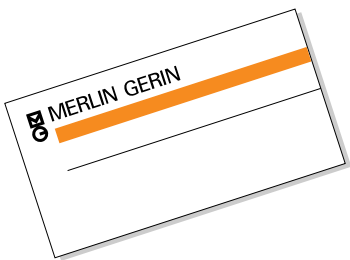


COMPACT® NSE

100 A Molded Case Circuit Breaker

Class 621



SQUARE D
GROUPE SCHNEIDER

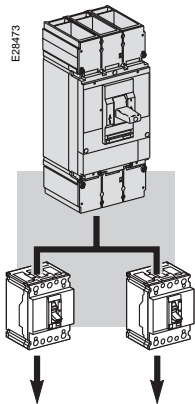
COMPACT[®] NSE

100 A Molded Case Circuit Breaker

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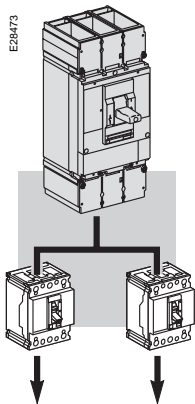
The COMPACT® circuit breaker line

Circuit breakers page 6



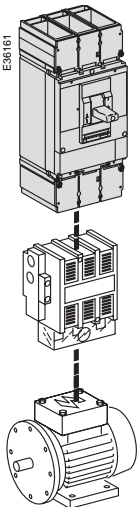
Rated current (A)	15–100	15–250	150–600	400–1200	1250–2500
COMPACT®	NSE100	NSF150 NSF250	NSJ400 NSJ600	CK400– CK1200	CM1250– CM2500
Interrupting rating at 480 V	N	18	35	35	50
	H	–	65	65	65
	L	–	–	100	150

Switches page 7



Rated current (A)	100	150–250	400–600	800–1200	1600–2500
COMPACT®	NSE100A	NSF150A NSF250A	NSJ400A NSJ600A	CK800NA	CM1600HA CM2000HA CM2500HA

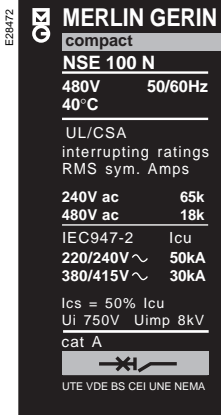
Motor circuit protectors page 8



Rated current (A)	3–75	100–250	400–600	800–1200	
COMPACT®	NSE75HC	NSF150HC NSF250HC	NSJ400HC NSJ600HC	CK800N/H CK1000HL/L CK1200N/H	

General characteristics

Compliance with standards



Compliance with North American standards

COMPACT® NS circuit breakers are built in accordance with Underwriters Laboratories Inc. UL 489 Standard and Canadian Standards Association CSA C22.2 No.5.1 Standard. Circuit breakers, switches and their accessories, except where noted, are Listed under UL files E63335, E103740, E103955, and Certified under CSA files LR69561 and LR88980.

Compliance with international standards

COMPACT® NS circuit breakers and their accessories comply also with the following international standards:

- IEC 947-1: general rules;
 - IEC 947-2: circuit breakers;
 - IEC 947-3: switches, disconnectors, switch disconnectors, etc.
- In that these standards are applied in most countries, COMPACT® circuit breakers and their accessories comply with European (EN 60947-1 and EN 60947-2) and the corresponding national standards:
- France NF;
 - Germany VDE;
 - U.K. BS;
 - Australia AS;
 - Italy CEI.

Compliance with the specifications of marine classification organizations

COMPACT® NS circuit breakers have been approved for marine application by the American Bureau of Shipping, Bureau Veritas, Lloyd's Register of Shipping, Registro Italiano Navale, Germanischer Lloyd's and Det Norske Veritas.

They comply with the following standards:

- UL 489 Supplement SA. Marine use on vessels over 65 feet in length;
- US Coast Guard specifications;
- IEC 92-504 and marine specifications: inclination, vibrations, insulation resistance;
- IEC 803 Electromagnetic Disturbance Immunity.

Tropicalization

COMPACT® NS circuit breakers comply with NF C 63-100 standard level 2 conditions (95% relative humidity at 45 °C or 80% at 55 °C, hot and humid climate conditions).

They also comply with the following standards:

- IEC 68-2-30 damp heat;
- IEC 68-2-2 dry heat;
- IEC 68-2-11 salt spray;
- IEC 68-2-1 low temperatures.

Pollution degree

COMPACT® NS circuit breakers are certified for operation in pollution degree III environments as defined by IEC standard 947 (industrial environments).

Environmental protection

COMPACT® NS circuit breakers take into account concerns for environmental protection. Most components are recyclable and parts are marked as specified in applicable standards.

General characteristics



Suitability for isolation positive contact indication

All COMPACT® NS circuit breakers and switches are suitable for isolation as defined in the IEC 947-2 Standard:

- The isolation position corresponds to the O (OFF position);
- The operating handle cannot indicate the OFF position unless the contacts are open;
- Padlocks may not be installed unless the contacts are open.

Installation of a rotary handle or a motor mechanism does not alter the functionality of the position indication system.

The isolation function is certified by tests guaranteeing:

- The mechanical reliability of the position indication system;
- The absence of leakage currents;
- Overvoltage withstand capacity between upstream and downstream connections.

E16669



Circuit breaker marking

E349863



Switch marking

Installation in Class II switchboards

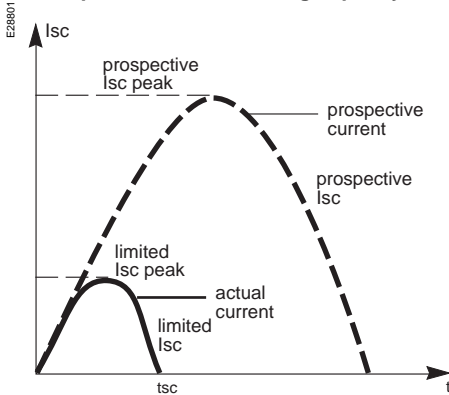
All COMPACT® NS circuit breakers, even when fitted with a rotary handle or a motor mechanism, can be installed through the door of Class II IEC switchboards (as per IEC 664 Standard). Refer to circuit breaker installation instructions prior to installing circuit breaker.

Installation requires no special insulation because COMPACT® NS circuit breakers provide Class II insulation between the front face and all internal circuits.

General characteristics

The limiting capacity of a circuit breaker is its ability to limit short-circuit currents.

Exceptional current limiting capacity



Circuit breaker current limiting capacity

The exceptional limiting capacity of the COMPACT® NS line is due to the double break technique (very rapid natural repulsion of contacts and the appearance of two arc voltages in series with a very steep wavefront).

The exceptional limiting capacity of the COMPACT® NS line greatly reduces the forces created by fault currents in devices. The result is a major increase in breaking performance. In particular, the service breaking capacity I_{cs} is equal to 50% of I_{cu} . The I_{cs} value, defined by IEC 947-2, is guaranteed by tests comprising the following operations:

- Breaking a fault current equal to 50% of I_{cu} three times consecutively;
- Checking that the device continues to function normally;
- Conduction of rated current without abnormal temperature rise;
- Protection functions perform within the limits specified by the standard;
- Suitability for isolation is not impaired.

Longer service life of electrical installations

Current limiting circuit breakers greatly reduce the negative effects of short circuits on installations.

Thermal effects

Less temperature rise in conductors, therefore longer service life for cables.

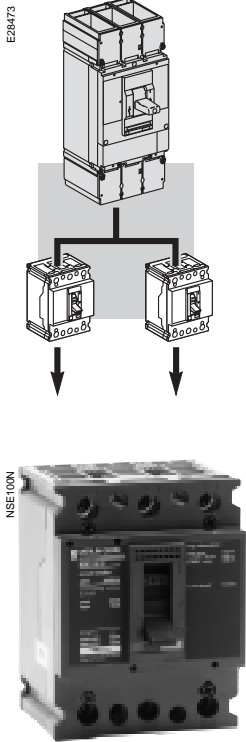
Mechanical effects

Reduced electrodynamic forces, therefore less risk of electrical contacts or bus bars being distorted or broken.

Electromagnetic effects

Less disturbance for measuring devices located near electrical circuits.

Circuit breaker



COMPACT® NSE100N circuit breaker

Ratings and interrupting ratings

UL 489 Listed ratings

COMPACT® circuit breakers		NSE100N
Number of poles		3
Rated voltage (V)	AC 50/60 Hz	480
Rated current (A)	40°C	15–100
Interrupting ratings (kA rms)	240 V	65
	480 V	18

IEC 947-2 and EN 60947-2 Ratings

COMPACT® circuit breakers		NSE100N		
Number of poles		3		
Rated insulation voltage (V)	Ui	750		
Rated impulse withstand voltage (kV)	Uimp	8		
Rated operational voltage (V)	Ue	AC 50/60 Hz	480	
		DC	250	
Rated current (A)	In	40°C	15–100	
Ultimate breaking capacity (kA rms)	Icu	AC 50/60 Hz	220/240 V	50
			380/415 V	30
			440 V	15
			500 V	–
			525 V	–
			660/690 V	–
			DC	
250 V (2 poles in series)	10			
Service breaking capacity	Ics	(% Icu)		50
Utilization category				A

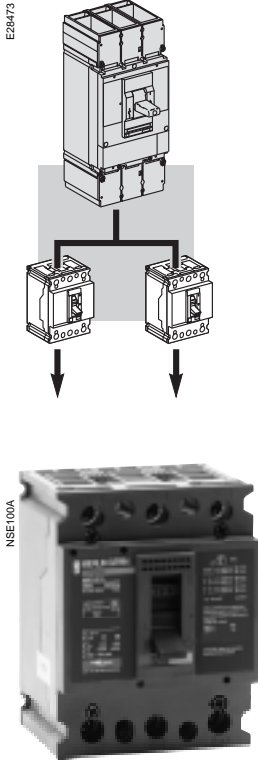
Protection characteristics

Protection against overloads and short circuits with a built-in thermal-magnetic trip unit (fixed thresholds).

Ratings (A)	40°C	15	20	30	40	50	60	70	80	100
Overload protection										
Thermal		non-adjustable								
Short-circuit protection										
Magnetic		non-adjustable								
Hold		600	600	600	600	800	800	800	800	800
Trip		1200	1200	1200	1200	1400	1400	1400	1400	1400

Circuit breaker is Listed under UL file E63335 and Certified under CSA file LR 69561.

Switch



COMPACT® NSE100A circuit breaker

Ratings and withstand ratings

UL 1087 Listed Ratings

COMPACT® switches		NSE100A
Number of poles		3
Rated voltage (V)	AC 50/60 Hz	480
Rated current (A)		100
Withstand rating (kA RMS)	240 V	65
	480 V	18

IEC 947-3 Ratings

COMPACT® switches		NSE100A	
Number of poles		3	
Rated insulation voltage (V)	Ui	750	
Rated impulse withstand voltage (kV)	Uimp	8	
Rated operational voltage (V)	Ue	AC 50/60 Hz	480
		DC	250
Rated operational current (A)	Ie	AC23A 690 V	100
		DC23A 250 V	100
		DC23A 500 V	100
		(2 poles in series)	
Making capacity (kA peak)		2	
Short-time withstand current (kA rms)	Icw	Icw (kA rms)	1.5
		duration (s)	3

Short-circuit withstand current

Molded case switches are identical to molded case circuit breakers, except that they are not equipped with trip units. When protected by any protective device, they are suitable for use on a circuit capable of delivering not more than:

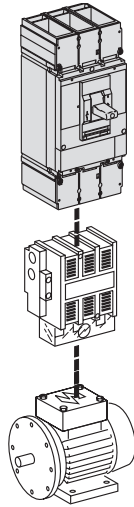
- 240 V: 150 kA;
- 480 V: 100 kA.

Switch is Listed under UL file E103740 and Certified under CSA file LR 88980.

Molded case switches are automatic and open instantaneously at a factory preset magnetic trip point of 1100A. Molded case switches are calibrated to protect only the molded case switch itself when subjected to high fault currents. The trip point is non-adjustable and provides no overload protection.

Molded case switches open when the handle is switched to the OFF position or in response to an auxiliary tripping device such as a shunt trip or an undervoltage release.

Motor circuit protector



COMPACT® NSE75HC circuit breaker

Ratings and interrupting ratings

UL 489 Recognized Component

COMPACT® circuit breakers		NSE75HC
Number of poles		3
Rated voltage (V)		600Y/347
Rated current (A)	In 40°C	3–75

Interrupting ratings In combination with Telemecanique LC1 contactors and LR2 overload relays

IEC 947-2 and EN 60947-2 interrupting ratings

COMPACT® circuit breakers		NSE75HC
Number of poles		3
Rated insulation voltage (V) Ui		750
Rated impulse withstand voltage (kV) Uimp		8
Rated operational voltage (V) Ue	AC 50/60 Hz	690
Rated current (A)	In 40°C	3–75

Ultimate breaking capacity (kA rms)	Icu	AC 50/60 Hz	200/240 V	100
			380/415 V	70
			440 V	65
			690 V	6

Service breaking capacity	Ics	(% Icu)	50
Utilization category			A

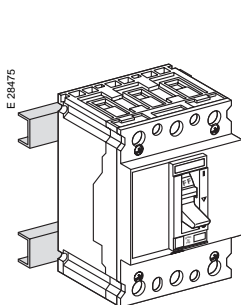
Motor circuit protector is Recognized under UL file E113389 and Certified under CSA file LR 69561.

Installation and connections

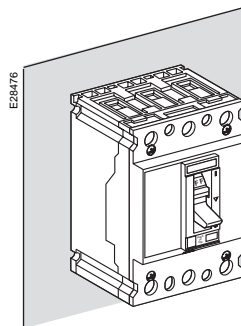
Refer to circuit breaker installation instructions before installing circuit breaker, accessories or wiring.

Fixed mounting

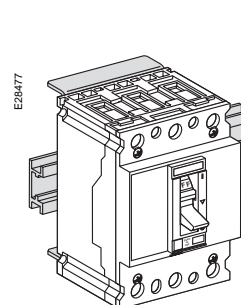
Mounting on rails



Mounting on backplate

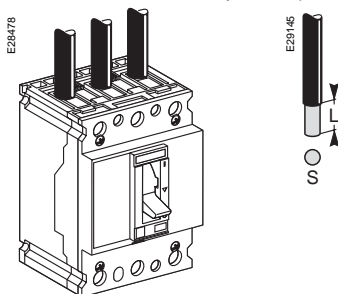


Mounting on DIN rail



Cable connections

The COMPACT® NSE100 circuit breaker is equipped as standard with connectors for bare cables and is suitable for reverse feeding. Terminal covers are optional (see page 15).

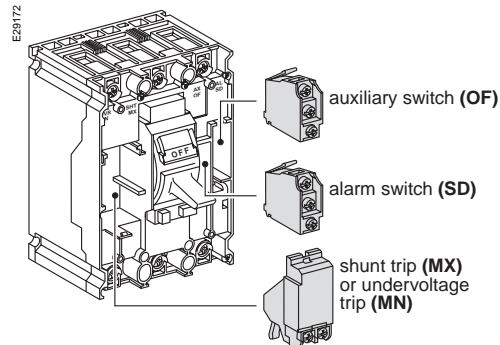


NSE75/NSE100		
L	Inch	0.75
	mm	19
S	AWG	#14-#1/0 Cu
		#8-#1/0 Al
	mm ²	1.5-70

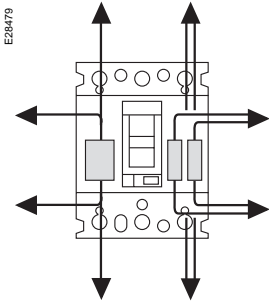
Accessories

Location

Internal accessories comply with requirements of Underwriters Laboratories Inc. UL 489 and Canadian Standards Association (CSA) C22.2 No. 5.1 Standards. All internal accessories are listed for field installation per UL file 103955 and Certified under CSA file LR 69561.



Connections



Each electrical accessory is fitted with numbered terminal blocks for wires with the following maximum size:
■ #18 AWG (0.75 mm²) to #14 AWG (2.5 mm²) for auxiliary switches, shunt trip or undervoltage release.

Auxiliary circuits exit the device through a knock-out in the front cover.

Accessories

Auxiliary and alarm switches



For COMPACT® NSE100N circuit breaker

Changeover switches

Auxiliary switches provide remote information of the circuit breaker status and can thus be used for indications, electrical locking, relays, etc.

Functions

- OF (open/closed): indicates the position of the circuit breaker contacts;
- SD (trip indication): indicates that the circuit breaker has tripped due to:
 - An overload;
 - A short circuit;
 - The operation of shunt trip or undervoltage trip or the "push-to-trip" button which resets when the circuit breaker is reset.
- CAM (early-make or early-break function): indicates the position of the rotary handle. Used in particular for advanced-opening safety trip devices;
- Switching of very low loads: all above auxiliary switches are also available in low-level versions capable of switching very low loads (e.g., for the control of PLCs or electronic circuits).

Standards

Auxiliary switches comply with UL 489, CSA C22.2 No. 5.1 and IEC 947-5 Standards.

Installation

- Functions OF and SD:
 - The switches snap into cavities under the front accessory cover of the circuit breaker,
 - One model serves for all indication functions depending on where it is fitted in the circuit breaker;
- CAM: to be fitted in the rotary handle module.

Electrical ratings

UL 489 and CSA C22.2 No. 5.1 ratings

	Low-level switches		Regular switches	
Minimum rating	1 mA—4 V		10 mA—24 V	
Maximum rating 50/60 Hz	240 V	5	6	
	480 V	5	6	
	600 V		3	
DC	48 V	2.5	2.5	
	125 V	0.8	0.8	
	250 V	0.3	0.3	

IEC 947 ratings

	Low-level switches				Regular switches				
Rated thermal current (A)	5				6				
Minimum rating	1 mA—4 V				10 mA—24 V				
	AC		DC		AC		DC		
Utilization category (IEC 947-4)	AC12	AC15	DC12	DC14	AC12	AC15	DC12	DC14	
Operational current (A)	24 V	5	3	5	1	6	6	2.5	1
	48 V	5	3	2.5	0.2	6	6	2.5	0.2
	110 V	5	2.5	0.8	0.05	6	5	0.8	0.05
	220/240 V	5	2			6	4		
	250 V			0.3	0.03			0.3	0.03
	380/415 V	5	1.5			6	3		
440 V	5	1.5			6	3			
660/690 V					6	0.1			

Accessories

Shunt trip and undervoltage trip



For COMPACT® NSE circuit breaker

A voltage release can be used to trip the circuit breaker via a control signal.

Undervoltage trip (MN)

- Trips the circuit breaker when the control voltage drops below a tripping threshold;
- Drops out between 35% and 70% of the rated voltage;
- Circuit breaker closing is possible only if the voltage exceeds 85% of the rated voltage;
- Permanent type;
- When an overvoltage condition exists, operation of the closing mechanism of the circuit breaker will not permit the main contacts to touch, even momentarily;

Shunt trip (MX)

Trips the circuit breaker when the control voltage rises above 70% of its rated voltage.

Impulse type ≥ 20 ms or maintained control signals.

AC shunt trips can be operated at 55% of their rated voltage, making them suitable for ground-fault protection when combined with a Class I ground-fault sensing element.

Operation

- The circuit breaker must be reset locally after being tripped by a shunt trip or undervoltage trip (MN or MX);
- MN or MX tripping has priority over manual closing. In the presence of a standing trip order, such an action does not result in any closing, even temporarily, of the main contacts;
- Endurance:
 - 50% of the rated mechanical endurance of the circuit breaker.

Installation and connection

- Accessories are located within the circuit breaker behind the front accessory cover;
- Each terminal can be connected by one stranded copper wire #18–#14 AWG (1.5 mm²).

Electrical characteristics

	AC (*)	DC
Rated voltage (V)	42, 48, 110/130, 208, 220/240	24, 48, 125
	277, 380/415, 440/480	250
Consumption	pickup (MX)	< 5 W
	seal-in (MN)	< 5 W
Clearing time (ms)	< 50	< 50

(*) 42 Vac rating not available on undervoltage trip (MN).

Accessories

Rotary operating handles



COMPACT® NS250L circuit breaker with direct rotary handle



COMPACT® NS250L circuit breaker with extended rotary handle

Direct rotary handle

Operation

- The direct rotary handle maintains:
 - Suitability for isolation;
 - Indication of three positions O (Off), I (On) and tripped;
 - Access to the push-to-trip button.
- The circuit breaker may be locked in the off position by one to three padlocks: Padlock shackle diameter 0.19 to 0.31 inch (5 to 8 mm) (padlocks are not supplied).

Installation

Replaces the circuit breaker front accessory cover. Secured by screws.

Models

- Standard with black handle;
- VDE type with red handle and yellow bezel for machine tool control.

Variations

Accessories transform the standard direct rotary handle for the following situations:

- Motor control centers (MCCs):
 - Door opening prevented when circuit breaker is on,
 - Circuit breaker closing inhibited when door is open.
- Listed under UL file E103955 and Certified under CSA file LR 69561.

Door mounted

Makes it possible to operate circuit breakers installed inside an enclosure from the front.

The handle mechanism can be used in NEMA 3R and 12 enclosure applications. Degree of protection: IP40 as per IEC 529.

Operation

- The unit maintains:
 - Suitability for isolation;
 - Indication of the three positions O (Off), I (On) and tripped;
 - Visibility of and access to trip unit settings when the door is open;
- Door opening prevented when circuit breaker is on;
- The circuit breaker may be locked in the off position by one to three padlocks: padlock shackle diameter 0.19 to 0.31 inch (5 to 8 mm) (padlocks are not supplied). Locking prevents opening of the switchboard door.

Models

- Standard with black handle;
- VDE with red handle and yellow bezel for machine tool control.

Installation

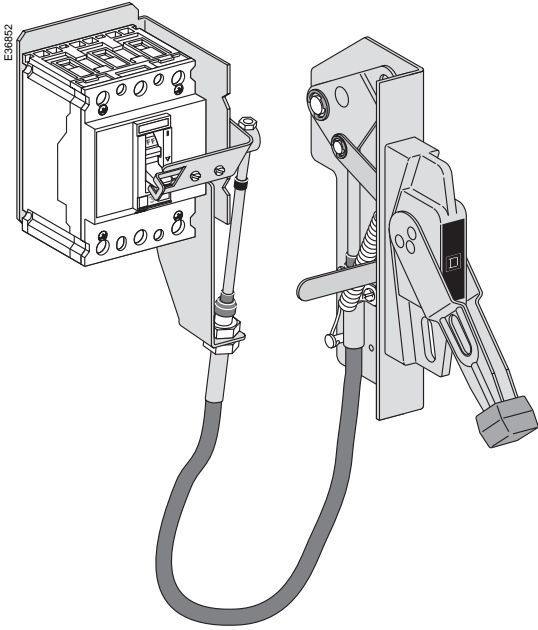
The extended rotary operating handle is made up of:

- A unit that replaces the front accessory cover of the circuit breaker (secured by screws);
- An assembly (handle and front plate) on the door that is always secured in the same position, whether the circuit breaker is installed vertically or horizontally;
- An extension shaft that must be adjusted. The distances between back of circuit breaker and door are 3.24 to 3.34 inch (82.5 to 85 mm).

Listed under UL file E103955 and Certified under CSA file LR 69561.

Accessories

Cable operating handle



Flange-mounted handle cable operating mechanism

Operation

- The cable operator maintains:
 - Suitability for isolation;
 - Indication of three positions O (Off) I (On) and tripped;
 - Access to push-to-test;
 - The circuit breaker may be locked in the off position by one to their padlocks;
 - Door can be locked closed due to interlocking features of the handle operator.

Installation

Handle is mounted on flange of enclosure using specified mounting dimensions while circuit breaker and operating mechanism are mounted to inside of enclosure using two screws.

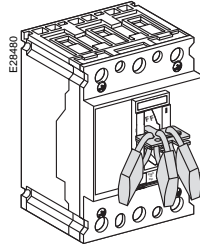
Cable lengths available in 3, 5 or 10 ft. lengths to accommodate a variety of mounting locations. Handles available in painted Nema 1, 3, 3R, 4 (sheet steel) and 12 ratings or chrome Nema 4, 4x.

Accessories

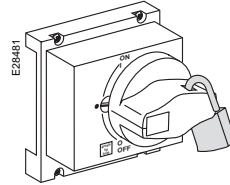
Locking and interlocking systems

Locking systems

- Padlocking systems can receive up to three padlocks with diameters ranging from 0.19 to 0.31 inch (5 to 8 mm) (padlocks are not supplied).

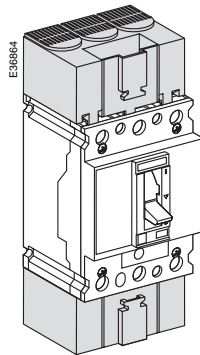


Locking of the toggle using a padlocking device



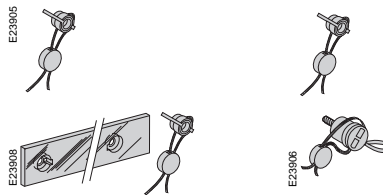
Locking of the rotary handle using a padlock

Terminal covers



Terminal covers provide protection against contact with live parts. Internal interphase barriers provide additional electrical clearances between poles. Terminal covers are sealable.

Sealing accessories



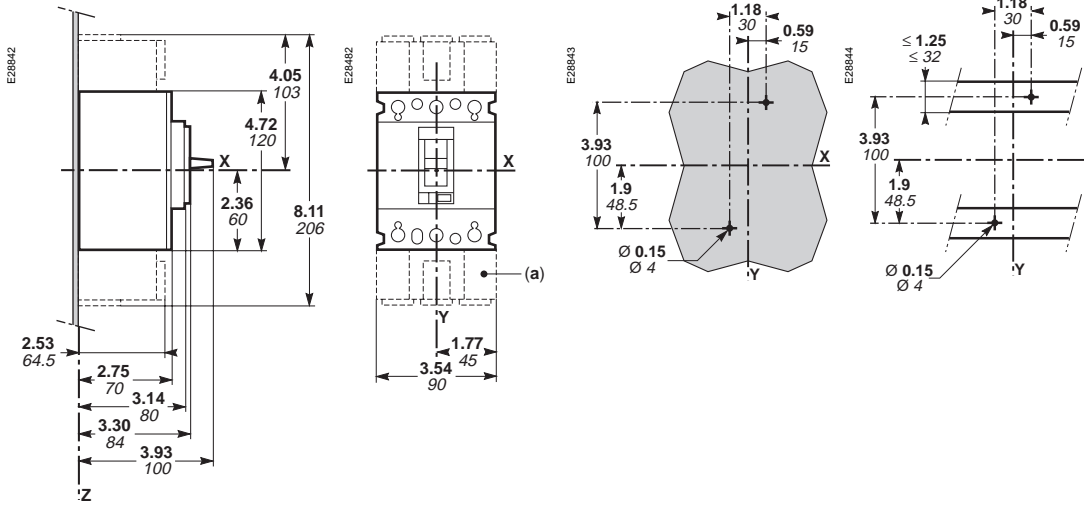
This accessory includes the elements required to fit lead seals to prevent:

- Front accessory cover removal;
- Rotary handle removal;
- Access to accessories;
- Terminal shield removal;
- Access to power connections.

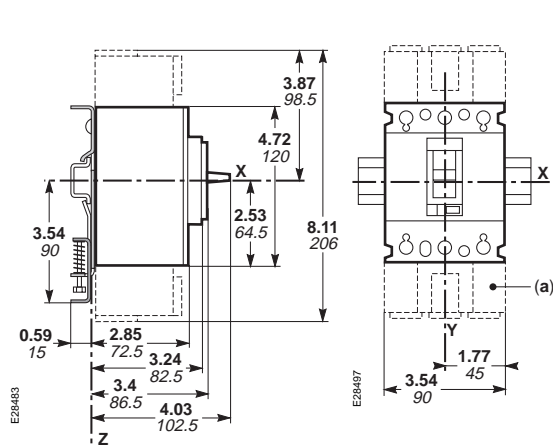
Dimensions $\frac{\text{inch}}{\text{mm}}$

COMPACT® NSE circuit breaker

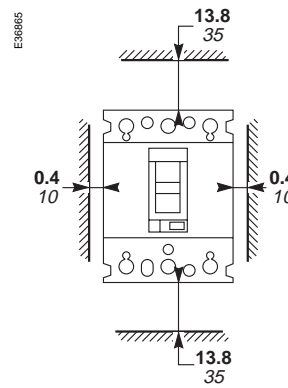
Mounting on backplate or on rails



Mounting on DIN rail

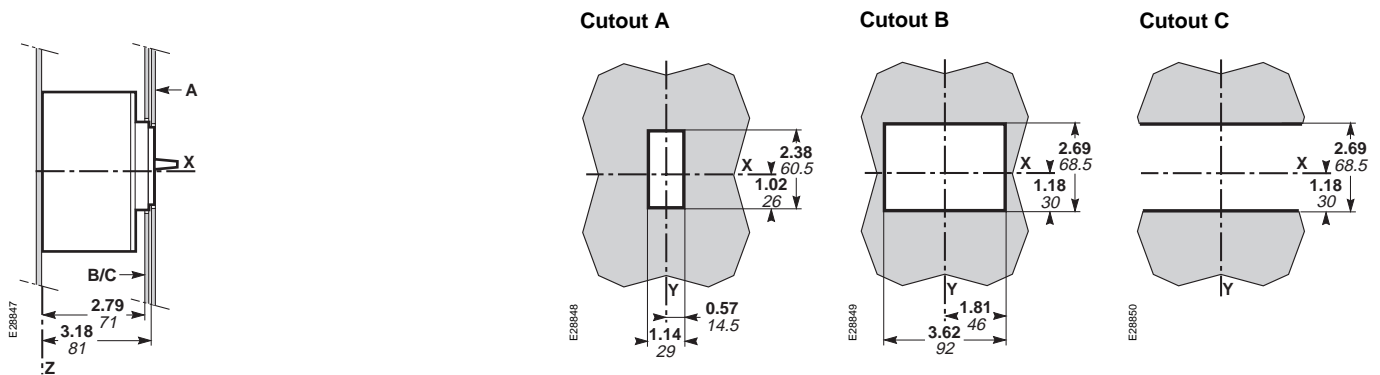


Electrical clearances



(a) Terminal shields.

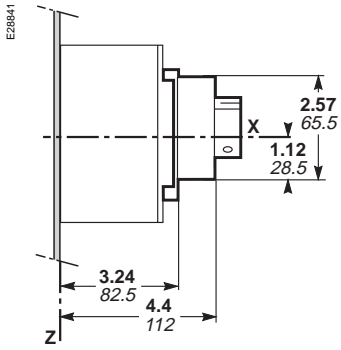
Front panel cutouts



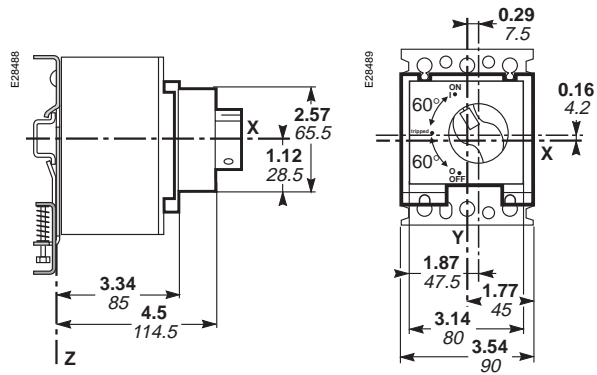
Dimensions $\frac{\text{inch}}{\text{mm}}$

Direct rotary handle

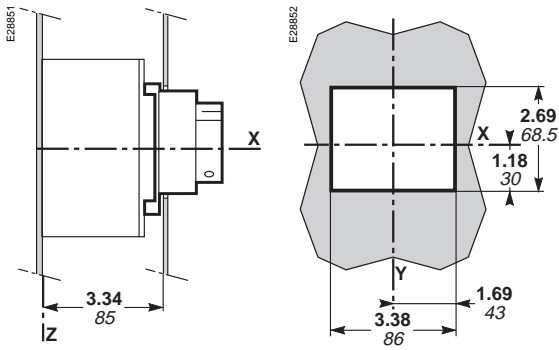
Mounting on backplate or on rails



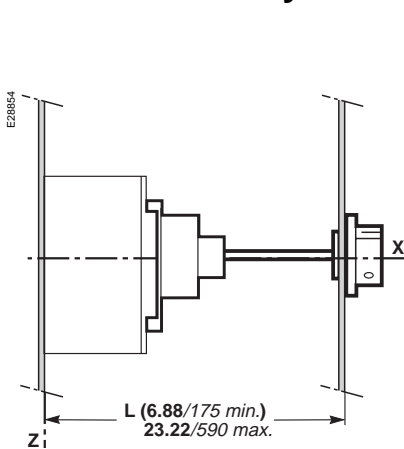
Mounting on DIN rail



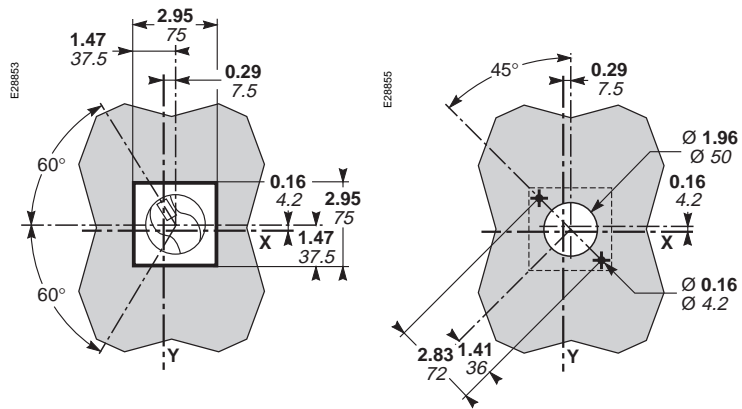
Front panel cutout



Extended rotary handle



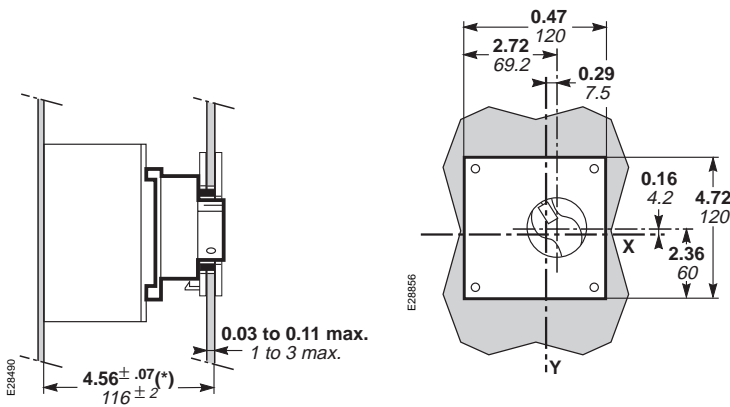
Front panel cutout



Cut shaft at length L - 4.29/109

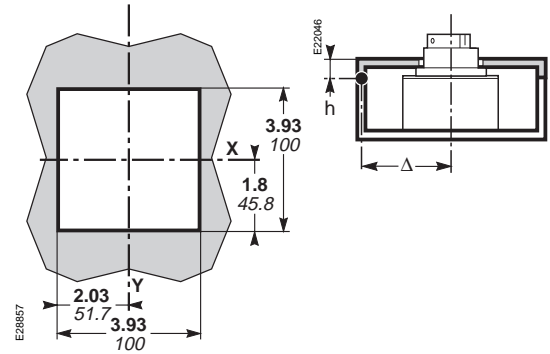
Dimensions $\frac{\text{inch}}{\text{mm}}$

Motor control center type rotary handle



(*) Mounting on DIN rail: $4.66/118.5 \pm 2$.

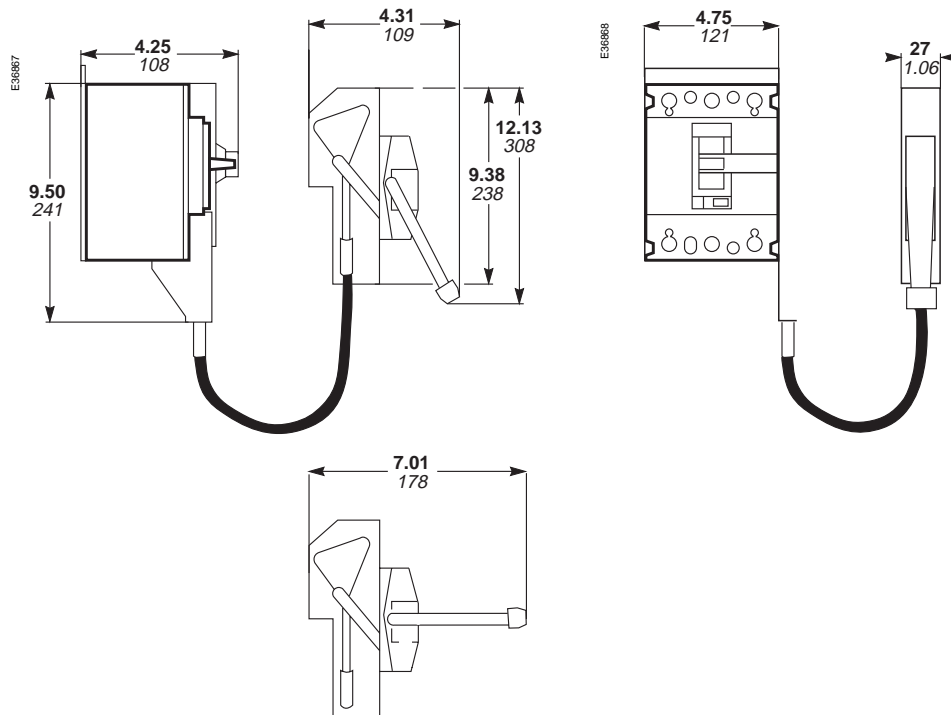
Front panel cutout



Note:

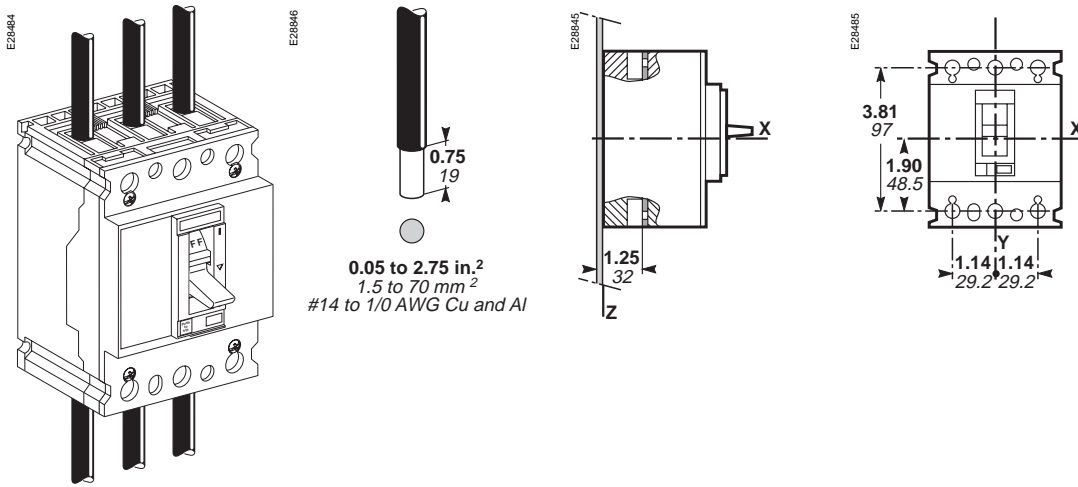
Door cutouts require a minimum distance between the center of the circuit breaker and the door hinge point $\Delta \geq 100 + (h \times 5)$.

Cable operating handle

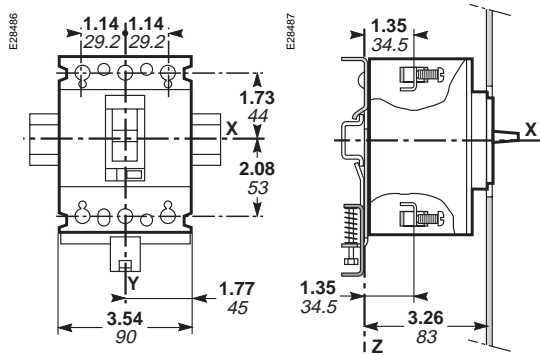


Connections

Front connections

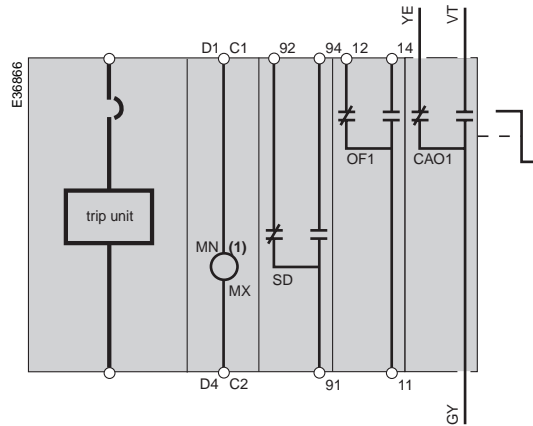


Mounting on DIN rail



Wiring diagrams

Auxiliary switches, shunt trip and undervoltage trip



Symbols

- MN** : undervoltage trip
- MX** : shunt trip
- SD** : alarm switch
- OF1** : auxiliary switch
- CA01** : early-break switch (rotary operating handle)

Legend

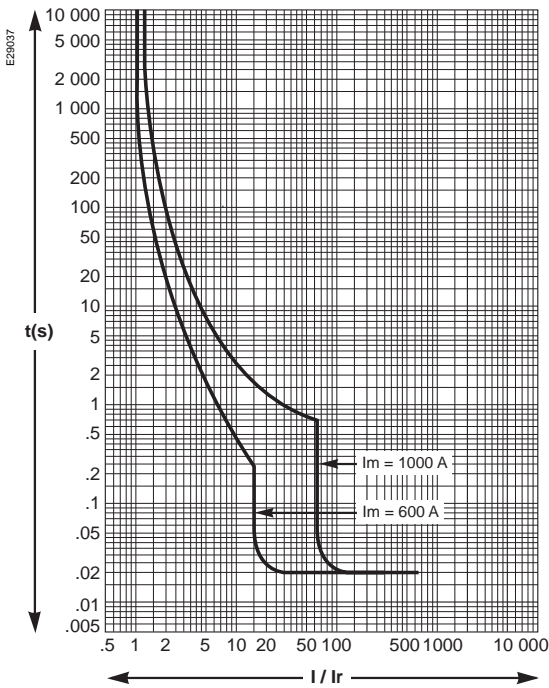
- (1)** : undervoltage or shunt trip

Color code

- YE** : yellow
- VT** : purple
- GY** : grey

Trip curves

TM15 to TM40 (15 to 40 A)



Effect of high temperatures

When the ambient temperature is greater than 40°C, overload protection characteristics are slightly modified. When determining tripping times using time/current curves, the Ir values corresponding to the thermal setting on the circuit breaker must be reduced using the coefficients below:

45°C	50°C	55°C	60°C	65°C	70°C
0.975	0.95	0.925	0.90	0.875	0.85

Example

For a TM100DP (100 A) circuit breaker, a 200 A fault current and an ambient temperature of 40°C. What is the tripping time?

■ $I_r = 100 \text{ A};$

■ $I/I_r = 200/100 = 2.$

On the time/current curve, $t = 100 \text{ sec.}$

Consider the same conditions, except an ambient temperature of 65°C.

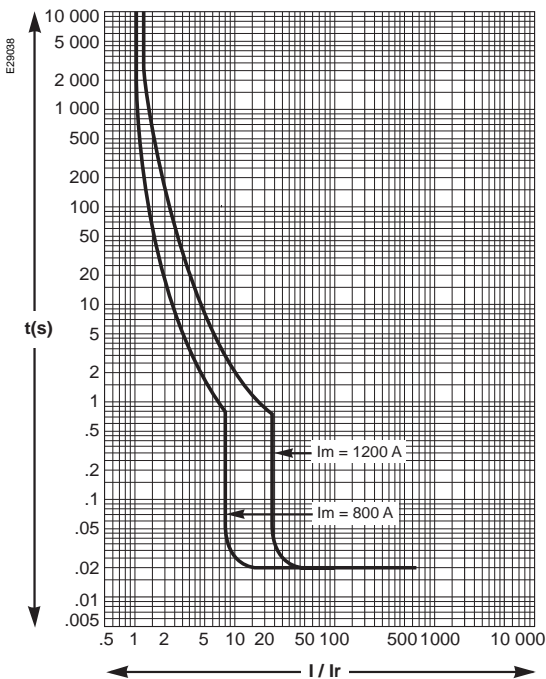
What is the tripping time?

■ $I_r = 100 \times 0.875 = 87.5 \text{ A};$

■ $I/I_r = 200/87.5 = 2.28.$

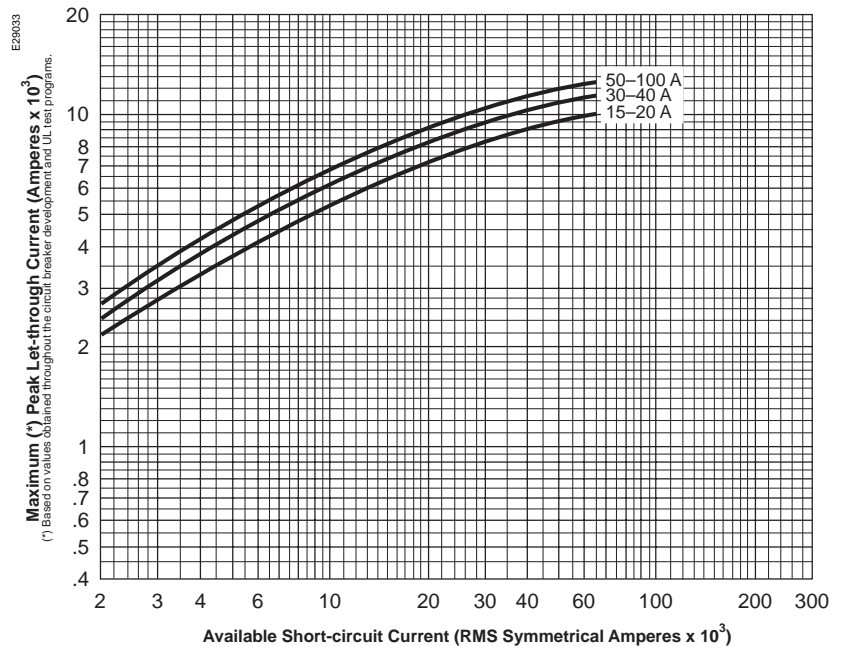
On the time/current curve, $t = 65 \text{ sec.}$

TM50 to TM100 (50 to 100 A)

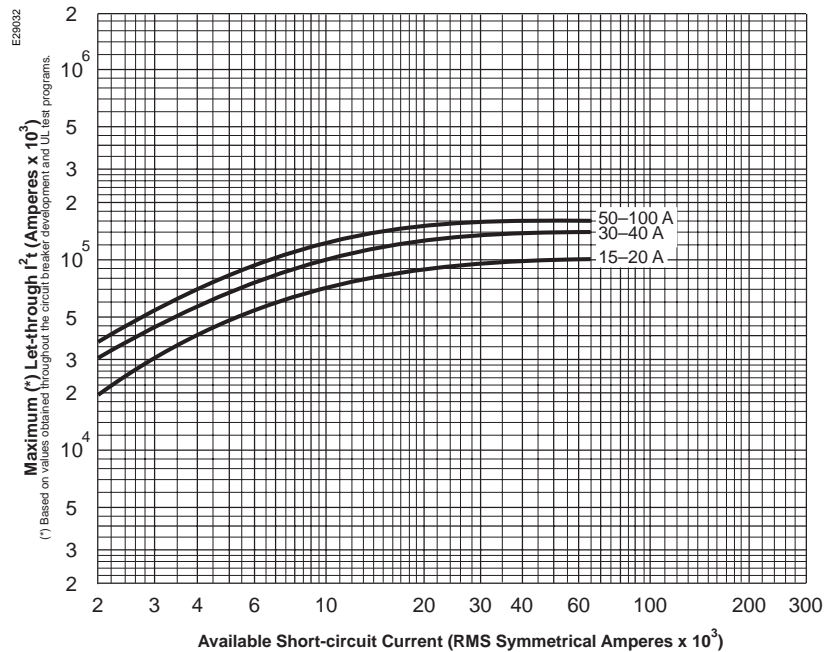


Let-through curves at 240 Vac

Maximum peak let-through current (amperes)

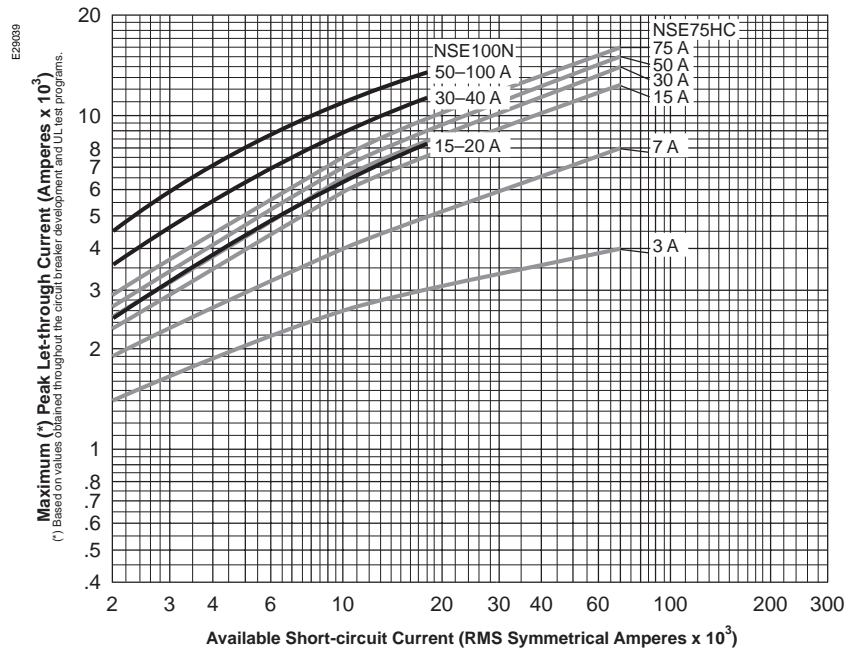


Maximum let-through I²t (amperes² seconds)

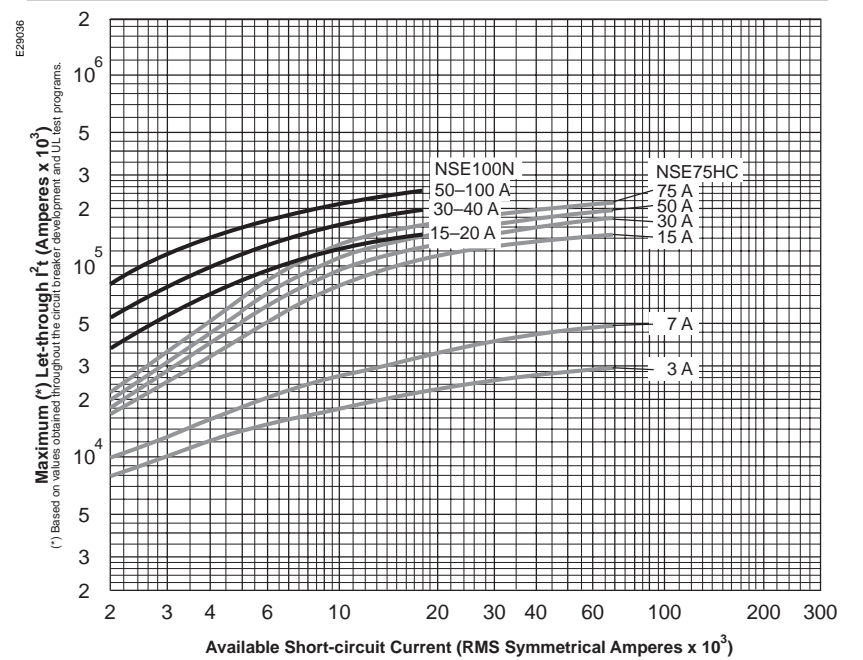


Let-through curves at 480 Vac

Maximum peak let-through current (amperes)

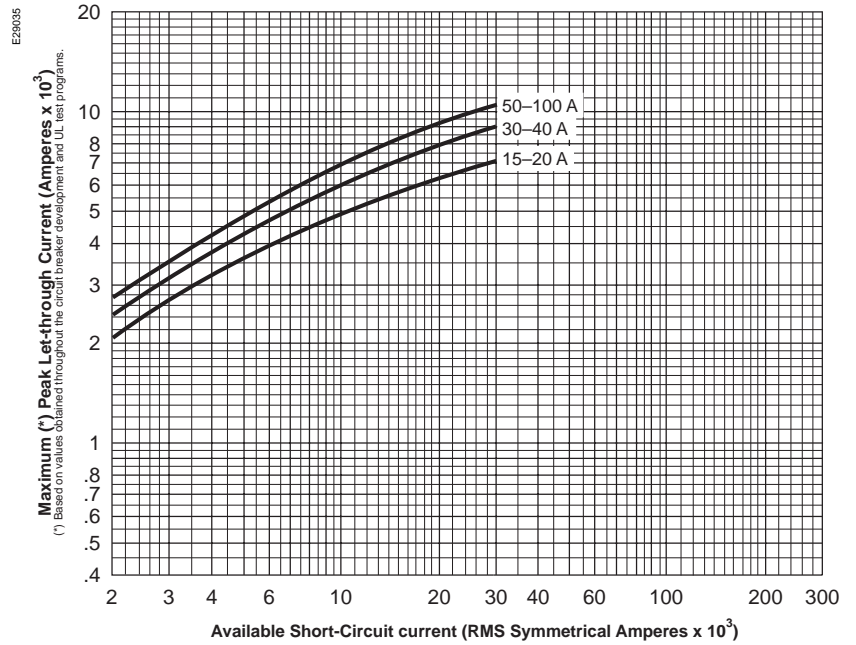


Maximum let-through I^2t (amperes² seconds)

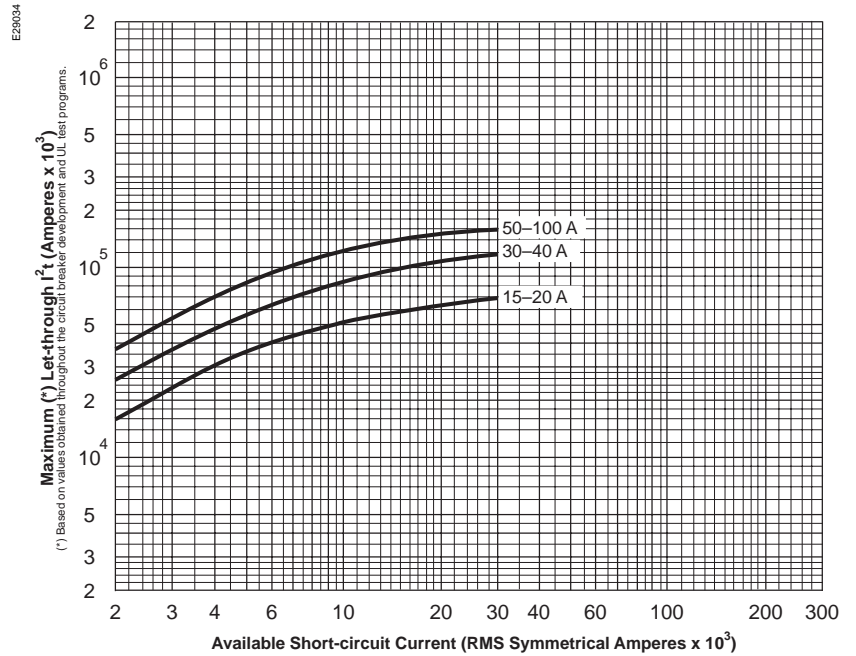


Let-through curves at 380/415 Vac

Maximum peak let-through current (amperes)



Maximum let-through I²t (amperes² seconds)



UL 489 test procedures

Standard tests

For electronic trip circuit breakers and thermal-magnetic circuit breakers rated 40°C with uncompensated thermal, the test sequences are as shown in the table:

Test	Sequence		
	X	Y	Z
200% calibration at 25°C (77°F)	■	■	■
135% calibration at 25°C (77°F)	■		
Calibration of adjustable instantaneous trip	■		
Overload	■		
Tungsten lamp load	①		
100% calibration at 40°C (104°F)	②		
Temperature and 100% calibration at 25°C (77°F)	■		
Endurance		■	
200% calibration at 25°C (77°F) repeated		■	
135% calibration at 25°C (77°F) repeated		■	
Interrupting ability (Y sequence)		■	
Interrupting ability (Z sequence)			■
200% trip out at 25°C (77°F)		■	■
Dielectric voltage withstand	■	■	■

① Applies only to circuit breakers rated 50 A or less, and 125 or 125/250 V or less
 ② Applies only to thermal-magnetic circuit breakers rated 40°C.

Standard specifications

Temperature

The temperature rise at the circuit breaker and at its terminals does not exceed specified limits when connected with specified cables or bus bars (see below) and at its rated current.

Examples of specified wires and bus

■ 75°C copper wire

Rating	Number	Size
100 A	1	# 1 AWG (60°C)
	1	# 3 AWG
250 A	1	250 kcmil
400 A	2	3/0 AWG
600 A	2	350 kcmil
800 A	3	300 kcmil
1000 A	3	400 kcmil
1200 A	4	350 kcmil

■ Copper bus bar

Rating	Number	Size (in./mm)
1600 A	2	0.25 x 3/6.4 x 76.2
2000 A	2	0.25 x 4/6.4 x 101.6
2500 A	2	0.25 x 5/6.4 x 127
	4	0.25 x 2–0.50/6.4 x 50.8–12.7
3000 A	4	0.25 x 4/6.4 x 101.6

(1200 A or less: 1000 A/in²)

Calibration

200% calibration at 25°C

The circuit breaker must trip within time limits which depend on the rating from three minutes for a 30 A rated circuit breaker, up to 30 minutes over 2000 A.

135% calibration at 25°C

The circuit breaker must trip within two hours (for circuit breakers rated more than 50 A).

Calibration of adjustable instantaneous trip

The circuit breaker must trip within the range of 80–120% of the maximum marked tripping current and 75–125% of the minimum marked tripping current.

Overload

- Up to 1600 A: 50 operations at 600% of rated current;
- 2000 and 2500 A: 25 operations at 600% of rated current;
- 3000 to 6000 A: three operations at 600% followed by 25 operations at 200% of rated current.

The power factor shall be from 0.45 to 0.50 lagging.

Endurance

The circuit breaker must complete an endurance test:

- Operations at rated current and rated voltage;
- Followed by no load operation.

The power factor shall be 0.75 to 0.80 lagging.

Examples

Frame size	Number of cycles of operations		
	With current	Without current	Total
100 A	6,000	4,000	10,000
225 A	4,000	4,000	8,000
400 A	1,000	5,000	6,000
600 A	1,000	5,000	6,000
800 A	500	3,000	3,500
1200 A	500	2,000	2,500
1600 A	500	2,000	2,500
2000 A	500	2,000	2,500
2500 A	500	2,000	2,500
3000 A	400	1,100	1,500

UL 489 test procedures

Interrupting ability

Interrupting ability (Y sequence)

After endurance tests and calibrations are repeated, the circuit breaker completes an opening operation followed by a close-open operation (O-and-CO), with specified current.

Examples for 3-pole breakers

Frame rating	RMS Sym. Amperes (3-pole O-and-CO)
100 A ①	3,000
225 A	3,000
400 A	5,000
600 A	6,000
800 A	10,000
1200 A	14,000
1600 A	20,000
2000 A	25,000
3000 A	35,000

① Above 250 V.

Interrupting ability (Z sequence)

A 3-pole circuit breaker rated 240, 480 or 600 V has to complete an opening operation (O) and a close-open operation (O-and-CO) on each pole, at rated voltage, followed by an opening operation (O) using all 3 poles.

Examples of 3-pole circuit breakers

Frame rating	RMS Sym. Amperes	
	Each pole	Common
	O-and-CO	O
100 to 800 A	8,660	10,000
801 to 1200 A	12,120	14,000
1201 to 1600 A	14,000	20,000
1601 to 2000 A	14,000	25,000
2501 to 3000 A	25,000	35,000

Dielectric

After testing, the circuit breaker must withstand for one minute a voltage of 1000 V plus twice the rated voltage between:

- Line and load terminals with circuit breaker in open, tripped and off positions;
- Terminals of opposite polarity with circuit breaker closed;
- Live parts and the overall enclosure with circuit breaker open and closed.

Optional tests

■ High available fault current

Circuit breakers having passed all the standard tests may have the UL Listing label applied at higher values than the standard.

Test sequence is as follows:

- 200% calibration;
- Interrupting capacity: an opening operation followed by a close-open operation (O-and-CO) on all poles are performed on the circuit breaker.

The power factor over 20000 RMS sym. amperes shall be 0.15 to 0.2 lagging:

- Trip out at 250%;
- Dielectric at twice the rated test voltage.

■ 100% rated

Circuit breakers having passed all the standard tests may have the UL Listing label applied to use the circuit breaker in an enclosure when carrying 100% of its maximum rating.

The circuit breaker is submitted to additional temperature tests performed as in standard tests, except that the circuit breaker is installed in an enclosure.

The dimensions and permissible ventilations shall be recorded and shall be marked on the circuit breaker.

Tests on accessories

Shunt trip and undervoltage trip

These devices are submitted to temperature, overvoltage, operation, endurance and dielectric tests.

■ Overvoltage test

The device must be capable of withstanding 110% of its rated voltage continuously without damage (this test does not apply to a shunt trip with an "a" contact connected in series).

■ Operation

The shunt trip must operate at 75% of its rated voltage (except that shunt trip devices for use with ground-fault protection shall operate at 55% of its rated voltage).

The undervoltage trip must trip the circuit breaker when the voltage is less than 35% and may trip the circuit breaker between 35 and 70% of its rated voltage and shall pickup and seal when the voltage is at 85% or more of its rated voltage.

■ Endurance

The device must be capable of performing successfully for 10% of the number of "with current" operations of the circuit breaker.

Auxiliary and alarm switches

Auxiliary and alarm switches must be submitted to temperature, overload, endurance and dielectric tests.

■ Overload test

The test consists of fifty operations making and breaking 150% of rated current at rated voltage, with a 75–80% power factor in ac and noninductive load in dc.

■ Endurance

The switch must make and break its rated current at rated voltage, with a 75–80% power factor in ac, and noninductive load in dc for 100% of the number of operations "with current" for auxiliary switches, and 10% of this number for alarm switches.

Motor operator

The motor operator shall perform the number of "without current" operations indicated for the circuit breaker endurance tests. The first 25 operations shall be conducted at 85% of the motor operator voltage rating.

The circuit breaker is to be tripped during these tests.

The next 25 operations shall be conducted at 110% of the motor operator voltage rating. The balance shall be completed at rated voltage without tripping the circuit breaker.

IEC 947-2 test procedures

Standard tests

Consisting of seven parts, the IEC 947 Standard applies to all low-voltage equipment designed for industrial application.

Three documents are to be consulted for circuit breakers and switches.

- IEC 947-1: general regulations;
- IEC 947-2: circuit breakers;
- IEC 947-3: switches.

Two categories of devices

The IEC 947-1 standard defines two categories of devices.

Category A

Devices not specifically designed to carry out chronometric selectivity.

Category B

Devices specifically designed to carry out chronometric selectivity. These circuit breakers possess a compulsory additional characteristic: short-time withstand (I_{cw}).

Breaking capacity

■ Ultimate breaking capacity: I_{cu}

I_{cu} is the value to be taken into account when calculating an installation.

The rule remains: $I_{cu} > I_{cc}$ (maximum fault current of the installation).

■ Breaking performance during operation: I_{cs}

This characteristic indicates the ability of the device to eliminate short-circuit currents less than I_{cc} and with a greater likelihood of occurring, generally near the application. I_{cs} is expressed in percent of I_{cu} (values retained by the standard IEC 25-50-75-100% of I_{cu}).

Following the breaking test (O-CO-CO), this test sequence groups together on the same device certain checks such as:

- Temperature rise under I_n ;
- Calibration at $1.45 I_n$;
- Leakage current (for devices suitable for disconnection).

The leakage current should not exceed 2 mA under the application voltage (0.5 mA at initial use).

These checks ensure that the device is able to carry out all its functions after elimination of a fault of I_{cs} value and to be put back in operation; hence the notion of breaking power performance during operation I_{cs} .

Isolation

Function

Recognition and definition of the disconnection capacity for industrial low-voltage equipment

Until recently, there has been limited information regarding regulations of the isolation function.

The IEC 947 Standard takes this function into account. In the "general regulations" section, it clearly states:

- The manufacturing regulation;
- The tests to be performed.

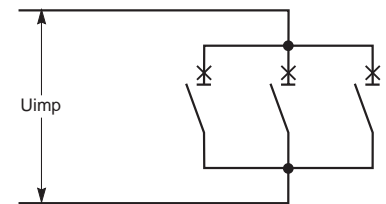
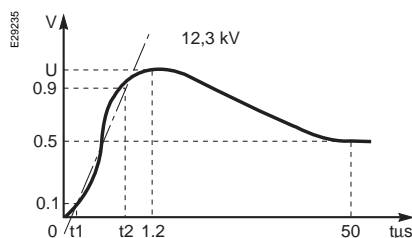
The circuit breaker standard should define the manner in which the tests are to be performed (under study).

The manufacturing regulations state, for example:

- Both the isolation and the inner contact distances (open > 8 mm);
- A device indicating the true position of the contacts (operating handle if representative of the state of all the contacts);
- When a "locked" position is provided, this should only be possible with "open" contacts.

The tests to be performed are as follow:

■ Shock wave voltage strength (U_{imp})



1.2/50 μ s - 12.3 kV plus 25% between open contacts in comparison with devices not fitted with the applied isolation function according to the figure below.

The test is validated if no triggering occurs between the contacts.

■ Measurement of the leakage current

Under 110% of the device application voltage

- maximum leakage currents proposed per pole:

- 0.5 mA new device;
- 2 mA device after I_{cs} ;
- 6 mA device after I_{cu} or after endurance tests, representative of the "end of service life".

IEC 947-2 test procedures

Test sequences

Sequence	Category of devices	Tests
1 - General characteristics	All circuit breakers	<ul style="list-style-type: none"> - trip unit control - dielectric properties - mechanical and electrical endurance - overload - dielectric voltage withstand - temperature rise - 145% calibration (3 phases test)
2 - Breaking capacity during operation	All circuit breakers	<ul style="list-style-type: none"> - breaking capacity during operation (Ot-CO-t-CO) - dielectric voltage withstand - temperature rise - 145% calibration (3 phases test)
3 - Ultimate breaking capacity (Icu)	A B if Icu > Icw	<ul style="list-style-type: none"> - 200% calibration (each pole separately) - ultimate breaking capacity (O-t-CO) - dielectric voltage withstand - 250% calibration (each pole separately)
4 - Admissible short duration current (Icw)	B	<ul style="list-style-type: none"> - 200% calibration (each pole separately) - short-time current withstand - temperature rise - breaking capacity at admissible short-time current (O-t-CO) - dielectric voltage withstand - 200% calibration (each pole separately)
Combined sequence	Icw = Ics replaces sequences 2 and 4 Icw = Ics = Icu replaces sequences 2, 3 and 4	<ul style="list-style-type: none"> - 200% calibration (each pole separately) - short-time current withstand Icw - breaking capacity at Ics (O-CO-CO) at maximum relay temp. - dielectric voltage withstand - temperature rise - 200% calibration (each pole separately)

Routine maintenance guidelines

DANGER

HAZARD OF ELECTRIC SHOCK, BURN, OR EXPLOSION

- This equipment must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this equipment before working on or inside equipment.
- Always use a properly rated voltage sensing device to confirm power is off.
- Replace all devices, doors, and covers before turning on power to this equipment.

Failure to follow these instructions will result in death or serious injury.

CAUTION

Molded case circuit breakers contain factory-sealed and calibrated elements. The seal must not be broken and the circuit breaker must not be tampered with.

Molded case circuit breakers should not be field adjusted or repaired. In the case of a malfunction, the circuit breaker should be replaced or inspected at the Schneider Electric factory, or by an authorized representative.

Recommended inspection intervals

Merlin Gerin circuit breakers are designed to be maintenance-free. However, all equipment with moving parts requires periodic inspection to ensure optimum performance and reliability. It is recommended that the circuit breakers be inspected six months after installation, followed by routine annual inspection. Intervals can vary depending on particular usages and environments.

Inspection of connections

- Circuit breaker connections should be inspected. It is essential that electrical connections be made carefully in order to prevent overheating;
- Check connections for proper torque.

Cleaning

Remove the dust and dirt that have accumulated on the circuit breaker surface and terminals.

Mechanical checks

Even over long periods of time, circuit breakers are not often required to operate on overload or short-circuit conditions. Therefore it is essential to operate the circuit breaker periodically.

To trip the circuit breaker, push the push-to-trip button.

Insulation resistance tests

When a circuit breaker is subjected to severe operating conditions, an insulation resistance test should be performed as indicated in NEMA standard publication No. AB4. An insulation resistance test is used to determine the quality of the insulation between phases and phase-to-ground. The resistance test is made with a dc voltage higher than the rated voltage to determine the actual resistance of the insulation.

The most common testing method employs a "megger" type instrument. A 1000 V instrument will provide a more reliable test because it is capable of detecting tracking on insulated surfaces. Resistance values below one megohm are unsafe and should be investigated. An insulation test should be made:

- Between line and load terminals of individual poles with the circuit breaker contacts open;
- Between adjacent poles and from poles to the metallic supporting structure with the circuit breaker contacts closed. The latter test may be done with the circuit breaker in place after the line and load conductors have been removed, or with the circuit breaker bolted to a metallic base which simulates the in-service mounting.

Electrical tests

These tests require equipment for conducting pole resistance, overcurrent and instantaneous tripping, in accordance with NEMA Standard publication No. AB4. They are not within the scope of normal field operation.

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