characteristics

Characteristics				Factory-Installed Cat. No. Suffix	Field-Installable Cat. No.
Voltage Ratings of Time-delay Module	Adjustable	Vac 50/60 Hz / Vdc	48-60	—	S33680
			100-130	—	S33681
			200-250	—	S33682
			380-480	—	S33683
	Non-Adjustable	Vac 50/60 Hz / Vdc	100-130	—	S33684
			200-250	—	S33685
Operating Threshold		Opening	0.35 to 0.7 V _N		
		Closing	0.85 V _N		
Power Consumption			4.5 VA/W (holding), 200 VA/W (inrush)		
Time-Delay Settings	Adjustable		0.5, 0.9, 1.5, and 3.0 s		
	Non-Adjustable		0.25 s		

Indication Contacts

Changeover contacts are used to provide remote circuit breaker status information and can be used for indications, electrical locking, relaying, etc. All the auxiliary contacts are also available in “low-level” versions capable of switching very low loads (for the control of PLCs or electronic circuits).

Auxiliary Switch (OF):

- remotely indicates the position of the main circuit breaker contacts.
- can be used to operate indicator lights, relays or other accessories.
- circuit breaker can accommodate up to three 1A/1B auxiliary switches.

Alarm Switch (SD)

- indicates that the circuit breaker has tripped due to:
 - an overload
 - a short circuit
 - an earth-leakage fault
 - operation of a voltage release
 - operation of the “push-to-trip” button
- Returns to de-energized state when the circuit breaker is reset.

Overcurrent Trip Switch (SDE)

- indicates that the circuit breaker has tripped due to:
 - an overload
 - a short circuit
 - an earth-leakage fault
- Returns to de-energized state when the circuit breaker is reset.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 9—Accessories

Table 73: Electrical Characteristics of the OF/SD/SDE Auxiliary Contacts

Contacts		Standard		Low Level ¹	
Rated thermal current (A)		6		5	
Minimum load		100 mA at 24 V		1 mA at 24 V	
Operational current (A)	Voltage	AC	DC	AC	DC
	24 V	6	6	5	5
	48 V	6	2.5	5	2.5
	110 V	6	0.6	5	0.6
	220/240 V	6	—	5	—
	250 V	—	0.3	5	0.3
	380/440 V	6	—	5	—
	480 V	6	—	5	—
	660/690 V	6	—	—	—

¹ SDE is not available in low level for electrically-operated P-frame circuit breakers.

NOTE: If the maximum voltage and current is exceeded, the low-level functions of the switch will be lost but the switch will continue to function as a standard switch.

Table 74: Catalog Numbers

Description	Standard Min Load = 100 mA with 24 V		Low Level Min Load = 1 mA with 24 V	
	Factory-Installed Cat. No. Suffix	Field-Installable Cat. No.	Factory-Installed Cat. No. Suffix	Field-Installable Cat. No.
1 Auxiliary Switch (OF) 1a1b	AA	S29450	AE	S29452
2 Auxiliary Switch (OF) 1a1b	AB	2x S29450	AF	2x S29452
3 Auxiliary Switch (OF) 1a1b	AC	3x S29450	AG	3x S29452
Alarm Switch (SD) 1a1b	BC	S29450	BH	S29452
Overcurrent Trip Switch (SDE) 1a1b	BD	S29450	BJ ¹	S29452
Alarm Switch/Overcurrent Trip Switch (SD/SDE) 2a2b	BE	2x S29450	BK ¹	2x S29452

¹ Not available on an electrically-operated P-frame circuit breaker.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 9—Accessories

Spring-Charging Motors (MCH) for P-Frame Circuit Breakers

The spring-charging motor automatically charges the spring mechanism for closing the circuit breaker and also recharges the spring mechanism when the circuit breaker is in the ON position. Instantaneous reclosing of the circuit breaker is thus possible following circuit breaker opening. The spring-mechanism charging handle is used only as a backup if auxiliary power is absent.

The spring-charging motor is equipped as standard with a limit switch contact (CH) that signals the charged position of the mechanism (springs charged).

Table 75: Spring-Charging Motor Characteristics

Characteristics		MCH
Voltage Ratings (V_n)	Vac 50/60 Hz	48-60, 100-130, 200-250, 240-277, 380-415, 400-440, 480
	Vdc	24-30, 48-60, 100-125, 200-250
Operating Threshold		0.85 to 1.1 V_n
Power Consumption		180 VA
Motor Overcurrent		2–3 x I_n for 0.1 s
Charging Time		4 s maximum on NW, 3 s maximum on NT
Duty Cycle		3 cycles per minute maximum
Endurance		10,000 cycles for NW < 4000 A
		5000 cycles for NW ≥ 4000 A
CH Contact		10 A at 240 V

Table 76: Spring-Charging Motors for Electrically-Operated P-Frame Circuit Breakers

Description	Rated Voltage (+10%/-15%)		Factory Installed Cat. No. Suffix	Field- Replacement Spring Charging Motor Cat. No.	Replacement Coils	
					Factory Installed Cat. No. Suffix	Opening/Closing Coil Cat. No.
Standard Motor for Electrically-Operated Circuit Breakers	Vac	48	ML	S47391	SL	S33660
		100-130	MA	S47395	SA	S33661
		220-240	MC	S47396	SC	S33662
		380-415	MF	S47398	SH	S33664
	Vdc	24-30	MO	S47390	SK	S33659
		48-60	MV	S47391	SL	S33660
		110/130	MR	S47392	SA	S33661
		200/250	MS	S47393	SC	S33662
Communicating Motor Mechanism for Electrically-Operated Circuit Breakers	Vac	48	NL	S47391	EL	S33034
		100-130	NA	S47395	EA	S33035
		220-240	NC	S47396	EC	S33036
		380-415	NF	S47398	EH	S33038
	Vdc	24-30	NO	S47390	EK	S33033
		48-60	NV	S47391	EL	S33034
		110-130	NR	S47392	EA	S33035
		200-250	NS	S47393	EC	S33036

Micrologic Trip Unit Accessories

Circuit breakers are shipped with trip unit installed, but can have the trip units replaced in the field. Actual trip units and settings required for specific applications must be determined by a qualified consultant or plant engineer. A coordination study is recommended to provide coordination between all circuit breakers in the distribution system.

Table 77: Field-Installable Micrologic Trip Unit

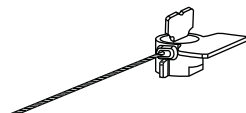
Model	Protection	Additional Features	Field-Installable Cat. No. ¹
2.0 (IEC only)	LSO	None	S132R
3.0 (UL/ANSI only)	LI		S131A
5.0	LSI		S133A
2.0A (IEC only)	LSO	Ammeter	S142R
3.0A (UL/ANSI only)	LI		S141A
5.0A	LSI		S143A
6.0A	LSIG		S144A
5.0P	LSI	Metering, Advanced Protection	S163A ²
6.0P	LSIG		S164A ²
5.0H	LSI	Metering, Advanced Protection & Harmonic Analysis	S173A ²
6.0H	LSIG		S174A ²

¹ The standard rating plug supplied with a trip unit is the "A" rating plug. To specify an alternative adjustable rating plug, please add the letter designation to the end of the catalog number. Please refer to the Digest for a complete listing of adjustable settings available with each plug. (Example: S143B would specify a "B" rating plug instead of the standard "A" plug.) Use suffix "N" if no rating plug is required.

When replacing a Basic trip unit with Type A (Ammeter), P (Power metering) or H (Harmonic analysis) trip unit, order the 12-pin connector kit S33101 for the PowerPact P-frame drawout circuit breakers or kit S33100 for PowerPact P-frame unit-mount and R-frame circuit breakers.

² Requires Circuit Breaker Communications Module.

Lead-Free Trip Unit Sealing Kit



The MICROTUSEAL lead-free trip unit seal was designed as a RoHS-compliant replacement for lead seals. It may be used to seal Micrologic trip units and other devices. It is manufactured as a stainless steel cable and polycarbonate locking mechanism which shows evidence of tampering. The seal is individually numbered for control purposes.

Order kit number **MICROTUSEAL**.

Replacement Covers

Table 78: Replacement Covers

Device	Cat. No.
Micrologic A Trip Unit Cover, clear	S33592
Micrologic P/H Trip Unit Cover, opaque gray	S47067

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 9—Accessories



Neutral Current Transformer (CT)

Current transformers are available for applications requiring ground-fault protection on three-phase, four-wire systems or for neutral protection and metering. Neutral current transformers are not required on non-ground-fault circuit breakers, or on three-phase, three-wire systems. The rating of the external neutral current transformer must be compatible with the rating of the circuit breaker.

Table 79: Neutral Current Transformer Catalog Numbers

Circuit Breaker	Sensor	Cat. No.
P-Frame	250	S33575
	400–1600	S33576
R-Frame	250	S48916
	400–1600	S34036
	2000	S48896
	2500	S48182
All	All	NCTWIRING¹
12-pin Trip Unit Connector		S33100

¹ Included with NCT.

NOTE: These neutral current transformers cannot be used for SGR (Source Ground-Return) or MDGF (Modified Differential Ground Fault) applications.

Ground-Fault Interface Module



The ground-fault interface module (P-frame, R-frame and NS630b–NS3200 circuit breakers only) is used to sum the current flow in three-phase, four-wire systems and multiple-sourced systems, using one or more specially-designed external current sensors to measure current flow. The ground-fault interface module is commonly used in two applications:

- For a ground-source return ground-fault sensing (SGR) system
- For a modified differential ground-fault (MDGF) system

More complex systems are possible, for information about these, contact a field sales representative.

Order kit number **S48891**.

External Sensor for SGR or MDGF Protections

For use on 400 A sensor or higher.

In SGR applications, an external sensor is installed around the connection of the transformer neutral point to ground. Its secondary is connected to the Micrologic™ 6.0A, 6.0P or 6.0H trip units.

In MDGF applications, a sensor is installed on each phase and neutral conductor. The sensors for each circuit breaker are connected to an interface module. These, in turn, connect to the Micrologic 6.0A, 6.0P or 6.0H trip units.

Order kit number **S33579**.



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Sensor Plugs



Sensor plugs are used to set the current rating (I_n) of the PowerPact P- and R-frame circuit breakers.

Beginning in January 2007 (date code 07011), the sensor plugs are field-replaceable, down to 50% of the original rating. Mechanical keying in the circuit breaker prevents changing a rating plug to a higher rating than the original factory-installed sensor plug.

Table 80: Sensor Plugs

Circuit Breaker	Original Circuit Breaker Amperage	Sensor Plug Range	Sensor Plug Catalog No.
UL P-Frame	250 A	250 A	S47052
	400 A	400 A	S47053
	600 A	600 A	S48823
	800 A	600–800 A	S33092
	1000 A	600–1000 A	S33093
	1200 A	600–1200 A	S48824
IEC P-Frame	630 A	630 A	S33091
	800 A	600–800 A	S33092
	1000 A	600–1000 A	S33093
	1250 A	600–1250 A	S33094
	1600 A	600–1600 A	S33095
UL R-Frame	600 A	600 A	S48823
	800 A	600–800 A	S33092
	1000 A	600–1000 A	S33093
	1200 A	600–1200 A	S48824
	1600 A	800–1600 A	S33095
	2000 A	1000–2000 A	S33982
	2500 A	1200–2500 A	S33983
	3000 A	1200–3000 A	S48825
IEC R-Frame	1600 A	1600 A	S33095
	2000 A	1600–2000 A	S33982
	2500 A	1600–2500 A	S33983
	3200 A	1600–3200 A	S33984

Rating Plugs

Interchangeable rating plugs are available to limit the long-time threshold setting range for greater versatility.



Table 81: Rating Plug Settings

Rating Plug		Switch Settings $I_r = I_n \times \dots$										Cat. No.
For P-Frame and R-Frame Circuit Breakers	Type A	0.4	0.45	0.5	0.6	0.63	0.7	0.8	0.9	1		S48818
	Type B	0.4	0.44	0.5	0.56	0.63	0.75	0.88	0.95	1		S48819
	Type C	0.42	0.50	0.53	0.58	0.67	0.75	0.83	0.95	1		S48820
	Type D	0.4	0.48	0.64	0.7	0.8	0.9	0.93	0.95	1		S48836
	Type E	0.6	0.7	0.75	0.8	0.85	0.9	0.93	0.95	1		S48837
	Type F	0.84	0.86	0.88	0.9	0.92	0.94	0.96	0.98	1		S48838
	Type G	0.66	0.68	0.7	0.72	0.74	0.76	0.78	0.8	0.82		S48839
	Type H	0.48	0.5	0.52	0.54	0.56	0.58	0.6	0.62	0.64		S48840
	Type R ¹	0.4	0.5	0.6	0.7	0.8	0.9	0.95	0.98	1		S33542
For NS630b–NS3200 Circuit Breakers	Type S	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8		S33543
	Type T	0.8	0.82	0.85	0.88	0.9	0.92	0.95	0.98	1		S33544
	Type P (Off Plug)	No Long-Time Protection.										S33545

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Modbus Circuit Breaker Communication Module (BCM-ULP)

The circuit breaker communication module is independent of the trip unit. Installed on the circuit breaker, behind the trip unit, it receives and transmits information on the communication network. An optical link is used for communication with the Micrologic A, P, and H trip units. Power requirements are 30 mA, 24 Vdc.

NOTE: The power supply for the circuit breaker communication module must be separate and isolated from the power supply for the trip unit.

The following may be connected to this module:

- A set of dedicated switches which read the status of the circuit breaker.
- A set of “actuators” (MX shunt trip or motor mechanism) to control the circuit breaker.

Table 82: Circuit Breaker Communication Module Characteristics

Circuit Breaker Identification	ID Code, Address Size, Rating, Performance Type of Trip Unit Type of Long-Time Rating Plug
Status Indication	On/Off Indication Fault Trip
Controls	Opening/Closing

¹ Up to 10 trips and 10 alarms.

Table 83: Trip Unit Field-Installable Accessories

Description	Factory-Installed Cat. No. Suffix	Field-Installable Kit Cat. No.						
		P-Frame					R-Frame	
		Unit Mount	I-Line™	Motor Operated	Drawout	With Rotary Handle	Unit Mount	I-Line
Circuit Breaker Communication Module (BCM) (Modbus)	E1	S64205		S64207	S64206	S64205		
Two Programmable Contacts Module (M2C)	V	S64273						
Six Programmable Contacts Module (M6C)	W	S64204			S64202	S64204	S64201	
External Voltage Sensing (EVS)	YV	S64203		S64210	S64209	S64210	S64208	
Trip Unit Battery for Trip Indicator Lights	—	S33593						
12-pin Trip Unit Connector for P- and R-Frame Circuit Breakers	—	S33100						

M2C and M6C Programmable Contacts



The M2C and M6C contacts are used with the Micrologic P and H control units, and indicate the type of fault and instantaneous or delayed threshold overruns (i.e: trip unit protection pickup, current/voltage unbalance, under/over voltage, reverse power, phase rotation, under/over frequency, and load shedding). The M2C has two programmable contacts while the M6C has six. They require an external 24 Vdc power supply (100 mA consumption).

NOTE: The M2C and M6C may use the same 24 V power supply as the trip unit. The M2C, M6C and trip unit power supply must be separate and isolated from the power supply used for the BCM/CCM.

M6C contacts are programmed via the control unit using a keypad or via a supervisory station with the COM communication option. They may be programmed:

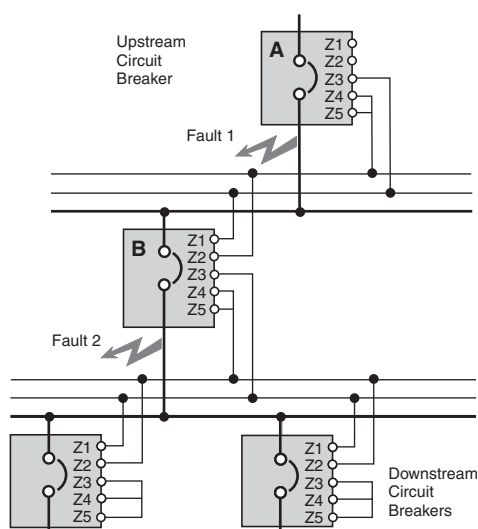
- With instantaneous return to the initial state
- Without return to the initial state
- With return to the initial state following a delay

Table 84: Characteristics for M2C and M6C Programmable Contacts

Minimum Load		100 mA/24 V
Breaking Capacity at a Power Factor (p.f.) of 0.7	240 Vac	5 A
	380 Vac	3 A
	24 Vdc	1.8 A
	48 Vdc	1.5 A
	125 Vdc	0.4 A
	250 Vdc	0.15 A

Zone-Selective Interlocking (ZSI)

Table 85:



ZSI is used to reduce the stress on electrical distribution equipment during fault conditions by reducing the time it takes to clear the fault, while maintaining system coordination between overcurrent protective devices.

During a short-circuit or ground-fault condition on a ZSI system, the device directly ahead of the fault sends a signal upstream via control wiring to restrain upstream circuit breakers from tripping and then trips with no intentional time delay to clear the fault. Upstream devices which receive a restraint signal obey their short-time and/or ground-fault delay settings to maintain coordination in other areas of the system. Upstream devices that do not receive a restraint signal trip with no intentional time delay.

- Fault 1—The upstream circuit breaker (A) will clear the fault with no intentional delay, regardless of its time-delay setting.
- Fault 2—Circuit breaker (B) will inform upstream circuit breaker (A) that it is clearing the fault. This will prevent circuit breaker (A) from tripping instantaneously. Circuit breaker (A) will trip at the end of its time delay setting if the fault is not cleared during this time.

ZSI requires trip settings be coordinated so a downstream circuit breaker will trip before an upstream circuit breaker under overload, short-circuit or ground-fault conditions. Effective coordination requires a system coordination study. See data bulletin 0100DB0501, *Short Circuit Coordination for Low-Voltage Circuit Breakers*.

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Restraint Interface Module (RIM)



The restraint interface module (RIM) is used to allow zone-selective interlocking communications between circuit breakers with old Micrologic, Merlin Gerin™, or Federal Pioneer™ trip units and GC series ground-fault relays. For 120 Vac/24 Vdc systems, use catalog number S48890. For 240 Vac/24 Vdc systems, use catalog number S48895.

Downstream circuit breakers with Micrologic 2.0A, 5.0A, 5.0P, 5.0H, 6.0A, 6.0P, and 6.0H trip units can restrain up to fifteen upstream circuit breakers with Micrologic 5.0A, 5.0P, 5.0H, 6.0A, 6.0P, and 6.0H trip units without requiring a restraint interface module. If the number of upstream circuit breakers exceeds fifteen, then a RIM is required.

Table 86: RIM Requirements¹

Upstream Device (Receives input from RIM)	Downstream Device (Sends output to RIM)	Micrologic trip unit ²	Micrologic Series B trip unit	Square D GC-100 relay	Square D GC-200 relay	Merlin Gerin STR58 trip units	Federal Pioneer USRC and USRCM trip units
Micrologic Trip Unit ²		15	R	R	15	15	R
Square D Micrologic Series B Trip Units		R	26	R	R	R	15
Square D GC-100 Relay		R	R	7	R	R	R
Square D GC-200 Relay		15	R	R	15	15	R
Merlin Gerin STR58 Trip Units		15	R	R	15	15	R
Merlin Gerin STR53 Trip Units		15	R	R	15	15	R
Federal Pioneer USRC and USRCM Trip Units		R	15	R	R	R	15
Square D Add-on Ground Fault Module for Equipment Protection		R	5	R	R	R	R

¹ R = RIM is required.

Number denotes maximum number of upstream circuit breakers that can be restrained without requiring a RIM.

² Includes 2.0A (as a downstream trip unit only), 5.0A, 5.0P, 5.0P, 5.0H, 6.0A, 6.0P, and 6.0H trip units.

External Power Supply Module

When used with the Micrologic A, P, and H trip units, a power supply module makes it possible to:

- Display currents less than 20% of sensor (I_n).
- Maintain display of tripping causes after opening of the circuit breaker.
- Store the value of the interrupted current (P and H trip units only).
- The modules are not UL Listed.

Table 87: External Power Supply Module

Power Supply Input (+10%, -15%)	Output Voltage	Output Power	Cat. No.
24–30 Vdc Input	24 Vdc	5 VA/5 W (Ripple < 5%)	685823
48/60 Vdc Input			685824
125 Vdc Input			685825
110–130 Vac Input			685826
200–240 Vac Input			685827
380–415 Vac Input			685829

External Battery Backup Module

The external battery backup module (Catalog No. 685831) provides up to twelve hours of backup power for the power supply module.

Test Equipment

Hand-Held Test Kit



The hand held test kit may be used to:

- Verify trip unit operation, the mechanical operation of the circuit breaker, and the electrical continuity of the connection between the tripping coil and the trip unit.
- Supply control power to the trip unit for settings via the keypad when the circuit breaker is open (Micrologic P and H trip units).
- Inhibit thermal imaging for primary injection test (for Micrologic types A, P or H).
- Inhibit ground fault for primary injection test (for Micrologic types A, P or H).
- Self-restrain Zone-Selective Interlocking (ZSI) (for Micrologic types A, P or H).

Table 88: Hand-held Test Kit Catalog Numbers

Device	Cat. No.
Hand-held Test Kit	S33594
Seven-pin Test Cable (for Connection Between Test Kit and Trip Unit) ¹	S48907
Two-pin Test Cable (for Connection Between Test Kit and Trip Unit)	S48908

¹ Included in the test kit. Kit for replacement only.

Full-Function Test Kit



The full-function test kit consists of a signal-injection box which can be used alone or with a supporting personal computer (PC). The optional test kit software is compatible with Windows® 95, 98 and Windows NT® operating systems.

The test kit **without** a supporting PC may be used to check:

- The mechanical operation of the circuit breaker
- The electrical continuity of the connection between the tripping coil and the trip unit
- Trip unit operation — for example:
 - Display of settings
 - Operating tests on the electronic component
 - Automatic and manual tests on protection functions (trip curve verification)
 - Tests on the Zone-Selective Interlocking (ZSI) function
 - Inhibition of the ground-fault protection for equipment
 - Inhibition of the thermal imaging
- Save test data into test kit

The test kit **with** a supporting PC may be used to:

- Print test data
- Compare the real tripping curve with the curves available on the PC

Table 89: Full-Function Test Kit Catalog Numbers

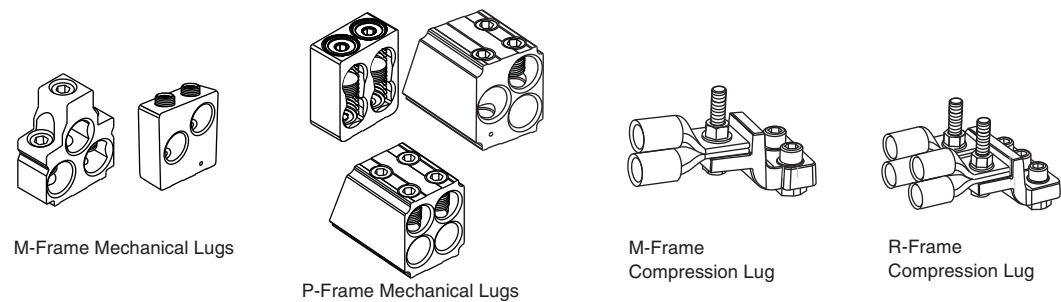
Device	Cat. No.
Full-function Test Kit	S33595
Seven-pin Test Cable (for Connection Between Test Kit and Trip Unit) ¹	S48907
230 Vac Filtered Power Cord ¹	S48856
120 Vac Filtered Power Cord ¹	S48855

¹ Included in the test kit. Kit for replacement only.

Circuit Breaker Terminations

Mechanical, Compression, and Distribution Lugs

The M-frame, P-frame and NS630b–NS1250 circuit breakers have mechanical lugs standard on both ends of the unit-mounted circuit breakers. The M-frame and P-frame I-Line™ circuit breakers have mechanical lugs standard on the O/OFF end only. These lugs are suitable for use with copper or aluminum wire. Rear connectors, compression lugs and distribution lugs are available for special applications.



P-frame and NS630b–NS1600 circuit breakers are also available in drawout construction. See Section 8 for drawout cradle details.

The R-frame and NS1600b–NS3200 circuit breakers have terminal pads only (no lugs) for bus connections on both ends. Terminal pads are required for the use of lugs on R-frame circuit breakers, lugs are not available for NS1600b–NS3200 circuit breakers. See the section on R-frame and NS1600b–NS3200 circuit breakers for information on terminal pad requirements. R-frame I-Line circuit breakers have mechanical lugs standard on the O/OFF end only (AL1200R53K).

Copper mechanical lugs are available for use with copper wire only. These lugs can be factory installed by adding an LC suffix to the circuit breaker catalog number for standard copper lugs and LD suffix for high-amp copper lugs (M-frame, P-frame and NS630b–NS1250 ≤ 800 A circuit breakers only). See the Digest or product selector or contact the field office for more information.

I-Line™ Jaw Configurations

Standard 3P I-Line circuit breakers are supplied with an ABC phase jaw connection. In applications where the jaw configuration must be reversed, specify a CBA jaw configuration by adding the digit 6 to the phasing position of the circuit breaker catalog number.

I-Line 2P circuit breakers are available in AC or CA phasing. Add the digit of the desired phasing to the phasing position of the circuit breaker catalog number.

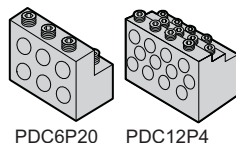
Table 90: I-Line Phase Options

Phase Option Number	Phase Connections
1	AB
2	AC
3	BA
4	BC
5	CA
6	CB
Standard	ABC
6	CBA

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Power Distribution Connectors



Power distribution connectors (PDCs) are available for M-frame, P-frame and NS630b–NS1250 unit-mount circuit breakers as field-installable kits. They can be used for multiple load wire connections on one circuit breaker. Each is UL Listed for copper wire only. Power distribution connectors are for use on the O/OFF end of the circuit breaker only, and the O/OFF end must be connected to the load. PDCs are for use in UL508 applications only.

Control Wire Terminations

Mechanical lug kits are available with provisions for control wire terminations. The control wire is crimped to a standard ring-type wire crimp terminal (not included) and secured to the lug using the #6-32 screw included in the kit. These lugs are UL and CSA Recognized as a circuit breaker component.

These lugs are available factory installed or as field-installable kits. For factory-installed control wire terminations, add the suffix from the table below in the lug option field of the catalog number.

Table 91: Control Wire Termination

Termination Code	Control Wire Location	Control Wire Suffix
L	Both ends	LW
M	ON end only	LU
P	OFF end only	LV

Table 92: Lug Kits

Lug Type	Catalog Number	Used On	Circuit Breaker Type	Lugs Per Kit ¹	Max. Amp. Rating	Conductors/Lug	
						No.	Range
Aluminum Mechanical Lug ²	AL800M23K	M-Frame, P-Frame ≤ 800 A, NS630b–NS800	Unit-Mount, I-Line	3, 4	800	3	3/0 AWG–500 kcmil (95–250 mm ²)
	AL800P6K	M-Frame, P-Frame ≤ 800 A ³ , NS630b–NS800	Unit-Mount, I-Line	3, 4	800	2	3/0 AWG–600 kcmil (95–300 mm ²)
	AL800P7K	M-Frame, P-Frame ≤ 800 A ³ , NS630b–NS800	Unit-Mount, I-Line	3	770	2	3/0 AWG–750 kcmil (95–400 mm ²); Compact AL 750 kcmil (400 mm ²) only
	AL1200P24K ³	M-Frame, P-Frame > 800 A, optional for ≤ 800 A, NS630b–NS1200	Unit-mount, I-Line	1	1200	4	3/0 AWG–500 kcmil (95–250 mm ²)
	AL1200P25K	P-Frame > 800 A, optional for ≤ 800 A, NS630b–NS1200	Unit-Mount	3, 4	1200	4	3/0 AWG–500 kcmil (95–250 mm ²)
	AL1200R53K	R-Frame, NS1600b–NS3200	I-Line	1	1200	4	3/0 AWG–600 kcmil (95–300 mm ²)
	AL1200P6KU	P-Frame > 800 A, optional for ≤ 800 A, NS630b–NS1200	Unit-Mount	3	1200	3	350–600 kcmil (185–300 mm ²)
	AL1200P7KU	P-Frame ≤ 800 A ³ , NS630b–NS800	Unit-Mount	3	1155	3	3/0 AWG–750 kcmil (95–400 mm ²); Compact AL 750 kcmil only
	AL2500RK	R-Frame, NS1600b–NS3200	Unit-Mount	2	2500	1	1/0 AWG–750 kcmil (50–400 mm ²)

Continued on next page

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Table 92: Lug Kits (continued)

Lug Type	Catalog Number	Used On	Circuit Breaker Type	Lugs Per Kit ¹	Max. Amp. Rating	Conductors/Lug	
						No.	Range
Copper Mechanical Lugs ⁴	CU800M23K	M-Frame, P-Frame ≤ 800 A, NS630b–NS800	Unit-Mount, I-Line	3, 4	800	3	3/0 AWG–500 kcmil (95–250 mm ²)
	CU1200P24K	M-Frame, P-Frame > 800 A, optional for ≤ 800 A, NS630b–NS1200	Unit-Mount, I-Line	1	1200	4	3/0 AWG–500 kcmil (95–250 mm ²)
	CU1200P25K	P-Frame > 800 A, optional for ≤ 800 A, NS630b–NS1200	Unit-Mount	3, 4	800	4	3/0 AWG–500 kcmil (95–250 mm ²)
	CU1200R53K	R-Frame, NS1600b–NS3200	I-Line	1	1200	4	3/0 AWG–600 kcmil (95–300 mm ²)
	CU250P1K	M-Frame, P-Frame ≤ 800 A, NS630b–NS800	PJ	3	150 A	1	1–1/0 AWG (50 mm ²)
Aluminum Compression Lugs	YA250P3	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	1	250	1	2/0 AWG–300 kcmil (70–150 mm ²)
	YA400P3	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	2	400	1	2/0 AWG–300 kcmil (70–150 mm ²)
	YA1200R3	R-Frame, NS1600b–NS3200	I-Line	4	1200	1	2/0 AWG–300 kcmil (70–150 mm ²)
	YA300P5	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	1	300	1	4/0 AWG–500 kcmil (95–240 mm ²)
	YA600P5	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	2	600	1	4/0 AWG–500 kcmil (95–240 mm ²)
	YA1200R5	R-Frame, NS1600b–NS3200	I-Line	4	1200	1	4/0 AWG–500 kcmil (95–240 mm ²)
	YA400P7	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	1	400	1	500–750 kcmil (240–400 mm ²)
	YA800P7	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	2	800	1	500–750 kcmil (240–400 mm ²)
	YA1200R7	R-Frame, NS1600b–NS3200	I-Line	4	1200	1	500–750 kcmil (240–400 mm ²)
	YA2500R7	R-Frame, NS1600b–NS3200	Unit-Mount	2	2500	1	500–750 kcmil (240–400 mm ²)
Copper Compression Lugs ⁴	CYA400P5	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	1	400	1	4/0 AWG–500 kcmil (95–240 mm ²)
	CYA600P5	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	2	600	1	4/0 AWG–500 kcmil (95–240 mm ²)
	CYA1200R5	R-Frame, NS1600b–NS3200	I-Line	4	1200	1	4/0 AWG–500 kcmil (95–240 mm ²)
	CYA800R7	M-Frame, P-Frame, NS630b–NS1200	I-Line	2	800	1	500–750 kcmil (240–400 mm ²)
	CYA1200R7	R-Frame, NS1600b–NS3200	I-Line	4	1200	1	500–750 kcmil (240–400 mm ²)
Power Distribution Connectors (Copper Only)	PDC12P4	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	3	400	12	10–4 AWG (6–25 mm ²)
	PDC12P44	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	4	400	12	10–4 AWG (6–25 mm ²)
	PDC6P20	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	3	600	6	12–2/0 AWG (25–70 mm ²)
	PDC6P204	M-Frame, P-Frame, NS630b–NS1200	Unit-Mount, I-Line	4	600	6	12–2/0 AWG (25–70 mm ²)

¹ For 4P circuit breakers, add “4” to kit catalog number (AL800M23K4 instead of AL800M23K).

² For version with tapped hole for control wire add a T before the K to the kit catalog number (AL800M23TK instead of AL800M23K).

³ Does not fit onto I/ON end of unit-mount P-frame circuit breakers.

⁴ Not available with tapped hole for control wire.

External Accessories

Phase Barriers

Phase barriers are available for M-frame, P-frame and NS630b–NS1600 unit-mount circuit breakers with bus connections or with lugs ≤ 800 A. Phase barriers are also available for R-frame and NS1600b–NS3200 unit-mount circuit breakers.

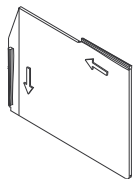


Table 93: Phase Barriers

Used With	Cat. No.	Qty Per Kit
M-Frame and P-Frame	S33646	3
R-Frame	S33998	

Electric Joint Compound

I-Line circuit breakers, I-Line busway plug-on units and I-Line panelboards and switchboards are supplied with factory-applied joint compound on the plug-on connectors. The compound is especially formulated for I-Line connections and contributes to the overall performance of the connection.

If the joint compound is removed, it must be reapplied. A two-ounce container of the compound (Cat. No. PJC7201) is available.

Door-Mounted Operating Mechanisms

Door-mounted operating mechanisms are available for M- and P-frame circuit breakers. The Type L door-mounted variable-depth operating mechanism feature heavy-duty, all-metal constructions. They can be padlocked in the OFF position when the enclosure door is open. Handle assemblies can be locked OFF with up to three padlocks, which also locks the door closed. Complete kits include a handle assembly, operating mechanism, and shaft assembly, and are rated for NEMA Type 1, 3R and 12 enclosures. A door drilling template is supplied for ease of installation.



Table 94: Door-Mounted Operating Mechanisms

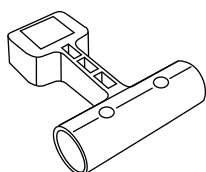
Description	Description	Handle Assembly ¹	Shaft Mounting Depth	Cat. No.
Circuit Breaker Mechanism	Type L	Painted, 8 inch	7.2–11.625 in. (182–295 mm)	LW1
		Painted, 8 inch	7.2–22.25 in. (182–565 mm)	LW4
Handle Assembly ²	Type 3, 4	Painted, 8 inch	7.2–11.625 in. (182–295 mm)	LHP48
	Type 3, 4, 4X	Chrome Plated, 8 inch		LCP48
Replacement Parts	Handle Assembly	Painted, 8 inch	—	LHP8
	Operating Mechanism	—	—	LW7
	Standard Shaft	—	7.2–11.625 in. (182–295 mm)	LS8
	Long Shaft	—	7.2–22.25 in. (182–565 mm)	LS10

¹ Painted handles are painted flat black, with the base ring silver.

² Due to gasketing, NEMA 3 and 4 handle assemblies are NOT trip indicating.

Handle Extension

Handle extensions are available for M- and P-frame circuit breakers. Order catalog number 33195.



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

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Rotary Operating Handles

P-frame and NS630b–NS1600 circuit breakers are available with standard black directly-mounted (IP-40) or door-mounted / telescopic door-mounted (IP-55) rotary handles. The rotary handles are factory-installed and available with two early-break or two early-make contacts.

Table 95: Rotary Operated Handles

Device	Switches	Factory-Installed Cat. No. Suffix
Direct Mounted, Standard Black Handle	—	RD10
	Two Early-Break and Two Early-Make Switches	RD16
Door Mounted, Standard Black Handle	—	RE10
	Two Early-Break and Two Early-Make Switches	RE16
Rotary Handle Replacement Kit	—	S33875

Replacement Handles

Replacement handle assemblies are available for R-frame and NS1600b–NS3200 circuit breakers. Replacement toggle handle extensions, including an optional longer handle extension, are available for M-frame, P-frame, and NS630b–NS1600 circuit breakers.

Table 96: Replacement Handles for M-, P-, and R-Frame Circuit Breakers

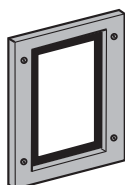
Description	Frame	Field-Installed Cat. No.
Standard	R-Frame	S33997
Standard Short	M-, P-Frame	S46998
Long	M-, P-Frame	S46996

Door Escutcheons

Accessory cover door escutcheons are available for all M-frame, P-frame, R-frame and NS630b–NS3200 circuit breakers. Toggle door escutcheons are also available for fixed-mounted, P-frame, manually-operated circuit breakers.

Table 97: Door Escutcheons for M-, P-, and R-Frame Circuit Breakers

Description	Frame	Field-Installed Cat. No.
Accessory Cover	M-, P-Frame	S33718
	R-Frame	S33929
Toggle Handle Drawout	M-, P-Frame	S33717
	P-Frame	S33857



Locking Accessories

Field-installable handle padlock attachments are available for manually-operated circuit breakers. These attachments will accommodate three padlocks with a shackle diameter of 3/16–5/16 in. (5–8 mm) and will lock the circuit breaker in the O/OFF position only.

A handle padlock attachment is also available for locking manually-operated circuit breakers in either the I/ON or O/OFF position. This attachment will accommodate three padlocks with a shackle diameter of 3/16–5/16 in. (5–8 mm) and is available as factory or field installation.

Kirk® key interlock brackets are also available for locking circuit breakers in the O/OFF position only. Not available for drawout P-frame or NS630b–NS1600.

Circuit breakers with rotary handles come standard with provision for padlocking the handle in the O/OFF position only. Key locks are also available for locking the circuit breaker in the I/ON or O/OFF positions.

A keylock or padlock provision for padlocking the circuit breaker in the O/OFF position is optional on electrically-operated P-frame and NS-630b–NS1600 circuit breakers.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

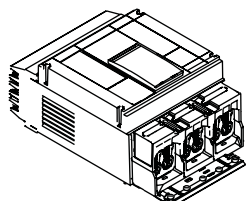
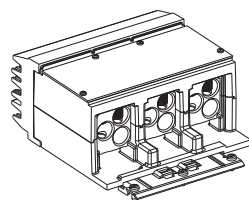
Section 9—Accessories

Table 98: Locks and Interlocking

Device	Description	M- and P-Frame		R-Frame	
		Factory-Installed Cat. No. Suffix	Field-Installed Cat. No.	Factory-Installed Cat. No. Suffix	Field-Installed Cat. No.
Handle Padlocking Device	Removable (Lock Off or On)	—	—	—	—
	Removable (Lock Off Only)	—	S44936	—	S33996
	Fixed (Lock Off or On)	YP	S32631	YP	S32631
	Fixed (Lock Off Only)	YQ	MPRPAF	YQ	MPRPAF
Interlocking (Not UL listed)	Mechanical for Circuit Breakers with Rotary Handles	—	S33890 ¹	—	—
Key Locking	Provision Only, Vertical Mount, 1 key interlock including padlock provision, open position only	Kirk	JE ¹	—	JE ¹
	Provision Only, Vertical Mount, 1 or 2 Locks	Kirk	JA	—	—
	Provision Only, Horizontal Mount	Kirk	JK	—	JK
	1 Lock, M- and P-Frame	Ronis	JB	—	JB
	1 or 2 Locks, R-Frame	Profalux	JD	—	JD
	Provision and 1 Lock, Vertical Mount	Kirk	JG	—	—
	Provision and 1 Lock, Horizontal Mount	Kirk	JL	—	JL
		Ronis	JC	—	JC
		Profalux	JF	—	JF
	Provision and 2 Locks Keyed Alike, Vertical Mount	Kirk	JN	—	—
	Provision and 2 Locks Keyed Alike, Horizontal Mount	Kirk	—	—	JN
	Provision and 2 Locks Keyed Differently, Vertical Mount	Kirk	JP	—	—
	Provision and 2 Locks Keyed Differently, Horizontal Mount	Kirk	—	—	JP

¹ Not available on M-frame, motor-operated P-frame, or I-Line circuit breakers.

Sub-Feed Lugs



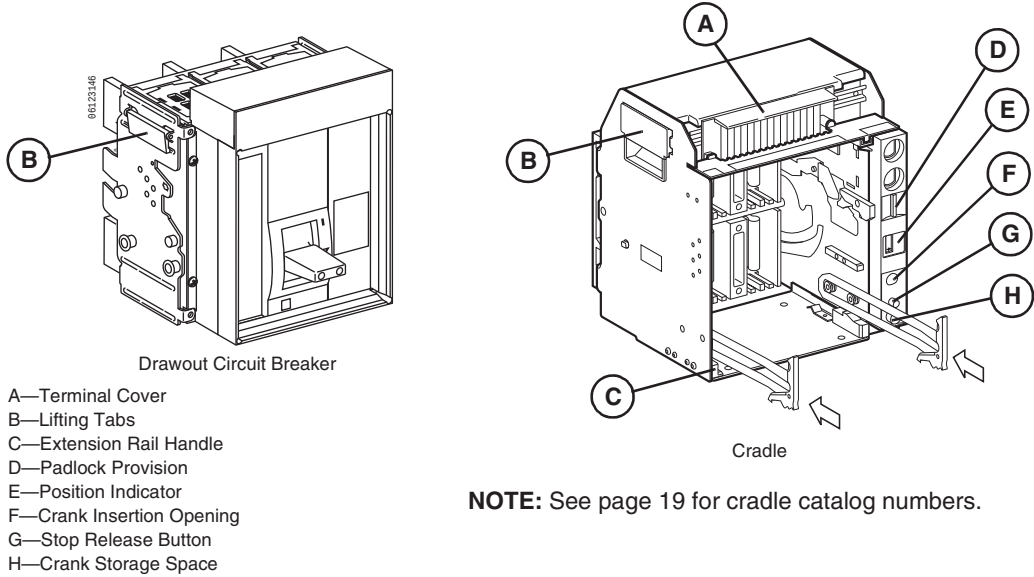
Sub-feed lug kits are UL Listed for use on Listed equipment. They have plug-on jaw construction and plug on to the I-Line bus stack in the same manner as branch circuit breakers. Lugs on these devices accommodate the same wire sizes as the equivalent ampere rated circuit breakers.

Table 99: I-Line Sub-Feed Lug Kit Terminations

Plug-On Lug Kit Cat. No.	Poles	Mounting Height	Ampere Rating	Lug		
				Catalog No.	Wire Size	Conductors Per Lug
SL800M5	3		800 A	—	3/0 AWG–500 kcmil (95–240 mm ²)	3
SL1200P5	3		1200 A	—	3/0 AWG–500 kcmil (95–240 mm ²)	4
SL1200P6	3		1200 A	—	350–600 kcmil (185–300 mm ²)	3
SL1200P7	3		1200 A	—	3/0 AWG–750 kcmil (95–400 mm ²)	2
S33931	3	9 in.	1200 A	AL1200P24K	3/0 AWG–500 kcmil (95–240 mm ²)	4
S33930	3	15 in.	1200 A	AL1200R53K	3/0 AWG–600 kcmil (95–300 mm ²)	4

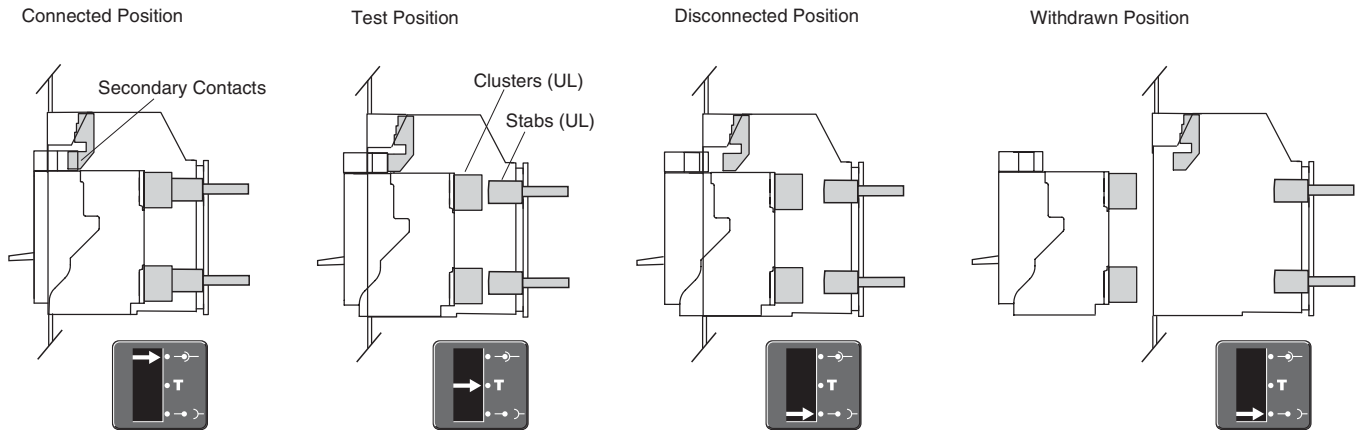
Section 10—P-Frame Cradles and Cradle Accessories

Circuit Breaker and Cradle Design



Drawout Mechanism

The drawout assembly mechanism allows the circuit breaker to be racked in four positions (connected, test, disconnected, or withdrawn), as shown in the figure below.



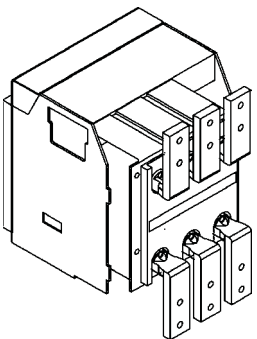
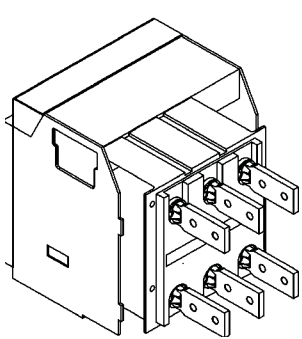
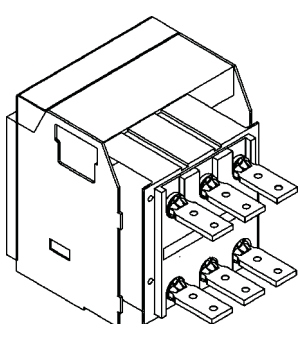
NOTE: For UL/CSA Listed devices, the clusters are mounted on the circuit breaker and the stabs are on the cradle. For IEC devices, the clusters are mounted on the cradle and the stabs are mounted on the circuit breaker.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 10—P-Frame Cradles and Cradle Accessories

Connectors

Table 100: Available Connectors

Front-Connected Flat (FCF)	Rear-Connected “T” Vertical (RCTV)	Rear-Connected “T” Horizontal (RCH)
		

Cradle Accessories

Cradle Position Switches

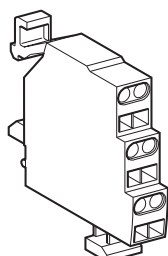
Three optional cradle position switches are available for the cradle:

- Cradle position switches (CE) to indicate the connected position.
- Cradle position switches (CD) to indicate the disconnected position. This position is indicated when the required clearance for isolation of the power and auxiliary circuits is reached.
- Cradle position switches (CT) to indicate the test position. In this position, the power circuits are disconnected and the auxiliary circuits are connected.

Table 101: Cradle Position Switches

Switch Type		CE	CD	CT	Cat. No.		CE	CD	CT	Cat. No.
Maximum Push-In Switches		3	2	1			3	2	1	
Breaking Capacity at a Power Factor (pf) of 0.3	Standard: 10 mA/24 V Min. Load				S33170	Low-Level: 1 mA/4 V Min. Load ¹				S33171
	240 Vac	8 A				24-48 Vac	5 A			
	380 Vac	8 A				240 Vac	5 A			
	480 Vac	8 A				380 Vac	5 A			
	600-690 Vac	6 A				24-48 Vdc	2.5 A			
	24-48 Vdc	2.5 A				125 Vdc	0.8 A			
	125 Vdc	0.8 A				250 Vdc	0.8 A			
	250 Vdc	0.3 A								

¹ If the maximum voltage and current is exceeded, the low-level function of the switch will be lost but the switch will continue to function as a standard switch with standard switch specifications.

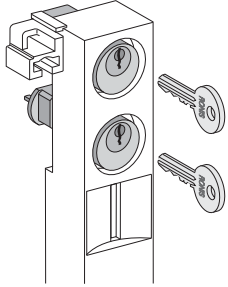


Cradle Locking and Interlocking

Disconnected Position Locking

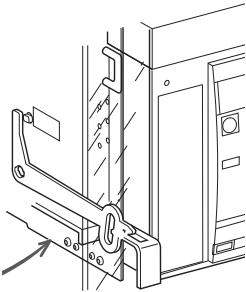
The circuit breaker can be locked in the disconnected position by key interlock (optional, catalog number **S33772**) or padlock (standard). The key interlock is on the cradle and accessible with the door locked.

- Kirk key interlocks are available for UL/CSA circuit breakers. Key is captive when circuit breaker is closed.
- Locking in all positions (disconnected, test, and connected) is possible. Factory standard setting is locking in disconnected position.



Door Interlock

The door interlock (catalog number **S33786**) prevents the compartment door from being opened when the circuit breaker is in the connected or test position. If the circuit breaker is put into the connected position with the door open, the door can be closed without disconnecting the circuit breaker. For greater protection, this interlock can be used in conjunction with the open door racking interlock.



Open Door Racking Interlock

The racking interlock (catalog number **S33788**) prevents racking in the circuit breaker when the door is open. (Insertion of the circuit breaker racking crank is not possible when the compartment door is open.)

Cradle Rejection Kits

The cradle rejection feature (optional, catalog number **S33767**) ensures that only the properly designated circuit breaker or switch is matched with the selected cradle assembly.

Miscellaneous Accessories

Shutter and Shutter Lock

The shutters automatically block access to the main disconnects when the circuit breaker is in the disconnected, test, or fully withdrawn position. The shutter lock is used to prevent connection of the circuit breaker or to lock the shutters in the closed position.

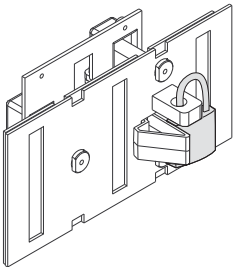
The optional shutter assembly (catalog number **S48933**) consists of shutter and padlock provision.

Door Escutcheon (CDP)

The door escutcheon (catalog number **S33857**) provides a frame and seal for the circuit breaker.

Transparent Cover for Door Escutcheon (CCP) (P-Frame Only)

The door escutcheon cover (catalog number **S33859**) is hinge-mounted and is designed to be installed on the door escutcheon for the P-frame drawout circuit breaker.

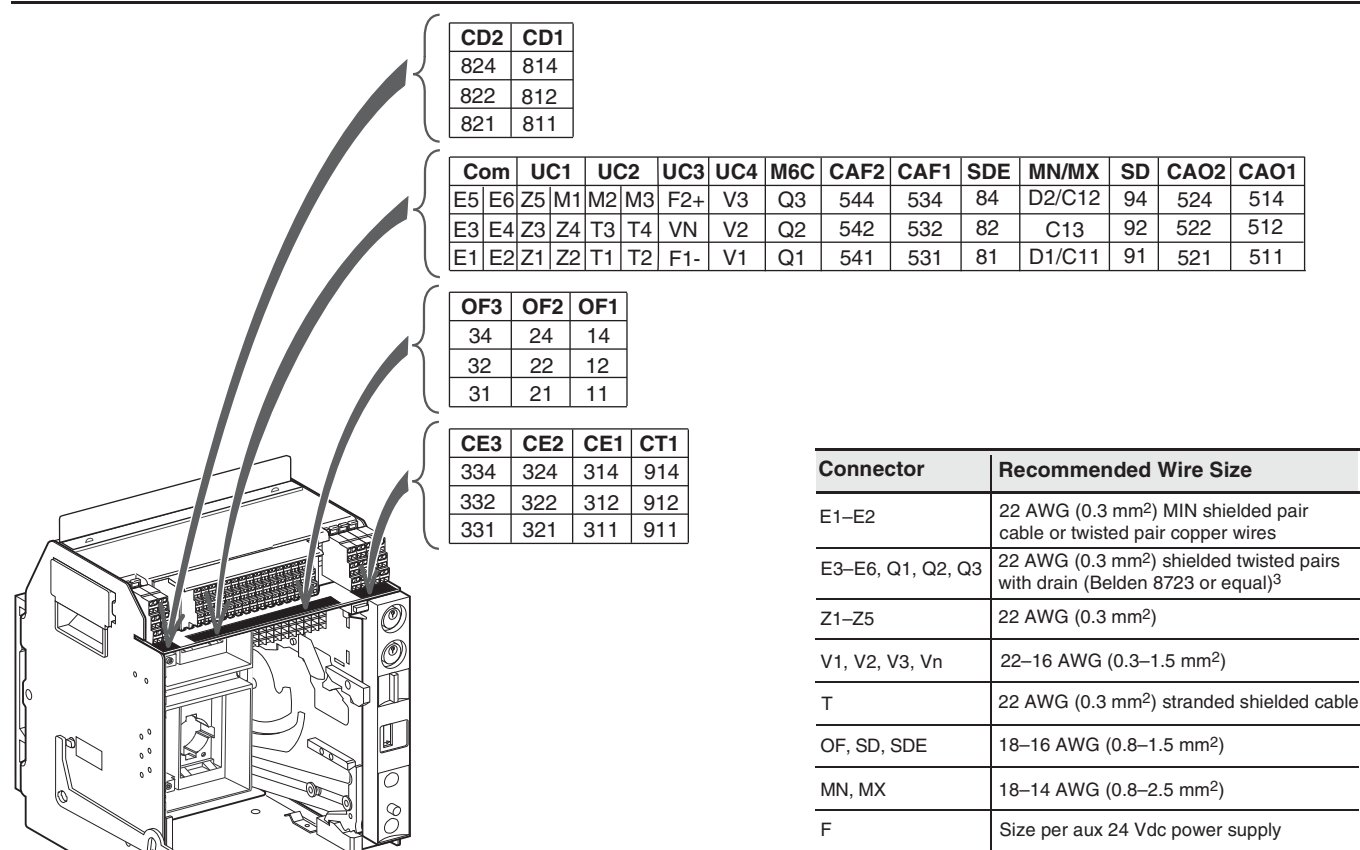


PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 10—P-Frame Cradles and Cradle Accessories

Wiring Diagrams

Figure 11: Terminal Layout for Push-In Connector Installation



Function	Connector	Description
Auxiliary Contacts	OF	Open/Closed circuit breaker or switch position contacts
Rotary Handle Contacts	CAO	Early break contact
	CAF	Early make contact
Cradle Contacts	CD	Disconnected position contacts
	CE	Connected position contacts
	CT	Test position contacts
Remote Operation	SDE	Electrical fault alarm contact
	SD	Alarm contact
	MN	Undervoltage trip device
	MX ¹	Shunt trip

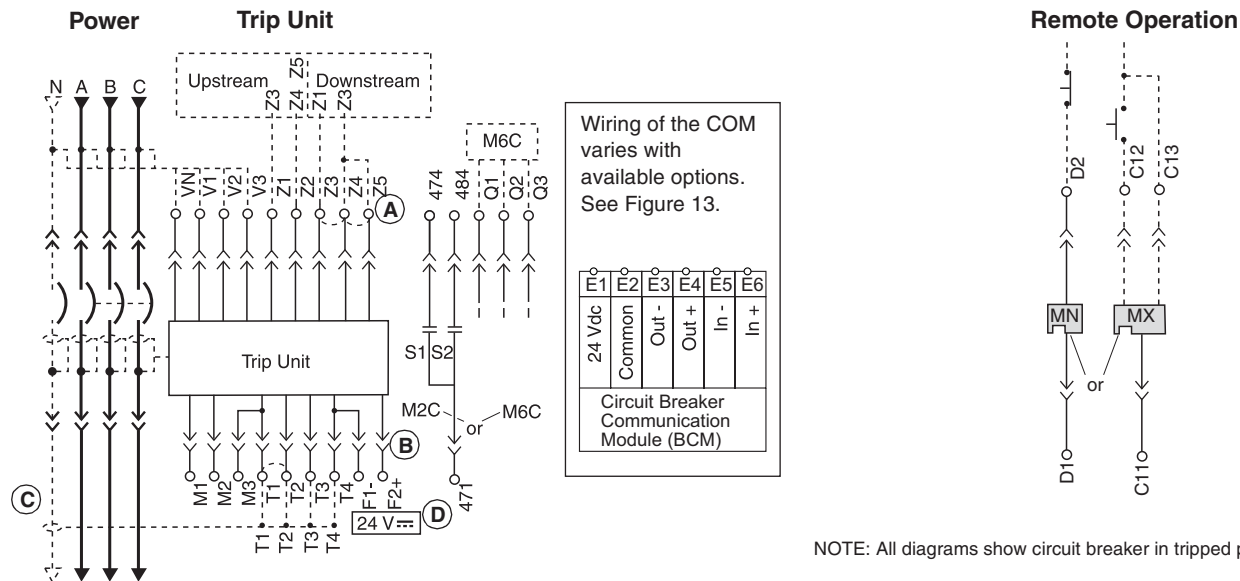
¹ When networked MXF coils are used, terminal C3 must be connected to line even if the communication module is not installed.

Trip Unit Type					
Basic	A	P	H	Connector	Description
—	X	X	X	Com: E1-E6	Communication
—	X	X	X	UC1: Z	Zone-selective Interlocking Z1 = ZSI OUT signal Z2 = ZSI OUT Z3 = ZSI IN signal Z4 = ZSI IN short time Z5 = ZSI IN ground fault
—	X	X	X	UC1: M1	Modified differential ground fault (MDGF)
—	X	X	X	UC2: T	External neutral
—	X	X	X	UC2: M	Modified differential ground fault (MDGF)
—	X	X	X	UC3: F	24 Vdc external power supply (F1 -, F2 +)
—	—	X	X	UC3: Vn	External neutral plug
—	—	X	X	UC4	External phase voltage sensing
—	—	X	X	M6C	Six programmable contacts

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

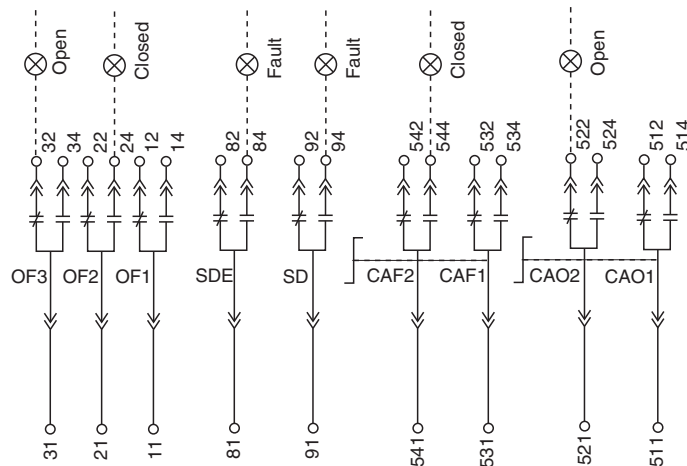
Section 10—P-Frame Cradles and Cradle Accessories

Figure 12: Wiring Diagrams for Auxiliary Connections

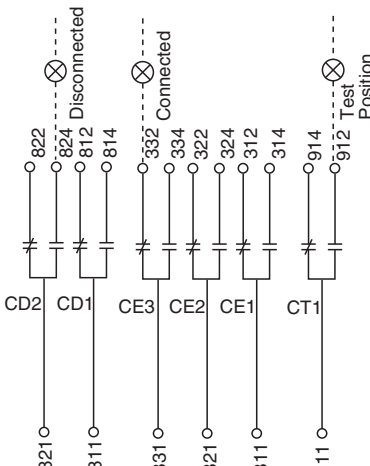


- A—Do not remove factory-installed jumpers between Z3, Z4 and Z5 unless ZSI is connected.
- B—Do not remove factory-installed jumper between T1 and T2 unless neutral CT is connected. Do not install jumper between T3 and T4.
- C—For proper wiring of neutral CT, refer to Instruction Bulletin 48041-082-01 shipped with it.
- D—24 Vdc power supply for trip unit must be separate and isolated from 24 Vdc power supply for communication modules.
- E—For proper wiring of the FDM, refer to user guide 5100512864A-02.

Auxiliary Contacts



Cell Switches

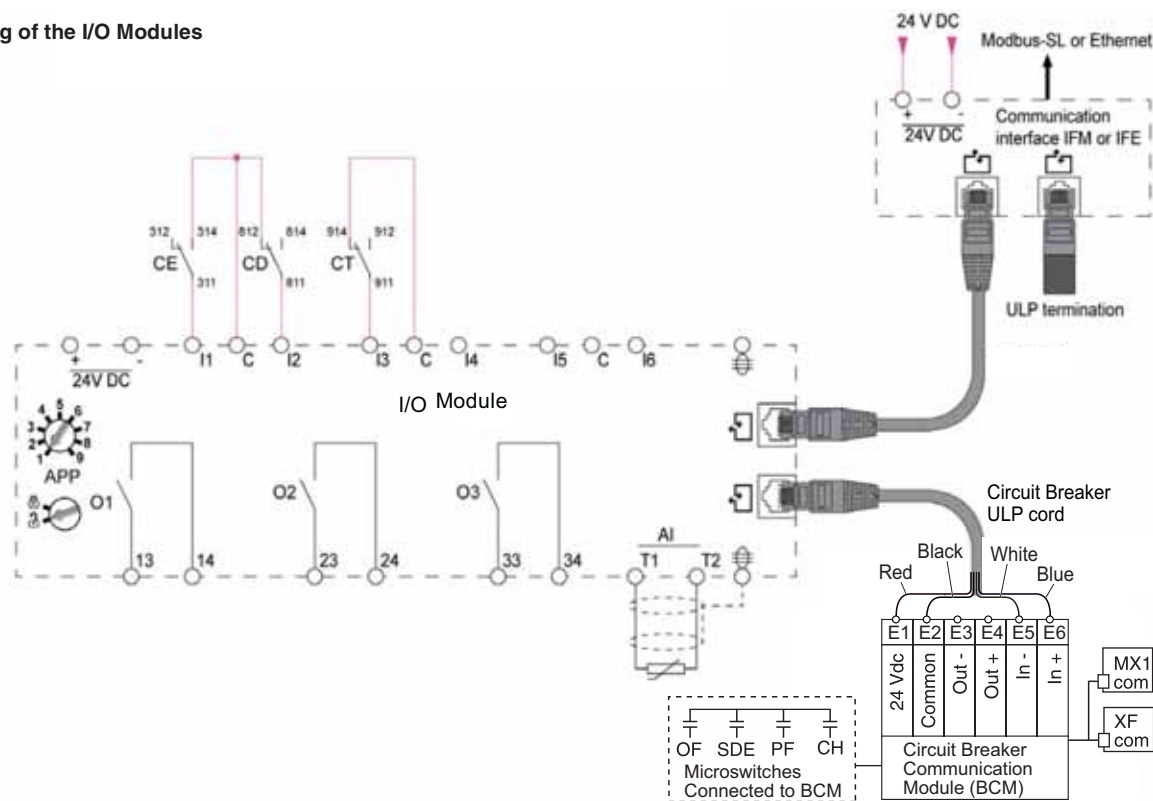


PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

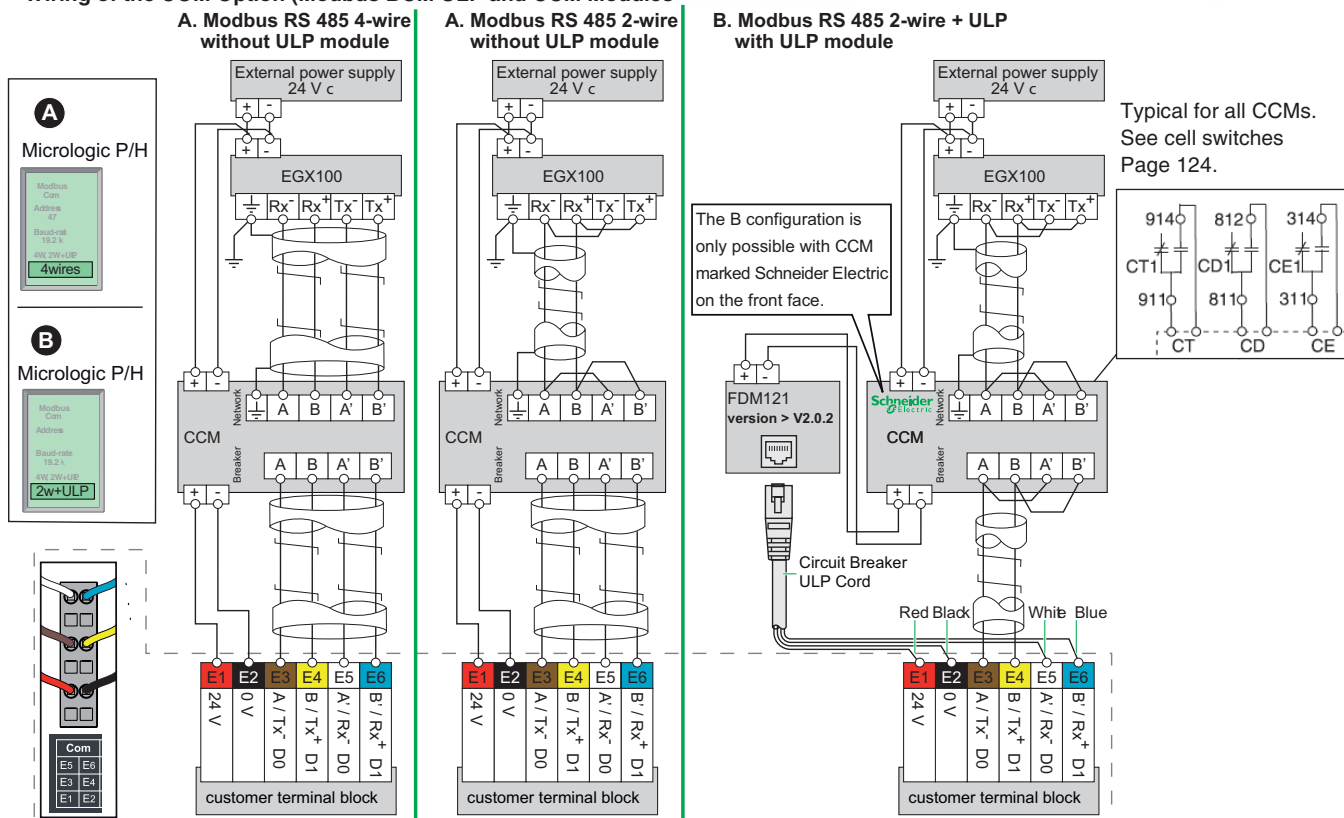
Section 10—P-Frame Cradles and Cradle Accessories

Figure 13 – Wiring Diagrams for the COM Option

Wiring of the I/O Modules



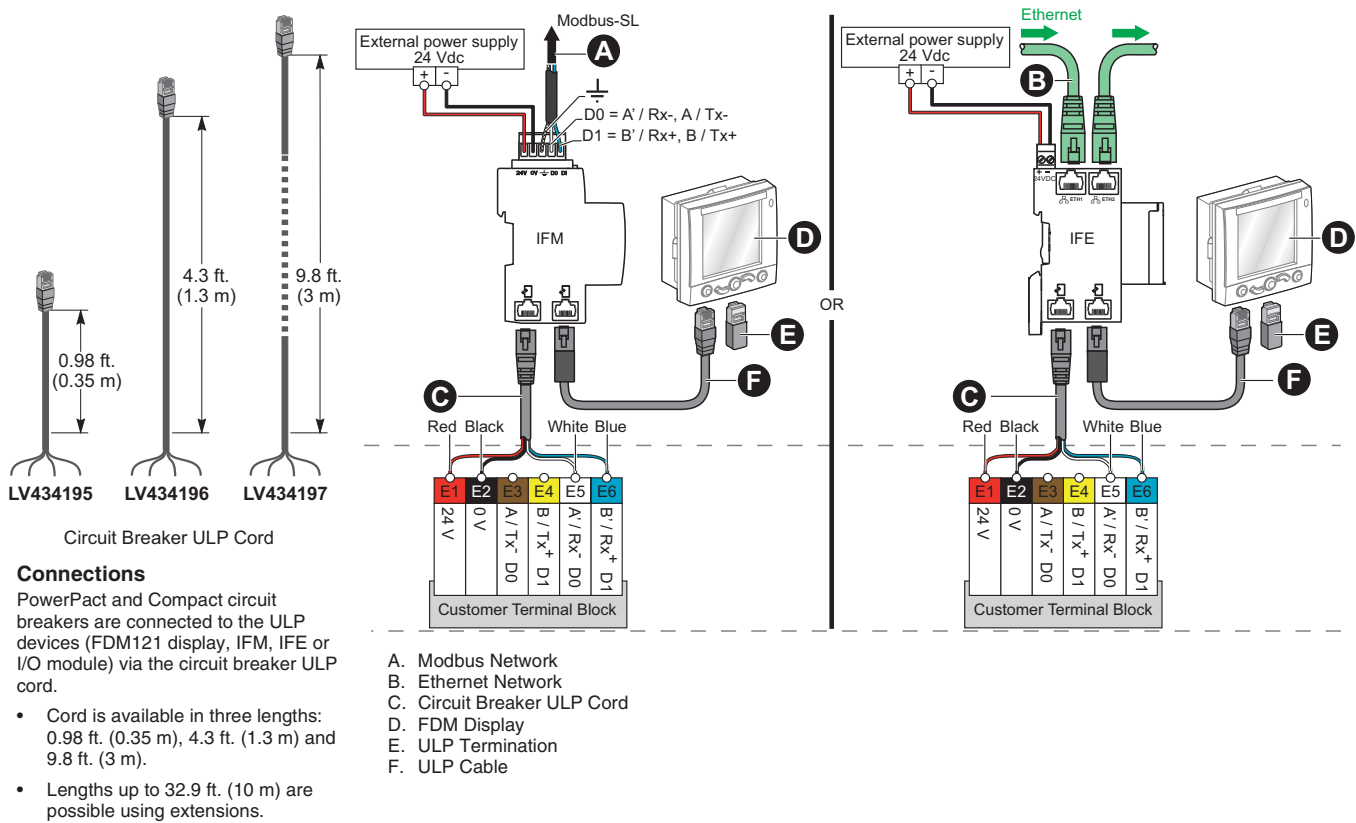
Wiring of the COM Option (Modbus BCM ULP and CCM Modules)



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 10—P-Frame Cradles and Cradle Accessories

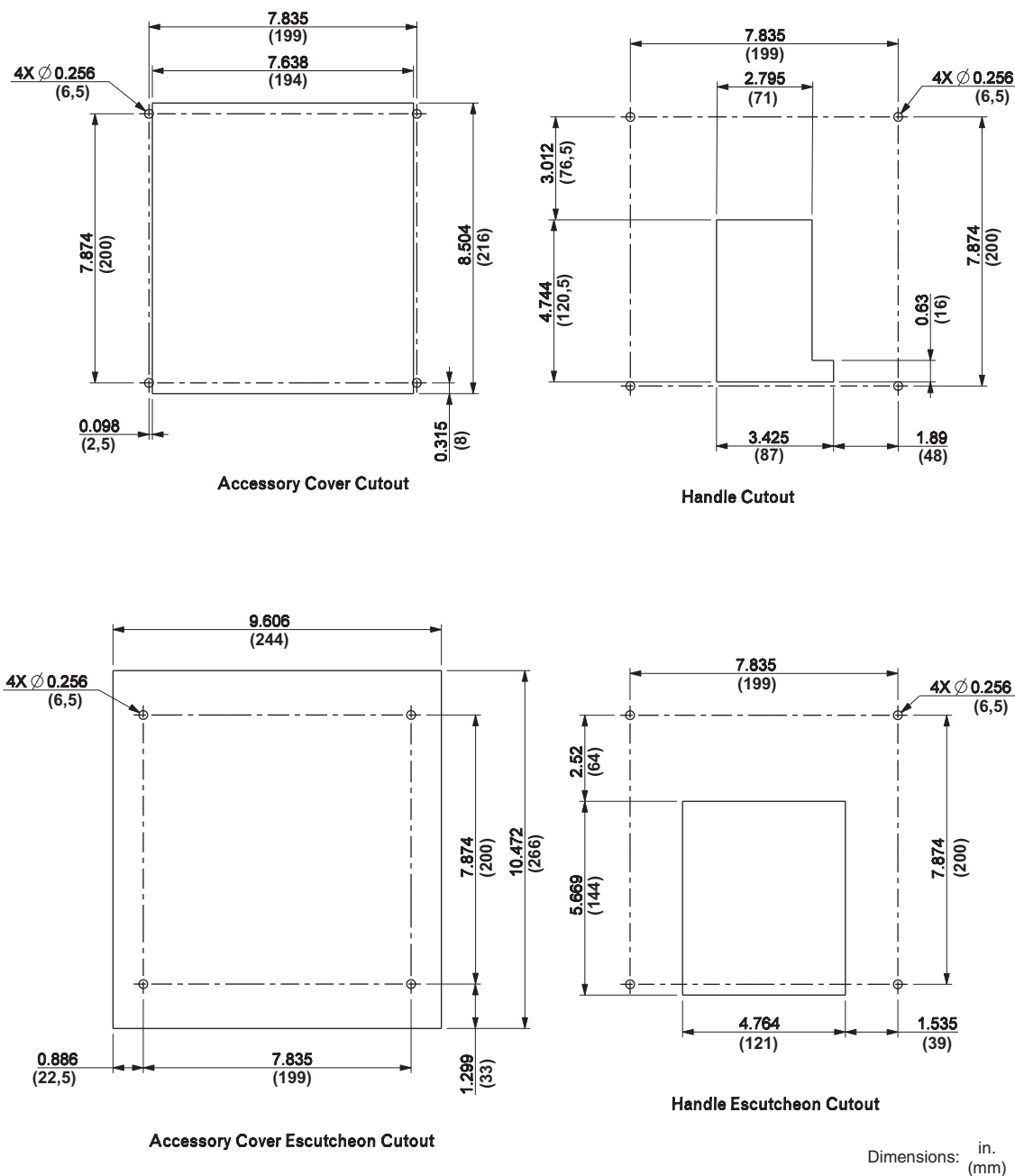
Figure 14: Communication Components and FDM121 Connections



Section 11—Circuit Breaker Dimensional Drawings

Dimensions for M-Frame Circuit Breakers

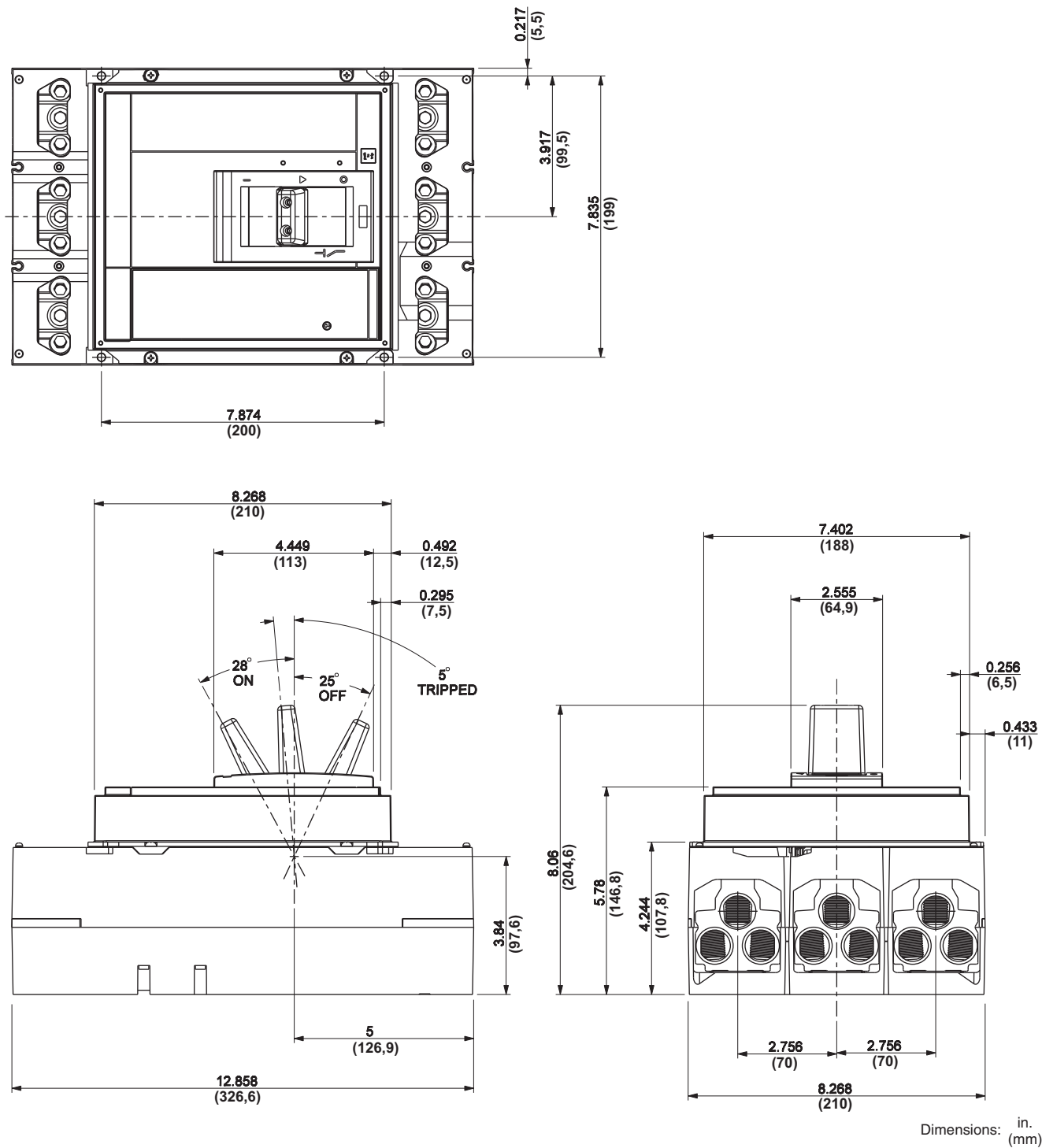
Figure 15: M-Frame Individually-Mounted Circuit Breaker Enclosure Mounting Holes and Door Cutouts



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

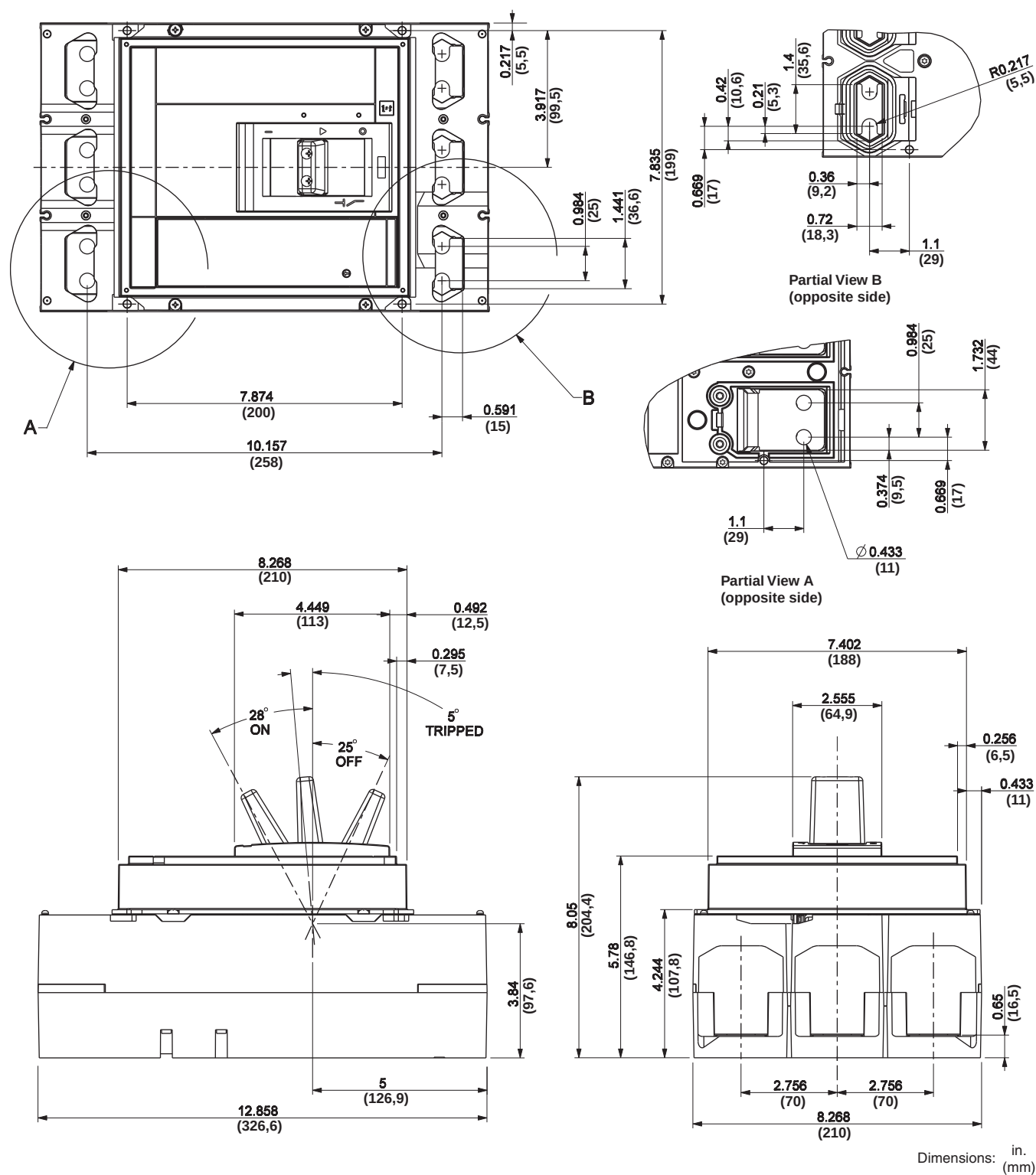
Figure 16: M-Frame Individually-Mounted 3P 800 A Circuit Breaker with Lugs on Both Ends



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 17: M-Frame Individually-Mounted 3P 800 A Circuit Breaker without Lugs

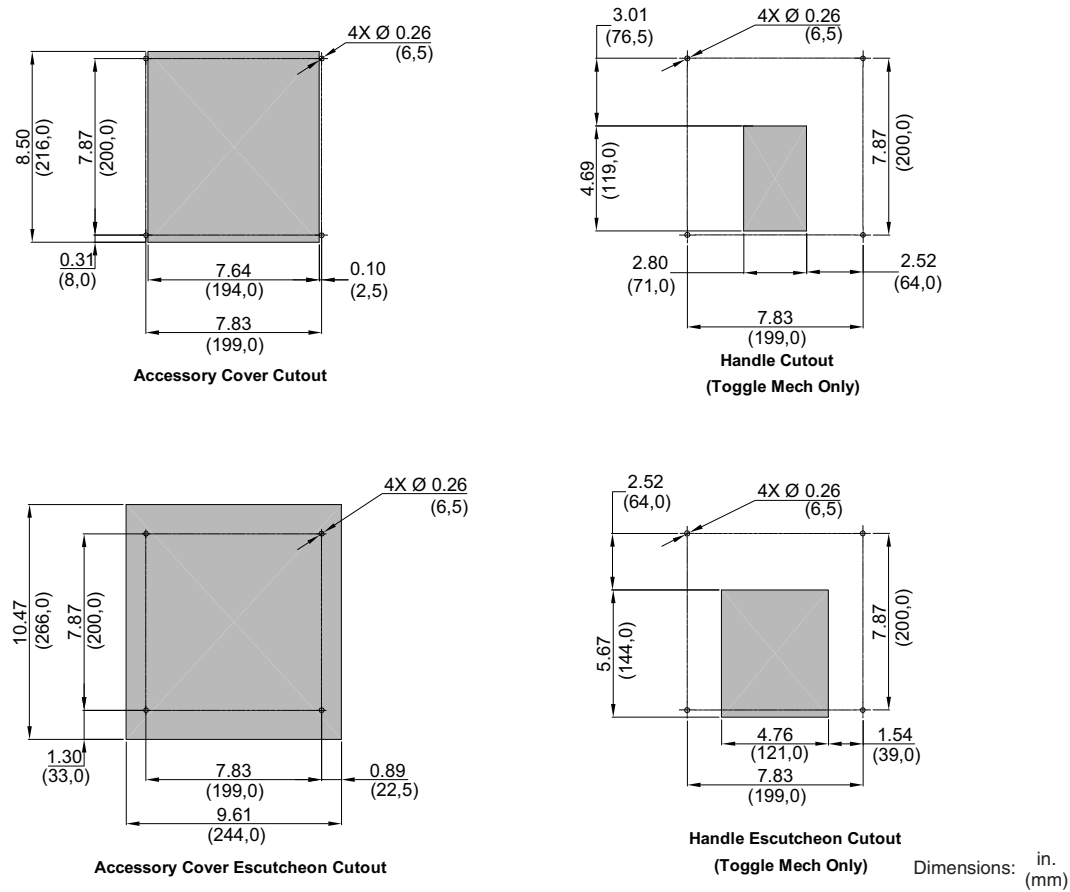


Dimensions for P-Frame and NS630b–NS1600 Circuit Breakers

Table 102: Enclosure Dimensions

Circuit Breaker Rating	Circuit Breaker Enclosure Dimensions (H x W x D)		Ventilation Area			
	in.	mm	Top		Bottom	
≤ 800 A, 100% rated	51.9 x 20.25 x 7.75	1318.3 x 514.4 x 196.9	–	–	–	–
≤ 1200 A, standard rated	51.9 x 20.25 x 7.75	1318.3 x 514.4 x 196.9	–	–	–	–
> 800 A, 100% rated	62.25 x 23 x 14.75	1581.2 x 584.2 x 374.7	16.5 in. ²	10,645 mm ²	16.5 in. ²	10,645 mm ²

Figure 18: P-Frame and NS630b–NS1600 Individually-Mounted Circuit Breaker Enclosure Mounting Holes and Door Cutouts



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 19: P-Frame and NS630b–NS1600 Individually-Mounted 3P Circuit Breaker ≤ 800 A with Lugs on Both Ends

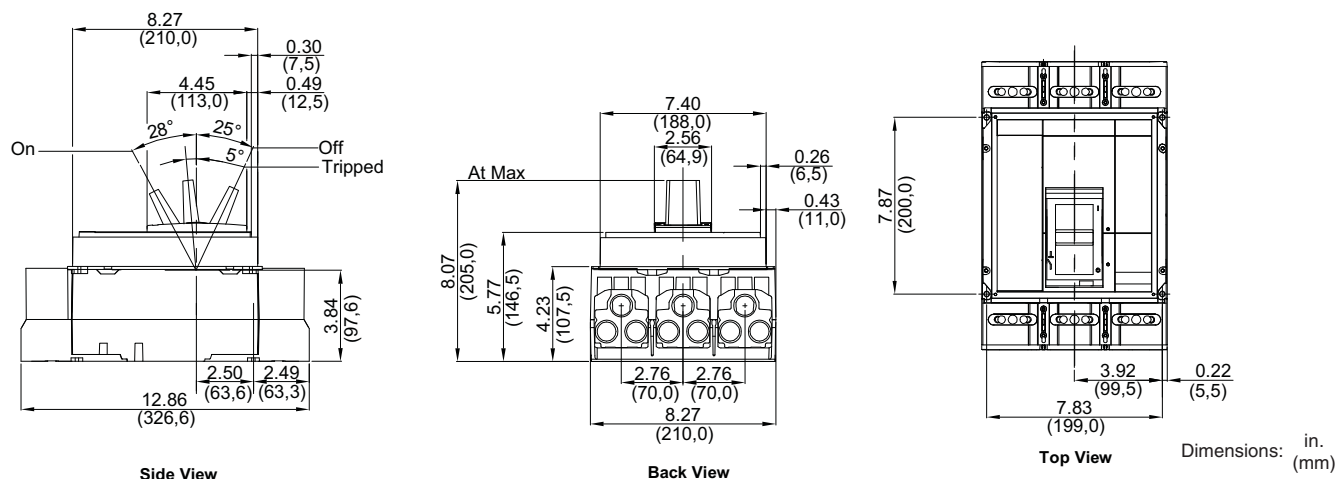
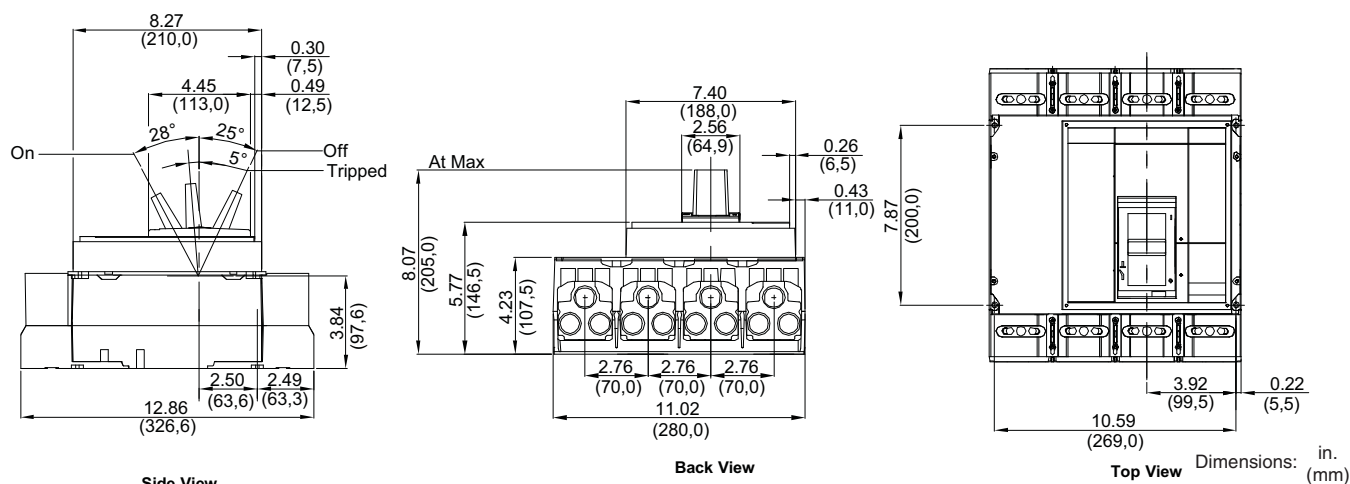


Figure 20: P-Frame and NS630b–NS1600 Individually-Mounted 4P Circuit Breaker ≤ 800 A with Lugs on Both Ends



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 21: P-Frame and NS630b–NS1600 Individually-Mounted 3P Circuit Breaker > 800 A with Lugs on Both Ends

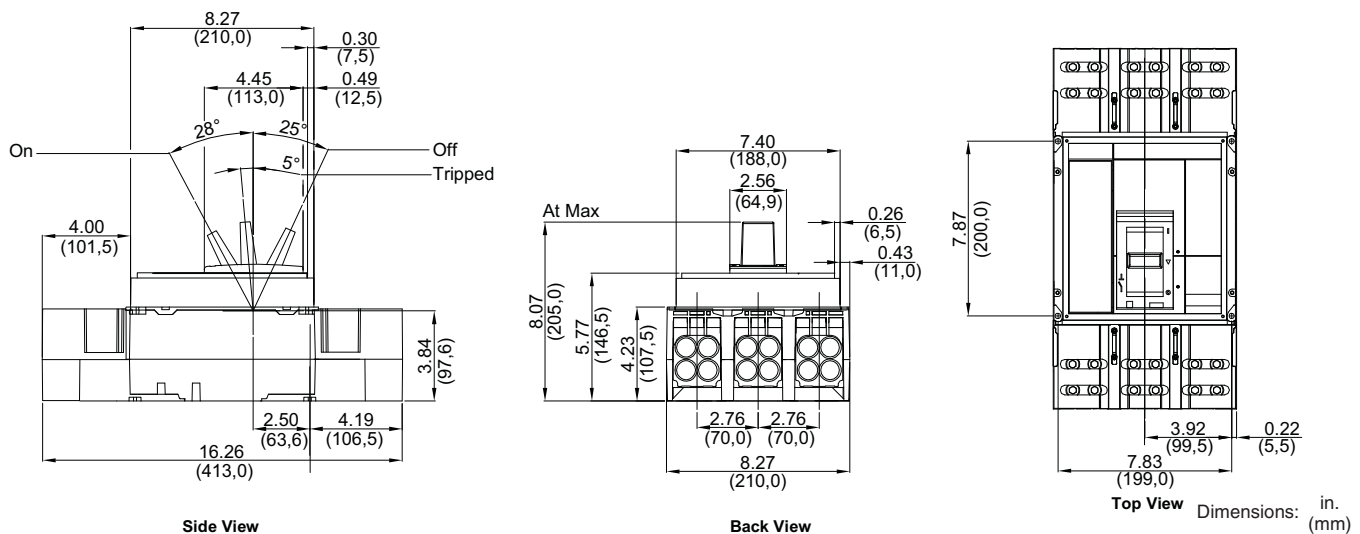
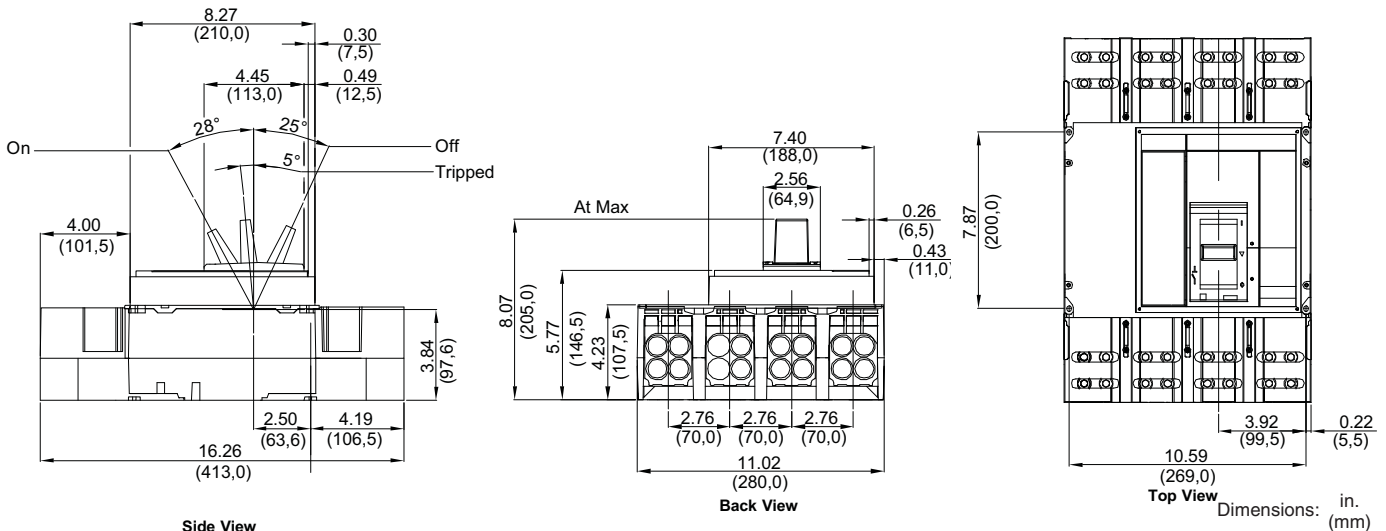


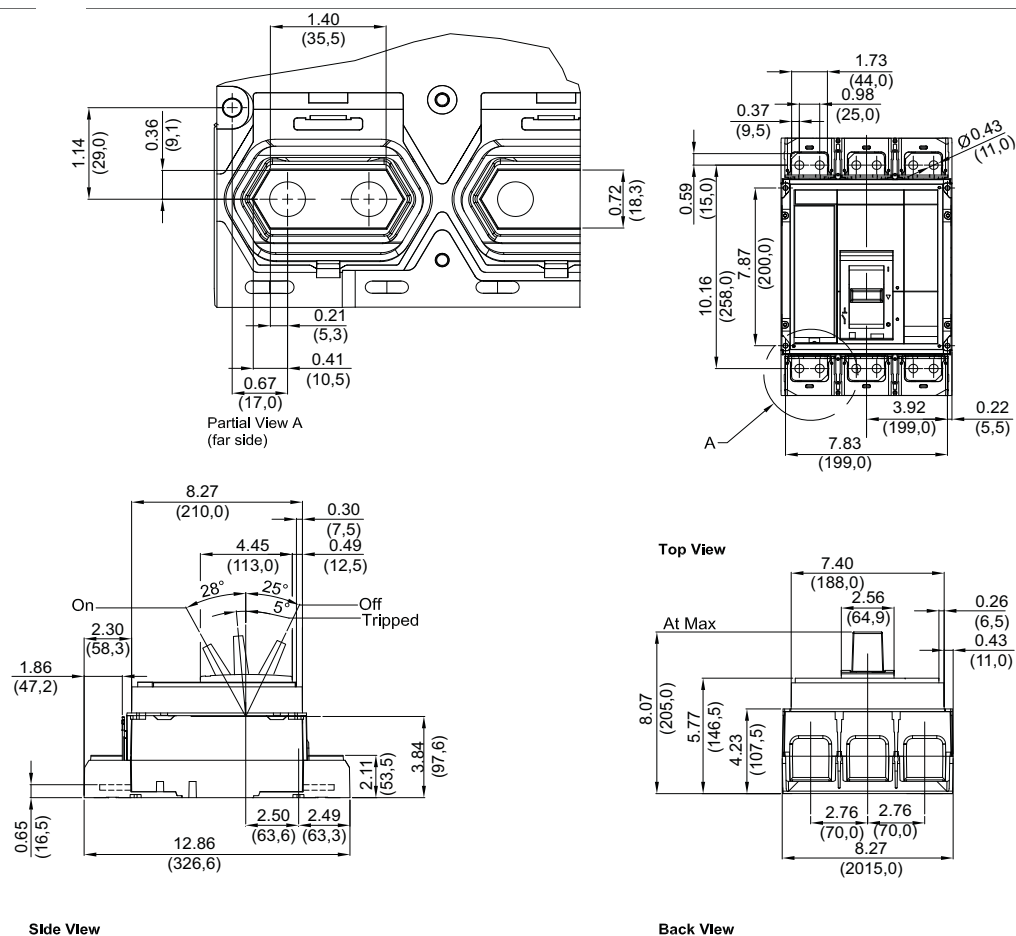
Figure 22: P-Frame and NS630b–NS1600 Individually-Mounted 4P Circuit Breaker > 800 A with Lugs on Both Ends



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 23: P-Frame and NS630b–NS1600 Individually-Mounted 3P Circuit Breaker without Lugs

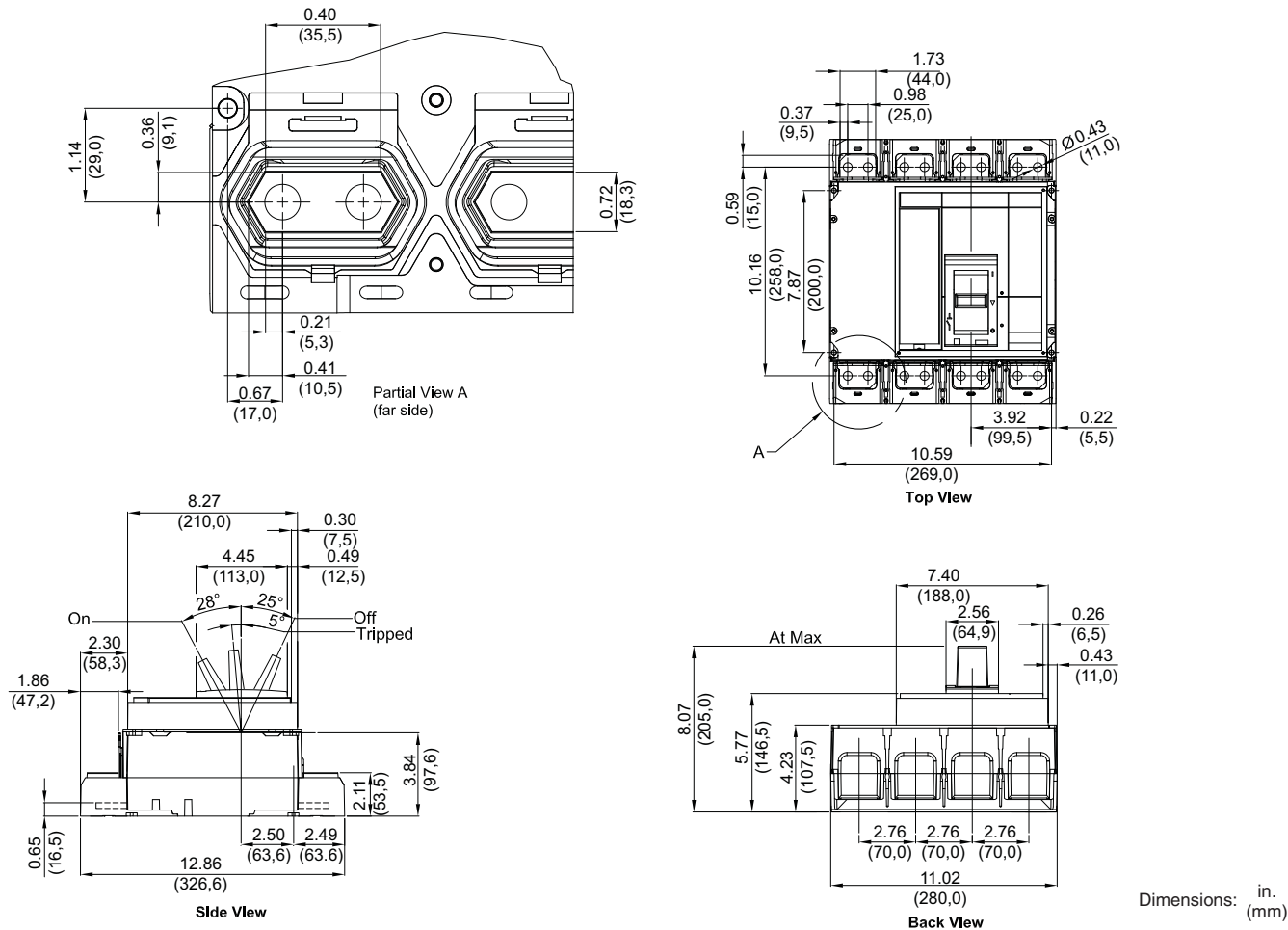


Dimensions: in.
(mm)

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 24: P-Frame and NS630b–NS1600 Individually-Mounted 4P Circuit Breaker without Lugs



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 25: P-Frame and NS630b–NS1600 Individually-Mounted Electrically-Operated 3P Circuit Breaker ≤ 800 A with Lugs on Both Ends

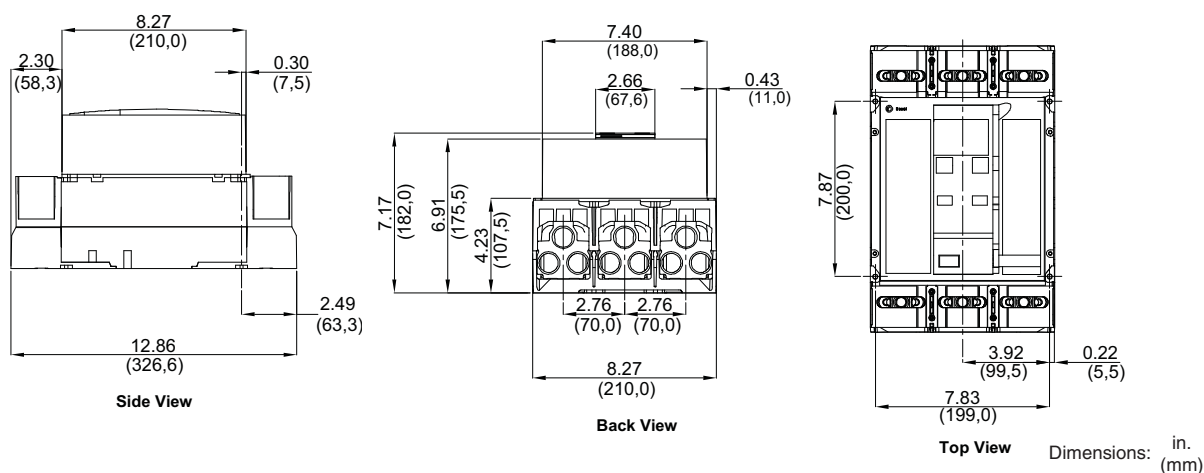
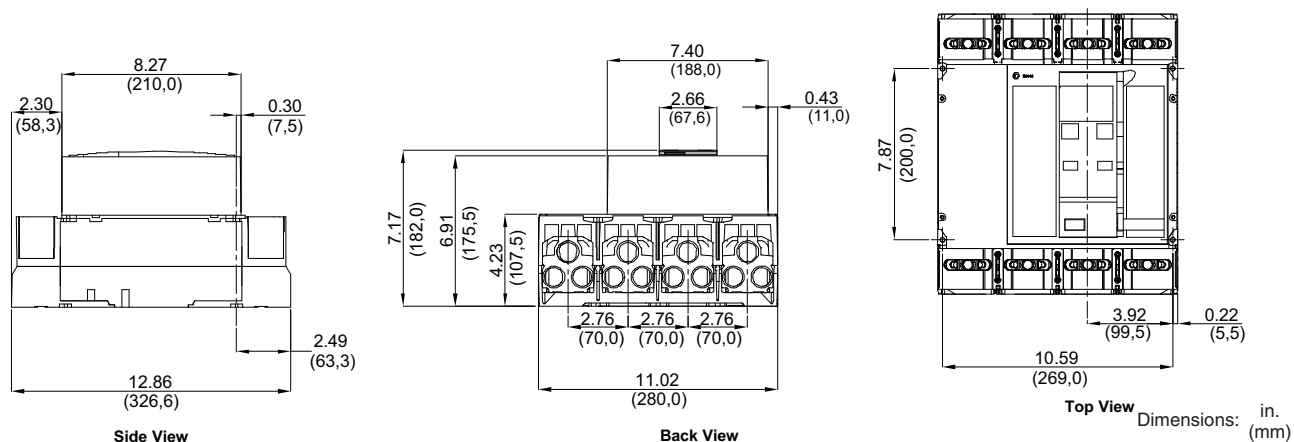


Figure 26: P-Frame and NS630b–NS1600 Individually-Mounted Electrically-Operated 4P Circuit Breaker ≤ 800 A with Lugs on Both Ends



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 27: P-Frame and NS630b–NS1600 Individually-Mounted Electrically-Operated 3P Circuit Breaker > 800 A with Lugs on Both Ends

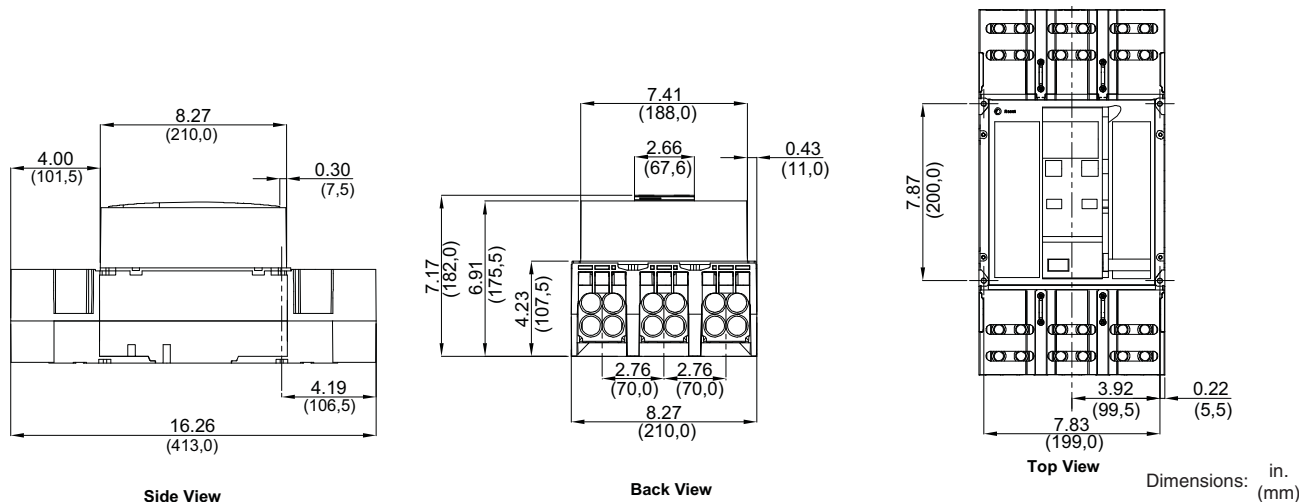
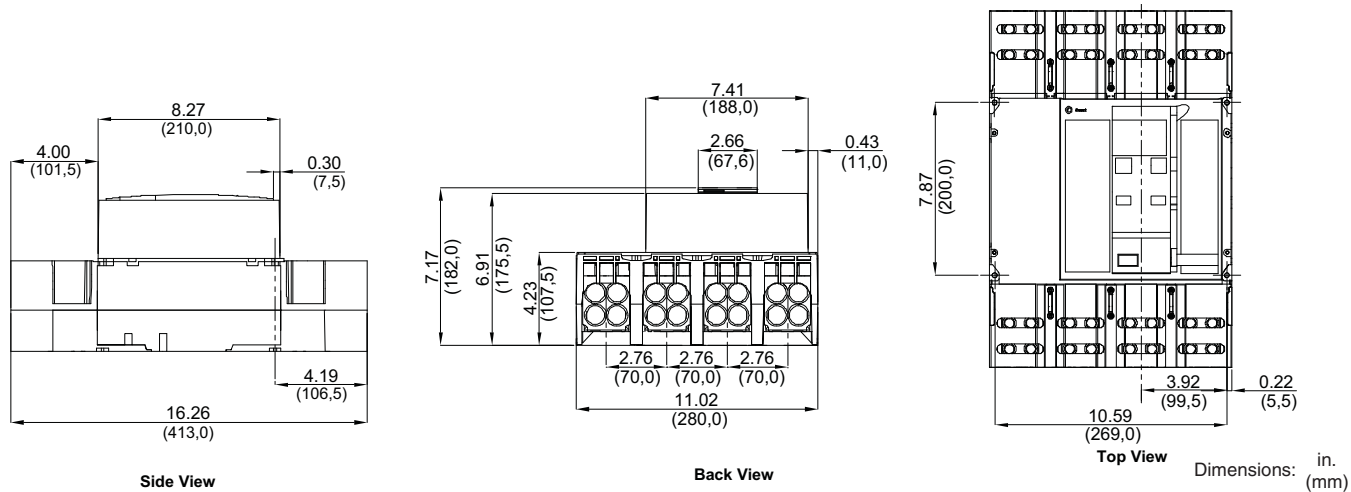


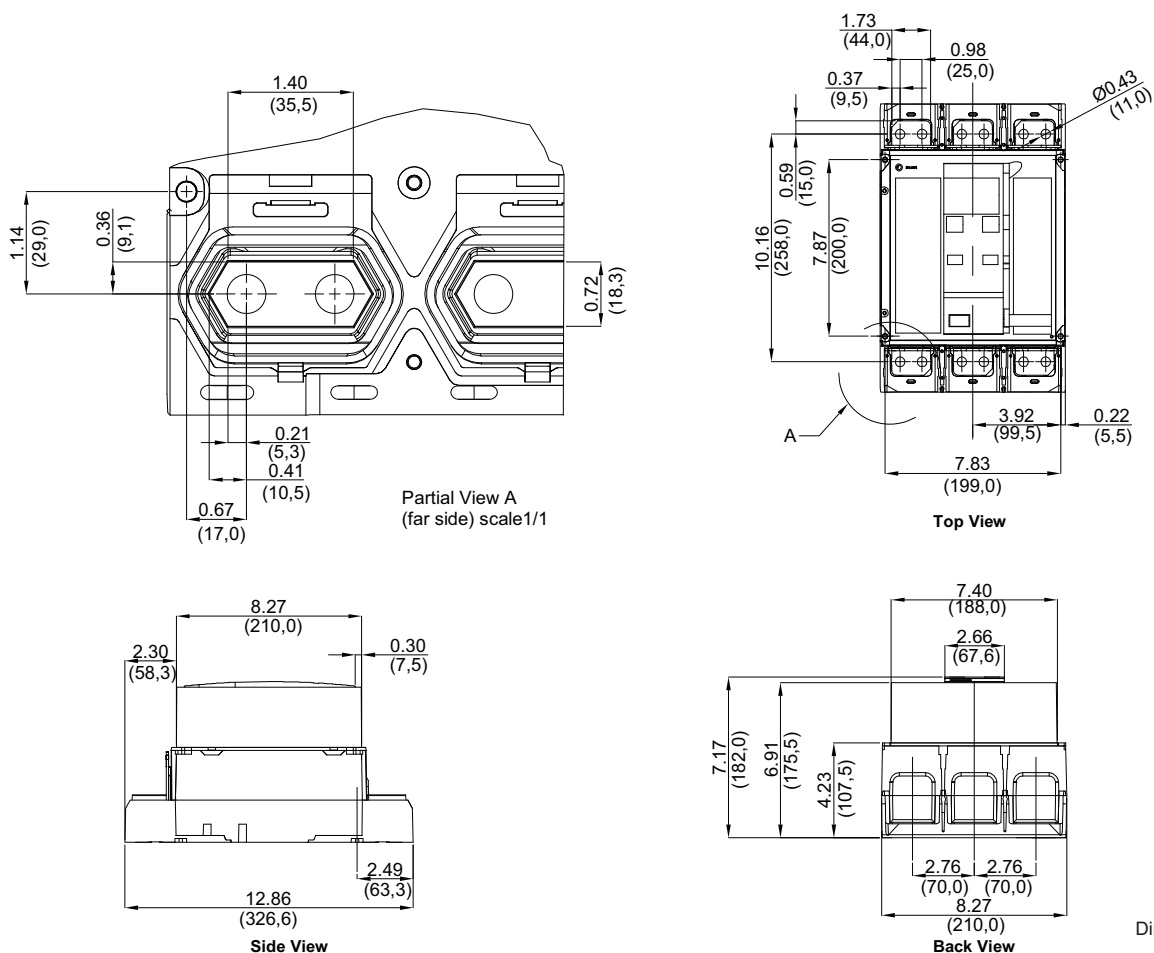
Figure 28: P-Frame and NS630b–NS1600 Individually-Mounted Electrically-Operated 4P Circuit Breaker > 800 A with Lugs on Both Ends



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

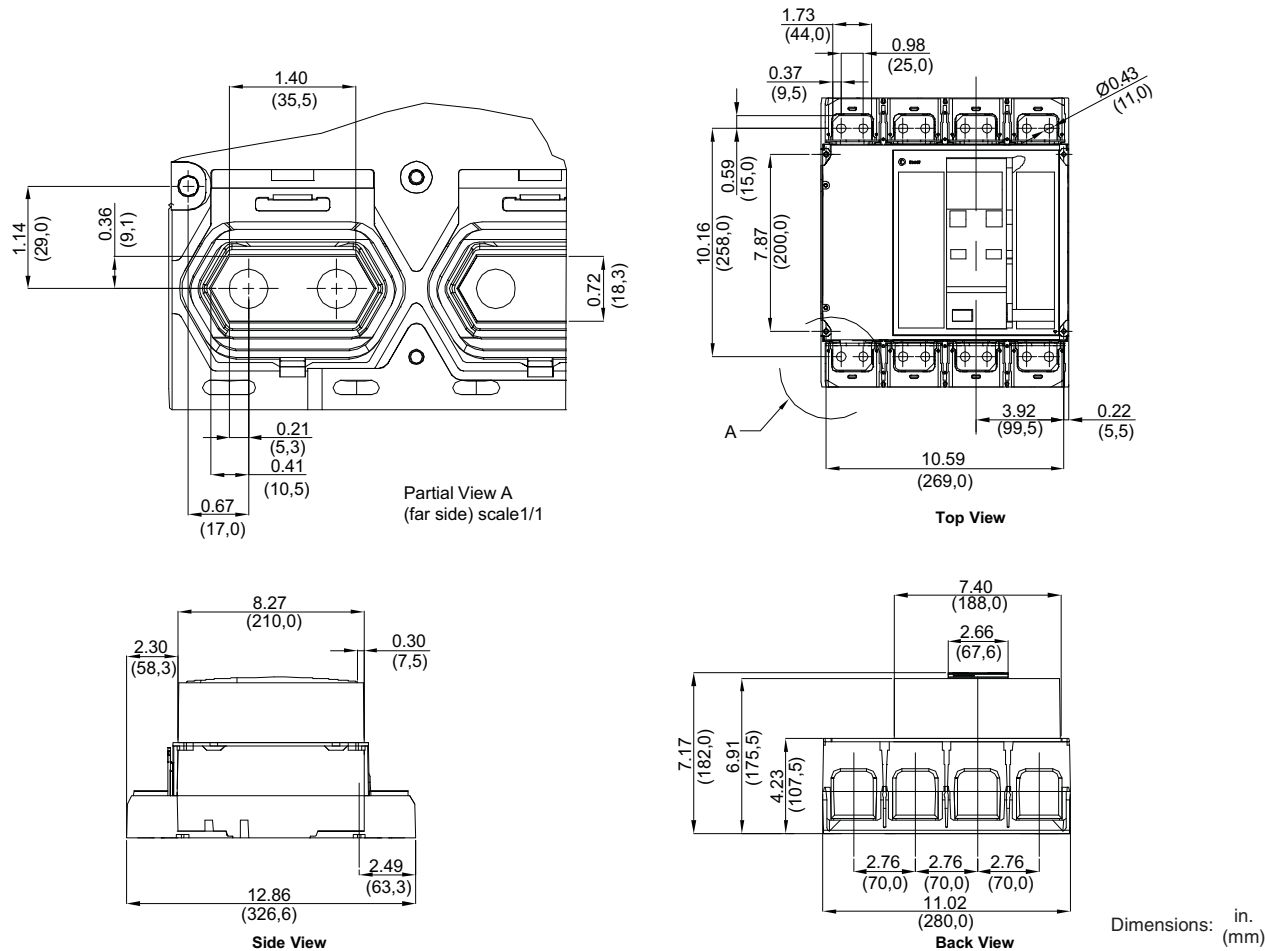
Figure 29: P-Frame and NS630b–NS1600 Individually-Mounted Electrically-Operated 3P Circuit Breaker without Lugs



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

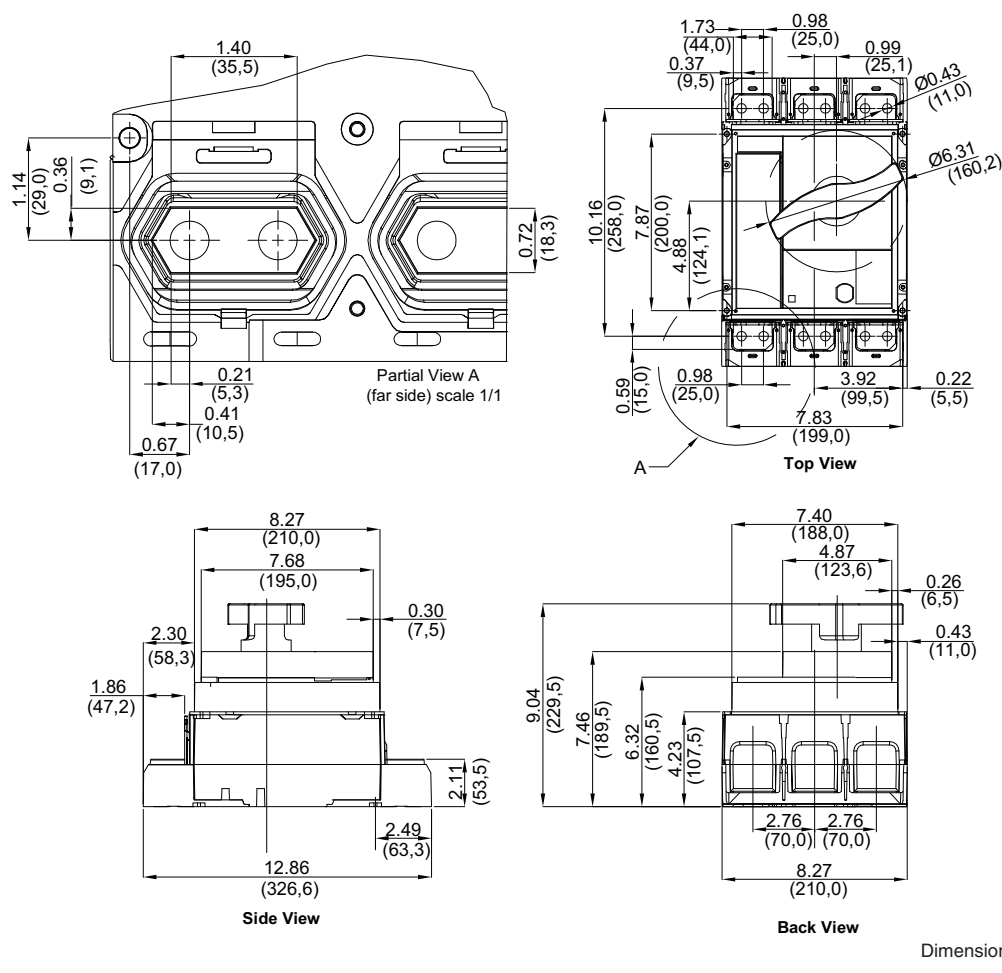
Figure 30: P-Frame and NS630b–NS1600 Individually-Mounted Electrically-Operated 4P Circuit Breaker without Lugs



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 31: P-Frame and NS630b–NS1600 Individually-Mounted 3P Circuit Breaker with Rotary Handle



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 32: P-Frame and NS630b–NS1600 Individually-Mounted 4P Circuit Breaker with Rotary Handle

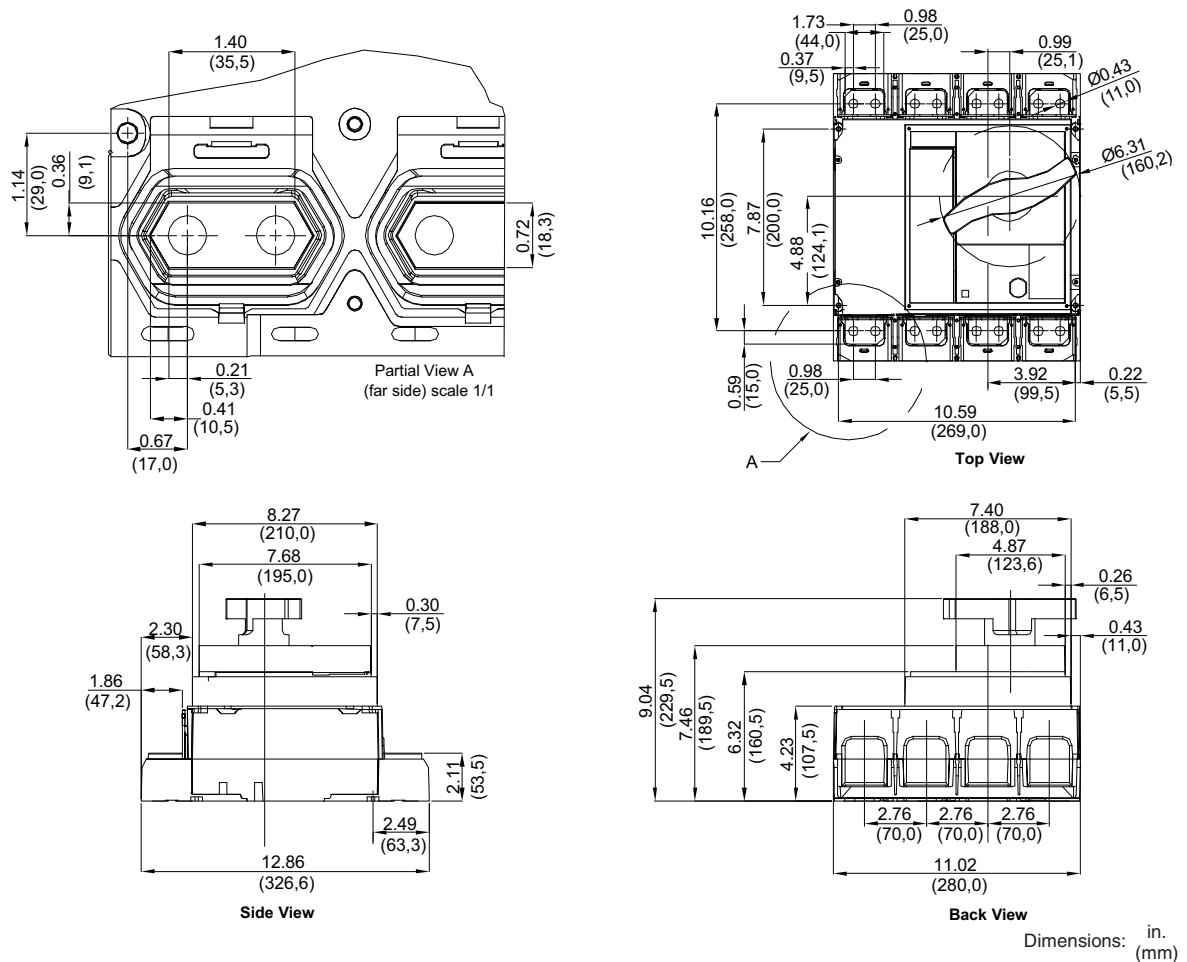
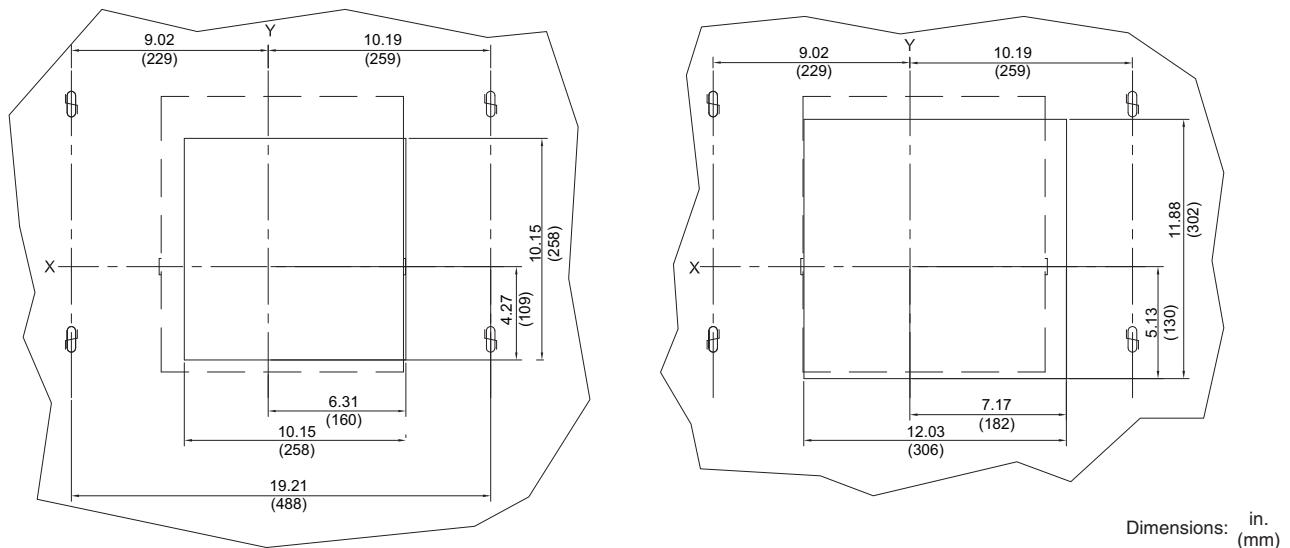


Figure 33: P-Frame and NS630b–NS1600 3P Drawout Circuit Breaker Door Cutout



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 34: P-Frame and NS630b–NS1600 4P Drawout Circuit Breaker Door Cutout

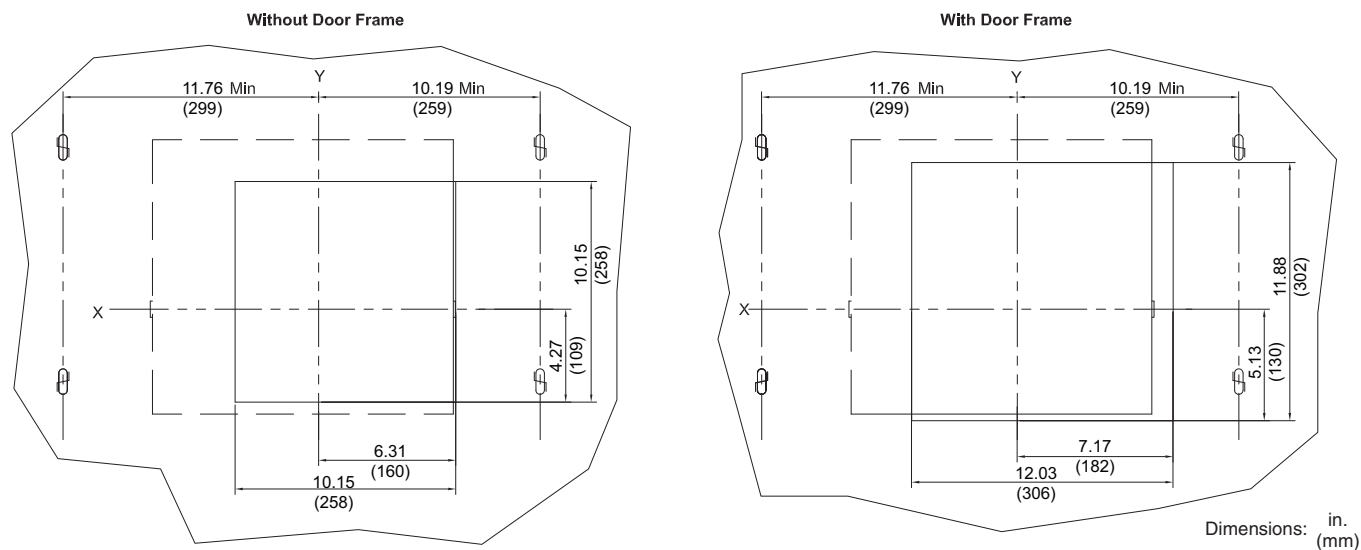
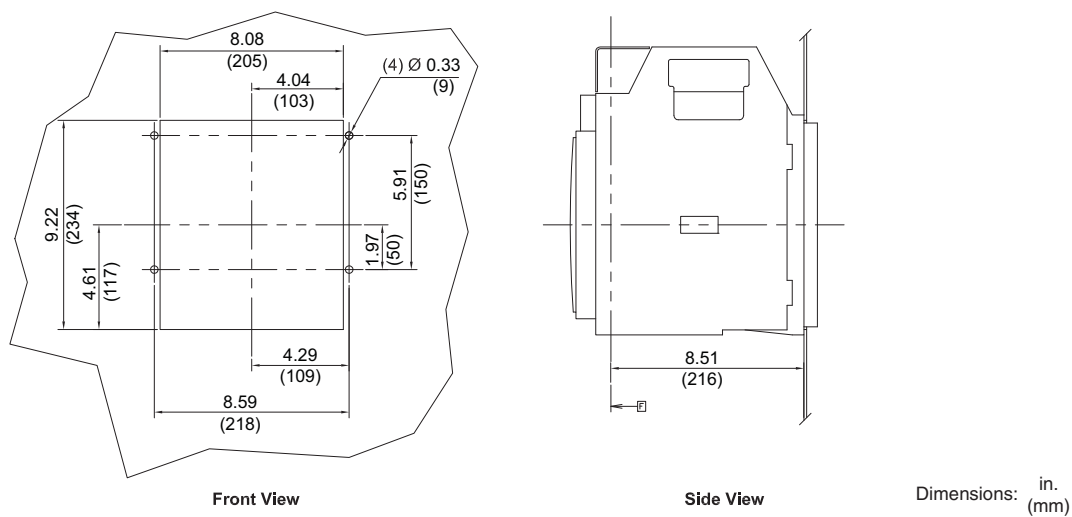


Figure 35: P-Frame and NS630b–NS1600 3P Drawout Circuit Breaker Rear Cutout



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 11—Circuit Breaker Dimensional Drawings

Figure 36: P-Frame and NS630b–NS1600 4P Drawout Circuit Breaker Rear Cutout

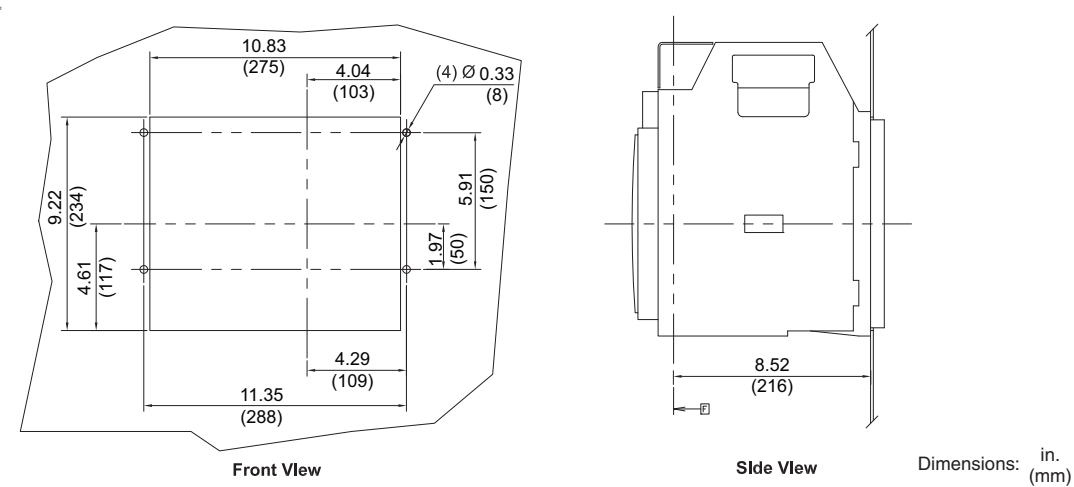
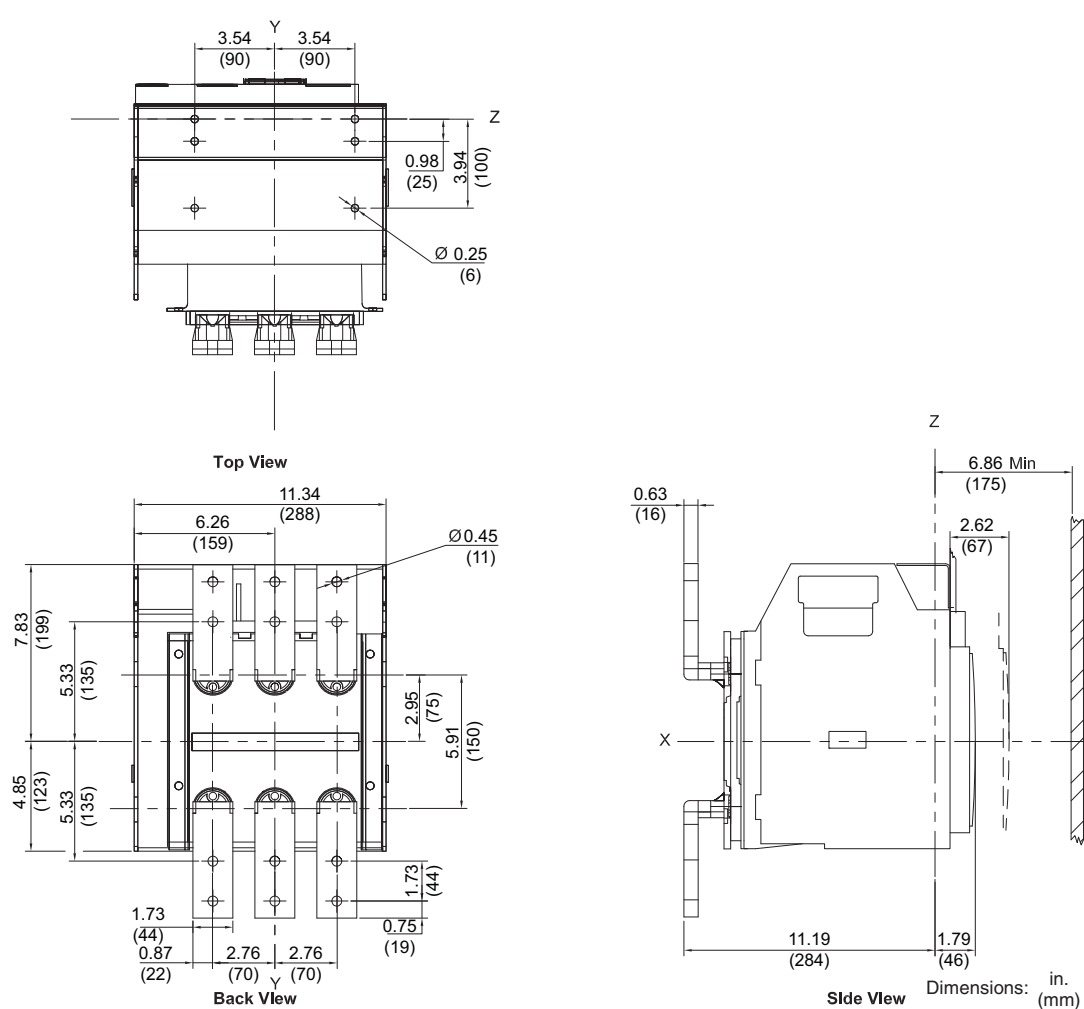


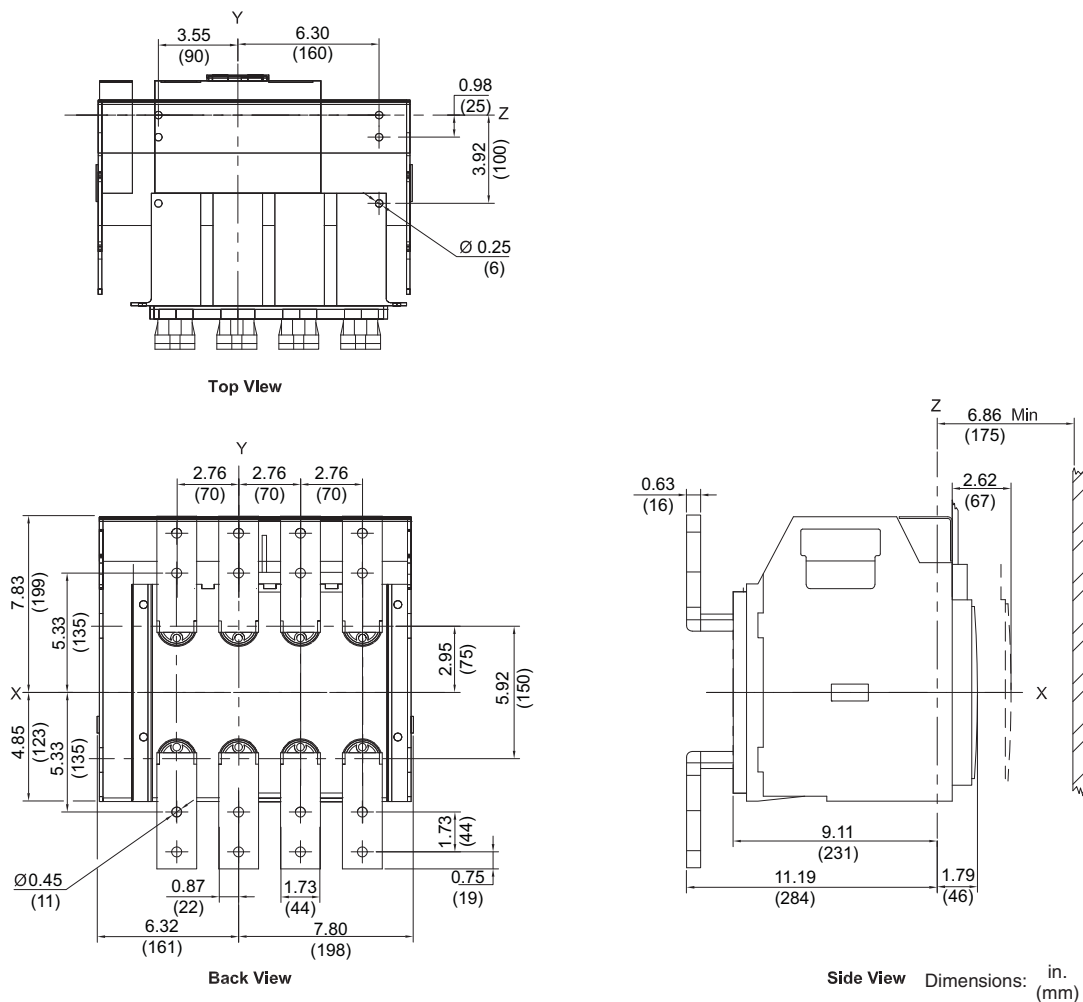
Figure 37: P-Frame Drawout 3P Circuit Breaker ≤ 1200 A with Front-Connected Flat (FCF) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

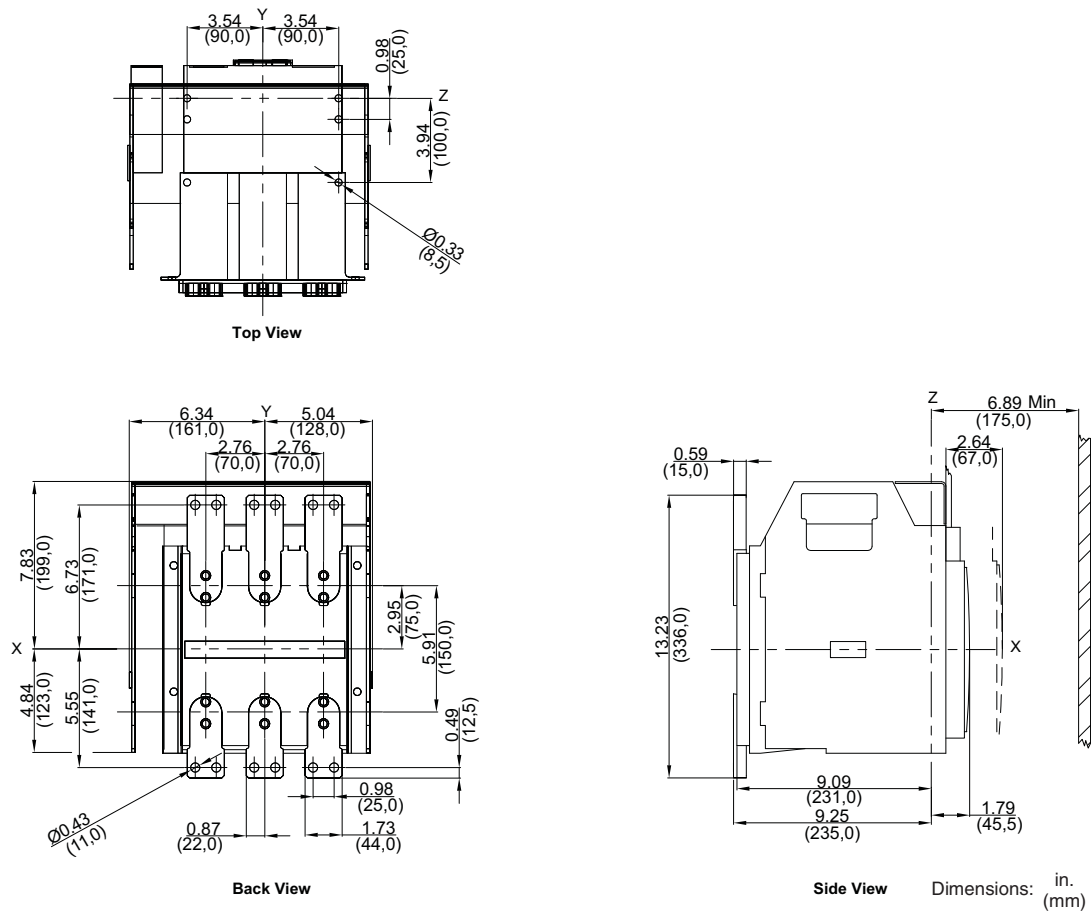
Figure 38: P-Frame Drawout 4P Circuit Breaker ≤ 1200 A with Front-Connected Flat (FCF) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

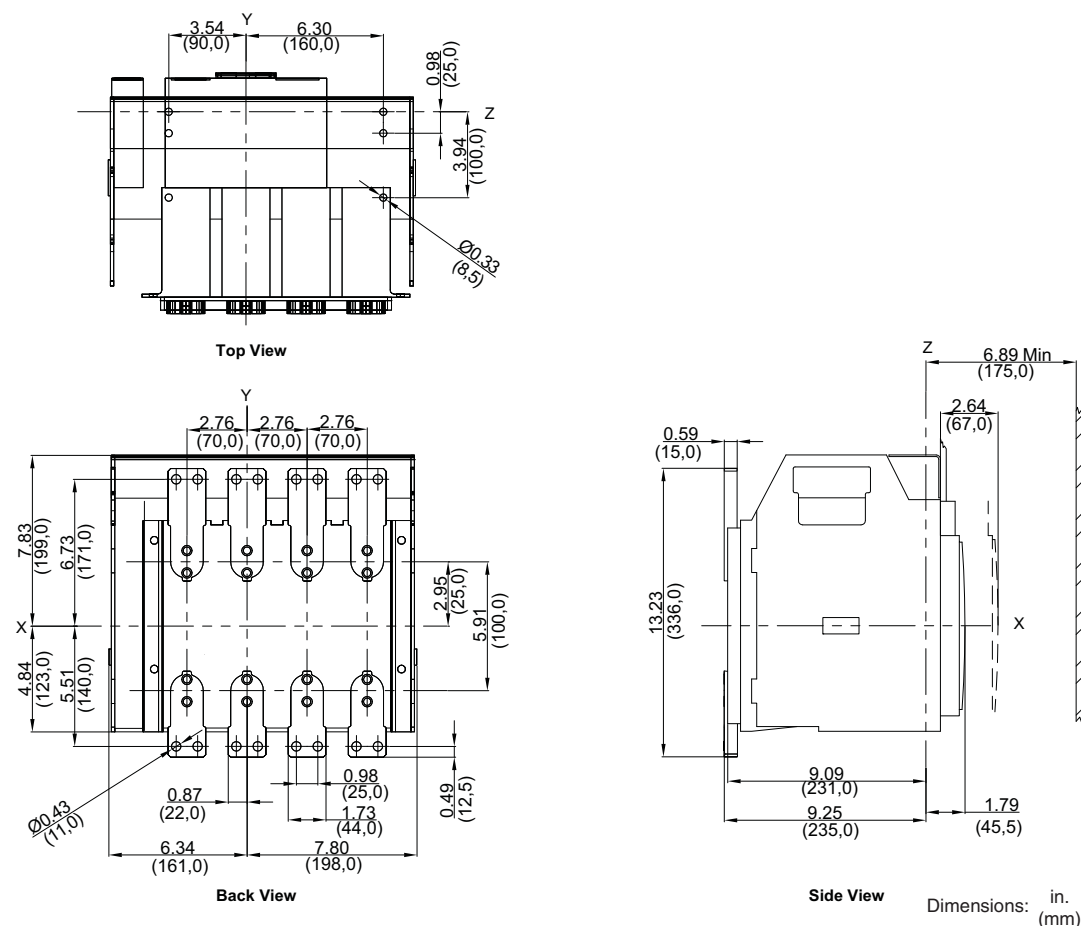
Figure 39: NS630b–NS1600 Drawout 3P Circuit Breaker ≤ 1600 A with Front-Connected Flat (FCF) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

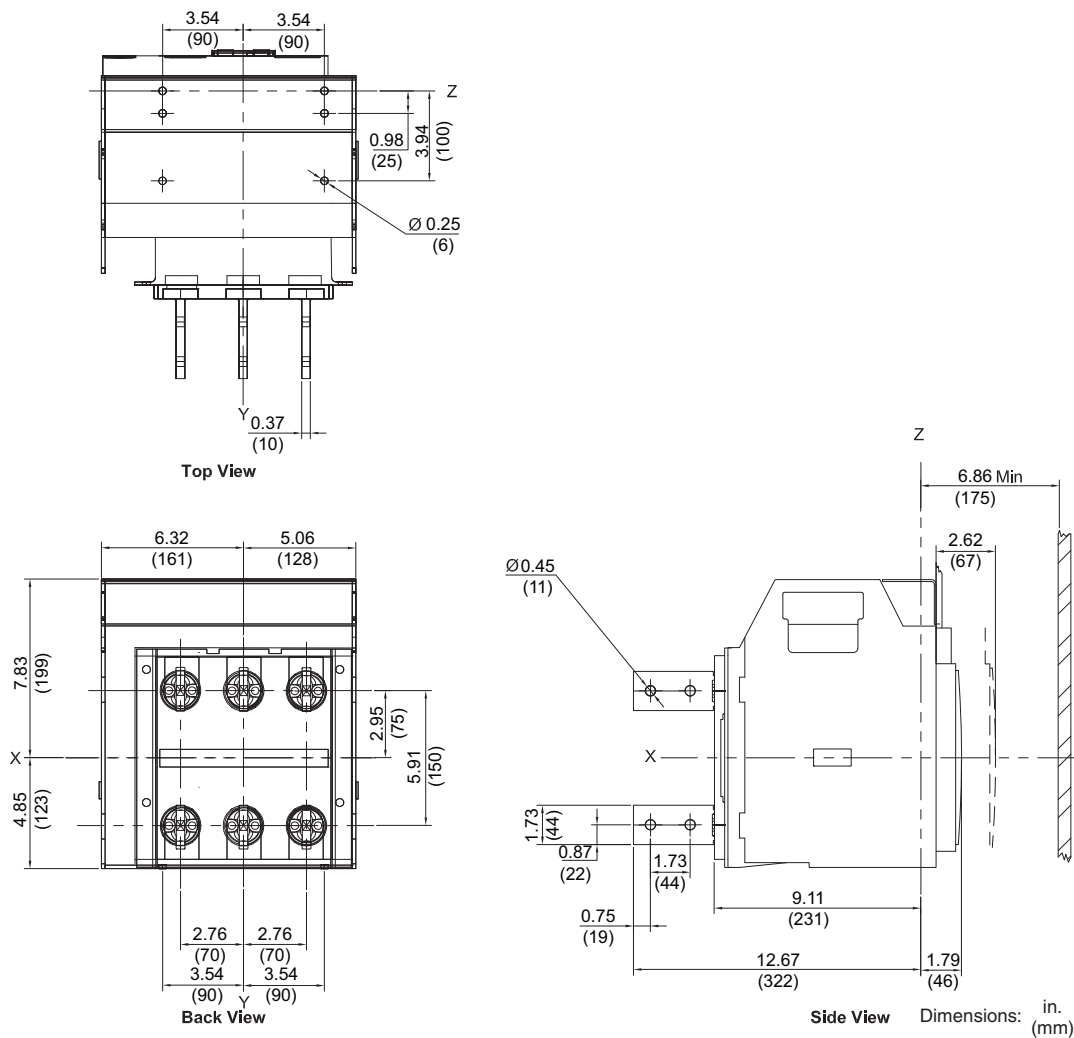
Figure 40: NS630b–NS1600 Drawout 4P Circuit Breaker ≤ 1600 A with Front-Connected Flat (FCF) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

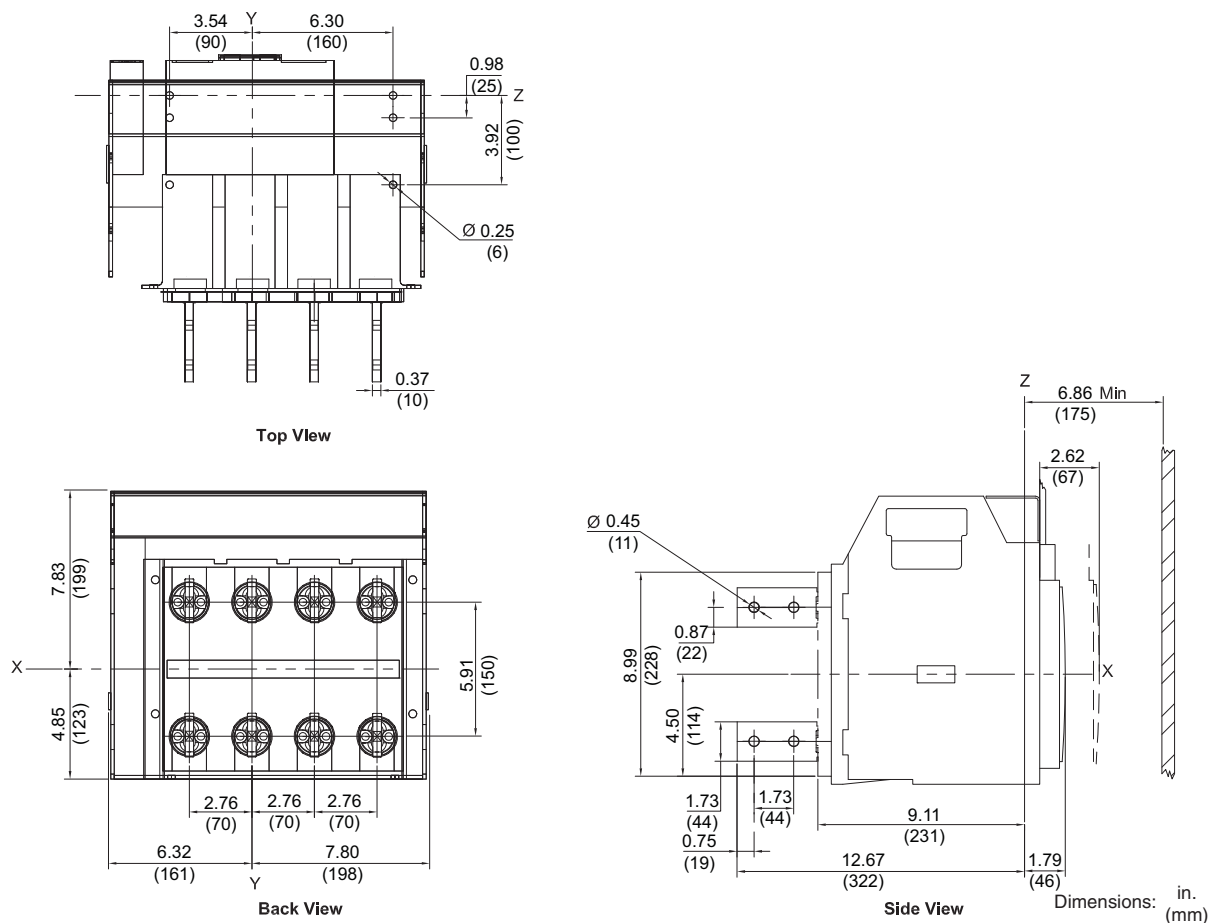
Figure 41: P-Frame Drawout 3P Circuit Breaker ≤ 1200 A with Rear-Connected “T” Vertical (RCTV) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

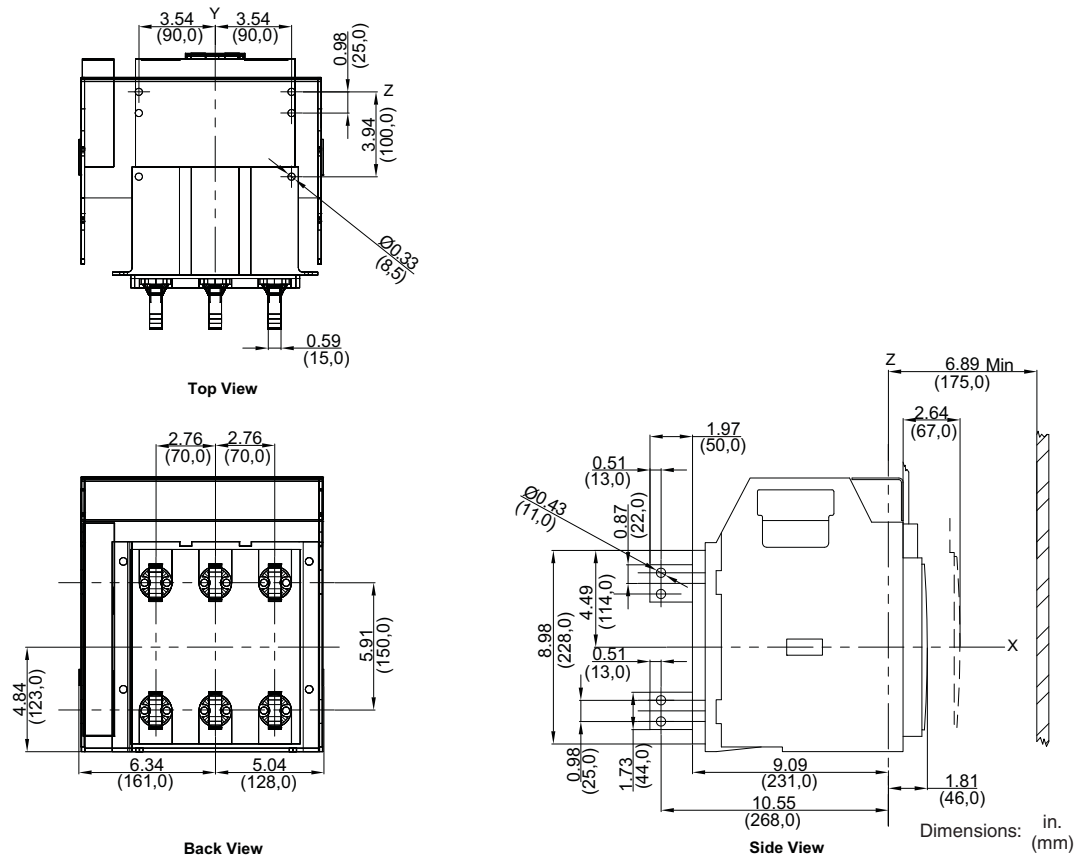
Figure 42: P-Frame Drawout 4P Circuit Breaker ≤ 1200 A with Rear-Connected “T” Vertical (RCTV) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

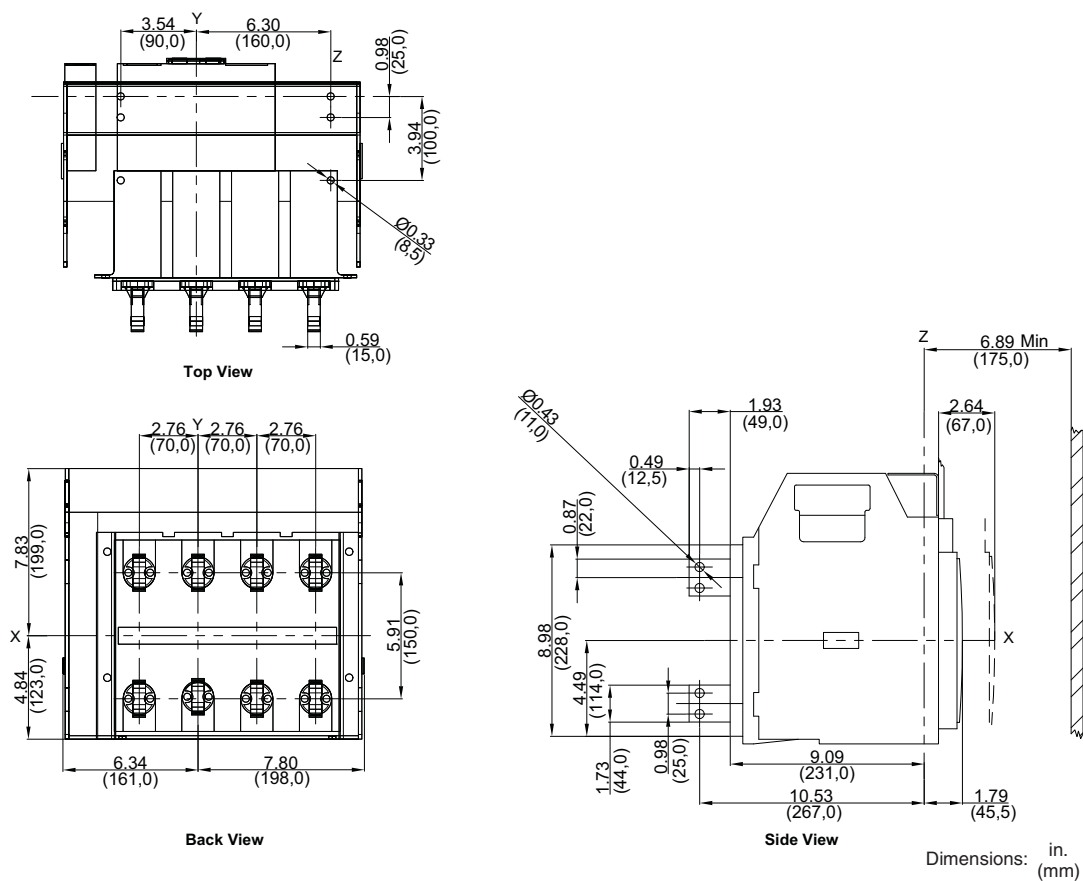
Figure 43: NS630b–NS1600 Drawout 3P Circuit Breaker ≤ 1600 A with Rear-Connected “T” Vertical (RCTV) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

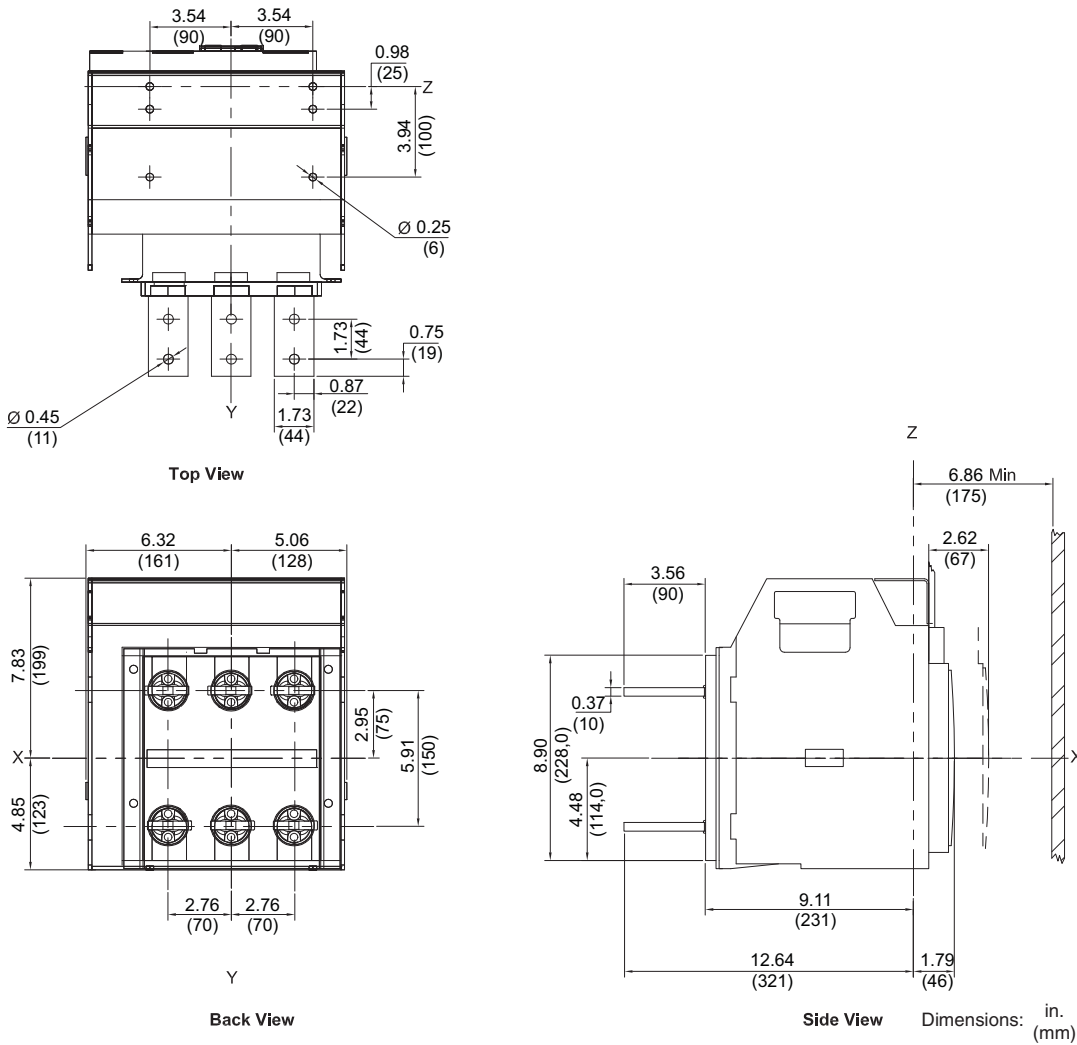
Figure 44: NS630b–NS1600 Drawout 4P Circuit Breaker ≤ 1600 A with Rear-Connected “T” Vertical (RCTV) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

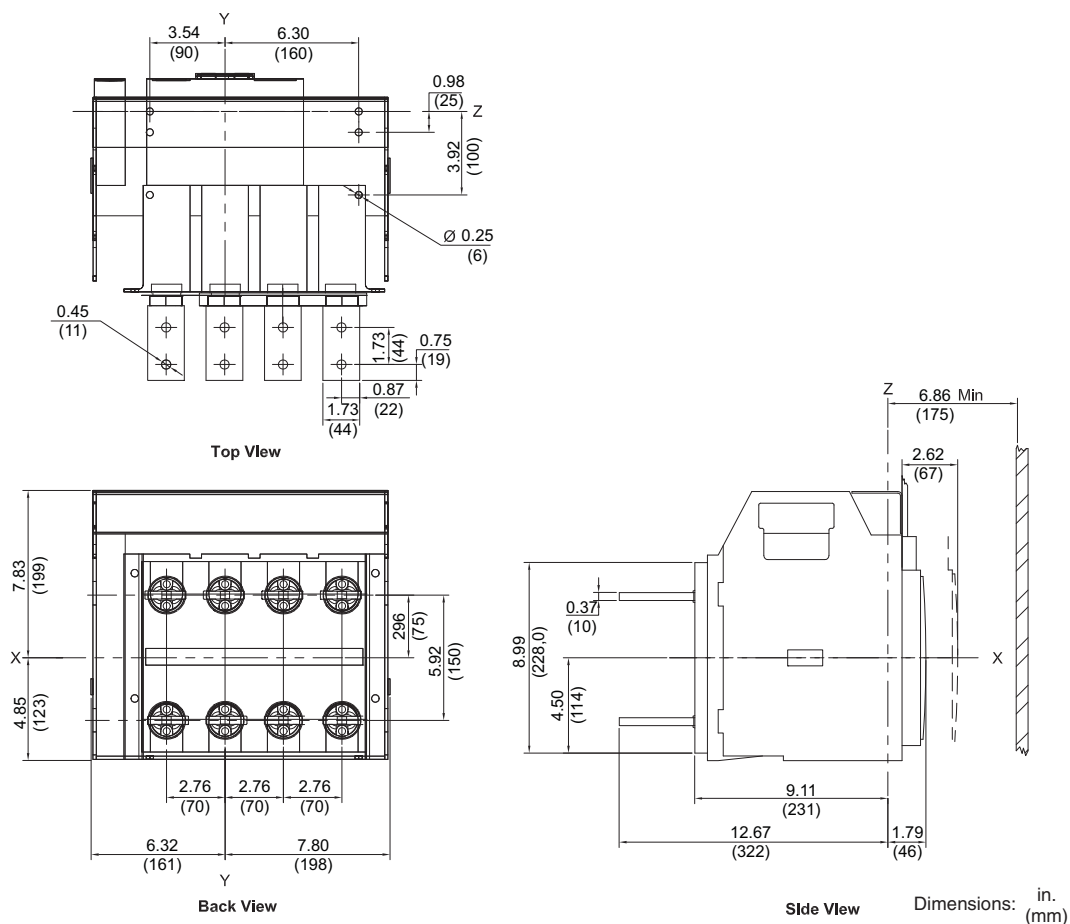
Figure 45: P-Frame Drawout 3P Circuit Breaker ≤ 1200 A with Rear-Connected “T” Horizontal (RCTH) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

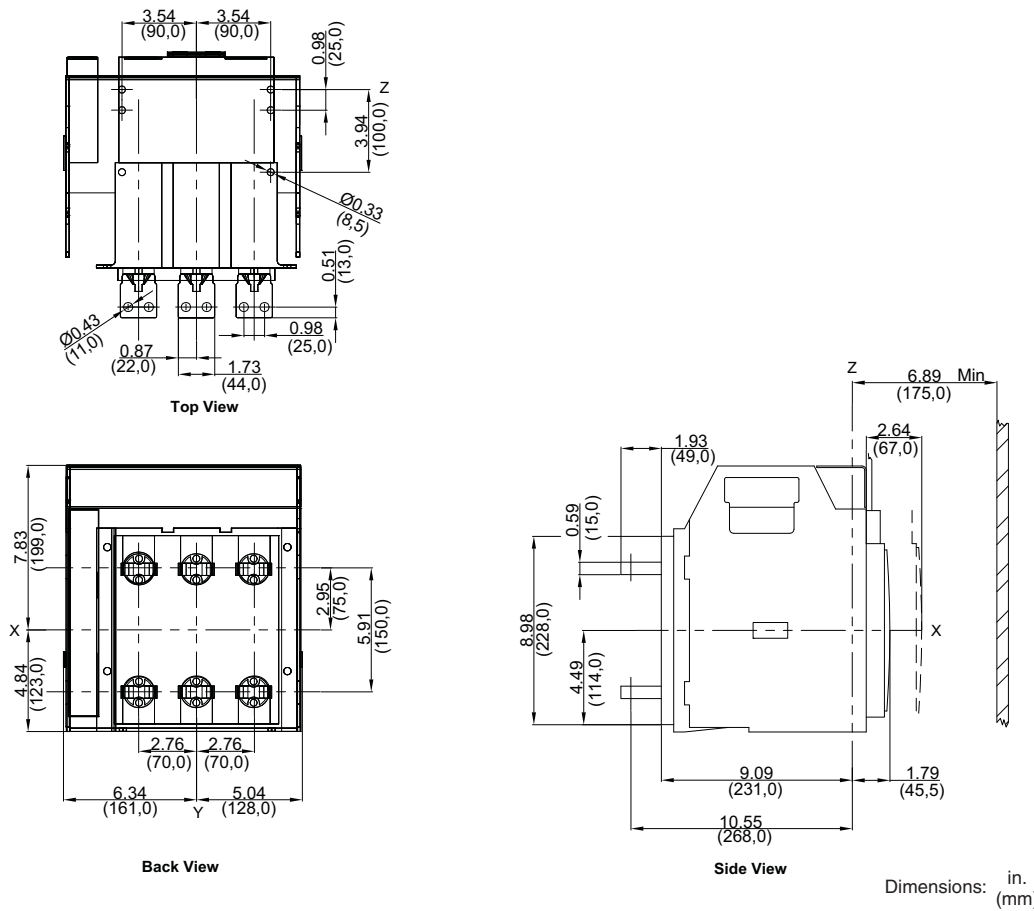
Section 11—Circuit Breaker Dimensional Drawings

Figure 46: P-Frame Drawout 4P Circuit Breaker ≤ 1200 A with Rear-Connected “T” Horizontal (RCTH) Connectors



Section 11—Circuit Breaker Dimensional Drawings

Figure 47: NS630b-NS1600 Drawout 3P Circuit Breaker ≤ 1600 A with Rear-Connected “T” Horizontal (RCTH) Connectors



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 48: NS630b–NS1600 Drawout 4P Circuit Breaker ≤ 1600 A with Rear-Connected “T” Horizontal (RCH) Connectors

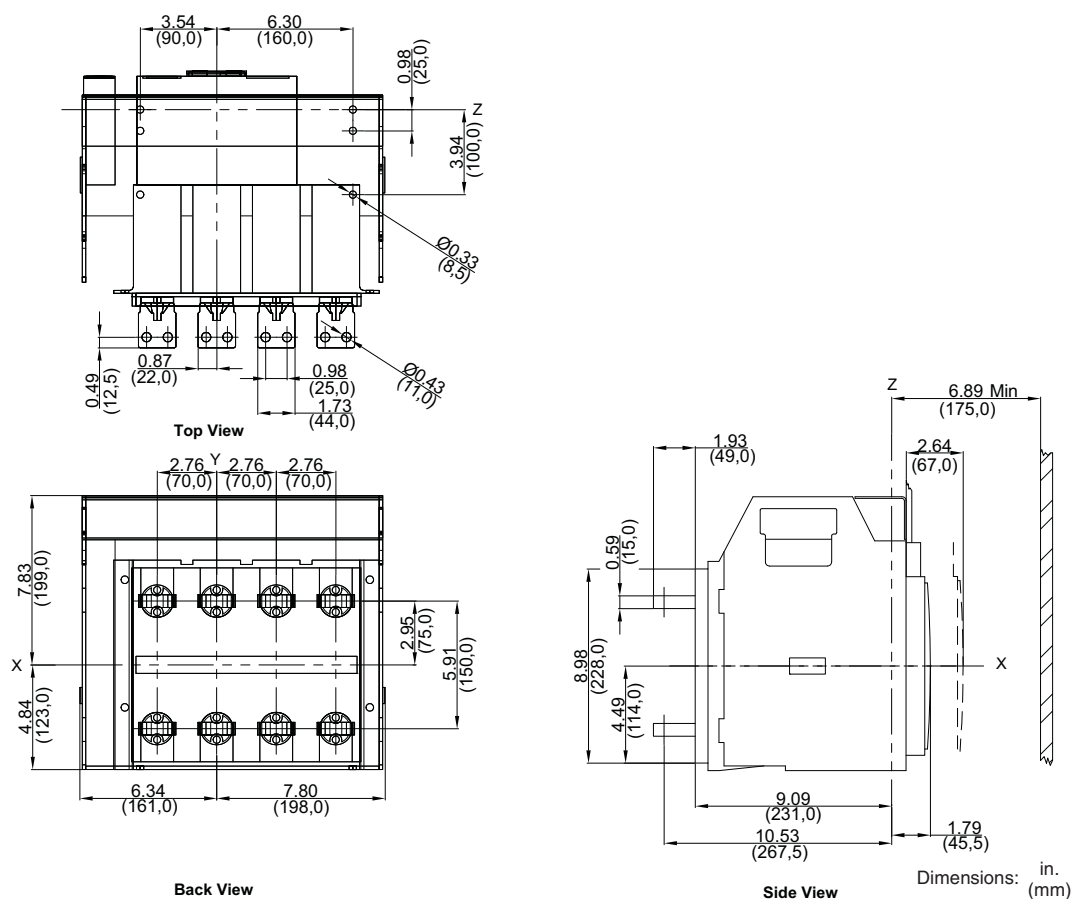
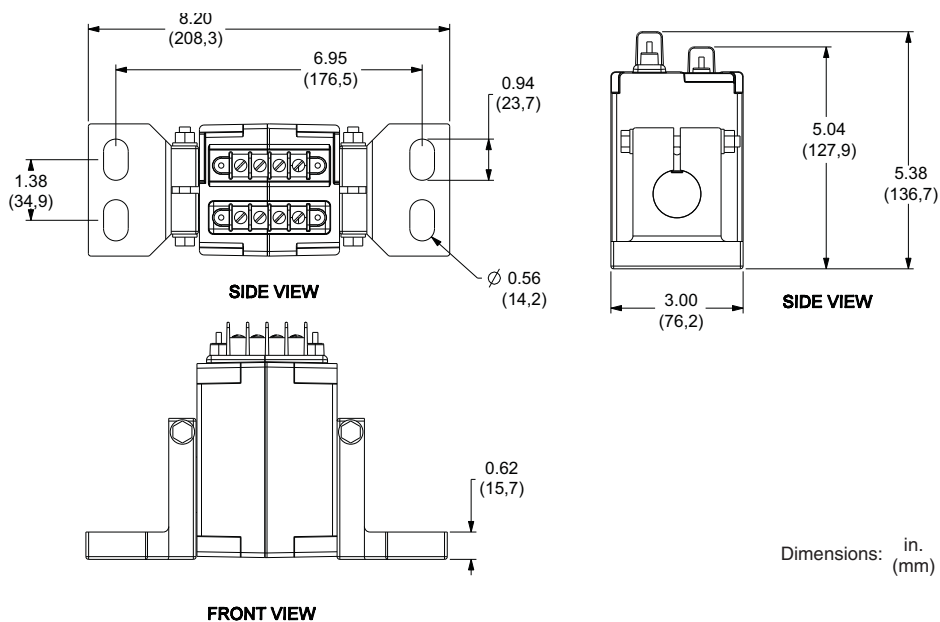


Figure 49: P-Frame and NS630b–NS1600 100–1600 A External Neutral Current Transformers



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Dimensions for R-Frame and NS1600b–NS3200 Circuit Breakers

Figure 50: R-Frame Individually-Mounted UL Listed 3P Circuit Breaker

Minimum Enclosure Size

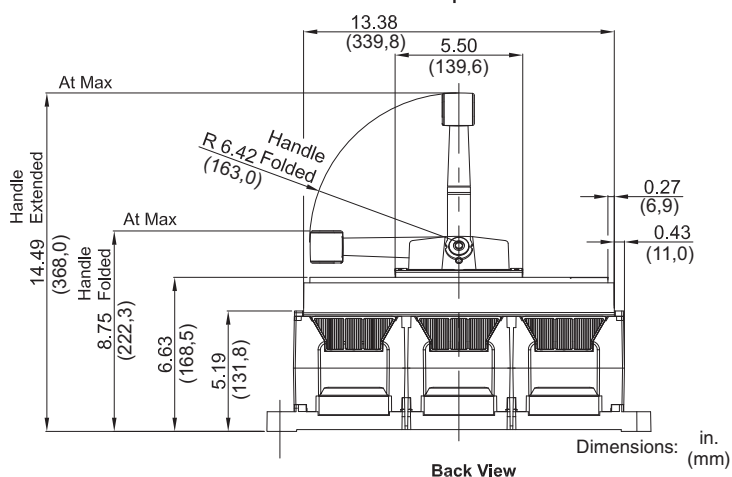
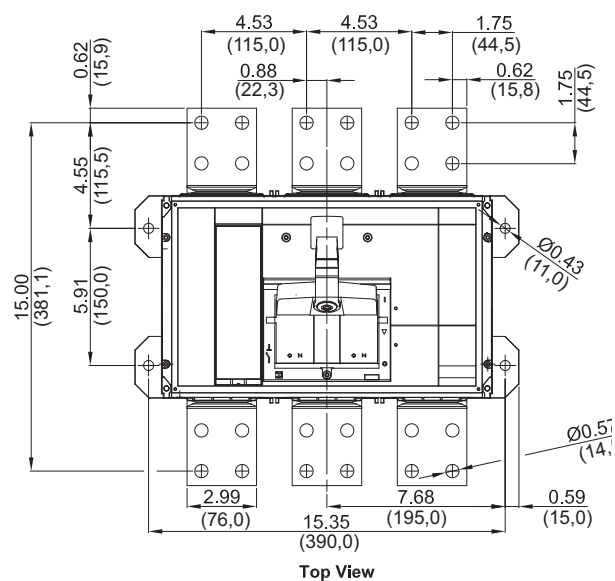
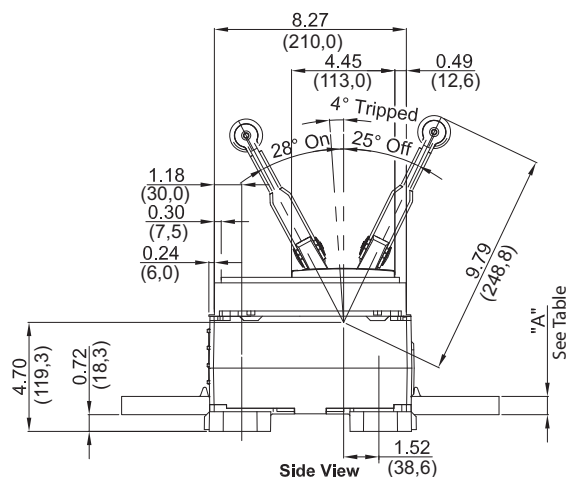
30 x 21 x 7
(762 x 533 x 178)

Minimum Ventilation

(100% Rated Circuit Breakers Only):

40.25 in.2 (250 cm2) on top and bottom of enclosure

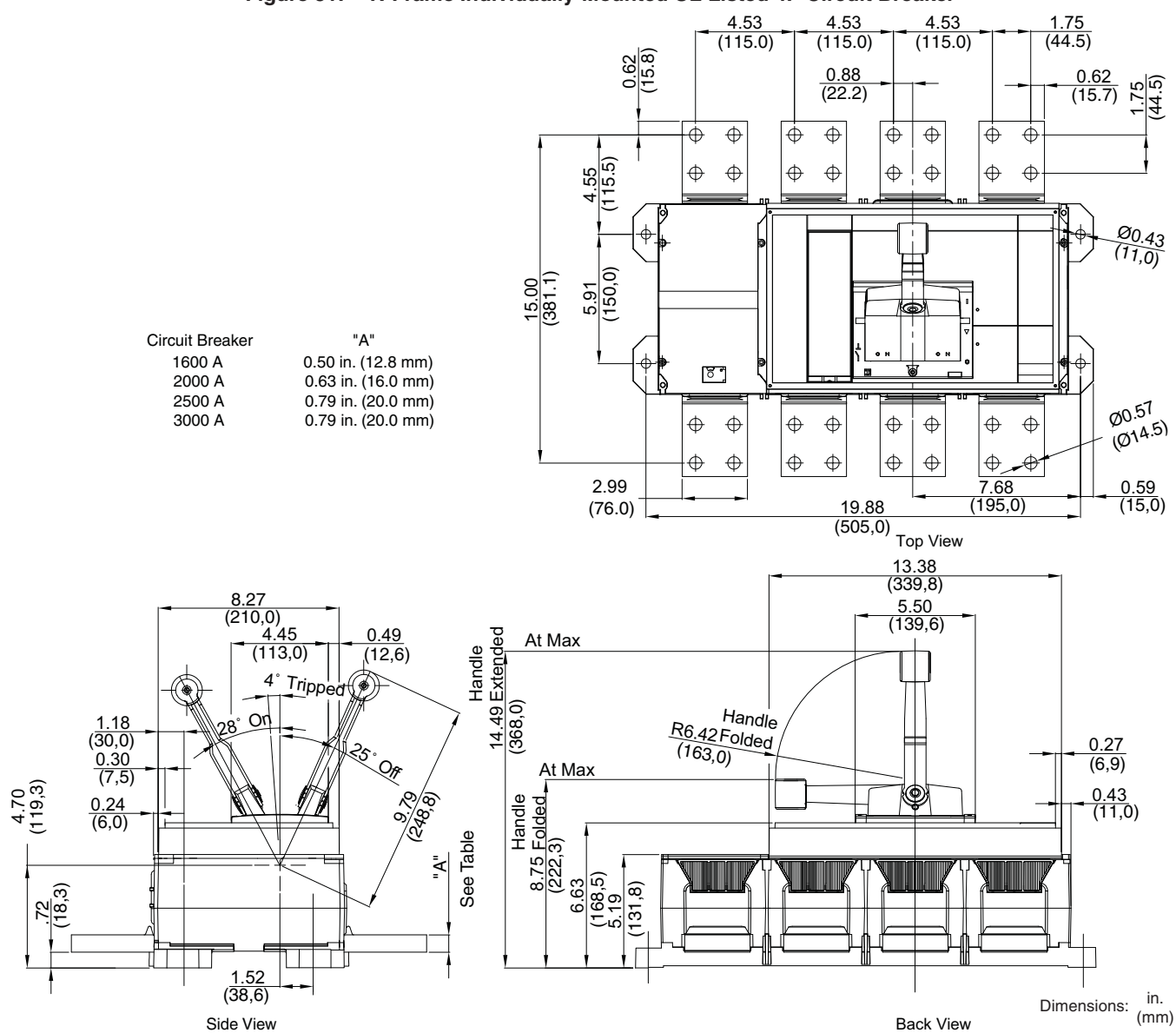
Circuit Breaker	"A"
1600 A	0.50 in. (12.8 mm)
2000 A	0.63 in. (16 mm)
2500 A	0.79 in. (20 mm)
3000 A	0.79 in. (20 mm)



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

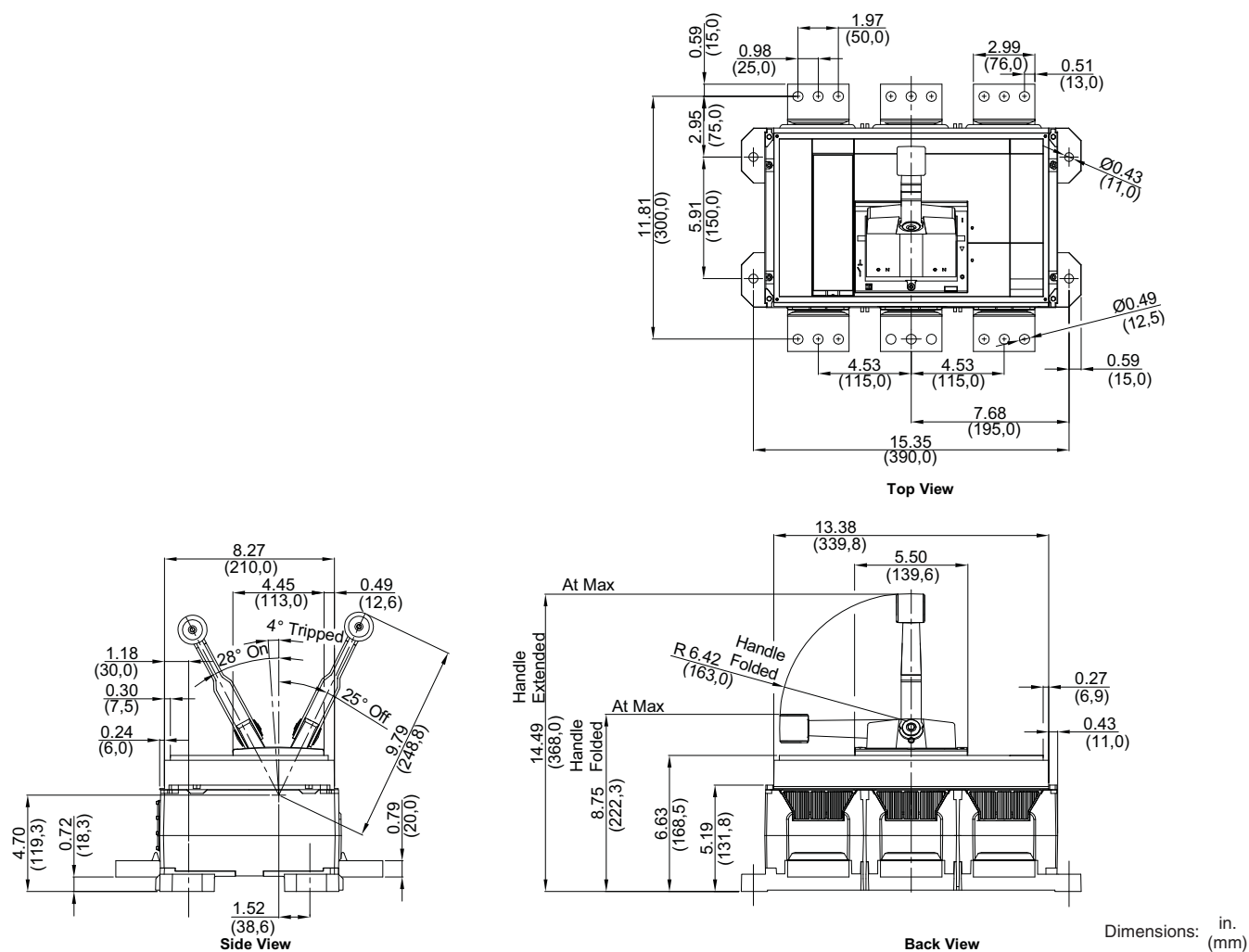
Section 11—Circuit Breaker Dimensional Drawings

Figure 51: R-Frame Individually-Mounted UL Listed 4P Circuit Breaker



Section 11—Circuit Breaker Dimensional Drawings

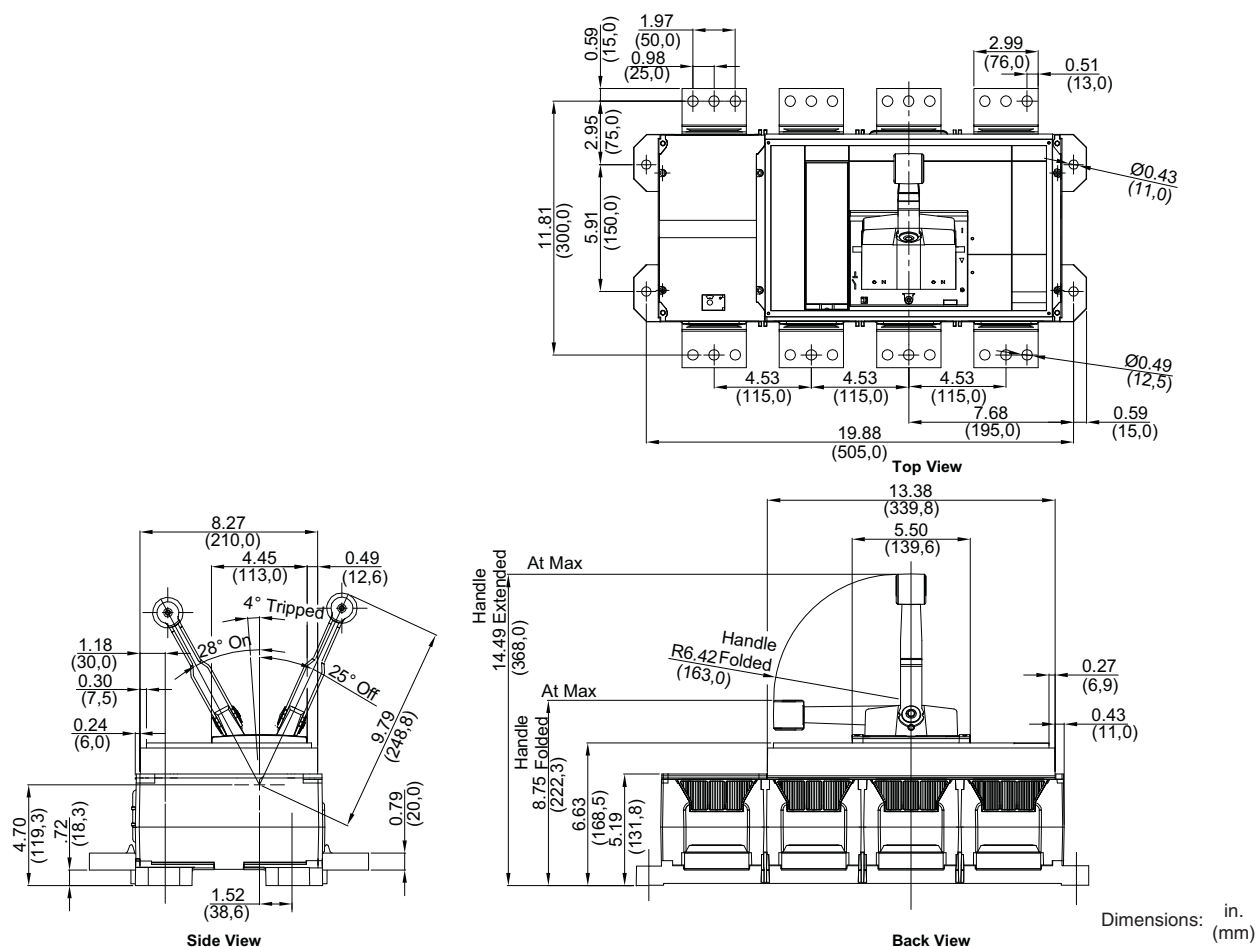
Figure 52: NS1600b–NS3200 Individually-Mounted IEC Rated, 3P Circuit Breaker



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

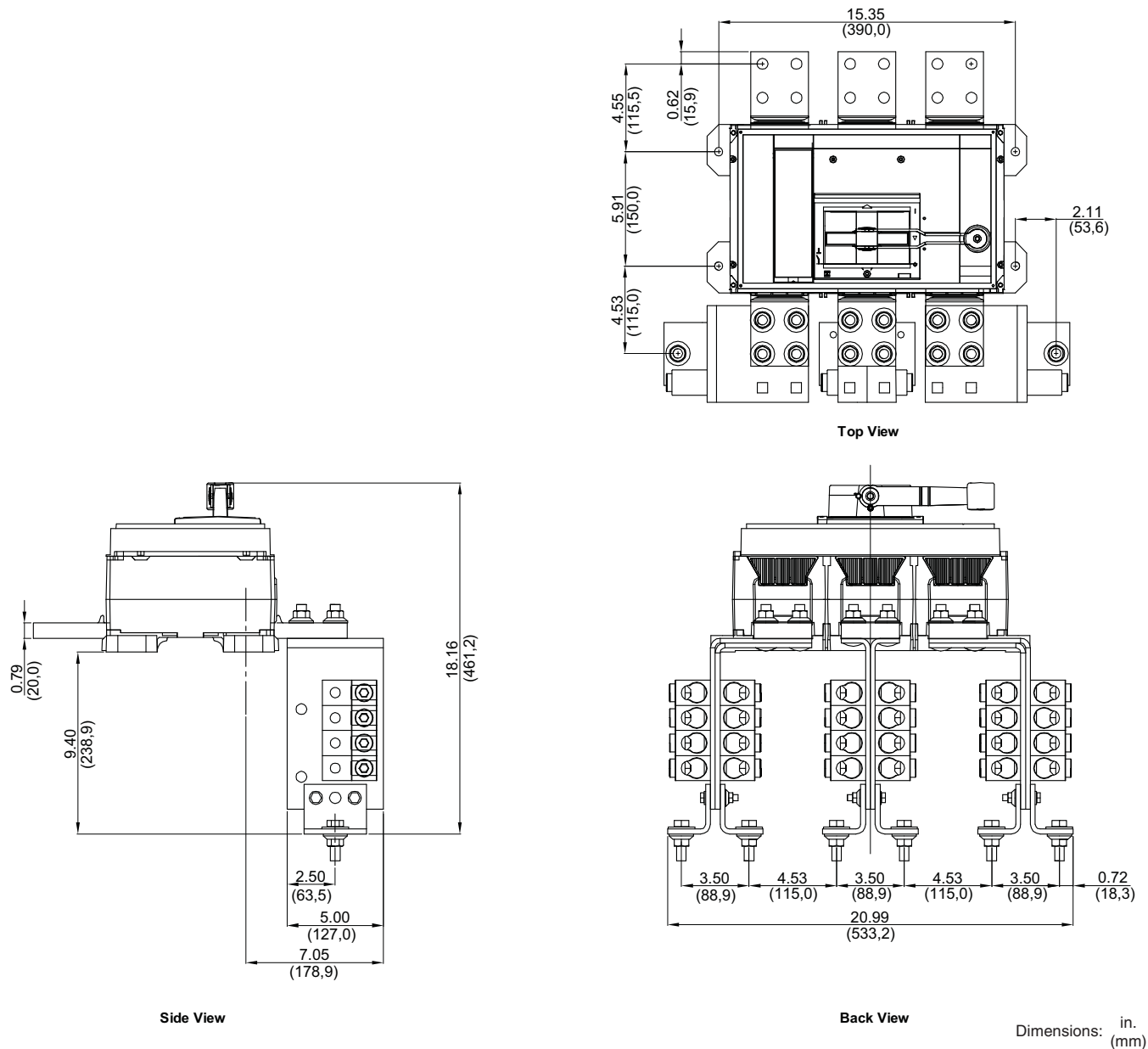
Figure 53: NS1600b–NS3200 Individually-Mounted IEC Rated 4P Circuit Breaker



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

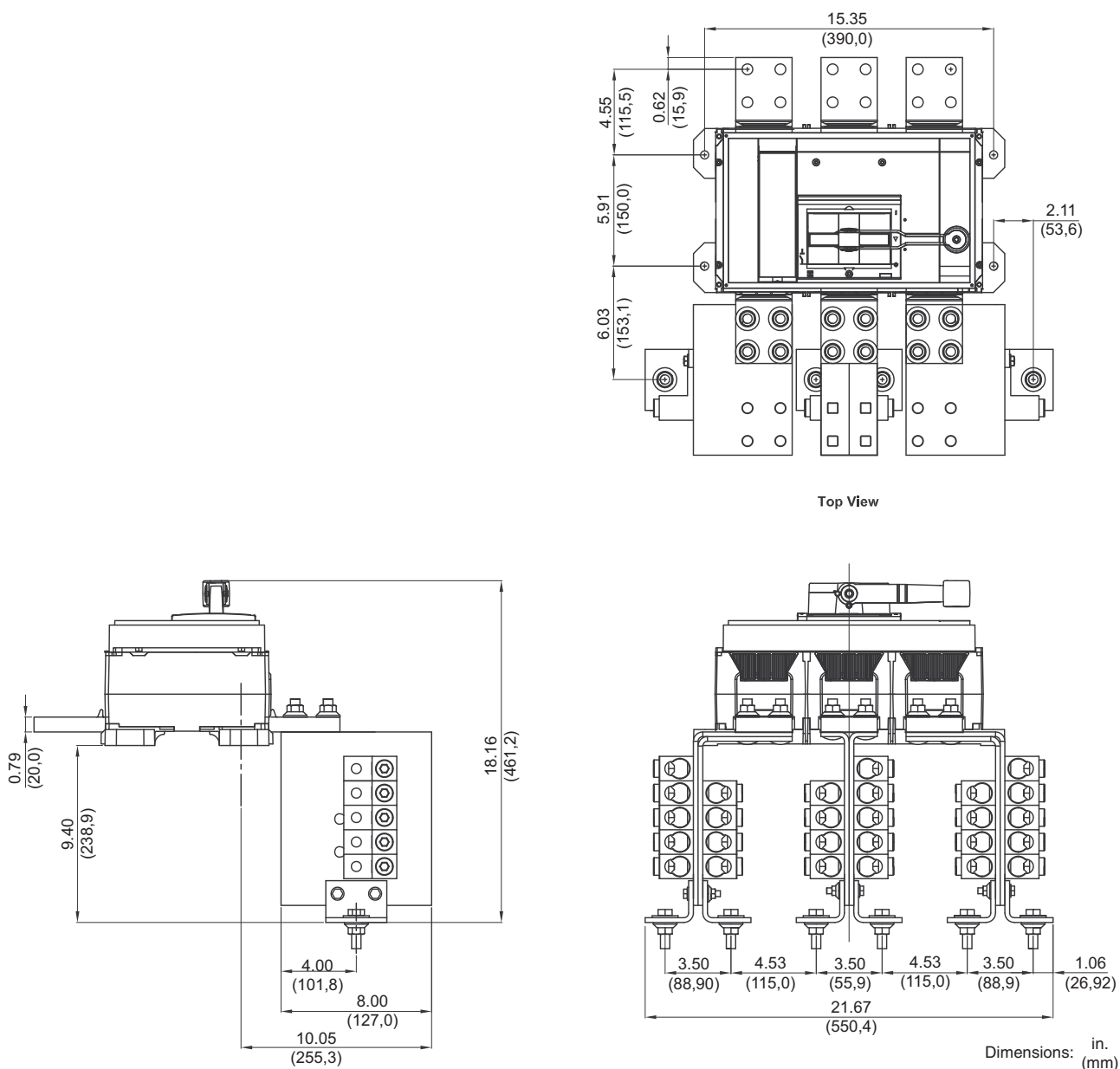
Figure 54: R-Frame RLTB 3P Terminal Pad (UL)



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

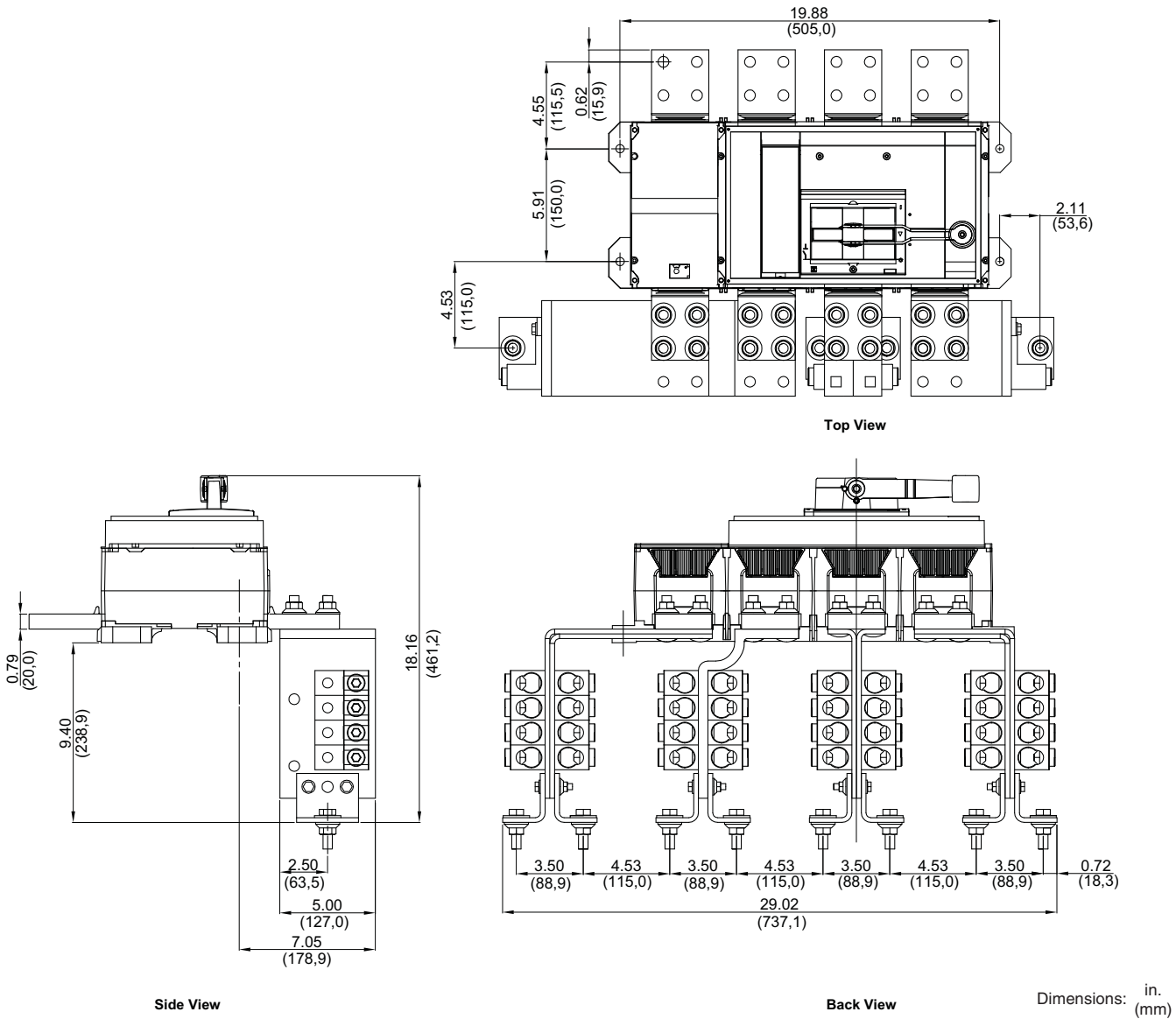
Section 11—Circuit Breaker Dimensional Drawings

Figure 55: R-Frame RL3TB 3P Terminal Pad (UL)



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 11—Circuit Breaker Dimensional Drawings

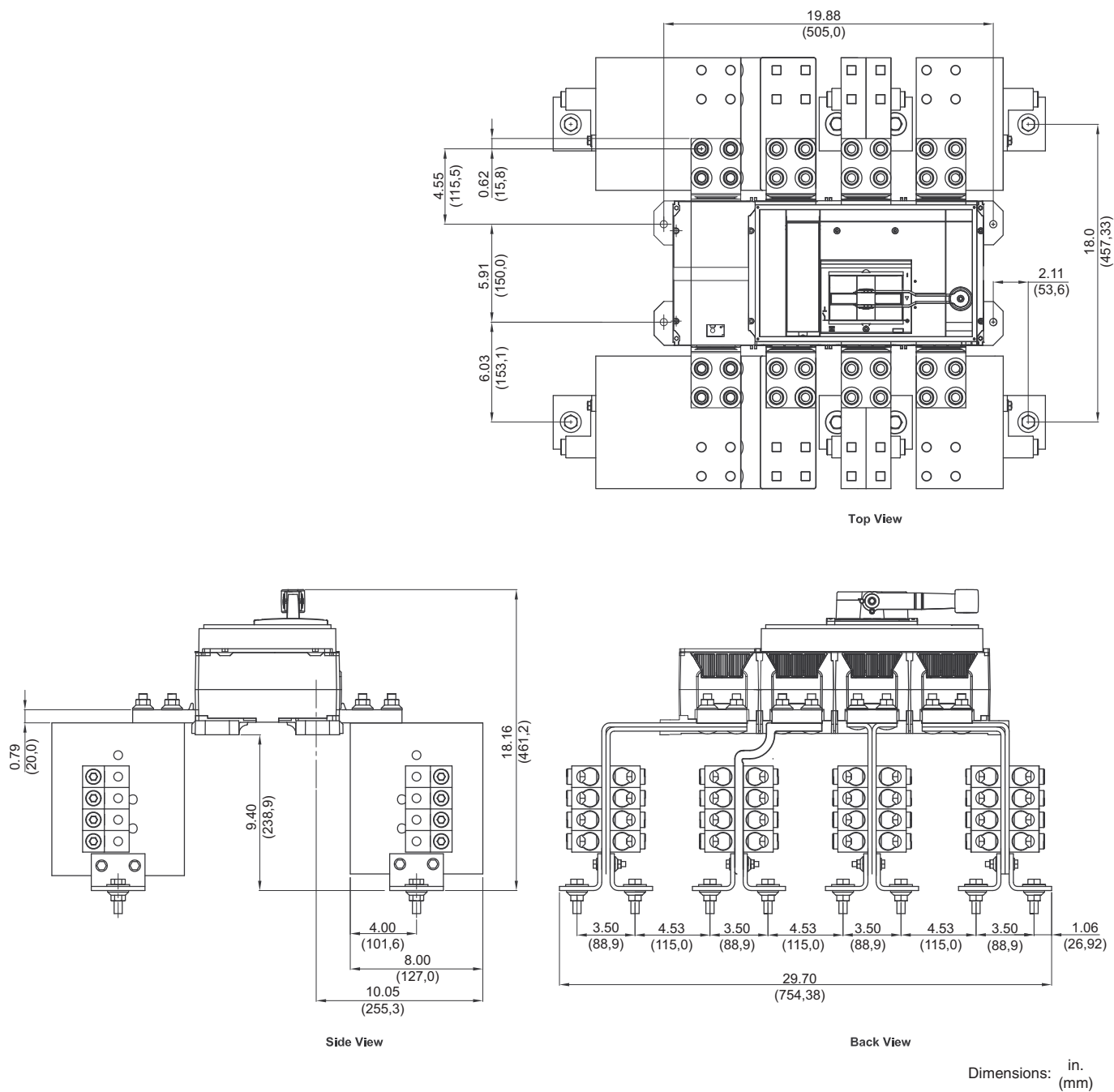
Figure 56: R-Frame RLTB 4P Terminal Pad (UL)



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

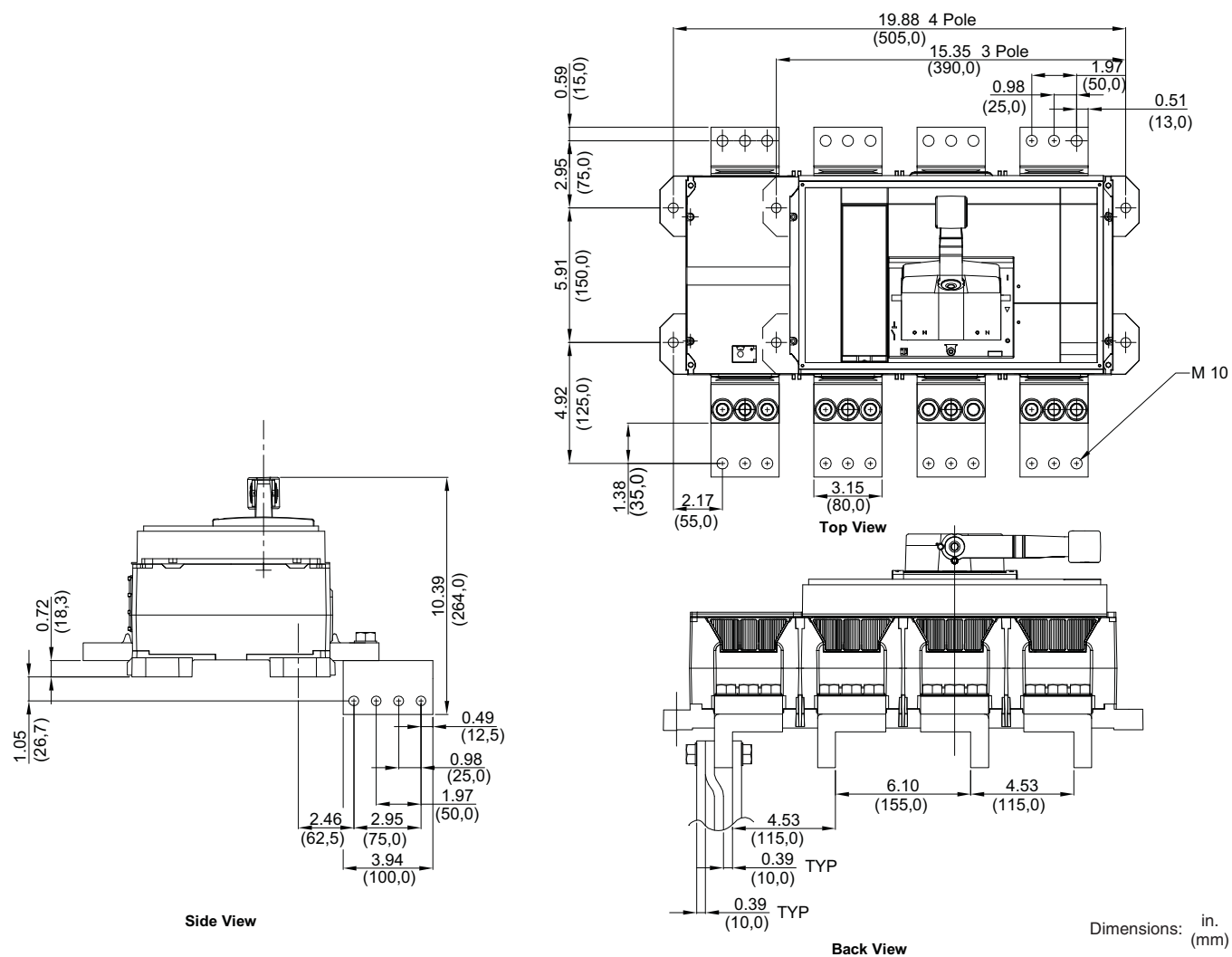
Section 11—Circuit Breaker Dimensional Drawings

Figure 57: R-Frame RL3TB 4P Terminal Pad (UL)



Section 11—Circuit Breaker Dimensional Drawings

Figure 58: NS1600b–NS3200 RLTBE Terminal Pad (IEC)



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 59: R-Frame and NS1600b–NS3200 Enclosure Mounting Holes and Door Cutouts

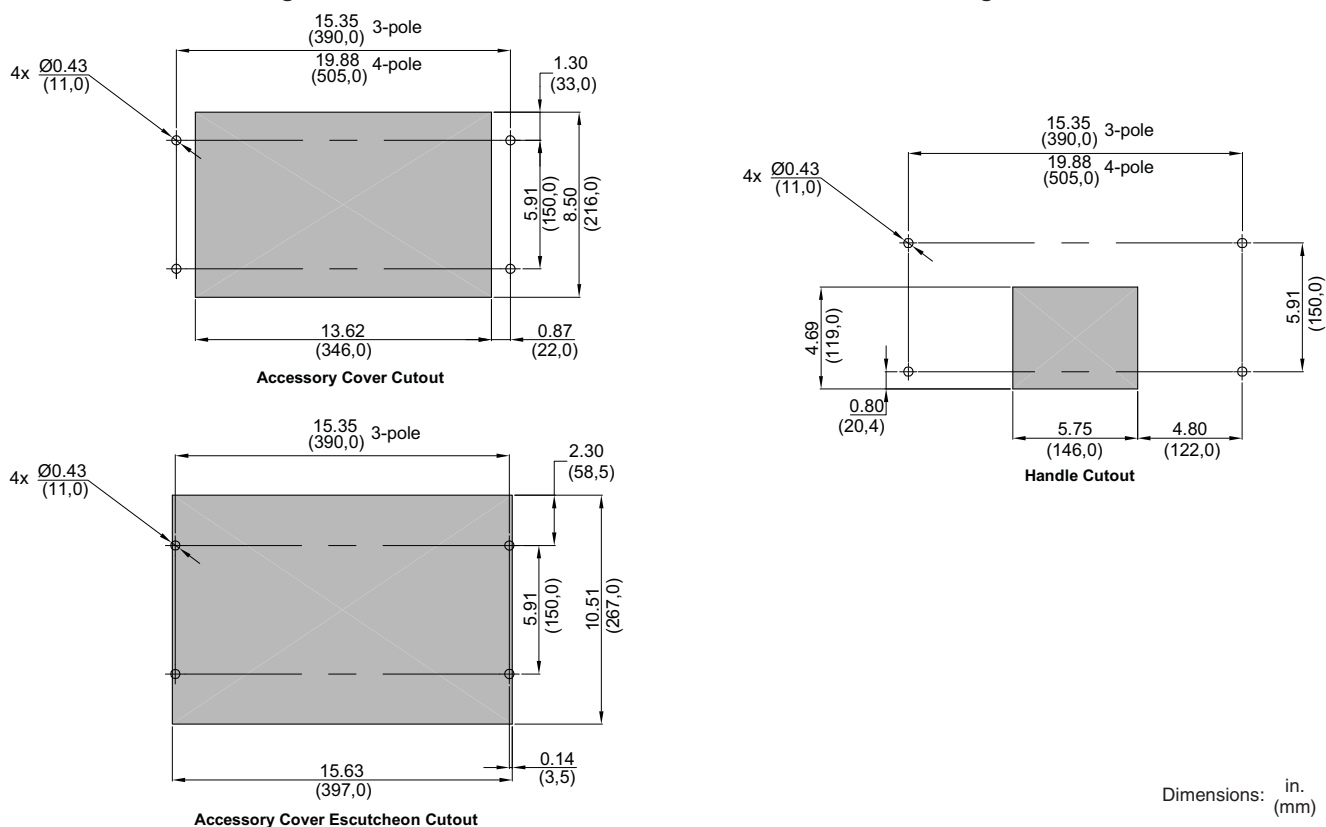
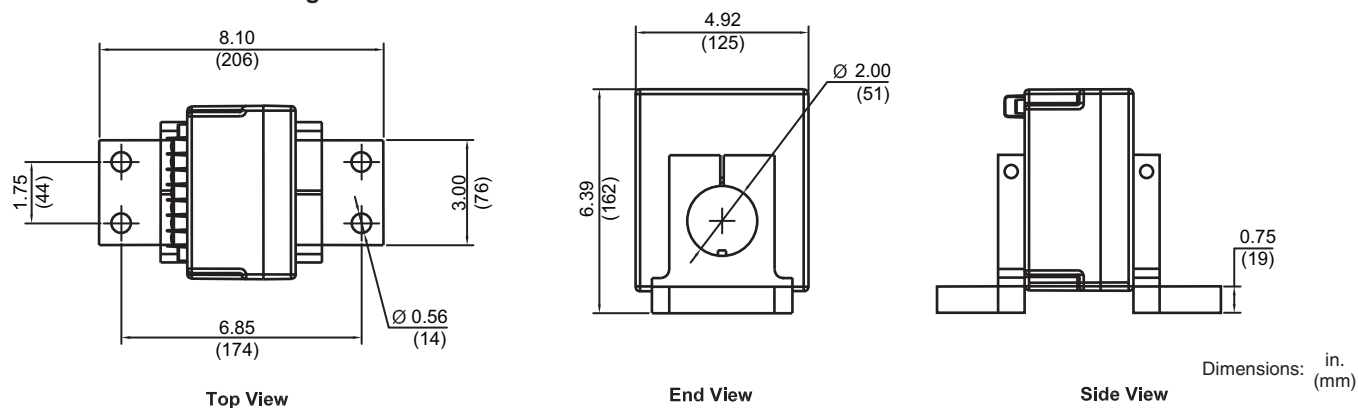


Figure 60: R-Frame and NS1600b–NS3200 100–1600 A External Neutral Current Transformers



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 11—Circuit Breaker Dimensional Drawings

Figure 61: R-Frame and NS1600b–NS3200 2000 A External Neutral Current Transformers

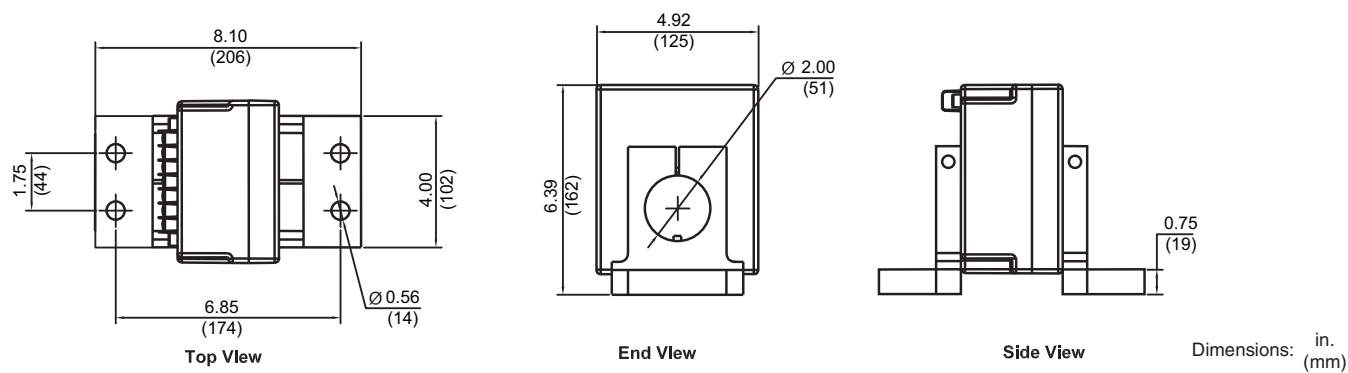
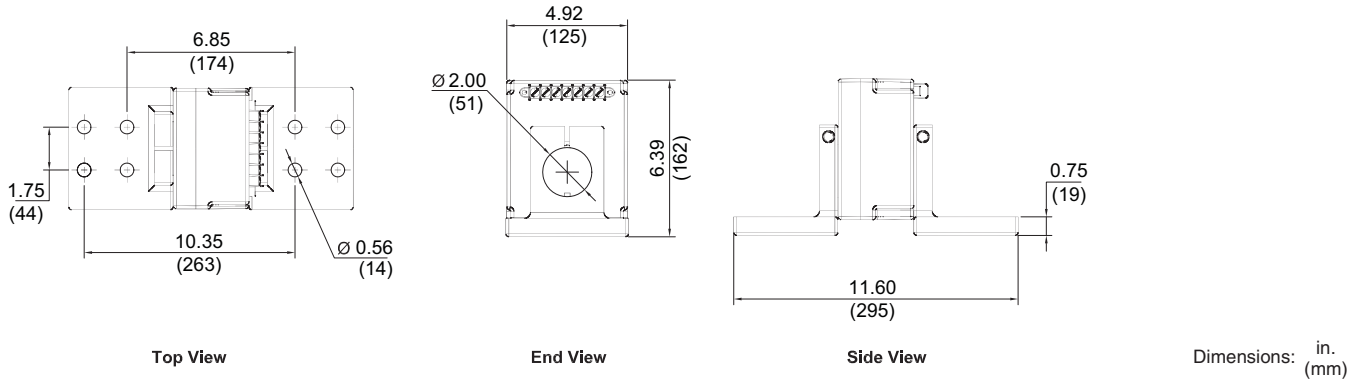


Figure 62: R-Frame and NS1600b–NS3200 2500–3200 A External Neutral Current Transformers



Section 12—Accessory Dimensional Drawings

Accessory Dimensions

Figure 63: IFE Ethernet Interface

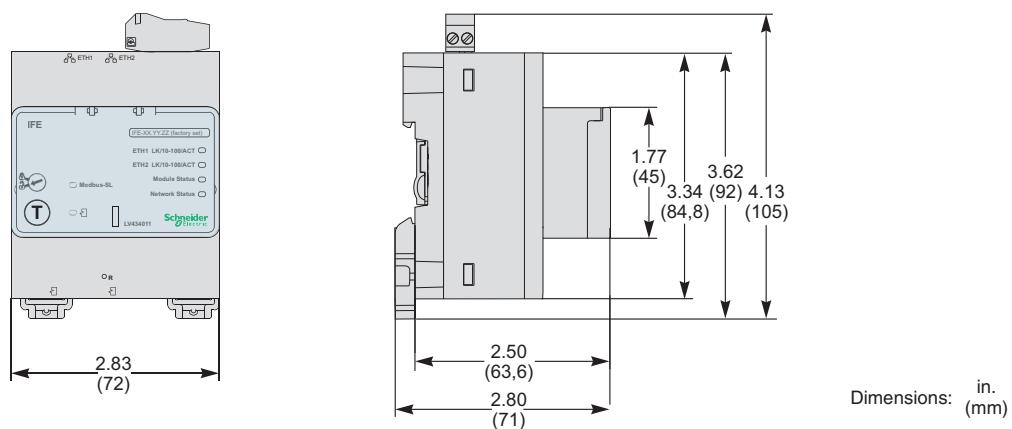


Figure 64: I/O (Input/Output) Application Module

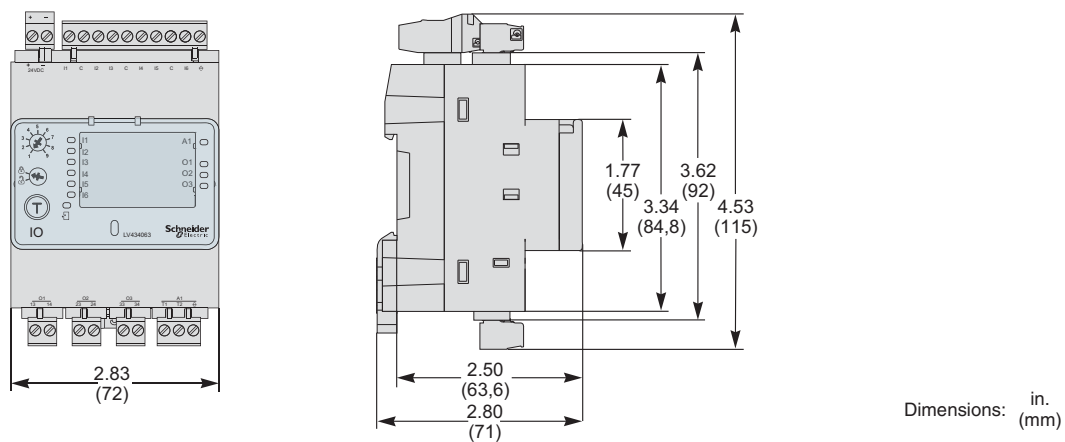


Figure 65: IFM Modbus-SL Interface

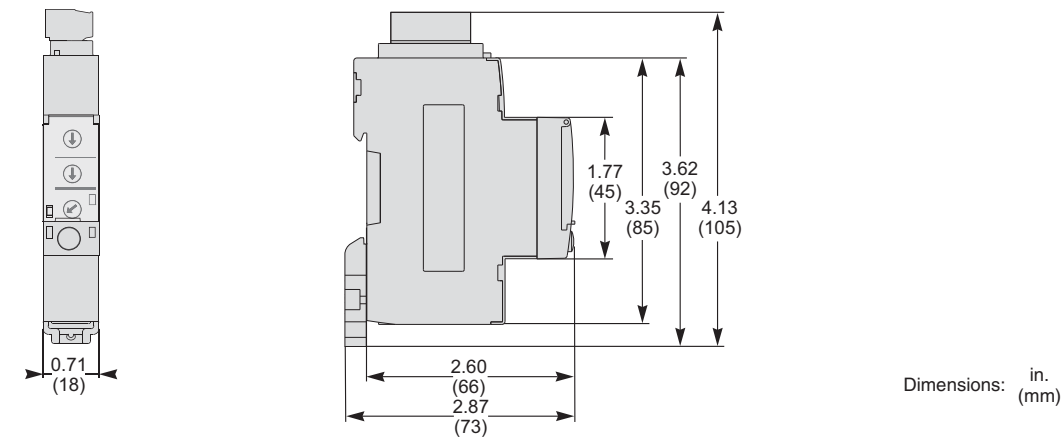


Figure 66: FDM121 Switchboard Display Dimensions

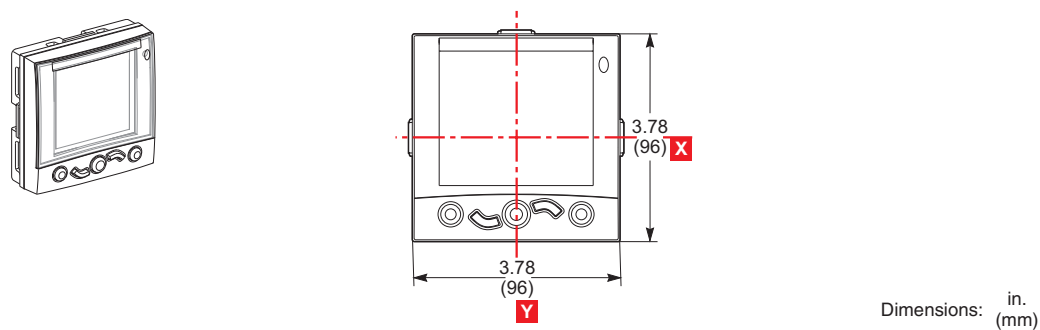


Figure 67: FDM121 Switchboard Display Mounting Through Panel

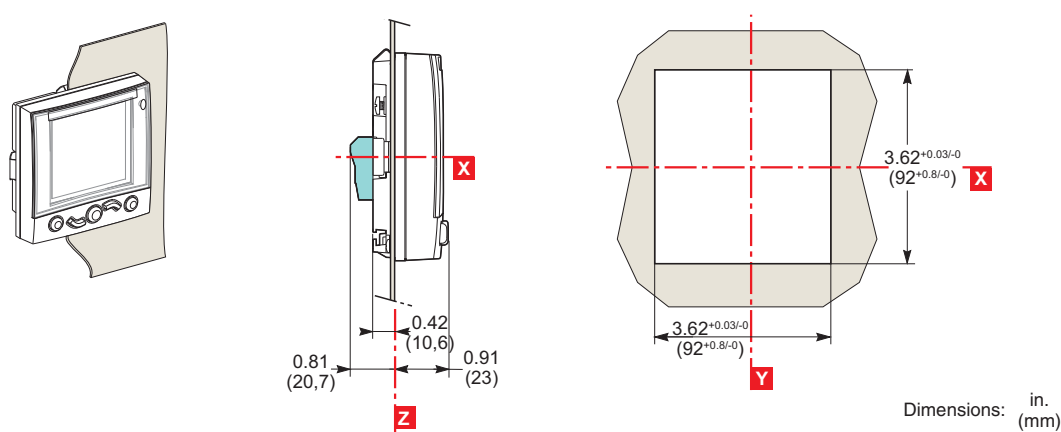


Figure 68: FDM121 Switchboard Display Mounting On Panel

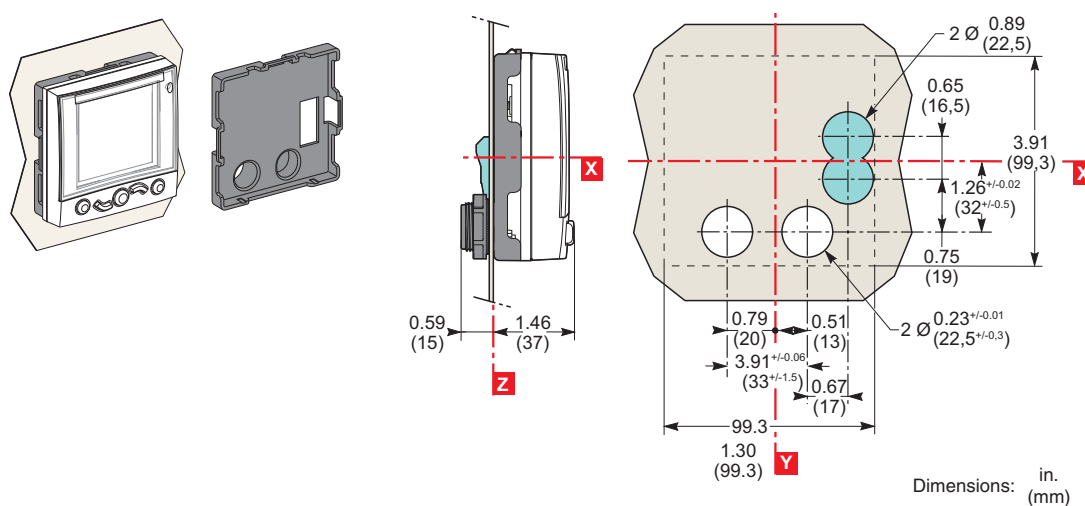


Figure 69: FDM128 Switchboard Display Dimensions

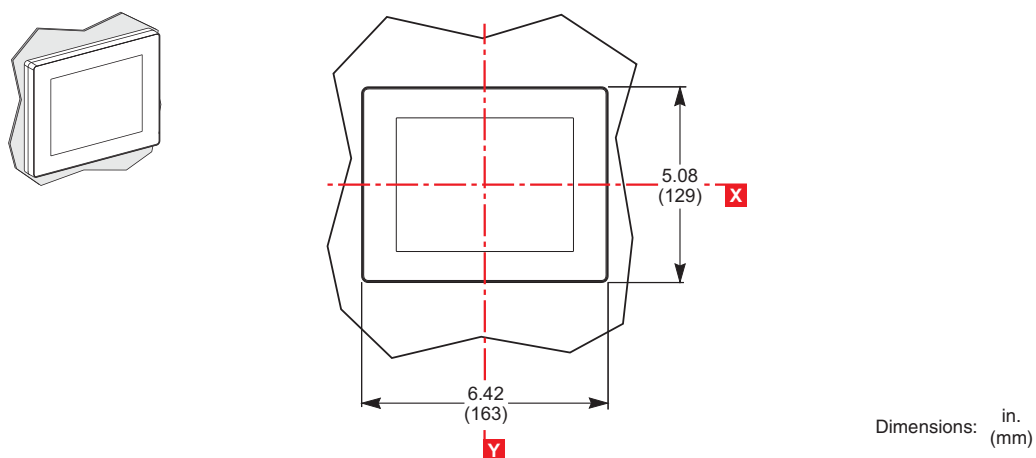
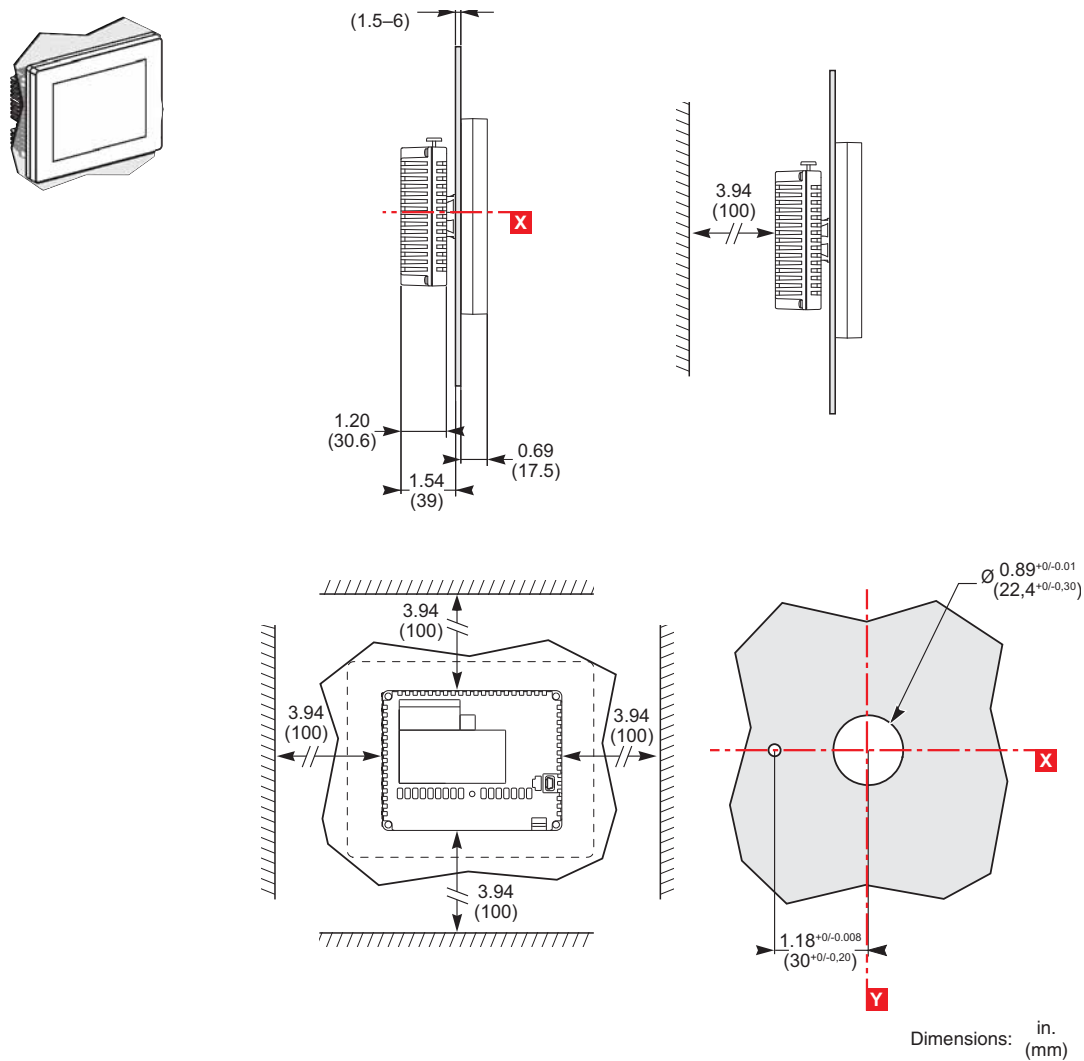
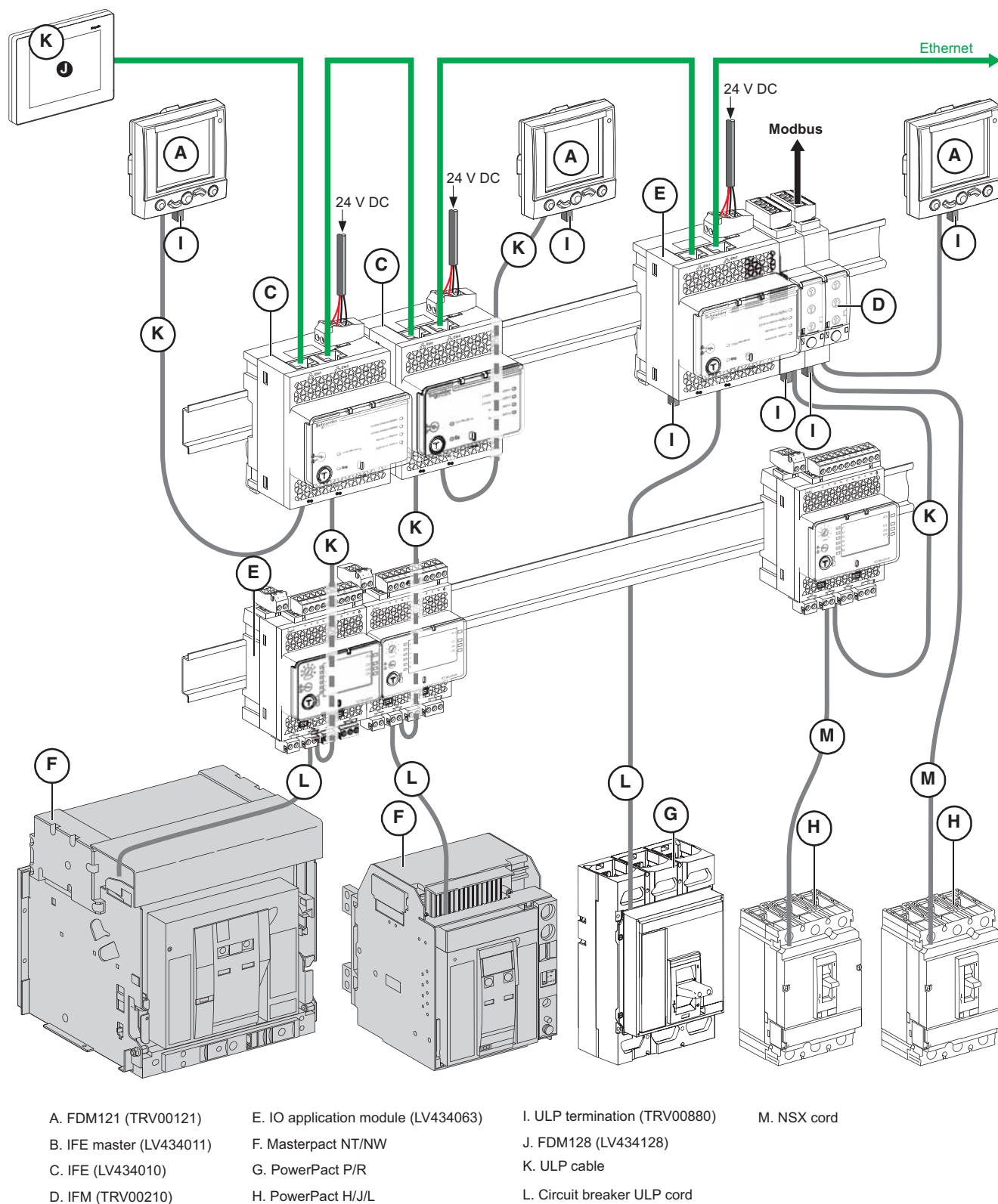


Figure 70: FDM128 Switchboard Display Mounting on Panel



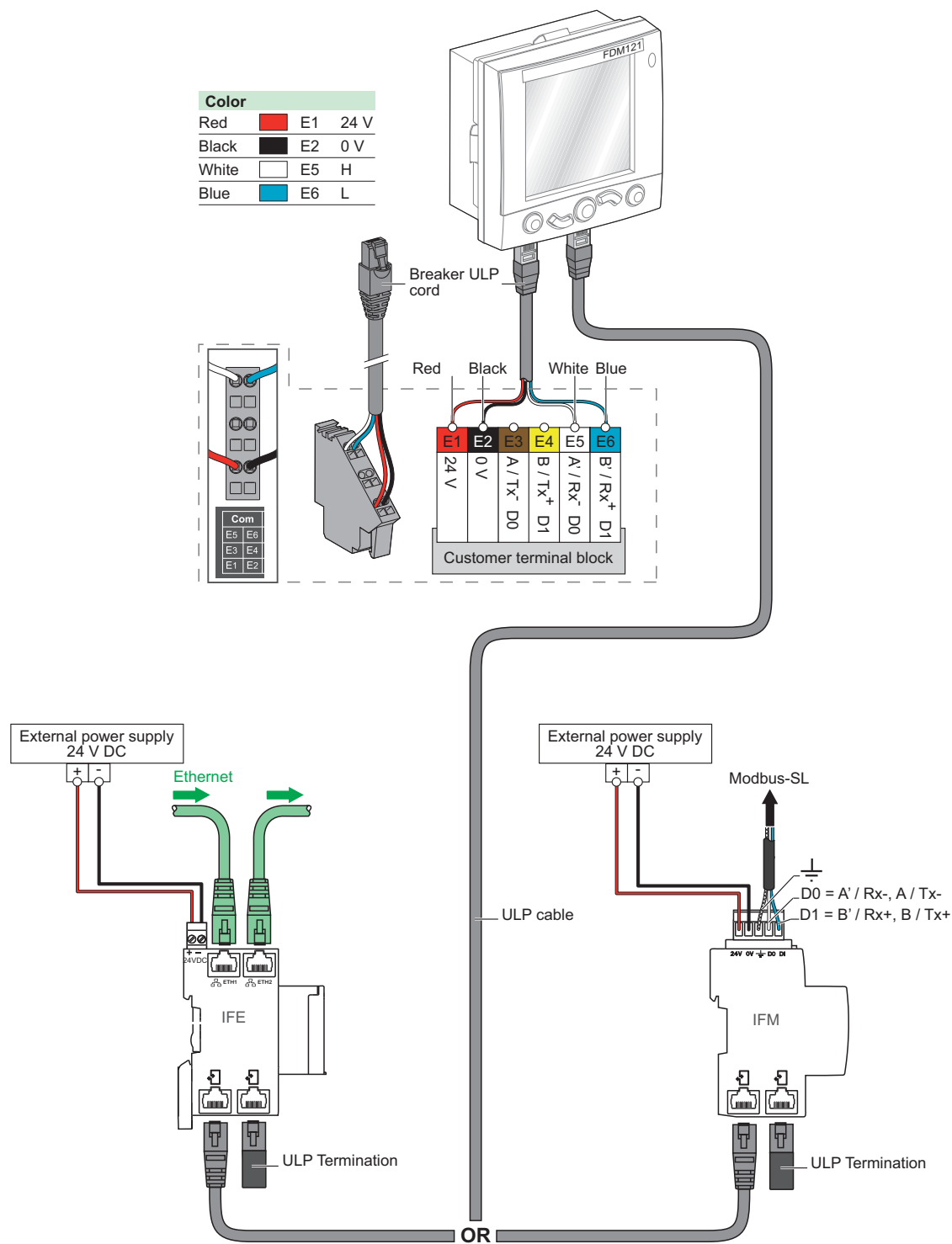
PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Figure 71: Masterpact, PowerPact, and Compact Circuit Breaker Communication



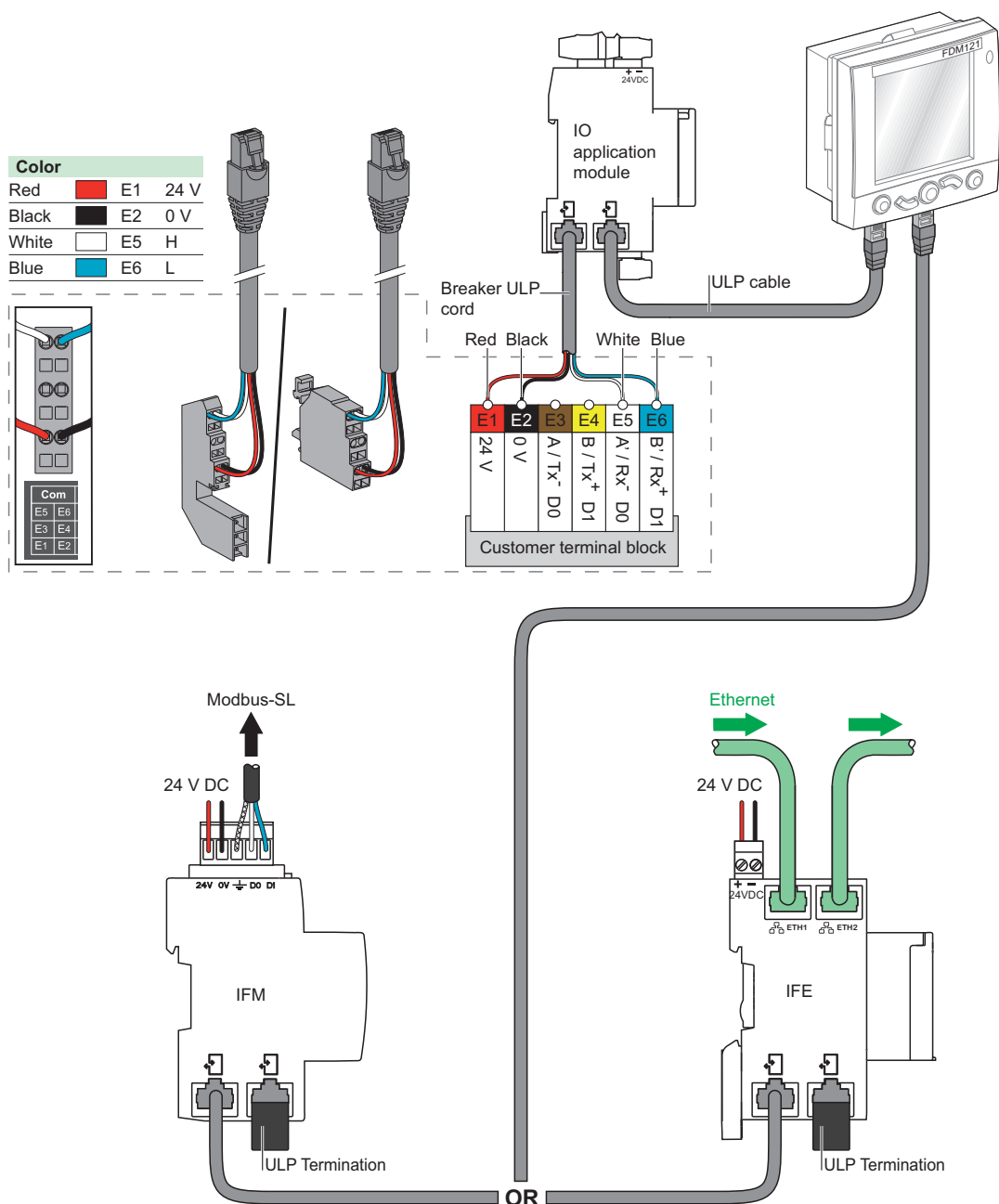
PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Figure 72: Fixed Masterpact, PowerPact, and Compact Circuit Breaker Connection to the Communication Interface Module



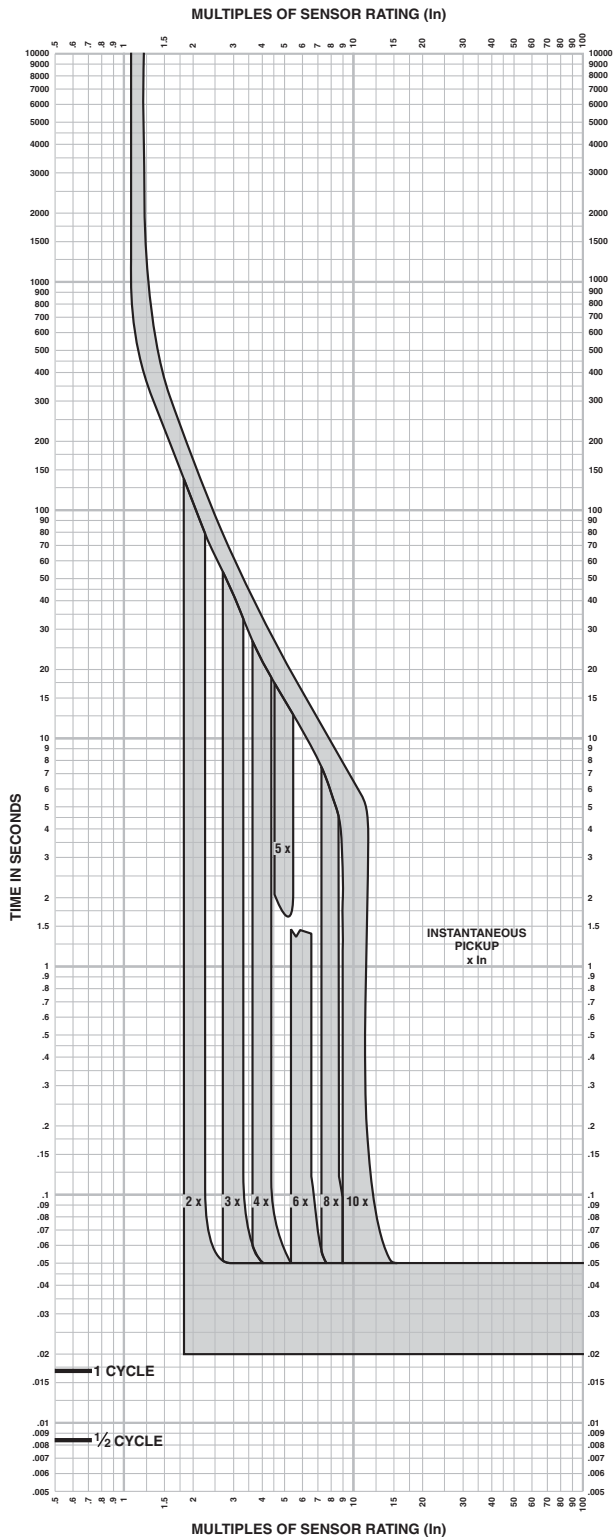
PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Figure 73: Drawout Masterpact, PowerPact, and Compact Circuit Breaker Connection to the I/O and Communication Interface Module



Section 13—Trip Curves

Basic Electronic Trip Unit ET 1.0I, M-Frame 800 A Characteristic Trip Curve



ELECTRONIC TRIP 1.0
CHARACTERISTIC TRIP CURVE NO. 613-14
Long-time Pickup and Delay
Instantaneous Pickup and Delay
2x–10x

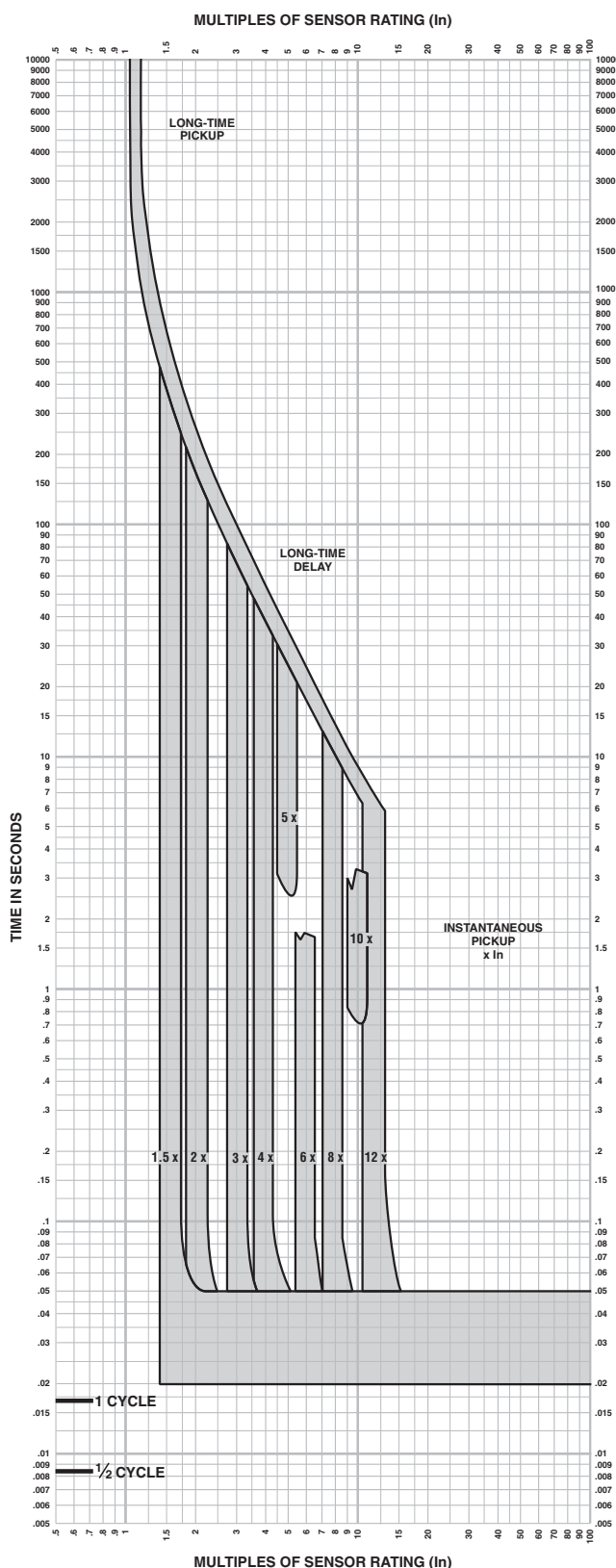
The time-current curve information is to be used for application and coordination purposes only.
Curves apply from -25°C to +70°C (-13°F to +158°F) ambient temperature.
Instantaneous override values are given on 613-10.

- Notes:**
1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
 2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Basic Electronic Trip Unit 1.0I P- and R-Frame Characteristic Trip Curve



ELECTRONIC TRIP 1.0I CHARACTERISTIC TRIP CURVE NO. 613-12

Long-time Pickup and Fixed Delay
Instantaneous Pickup
1.5x-12x

The time-current curve information is to be used for application and coordination purposes only.

Curves apply from -25°C to +70°C
(-13°F to +158°F) ambient temperature.

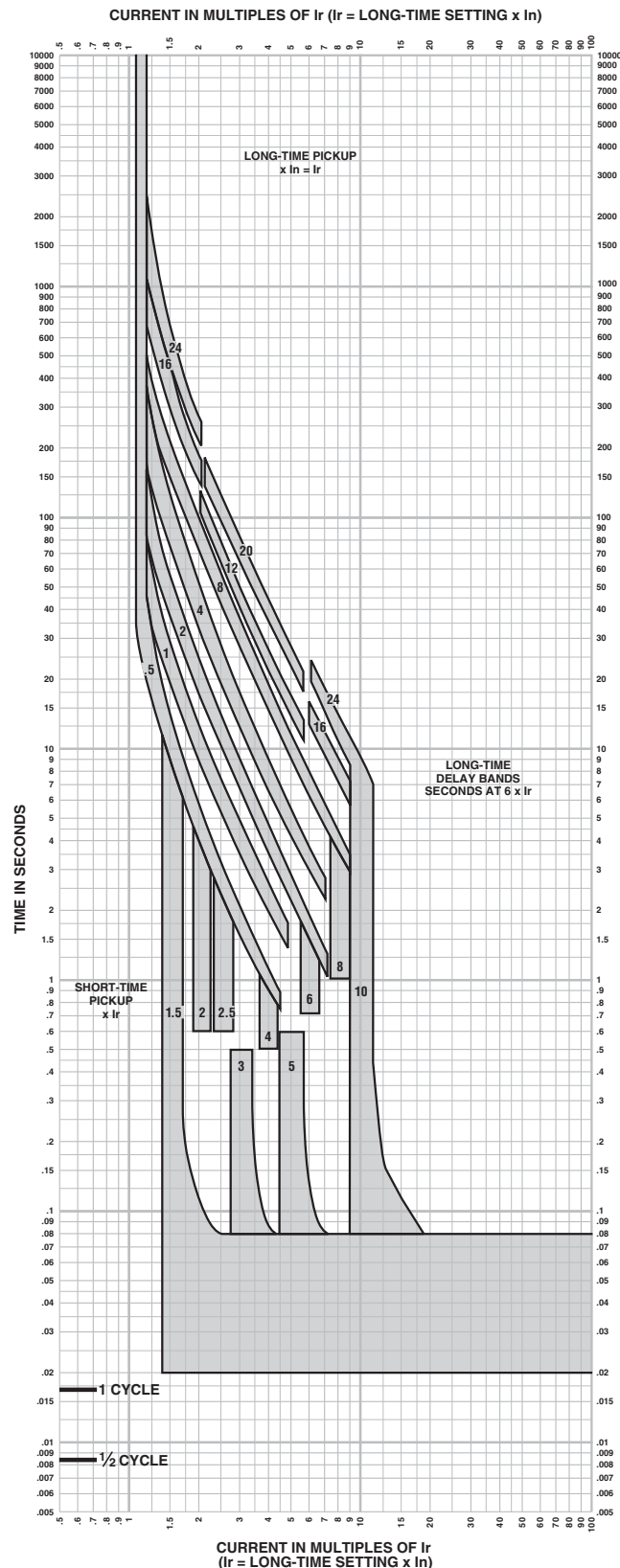
Instantaneous override values are given on 613-10.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately 20 minutes is required between overloads to completely reset thermal-imaging.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 13—Trip Curves

Micrologic 2.0A NS630b–NS3200 Trip Unit Characteristic Trip Curve



Micrologic 2.0A Trip Unit
Characteristic Trip Curve No. 613-9
Long-Time Pickup and Delay
Short-Time Pickup with No Delay

The time-current curve information is to be used for application and coordination purposes only. Curves apply from -25°C to $+70^{\circ}\text{C}$ (-13°F to $+158^{\circ}\text{F}$) ambient temperature.

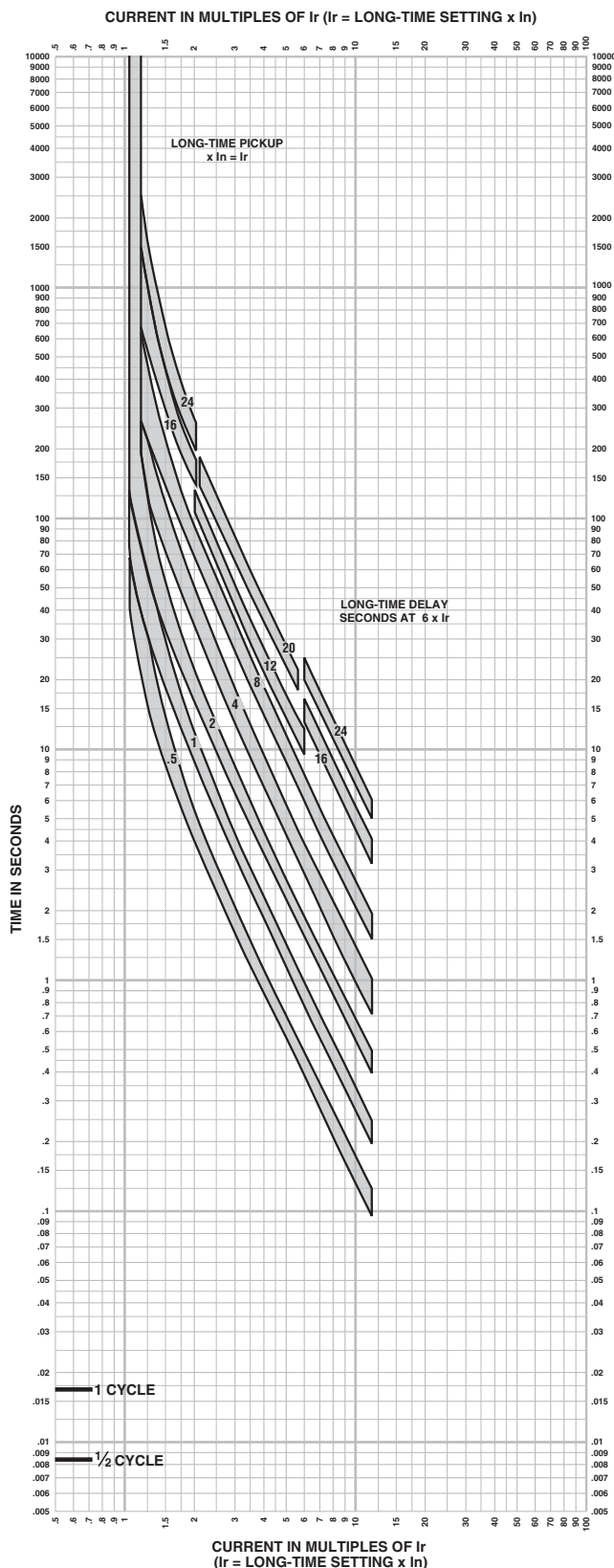
Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately twenty minutes is required between overloads to completely reset thermal-imaging.
2. The end of the curve is determined by the short-time setting.
3. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
4. Overload indicator illuminates at 100%.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Micrologic 3.0A P-Frame and R-Frame Trip Unit Characteristic Trip Curve



Micrologic 3.0A Trip Unit Characteristic Trip Curve No. 613-6 Long-Time Pickup and Delay

The time-current curve information is to be used for application and coordination purposes only.

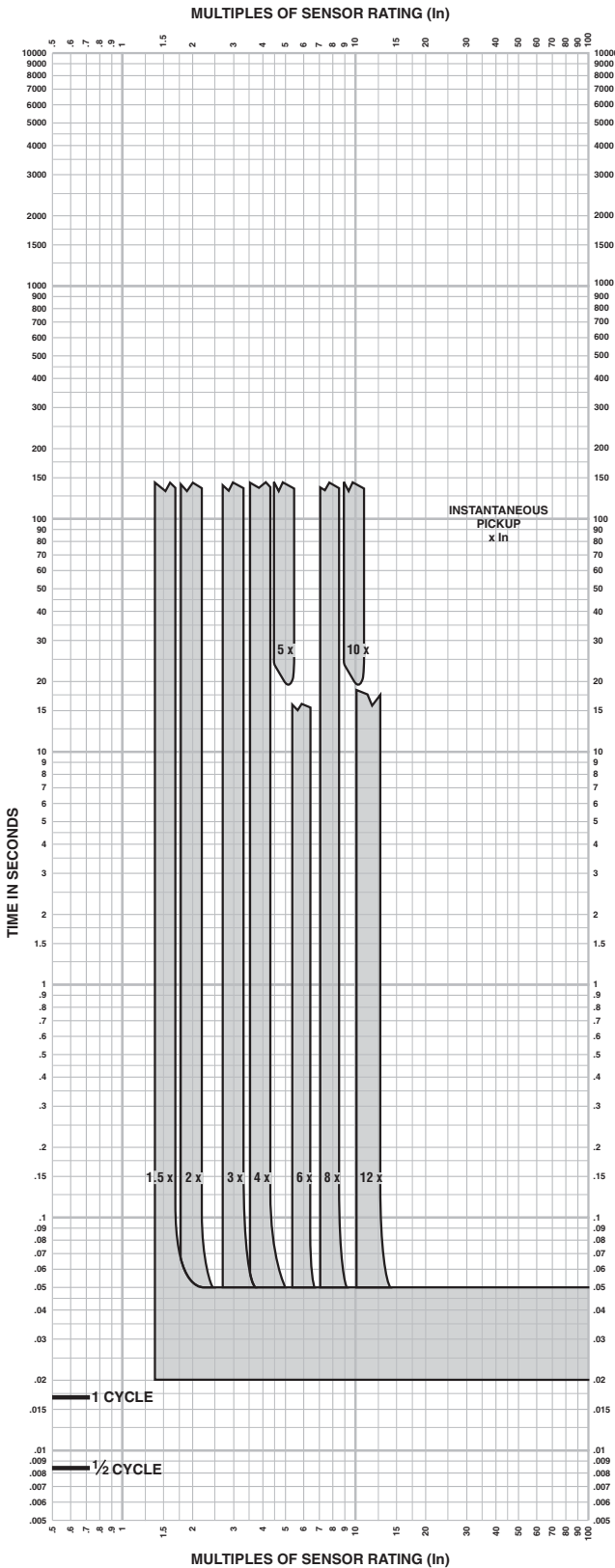
Curves apply from -25°C to $+70^{\circ}\text{C}$
(-13°F to $+158^{\circ}\text{F}$) ambient temperature.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately twenty minutes is required between overloads to completely reset thermal-imaging.
2. The end of the curve is determined by the instantaneous setting of the circuit breaker.
3. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
4. See trip curve 613-8 on page 176 for instantaneous pickup trip curve.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 13—Trip Curves

Micrologic 3.0A P-Frame and R-Frame Trip Unit Characteristic Trip Curve



Micrologic 3.0A Trip Unit
Characteristic Trip Curve No. 613-8
Instantaneous Pickup, 1.5X to 12X

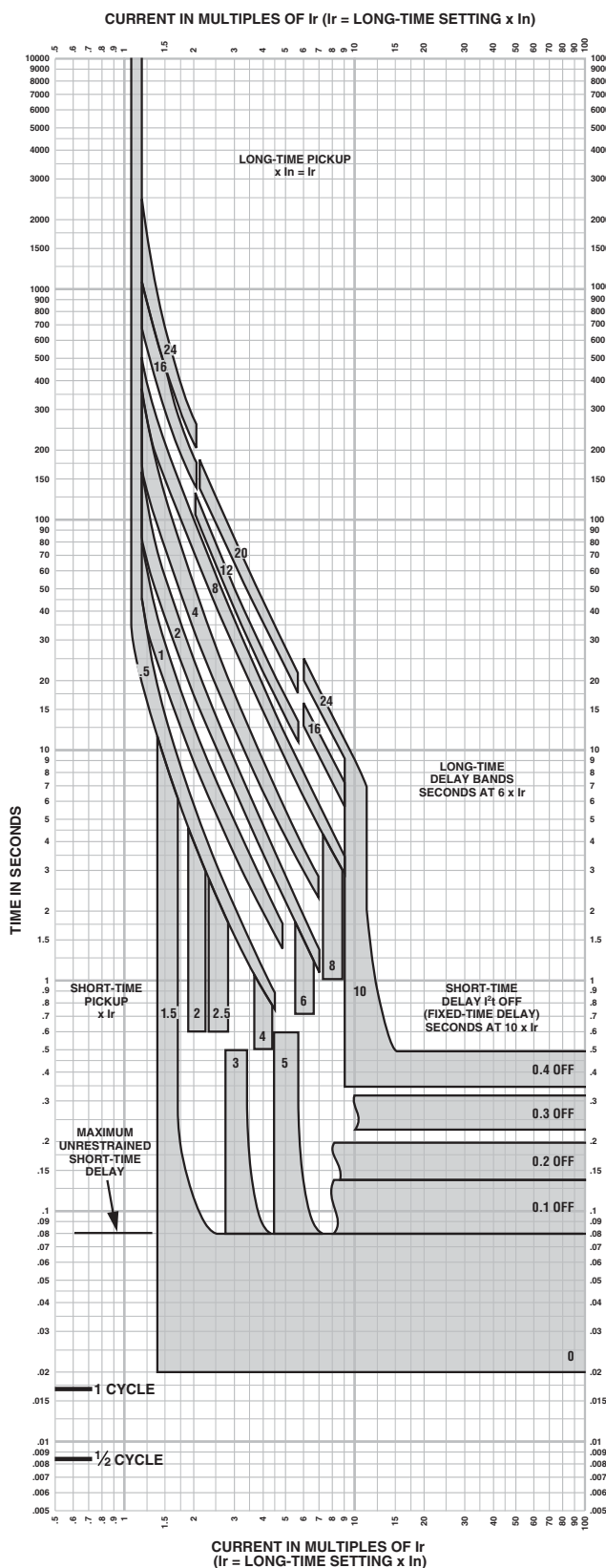
The time-current curve information is to be used for application and coordination purposes only. Curves apply from -25°C to +10°C (-13°F to +158°F) ambient temperature. Instantaneous override values are given on 613-10.

- Notes:**
1. The end of the curve is determined by the interrupting rating of the circuit breaker.
 2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
 3. The instantaneous region of the trip curve shows maximum total clearing times. Actual clearing times in this region can vary depending on the circuit breaker mechanism design and other factors. The actual clearing time can be considerably faster than indicated. Contact your local sales office for additional information.
 4. See trip curve 613-6 on page 175 for long-time pickup and delay trip curves.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Micrologic 5.0/6.0 P-Frame, R-Frame and NS630b–NS3200 A/P/H Trip Unit Characteristic Trip Curve



Micrologic 5.0/6.0 A/P/H Trip Units Characteristic Trip Curve No. 613-4

Long-Time Pickup and Delay
Short-Time Pickup and I^2t OFF Delay

The time-current curve information is to be used for application and coordination purposes only. Curves apply from -25°C to $+70^\circ\text{C}$ (-13°F to $+158^\circ\text{F}$) ambient temperature.

Notes:

1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately twenty minutes is required between overloads to completely reset thermal-imaging.
2. The end of the curve is determined by the interrupting rating of the circuit breaker.
3. With zone-selective interlocking ON, short-time delay utilized, and no restraining signal, the maximum unrestrained short-time delay time band applies regardless of the setting.
4. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of the current.
5. For a withstand circuit breaker, instantaneous can be turned OFF. See trip curve 613-7 on page 179 for instantaneous trip curve. See table on page 183 for instantaneous override values.
6. Overload indicator illuminates at 100%.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Micrologic 5.0/6.0 P-Frame, R-Frame and NS630b-NS3200 A/P/H Trip Units Characteristic Trip Curve

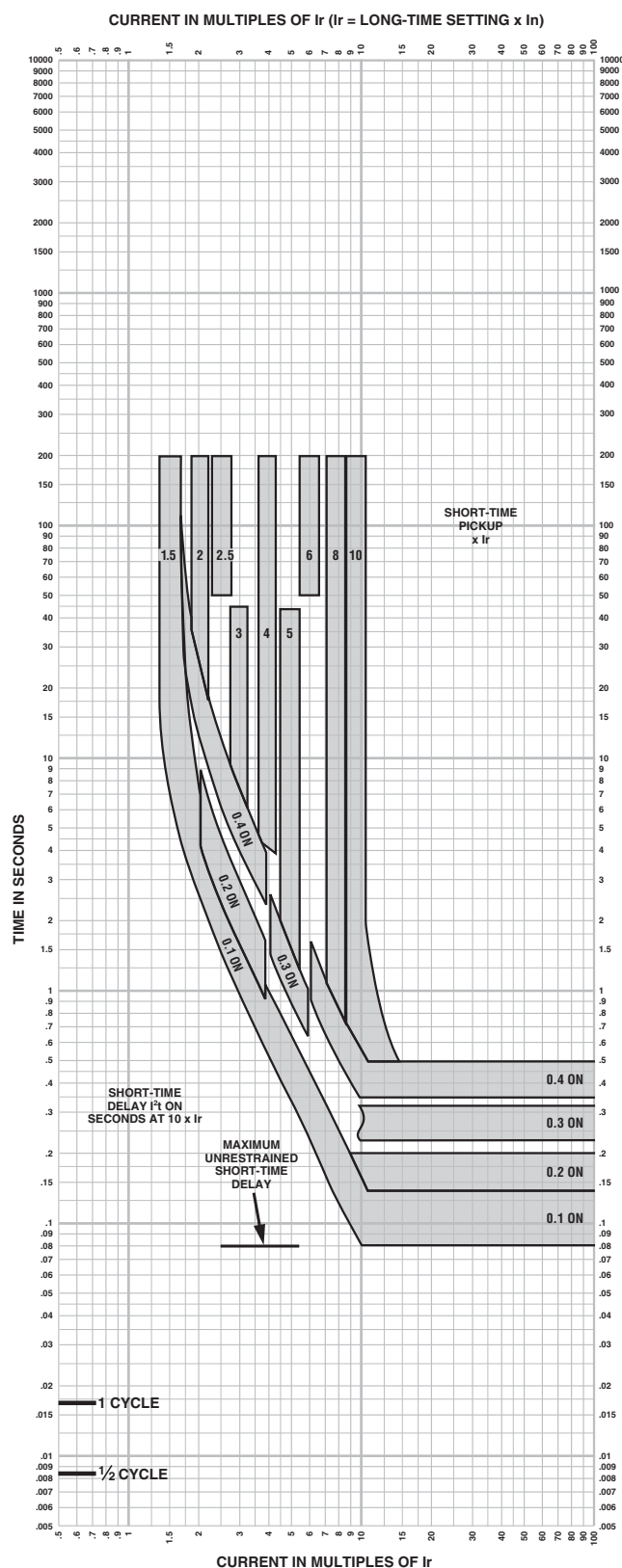
Micrologic 5.0/6.0 A/P/H Trip Units
Characteristic Trip Curve No. 613-5
Short-Time Pickup and I²t ON Delay

The time-current curve information is to be used for application and coordination purposes only.

Curves apply from -25°C to +70°C
(-13°F to +158°F) ambient temperature.

Notes:

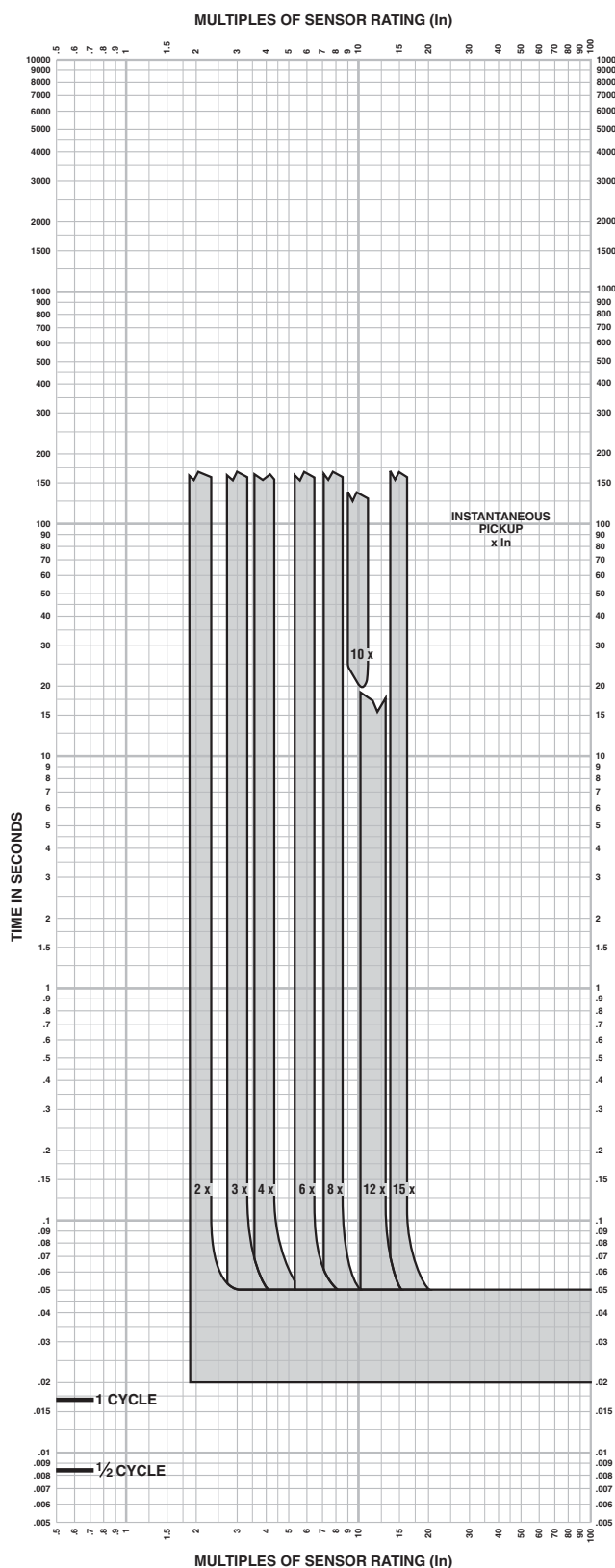
1. There is a thermal-imaging effect that can act to shorten the long-time delay. The thermal-imaging effect comes into play if a current above the long-time delay pickup value exists for a time and then is cleared by the tripping of a downstream device or the circuit breaker itself. A subsequent overload will cause the circuit breaker to trip in a shorter time than normal. The amount of time delay reduction is inverse to the amount of time that has elapsed since the previous overload. Approximately twenty minutes is required between overloads to completely reset thermal-imaging.
2. The end of the curve is determined by the interrupting rating of the circuit breaker.
3. With zone-selective interlocking ON, short-time delay utilized, and no restraining signal, the maximum unrestrained short-time delay time band applies regardless of the setting.
4. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
5. For withstand standstill breaker, instantaneous can be turned OFF. See trip curve 613-7 on page 179 for instantaneous trip curve. See table on page 183 for instantaneous override values.
6. See Trip Curve 613-4 on page 177 for long-time pickup and delay trip curve.



PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Micrologic 5.0/6.0 P-Frame, R-Frame and NS630b–NS3200 A/P/H Trip Units Characteristic Trip Curve



Micrologic 5.0/6.0 Trip Units Characteristic Trip Curve No. 613-7 Instantaneous Pickup, 2X to 15X and OFF

The time-current curve information is to be used for application and coordination purposes only.

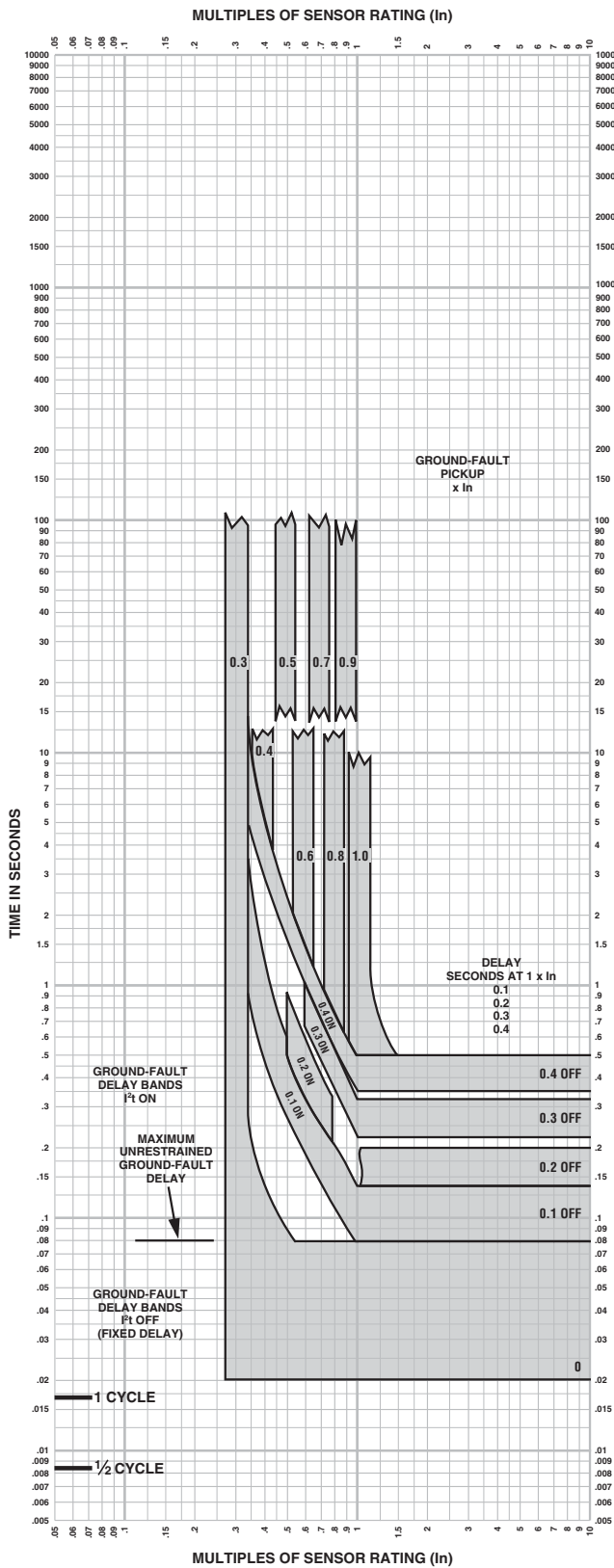
Curves apply from -30°C to +60°C
(-22°F to +140°F) ambient temperature.

Notes:

1. The end of the curve is determined by the interrupting rating of the circuit breaker.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
3. The instantaneous region of the trip curve shows maximum total clearing times. Actual clearing times in this region can vary depending on the circuit breaker mechanism design and other factors. The actual clearing time can be considerably faster than indicated. Contact your local sales office for additional information.
4. For a withstand circuit breaker, instantaneous can be turned OFF. See trip curve 613-7 on page 179 for the instantaneous trip curve. See table on page 183 for the instantaneous override values.
5. See trip curve 613-4 on page 177 and trip curve 613-5 on page 178 for long-time pickup, long-time delay, short-time pickup and short-time delay trip curves.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 13—Trip Curves

Micrologic 6.0 P-Frame, R-Frame and NS630b–NS3200 A/P/H Trip Units with Adjustable
Ground-fault Pickup and Delay Characteristic Trip Curve



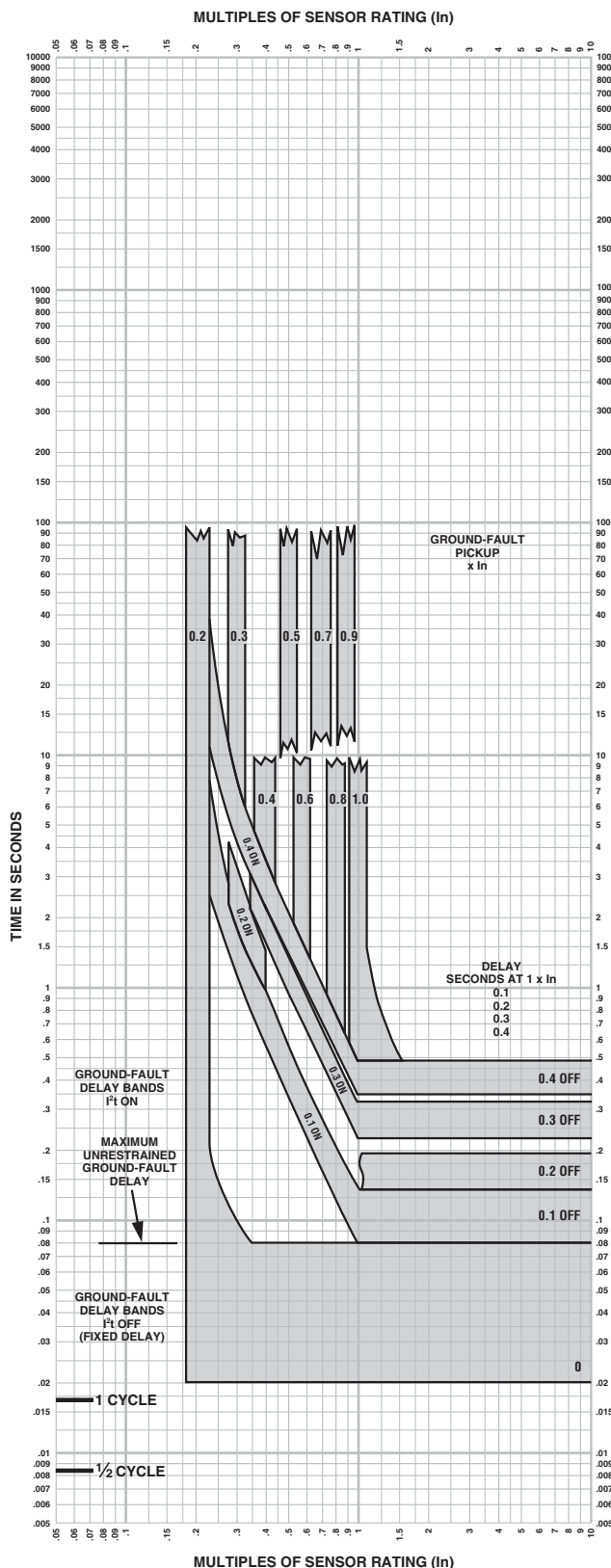
Micrologic 6.0 A/P/H Trip Units
with Adjustable Ground-Fault Pickup and
Delay
Characteristic Trip Curve No. 613-1
Ground Fault I_{2t} OFF and ON
I_n ≤ 400 A

The time-current curve information is to be used
for application and coordination purposes only.
Curves apply from -25°C to +70°C
(-13°F to +158°F) ambient temperature.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Micrologic 6.0 P-Frame, R-Frame and NS630b–NS3200 A/P/H Trip Units with Adjustable Ground-fault Pickup and Delay Characteristic Trip Curve



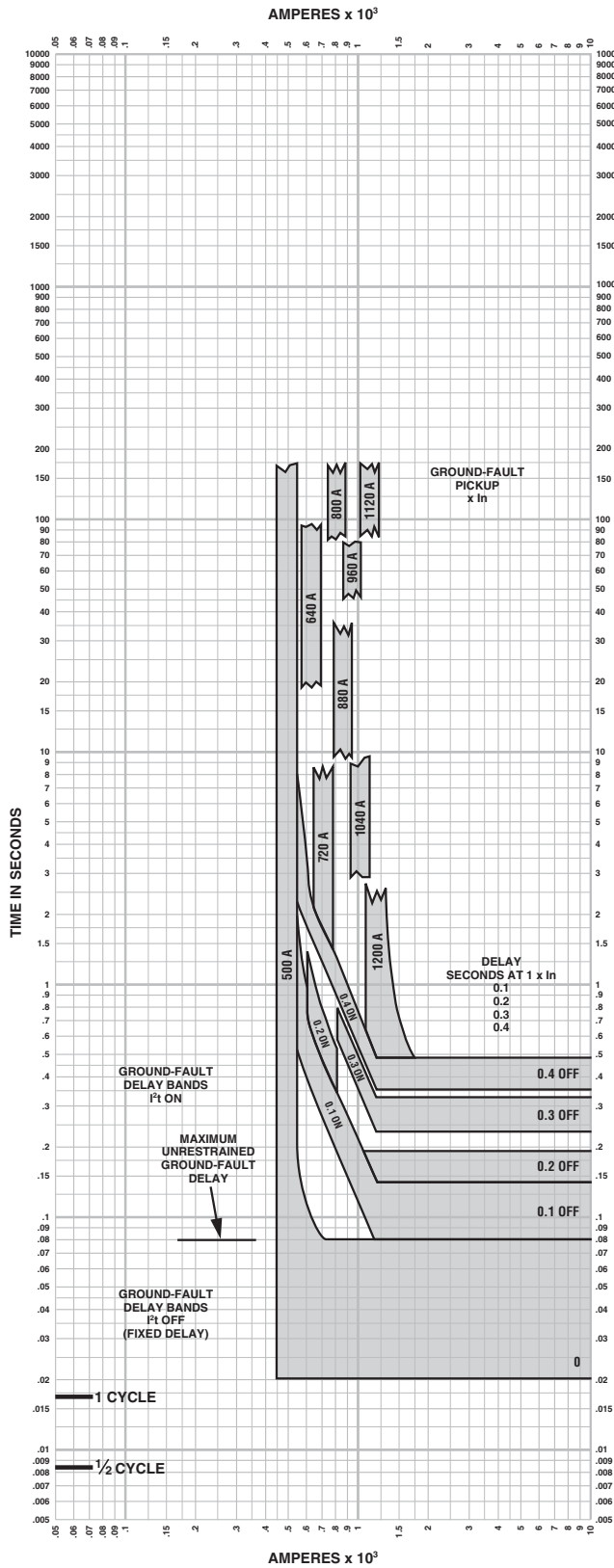
Micrologic 6.0 A/P/H Trip Units
with Adjustable Ground-Fault Pickup and
Delay
Characteristic Trip Curve No. 613-2
Ground Fault I^2t OFF and ON
 $400 \text{ A} < I_n \leq 1200 \text{ A}$

The time-current curve information is to be used
for application and coordination purposes only.

Curves apply from -25°C to $+70^\circ\text{C}$
(-13°F to $+158^\circ\text{F}$) ambient temperature.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 13—Trip Curves

Micrologic 6.0 P-Frame, R-Frame and NS630b–NS3200 A/P/H Trip Units with Adjustable
Ground-fault Pickup and Delay Characteristic Trip Curve



Micrologic 6.0 A/P/H Trip Units
with Adjustable Ground-Fault Pickup and
Delay
Characteristic Trip Curve No. 613-3
Ground Fault I^2t OFF and ON
 $I_n > 1200$ A

The time-current curve information is to be used for
application and coordination purposes only.
Curves apply from -25°C to +70°C
(-13°F to +158°F) ambient temperature.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

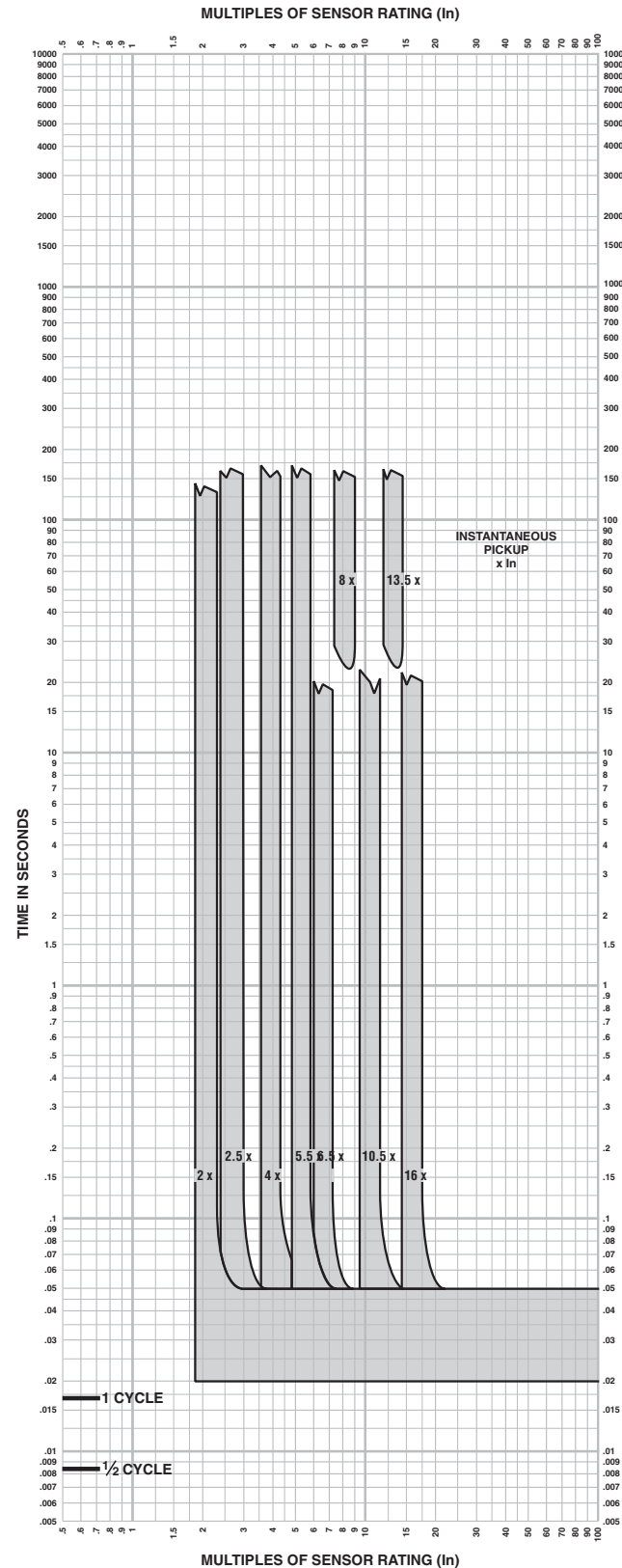
Table 103: Instantaneous Override Values Characteristic Trip Curve

UL/IEC Circuit Breaker	Instantaneous Override ¹ (kA Peak)	UL/IEC Circuit Breaker	Instantaneous Override ¹ (kA Peak)
RG 600	130 ± 10%	MG300	20 ± 15%
RG 800	130 ± 10%	MG350	20 ± 15%
RG 1000	130 ± 10%	MG400	20 ± 15%
RG 1200	130 ± 10%	MG450	20 ± 15%
RG 1600	130 ± 10%	MG500	20 ± 15%
RG 2000	130 ± 10%	MG600	20 ± 15%
RG 2500	130 ± 10%	MG700	20 ± 15%
RJ 600	90 ± 15%	MG800	20 ± 15%
RJ 800	90 ± 15%	MJ300	20 ± 15%
RJ 1000	90 ± 15%	MJ350	20 ± 15%
RJ 1200	90 ± 15%	MJ400	20 ± 15%
RJ 1600	90 ± 15%	MJ450	20 ± 15%
RJ 2000	90 ± 15%	MJ500	20 ± 15%
RJ 2500	90 ± 15%	MJ600	20 ± 15%
RK 600	130 ± 10%	MJ700	20 ± 15%
RK 800	130 ± 10%	MJ800	20 ± 15%
RK 1000	130 ± 10%	IEC Circuit Breaker	Instantaneous Override ¹ (kA Peak)
RK 1200	130 ± 10%		
RK 1600	130 ± 10%	NS 800bN	130 ± 10%
RK 2000	130 ± 10%	NS1000bN	130 ± 10%
RK 2500	130 ± 10%	NS1250bN	130 ± 10%
RL 600	90 ± 15%	NS1600bN	130 ± 10%
RL 800	90 ± 15%	NS2000N	130 ± 10%
RL 1000	90 ± 15%	NS2500N	90 ± 15%
RL 1200	90 ± 15%	NS 3200N	90 ± 15%
RL 1600	90 ± 15%	NS 800bH	90 ± 15%
RL 2000	90 ± 15%	NS1000bH	90 ± 15%
RL 2500	90 ± 15%	NS1250bH	55 ± 10%
PG 250	55 ± 10%	NS1600bH	55 ± 10%
PG 400	55 ± 10%	NS2000H	55 ± 10%
PG 600	55 ± 10%	NS2500H	55 ± 10%
PG 800	55 ± 10%	NS3200H	55 ± 10%
PG 1000	55 ± 10%	NS630bN	55 ± 10%
PG 1200	55 ± 10%	NS800N	55 ± 10%
PJ 250	15 ± 10%	NS1000N	55 ± 10%
PJ 400	22 ± 10%	NS1250N	55 ± 10%
PJ 600	22 ± 10%	NS1600N	55 ± 10%
PJ 800	22 ± 10%	NS630bH	55 ± 10%
PJ 1000	22 ± 10%	NS800H	55 ± 10%
PJ 1200	22 ± 10%	NS1000H	55 ± 10%
PK 250	55 ± 10%	NS1250H	55 ± 10%
PK 400	55 ± 10%	NS1600H	55 ± 10%
PK 600	55 ± 10%	NS630bL	55 ± 10%
PK 800	55 ± 10%	NS800L	55 ± 10%
PK 1000	55 ± 10%	NS1000L	55 ± 10%
PK 1200	55 ± 10%	NS1250L	55 ± 10%
PL 250	20 ± 10%	NS1600L	55 ± 10%
PL 400	22 ± 10%		
PL 600	22 ± 10%		
PL 800	22 ± 10%		
PL 1000	22 ± 10%		
PL 1200	22 ± 10%		

¹ Faults at or above instantaneous override value will be cleared at 25 msec or less.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers
Section 13—Trip Curves

Basic Electronic Trip Unit 1.0M, P-Frame 600 A MDP Characteristic Trip Curve



Basic Electronic Trip Unit 1.0M, 600 A
Characteristic Trip Curve No. 613-13
Instantaneous Pickup, 2X to 16X

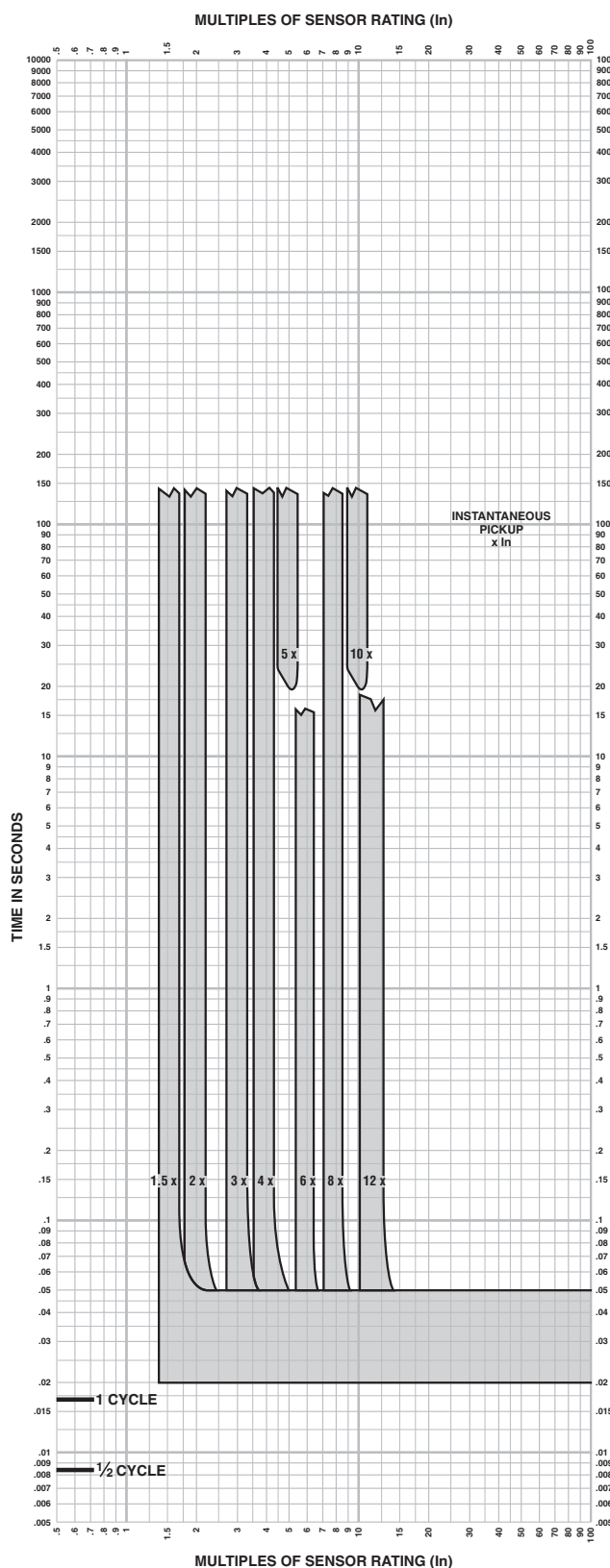
The time-current curve information is to be used for application and coordination purposes only.
Curves apply from -25°C to +70°C (-13°F to +158°F) ambient temperature.
Instantaneous override values are given on page 183.

- Notes:**
1. The end of the curve is determined by the interrupting rating of the circuit breaker.
 2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
 3. The instantaneous region of the trip curve shows maximum total clearing times. Actual clearing times in this region can vary depending on the circuit breaker mechanism design and other factors. The actual clearing time can be considerably faster than indicated. Contact your local sales office for additional information.

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

Section 13—Trip Curves

Basic Electronic Trip Unit 1.0M P-Frame 800–1200A MCP Characteristic Trip Curve



Basic Electronic Trip Unit 1.0M 800 A–1200 A

Characteristic Trip Curve No. 613-11

Instantaneous Pickup, 1.5X to 12X

The time-current curve information is to be used for application and coordination purposes only.

Curves apply from -25°C to +70°C (-13°F to +158°F) ambient temperature.

Instantaneous override values are given on page 183.

Notes:

1. The end of the curve is determined by the interrupting rating of the circuit breaker.
2. Total clearing times shown include the response times of the trip unit, the circuit breaker opening, and the extinction of current.
3. The instantaneous region of the trip curve shows maximum total clearing times. Actual clearing times in this region can vary depending on the circuit breaker mechanism design and other factors. The actual clearing time can be considerably faster than indicated. Contact your local sales office for additional information.

Section 14—Catalog Numbers

685823	112	MJA267002	70	NPLLE34063U33R	94	NPRLE34063U43R	94	PDC6P204	116
685824	112	MJA268002	70	NPLLE34063U42R	94	NPRLE34063U44R	94	PGA36025CU31A	76
685825	112	MJA36300	70	NPLLE34063U43R	94	NPRLE34063U63RE1	94	PGA36025CU33A	76
685826	112	MJA36350	70	NPLLE34063U44R	94	NPRLE34063U64RE1	94	PGA36025CU41A	76
685827	112	MJA36400	70	NPLLE34063U63RE1	94	NPRLE34063U73RE1	94	PGA36025CU43A	76
685829	112	MJA36450	70	NPLLE34063U64RE1	94	NPRLE34063U74RE1	94	PGA36025CU44A	76
AL1200P24K	119	MJA36500	70	NPLLE34063U73RE1	94	NPRLE34080U32R	94	PGA36025CU63AE1	76
AL1200P24K3	115	MJA36600	70	NPLLE34063U74RE1	94	NPRLE34080U33R	94	PGA36025CU64AE1	76
AL1200P25K	115	MJA36700	70	NPLLE34080U32R	94	NPRLE34080U42R	94	PGA36025CU73AE1	76
AL1200P6KU	115	MJA36800	70	NPLLE34080U33R	94	NPRLE34080U43R	94	PGA36025CU74AE1	76
AL1200P7KU	115	MJL26300	70	NPLLE34080U42R	94	NPRLE34080U44R	94	PGA36025CU75A	75
AL1200R53K	115	MJL26350	70	NPLLE34080U43R	94	NPRLE34080U63RE1	94	PGA36025U33A	75
AL1200R53K	119	MJL26400	70	NPLLE34080U44R	94	NPRLE34080U64RE1	94	PGA36025U41A	75
AL2500RK	115	MJL26450	70	NPLLE34080U63RE1	94	NPRLE34080U73RE1	94	PGA36025U43A	75
AL800M23K	115	MJL26500	70	NPLLE34080U64RE1	94	NPRLE34080U74RE1	94	PGA36025U44A	75
AL800P6K	115	MJL26600	70	NPLLE34080U73RE1	94	NRHFE36160U32R	98	PGA36025U63AE1	75
AL800P7K	115	MJL26700	70	NPLLE34080U74RE1	94	NRHFE36160U33R	98	PGA36025U64AE1	75
CU1200P24K	116	MJL26800	70	NPLLE34100U32R	94	NRHFE36160U42R	98	PGA36025U73AE1	75
CU1200P25K	116	MJL36300	70	NPLLE34100U33R	94	NRHFE36160U43R	98	PGA36025U74AE1	75
CU1200R53K	116	MJL36350	70	NPLLE34100U42R	94	NRHFE36160U44R	98	PGA36040CU31A	76
CU250P1K	116	MJL36400	70	NPLLE34100U43R	94	NRHFE36160U63RE1	98	PGA36040CU33A	76
CU800M23K	116	MJL36450	70	NPLLE34100U44R	94	NRHFE36160U64RE1	98	PGA36040CU41A	76
CYA1200R5	116	MJL36500	70	NPLLE34100U63RE1	94	NRHFE36200U32R	98	PGA36040CU43A	76
CYA1200R7	116	MJL36600	70	NPLLE34100U64RE1	94	NRHFE36200U33R	98	PGA36040CU44A	76
CYA400P5	116	MJL36700	70	NPLLE34100U73RE1	94	NRHFE36200U42R	98	PGA36040CU63AE1	76
CYA600P5	116	MJL36800	70	NPLLE34100U74RE1	94	NRHFE36200U43R	98	PGA36040CU64AE1	76
CYA800R7	116	MPRPAF	119	NPNFE36160U32R	94	NRHFE36200U44R	98	PGA36040CU73AE1	76
LCP48	117	MPRPAF	119	NPNFE36160U33R	94	NRHFE36200U63RE1	98	PGA36040CU74AE1	76
LHP48	117	NCWIRING	108	NPNFE36160U42R	94	NRHFE36200U64RE1	98	PGA36040U31A	75
LHP8	117	NPHFE36160U32R	94	NPNFE36160U43R	94	NRHFE36250U32R	98	PGA36040U33A	75
LS10	117	NPHFE36160U33R	94	NPNFE36160U44R	94	NRHFE36250U33R	98	PGA36040U41A	75
LS8	117	NPHFE36160U42R	94	NPNFE36160U63RE1	94	NRHFE36250U42R	98	PGA36040U43A	75
LW1	117	NPHFE36160U43R	94	NPNFE36160U64RE1	94	NRHFE36250U43R	98	PGA36040U44A	75
LW4	117	NPHFE36160U44R	94	NPNFE36160U73RE1	94	NRHFE36250U63RE1	98	PGA36040U63AE1	75
LW7	117	NPHFE36160U63RE1	94	NPNFE36160U74RE1	94	NRHFE36250U64RE1	98	PGA36040U64AE1	75
MGA263002	70	NPHFE36160U64RE1	94	NPNLE36063U32R	94	NRHFE36320U32R	98	PGA36040U73AE1	75
MGA263502	70	NPHFE36160U73RE1	94	NPNLE36063U33R	94	NRHFE36320U33R	98	PGA36040U74AE1	75
MGA264002	70	NPHFE36160U74RE1	94	NPNLE36063U42R	94	NRHFE36320U42R	98	PGA36060	75
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MGA266002	70	NPHLE36063U42R	94	NPNLE36063U63RE1	94	NRHFE36320U63RE1	98	PGA36060CU41A	76
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MGA268002	70	NPHLE36063U44R	94	NPNLE36063U73RE1	94	NRHFE36320U64RE1	98	PGA36060CU44A	76
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MGA36400	70	NPHLE36063U73RE1	94	NPNLE36080U33R	94	NRNFE36160U42R	98	PGA36060CU73AE1	76
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MGA36500	70	NPHLE36080U32R	94	NPNLE36080U43R	94	NRNFE36160U44R	98	PGA36060U31A	75
MGA36600	70	NPHLE36080U33R	94	NPNLE36080U44R	94	NRNFE36160U63RE1	98	PGA36060U33A	75
MGA36700	70	NPHLE36080U42R	94	NPNLE36080U63RE1	94	NRNFE36160U64RE1	98	PGA36060U41A	75
MGA36800	70	NPHLE36080U43R	94	NPNLE36080U64RE1	94	NRNFE36200U32R	98	PGA36060U43A	75
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MGL36450	70	NPHLE36100U64RE1	94	NPNLE36125U32R	94	NRNFE36250U63RE1	98	PGA36080CU63AE1	76
MGL36500	70	NPHLE36100U73RE1	94	NPNLE36125U33R	94	NRNFE36250U64RE1	98	PGA36080CU64AE1	76
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MGL36700	70	NPHLE36125U32R	94	NPNLE36125U43R	94	NRNFE36320U33R	98	PGA36080CU74AE1	76
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MJA264002	70	NPHLE36125U64RE1	94	NPNLE36125U74RE1	94	NRNFE36320U64RE1	98	PGA36080U44A	75
MJA264502	70	NPHLE36125U73RE1	94	NPRLE34063U32R	94	PDC12P4	116	PGA36080U63AE1	75
MJA265002	70	NPHLE36125U74RE1	94	NPRLE34063U33R	94	PDC12P44	116	PGA36080U64AE1	75
MJA266002	70	NPLLE34063U32R	94	NPRLE34063U42R	94	PDC6P20	116	PGA36080U73AE1	75

PowerPact™ M-, P- and R-Frame, and Compact™ NS630b–NS3200 Circuit Breakers

PGA36080U74AE1	75	PGL36080CU43A	74	PJA36040CU74AE1	76	PJL36025CU74AE1	74	PJL36100U33A	73
PGA36100	75	PGL36080CU44A	74	PJA36040U31A	75	PJL36025U31A	73	PJL36100U41A	73
PGA36100U31A	75	PGL36080CU63AE1	74	PJA36040U33A	75	PJL36025U33A	73	PJL36100U43A	73
PGA36100U33A	75	PGL36080CU64AE1	74	PJA36040U41A	75	PJL36025U41A	73	PJL36100U44A	73
PGA36100U41A	75	PGL36080CU73AE1	74	PJA36040U43A	75	PJL36025U43A	73	PJL36100U63AE1	73
PGA36100U43A	75	PGL36080CU74AE1	74	PJA36040U44A	75	PJL36025U44A	73	PJL36100U64AE1	73
PGA36100U44A	75	PGL36080U31A	73	PJA36040U63AE1	75	PJL36025U63AE1	73	PJL36100U73AE1	73
PGA36100U63AE1	75	PGL36080U33A	73	PJA36040U64AE1	75	PJL36025U64AE1	73	PJL36100U74AE1	73
PGA36100U64AE1	75	PGL36080U41A	73	PJA36040U73AE1	75	PJL36025U73AE1	73	PJL36120	73
PGA36100U73AE1	75	PGL36080U43A	73	PJA36040U74AE1	75	PJL36025U74AE1	73	PJL36120CU31A	74
PGA36100U74AE1	75	PGL36080U44A	73	PJA36060	75	PJL36040CU31A	74	PJL36120CU33A	74
PGA36120	75	PGL36080U63AE1	73	PJA36060CU31A	76	PJL36040CU33A	74	PJL36120CU41A	74
PGA36120U31A	75	PGL36080U64AE1	73	PJA36060CU33A	76	PJL36040CU41A	74	PJL36120CU43A	74
PGA36120U33A	75	PGL36080U73AE1	73	PJA36060CU41A	76	PJL36040CU43A	74	PJL36120CU44A	74
PGA36120U41A	75	PGL36080U74AE1	73	PJA36060CU43A	76	PJL36040CU44A	74	PJL36120CU63AE1	74
PGA36120U43A	75	PGL36100	73	PJA36060CU44A	76	PJL36040CU63AE1	74	PJL36120CU64AE1	74
PGA36120U44A	75	PGL36100CU31A	74	PJA36060CU63AE1	76	PJL36040CU64AE1	74	PJL36120CU73AE1	74
PGA36120U63AE1	75	PGL36100CU33A	74	PJA36060CU64AE1	76	PJL36040CU73AE1	74	PJL36120CU74AE1	74
PGA36120U64AE1	75	PGL36100CU41A	74	PJA36060CU73AE1	76	PJL36040CU74AE1	74	PJL36120M70	79
PGA36120U73AE1	75	PGL36100CU43A	74	PJA36060CU74AE1	76	PJL36040U31A	73	PJL36120U31A	73
PGA36120U74AE1	75	PGL36100CU44A	74	PJA36060U31A	75	PJL36040U33A	73	PJL36120U33A	73
PGL36025CU31A	74	PGL36100CU63AE1	74	PJA36060U33A	75	PJL36040U41A	73	PJL36120U41A	73
PGL36025CU33A	74	PGL36100CU64AE1	74	PJA36060U41A	75	PJL36040U43A	73	PJL36120U43A	73
PGL36025CU41A	74	PGL36100CU73AE1	74	PJA36060U43A	75	PJL36040U44A	73	PJL36120U44A	73
PGL36025CU43A	74	PGL36100CU74AE1	74	PJA36060U44A	75	PJL36040U63AE1	73	PJL36120U63AE1	73
PGL36025CU44A	74	PGL36100U31A	73	PJA36060U63AE1	75	PJL36040U64AE1	73	PJL36120U64AE1	73
PGL36025CU63AE1	74	PGL36100U33A	73	PJA36060U64AE1	75	PJL36040U73AE1	73	PJL36120U73AE1	73
PGL36025CU64AE1	74	PGL36100U41A	73	PJA36060U73AE1	75	PJL36040U74AE1	73	PJL36120U74AE1	73
PGL36025CU73AE1	74	PGL36100U43A	73	PJA36060U74AE1	75	PJL36060	73	PKA36025CU31A	76
PGL36025CU74AE1	74	PGL36100U44A	73	PJA36080	75	PJL36060CU31A	74	PKA36025CU33A	76
PGL36025U31A	73	PGL36100U63AE1	73	PJA36080CU31A	76	PJL36060CU33A	74	PKA36025CU41A	76
PGL36025U33A	73	PGL36100U64AE1	73	PJA36080CU33A	76	PJL36060CU41A	74	PKA36025CU43A	76
PGL36025U41A	73	PGL36100U73AE1	73	PJA36080CU41A	76	PJL36060CU43A	74	PKA36025CU44A	76
PGL36025U43A	73	PGL36100U74AE1	73	PJA36080CU43A	76	PJL36060CU44A	74	PKA36025CU63AE1	76
PGL36025U44A	73	PGL36120	73	PJA36080CU44A	76	PJL36060CU63AE1	74	PKA36025CU64AE1	76
PGL36025U63AE1	73	PGL36120CU31A	74	PJA36080CU63AE1	76	PJL36060CU64AE1	74	PKA36025CU73AE1	76
PGL36025U64AE1	73	PGL36120CU33A	74	PJA36080CU64AE1	76	PJL36060CU73AE1	74	PKA36025CU74AE1	76
PGL36025U73AE1	73	PGL36120CU41A	74	PJA36080CU73AE1	76	PJL36060CU74AE1	74	PKA36025U31A	75
PGL36025U74AE1	73	PGL36120CU43A	74	PJA36080CU74AE1	76	PJL36060M68	79	PKA36025U33A	75
PGL36040CU31A	74	PGL36120CU44A	74	PJA36080U31A	75	PJL36060U31A	73	PKA36025U41A	75
PGL36040CU33A	74	PGL36120CU63AE1	74	PJA36080U33A	75	PJL36060U33A	73	PKA36025U43A	75
PGL36040CU41A	74	PGL36120CU64AE1	74	PJA36080U41A	75	PJL36060U41A	73	PKA36025U44A	75
PGL36040CU43A	74	PGL36120CU73AE1	74	PJA36080U43A	75	PJL36060U43A	73	PKA36025U63AE1	75
PGL36040CU44A	74	PGL36120CU74AE1	74	PJA36080U44A	75	PJL36060U44A	73	PKA36025U64AE1	75
PGL36040CU63AE1	74	PGL36120U31A	73	PJA36080U63AE1	75	PJL36060U63AE1	73	PKA36025U73AE1	75
PGL36040CU64AE1	74	PGL36120U33A	73	PJA36080U64AE1	75	PJL36060U64AE1	73	PKA36025U74AE1	75
PGL36040CU73AE1	74	PGL36120U41A	73	PJA36080U73AE1	75	PJL36060U73AE1	73	PKA36040CU31A	76
PGL36040CU74AE1	74	PGL36120U43A	73	PJA36080U74AE1	75	PJL36060U74AE1	73	PKA36040CU33A	76
PGL36040U31A	73	PGL36120U44A	73	PJA36100	75	PJL36060U74AE1	73	PKA36040CU41A	76
PGL36040U33A	73	PGL36120U63AE1	73	PJA36100U31A	75	PJL36080CU31A	74	PKA36040CU43A	76
PGL36040U41A	73	PGL36120U64AE1	73	PJA36100U33A	75	PJL36080CU33A	74	PKA36040CU44A	76
PGL36040U43A	73	PGL36120U73AE1	73	PJA36100U41A	75	PJL36080CU41A	74	PKA36040CU63AE1	76
PGL36040U44A	73	PGL36120U74AE1	73	PJA36100U43A	75	PJL36080CU43A	74	PKA36040CU64AE1	76
PGL36040U63AE1	73	PHLE36125U33RN	94	PJA36100U44A	75	PJL36080CU44A	74	PKA36040CU73AE1	76
PGL36040U64AE1	73	PJA36025CU31A	76	PJA36100U63AE1	75	PJL36080CU63AE1	74	PKA36040CU74AE1	76
PGL36040U73AE1	73	PJA36025CU33A	76	PJA36100U64AE1	75	PJL36080CU64AE1	74	PKA36040U31A	75
PGL36040U74AE1	73	PJA36025CU41A	76	PJA36100U73AE1	75	PJL36080CU73AE1	74	PKA36040U33A	75
PGL36060	73	PJA36025CU43A	76	PJA36100U74AE1	75	PJL36080CU74AE1	74	PKA36040U41A	75
PGL36060CU31A	74	PJA36025CU44A	76	PJA36120	75	PJL36080M68	79	PKA36040U43A	75
PGL36060CU33A	74	PJA36025CU63AE1	76	PJA36120U31A	75	PJL36080U31A	73	PKA36040U44A	75
PGL36060CU41A	74	PJA36025CU64AE1	76	PJA36120U33A	75	PJL36080U33A	73	PKA36040U63AE1	75
PGL36060CU43A	74	PJA36025CU73AE1	76	PJA36120U41A	75	PJL36080U41A	73	PKA36040U64AE1	75
PGL36060CU44A	74	PJA36025CU74AE1	76	PJA36120U43A	75	PJL36080U43A	73	PKA36040U73AE1	75
PGL36060CU63AE1	74	PJA36025U31A	75	PJA36120U44A	75	PJL36080U44A	73	PKA36040U74AE1	75
PGL36060CU64AE1	74	PJA36025U33A	75	PJA36120U63AE1	75	PJL36080U63AE1	73	PKA36060	75
PGL36060CU73AE1	74	PJA36025U41A	75	PJA36120U64AE1	75	PJL36080U64AE1	73	PKA36060CU31A	76
PGL36060CU74AE1	74	PJA36025U43A	75	PJA36120U73AE1	75	PJL36080U73AE1	73	PKA36060CU33A	76
PGL36060U31A	73	PJA36025U44A	75	PJA36120U74AE1	75	PJL36080U74AE1	73	PKA36060CU41A	76
PGL36060U33A	73	PJA36025U63AE1	75	PJL36000S10	78	PJL36100	73	PKA36060CU43A	76
PGL36060U41A	73	PJA36025U64AE1	75	PJL36000S12	78	PJL36100CU31A	74	PKA36060CU44A	76
PGL36060U43A	73	PJA36025U73AE1	75	PJL36000S60	78	PJL36100CU33A	74	PKA36060CU63AE1	76
PGL36060U44A	73	PJA36025U74AE1	75	PJL36000S80	78	PJL36100CU41A	74	PKA36060CU64AE1	76
PGL36060U63AE1	73	PJA36040CU31A	76	PJL36000S31A	74	PJL36100CU43A	74	PKA36060CU73AE1	76
PGL36060U64AE1	73	PJA36040CU33A	76	PJL36025CU33A	74	PJL36100CU44A	74	PKA36060CU74AE1	76
PGL36060U73AE1	73	PJA36040CU41A	76	PJL36025CU41A	74	PJL36100CU63AE1	74	PKA36060U31A	75
PGL36060U74AE1	73	PJA36040CU43A	76	PJL36025CU43A	74	PJL36100CU64AE1	74	PKA36060U33A	75
PGL36080	73	PJA36040CU44A	76	PJL36025CU44A	74	PJL36100CU73AE1	74	PKA36060U41A	75
PGL36080CU31A	74	PJA36040CU63AE1	76	PJL36025CU63AE1	74	PJL36100CU74AE1	74	PKA36060U43A	75
PGL36080CU33A	74	PJA36040CU64AE1	76	PJL36025CU64AE1	74	PJL36100M69	79	PKA36060U44A	75
PGL36080CU41A	74	PJA36040CU73AE1	76	PJL36025CU73AE1	74	PJL36100U31A	73	PKA36060U63AE1	75

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PKA36060U64AE1	75	PKL36040U73AE1	73	PLA34025CU41A	76	PLA34100U73AE1	75	PLL34080CU73AE1	74
PKA36060U73AE1	75	PKL36040U74AE1	73	PLA34025CU43A	76	PLA34100U74AE1	75	PLL34080CU74AE1	74
PKA36060U74AE1	75	PKL36060	73	PLA34025CU44A	76	PLA34120	75	PLL34080M68	79
PKA36080	75	PKL36060CU31A	74	PLA34025CU63AE1	76	PLA34120U31A	75	PLL34080U31A	73
PKA36080CU31A	76	PKL36060CU33A	74	PLA34025CU64AE1	76	PLA34120U33A	75	PLL34080U33A	73
PKA36080CU33A	76	PKL36060CU41A	74	PLA34025CU73AE1	76	PLA34120U41A	75	PLL34080U41A	73
PKA36080CU41A	76	PKL36060CU43A	74	PLA34025CU74AE1	76	PLA34120U43A	75	PLL34080U43A	73
PKA36080CU43A	76	PKL36060CU44A	74	PLA34025U31A	75	PLA34120U44A	75	PLL34080U44A	73
PKA36080CU44A	76	PKL36060CU63AE1	74	PLA34025U33A	75	PLA34120U63AE1	75	PLL34080U63AE1	73
PKA36080CU63AE1	76	PKL36060CU64AE1	74	PLA34025U41A	75	PLA34120U64AE1	75	PLL34080U64AE1	73
PKA36080CU64AE1	76	PKL36060CU73AE1	74	PLA34025U43A	75	PLA34120U73AE1	75	PLL34080U73AE1	73
PKA36080CU73AE1	76	PKL36060CU74AE1	74	PLA34025U44A	75	PLA34120U74AE1	75	PLL34080U74AE1	73
PKA36080CU74AE1	76	PKL36060U31A	73	PLA34025U63AE1	75	PLL34000S10	78	PLL34100	73
PKA36080U31A	75	PKL36060U33A	73	PLA34025U64AE1	75	PLL34000S12	78	PLL34100CU31A	74
PKA36080U33A	75	PKL36060U41A	73	PLA34025U73AE1	75	PLL34000S60	78	PLL34100CU33A	74
PKA36080U41A	75	PKL36060U43A	73	PLA34040CU41A	76	PLL34000S80	78	PLL34100CU41A	74
PKA36080U43A	75	PKL36060U44A	73	PLA34040CU31A	76	PLL34025CU31A	74	PLL34100CU43A	74
PKA36080U44A	75	PKL36060U63AE1	73	PLA34040CU33A	76	PLL34025CU33A	74	PLL34100CU44A	74
PKA36080U63AE1	75	PKL36060U64AE1	73	PLA34040CU41A	76	PLL34025CU41A	74	PLL34100CU63AE1	74
PKA36080U64AE1	75	PKL36060U73AE1	73	PLA34040CU43A	76	PLL34025CU43A	74	PLL34100CU64AE1	74
PKA36080U73AE1	75	PKL36060U74AE1	73	PLA34040CU44A	76	PLL34025CU44A	74	PLL34100CU73AE1	74
PKA36080U74AE1	75	PKL36080	73	PLA34040CU63AE1	76	PLL34025CU63AE1	74	PLL34100CU74AE1	74
PKA36100	75	PKL36080CU31A	74	PLA34040CU64AE1	76	PLL34025CU64AE1	74	PLL34100M69	79
PKA36100U31A	75	PKL36080CU33A	74	PLA34040CU73AE1	76	PLL34025CU73AE1	74	PLL34100U31A	73
PKA36100U33A	75	PKL36080CU41A	74	PLA34040CU74AE1	76	PLL34025CU74AE1	74	PLL34100U33A	73
PKA36100U41A	75	PKL36080CU43A	74	PLA34040U31A	75	PLL34025U31A	73	PLL34100U41A	73
PKA36100U43A	75	PKL36080CU44A	74	PLA34040U33A	75	PLL34025U33A	73	PLL34100U43A	73
PKA36100U44A	75	PKL36080CU63AE1	74	PLA34040U41A	75	PLL34025U41A	73	PLL34100U44A	73
PKA36100U63AE1	75	PKL36080CU64AE1	74	PLA34040U43A	75	PLL34025U43A	73	PLL34100U63AE1	73
PKA36100U64AE1	75	PKL36080CU73AE1	74	PLA34040U44A	75	PLL34025U44A	73	PLL34100U64AE1	73
PKA36100U73AE1	75	PKL36080CU74AE1	74	PLA34040U63AE1	75	PLL34025U63AE1	73	PLL34100U73AE1	73
PKA36100U74AE1	75	PKL36080U31A	73	PLA34040U64AE1	75	PLL34025U64AE1	73	PLL34100U74AE1	73
PKA36120	75	PKL36080U33A	73	PLA34040U73AE1	75	PLL34025U73AE1	73	PLL34120	73
PKA36120U31A	75	PKL36080U41A	73	PLA34040U74AE1	75	PLL34025U74AE1	73	PLL34120CU31A	74
PKA36120U33A	75	PKL36080U43A	73	PLA34060	75	PLL34040CU31A	74	PLL34120CU33A	74
PKA36120U41A	75	PKL36080U44A	73	PLA34060CU31A	76	PLL34040CU33A	74	PLL34120CU41A	74
PKA36120U43A	75	PKL36080U63AE1	73	PLA34060CU33A	76	PLL34040CU41A	74	PLL34120CU43A	74
PKA36120U44A	75	PKL36080U64AE1	73	PLA34060CU41A	76	PLL34040CU43A	74	PLL34120CU44A	74
PKA36120U63AE1	75	PKL36080U73AE1	73	PLA34060CU43A	76	PLL34040CU44A	74	PLL34120CU63AE1	74
PKA36120U64AE1	75	PKL36080U74AE1	73	PLA34060CU44A	76	PLL34040CU63AE1	74	PLL34120CU64AE1	74
PKA36120U73AE1	75	PKL36100	73	PLA34060CU63AE1	76	PLL34040CU64AE1	74	PLL34120CU73AE1	74
PKA36120U74AE1	75	PKL36100CU31A	74	PLA34060CU64AE1	76	PLL34040CU73AE1	74	PLL34120CU74AE1	74
PKA36120U41A	75	PKL36100CU33A	74	PLA34060CU73AE1	76	PLL34040CU74AE1	74	PLL34120M70	79
PKA36120U43A	75	PKL36100CU41A	74	PLA34060CU74AE1	76	PLL34040U31A	73	PLL34120U31A	73
PKA36120U44A	75	PKL36100CU43A	74	PLA34060U31A	75	PLL34040U33A	73	PLL34120U33A	73
PKA36120U63AE1	75	PKL36100CU44A	74	PLA34060U33A	75	PLL34040U41A	73	PLL34120U41A	73
PKA36120U64AE1	75	PKL36100CU63AE1	74	PLA34060U41A	75	PLL34040U43A	73	PLL34120U43A	73
PKA36120U73AE1	75	PKL36100CU64AE1	74	PLA34060U43A	75	PLL34040U44A	73	PLL34120U44A	73
PKA36120U74AE1	75	PKL36100CU73AE1	74	PLA34060U44A	75	PLL34040U63AE1	73	PLL34120U63AE1	73
PKA36120U41A	75	PKL36100CU74AE1	74	PLA34060U63AE1	75	PLL34040U64AE1	73	PLL34120U64AE1	73
PKA36120U43A	75	PKL36100U31A	73	PLA34060U64AE1	75	PLL34040U73AE1	73	PLL34120U73AE1	73
PKA36120U44A	75	PKL36100U33A	73	PLA34060U73AE1	75	PLL34040U74AE1	73	PLL34120U74AE1	73
PKA36120U63AE1	75	PKL36100U41A	73	PLA34060U74AE1	75	PLL34060	73	RD10	118
PKA36120U64AE1	75	PKL36100U43A	73	PLA34080	75	PLL34060CU31A	74	RD16	118
PKA36120U73AE1	75	PKL36100U44A	73	PLA34080CU31A	76	PLL34060CU33A	74	RE10	118
PKA36120U74AE1	75	PKL36100U63AE1	73	PLA34080CU33A	76	PLL34060CU41A	74	RE16	118
PKA36120U31A	75	PKL36100U64AE1	73	PLA34080CU41A	76	PLL34060CU43A	74	RGA36100CU31A	88
PKA36120U33A	75	PKL36100U73AE1	73	PLA34080CU43A	76	PLL34060CU44A	74	RGA36100CU33A	88
PKA36120U41A	75	PKL36100U74AE1	73	PLA34080CU44A	76	PLL34060CU63AE1	74	RGA36100CU41A	88
PKA36120U43A	75	PKL36120	73	PLA34080CU63AE1	76	PLL34060CU64AE1	74	RGA36100CU43A	88
PKA36120U44A	75	PKL36120CU31A	74	PLA34080CU64AE1	76	PLL34060CU73AE1	74	RGA36100CU44A	88
PKA36120U63AE1	75	PKL36120CU33A	74	PLA34080CU73AE1	76	PLL34060CU74AE1	74	RGA36100CU63AE1	88
PKA36120U64AE1	75	PKL36120CU41A	74	PLA34080CU74AE1	76	PLL34060M68	79	RGA36100CU64AE1	88
PKA36120U73AE1	75	PKL36120CU43A	74	PLA34080U31A	75	PLL34060U31A	73	RGA36100CU73AE1	88
PKA36120U74AE1	75	PKL36120CU44A	74	PLA34080U33A	75	PLL34060U33A	73	RGA36100CU74AE1	88
PKA36120U31A	75	PKL36120CU63AE1	74	PLA34080U41A	75	PLL34060U41A	73	RGA36120CU31A	88
PKA36120U33A	75	PKL36120CU64AE1	74	PLA34080U43A	75	PLL34060U43A	73	RGA36120CU33A	88
PKA36120U41A	75	PKL36120CU73AE1	74	PLA34080U44A	75	PLL34060U44A	73	RGA36120CU41A	88
PKA36120U43A	75	PKL36120CU74AE1	74	PLA34080U63AE1	75	PLL34060U63AE1	73	RGA36120CU43A	88
PKA36120U44A	75	PKL36120U31A	73	PLA34080U64AE1	75	PLL34060U64AE1	73	RGA36120CU44A	88
PKA36120U63AE1	75	PKL36120U33A	73	PLA34080U73AE1	75	PLL34060U73AE1	73	RGA36120CU63AE1	88
PKA36120U64AE1	75	PKL36120U41A	73	PLA34080U74AE1	75	PLL34060U74AE1	73	RGA36120CU64AE1	88
PKA36120U73AE1	75	PKL36120U43A	73	PLA34100	75	PLL34080	73	RGA36120CU73AE1	88
PKA36120U74AE1	75	PKL36120U44A	73	PLA34100U31A	75	PLL34080CU31A	74	RGA36120CU74AE1	88
PKA36120U31A	75	PKL36120U63AE1	73	PLA34100U33A	75	PLL34080CU33A	74	RGF36060	84
PKA36120U33A	75	PKL36120U64AE1	73	PLA34100U41A	75	PLL34080CU41A	74	RGF36060CU31A	86
PKA36120U41A	75	PKL36120U73AE1	73	PLA34100U43A	75	PLL34080CU43A	74	RGF36060CU33A	86
PKA36120U43A	75	PKL36120U74AE1	73	PLA34100U44A	75	PLL34080CU44A	74	RGF36060CU41A	86
PKA36120U63AE1	75	PLA34025CU31A	76	PLA34100U63AE1	75	PLL34080CU63AE1	74	RGF36060CU43A	86
PKA36120U64AE1	75	PLA34025CU33A	76	PLA34100U64AE1	75	PLL34080CU64AE1	74	RGF36060CU44A	86

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RGF36060CU63AE1	86	RGF36160U31A	85	RJA36120CU64AE1	88	RJF36160CU31A	87	RKA36100CU64AE1	88
RGF36060CU64AE1	86	RGF36160U33A	85	RJA36120CU73AE1	88	RJF36160CU33A	87	RKA36100CU73AE1	88
RGF36060CU73AE1	86	RGF36160U41A	85	RJA36120CU74AE1	88	RJF36160CU41A	87	RKA36100CU74AE1	88
RGF36060CU74AE1	86	RGF36160U43A	85	RJF36060	84	RJF36160CU43A	87	RKA36120CU31A	88
RGF36060U31A	84	RGF36160U44A	85	RJF36060CU31A	86	RJF36160CU44A	87	RKA36120CU33A	88
RGF36060U33A	84	RGF36160U63AE1	85	RJF36060CU33A	86	RJF36160CU63AE1	87	RKA36120CU41A	88
RGF36060U41A	84	RGF36160U64AE1	85	RJF36060CU41A	86	RJF36160CU64AE1	87	RKA36120CU43A	88
RGF36060U43A	84	RGF36160U73AE1	85	RJF36060CU43A	86	RJF36160CU73AE1	87	RKA36120CU44A	88
RGF36060U44A	84	RGF36160U74AE1	85	RJF36060CU44A	86	RJF36160CU74AE1	87	RKA36120CU63AE1	88
RGF36060U63AE1	84	RGF36200	85	RJF36060CU63AE1	86	RJF36160U31A	85	RKA36120CU64AE1	88
RGF36060U64AE1	84	RGF36200CU31A	87	RJF36060CU64AE1	86	RJF36160U33A	85	RKA36120CU73AE1	88
RGF36060U73AE1	84	RGF36200CU33A	87	RJF36060CU73AE1	86	RJF36160U41A	85	RKA36120CU74AE1	88
RGF36060U74AE1	84	RGF36200CU41A	87	RJF36060CU74AE1	86	RJF36160U43A	85	RKF36000S12	89
RGF36080	84	RGF36200CU43A	87	RJF36060U31A	84	RJF36160U44A	85	RKF36000S16	89
RGF36080CU31A	86	RGF36200CU44A	87	RJF36060U33A	84	RJF36160U63AE1	85	RKF36000S20	89
RGF36080CU33A	86	RGF36200CU63AE1	87	RJF36060U41A	84	RJF36160U64AE1	85	RKF36000S25	89
RGF36080CU41A	86	RGF36200CU64AE1	87	RJF36060U43A	84	RJF36160U73AE1	85	RKF36000S30	89
RGF36080CU43A	86	RGF36200CU73AE1	87	RJF36060U44A	84	RJF36160U74AE1	85	RKF36060	84
RGF36080CU44A	86	RGF36200CU74AE1	87	RJF36060U63AE1	84	RJF36200	85	RKF36060CU31A	86
RGF36080CU63AE1	86	RGF36200U31A	85	RJF36060U64AE1	84	RJF36200CU31A	87	RKF36060CU33A	86
RGF36080CU64AE1	86	RGF36200U33A	85	RJF36060U73AE1	84	RJF36200CU33A	87	RKF36060CU41A	86
RGF36080CU73AE1	86	RGF36200U41A	85	RJF36060U74AE1	84	RJF36200CU41A	87	RKF36060CU43A	86
RGF36080CU74AE1	86	RGF36200U43A	85	RJF36080	84	RJF36200CU43A	87	RKF36060CU44A	86
RGF36080U31A	84	RGF36200U44A	85	RJF36080CU31A	86	RJF36200CU44A	87	RKF36060CU63AE1	86
RGF36080U33A	84	RGF36200U63AE1	85	RJF36080CU33A	86	RJF36200CU63AE1	87	RKF36060CU64AE1	86
RGF36080U41A	84	RGF36200U64AE1	85	RJF36080CU41A	86	RJF36200CU64AE1	87	RKF36060CU73AE1	86
RGF36080U43A	84	RGF36200U73AE1	85	RJF36080CU43A	86	RJF36200CU73AE1	87	RKF36060CU74AE1	86
RGF36080U44A	84	RGF36200U74AE1	85	RJF36080CU44A	86	RJF36200CU74AE1	87	RKF36060U31A	84
RGF36080U63AE1	84	RGF36250	85	RJF36080CU63AE1	86	RJF36200U31A	85	RKF36060U33A	84
RGF36080U64AE1	84	RGF36250CU31A	87	RJF36080CU64AE1	86	RJF36200U33A	85	RKF36060U41A	84
RGF36080U73AE1	84	RGF36250CU33A	87	RJF36080CU73AE1	86	RJF36200U41A	85	RKF36060U43A	84
RGF36080U74AE1	84	RGF36250CU41A	87	RJF36080CU74AE1	86	RJF36200U43A	85	RKF36060U44A	84
RGF36100	84	RGF36250CU43A	87	RJF36080U31A	84	RJF36200U44A	85	RKF36060U63AE1	84
RGF36100CU31A	86	RGF36250CU44A	87	RJF36080U33A	84	RJF36200U63AE1	85	RKF36060U64AE1	84
RGF36100CU33A	86	RGF36250CU63AE1	87	RJF36080U41A	84	RJF36200U64AE1	85	RKF36060U73AE1	84
RGF36100CU41A	86	RGF36250CU64AE1	87	RJF36080U43A	84	RJF36200U74AE1	85	RKF36060U74AE1	84
RGF36100CU43A	86	RGF36250CU73AE1	87	RJF36080U44A	84	RJF36250	85	RKF36080	84
RGF36100CU44A	86	RGF36250CU74AE1	87	RJF36080U63AE1	84	RJF36250CU31A	87	RKF36080CU31A	86
RGF36100CU63AE1	86	RGF36250U31A	85	RJF36080U64AE1	84	RJF36250CU33A	87	RKF36080CU33A	86
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RGF36100CU73AE1	86	RGF36250U41A	85	RJF36080U74AE1	84	RJF36250CU43A	87	RKF36080CU43A	86
RGF36100CU74AE1	86	RGF36250U43A	85	RJF36100	84	RJF36250CU44A	87	RKF36080CU44A	86
RGF36100U31A	84	RGF36250U44A	85	RJF36100CU31A	86	RJF36250CU63AE1	87	RKF36080CU63AE1	86
RGF36100U33A	84	RGF36250U63AE1	85	RJF36100CU33A	86	RJF36250CU64AE1	87	RKF36080CU64AE1	86
RGF36100U41A	84	RGF36250U64AE1	85	RJF36100CU41A	86	RJF36250CU73AE1	87	RKF36080CU73AE1	86
RGF36100U43A	84	RGF36250U73AE1	85	RJF36100CU43A	86	RJF36250CU74AE1	87	RKF36080CU74AE1	86
RGF36100U44A	84	RGF36250U74AE1	85	RJF36100CU44A	86	RJF36250U31A	85	RKF36080U31A	84
RGF36100U63AE1	84	RGF36300CU31A	87	RJF36100CU63AE1	86	RJF36250U33A	85	RKF36080U33A	84
RGF36100U64AE1	84	RGF36300CU33A	87	RJF36100CU64AE1	86	RJF36250U41A	85	RKF36080U41A	84
RGF36100U73AE1	84	RGF36300CU41A	87	RJF36100CU73AE1	86	RJF36250U43A	85	RKF36080U43A	84
RGF36100U74AE1	84	RGF36300CU43A	87	RJF36100CU74AE1	86	RJF36250U44A	85	RKF36080U44A	84
RGF36120	84	RGF36300CU44A	87	RJF36100U31A	84	RJF36250U63AE1	85	RKF36080U63AE1	84
RGF36120CU31A	86	RGF36300CU63AE1	87	RJF36100U33A	84	RJF36250U64AE1	85	RKF36080U64AE1	84
RGF36120CU33A	86	RGF36300CU64AE1	87	RJF36100U41A	84	RJF36250U73AE1	85	RKF36080U73AE1	84
RGF36120CU41A	86	RGF36300CU73AE1	87	RJF36100U43A	84	RJF36250U74AE1	85	RKF36080U74AE1	84
RGF36120CU43A	86	RGF36300CU74AE1	87	RJF36100U44A	84	RJF36300CU31A	87	RKF36100	84
RGF36120CU44A	86	RGF36300U31A	85	RJF36100U63AE1	84	RJF36300CU33A	87	RKF36100CU31A	86
RGF36120CU63AE1	86	RGF36300U33A	85	RJF36100U64AE1	84	RJF36300CU41A	87	RKF36100CU33A	86
RGF36120CU64AE1	86	RGF36300U41A	85	RJF36100U73AE1	84	RJF36300CU43A	87	RKF36100CU41A	86
RGF36120CU73AE1	86	RGF36300U43A	85	RJF36100U74AE1	84	RJF36300CU44A	87	RKF36100CU43A	86
RGF36120CU74AE1	86	RGF36300U44A	85	RJF36120	84	RJF36300CU63AE1	87	RKF36100CU44A	86
RGF36120U31A	84	RGF36300U63AE1	85	RJF36120CU31A	86	RJF36300CU64AE1	87	RKF36100CU63AE1	86
RGF36120U33A	84	RGF36300U64AE1	85	RJF36120CU33A	86	RJF36300CU73AE1	87	RKF36100CU64AE1	86
RGF36120U41A	84	RGF36300U73AE1	85	RJF36120CU41A	86	RJF36300CU74AE1	87	RKF36100CU73AE1	86
RGF36120U43A	84	RGF36300U74AE1	85	RJF36120CU43A	86	RJF36300U31A	85	RKF36100CU74AE1	86
RGF36120U44A	84	RJA36100CU31A	88	RJF36120CU44A	86	RJF36300U33A	85	RKF36100U31A	84
RGF36120U63AE1	84	RJA36100CU33A	88	RJF36120CU63AE1	86	RJF36300U41A	85	RKF36100U33A	84
RGF36120U64AE1	84	RJA36100CU41A	88	RJF36120CU64AE1	86	RJF36300U43A	85	RKF36100U41A	84
RGF36120U73AE1	84	RJA36100CU43A	88	RJF36120CU73AE1	86	RJF36300U44A	85	RKF36100U43A	84
RGF36120U74AE1	84	RJA36100CU44A	88	RJF36120CU74AE1	86	RJF36300U63AE1	85	RKF36100U44A	84
RGF36160	85	RJA36100CU63AE1	88	RJF36120U31A	84	RJF36300U64AE1	85	RKF36100U63AE1	84
RGF36160CU31A	87	RJA36100CU64AE1	88	RJF36120U33A	84	RJF36300U73AE1	85	RKF36100U64AE1	84
RGF36160CU33A	87	RJA36100CU73AE1	88	RJF36120U41A	84	RJF36300U74AE1	85	RKF36100U73AE1	84
RGF36160CU41A	87	RJA36100CU74AE1	88	RJF36120U43A	84	RJF363200U73AE1	85	RKF36100U74AE1	84
RGF36160CU43A	87	RJA36120CU31A	88	RJF36120U44A	84	RKA36100CU31A	88	RKF36120	84
RGF36160CU44A	87	RJA36120CU33A	88	RJF36120U63AE1	84	RKA36100CU33A	88	RKF36120CU31A	86
RGF36160CU63AE1	87	RJA36120CU41A	88	RJF36120U64AE1	84	RKA36100CU41A	88	RKF36120CU33A	86
RGF36160CU64AE1	87	RJA36120CU43A	88	RJF36120U73AE1	84	RKA36100CU43A	88	RKF36120CU41A	86
RGF36160CU73AE1	87	RJA36120CU44A	88	RJF36120U74AE1	84	RKA36100CU44A	88	RKF36120CU43A	86
RGF36160CU74AE1	87	RJA36120CU63AE1	88	RJF36160	85	RKA36100CU63AE1	88	RKF36120CU44A	86

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RKF36120CU63AE1	86	RKF36300U41A	85	RLF36100CU74AE1	86	RLF36250U41A	85	S33170	121
RKF36120CU64AE1	86	RKF36300U43A	85	RLF36100U31A	84	RLF36250U43A	85	S33171	121
RKF36120CU73AE1	86	RKF36300U44A	85	RLF36100U33A	84	RLF36250U44A	85	S33542	109
RKF36120CU74AE1	86	RKF36300U63AE1	85	RLF36100U41A	84	RLF36250U63AE1	85	S33543	109
RKF36120U31A	84	RKF36300U64AE1	85	RLF36100U43A	84	RLF36250U64AE1	85	S33544	109
RKF36120U33A	84	RKF36300U73AE1	85	RLF36100U44A	84	RLF36250U73AE1	85	S33545	109
RKF36120U41A	84	RKF36300U74AE1	85	RLF36100U63AE1	84	RLF36250U74AE1	85	S33575	108
RKF36120U43A	84	RKF363200U73AE1	85	RLF36100U64AE1	84	RLF36300CU31A	87	S33576	108
RKF36120U44A	84	RL3TB	90	RLF36100U73AE1	84	RLF36300CU33A	87	S33579	108
RKF36120U63AE1	84	RL3TB4	90	RLF36100U74AE1	84	RLF36300CU41A	87	S33592	107
RKF36120U64AE1	84	RLA36100CU31A	88	RLF36120	84	RLF36300CU43A	87	S33593	110
RKF36120U73AE1	84	RLA36100CU33A	88	RLF36120CU31A	86	RLF36300CU44A	87	S33594	113
RKF36120U74AE1	84	RLA36100CU41A	88	RLF36120CU33A	86	RLF36300CU63AE1	87	S33595	113
RKF36160	85	RLA36100CU43A	88	RLF36120CU41A	86	RLF36300CU64AE1	87	S33646	117
RKF36160CU31A	87	RLA36100CU44A	88	RLF36120CU43A	86	RLF36300CU73AE1	87	S33659	106
RKF36160CU33A	87	RLA36100CU63AE1	88	RLF36120CU44A	86	RLF36300CU74AE1	87	S33660	106
RKF36160CU41A	87	RLA36100CU64AE1	88	RLF36120CU63AE1	86	RLF36300U31A	85	S33660	106
RKF36160CU43A	87	RLA36100CU73AE1	88	RLF36120CU64AE1	86	RLF36300U33A	85	S33661	106
RKF36160CU44A	87	RLA36100CU74AE1	88	RLF36120CU73AE1	86	RLF36300U41A	85	S33661	106
RKF36160CU63AE1	87	RLA36120CU31A	88	RLF36120CU74AE1	86	RLF36300U43A	85	S33662	106
RKF36160CU64AE1	87	RLA36120CU33A	88	RLF36120U31A	84	RLF36300U44A	85	S33662	106
RKF36160CU73AE1	87	RLA36120CU41A	88	RLF36120U33A	84	RLF36300U63AE1	85	S33664	106
RKF36160CU74AE1	87	RLA36120CU43A	88	RLF36120U41A	84	RLF36300U73AE1	85	S33680	104
RKF36160U31A	85	RLA36120CU44A	88	RLF36120U43A	84	RLF36300U74AE1	85	S33681	104
RKF36160U33A	85	RLA36120CU63AE1	88	RLF36120U44A	84	RLTB	90	S33682	104
RKF36160U41A	85	RLA36120CU64AE1	88	RLF36120U63AE1	84	RLTB	90	S33683	104
RKF36160U43A	85	RLA36120CU73AE1	88	RLF36120U64AE1	84	RLTB1	90	S33684	104
RKF36160U44A	85	RLA36120CU74AE1	88	RLF36120U73AE1	84	RLTB1	90	S33685	104
RKF36160U63AE1	85	RLF36000S12	89	RLF36120U74AE1	84	RLTB4	90	S33717	118
RKF36160U64AE1	85	RLF36000S16	89	RLF36160	85	RLTB4	90	S33718	118
RKF36160U73AE1	85	RLF36000S20	89	RLF36160CU31A	87	RLTB4	90	S33767	122
RKF36160U74AE1	85	RLF36000S25	89	RLF36160CU33A	87	RLTB4	90	S33772	122
RKF36200	85	RLF36000S30	89	RLF36160CU41A	87	RLTBE	99	S33788	122
RKF36200CU31A	87	RLF36060	84	RLF36160CU43A	87	RLTBE4	99	S33857	118
RKF36200CU33A	87	RLF36060CU31A	86	RLF36160CU44A	87	S131A	107	S33857	122
RKF36200CU41A	87	RLF36060CU33A	86	RLF36160CU63AE1	87	S132R	107	S33859	122
RKF36200CU43A	87	RLF36060CU41A	86	RLF36160CU64AE1	87	S133A	107	S33875	118
RKF36200CU44A	87	RLF36060CU43A	86	RLF36160CU73AE1	87	S141A	107	S33890	119
RKF36200CU63AE1	87	RLF36060CU44A	86	RLF36160CU74AE1	87	S142R	107	S33929	118
RKF36200CU64AE1	87	RLF36060CU63AE1	86	RLF36160U31A	85	S143A	107	S33982	109
RKF36200CU73AE1	87	RLF36060CU64AE1	86	RLF36160U33A	85	S144A	107	S33982	109
RKF36200CU74AE1	87	RLF36060CU73AE1	86	RLF36160U41A	85	S163A	107	S33983	109
RKF36200U31A	85	RLF36060CU74AE1	86	RLF36160U43A	85	S164A	107	S33983	109
RKF36200U33A	85	RLF36060U31A	84	RLF36160U44A	85	S173A	107	S33984	109
RKF36200U41A	85	RLF36060U33A	84	RLF36160U63AE1	85	S174A	107	S33996	119
RKF36200U43A	85	RLF36060U41A	84	RLF36160U64AE1	85	S29450	105	S33997	118
RKF36200U44A	85	RLF36060U43A	84	RLF36160U73AE1	85	S29450	105	S33998	117
RKF36200U63AE1	85	RLF36060U44A	84	RLF36160U74AE1	85	S29450	105	S34036	108
RKF36200U64AE1	85	RLF36060U63AE1	84	RLF36200	85	S29450	105	S44936	119
RKF36200U74AE1	85	RLF36060U64AE1	84	RLF36200CU31A	87	S29450	105	S46996	118
RKF36250	85	RLF36060U73AE1	84	RLF36200CU33A	87	S29450	105	S46998	118
RKF36250CU31A	87	RLF36060U74AE1	84	RLF36200CU41A	87	S29452	105	S47052	109
RKF36250CU33A	87	RLF36080	84	RLF36200CU43A	87	S29452	105	S47053	109
RKF36250CU41A	87	RLF36080CU31A	86	RLF36200CU44A	87	S29452	105	S47067	107
RKF36250CU43A	87	RLF36080CU33A	86	RLF36200CU63AE1	87	S29452	105	S47390	106
RKF36250CU44A	87	RLF36080CU41A	86	RLF36200CU64AE1	87	S29452	105	S47390	106
RKF36250CU63AE1	87	RLF36080CU43A	86	RLF36200CU73AE1	87	S29452	105	S47391	106
RKF36250CU64AE1	87	RLF36080CU44A	86	RLF36200CU74AE1	87	S32631	119	S47391	106
RKF36250CU73AE1	87	RLF36080CU63AE1	86	RLF36200U31A	85	S32631	119	S47391	106
RKF36250CU74AE1	87	RLF36080CU64AE1	86	RLF36200U33A	85	S33033	106	S47391	106
RKF36250U31A	85	RLF36080CU73AE1	86	RLF36200U41A	85	S33034	106	S47392	106
RKF36250U33A	85	RLF36080CU74AE1	86	RLF36200U43A	85	S33034	106	S47392	106
RKF36250U41A	85	RLF36080U31A	84	RLF36200U44A	85	S33035	106	S47393	106
RKF36250U43A	85	RLF36080U33A	84	RLF36200U63AE1	85	S33035	106	S47393	106
RKF36250U44A	85	RLF36080U41A	84	RLF36200U64AE1	85	S33036	106	S47395	106
RKF36250U63AE1	85	RLF36080U43A	84	RLF36200U64AE1	85	S33036	106	S47395	106
RKF36250U64AE1	85	RLF36080U44A	84	RLF36200U73AE1	85	S33038	106	S47396	106
RKF36250U73AE1	85	RLF36080U63AE1	84	RLF36200U74AE1	85	S33091	109	S47396	106
RKF36250U74AE1	85	RLF36080U64AE1	84	RLF36250	85	S33092	109	S47398	106
RKF36300CU31A	87	RLF36080U73AE1	84	RLF36250CU31A	87	S33092	109	S47398	106
RKF36300CU33A	87	RLF36080U74AE1	84	RLF36250CU33A	87	S33092	109	S48182	108
RKF36300CU41A	87	RLF36100	84	RLF36250CU41A	87	S33093	109	S48818	109
RKF36300CU43A	87	RLF36100CU31A	86	RLF36250CU43A	87	S33093	109	S48819	109
RKF36300CU44A	87	RLF36100CU33A	86	RLF36250CU44A	87	S33093	109	S48820	109
RKF36300CU63AE1	87	RLF36100CU41A	86	RLF36250CU63AE1	87	S33094	109	S48823	109
RKF36300CU64AE1	87	RLF36100CU43A	86	RLF36250CU64AE1	87	S33095	109	S48823	109
RKF36300CU73AE1	87	RLF36100CU44A	86	RLF36250CU73AE1	87	S33095	109	S48824	109
RKF36300CU74AE1	87	RLF36100CU63AE1	86	RLF36250CU74AE1	87	S33095	109	S48824	109
RKF36300U31A	85	RLF36100CU64AE1	86	RLF36250U31A	85	S33100	108	S48825	109
RKF36300U33A	85	RLF36100CU73AE1	86	RLF36250U33A	85	S33100	110	S48836	109

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