Emax Link
Abbreviated switchgear
Application guide

Power and productivity
for a better world™

Emax Link Application Guide
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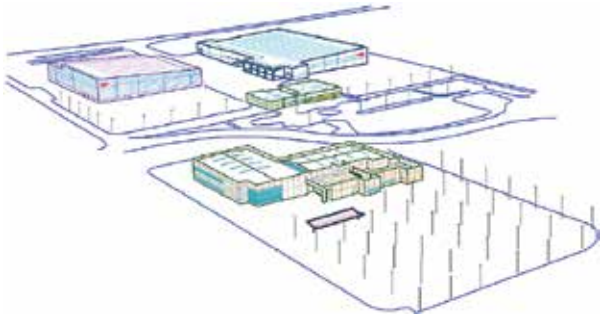
General



The Emax Link has been utilized in the following markets:

- Oil and gas
- Utility and co-generation
- Pharmaceutical
- Food and beverage
- Health care
- Critical power and data
- Marine
- Mining & materials
- Steel mill
- Waste water
- Power generation
- Aerospace
- Semiconductor centers manufacturing

System overview

The Emax Link abbreviated switchgear is designed, constructed, and tested to provide superior power distribution, protection, and safety. Emax Link is designed to maximize the functionality of the world class Emax power circuit breakers. It follows the vision of ABB products in providing customers with advanced solutions to meet the needs associated with the mechanical, electrical and thermal stress of today's manufacturing environment.

The Emax Link metal-enclosed abbreviated switchgear offers many advantages that include:

- Modular frame design arrangements for flexibility
- Barriers for increased personnel protection
- High short circuit ratings
- Insulated bus options
- Standard connections to a full range of ABB products
- Ample room for adding controls
- Main bus ratings up to 10,000 amps
- Competitive footprint

Product description

Key features

- Strong frame constructed of 11 GA steel
- Rigid bolt together frame construction
- True ANSI design and competitive dimensions
- Standardized configurations of sections
- Electrostatically deposited powder coat paint
- High short circuit and bus withstand ratings
- High ampacity ratings for main and section bus
- Reversible door design, front and rear doors can be hinged on the right or left sides
- Silver plated copper bus supplied as standard
- Rear bolted covers or rear hinged doors
- Overhead or floor lifting device for breakers
- UL 1558 Recognized - UR
- Made in the USA
- Provision for handling of sections by overhead lifting or lift truck

Standards

The Emax Link abbreviated switchgear is designed, tested, and constructed in accordance with the following industry standards:

- UL 1558 - Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
- ANSI C37.20.1 - Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
- ANSI C37.51 - Conformance Testing of Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies

The Emax low voltage power circuit breakers are designed, tested, and constructed in accordance with the following standards.

- ANSI C37.13 - Low Voltage AC Power Circuit Breakers Used in Enclosures
- ANSI C37.16 - Preferred Ratings, Related Requirements, and Application for Low Voltage Power Circuit Breakers and AC Power Circuit Protectors
- ANSI C37.17 - Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers
- ANSI C37.50 - Test Procedure for Low Voltage AC Power Circuit Breakers Used in Enclosures
- UL1066 - Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

Product description

Ratings

Description	Value
Rated continuous current	2000, 2500, 3200, 4000, 5000, 6000, 8000 & 10,000 A
Rated tested maximum voltage	254 Vac, 508 Vac, 635 Vac
Rated nominal voltage	240 Vac, 480 Vac, 600 Vac
Phases	3 phase 3 wire, 3 phase 4 wire
Neutral	100% rated
Frequency	60 Hz
Short circuit current withstand at 600 Vac	65 kA, 100 kA
Max peak short circuit current	149.5 kA, 230 kA
Short time bus withstand	85 kA for 1 second

Ambient conditions

Requirements	Unit	Value
Temperature range during operation	°C	-25 to +40
Temperature range for transport and storage	°C	-40 to +70
Maximum bus temperature	°C	65 over 40
Place of operation		Indoor and Outdoor

Overall system derating

ANSI Switchgear altitude correction factors

Altitude (m)	Voltage	Current
2000m and below	1.00	1.00
2600m	0.95	0.99
3900m	0.80	0.96

Notes:

- Intermediate values may be obtained by interpolation.
- For devices used in switchgear assemblies, standards covering the specific devices should be used to determine the specific altitude correction factors.
- 1000m is approximately 3300 ft.

Breaker derating

The Emax power breakers do not undergo any changes in their rated performance up to an altitude of 6600 ft (2000m).
As the altitude increases the atmospheric properties alter in terms of composition, dielectric capacity, cooling power and pressure.
Therefore the breaker undergoes the following derating:

Altitude	**(ft)** **(m)**	**<6600** **2000**	**9900** **3000**	**13200** **4000**	**16500** **5000**
Rated service voltage	[V]	600	600	500	440
Continuous current rating	[A]	In	0.98xIn	0.93xIn	0.90xIn

Notes:

- In = breaker current

Breaker loss

Circuit breaker	Iu [A]	Withdrawable 3 Pole [W]
E3N- A/S-A/H-A/V-A	800 1200 1600 2000 2500	37 83 150 225 350
E4S-A/H-A/V-A	3000 3200	374 422
E6H-A/V-A	4000 5000	445 700

Breaker temperature derating

The continuous current rating of Emax circuit breakers is based on their use in an enclosure at 40°C ambient temperature and 105°C maximum temperature (65°C rise). The continuous current ratings of Emax circuit breakers must be derated for ambient temperatures above 40°C.

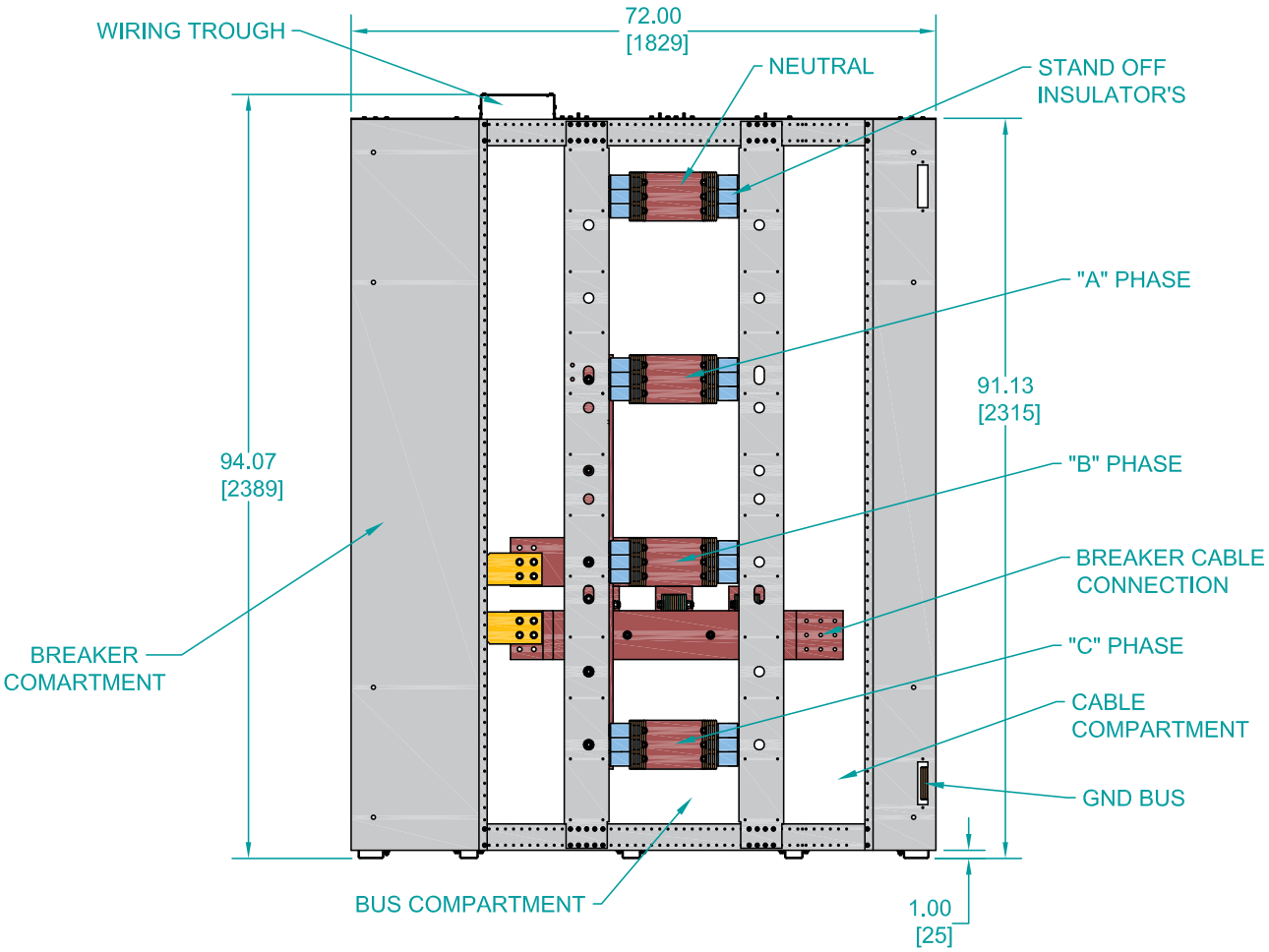
Ambient temperature (°C)	Derating factor
40	1.00
45	0.95
50	0.89
55	0.84
60	0.77
65	0.71
70	0.63

Technical data

Structure

The Emax Link switchgear assembly consists of one or more enclosed vertical sections. The ends of the main busbars are designed to allow for installation of future sections by means of splicing plates. The individual sections have the capability of being bolted together to form a single multi-section assembly. Each vertical section consists of up to four individually enclosed Emax low voltage power circuit breakers. One or more of these compartments can be utilized as an instrument compartment for mounting of control devices such as potential transformers, control power transformers, relays, meters and terminal blocks.

The sections are constructed in a compartmentalized manner from front to back. Each vertical section consist of three compartments: the front compartment (circuit breaker compartment), middle compartment (bus compartment), and a rear compartment (cable compartment). A continuous wire tray measuring 3” H x 9” W is placed on top of the roof above the breaker compartment.



Short circuit rating

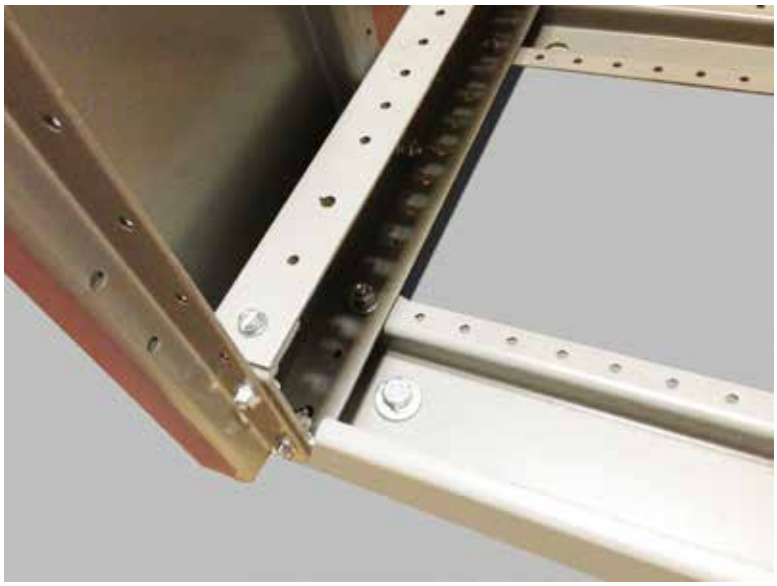
The switchgear sections are tested to withstand 100kA RMS symmetrical short circuit in accordance with UL 1558 and ANSI C37.20.1 standards, however, the short circuit rating of the switchgear lineup is determined by the lowest short circuit interrupting rating of the devices installed in the switchgear.

Finish

The standard paint color for the structure is ANSI 61 light gray (Tiger paints, T3-GY19) with a smooth finish. Removable mounting panels inside instrument compartments are painted gloss white (Tiger paints, T9-WH1). The painting process is a UL approved electrostatic powder coat paint system utilizing polyester powder coat paint. The completed finish has a nominal 2.0-2.5 mils dry film thickness. The painting process includes cleaning away any grease, rust or scale with a phosphate wash, rinsing, spray coating, oven drying, electrostatic powder spray paint coating, and oven baking.

Frame

The basic elements of the frame assembly are rigid formed rails of 11 GA (0.120" thick) steel. Vertical frame members have a pattern of holes at 1-1/2" (38.1 mm) intervals and horizontal frame members utilize a pattern of holes at 1" (25.4 mm) intervals. The frames are assembled and secured with Grade 5 tri-lobular thread forming screws and require no maintenance. The corners are squared up and kept square by the design of the steel frame members and the way that they are fitted together. Lifting eyes are provided as a standard on the roof of the enclosure to allow lifting by the use of an overhead crane.

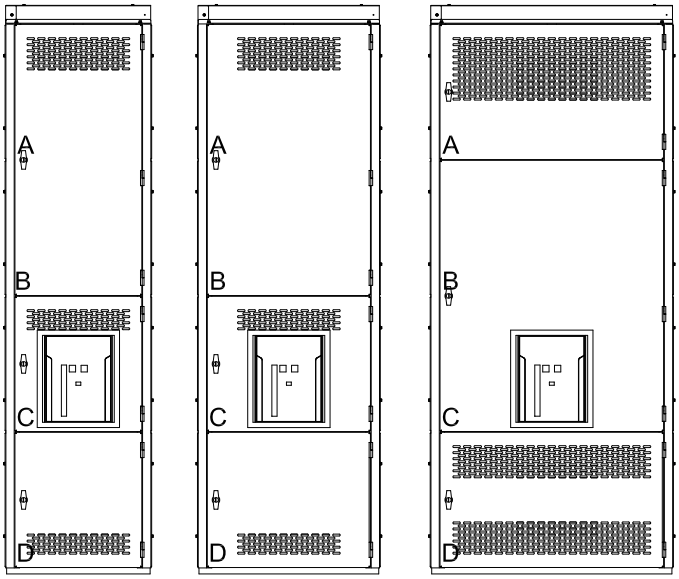


Available dimensions

The available section widths are: 24" (610 mm), 30" (762mm), and 40" (1016mm). The standard frame height is 91.13" (2315 mm) without wire trough or roof cap. With wire trough the height is 94" (2387.6 mm). The height with a roof cap, when required, is 96.75" (2457 mm).

The available depths are 60" (1524 mm), 72" (1829 mm) or 84" (2137 mm) – restrictions apply to the available switchgear section depths based on the main bus ampacity.

Technical data



24” Wide 30” Wide 40” Wide

Shipping design

A wooden shipping base is provided for each individual vertical section and is anchored at four points with lag screws. The maximum switchgear section shipping dimensions are 44”W x 88”D x 99”H (1118 mm W x 2236 mm D x 2515 mm H).

All breakers will be shipped separately, coming from a different location than the switchgear assembly; they are to be installed in the switchgear section by the OEM completing the switchgear assembly.

Barriers and covers

Side covers consist of a 4-piece design of 14 GA (0.075”) thick steel secured by Grade 5 tri-lobular thread forming screws. Rear covers are of a 2-piece design of 14 GA (0.075”) thick steel. A hinged rear door is available as an option and is provided with 3 quarter-turn latches.

Receiving and handling

Before leaving the factory each vertical section is bolted to a wooden base and given a complete mechanical and electrical inspection. Each section is fitted with cardboard corner protection and wrapped with polyethylene film in order that it may reach the destination in good condition. Each vertical section is provided with removable lifting hooks at the top four corners and is mounted on a wooden base for handling. The switchgear is shipped upright in single vertical sections, the sections should remain in an upright position during all shipping and handling activities with proper care exercised to keep the section stabilized to prevent damaging, tipping or dropping the section.

Storage

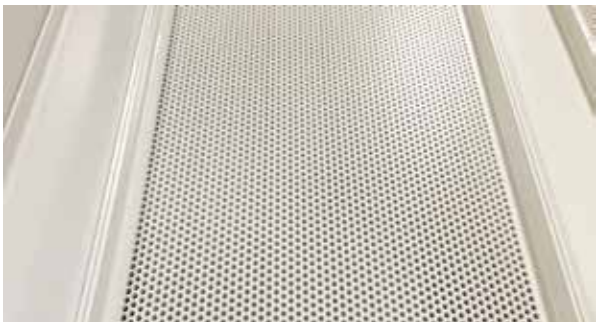
When it is necessary to store the sections for any length of time the following steps should be taken to protect the equipment;

1. Store the equipment indoors in a clean, dry area at a moderate temperature, never store the equipment outdoors.
2. Cover the equipment with a suitable heavy duty plastic sheet to prevent the entrance of foreign particles.
3. If the storage area is damp or cool place a 200 watt space heater in the bottom of each vertical section in order to prevent condensation inside the equipment.

Ventilation

The Emax Link is provided with a ventilated top cover. The mesh screen is there to allow for ventilation in each section to reduce heat rise. The size of the openings in the mesh is small enough to keep potentially dangerous foreign materials out of the switchgear. There is a dust tray underneath the mesh screen to catch any dust and dirt that is able to enter the switchgear. The top covers are made of 14 gauge thickness steel and are removable to allow for punching of conduit holes. A continuous wire tray is placed on top of the roof above the breaker compartment in order to allow for the routing of wiring between sections and shipping splits. The dimensions of the wiring trough are 3” (76.2 mm) high by 9” (228.6 mm) wide, allowing ample space for customer control wiring and connections to be run through it. The cover of the wiring trough has key hole slots to allow for easy removal and reinstallation.

Ventilated barriers are provided between the bus compartment and the cable compartment which consists of a four piece design made of 10 GA (0.102” thick) aluminum and are secured with Grade 5 tri-lobular thread forming screws.



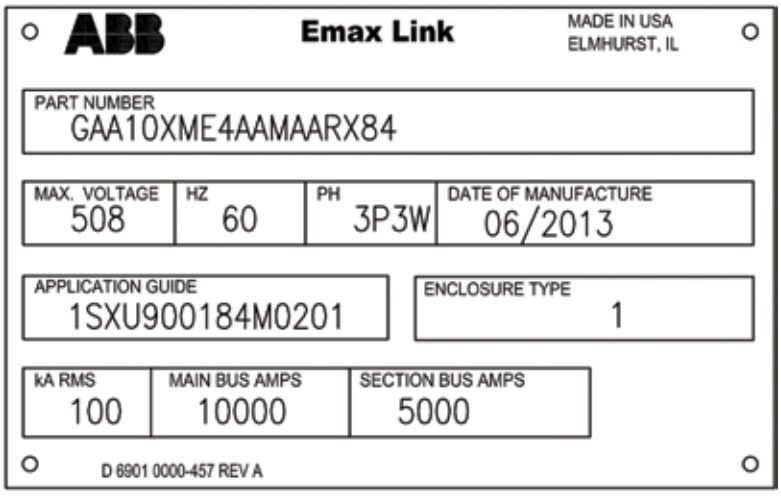
Technical data

Circuit breaker and instrument compartments doors are provided with hinges that are of a lift off design. All doors are key lockable and secured by quarter-turn latches.

Nameplates

Emax Link nameplates meet all requirements listed in ANSI C37.20.1. The main system nameplate is made from a phenolic material and has a white background and engraved black lettering. It is secured to the switchgear with self-tapping screws. The following information is available on switchgear assembly nameplates:

- Manufacturer's name and address
- Manufacturer's type designations
- Manufacturer's identification reference
- Rated maximum voltage (where applicable)
- Rated power frequency (where applicable)
- Rated continuous current (main bus)
- Rated short-circuit withstand current
- Date of manufacture
- Instruction manual number



Enclosure

NEMA-1

Emax Link switchgear enclosures are dead-front, metal-enclosed structures, rated for NEMA 1. All front doors, side covers, and rear covers or doors are painted using an electrostatic powder coat paint process.

Standard features:

- ANSI 61 paint color (smooth finish)
- Steel barriers between breaker compartment and bus compartment
- Aluminum and Glastic (GPO-3) barriers between bus compartment and cable compartment
- Ground bus can be mounted at top or bottom of enclosure
- Removable, steel top plates over conduit entrance
- Top mounted control wire way (3”H x 9”W)
- Removable lifting eyes for overhead lifting. Wooden base for handling by lift truck.

Available options and accessories:

- Side covers
- Rear covers
- Rear hinged doors
- Overhead lift device
- Floor mounted lift device
- Insulated bus – baked on epoxy coating
- Front doors

Technical data

Busbar system

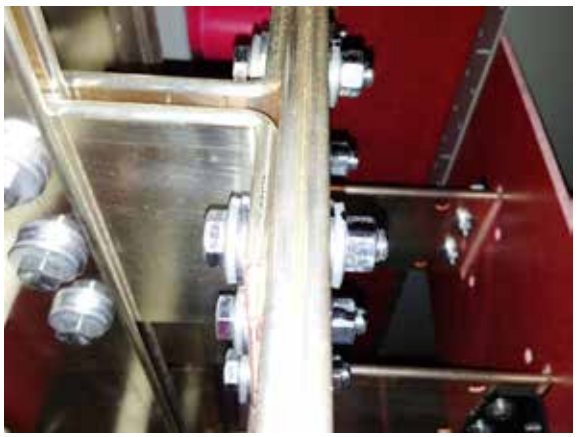
The busbar system is installed in the middle compartment of the switchgear vertical section; it includes the main horizontal busbar system (including a neutral bus when required) and vertical busbars for sections containing feeder breakers.

The horizontal busbars are arranged with phases N, A, B, C from top to bottom in each vertical section. The busbars are connected to the adjacent section at each end by means of splice plates. All busbar joints are secured by Grade 5 hardware with a flat washer and a Belleville washer on each side of the busbar to maintain constant pressure on the connection after multiple heating and cooling cycles. The hardware is torqued and marked with a permanent marker during the assembly process and rechecked in a final quality inspection and marked again with torque seal. There are also two ¼" screws on each end of the phase busbars for connection of control wires. The bus designs are based on UL 1558 and ANSI C37.20.1 standard temperature rise of 65°C above a maximum ambient air temperature of 40°C. The busbar compartment is separated from the breaker compartment by painted steel barriers. The busbar compartment is also separated from the cable compartment by means of aluminum and Glastic barriers. All bus is supported by Nema GPO-3 molded or sheet glass-filled polyester insulating materials.

Main bus amperages include: 2000A, 2500A, 3200A, 4000A, 5000A, 6000A, 8000A and 10,000A with bus bracing for 65kA or 100kA. Non-insulated silver plated bus is standard; optional tin-plated bus is available.

All main bus construction is based on single section shipping splits.

Optional insulated bus consisting of a durable, gray, flame retardant, baked on epoxy powder coating (12-20 Mil film thickness) and boots on main horizontal and cable compartment runback bussing.



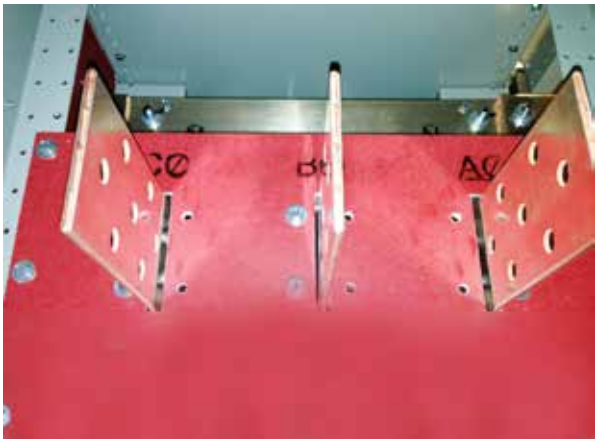
For incoming cable applications, ABB can accommodate top or bottom cable entry for all main bus amperages.

The vertical busbars are arranged A, B, C from left to right when viewed from the front of the vertical section (C, B, A when viewed from the rear as shown below). The vertical bus riser has a rated ampacity of 2000A, 3200A or 4000A for feeder sections (30” section width is required for vertical bus ratings of 3200 or 4000 amps). The bus bracing is rated for 65kA or 100kA. The vertical bus is supplied with silver plating as standard or tin plating as an option for use in harsh or corrosive environments.

Application note:

Cumulative loading limits apply to vertical sections with more than one breaker.

The cumulative circuit breaker loading is the total current that all circuit breakers within a vertical section can carry simultaneously without exceeding the temperature limits in the ANSI switchgear standard C37.20.1. It is recommended that the values for the allowable cumulative loading not be exceeded for an indoor ambient temperature of + 40°C. The values of allowable cumulative load can be based on equal loading (as a percentage of rating) of all compartments in the same vertical section. If equal loading is not practical, the load distribution should be such that the heavier loads are connected to the lowest circuit breaker compartment. Typically, a section with multiple circuit-breaker compartments carrying load should be loaded to the lesser amount as shown in Table 1 or Table 2.



Technical data

Table 1 - Allowable cumulative load

Number of compartments	Allowable load for each compartment
Four circuit breaker compartments	
Bottom compartment	90% of compartment rating
Next to bottom compartment	75% of compartment rating
Next to top compartment	60% of compartment rating
Top compartment	50% of compartment rating
Three circuit breaker compartments	
Bottom compartment	90% of compartment rating
Middle compartment	75% of compartment rating
Top compartment	60% of compartment rating
Two circuit breaker compartments	
Bottom compartment	90% of compartment rating
Top compartment	75% of compartment rating
Once circuit breaker compartment	100% of compartment rating

Table 2 - Circuit breaker loads

Circuit breaker frame size (A)	Number of circuit breakers carrying load	Allowable cumulative load (A) ①
600	1	600
600	2	1000
600	3	1400
600	4	1700
800	1	800
800	2	1300
800	3	1800
800	4	2200
1600	1	1600
1600	2	2600
1600	3	3600
1600	4	4500
2000	1	2000
2000	2	3200
3000/3200	1	3000/3200
3000/3200	2	4800/5200
4000	1	4000
5000	1	5000

① Without forced ventilation

When different ratings of circuit breakers are utilized in the same vertical section, the allowable cumulative circuit breaker loading should be determined based on the number of circuit breakers in the vertical section and the corresponding value for each circuit breaker.

The following examples will illustrate the above:

One 1600A and three 800 A

Compartment	Equal loading factor	Equal loading	Distributed loading factor	Distributed loading
Top 800 A	2200/4	550	0.5	400
Next to top 800 A	2200/4	550	0.6	480
Next to bottom 800 A	2200/4	550	0.75	600
Bottom 1600 A	4500/4	1125	0.9	1440
Cumulative loading	–	2775	–	2920

Compartment	Equal loading factor	Equal loading	Distributed loading factor	Distributed loading
Top 1600 A	4500/4	1125	0.5	800
Next to top 800 A	2200/4	550	0.6	480
Next to bottom 800 A	2200/4	550	0.75	600
Bottom 800 A	2200/4	550	0.9	720
Cumulative loading	–	2775	–	2600

One 1600 A and two 600 A

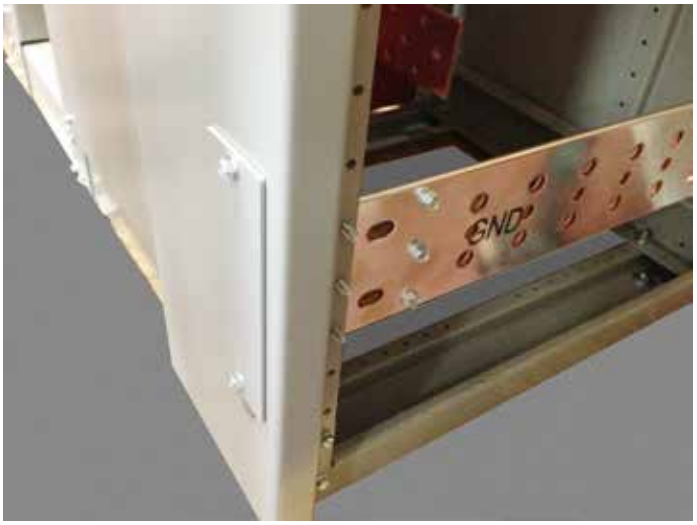
Compartment	Equal loading factor	Equal loading	Distributed loading factor	Distributed loading
Top 600 A	1400/3	467	0.6	360
Middle 600 A	1400/3	467	0.75	450
Bottom 1600 A	3600/3	1200	0.9	1440
Cumulative loading	–	2134	–	2250

One 3200 A and one 1600 A

Compartment	Equal loading factor	Equal loading	Distributed loading factor	Distributed loading
Top 1600 A	2600/2	1300	0.75	1200
Bottom 3200 A	5200/2	2600	0.9	2880
Cumulative loading	–	3900	–	4080

Technical data

As a standard feature ABB provides a ground bus in the rear cable compartment that can be located at either the bottom or the top of the section for ease of connection. The switchgear section has a side plate that is removed to add an additional section and make the splice connection. There are three ¼” screws on each end of the ground bus for connection of control ground wires and 1/2” holes pre-punched every 2” along the length of the ground bar to accept field grounding cables.



Wiring

Wiring is not provided by ABB in the Emax Link abbreviated switchgear, it is left up to the OEM to provide the wiring necessary to customize the switchgear according to the customer's specifications. ABB and Thomas & Betts manufactures a wide range of connection products such as; terminal blocks, wireway, crimp terminals and other wiring devices that can be used in the final assembly of the switchgear.

Select the wire size and type suitable for the application; typically this means #14 AWG minimum, SIS type wire with crimped on ring terminal connectors. Wire used for current transformers, potential transformers or control power transformers may need to be a larger gauge, make sure the appropriate wire size is used.

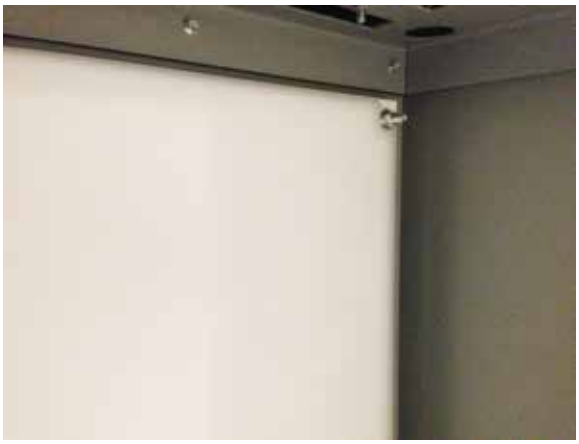
Openings are provided to allow for quick and easy routing of the control wires between compartments within the vertical section.

Technical data

Instrument compartments

Instrument compartments are supplied with removable mounting pans to mount control devices such as; voltage transformers, control power transformers, meters, relays and terminal blocks. Internal mounting pans are painted gloss white (Tiger paints T9-WH1). Breaker control devices such as indicating lights, and control switches can be mounted on the breaker compartment doors. Due to space limitations in the breaker compartment, the use of an instrument compartment may be required.

Spare customer terminal points can be located on a mounting pan in an instrument compartment. The number of spare terminal points may impact overall equipment layout dimensions.



Instrumentation/metering

Voltage transformer – external metering and relaying

Voltage transformers utilized in the Emax Link abbreviated switchgear should be mounted on the removable mounting pan inside of an instrument compartment. Select voltage transformers with the proper electrical characteristics for the application.

Control power transformer

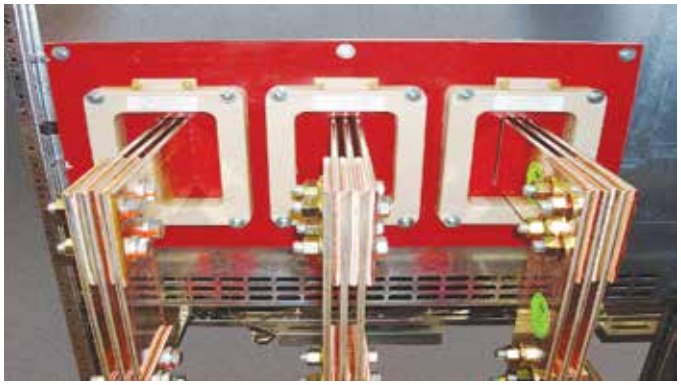
The ABB Emax Link can be equipped by the OEM with a control power transformer in order to provide 120VAC control power. The control power transformer shall be sized according to the load requirements of the circuit breaker accessories and other equipment installed in the switchgear. The control power transformer shall be mounted in an available instrument compartment.

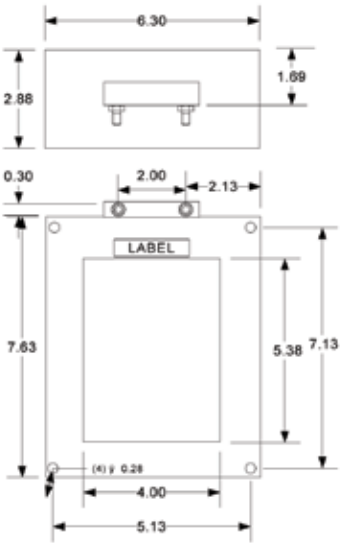
Primary and secondary fuses can be mounted separately within an instrument compartment or with onboard fuse clips.

Current transformers

The ABB Emax Link can be easily equipped with main or feeder breaker current transformers by the OEM, the current transformers will mount on the GPO-3 insulating board supporting the bus runbacks in the cable compartment and do not require any disassembly of the busbars. The insulating boards can be drilled by the OEM with mounting holes to fit a variety of current transformers.

Select the proper current transformer for your application based on the window size, CT ratio and the burden.





Instrumentation/metering

Metering

The Emax Link abbreviated switchgear allows for the mounting of an endless variety of metering options, simply make the required cutout in the instrument compartment door for the meter that you have selected. Refer to meter installation manual for cutout dimensions.

Breaker control switch

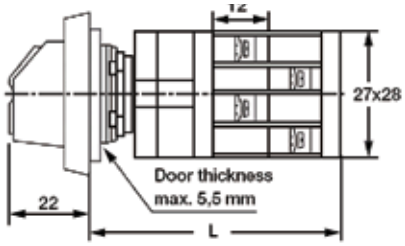
Electrically operated breakers can be controlled with circuit breaker control switches mounted in the breaker compartment door. Some devices may not fit in the available space, check clearances before locating any mounting holes in the door.

Series 20

Series 24

Selector switches

When selector switches are required such as for Auto/Manual transfer schemes or Local/Remote selection an ABB type cam switch can be used; refer to the ABB Product Selector catalog, 1SXU000023C0202 Rev A.



Test switches and plugs

The ABB Emax Link abbreviated switchgear will allow the installation of ABB FT-1 or FT-14 test switches or test plugs. The test switch may be utilized for current transformer and potential transformer testing. The test switch cover comes in either black or clear.

Space heaters, thermostats, and humidistat

The Emax Link can be equipped by the OEM with space heaters, thermostats and/or humidistats. Space heaters are used to prevent condensation from forming on the equipment and are mounted in the bottom of the equipment section. Space heaters are typically rated for 240V but operated at 120V and may be enclosed in a metal protective housing. Thermostats are typically located about 3/4 of the distance from the floor to the top of the cabinet.

Emax power breakers
Breaker ratings

Ratings

The Emax Link is designed to accommodate up to four draw out Emax power circuit breakers in a vertical section. Each circuit breaker is located in a completely enclosed ventilated compartment with top, bottom, and rear steel barriers.

There are three frame sizes that may be used in the Emax Link: E3, E4, and E6.

The Emax power circuit breaker is available in various levels of interrupting ratings (AIR) as listed below.

Table 1: Emax power circuit breaker interrupting rating

Frame size	Circuit breaker model	240V [kA]	480V [kA]	600V [kA]	Rated short time current [kA]
2000 2500	E3 N-A	65	50	50	50
800 1200 1600 2000 2500	E3 S-A	85	65	65	65
800 1200 1600 2000 2500	E3 H-A	85	85	85	65
800 1200 1600 2000 2500	E3 V-A	125	125	100	85
2500 3200	E4 S-A	85	65	65	65
3000 3200	E4 H-A	100	85	85	85
3000 3200	E4 V-A	100	100	100	100
3000 3200	E4 L-A	150	150	100	100
4000 5000	E6 H-A	125	85	85	100
4000 5000	E6 V-A	125	125	100	100
4000 5000	E6 L-A	150	150	100	100

Emax power breakers
Switch ratings

ABB offers non-automatic UL switches; electrical characteristics shown below.

Table 2: Emax switch short time rating

Frame size	Circuit breaker model	Rated short time current 600V [kA]
2000, 2500	E3N-A/MS	50
800, 1200, 1600, 2000, 2500	E3S-A/MS	65
800, 1200, 1600, 2000, 2500	E3V-A/MS	85
3200	E4S-A/MS	65
3200	E4H-A/MS	85
3200	E4V-A/MS	100
4000, 5000	E6H-A/MS	100

Emax power breakers
Rating plugs

Table 3: Emax circuit breaker rating plugs for electronic trip units

Type of circuit breaker	Rated current Iu	400	600	800	1000	1200	1600	2000	2500	3000	3200	4000	5000
E3	800	•	•	•									
	1200	•	•	•	•	•							
	1600	•	•	•	•	•	•						
	2000	•	•	•	•	•	•	•					
	2500	•	•	•	•	•	•	•	•				
E4	3200			•	•	•	•	•	•	•	•		
E6	4000			•	•	•	•	•	•	•	•	•	
	5000			•	•	•	•	•	•	•	•	•	•

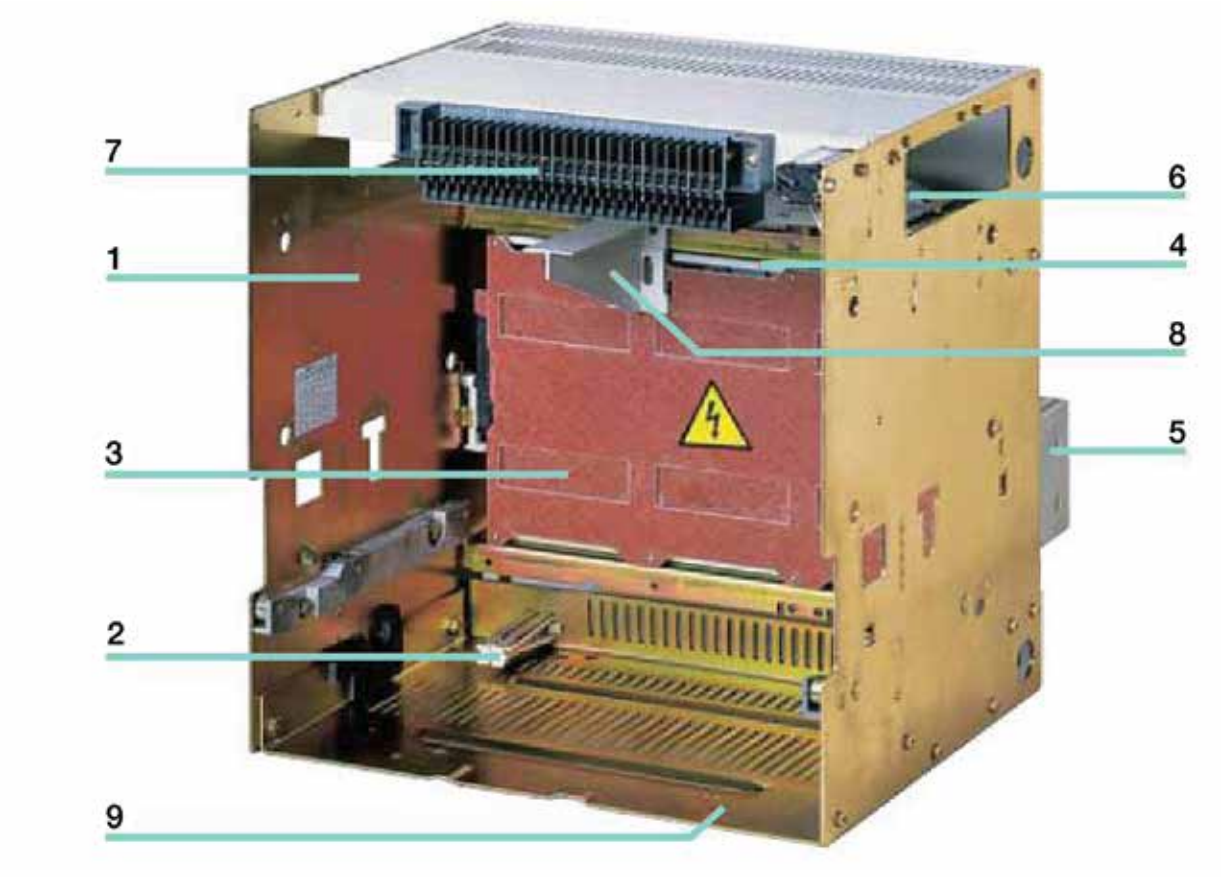
Construction characteristics

The Emax power circuit breaker offers a series of operating and signaling parts to minimize the risk of operational errors:

Legend	
1	Trademark and size of circuit breaker
2	PR121, PR122 or PR123 trip units
3	Pushbutton for manual opening
4	Pushbutton for manual closing
5	Lever to manually charge closing springs
6	Label with electrical characteristics
7	Mechanical device to signal circuit breaker open “O” and closed “I”
8	Signal for springs charged or discharged
9	Mechanical indication of trip
10	Key lock in open position
11	Key lock and padlock in racked-in/racked-out position (for draw out version only)
12	Racking-in/racking out device (for draw out version only)
13	Terminal box (for fixed version only)
14	Sliding contacts (for draw out version only)
15	Circuit breaker position indicator: connected/ isolated for test/racked-out (for draw out version only)

Draw-out version

Emax power breakers
Cradle details



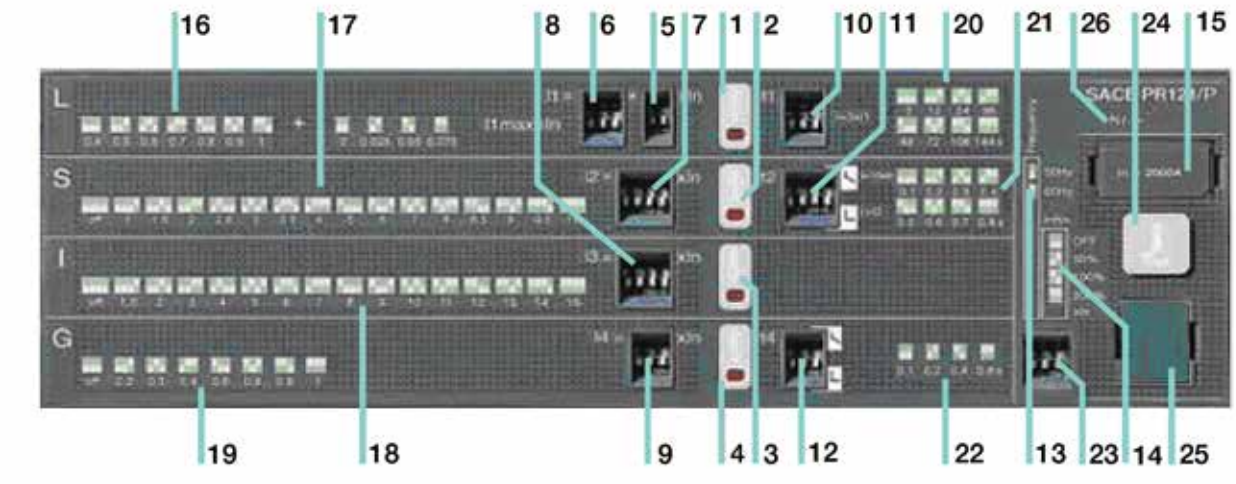
Legend

1	Sheet steel supporting structure
2	Single grounding pilers mounted on the left for E1, E2, and E3 double grounding pilers for E4 and E6
3	Safety shutters
4	Terminal support base
5	Terminals
6	Contacts signaling that the circuit breaker is connected, Isolated for test, racked-out
7	Sliding contacts
8	Padlock device for safety shutters (on request)
9	Fixing points (4 for E1, E2, E3, and 6 for E4, E6)

Emax power breakers
Trip units PR121/P

Electronic trip units and related accessories

PR121/P is the new basic and complete release for the Emax circuit breaker series. The complete range of protection functions together with the wide combination of thresholds and trip times offered make it suitable for protecting a wide range of alternating current installation. In addition to protection functions the unit is provided with multifunction LED indicators. Furthermore, PR121/P allows connection to external devices enhancing its advanced characteristics like remote signaling and monitoring, or remote supervision display.



Legend

1. LED signaling alarm for pro tection function L	**9.** DIP switches for setting current threshold I4	**17.** Indication of the DIP switch positions for the various current threshold values I2	**25.** Test connector for connecting or testing the release through an external device (PR030/B battery unit, BT030 wireless communication unit and SACE PR010/T unit)
2. LED signaling alarm for protection function S	**10.** DIP switches for setting trip time t1 (type of curve)	**18.** Indication of the DIP switch positions for the various current threshold values I3	**26.** Serial number of protection release
3. LED signaling alarm for protection function I	**11.** DIP switches for setting trip time t2 (type of curve)	**19.** Indication of the DIP switch positions for the various current threshold values I4	
4. LED signalling alarm for protection function G1	**12.** DIP switches for setting trip time t4 (type of curve)	**20.** Indication of DIP switch positions for the various time settings t1	
5. DIP switches for fine setting current threshold I1	**13.** Indication of the DIP switch position for network frequency	**21.** Indication of DIP switch positions for the various time settings t2	
6. DIP switches for main setting curren threshold I1	**14.** Indication of the DIP switch position for Neutral protection setting	**22.** Indication of DIP switch positions for the various time settings t4	
7. DIP switches for setting current threshold I2	**15.** Rating plug	**23.** DIP switch for setting network frequency and neutral protection setting	
8. DIP switches for setting current threshold I3	**16.** Indication of the DIP switch positions for the various current thresholds values I1	**24.** Trip cause indication and trip test pushbutton	

Emax power breakers
Trip units PR121/P

Operation and protection functions

Protection functions
The PR121 release offers the following protection functions:

- Overload (L)
- Selective short-circuit (S)
- Instantaneous short-circuit (I)
- Ground fault (G).

Overload (L)
The inverse long time-delay trip overload protection L is type $I^2t = k$; 25 current thresholds and 8 curves are available. Each curve is identified by the trip time in relation to the current I = 3 x I1 (I1 = set threshold).

Selective short-circuit (S)
The selective short-circuit protection S can be set with two different types of curves with a trip time independent of the current (t = k) or with a constant specific let-through energy ($t = k/I^2$).

I4 threshold	Repression threshold
I4 < 0.5 In	4 In
0.5 In ≤ I4 < 0.8 In	6 In
I4 ≥ 0.8 In	8 In

In = rated current of the rating plug

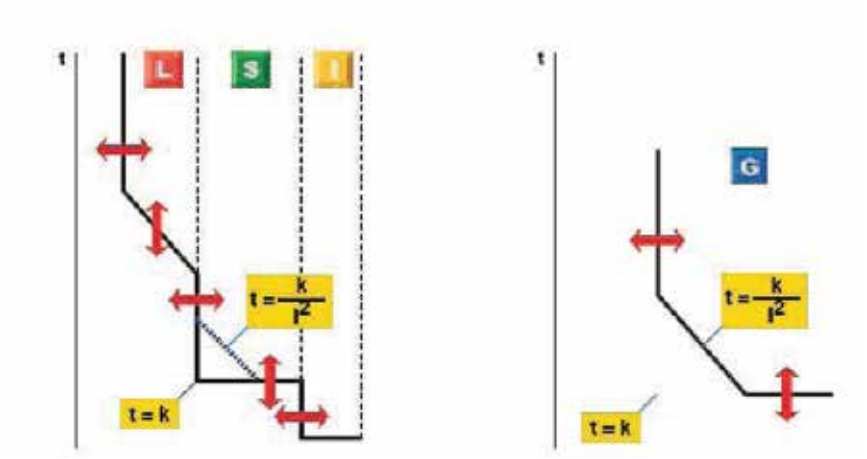
15 current thresholds and 8 curves are available, allowing a fine setting. Each curve is identified as follows:

- For curves t = k by the trip time for I > I2
- For curves t = k/I 2 by the trip time for I = 10xIn (In = rated current of the circuit breaker). The function can be excluded by setting the DIP switches to the combination labelled “OFF”.

Adjustable instantaneous short-circuit (I)
The protection I offers 15 trip thresholds and can be excluded (DIP switches in “OFF” position).

Ground fault (G)
The ground fault protection G (which can be excluded) offers 7 current thresholds and 4 curves. Each curve is identified by the time t4 in relation to current I4. As per S protection the trip time can be chosen independent of the current (t = k) or with a constant specific let-through energy (t2= k/I).

Note: the function G is repressed for fault current values higher than the values shown in table below.



User interface

The user communicates directly with the release in the trip parameter preparation stage by means of the dip switches.

Up to four LEDs (according to the version) are also available for signalling.

These LEDs (one for each protection) are active when:

- A protection is timing. For protection L the prealarm status is also shown;
- A protection has tripped (the corresponding LED is activated by pressing the “Info/Test” pushbutton);
- A failure in connection of a current sensor or in the opening solenoid is detected. The indication is active when the unit is powered (through current sensors or an auxiliary power supply)
- Wrong rating plug for the circuit breaker.

The protection tripped indication works even with the circuit breaker open, without the need for any internal or external auxiliary power supply. This information is available for 48 hours of inactivity after the trip and is still available after reclosing. If the query is made more than 48 hours later it is sufficient to connect a PR030/B battery unit, PR010/T, or a BT030 wireless communication unit.

Communication

By means of the BT030 wireless communication unit, PR121/P can be connected to a pocket PC (PDA) or to a personal computer, extending the range of information available for the user. In fact, by means of ABB SACE’s SD-Pocket communication software, It is possible to read the values of the currents flowing through the circuit breaker, the value of the last 20 interrupted currents, and the protection settings. PR121 can also be connected to the optional external PR021/K signalling unit, for the remote signalling of protections alarms and trips, and to HMI030, for the remote user interfacing.

Setting the neutral

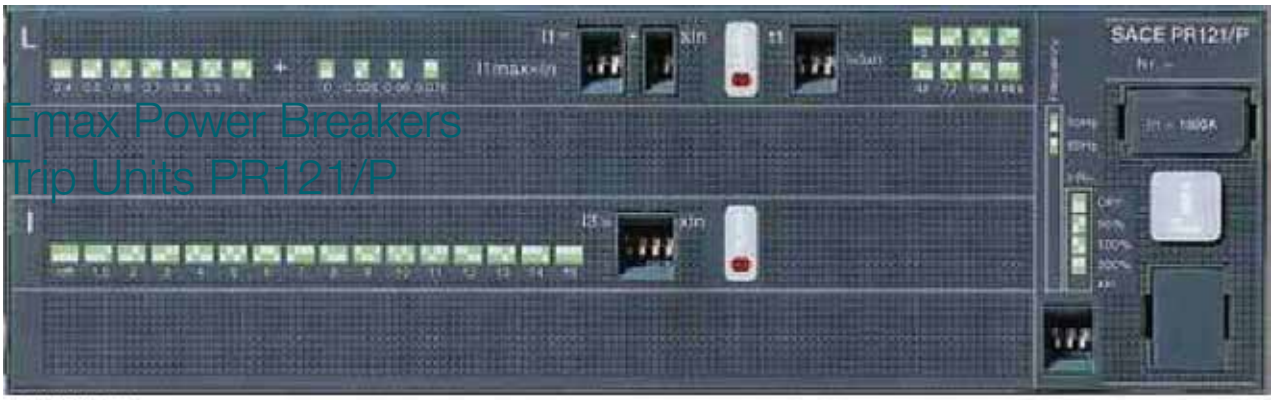
Protection of the neutral can be set at 50%, 100% or 200% of the phase currents. Settings above 50% can be selected for E1-E2-E3-E4/f and E6/f. In particular, setting the neutral at 200% of phase current requires protection L to be set at 0.5In in order to respect the current carrying capacity of the circuit breaker. The user can also switch the neutral protection OFF. When three poles circuit breakers with external neutral current sensor are used, a setting above 100% for the neutral does not require any reduction in the L setting.

Test function

The test function is carried out by means of the Info/Test pushbutton and the PR030/B battery unit (or BT030) fitted with a polarized connector housed on the bottom of the box, which allows the device to be connected to the test connector on the front of PR121/P releases. The PR121/P electronic release can be tested by using the SACE PR010/T test and configuration unit by connecting it to the TEST connector.

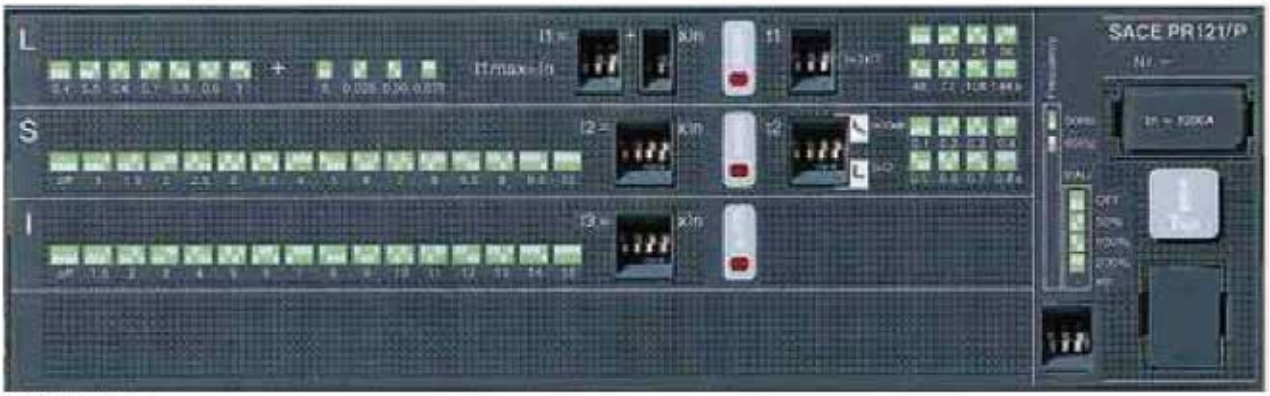
Emax power breakers
Trip units PR121/P

Versions available

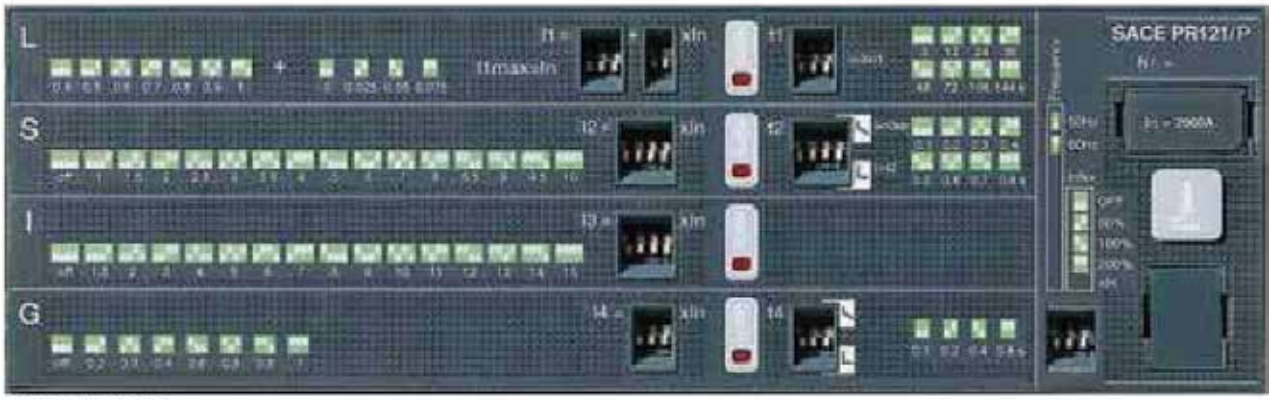


PR121/P LI

Emax Power Breakers
Trip Units PR121/P



PR121/P LSI



PR121/P LSIG

Protection functions and setting values - PR121

Function		Trip threshold	Trip time	Poss. excl.	Relation t=f(I)
L	Overload protection	I1=0.4 - 0.425 - 0.45 - 0.475 - 0.5 - 0.525 - 0.55 - 0.575 - 0.6 - 0.625 - 0.65 - 0.675 - 0.7 - 0.725 - 0.75 - 0.775 - 0.8 - 0.825 - 0.85 - 0.875 - 0.9 - 0.925 - 0.95 - 0.975 - 1 x In	With current I = 3 x I1 t1 = 3 - 12 - 24 - 36 - 48 - 72 - 108 - 144 s (1)	–	$t=k/I^2$
	Tolerance (2)	Release between 1.05 and 1.2 x I1	± 10% Ig ≤ 4 x In ± 20% Ig > 4 x In		
S	Selective short circuit protection	I2 = 1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 - 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	With current I > I2 t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8 s	♦	t=k
	Tolerance (2)	± 7% Ig ≤ 4 x In ± 10% Ig < 4 x In	The better of the two figures: ± 10% or ± 40 ms		
	Tolerance (2)	I2 = 1 - 1.5 - 2 - 2.5 - 3 - 3.5 - 4 - 5 - 6 - 7 - 8 - 8.5 - 9 - 9.5 - 10 x In	With current I =10 x In t2 = 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.6 - 0.7 - 0.8s	♦	$t=k/I^2$
		± 7% Ig ≤ 4 x In ± 10% Ig > 4 x In	± 15% Ig ≤ 4 x In ± 20% Ig > 4 x In		
I	Instantaneous short circuit protection	I3 = 1.5 - 2 -3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11 - 12 - 13 - 14 - 15 x In	Instantaneous	♦	t=k
	Tolerance (2)	± 10%	≤ 30 ms		
G	Earth fault protection	I4 = 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 x In	With current I = 4 x In t4 = 0.1 - 0.2 - 0.4 - 0.8 s	♦	$t=k/I^2$
	Tolerance (2)	± 7%	± 15%		
	Tolerance (2)	I4 = 0.2 - 0.3 - 0.4 - 0.6 - 0.8 - 0.9 - 1 x In	With current I > I4 t4 = 0.1 - 0.2 - 0.4 - 0.8 s	♦	t=k
		± 7%	The better of the two figures: ± 10% or ± 40 ms		

(1) The minimum trip time is 1 s, regardless of the type of curve set (self protection)

(2) These tolerances are valid in the following conditions:
- Self-supplied release at full power (without start-up)
- Two or three phase power supply
- Trip time set ≥ 100 ms

The following tolerance values apply in all cases not covered by the above:

	Trip threshold	Trip time
L	Release between 1.05 and 1.25 x I1	±20%
S	±10%	±20%
I	±15%	≤60ms
G	±15%	±20%

Power supply

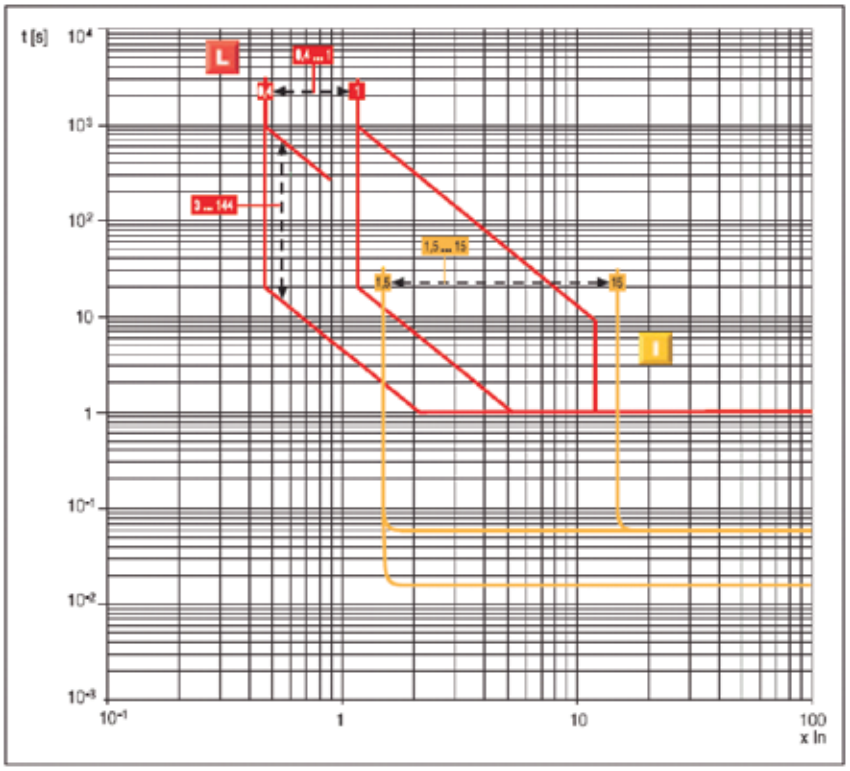
The unit does not require an external power supply either for protection functions or for alarm signaling functions. It is self-supplied by means of the current sensors installed on the circuit breaker.

For it to operate, it is sufficient for at least one phase to be loaded at 100A. An external power supply can be connected in order to activate additional features, and in particular for connection to external devices: HMI030, and PR021/K.

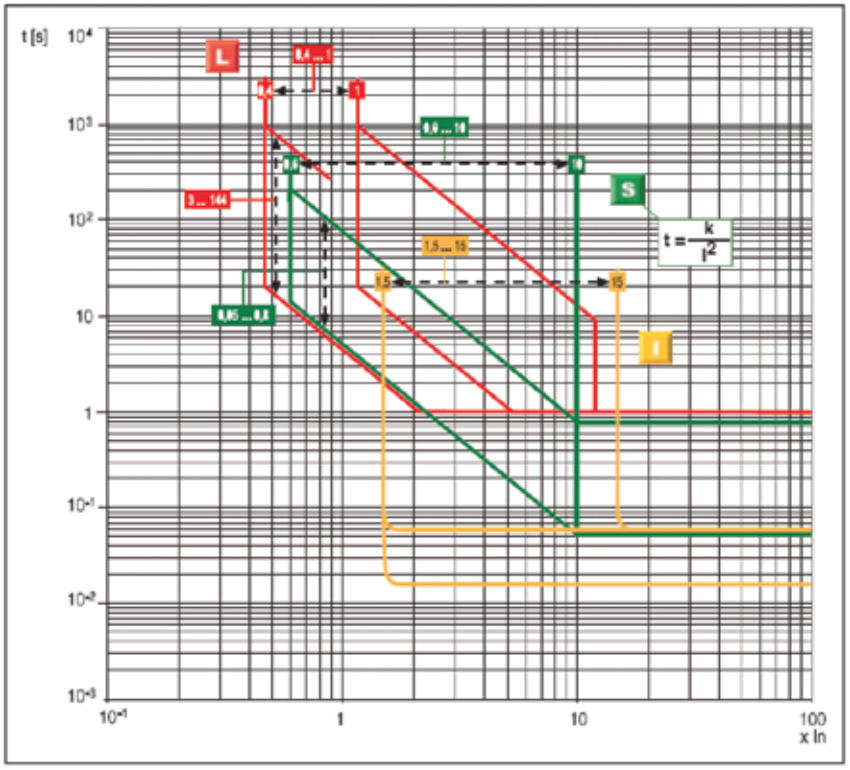
	PR121/P
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	5%
Inrush current @ 24 V	~10 A for 5 ms
Rated power @ 24 V	~2 W

Emax power breakers
Trip units PR121/P

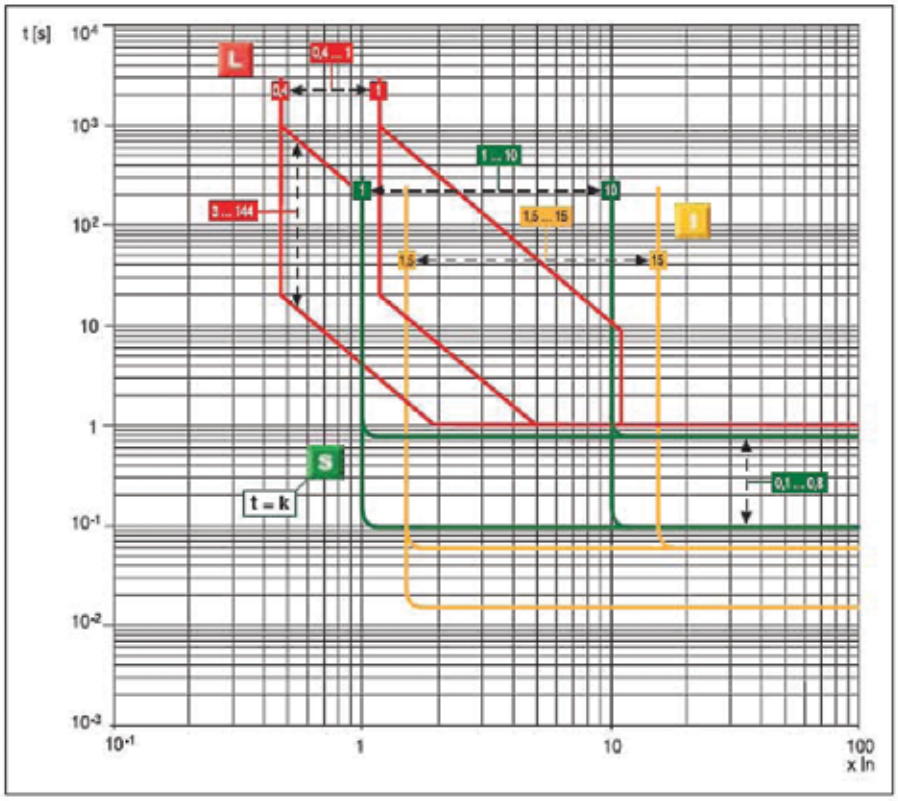
Functions L-I



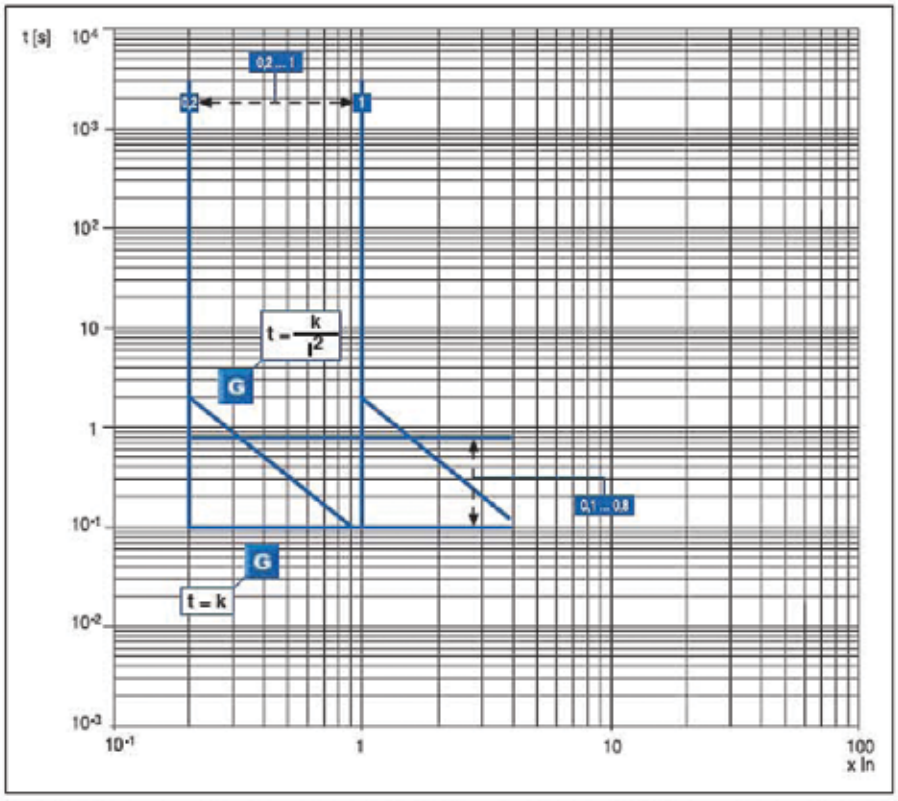
Functions L-S-I



Functions L-S-I



Function G



Emax power breakers
Trip units PR122/P

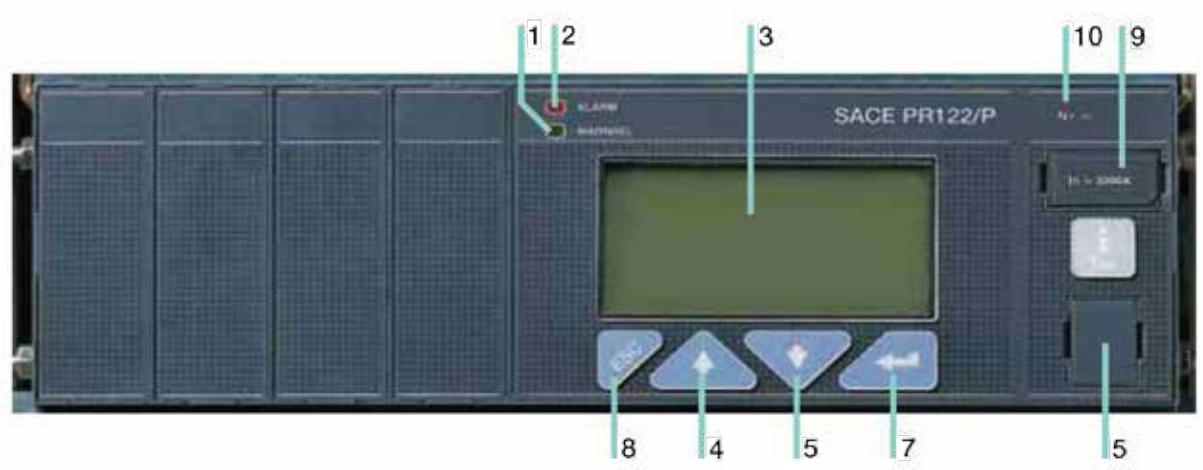
The SACE PR122 release is a sophisticated and flexible protection system based on a state-of the art microprocessor and DSP technology. Fitted with the optional internal PR120/D-M dialogue unit, PR122/P turns into an intelligent protection, measurement and communication device, based on the Modbus protocol.

The new PR122/P is the result of ABB SACE's experience in designing protection releases. The exhaustive range of settings makes this protection unit ideal for general use in any type of installation, from distribution to the protection of motors, transformers, drives and generators. Access to information and programming using a keyboard and graphic liquid crystal display is extremely simple and intuitive. The interface is now common to PR122/P and PR123/P in order to give to the user maximum ease of use.

An integrated ammeter and many other additional features are provided over and above the protection functions. These additional functions can be further increased with addition on board of the dialogue, signalling, measurement, and wireless communication units.

Functions S and G can operate with a time delay independent of the current (t = k) or with an inverse time delay (constant specific let-through energy: I^2 t = k), as required. Protection against ground faults can also be obtained by connecting the PR122 release to an external toroid located on the conductor that connects the transformer star centre to ground (homopolar toroid).

All the thresholds and trip curve delays of the protection functions are stored in special memories which retain the information even when no power is supplied.



Legend

1. LED Warning indicator	**6.** Test connector for connecting or testing the release by means of an external device (PR030/B battery unit, BT030 wireless communication unit and SACE PR010/T unit)
2. Alarm LED	**7.** ENTER button to confirm data or change pages
3. Rear-lit graphic display	**8.** Button to exit submenus or cancel operations (ESC)
4. Cursor UP button	**9.** Rating plug
5. Cursor DOWN button	**10.** Serial number of protection release

Operation, protection functions and self-test Basic Protection functions

The PR122 release offers the following protection functions (according to the version):

- Overload (L)
- Selective short-circuit (S)
- Instantaneous short-circuit (I)
- Ground fault (G)
- Phase unbalance (U)
- Self-protection against over temperature (OT)
- Thermal memory for functions L and S
- Zone selectivity for functions S and G
- Residual current (Rc) with external toroid
- Source ground return with external toroid

Setting the neutral

In PR122/P, and PR123/P as well, the neutral protection is 50% of the value set for phase protection in the standard version. The neutral protection can be excluded or set to 100% for E1, E2, E3, E4/f and E6/f. In installations where very high harmonics occur, the resulting current at the neutral can be higher than that of the phases. Therefore it is possible to set the neutral protection at 150% or 200% of the value set for the phases. In this case it is necessary to reduce the setting of protection L accordingly (1).

The table below lists the neutral settings for the various possible combinations between type of circuit breaker and the threshold I1 setting.

Start-up function

The start-up function allows protections S, I and G to operate with higher trip thresholds during the start-up phase. This avoids untimely tripping caused by the high inrush currents of certain loads (motors, transformers, lamps).

The start-up phase lasts from 100 ms to 1.5 s, in steps of 0.05 s. It is automatically recognized by the PR122 release as follows:

- When the circuit breaker closes with the release self-supplied;
- When the peak value of the maximum current exceeds 0.1 x In. A new start-up becomes possible after the current has fallen below the threshold of 0.1 x In, if the release is supplied from an external source.

I4 threshold	Repression threshold
I4 < 0.5 In	4 In
0.5 In ≤ I4 < 0.8 In	6 In
I4 ≥ 0.8 In	8 In

In = rated current of the rating plug

Adjustable neutral protection settings

	Threshold I1 settings (overload protection)		
Circuit breaker model	0.4 ≤ I1 ≤ 0.5	0.5 < I1 ≤ 0.66	0.66 < I1 ≤ 1(*)
E1B-N	0-50-100-150-200%	0-50-100-150%	0-50-100%
E2B-N-S-L	0-50-100-150-200%	0-50-100-150%	0-50-100%
E3N-S-H-V-L	0-50-100-150-200%	0-50-100-150%	0-50-100%
E4S-H-V	0-50-100%	0-50%	0-50%
E4S/f-H/f	0-50-100-150-200%	0-50-100-150%	0-50-100%
E6H-V	0-50-100%	0-50%	0-50%
E6H/f	50-100-150-200%	0-50-100-150%	0-50-100%

(*) The setting I1 = 1 indicates the maximum overload protection setting. The actual maximum setting allowable must take into account any derating based on temperature, the terminals used and the altitude.

(1) When three pole circuit breakers with external neutral current sensor are used, a setting above 100% for the neutral does not require any reduction in the L setting up to Iu N.

Phase unbalance protection U

Protection function U against phase unbalance is used in those situations requiring particularly precise control over missing and/or unbalanced phase currents, only giving the pre-alarm signal. This function can be excluded.

Protection against over temperature

The range of SACE PR122 releases allows the presence of abnormal temperatures, which could cause temporary or continuous malfunctions of the microprocessor, to be signaled to the user.

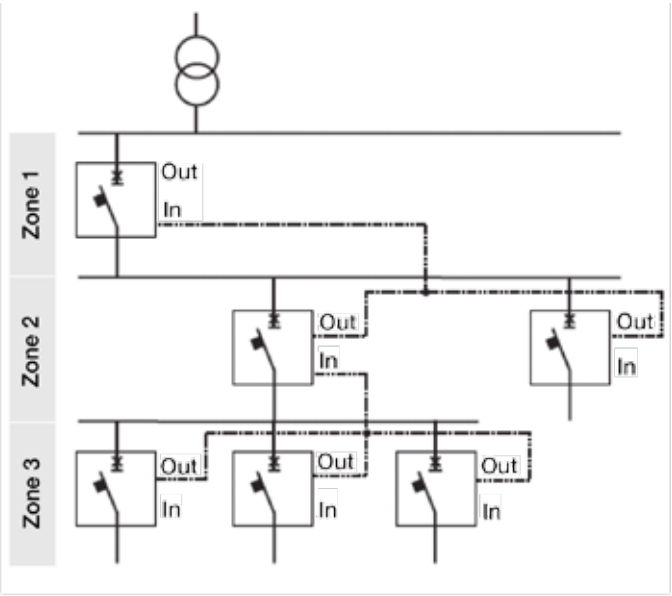
The user has the following signals or commands available:

- Lighting up of the “Warning” LED when the temperature is higher than 70 °C (temperature at which the microprocessor is still able to operate correctly)
- Lighting up of the “Alarm” LED when the temperature is higher than 85 °C (temperature above which the microprocessor may no longer correctly operate) and, when decided during the unit configuration stage, simultaneous opening of the circuit breaker with indication of the trip directly on the display, as for the other protections.

Zone selectivity for protections S and G

Zone selectivity is one of the most advanced methods for making coordination of the protections: by using this protection philosophy, it is possible to reduce the trip times of the protection closest to the fault in relation to the times foreseen by time selectivity, of which zone selectivity is an evolution.

Zone selectivity is applicable to protection functions S and G, even contemporarily and is available as standard on the PR122. The word zone is used to refer to the part of an installation between two circuit breakers in series (see figure to the right). Protection is provided by connecting all of the zone selectivity outputs of the releases belonging to the same zone together and taking this signal to the zone selectivity input of the release immediately to the supply side.



Each circuit breaker that detects a fault communicates this to the circuit breaker on the supply side using a simple connection wire. Therefore the fault zone is the zone immediately to the load side of the circuit breaker that detects the fault, but does not receive any communication from those on the load side. This circuit breaker opens without waiting for the set time-delay.

ABB SACE provides important calculation tools to facilitate the work of designers in coordinating protection devices, including the Slide rule kits, DOCWin and CAT software packages and updated coordination charts. The zone selectivity function S and G can be activated or deactivated using the keyboard.

Self-diagnosis

The PR122 range of releases contains an electronic circuit which periodically checks the continuity of internal connections (opening solenoid or each current sensor, including the Source Ground Return when present). In the case of a malfunction an alarm message appears directly on the display. The Alarm is highlighted by the Alarm LED as well.

Residual current

Different solutions are available for integrated residual current protection. The basic choice is PR122/P-LSIRc, which has all the characteristics of PR122/P-LSI and residual current protection as well. When additional features are required, the solution is PR122/P LSIG with an additional PR120/V module (see next paragraph). Using this configuration, residual current protection is added to a powerful unit, having the features of PR122/P-LSI and all the add-ons described for the PR120/V module, such as voltage protection and advanced measurement functions. Residual current protection acts by measuring the current from the external dedicated toroid.

Test functions

Once enabled from the menu, the “info/Test” pushbutton on the front of the release allows correct operation of the chain consisting of the microprocessor, opening solenoid and circuit breaker tripping mechanism to be checked.

The control menu also includes the option of testing correct operation of the display, signalling LEDs, and electrical contacts of the PR120/K release. By means of the front multi-pin connector it is possible to apply a SACE PR010/T Test unit which allows the functions of the PR121, PR122 and PR123 ranges of releases to be tested and checked.

User interface

The human-machine interface (HMI) of the device is made up of a wide graphic display, LEDs, and browsing pushbuttons. The interface is designed to provide maximum simplicity. The language can be selected from among five available options: Italian, English, German, French, and Spanish.

As in the previous generation of releases, a password system is used to manage the “Read” or “Edit” modes. The default password, 0001, can be modified by the user. The protection parameters (curves and trip thresholds) can be set directly via the HMI of the device. The parameters can only be changed when the release is operating in “Edit” mode, but the information available and the parameter settings can be checked at any time in “Read” mode.

When a communication device (internal PR120/D-M and PR120/D-BT modules or external BT030 device) is connected, it is possible to set parameters simply by downloading them into the unit (over the network for PR120/D-M, by using the SD-Pocket software and a PDA or a notebook for PR120/D-BT and BT030). Parameterisation can then be carried out quickly and automatically in an error-free way by transferring data directly from DocWin.

Indicator LEDs

LEDs on the front panel of the release are used to indicate all the pre-alarms (“WARNING”) and alarms (“ALARM”). A message on the display always explicitly indicates the type of event concerned.

Example of events indicated by the “WARNING” LED:

- Unbalance between phases
- Pre-alarm for overload (L1>90%)
- First temperature threshold exceeded (70 °C)
- Contact wear beyond 80%
- Phase rotation reversed (with optional PR120/V)

Example of events indicated by the “ALARM” LED:

- Overload (may begin from 1.05xI1<I<1.3xI1, in accordance with the standard IEC 60947-2)
- Timing of function L
- Timing of function S
- Timing of function G
- Second temperature threshold exceeded (85 °C)
- Contact wear 100%
- Timing of Reverse Power flow protection (with optional PR120/V)

Data logger

By default PR122/P, as well as PR123/P, is provided with the Data Logger function, that automatically records in a wide memory buffer the instantaneous values of all the currents and voltages. Data can be easily downloaded from the unit by means of SD-Pocket or Ekip applications using a Bluetooth port and can be transferred to any personal computer for elaboration. The function freezes the recording whenever a trip occurs, so that a detailed analysis of faults can be easily performed. SD-Pocket and Ekip allow also reading and downloading of all the others trip information.

- Number of channels: 8
- Maximum sampling rate: 4800 Hz
- Maximum sampling time: 27 s (@ sampling rate 600 Hz)
- 64 events tracking

Trip information and opening data

In case a trip occurs PR122/P and PR123/P store all the needed information:

- Protection tripped
- Opening data (current)
- Time stamp (designed with auxiliary supply or self-supply with power failure no longer than 48h)

By pushing the “info/Test” pushbutton the release shows all these data directly on display. No auxiliary power supply is needed. The information is available to user for 48 hours with the circuit breaker open or without current flowing. The information of the latest 20 trips are stored in memory. If the information can be furthermore retrieved more than 48 hours later, it is sufficient to connect a PR030/B battery unit or a BT030 wireless communication unit.

Load control

Load control makes it possible to engage/disengage individual loads on the load side before the overload protection L is tripped, thereby avoiding unnecessary trips of the circuit breaker on the supply side. This is done by means of contactors or switch-disconnectors (externally wired to the release), controlled by the PR122/P by PR120/K internal contacts, or by PR021/K unit.

Two different Load Control schemes can be implemented:

- Disconnection of two separate loads, with different current thresholds
- Connection and disconnection of a load, with hysteresis

Current thresholds and trip times are smaller than those available for selection with protection L, so that load control can be used to prevent overload tripping. Internal PR120/K or external PR021/K accessory unit is required for Load Control. The function is only active when an auxiliary power supply is present.

Measurement function

The current measurement function (ammeter) is present on all versions of the SACE PR122 trip unit. The display shows histograms showing the currents of the three phases and neutral on the main page. Furthermore, the most loaded phase current is indicated in numerical format. Ground fault current, where applicable, is shown on a dedicated page.

The latter current value takes on two different meanings depending on whether the external toroidal transformer for the “Source Ground Return” function or the internal transformer (residual type) is connected.

The ammeter can operate either with self-supply or with an auxiliary power supply voltage. In the latter case the display is rear-lit and the ammeter is active even at current levels lower than 160A. Accuracy of the ammeter measurement chain (current sensor plus ammeter) is no more than 1.5% in the 30% - 120% current interval of In.

- Currents: three phases (L1, L2, L3), neutral (Ne) and ground fault;
- Instantaneous values of currents during a period of time (data logger);
- Maintenance: number of operations, percentage of contact wear, opening data storage (last 20 trips and 20 events).

When the optional PR120/V is connected, the following additional measurement functions are present:

- Voltage: phase-phase, phase-neutral and residual voltage
- Instantaneous values of voltages during a period of time (data logger);
- Power: active, reactive and apparent
- Power factor
- Frequency and peak factor
- Energy: active, reactive, apparent, counter

Versions available
The following versions are available

PR122/P LI-LSI-LSIG-LSIRc

Emax power breakers
Trip units PR122/P

Protection functions and setting values - PR122

Function		Trip Threshold	Threshold steps	Trip time	Time step	Poss. excl.	Relation t-f(I)	Thermal memory	Zone selectivity
L	Overload protection	I1 = 0.4... 1 x In	0.01 x In	With current I = 3 x I1 t1 = 3 s... 144 s	3 s (1)	–	$t=k/I^2$	◆	–
	Tolerance (2)	Release between 1.05 and 1.2 x I1		±10% Ig ≤ 4 x In ± 20% Ig > 4 x In					
S	Selective short circuit protection	I2 = 0.6... 10 x In	0.1 x In	With current I > I2 t2 = 0.05 s... 0.8 s (2)	0.01 s	◆	t=k	–	◆
	Tolerance (2)	± 7% Ig ≤ 4 x In ± 10% Ig > 4 x In		The better of the two figures: ± 10% or ± 40 ms					
	Tolerance (2)	I2 = 0.6... 10 x In	0.1 x In	With current I = 10 x In t2 = 0.05 s... 0.8 s	0.01 s	◆	$t=k/I^2$	◆	–
		± 7% Ig ≤ 4 x In ± 10% Ig > 4 x In		±15% Ig ≤ 4 x In ± 20% Ig > 4 x In					
I	Instantaneous short circuit protection	I3 = 1.5... 15 x In	0.1 x In	Instantaneous	–	◆	t=k	–	–
	Tolerance (2)	± 10%		≤ 30 ms					
G	Earth fault protection	I4 = 0.2... 1 x In	0.02 x In	With current I > I4 t4 = 0.1 s... 1 s	0.05 s	◆	t=k	–	◆
	Tolerance (2)	± 7%		The better of the two figures: ± 10% or ± 40 ms					
	Tolerance (2)	I4 = 0.2... 1 x In ± 7%	0.02 x In	t4 = 0.1 s... 1 s (with I = 4 x In) ± 15%	0.05 s	◆	$t=k/I^2$	–	◆
Rc	Residual current protection	Id = 0.3 - 0.5 - 0.7 - 1 - 2 - 3 - 5 - 7 - 10 - 20 - 30 A	–	td = 0.06 - 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.8 - 1 - 3 - 4 - 4.8 s (3)	–	◆	t=k	–	–
	Tolerance (2)	± 10 %							
OT	Protection against overtemperature	May not be set	–	Instantaneous	–	–	temp=k	–	–
U	Phase unbalance protection	I6 = 5%... 90%	5%	t4 = 0.5 s... 60 s	0.5 s	◆	t=k	–	–
	Tolerance (2)	± 10 %		The better of the two figures: ± 20% or ± 100 ms					

(1) The minimum trip value is 1 s, regardless of the type of curve set (self protection).
(2) These tolerances are valid in the following conditions:
- Self-supplied release at full power and/or auxiliary power supply (without start-up)
- Two or three phase power supply
- Trip time set ≥ 100 ms

(3) Non intervention time

The following tolerance values apply in all cases not covered by the above:

Trip threshold	Trip time
L Release between 1.05 and 1.25 x I1	±20%
S ±10%	±20%
I ±15%	≤60ms
G ±15%	±20%
Others	±20%

Protection functions and setting values - PR122 with PR120/V

Function		Trip Threshold	Threshold steps	Trip time	Time step	Poss. excl.	Relation t-f(I)	Thermal memory	Zone selectivity
UV	Undervoltage protection	I8 = 0.5... 0.95 x Un	0.01 x Un	With current U < U8 t8 = 0.1 s.... 5 s	0.1 s	◆	t = k	–	◆
	Tolerance (1)	± 5%		The better of the two figures: ± 20% or ± 100 ms					
OV	Overvoltage protection	I9 = 1.05.... 1.2 x Un	0.01 x Un	With current U > U9 t9 = 0.1 s.... 5 s	0.1 s	◆	t = k	–	–
	Tolerance (1)	± 5%		The better of the two figures: ± 20% or ± 100 ms					
RV	Residual voltage protection	I10 = 0.1.... 0.4 x Un	0.05 x Un	With current U_0 > U10 t10 = 0.5 s.... 30 s	0.5 s	◆	t = k	–	–
	Tolerance (1)	± 5%		The better of the two figures: ± 10% or ± 100 ms					
RP	Reverse power protection	P11 = -0.3.... -0.1 x Pn	0.02 x Pn	With current P < P11 t11 = 0.5 s.... 25 s	0.1 s	◆	t = k	–	–
	Tolerance (1)	± 5%		The better of the two figures: ± 10% or ± 100 ms					
UF	Underfrequency protection	f12 = 0.90.... 0.99 x fn	0.01 x fn	With current f < f12 t9 = 0.5 s.... 3 s	0.1 s	◆	t = k	–	–
	Tolerance (1)	± 5%		The better of the two figures: ± 10% or ± 100 ms					
OF	Overfrequency protection	f13 = 1.01.... 1.10 x fn	0.01 x fn	With current f < f13 t10 = 0.5 s.... 3 s	0.1 s	◆	t = k	–	–
	Tolerance (1)	± 5%		The better of the two figures: ± 10% or ± 100 ms					

(1) These tolerances are valid in the following conditions:
- Self-supplied release at full power and/or auxiliary power supply (without start-up)
- Two or three phase power supply

Power supply

The PR122 release does not normally require any external power supplies, being self-supplied from the current sensors (CS): to activate the protection and ammeter functions, it is sufficient for at least one phase to have a current load higher than 70A (E3) or 140A (E4-E6).

When an auxiliary power supply is present, it is also possible to use the trip unit with the circuit breaker either open or closed with very low current flowing through.

It is also possible to use an auxiliary power supply provided by the PR030/B portable battery unit (always supplied), which allows the protection functions to be set when the release is not self-supplied.

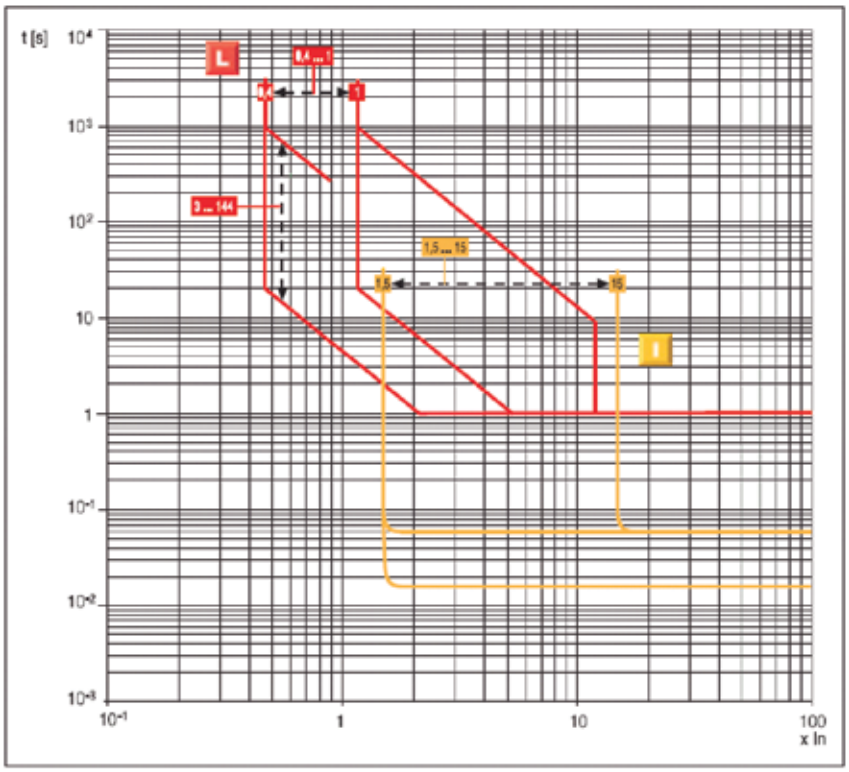
PR122/P stores and shows all the information needed after a trip (protection tripped, trip current, time, date). No auxiliary supply is required for this functionality.

	PR122/P	PR120/D-M	PR120/K	PR120/D-BT
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	from PR122/PR123	from PR122/PR123	from PR122/PR123
Maximum ripple	5%	–	–	–
Inrush current @ 24 V	~10 A for 5 ms	–	–	–
Rated power @ 24 V	~3 W	+1 W	+1 W	+1 W

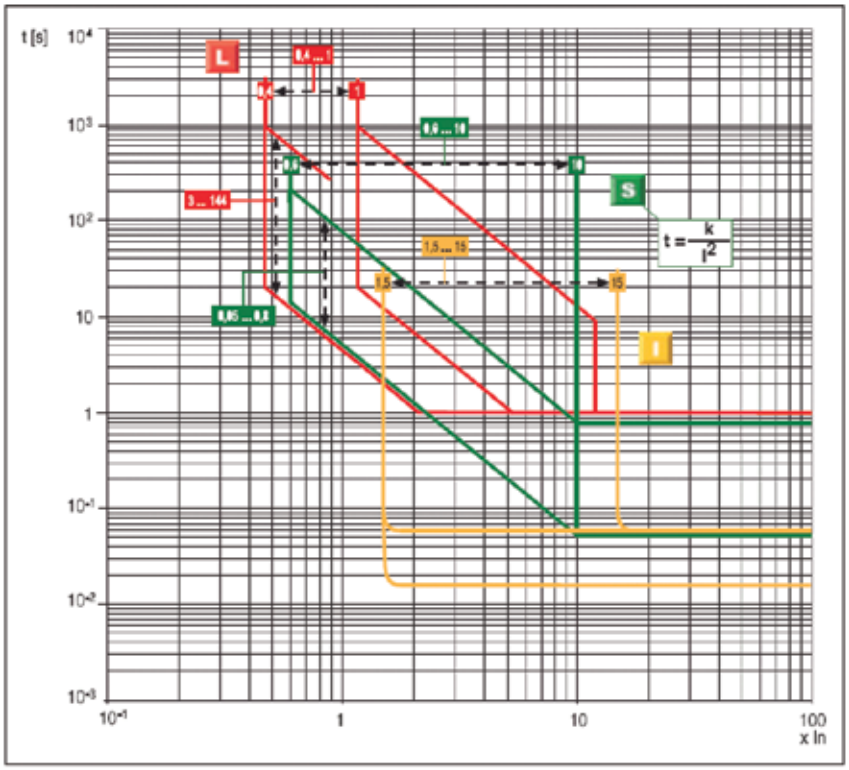
PR120/V can give power supply to the release when at least one line voltage is equal or higher to 85 V RMS.

Emax power breakers
Trip units PR122/P

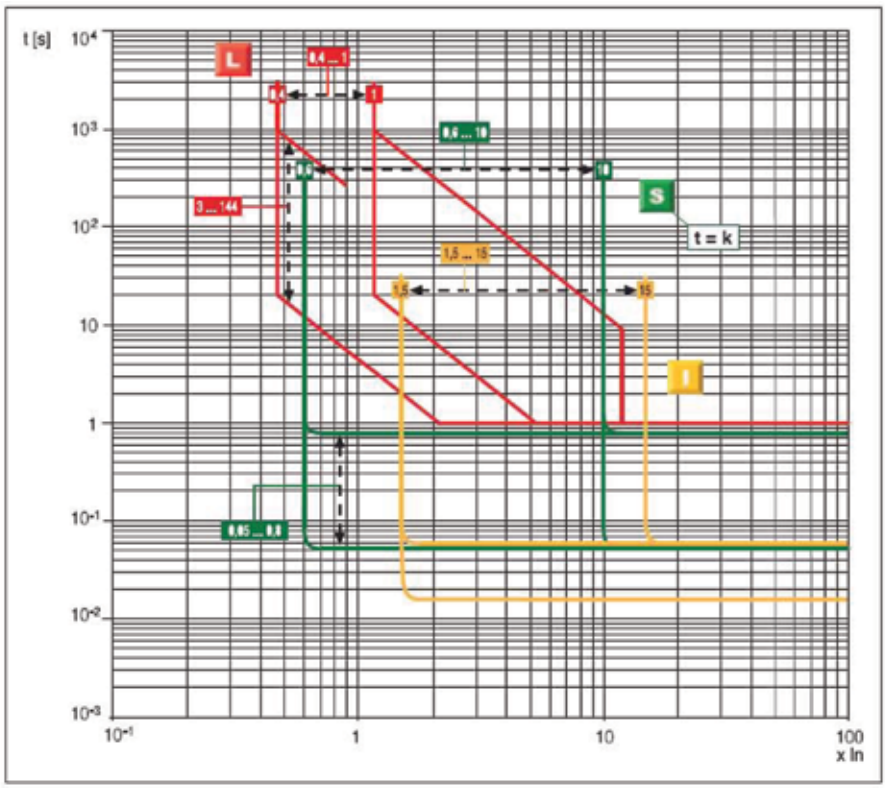
Functions L-I



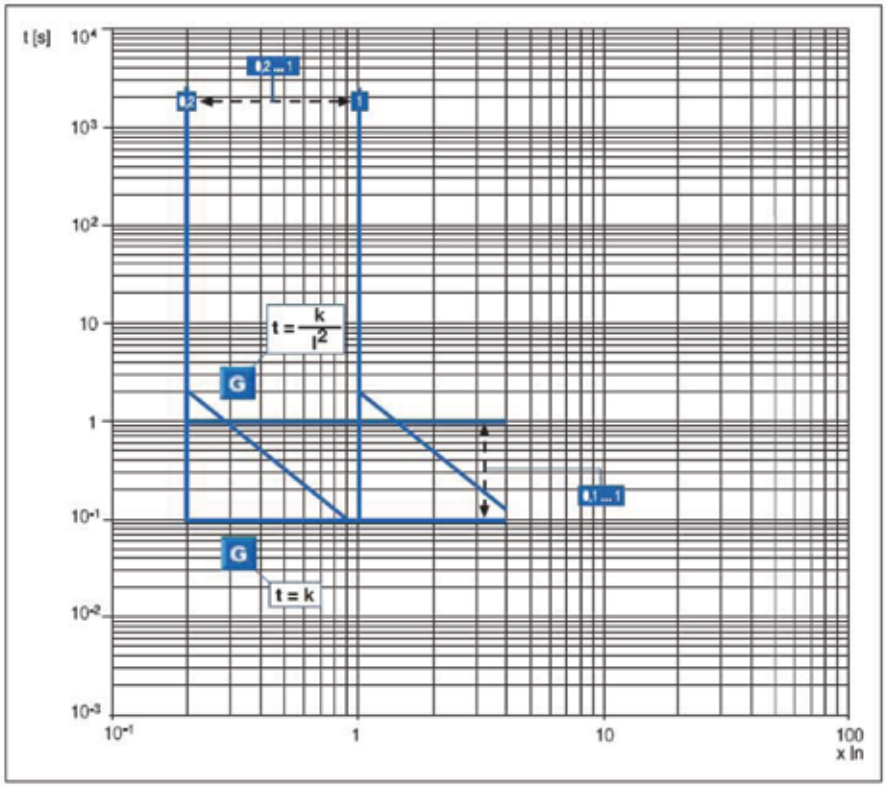
Functions L-S-I



Functions L-S-I

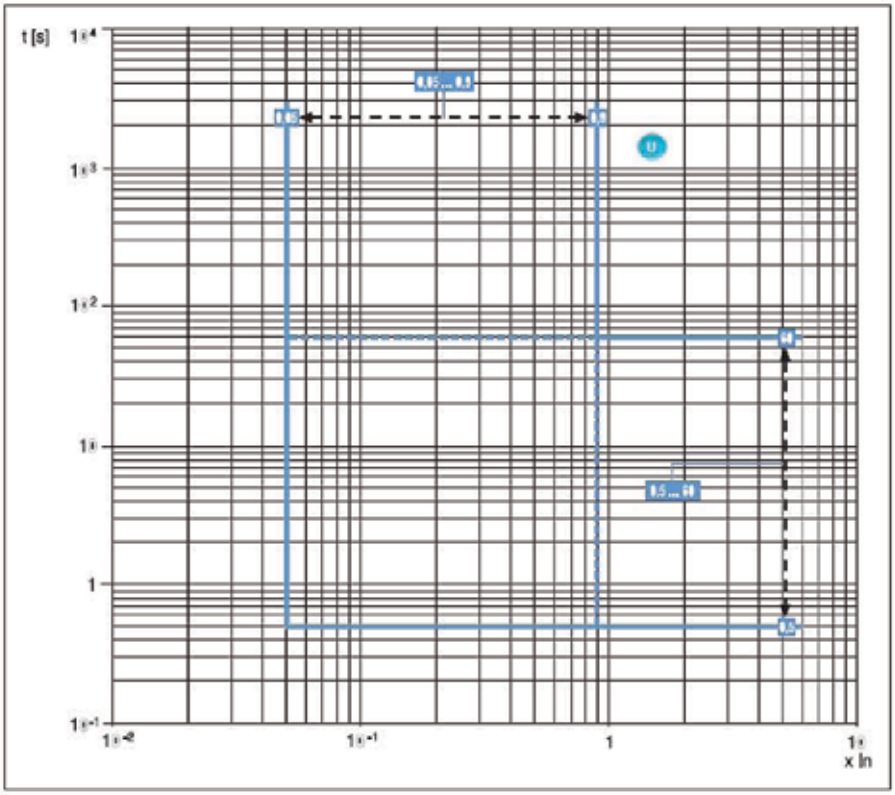


Function G

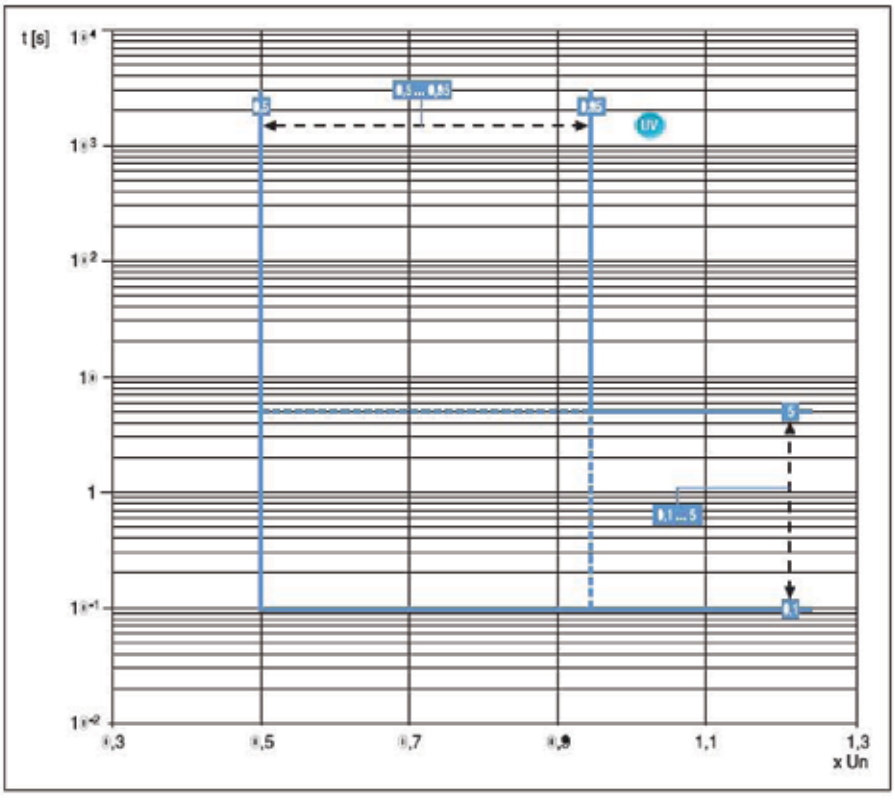


Emax power breakers
Trip units PR122/P

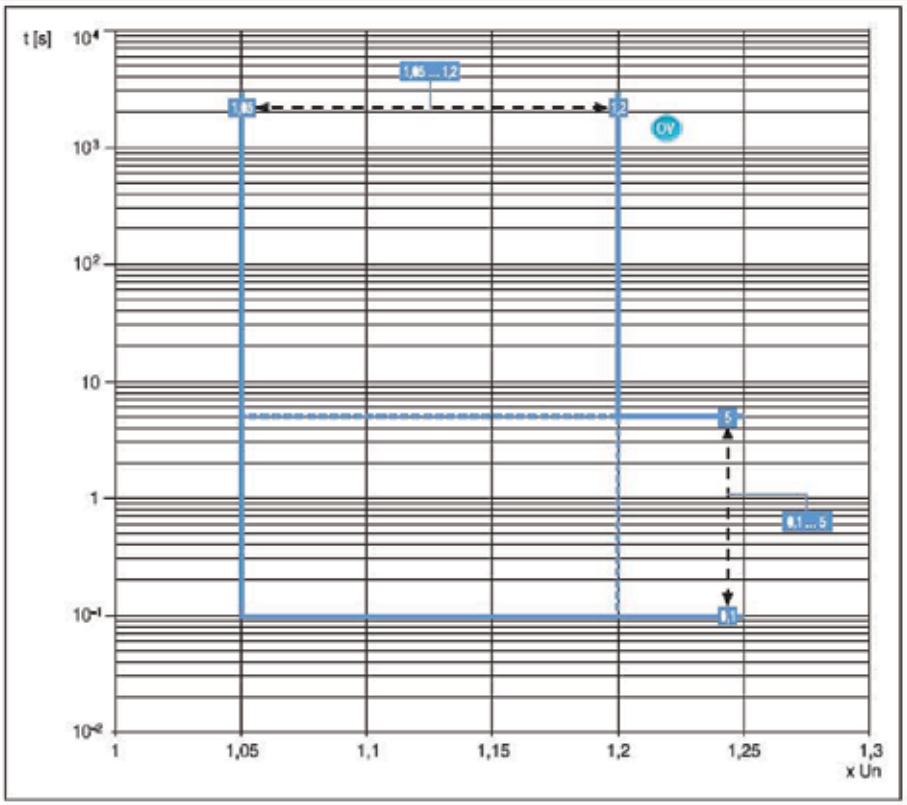
Function U



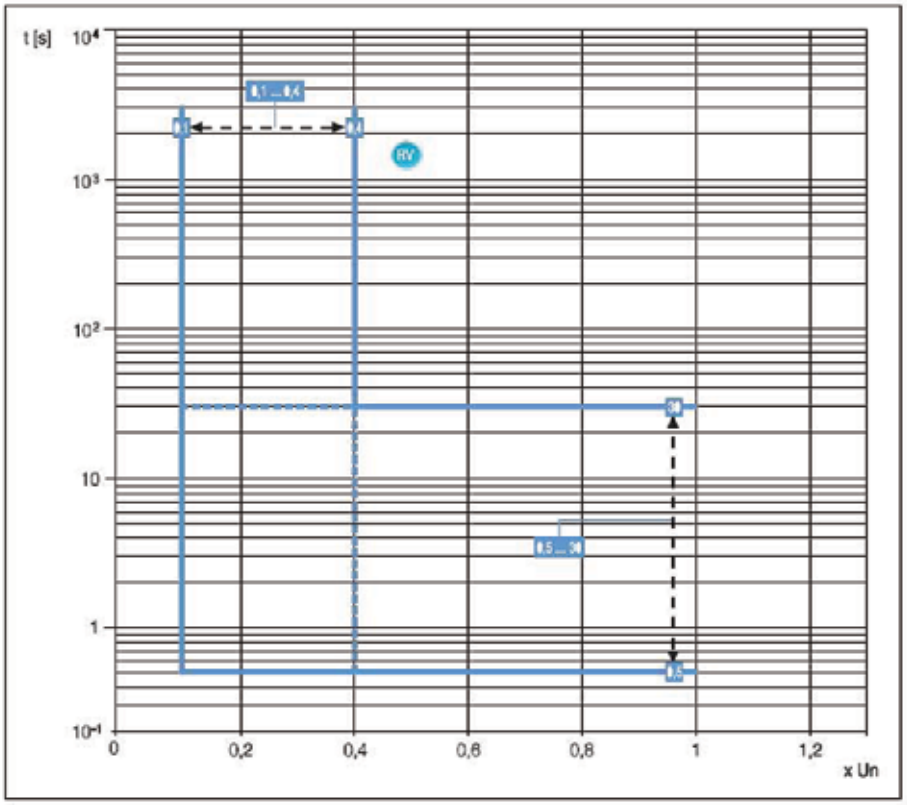
Function UV



Function OV

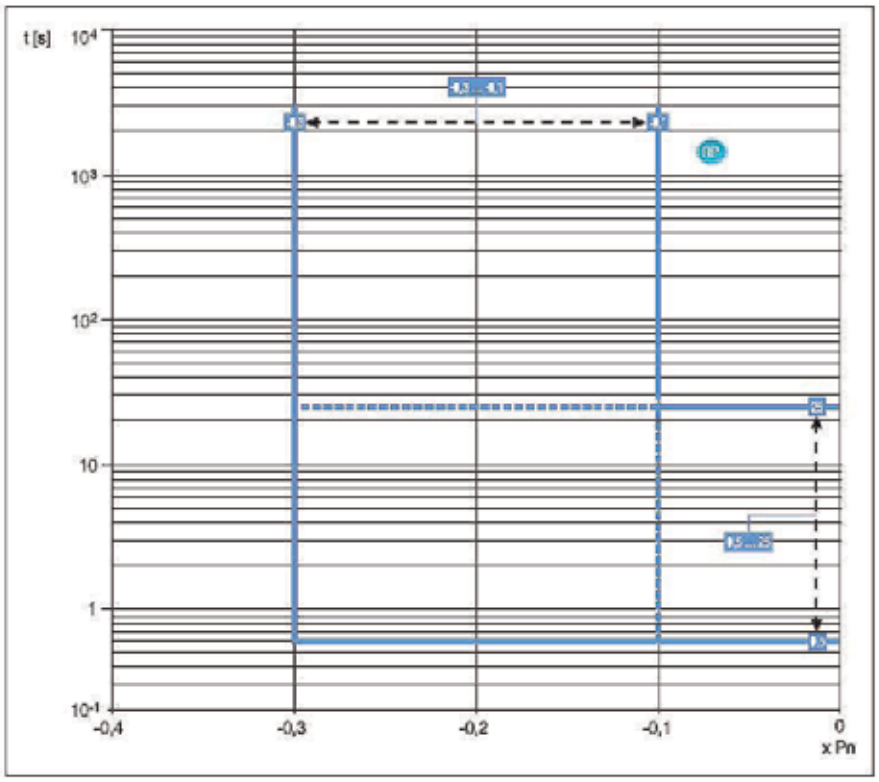


Function RV



Emax power breakers
Trip units PR122/P

Function RP



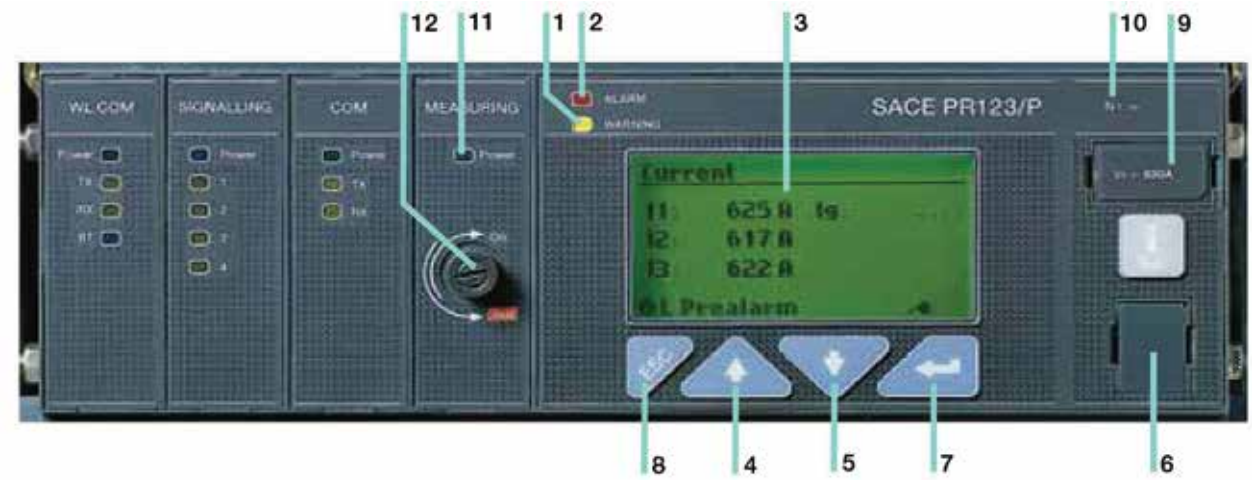
Emax power breakers
Trip units PR123/P

Characteristics

The PR123 protection release completes the range of releases available for the Emax family of circuit breakers. It is a high-performance and extraordinarily versatile release, capable of offering a complete set of functions for protection, measurement, signaling, data storage and control of the circuit breaker, and it represents the benchmark in low voltage protection units for circuit breakers.

The front interface of the unit, common to PR122/P, is extremely simple thanks to the aid of the liquid crystal graphics display. It can show diagrams, bar graphs, measurements and sine curves for the various electrical values.

PR123 integrates all the features offered by PR122/P plus a series of evolutionary functionalities. As well as PR122 it can be integrated with the additional features provided by internal modules and external accessories.



Legend

1. LED warning indicator	**6.** Test connector for connecting or testing the release by means of an external device (PR030/B battery unit, BT030 wireless communication unit and SACE PR010/T unit)	**11.** PowerLED
2. Alarm LED	**7.** Enter button to confirm data or Change pages	**12.** Voltage-uptake switch-disconnector
3. Rear-lit graphic display	**8.** Button to exit submenus or cancel operations (ESC)	
4. Cursor UP button	**9.** Rating plug	
5. Cursor DOWN button	**10.** Serial number of protection release	

Emax power breakers
Trip units PR123/P

Protection functions

- The PR123 release offers the following protection functions:
- Overload (L)
- Selective short-circuit (S)
- Instantaneous short-circuit (I)
- Ground fault with adjustable delay (G)
- Directional short-circuit with adjustable delay (D)
- Phase unbalance (U)
- Protection against overtemperature (OT)
- Load control (K)
- Undervoltage (UV)
- Overvoltage (OV)
- Residual voltage (RV)
- Reverse power (RP)
- Underfrequency (UF)
- Overfrequency (OF)
- Phase sequence (alarm only).

In addition to PR122/P features, the following improvements are available:

Overload protection L

With the PR123 unit, the overload protection L includes the option to adjust the slope of the protection curve. This adjustment allows perfect coordination with fuses or with medium-voltage protection systems.

Double selective short-circuit protection S

In addition to the standard S protection, PR123/P makes contemporarily available a second time-constant S protection (excludible) that allows two thresholds to be set independently achieving an accurate selectivity even under highly critical conditions.

Double ground fault protection G

While in PR121/P and PR122/P the user must choose among the implementation of G protection through internal current sensors (calculating the vectorial sum of currents) or external toroid (direct ground fault current measuring), PR123/P offers the exclusive feature of the contemporaneous management of both the configuration, by means of two independent ground fault protection curves. The main application of this characteristic is simultaneous activation of restricted and unrestricted ground fault protection.

Directional short-circuit protection with adjustable delay D

The protection works in a similar way to the fixed-time protection “S”, with the added ability to recognize the direction of the phases current during the fault period.

The current direction makes it possible to determine whether the fault is on the supply or load side of the circuit breaker. Particularly in ring distribution systems, this makes it possible to identify and disconnect the distribution segment where the fault has occurred, while keeping the rest of the installation running. If multiple PR122 or PR123 releases are used, this protection can be associated with zone selectivity.

Dual setting of protections

PR123/P can store an alternative set of all the protection parameters. This second set (set B) can replace, when needed, the default set (set A) by means of an external command. The command can be given typically when network configuration is modified, like when a parallel of incoming lines is closed or when an emergency source is present in the system, changing load capability and short-circuit levels.

The set B can be activated by:

- Digital input provided with PR120/K module. For example It can be connected to an auxiliary contact of a bus-tie
- Communication network, through PR120/D-M (i.e. when the changeover is scheduled);
- Directly from user interface of PR123/P
- An adjustable time internal after closing of the circuit breaker.

Zone selectivity function

The zone selectivity function allows the fault area to be insulated by segregating the system very rapidly only at the level closest to the fault, whilst leaving the rest of the installation running. This is done by connecting the releases together: the release nearest the fault is tripped instantly, sending a block signal to the other releases affected by the same fault. The zone selectivity function can be enabled if the fixed-time curve has been selected and an auxiliary power supply is present.

Zone selectivity can be applied with protections S and G or, alternatively, with protection D.

Measurement functions

The PR123 release provides a complete set of measurements:

- Currents: three phases (L1, L2, L3), neutral (Ne) and ground fault
- Voltage: phase-phase, phase-neutral and residual voltage
- Power: active, reactive and apparent
- Power factor
- Frequency and peak factor,
- Energy: active, reactive, apparent, counter
- Harmonics calculation: up to the 40th harmonic (waveform and module of the harmonics displayed); up to the 35th for frequency f = 60Hz
- Maintenance: number of operations, percentage of contact wear, opening data storage.

The PR123 unit is able to provide the pattern of measurements for some values over an adjustable period of time P, such as: mean active power, maximum active power, maximum current, maximum voltage and minimum voltage. The last 24 P periods (adjustable from 5 to 120 min.) are stored in a non-volatile memory and displayed in a bar graph.

Other functions

PR123/P integrates all the features (in terms of protection, measurement, signaling and communication) described for PR122/P equipped with PR120/V.

Note:
The directional short-circuit protection can be disabled for an adjustable set time (t = k), and can either be self-supplied or use the auxiliary power supply. Directional protection is not available on 400A rating.

Emax power breakers
Trip units PR123/P

Protection functions and setting values - PR123

Function		Trip Threshold	Threshold steps	Trip time	Time step	Poss. excl.	Relation t-f(I)	Thermal memory	Zone selectivity
L	Overload protection	I1 = 0.4... 1 x In	0.01 x In	With current I = 3 x I1 t1 = 3 s... 144 s	3 s (1)	–	$t=k/I^2$	◆	–
	Tolerance (2)	Release between 1.05 and 1.2 x I1		±10% If ≤ 6 x In ±20% If > 6 x In					
	Tolerance	I1 = 0.4.... 1 x In 1.05.... 1.2 x I1 (in accordance with IEC 60255-3)	0.01 x In	With current I = 3 x In (4) t1 = 3 s... 144 s ±20% If > 5 x I1 ±30% 2 x I1 ≤ If ≤ 5 x I1 In	3 s	–	–	–	–
S	Selective short circuit protection	I2 = 0.6... 10 x In	0.1 x In	With current I > I2 t2 = 0.05 s... 0.8 s	0.01 s	◆	t=k	–	◆
	Tolerance (2)	± 7% If ≤ 6 x In ± 10% If > 6 x In		The better of the two figures: ± 10% or ± 40 ms					
	Tolerance (2)	I2 = 0.6... 10 x In	0.1 x In	With current I = 10 x In t2 = 0.05 s... 0.8 s	0.01 s	◆	$t=k/I^2$	◆	–
		± 7% If ≤ 6 x In ± 10% If > 6 x In		±15% If ≤ 6 x In ± 20% If > 6 x In					
S_2	Selective short circuit protection	I2 = 0.6... 10 x In	0.1 x In	With current I > I2 t2 = 0.05 s... 0.8	0.01 s	◆	t=k	–	◆
	Tolerance (2)	± 7% If ≤ 6 x In ± 10% If > 6 x In		The better of the two figures: ± 10% or ± 40 ms					
I	Instantaneous short circuit protection	I3 = 1.5... 15 x In	0.1 x In	Instantaneous	–	◆	t=k	–	–
	Tolerance (2)	± 10%		≤ 30 ms					
G	Earth fault protection	I = 0.2... 1 x In (4)	0.02 x In	With current I > I4 t4 = 0.1 s.... 1 s	0.05 s	◆	t=k	–	◆
	Tolerance (2)	± 7%		The better of the two figures: ± 10% or ± 40 ms					
	Tolerance (2)	I4 = 0.2... 1 x In (4) ± 7%	0.02 x In	t4 = 0.1 s... 1 s (with I = 4 x I4) ± 15%	0.05 s	◆	$t=k/I^2$	–	–
Rc	Residual current protection	Id = 3 - 5 - 7 - 10 - 20 - 30 A	–	td = 0.06 - 0.1 - 0.2 - 0.3 - 0.4 - 0.5 - 0.8 s (3)	–	◆	t=k	–	–
	Tolerance (2)	± 10 %							
D	Directional short circuit protection	I7 = 0.6.... 10 x In	0.1 x In	With current I > I7 t7 = 0.20 s.... 0.8 s	0.01 s	◆	t=k	–	◆
	Tolerance (2)	± 10 %		The better of the two figures: ± 10% or ± 40 ms					
U	Phase unbalance protection	I6 = 5%.... 90%	5%	t6 = 0.5 s.... 60 s	0.5 s	◆	t=k	–	–
	Tolerance (2)	± 10 %		The better of the two figures: ± 20% or ± 100 ms					
OT	Protection against overtemperature	Cannot be set	–	Instantaneous	–	–	temp=k	–	–
UV	Undervoltage protection	I8 = 0.5.... 0.95 x Un	0.01 x In	With current U < U8 t8 = 0.1 s.... 5 s	0.1 s	◆	t=k	–	–
	Tolerance (2)	± 5 %		The better of the two figures: ± 20% or ± 40 ms					
OV	Overvoltage protection	I9 = 1.05.... 1.2 x Un	0.01 x In	With current U > U9 t9 = 0.1 s.... 5 s	0.1 s	◆	t=k	–	–
	Tolerance (2)	± 5 %		The better of the two figures: ± 20% or ± 40 ms					
RV	Residual voltage protection	I10 = 0.1.... 0.4 x Un	0.05 Un	With current U_0 > U10 t10 = 0.5 s.... 30 s	0.5 s	◆	t=k	–	–
	Tolerance (2)	± 5 %		The better of the two figures: ± 10% or ± 100 ms					

Protection functions and setting values - PR123 (cont.)

Function		Trip Threshold	Threshold steps	Trip time	Time step	Poss. excl.	Relation t-f(I)	Thermal memory	Zone selectivity
RP	Reverse power protection	P11 = -0.3.... -0.1 x Pn	0.02 Pn	With current P < P11 t11 = 0.5 s.... 25 s	0.1 s	◆	t=k	–	–
	Tolerance (2)	± 10 %		The better of the two figures: ± 10% or ± 100 ms					
UF	Underfrequency protection	f12 = 0.90.... 0.99 x fn	0.01 fn	With current f < f12 t9 = 0.5 s.... 3 s	0.1 s	◆	t=k	–	–
	Tolerance (2)	± 5 %		The better of the two figures: ± 10% or ± 100 ms					
OF	Overfrequency protection	f13 = 1.01.... 1.10 x fn	0.01 fn	With current f > f13 t10 = 0.5 s.... 3 s	0.1 s	◆	t=k	–	–
	Tolerance (2)	± 5 %		The better of the two figures: ± 10% or ± 100 ms					

(1) The minimum trip value is 1 s, regardless of the type of curve set (self protection).
(2) These tolerances are valid in the following conditions:
- Self-supplied release at full power and/or auxiliary power supply (without start-up)
- Two or three phase power supply
- Trip time set ≥ 100 ms

(3) Non-intervention time
(4) The maximum value for G protection is 1200 A.

The following tolerance values apply in all cases not covered by the above:

Trip threshold	Trip time
L Release between 1.05 and 1.25 x I1	±20%
S ±10%	±20%
I ±15%	≤60ms
G ±15%	±20%
Others	±20%

Power supply

The PR123 release does not normally require any external power supplies, being self-supplied from the current sensors (CS): to activate the protection and ammeter functions, it is sufficient for at least one phase to have a current load higher than 70A (E3) or 140A (E4-E6). The trip unit ensures fully self-supplied operation. When an auxiliary power supply is present, it is also possible to use the unit with the circuit breaker either open or closed with very low current flowing through.

It is also possible to use an auxiliary power supply provided by the PR030/B portable battery unit (always supplied), which allows the protection functions to be set when the release is not self-supplied.

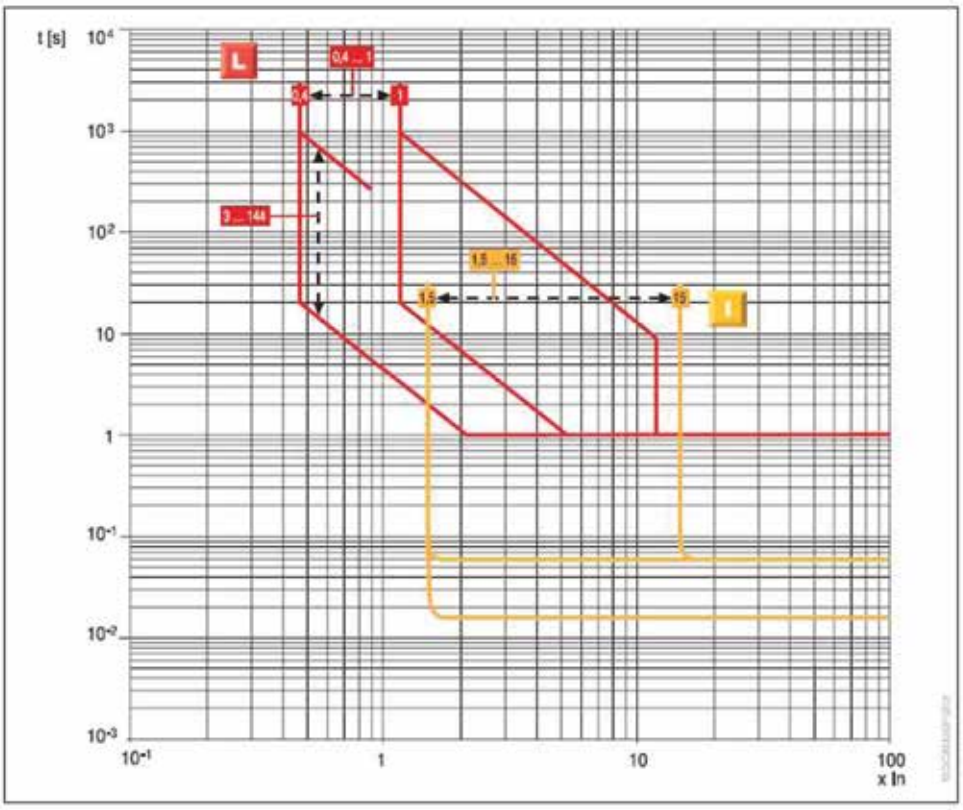
PR123/P stores and shows all the information needed after a trip (protection tripped, trip current, time, date). No auxiliary supply is required for this functionality.

	PR123P	PR120/D-M	PR120/K	PR120/D-BT
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	from PR122/PR123	from PR122/PR123	from PR122/PR123
Maximum ripple	5%	–	–	–
Inrush current @ 24 V	~10 A for 5 ms	–	–	–
Rated power @ 24 V	~3 W	+1 W	+1 W	+1 W

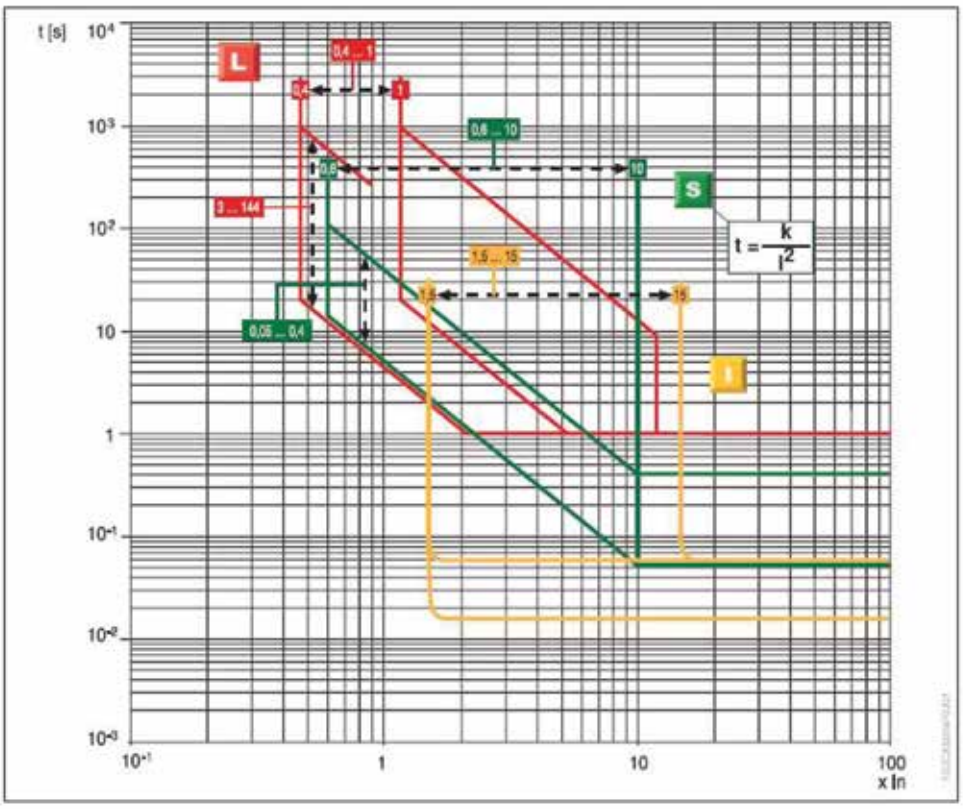
PR120/V can give power supply to the release when at least one line voltage is equal or higher to 85 V.

Emax power breakers
Trip units PR123/P

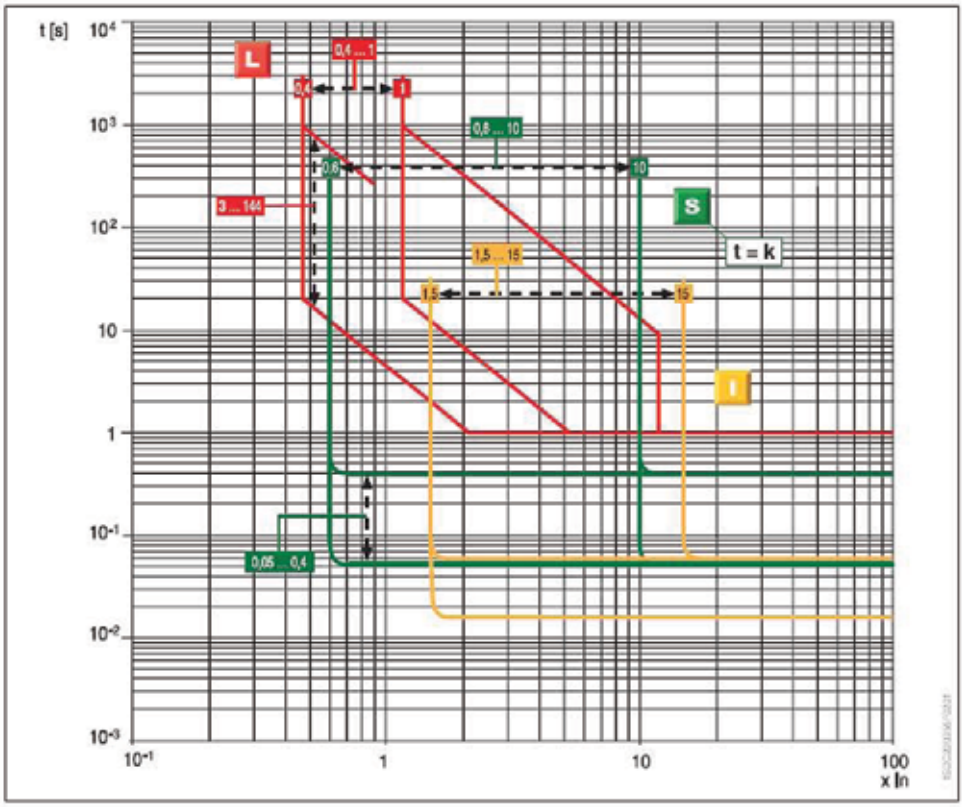
Functions L-I



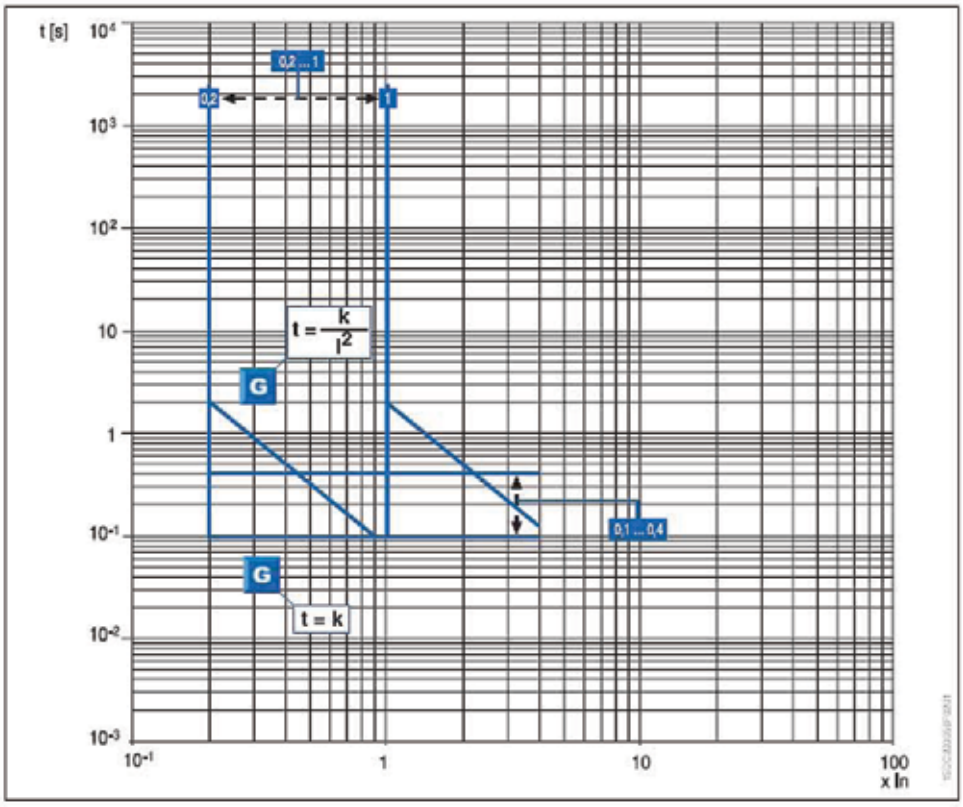
Functions L-S-I



Functions L-S-I

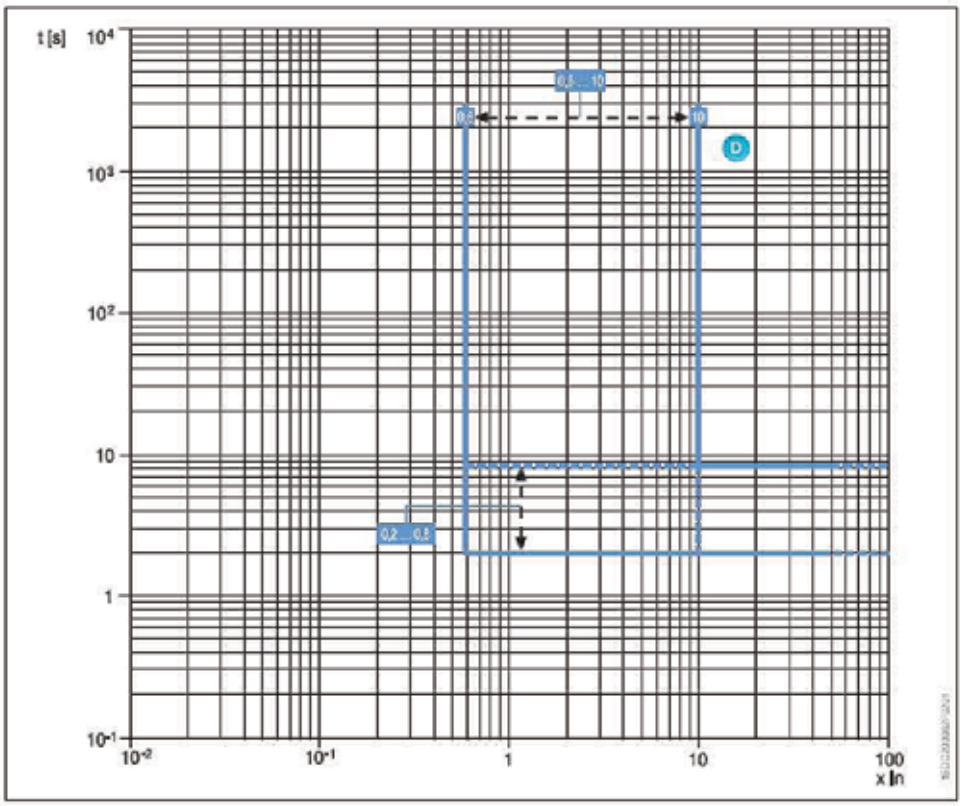


Functions G

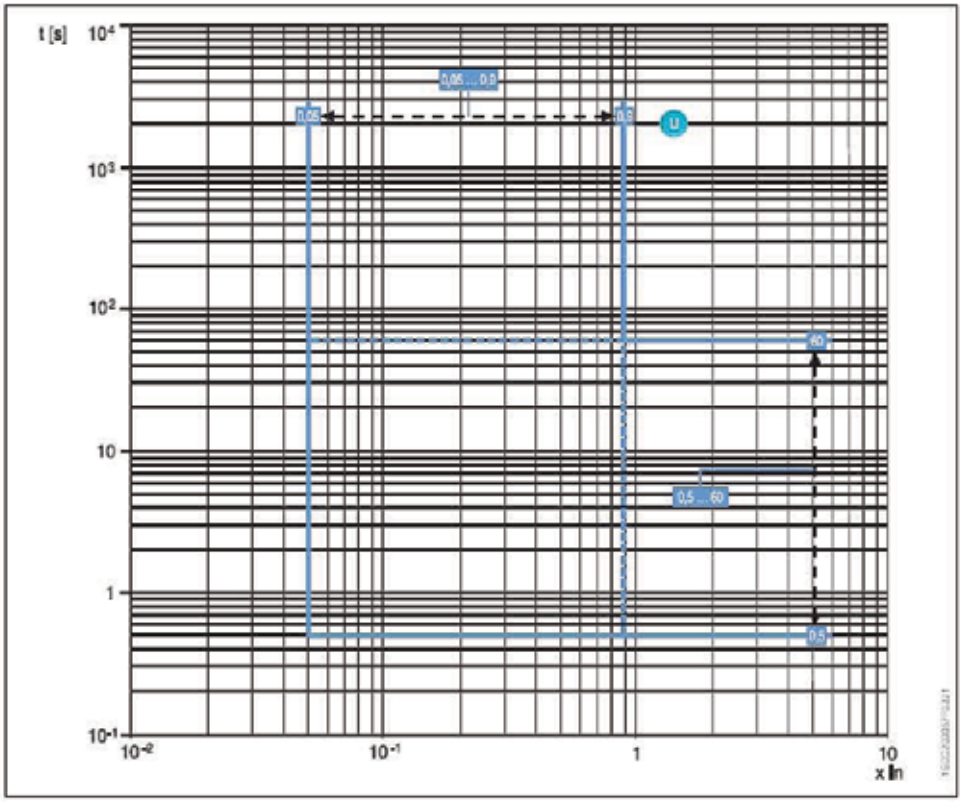


Emax power breakers
Trip units PR123/P

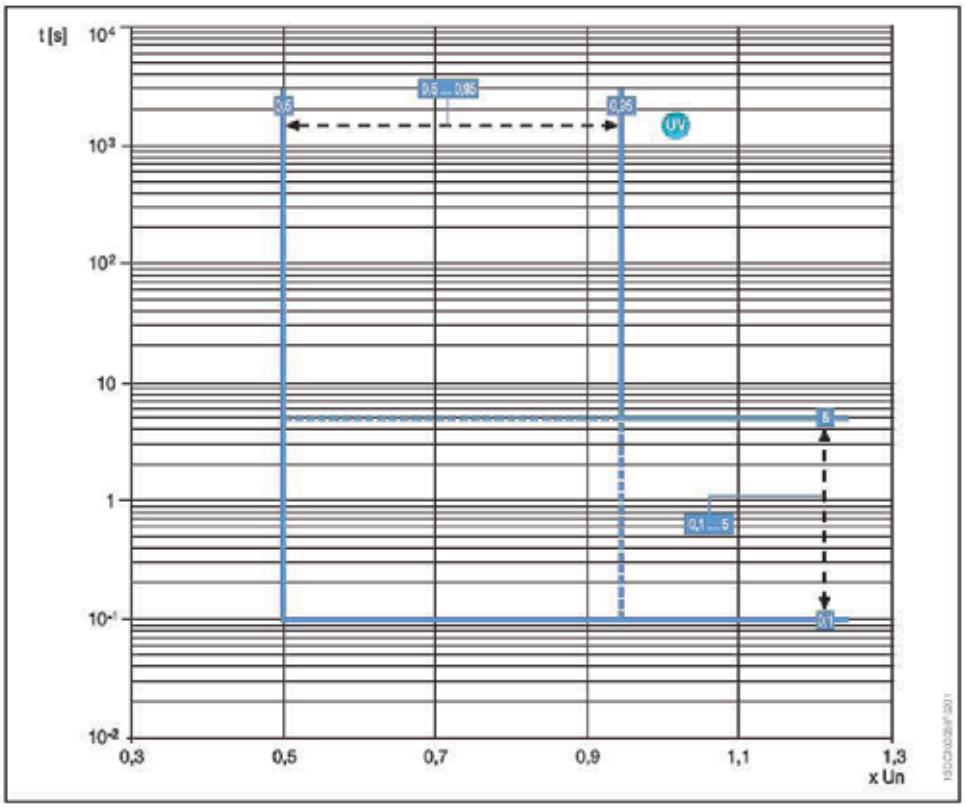
Functions D



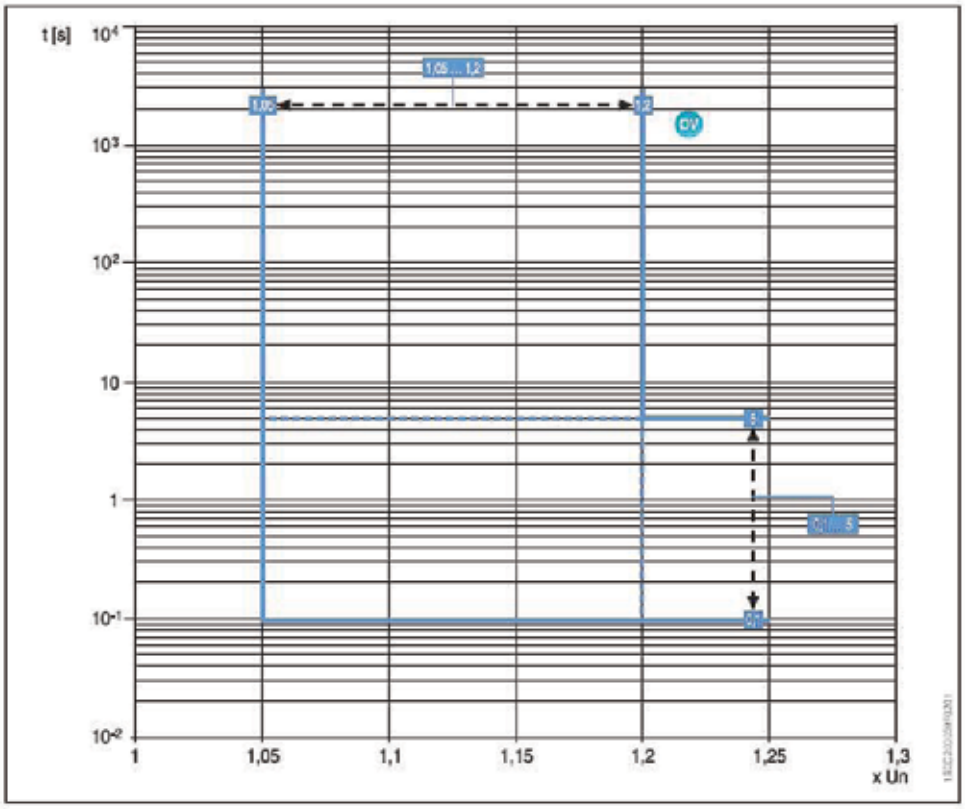
Functions U



Functions UV

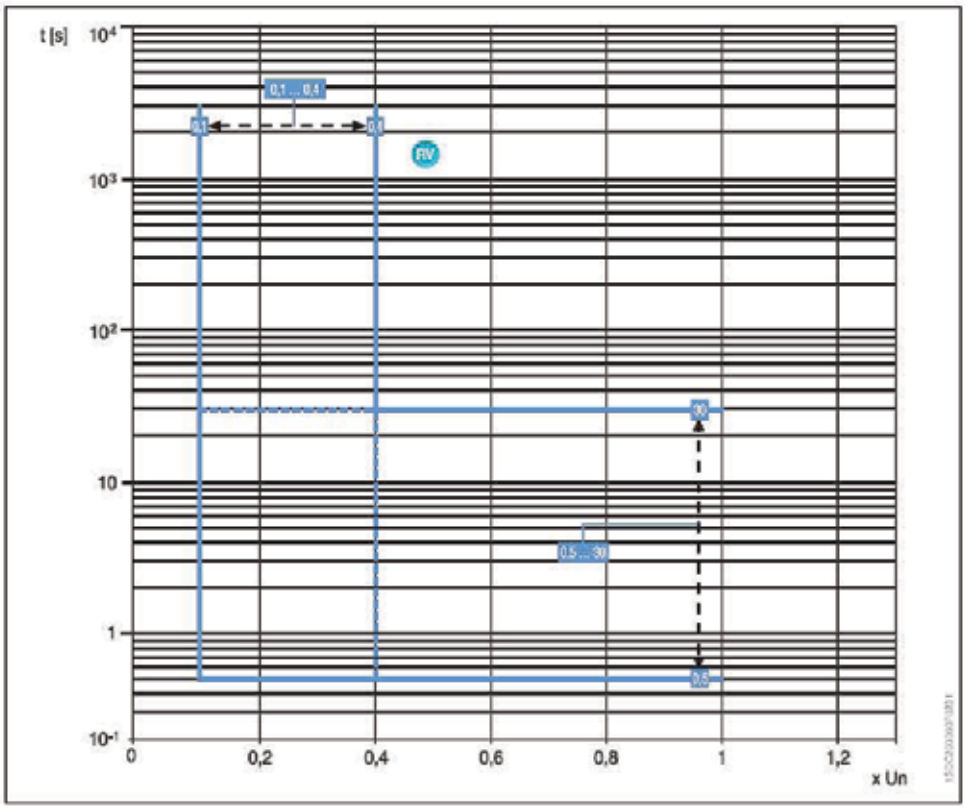


Functions OV

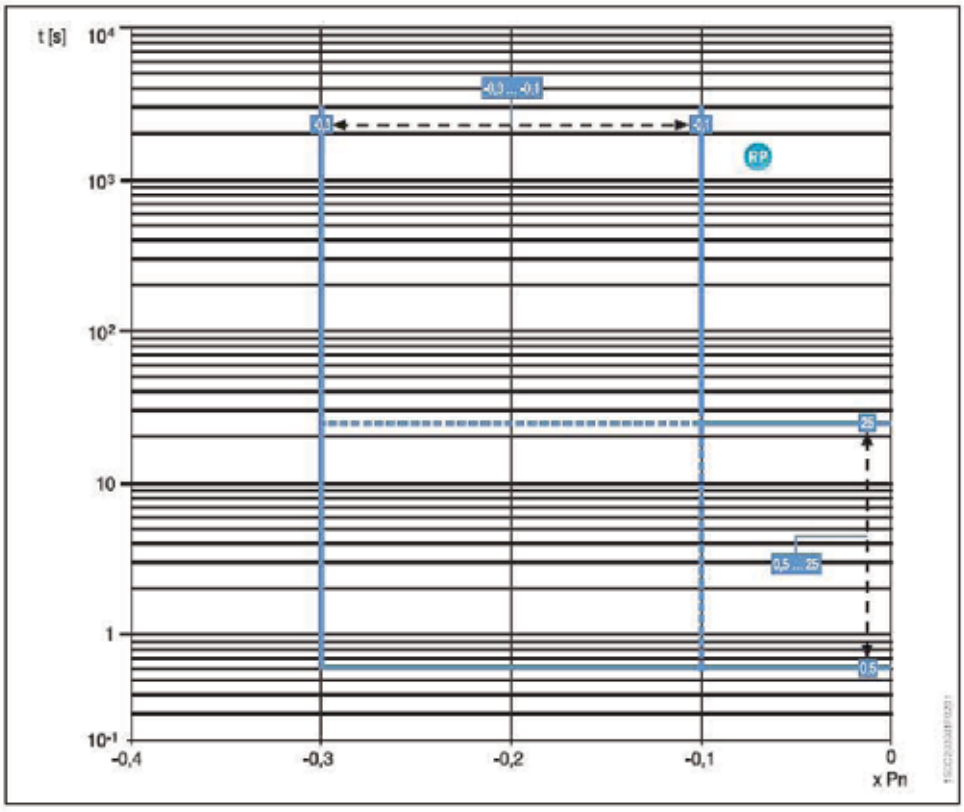


Emax power breakers
Trip units PR123/P

Functions RV



Functions RP



Emax power breakers
Accessories for trip units

Optional modules

PR122 and PR123 can be enriched with additional internal modules, increasing the capacity of the trip unit and making these units highly versatile.

Electrical signaling contacts: PR120/K Module

This unit, internally connected to PR122/P and PR123/P, allows the remote signaling of alarms and trips of the circuit breaker.

Four independent power relays provided on the PR120/K module enable electrical signaling of the following:

- Timing for protections L, S, G (and UV, OV, RV, RP, D, U, OF, UF where applicable)
- Protections L, S, I, G, OT, (and UV, OV, RV, RP, D, U, OF, UF where applicable) tripped and other events
- In addition, by using an external device (PR010/T, BT030, PR120/D-BT), the contacts can be freely configured in association with any possible event or alarm

PR120/K can also be used as actuator for the Load control function. In addition, the unit can be provided with a digital input signal, enabling the following functions:

- Activation of alternative set of parameter (PR123/P only)
- External trip command
- Trip reset of the trip unit
- Reset of PR120/K power relays

When the digital input is required the power relays have a common connection.

This latest kind of connection must be specified in the order when required together with the circuit breaker. When PR120/K is ordered as loose accessory both of the configurations are possible.

The auxiliary 24V DC power supply is needed for the unit (shown by a green power LED). Four yellow LEDs show the status of each output relay.

The use of voltage transformers is mandatory for rated voltages higher than 690V.

Specifications of the signaling relays

Type	Monostable STDP
Maximum switching power (resistive load)	100 W / 1250 VA
Maximum switching voltage	130 V DC / 250 V AC
Maximum switching current	5 A
Breaking capacity (resistive load) @ 30 V DC @ 250 V AC	 3.3 A 5 A
Contact / coil insulation	2000 V eff (1 min @ 50 Hz)

Emax power breakers
Accessories for trip units

PR120/V Measurement module

This optional internal module, installed in PR122 (standard in PR123), allows the release to measure the phase and neutral voltages and to process them in order to achieve a series of features, in terms of protection and measurement.

PR120/V does not normally require any external connection or Voltage Transformer, since it is connected internally to the lower terminals of Emax Circuit Breakers. When necessary, the connection of voltage pick-ups can be moved to any other points (i.e. upper terminals), by using the alternative connection located in the terminal box. The module is provided with a sealable switch-disconnector for the dielectric test. PR120/V is able to energize the PR123 while line voltage input is above 85V. The use of Voltage Transformers is mandatory for rated voltages higher than 690V. Voltage transformers shall have burdens equal to 10VA and accuracy class 0.5 or better.

Additional protections with PR120/V:

- Undervoltage (UV) protection
- Overvoltage (OV) protection
- Residual voltage (RV) protection
- Reverse power (RP) protection
- Underfrequency (UF) protection
- Overfrequency (OF) protection
- Phase sequence (alarm only)

All the above indicated protections can be excluded, although it is possible to leave only the alarm active when required. With the circuit breaker closed, these protections also operate when the release is self-supplied. With the circuit breaker open, they operate when the auxiliary power supply (24V DC or PR120/V) is present: in this case the release will indicate the “ALARM” status.

Voltage protections UV, OV, RV

With the PR120/V module, the PR122/P release is able to provide the undervoltage and overvoltage protection (UV, OV) and the residual voltage protection (RV). The residual voltage protection (RV) identifies interruptions of the neutral (or of the earthing conductor in systems with grounded neutral) and faults that shift the star center in systems with insulated neutral (e.g. large ground faults). The star center shift is calculated as a vectorial sum of the phase voltages.

Reverse power protection RP

Reverse power protection is especially suitable for protecting large machines such as motors and generators. The PR123 with the PR120/V module can analyze the direction of the active power and open the circuit breaker if the direction is opposite to that of normal operation. The reverse power threshold and the trip time are adjustable.

Frequency protections UF, OF

The frequency protections detect the variation of network frequency above adjustable thresholds, generating an alarm or opening the circuit breaker. It is a protection typically needed in an isolated network, i.e. powered by a generator.

PR120/D-M Communication module

PR120/D-M communication module is the solution for connecting Emax to a Modbus network, allowing the remote supervision and control of the circuit breaker.

It is suitable for PR122/P and PR123/P trip units. As for PR120/V this module can be added at any time to the protection trip unit and its presence is automatically recognized. When ordered separately from the circuit breakers it is supplied complete of all the accessories needed for its installation, such as pre-cabled auxiliary switches and cables for signaling the circuit breaker status (springs, position inserted).

It is provided with three LEDS on the front side:

- Power LED
- Rx/TX LEDs

PR030/B power supply unit

This accessory, always supplied with the PR122 and PR123 range of trip units, makes it possible to read and configure the parameters of the unit whatever the status of the circuit breaker (open-closed, in test isolated or racked-in position, with/without auxiliary power supply).

PR030/B is also needed for reading trip data if the trip occurred more than 48 hours earlier and the trip unit was no longer powered.

An internal electronic circuit supplies the unit for approximately 3 consecutive hours for the sole purpose of reading and configuring data.

In relation to the amount of use, battery life decreases if the PR030/B accessory is also used to perform the Trip test & Auto Test.

PR021/K signaling unit

The PR021/K signaling unit can convert the digital signals supplied by the PR121, PR122, and PR123 trip unit into electrical signals, via normally open electrical contacts (potential free). The unit is connected to the protection trip unit by means of a dedicated serial line through which all of the information about the activation status of the protection functions flows. The corresponding power contacts are closed based on this information.

The following signals/contacts are available:

- Overload pre-alarm L (the alarm signal remains active throughout the overload until the trip unit is tripped)
- Timing and tripping of any protections (the trip signals of the protections remain active during the timing phase, and after the trip unit has tripped)
- Protection I tripped
- Timing and overtemperature threshold exceeded (T>185 °F / 85 °C)
- Two load control contacts (connection and disconnection of a load, or disconnection of two loads)
- Trip unit tripped
- Dialogue fault on a serial line (connecting the protection and signaling units)
- Phase unbalance

Emax power breakers
Accessories for trip units

Setting a dip-switch allows up to seven signal contacts to be freely configured in PR122-PR123 including: direction protection D tripped, under and overvoltage UV, OV tripped, reverse power RP tripped, and others.

Two contacts available on the PR021/K unit (load control) can pilot a circuit breaker shunt trip and closing coil. These contacts allow various applications, including load control, alarms, signals and electrical locks.

Pressing the Reset pushbutton resets the status of all signals.

The unit also contains ten LEDs to visually signal the following information:

- "Power ON": auxiliary power supply present
- "TX (Int Bus)": flashing synchronized with dialogue with the Internal Bus
- Eight LEDs associated with the signaling contacts.

The table below lists the characteristics of the signaling contacts available in the PR021/K unit.

Auxiliary power supply	24 V DC ± 20%
Maximum ripple	5%
Rated power @ 24 V	4.4 W

Specifications of the signaling relays

Type	Monostable STDP
Maximum switching power (resistive load)	100 W / 1250 V AC
Maximum switching voltage	130 V DC / 250 V AC
Maximum switching current	5 A
Breaking capacity (resistive load) @ 30 V DC @ 250 V AC	 3.3 A 5 A
Contact / coil insulation	2000 V eff (1 min @ 50 Hz)

Details about functions available on PR122/P, PR123/P trip units with PR120/D-M

	PR122/P + PR120/D-M	PR123/P + PR120/D-M
Communication functions		
Protocol	Modbus RTU	Modbus RTU
Physical layer	RS-485	RS-485
Maximum baudrate	19,200 bps	19,200 bps
Measuring functions		
Phase currents	♦	♦
Neutral current	♦	♦
Ground current	♦	♦
Voltage (phase-phase, phase-neutral, residual)	opt. (1)	♦
Power (active, reactive, apparent)	opt. (1)	♦
Power factor	opt. (1)	♦
Frequency and peak factor	opt. (1)	♦
Energy (active, reactive, apparent)	opt. (1)	♦
Harmonic analysis up to the 40th harmonic	–	♦
Signaling functions		
LED: Auxiliary power supply, warning, alarm	♦	♦
Temperature	♦	♦
Indication for L, S, I, G and other protection	opt. (1)	♦
Available data		
Circuit breaker status (open, closed)	♦	♦
Circuit breaker position (racked-in, racked-out)	♦	♦
Mode (local remote)	♦	♦
Protection parameters set	♦	♦
Load control parameters	♦	♦
Alarms		
Protection L	♦	♦
Protection S	♦	♦
Protection I	♦	♦
Protection G	♦	♦
Trip unit command for fault failure	♦	♦
Undervoltage, overvoltage and residual voltage (timing and trip) protection	♦	♦
Reverse power protection (timing and trip)	opt. (1)	♦
Directional protection (timing and trip)	opt. (1)	♦
Underfrequency / overfrequency protection (timing and trip)	♦	♦
Phase rotation	opt. (1)	♦
Maintenance		
Total number of operations	♦	♦
Total number of trips	♦	♦
Number of trip tests	♦	♦
Number of manual operations	♦	♦
Number of separate trips for each protection function	♦	♦
Contact wear (%)	♦	♦
Record data of last trip	♦	♦
Operating mechanisms		
Circuit breaker open/close	♦	♦
Reset alarms	♦	♦
Setting of curves and protection thresholds	♦	♦
Synchronize system time	♦	♦
Events		
Status changes in circuit breaker, protections and all alarms	♦	♦

(1) with PR120V

Emax power breakers
Breaker electrical accessories

Auxiliary contacts

Auxiliary contacts are available installed on the circuit breaker, which enable signaling of the circuit breaker status.

Characteristics

Un	**In max**	**T**
125 V DC	0.3 A	10 ms
250 V DC	0.15 A	–
Un	**In max**	**cosφ**
250 V AC	15 A	0.3

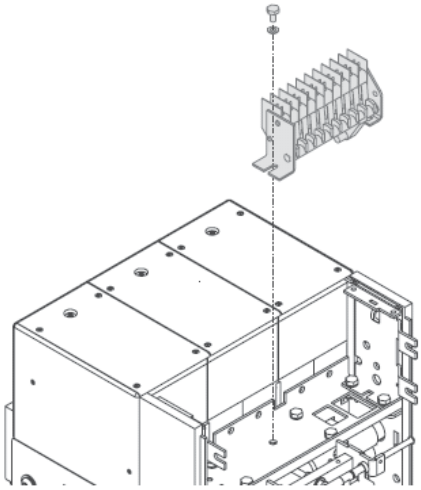
The versions available are as follows:

It is possible to have electrical signaling of the status (open/closed) of the circuit breaker using 4, 10, or 15 auxiliary contacts. The auxiliary contacts have the following configurations:

- 4 open/closed contacts for PR121 (2 normally open + 2 normally closed)
- 4 open/closed contacts for PR122/PR123 (2 normally open + 2 normally closed + 2 dedicated to trip unit)
- 10 open/closed contacts for PR121 (5 normally open + 5 normally closed)
- 10 open/closed contacts for PR122/PR123 (5 normally open + 5 normally closed + 2 dedicated to trip unit)
- 15 supplementary open/closed contacts for installation outside the circuit breaker

The standard configuration NO/NC described above can be modified by the user by repositioning the female disconnect connector on the microswitch.

When 10 open/closed contacts for PR122/PR123 are required, the zone discrimination feature and the PR120/K signaling unit are not available.

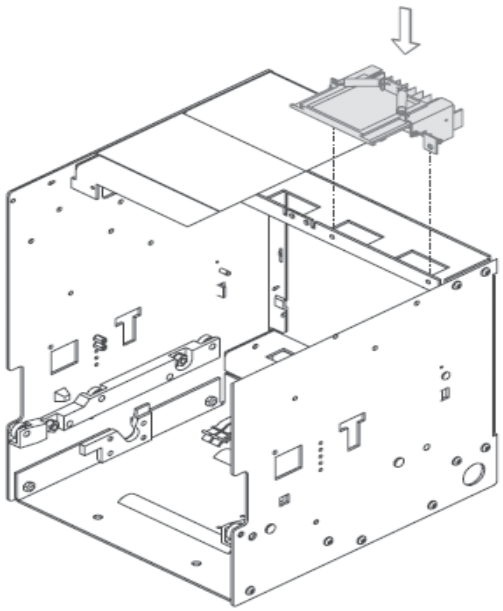


Electrical signaling of circuit breaker racked-in/test isolated/racked-out

In addition to visual mechanical signaling of the circuit breaker position, it is possible to have a remote electrical signal using auxiliary contacts which are installed into the cradle.

The auxiliary contacts take on the following configurations:

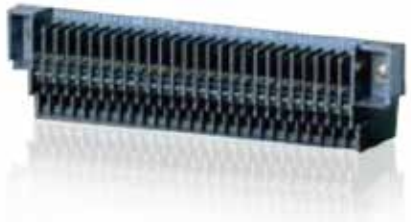
- 5 contacts: 2 contacts for racked-in signal, 2 contacts for racked-out signal, and 1 contact to signal the test position (main power isolated, but sliding contacts connected)
- 10 contacts: 4 contacts for rack-in signal, 4 contacts for racked-out signal, and 2 contacts to signal the test position (main power isolated, but sliding contacts connected)



Emax power breakers
Breaker electrical accessories

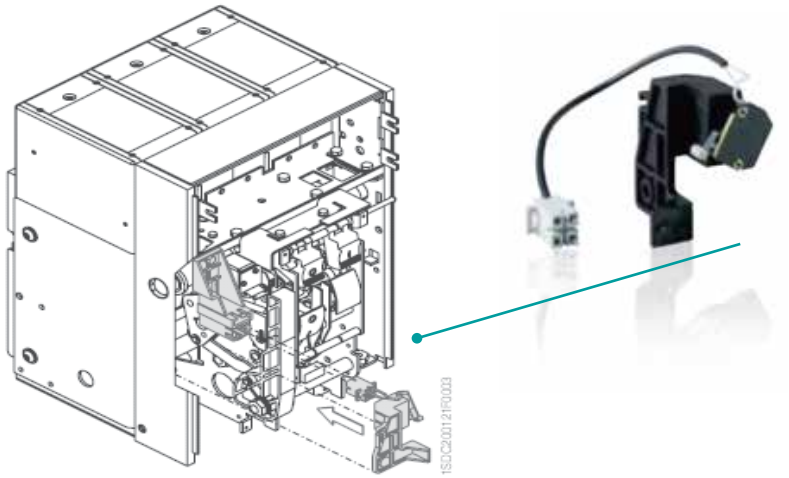
Sliding contacts

Inputs and outputs to the circuit breaker are wired through secondary disconnects located on the top of the circuit breaker. The plug-style secondary disconnects engage mating disconnects in the circuit breaker cubicle when the breaker is in the TEST or CONNECTED positions. Up to 54 points are available so that all circuit breaker accessories can be wired to dedicated disconnect points.



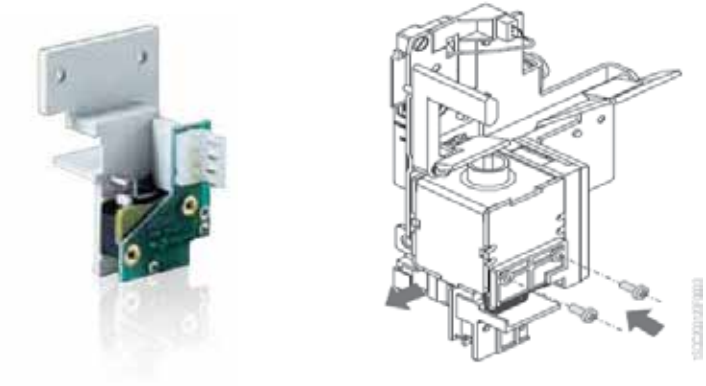
Contact signaling closing springs charged

A microswitch allows for remote electrical signaling of the status of the closing springs, this is always supplied as an integral part of the spring charging geared motor assembly but can also be supplied as an accessory separate from the spring charging motor assembly.



Contact signaling undervoltage release de-energized (C. Aux YU)

The undervoltage release can be fitted with either a normally open or normally closed contact for remote electrical signaling of the status of the undervoltage release.

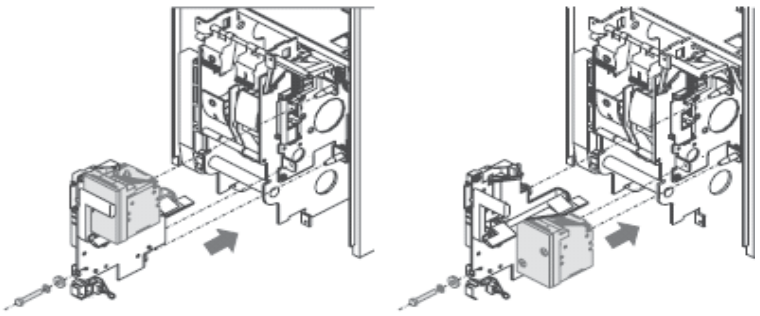


Shunt trip/closing coil (YO/YC) and second shunt trip (YO2)

This is used for remote control of the circuit breaker. The accessory utilizes the same coil and the function depends on the installation position on the accessory support. It can be used for either of these applications.

Given the characteristics of the circuit breaker operating mechanism, opening (with the circuit breaker closed) is always possible, while closing is only possible when the closing springs are charged. The release can operate with either direct current or alternating current. This release can be operated by a pulse of at least 100mS, or with a permanent signal. If the closing coil is powered with a continuous signal, the presence of the anti-pumping device requires it (after an opening operation) to momentarily de-energize the closing coil.

Emax circuit breakers can be equipped with a second shunt trip, mounted on a special accessory support as an alternative to the undervoltage release.



Characteristics

Power supply (Un)	24 V DC	125 - 127 V AC/DC
	30 V AC/DC	220 - 240 V AC/DC
	48 V AC/DC	240 - 250 V AC/DC
	60 V AC/DC	380 - 400 V AC
	110-120 V AC/DC	440 - 480 V AC
Operating limits	(YO-YO2): 70%....110% Un	
	(YC): 85%.... 110% Un	
Inrush power (Ps)	DC = 200 W	
Inrush time ~100 ms	AC = 200 VA	
Continuous power (Pc)	DC = 5 W	
	AC = 5 VA	
Opening time (YO - YO2)	(max) 60 ms	
Closing time (YC)	(max) 80 ms	
Insulation voltage	2500 V 50 Hz (for 1 min)	

Emax power breakers
Breaker electrical accessories

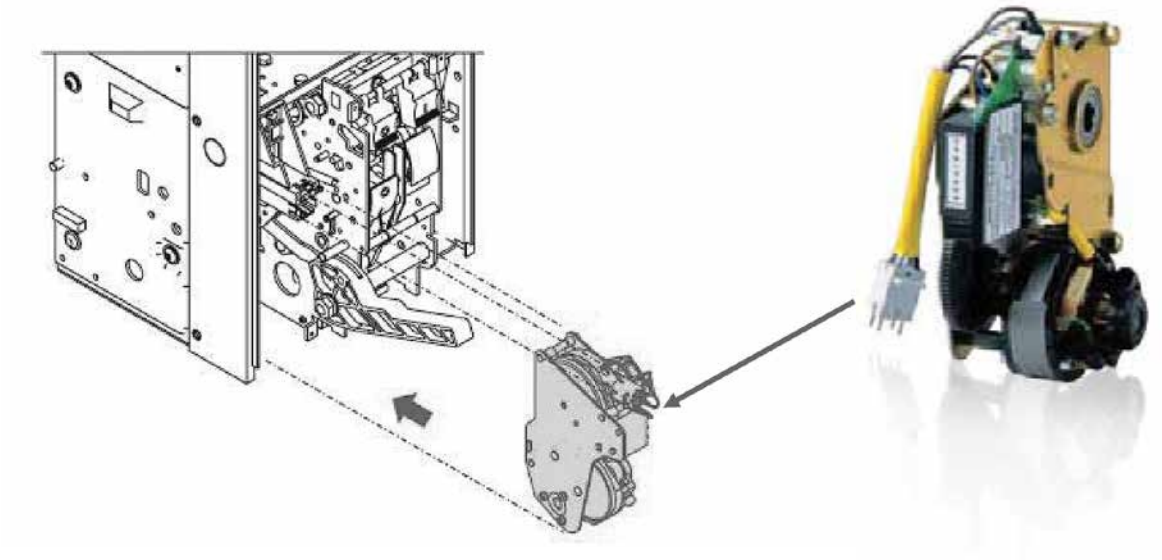
Gear motor for the automatic charging of closing springs (M)

The gear motor accessory automatically charges the closing springs of the circuit breaker operating mechanism. The gear motor immediately recharges the closing springs after closing the circuit breaker.

The closing springs can be charged manually (using the manual charging lever) in the event of a power supply failure or during maintenance.

It is always supplied with a limit switch for signaling that the closing springs are charged.

Characteristics	
Power supply	24 - 30 V AC/DC
	48 - 60 V AC/DC
	100 - 130 V AC/DC
	220 - 250 V AC/DC
Operating limits	85%.... 110% Un
Inrush power (Ps)	DC = 500 W
	AC = 500 VA
Rated power (Pn)	DC = 200 W
	AC = 200 VA
Inrush time	0.2 s
Charging time	4 - 5 s
Insulation voltage	2500 V, 50 Hz (for 1 min)

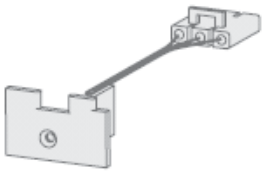


Bell alarm

The following signals are available after the trip unit opens the circuit breaker due to an overload or fault condition.

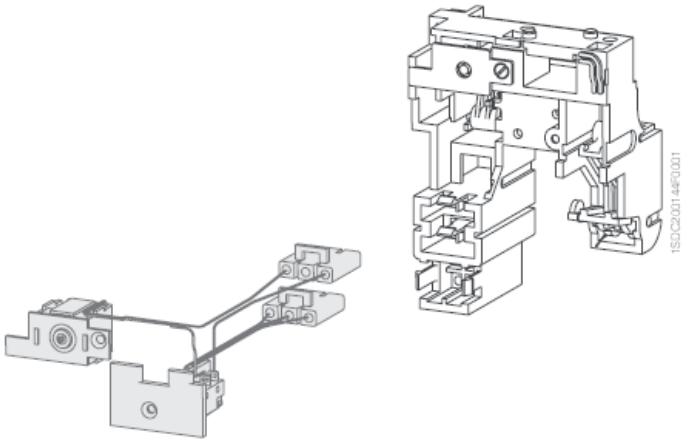
The blue “TU Reset” pushbutton (supplied as standard on circuit breakers) provides a local visual indication of tripped condition and also serves to lockout the circuit breaker to prevent reclosing. The mechanical signaling “TU Reset” pushbutton must be rearmed before you can reclose the circuit breaker.

The bell alarm contact provides remote signaling (electrical by means of a form C contact) that the circuit breaker is open following operation of the trip unit.



Bell alarm with remote reset command

In addition to the features provided by the bell alarm shown above, with this accessory it is possible to rearm the “TU Reset” mechanical signaling pushbutton via an electrical coil by a remote command, this allows the circuit breaker to be reset without physical intervention.



Emax power breakers
Breaker electrical accessories

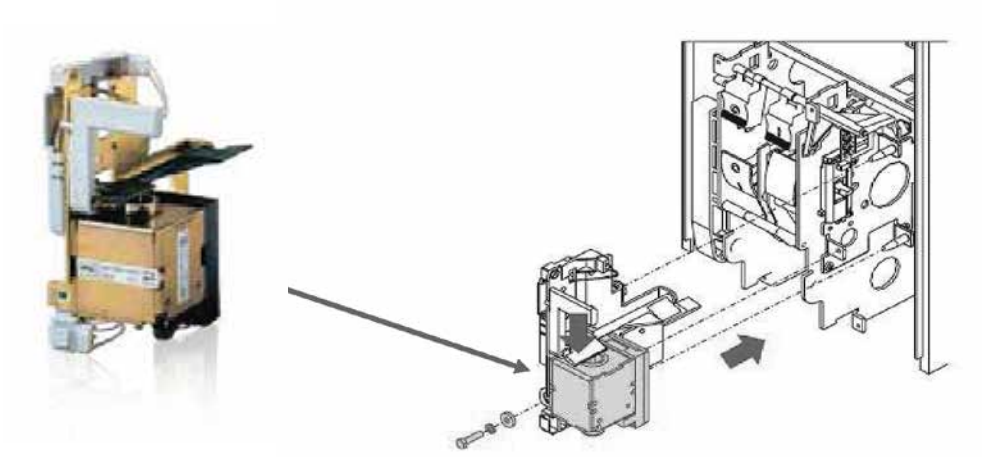
Undervoltage release (YU)

The under voltage release opens the circuit breaker when there is a significant voltage drop in the power supply.

Characteristics		
Power supply (Un)	24 V DC	125 - 127 V AC/DC
	30 V AC/DC	220 - 240 V AC/DC
	48 V AC/DC	240 - 250 V AC
	60 V AC/DC	380 - 400 V AC
	110 - 120 V AC/DC	440 - 480 V AC
Inrush power (Ps)	DC = 200 W	
	AC = 200 VA	
Continuous power (Pc)	DC = 5 W	
	AC = 5 VA	
Opening time (YU)	30 ms	
Insulation voltage	2500 V, 50 Hz (for 1 min)	

The power supply can be obtained from the supply side of the circuit breaker or from an independent source. The circuit breaker can be closed only when the release is energized. The release can operate with either direct current or alternating current. When the voltage drops below 35-70% of the rated voltage, the UVR trips the circuit breaker. The circuit breaker can be closed when the applied voltage is higher than 85%. It can be fitted with a contact to signal when the under voltage release is energized.

Note: With the undervoltage release, the use of the anti-racking-out device is not allowed.



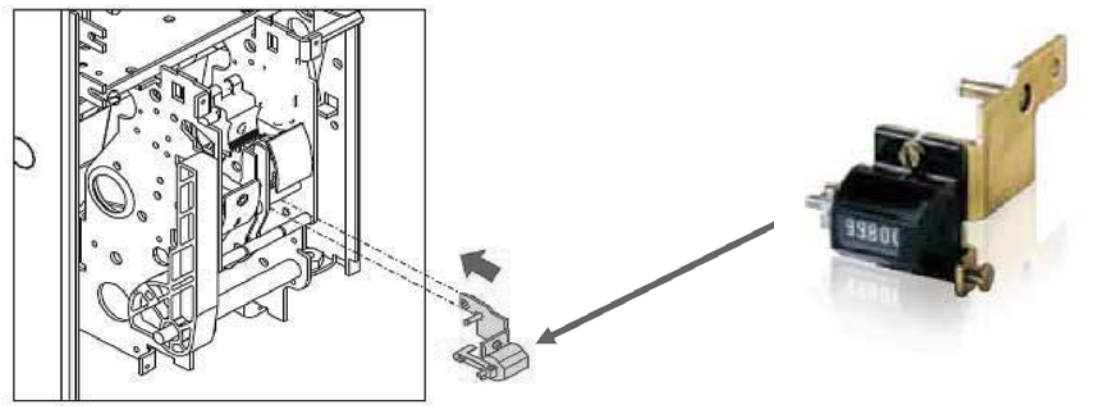
External current sensors for neutral conductor outside circuit breaker

For three-pole circuit breakers only. This allows protection of the neutral by connection to the trip unit. External neutral sensors are required for 3P4W systems utilizing the vector sum addition method of ground fault protection within the trip unit, LSIG trip units.

Emax power breakers
Breaker mechanical accessories

Mechanical operation counter

The mechanical operation counter is connected to the operating mechanism and indicates the number of mechanical operations carried out by the circuit breaker. The count is shown on the front of the circuit breaker.



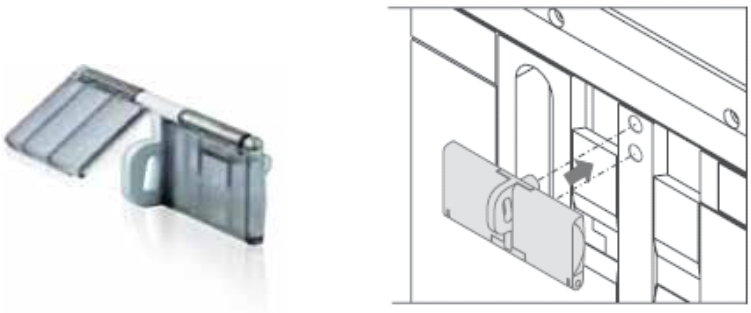
Locking provisions

Several different mechanisms are available which allow the circuit breaker to be locked in the open position or prevent tampering with pushbuttons.

These devices can be controlled by:

- Key: a special circular lock with different keys (for a single circuit breaker) or the same keys (for several circuit breakers).

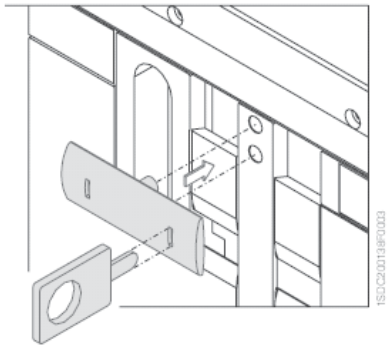
- The Emax circuit breaker can be provided with padlock provisions in order so that it can be padlocked in the open position with up to three padlocks to prevent unauthorized closing.



Emax power breakers
Breaker mechanical accessories

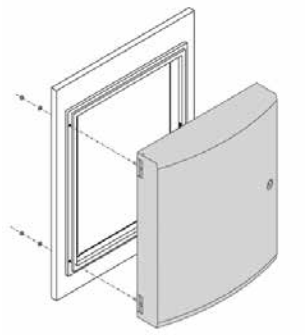
Locking provisions, cont.

- Transparent protective covers for opening and closing pushbuttons, preventing the relative circuit breaker operations unless a special tool is used.



Transparent protective covers

This is a transparent plastic protective cover which completely protects the front panel of the circuit breaker. Mounted on hinges, it is fitted with a key lock.



Emax power breakers
Features and options

Closed-door, draw-out capability (standard)

Emax Link offers the ability to rack the circuit breaker from the “CONNECTED” position through the “TEST” position and to the “DISCONNECTED” position while the circuit breaker compartment door remains closed providing maximum convenience and personnel safety.

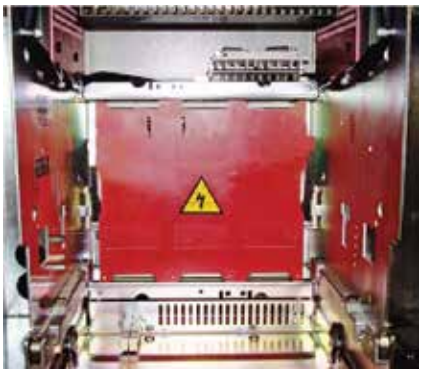
Complete closed door breaker operation

Circuit breaker rejection feature (standard)

This anti-insertion lock prevents circuit breakers with lower short circuit or higher continuous current ratings from being inserted into the circuit breaker compartment.

Safety shutters (standard)

Safety shutters to prevent accidental contact with live bus are standard in all circuit breaker compartments. In addition, a padlock feature is available to lock the shutters in the closed position for an added degree of safety.



Anti-racking-out device when the springs are charged (FAIL SAFE)

This feature prevents the moving part of the draw-out version circuit breaker from being racked out of the cradle when the springs are charged.

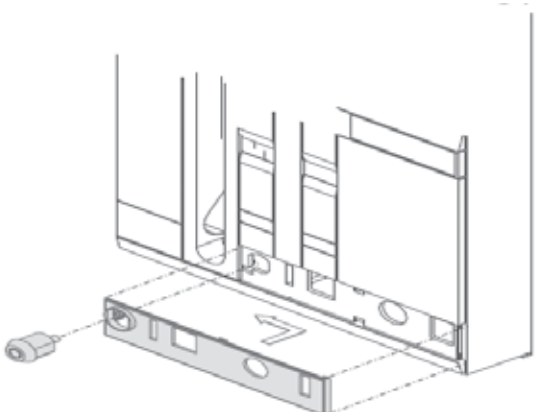
Emax power breakers
Features and options

Keylockable door

Emax Link offer an array of standard, safety locking features that provide extra measures of security when breaker, equipment, or load maintenance is performed. Keylocks are supplied as standard on all compartment doors to prevent access by unauthorized personnel.

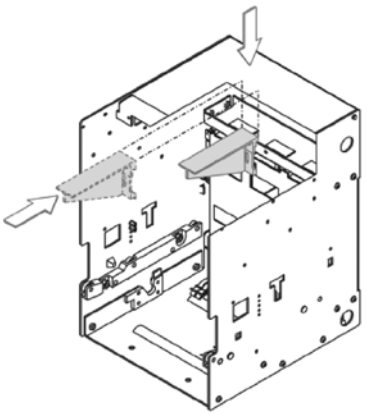
Circuit breaker lock in racked-in/test isolated/racked-out position

A key lock is available (with same or different keys) or a padlock device (up to 3 padlocks with a maximum 4mm diameter). It is only available for draw out circuit breakers to be installed on the moving part.



Accessories for lock-in test isolated/racked-out positions only

In addition to the circuit breaker lock-in, racked-in/test isolated/racked-out position, this allows the circuit breaker to be locked only in the racked-out or test-isolated positions. It is only available for draw out circuit breakers, to be installed on the moving part.



Padlock device for safety shutter (optional)

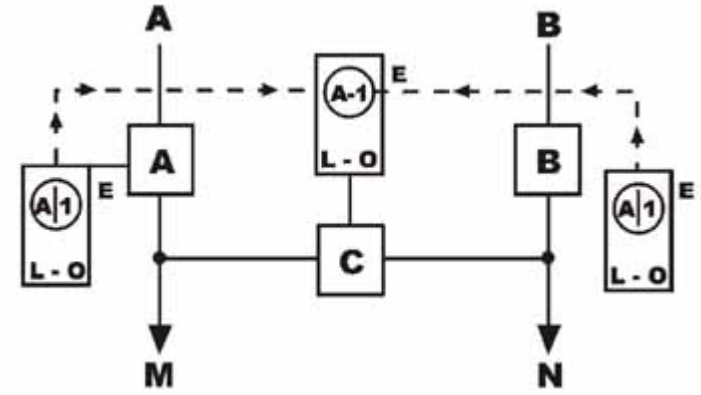
This feature allows the shutters into the cradle to be padlocked in the closed position

Mechanical lock for compartment door (optional)

This feature locks the compartment door from being opened when the circuit breaker is closed and circuit breaker racked-in; it also prevents the circuit breaker from closing when the compartment door is open.

Kirk key interlocks (optional)

This option allows locking of the circuit breaker in the open, trip-free position when fully connected. Applicable schemes would be mechanical interlocking of two breakers so only one can be closed at a time, or in load center unit substations, interlocking of the primary switch and secondary main breaker such that the secondary main must be open before the primary switch can be operated. Single cylinder key locks are available. Kirk key locking does not prevent operation when the breaker is in the test or disconnect position. Utilizes Kirk Key lock type F with a 1" bolt projection in the withdrawn position. Kirk Key locks are not provided by ABB.



Emax power breakers
Features and options

Mechanical interlock [interlock between circuit breakers] (optional)

This mechanism creates a mechanical interlock between two or three circuit breakers, even different frame sizes and in any version (fixed/ draw out) using flexible cables. The circuit breakers can be installed either vertically or horizontally.

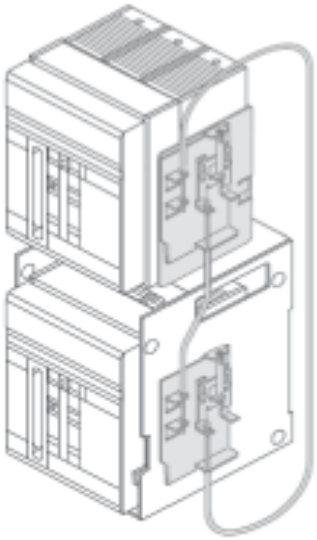
Four types of mechanical interlocks are available:

Type A
Between 2 circuit breakers (power supply + emergency power supply)

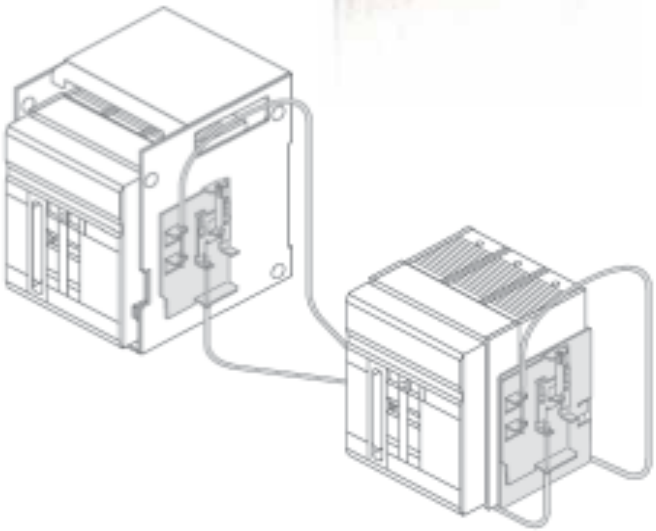
Type B
Between 3 circuit breakers (2 power supplies + emergency power supply)

Type C
Between 3 circuit breakers (2 power supplies + bus-tie)

Type D
Between 3 circuit breakers (3 power supplies / one single closed circuit breaker)

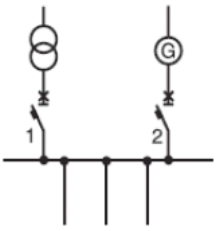
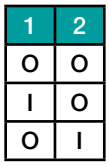
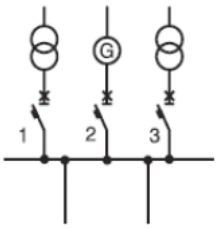
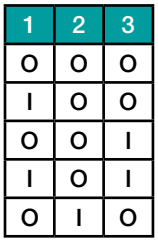
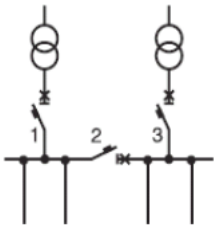
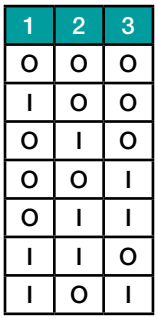
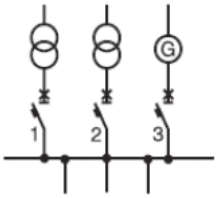
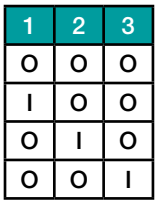


Vertical interlock



Horizontal interlock

The possible mechanical interlocks are shown below, depending on whether 2 or 3 circuit breakers (any model in any version) are used in the switching system.

Type of interlock	Typical circuit	Possible interlocks
Type A		
Between two circuit breakers One normal power supply and one emergency power supply	 O = Circuit breaker open I = Circuit breaker closed	 Circuit breaker 1 can only be closed if 2 is open, and vice versa
Type B		
Between three circuit breakers Two normal power supplies and one emergency power supply.	 O = Circuit breaker open I = Circuit breaker closed	 Circuit breakers 1 and 3 can only be closed if 2 is open. Circuit breaker 2 can only be closed if 1 and 3 are open.
Type C		
Between three circuit breakers The two half-busbars can be supplied by a single transformer (bus-tie closed) or by both at the same time (bus-tie open).	 O = Circuit breaker open I = Circuit breaker closed	 One or two circuit breakers out of three can be closed at the same time
Type D		
Between three circuit breakers Three power supplies (generators or transformers) on the same busbar, so parallel operation is not allowed.	 O = Circuit breaker open I = Circuit breaker closed	 Only one of three circuit breakers can be closed.

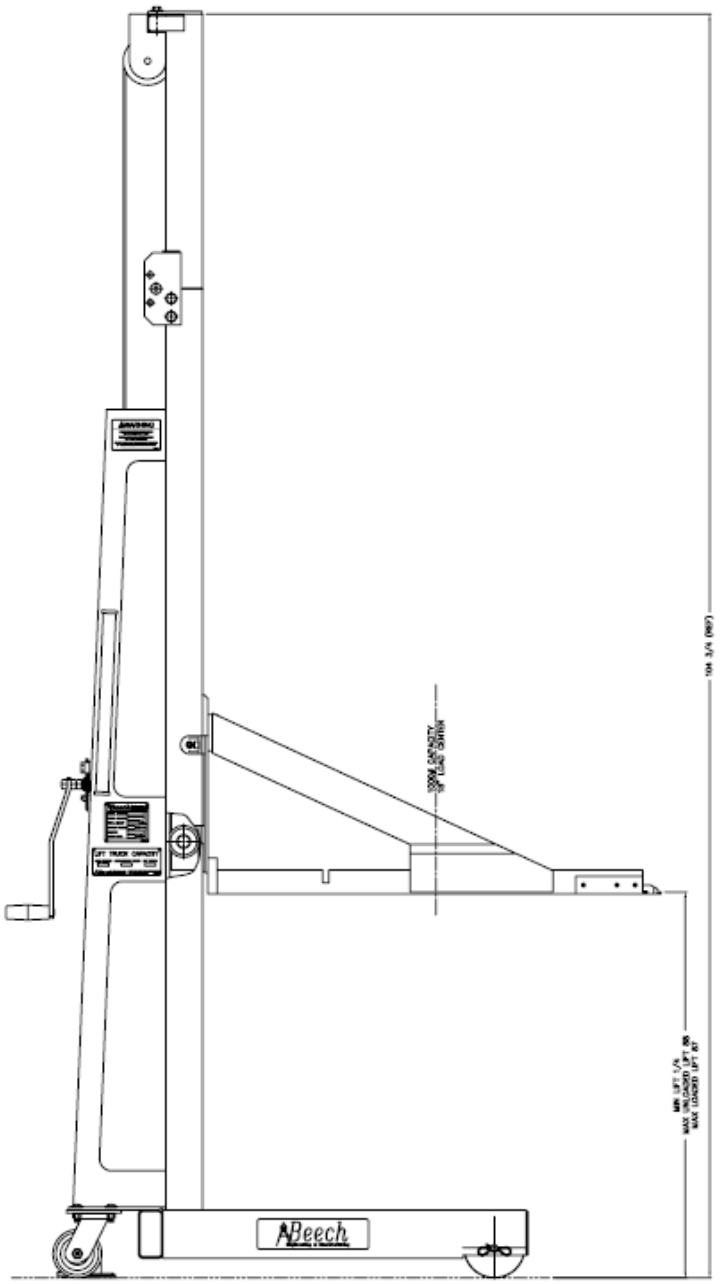
Emax Link
Features and options

Overhead lift device

As an accessory to the Emax Link abbreviated switchgear, a rail mounted hoist can be installed on top of the switchgear structure for lifting circuit breakers into and out of the breaker compartments. The overhead lift device shall be shipped uninstalled from the gear. The overhead lift device is available for use on indoor and outdoor walk-in enclosures.

Lift truck

Another available accessory is a circuit breaker lift truck which can be used to lift and/or lower the Emax circuit breakers in front of the switchgear to aid in the removal or installation of the circuit breakers. The device has a lifting capacity of 1000 lbs. and may be used in place of an overhead lift device.



Emax Link
Features and options

Remote racking device

ABB SACE offers a dedicated device – RRD - to remotely perform Emax circuit-breaker racking in and racking out operations in order to increase the safety of the personnel. ABB is constantly committed to the safety of the personnel during every phase of use of its products, including installation and maintenance. During the racking-in operations of the circuit-breaker, the RRD prevents from any risk of injuries due to any possible electric arc.

Arc flash

The electric arc can occur because of several reasons, such as human mistakes and bad connections. Accidents are quite unusual but when they happen their consequences may be really severe. The main risk of arc flash occurs when the cabinet door is open and the arc-proof characteristics of the switchgear are significantly decreased.

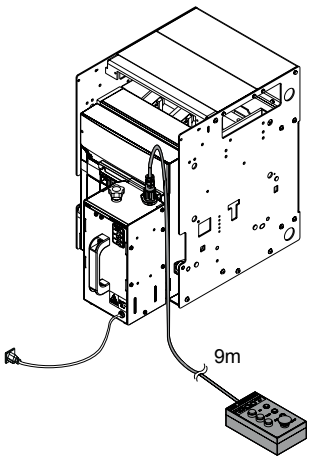
ABB Solution

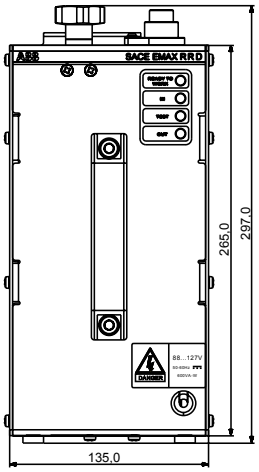
In order to maximize safety during the racking in of the CB moving part, ABB has developed the new Remote Racking Device - RRD - to operate Emax circuit-breakers without being in front of it. The device works with the circuit-breaker open and with the springs discharged.

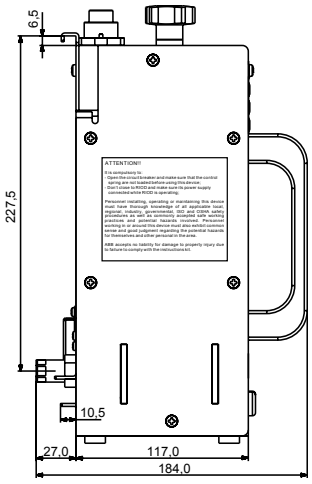
The RRD is supplied by the main grid. The remote control is connected to the main device with a thirty-foot cable which allows the racking in or out command from remote location. The cable length guarantees a far distance from the arc flash boundary for traditional LV switchgear.

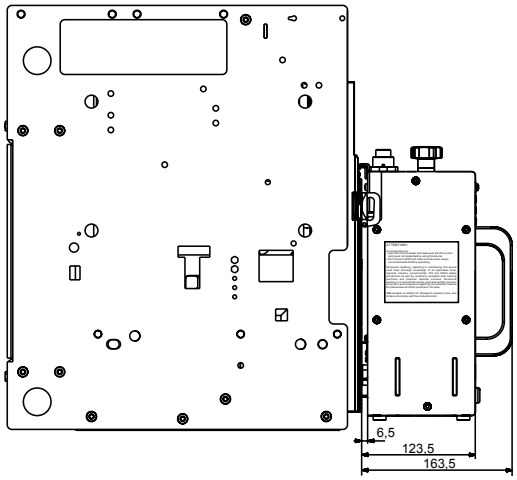
Advantages

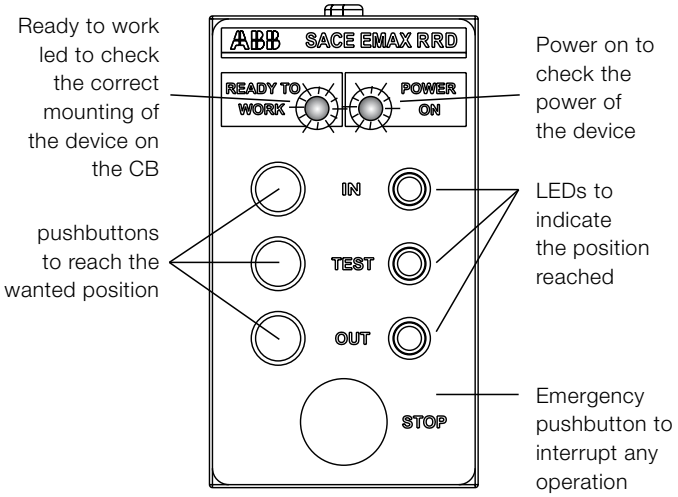
- Personnel safety increasing thanks to the long distance between the circuit breaker and the operator
- One single device for all the Emax circuit-breakers (Emax and New Emax – from the smallest E1 3 poles up to the biggest E6 full size)
- Easy installation thanks to the ergonomic handle to mount and to remove the device from the circuit-breaker
- All the positions can be reached: Connected/ Disconnected/ Test position
- Immediate visual check of the position reached thanks to the 3 LEDs available both on the device and on the remote control
- Possibility to interrupt the operation in any moment thanks to the emergency pushbutton on the remote control











Electrical and technical data

Rated service voltage	110 V AC (-20%/+15%) 110 V DC (-20%/+15%)
Frequency	50-60 Hz
Rated power	120 W, 120 VA
Inrush power consumption	600 W, 600 VA
Inrush time	0.5 s
Working and storage temperature range	-10 °C ... +40 °C
Duty cycle	20 operations / hour
Minimum time out between operations	1 minute
Maximum operating distance	9 m / 30 ft
Weight	9 kg / 20 lb

The device is always equipped with a dedicated adapter kit to allow the complete mounting of the RRD device on up to 5 Emax circuit-breakers. The kit can be ordered even as a loose accessory to allow the installation on other 5 additional Emax. To power the circuit-breaker it is necessary to uninstall the RRD device.

Ordering information

Product	Catalog number
RRD	KERRD
RRD adapter kit	KERRDKIT

A bit of theory: What is an electric arc?

The electric arc is a phenomenon that takes place as a consequence of a discharge. This occurs when the voltage between two points exceeds the insulating strength limit of the interposed gas. Gases, which are good insulating means under normal conditions, may become current conductors in consequence of a change in their chemical-physical properties due to a temperature rise or to other external factors. In case of abnormal conditions (e.g., doors open or closed, rack in or rack out) mentioned in NFPA 70E-2009, 130.7 (C) (9) FPN 2 (see doc 1SXU210018L0201), even in case of closed door, the arc flash effect cannot be easily analyzed. In order to improve personnel safety it is suggested to increase the distance between the door and personnel.

Emax Link
Features and options

Ekip Connect test unit

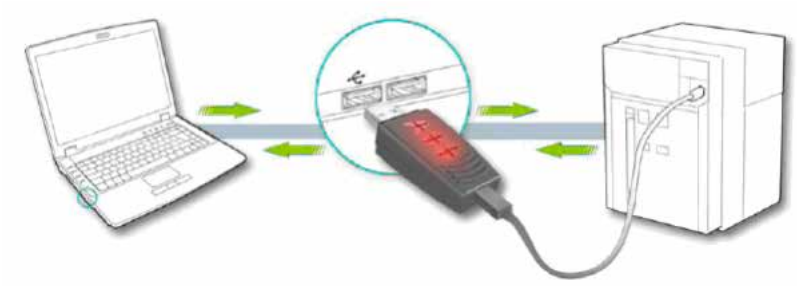
Ekip Connect is a software application for personal computers using Microsoft Windows® operating systems which allows data to be exchanged with one or more ABB low voltage appliances. In particular, Ekip Connect supports the connection of ABB automatic low voltage circuit breakers fitted with an electronic trip unit in order to:

- Set up
- Monitor status
- Read information (alarms, measurements, parameters)
- Modify configuration parameters, above all for trip units which do not feature a display
- Carry out commands
- Find faults in the communication network
- Carry out tests

Ekip Connect proves useful in a variety of phases during the life cycle of the trip unit:

- Set up
- Configuration
- Monitoring
- Maintenance and testing

Thanks to the possibility of carrying out a scan of the communications network and the possibility of saving parameters and test reports, the software also assists the process of operative testing of a switchboard.



Infrared windows

Infrared windows can be installed by the OEM in the switchgear rear covers or rear door to facilitate the use of IR cameras for thermally scanning cable terminations. The use of infrared windows minimize the exposure to live conductors while performing this type of preventative maintenance operation.

High resistance ground system

Where continuity of service is a high priority a high resistance grounding system can add the safety of a grounded system while minimizing the risk of service interruptions due to grounds. The concept is a simple one: provide a path for ground current via a resistance that limits the current magnitude, and monitor to determine when an abnormal condition exists. High resistance grounding equipment coordinates the use of resistors and control devices, creating a high-resistance ground for a power system.

Emax Link
Features and options

Maintenance switch

Brief description

The maintenance switch is used to manually change the circuit breaker's instantaneous protection settings to a preprogrammed set of values by means of a door mounted switch.

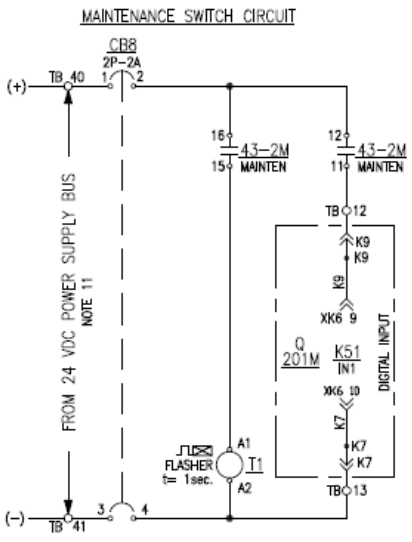
Application

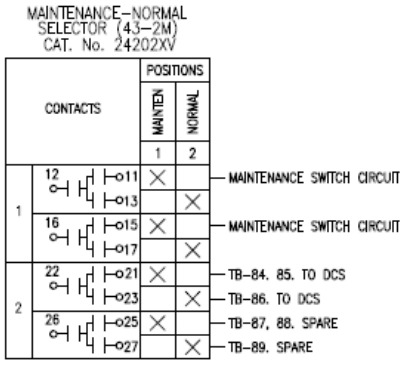
The maintenance switch concept is used when the customer requires a faster tripping time when personnel are working in and around the switchgear. The circuit breaker stores preset values (Value A = "Normal" and Value B = "Maintenance") with regards to the instantaneous settings. These values are determined by the customer and programmed into the circuit breaker trip unit. "Normal" values are specified for regular operation of the switchgear, "Maintenance" values are specified for when work is being performed on the switchgear. The values can be easily changed by means of the maintenance switch located on the circuit breaker or instrument compartment door.

Required parts

- PR123 Trip Unit for the Emax circuit breaker.
- PR120K4C signaling unit
- Blue indicating light (to be blinking when in maintenance mode)
- 24VDC power supply
- ABB 2 position changeover switch, 4 pole, with padlockable handle in both positions.

Example schematics





Arc flash safety options

Arc Guard relay system

Description

The Arc Guard arc protection relays minimizes material damage to switchgear, enables quick restoration of the power distribution and improves personnel safety. The Arc Guard detects an arc anywhere in the bus compartment and cable compartment utilizing fiber optic sensors. The reaction time of the detection is about 1ms.

Application

The Arc Guard relay system concept is used when the customer requires active protection on the equipment against an arc. The Arc Guard system uses fiber optic sensors installed in the bus compartment and cable compartment in order to detect an arc flash. It then feeds CSU signal to the Arc Guard relay which verifies current change on the incoming main bus by the use of CTs and a current sensing unit. If a change is detected by the CSU along with a signal from a fiber optic sensor the relay will then send a signal to the main breaker in the corresponding bus to trip, therefore opening the corresponding bus. Total reaction time is equal to the reaction time of the relay plus the Emax breaker opening time.

Installation

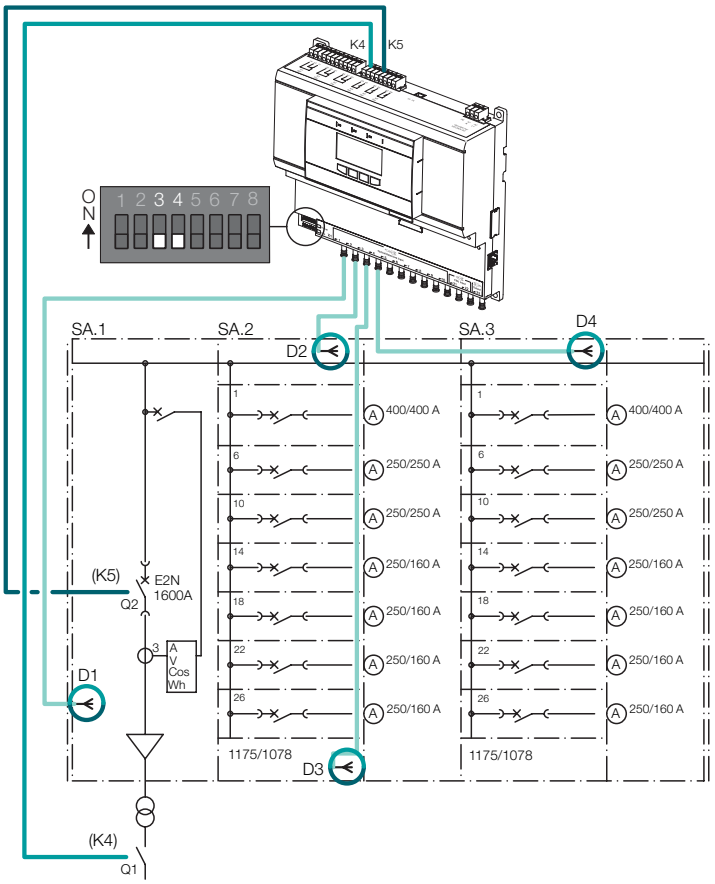
The Arc Guard relay shall be installed in an instrument compartment, the fiber optic cable shall be connected to the relay and routed through the instrument barrier through a hole. All holes where fiber is passed through shall have protection of some means in order to prevent damage of the fiber. Fiber shall be well supported along the process through some means of tie wraps or other means.

After the fiber is passed through the instrument compartment barrier it should be routed to the top of the main bus compartment.

An additional optical detector should be passed to the cable compartment through an opening in the main bus barrier and should be routed to the top of the enclosure overlooking the breaker load connections and supported with supports or other means. Refer to white paper titled, “Protection against electric arc, Integration between Arc Guard System (TVOC-2) and Emax air circuit breakers” for more information, document # 1SDC007407G0201.

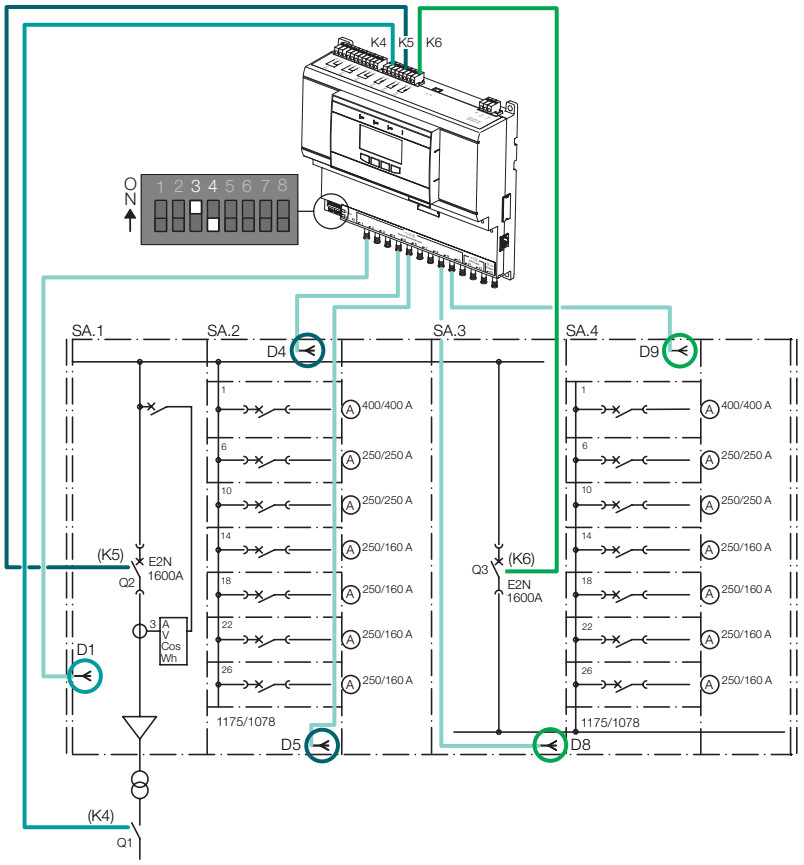
Arc flash safety options
Typical diagrams

Example 1: Arc Guard System™ configured to trip all contacts in case of an arc.



SA...SA3	Switchgear
K4, K5	Solid state tripping contacts
Q1, Q2, Q3	Circuit-breaker
D1...D4	Detectors

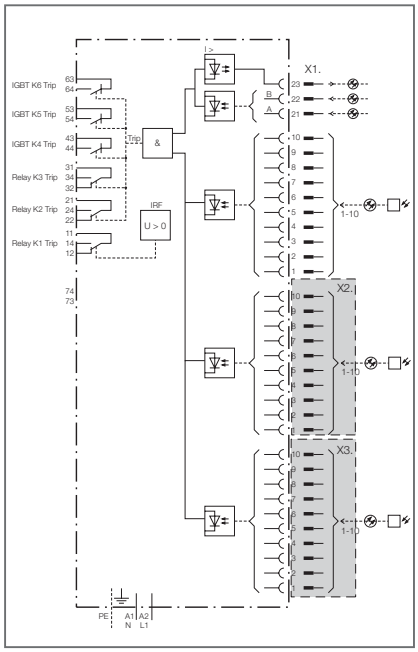
Example 2: Arc Guard system™ configured to trip different trip contacts depending on where the arc occurs.



SA...SA4	Switchgear
K4, K5, K6	Solid state tripping contacts
Q1, Q2	Circuit breaker
Q3	Bus couplar
D1...D9	Detectors

Arc flash safety options
Typical diagrams

Arc Monitor



Terminals	
X1 1-10	Detector input
X2 1-10	Extra extension module detector input (option)
X3 1-10	Extra extension module detector input (option)
A1, A2	Power supply
PE	Power supply
43, 44	Solid-state trip contact
53, 54	Solid-state trip contact
63, 64	Solid-state trip contact
11,12, 13	Internal relay fault, IRF
21,22, 24	signal relays
31, 32, 34	signal relays

Devices

Communications

Industrial networking and Emax circuit breakers

In addition to providing flexible and safe protection of power installations, ABB Emax electronic
releases have an extended range of communication features. PR122 and PR123 electronic
releases can be fitted with communication modules, which make it possible to exchange data and information with other industrial electronic devices by means of a network.

The basic communication protocol implemented is Modbus RTU, a well-known standard of widespread use in industrial automation and power distribution equipment. A Modbus RTU communication interface can be connected to exchange data with the wide range of industrial devices featuring the same protocol.

ABB products featuring the Modbus RTU protocol include:

- Low voltage circuit breakers such as Emax
- Sensors
- Automation I/O systems
- Power meters and other measurement devices
- Intelligent devices such as PLCs
- Operator interfaces
- Supervision and control systems

The power of industrial networking

The communication network can be used to read all information available in the protection release, from any location connected to the bus and in real time:

- Circuit breaker status: closed, open, opened by protection release trip
- All values measured by the protection release: RMS currents, voltages, power, power factor and so on
- Alarms and pre-alarms from protection release, e.g. overload protection alarm (timing to trip or pre-alarm warning)
- Fault currents in case of circuit breaker opening on a protection trip
- Number of operations performed by the circuit breaker, with indication of the number of trips per protection type (short-circuit, overload, etc.)
- Complete settings of the protection release
- Estimate of the residual life of circuit breaker contacts, calculated on the basis of interrupted currents

Remote control of circuit breakers is possible. Commands to open, close and reset alarms can be issued to the circuit breaker and protection release. Close commands are executed only after a security check (e.g., that there are no diagnostic alarms active on the release).

It is also possible to change the settings of the protection release remotely by means of the communication bus. All remote commands can be disabled by a “local” configuration feature, for safety of operators and installation.

Communications

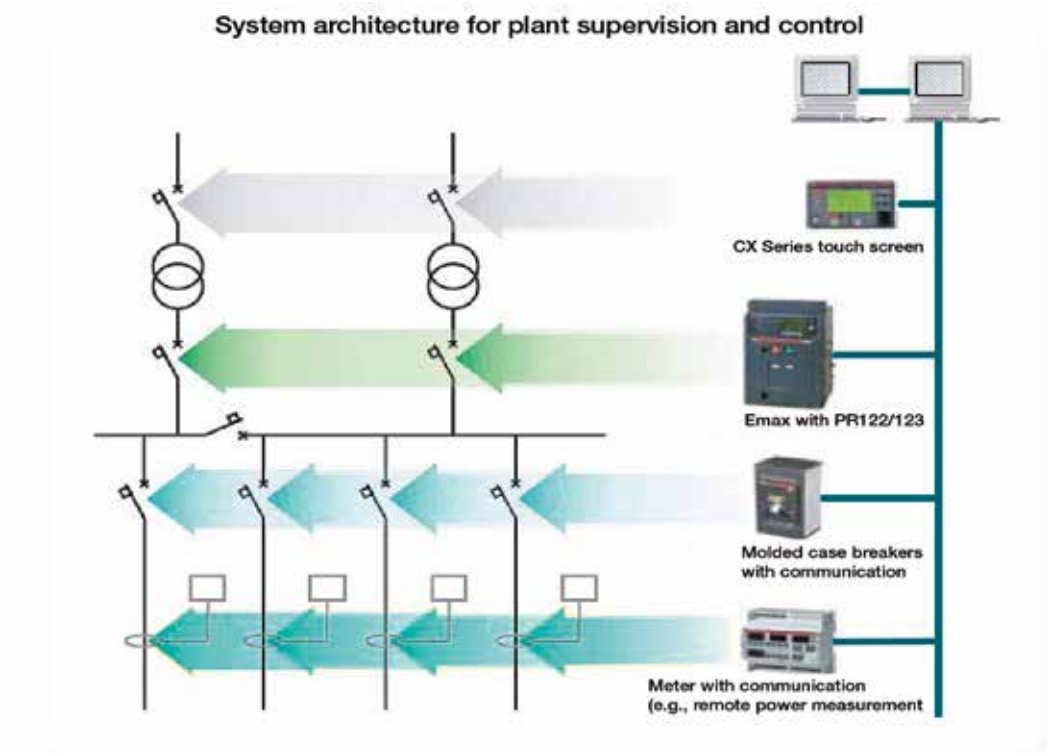
Communication products

Circuit breakers with communication can easily be integrated with automation and supervision systems. Typical applications include:

- Supervision of the installation with continuous data logging (values of currents, voltage, power) and event logging (alarms, faults, trip logs)
- Predictive maintenance, based on number of operations of each circuit breaker, interrupted currents and estimate of residual equipment life
- Load shedding and demand side management under control of PLC, DCS or computers

ABB SACE has developed a complete series of accessories for the Emax family of electronic releases:

- PR120/D-M communication module
- Furthermore, a new generation of software dedicated to installation, configuration, supervision and control of protection releases and circuit breakers is now available
- SDView 2000
- SD-Pocket
- Ekip



Ekip

Ekip is the ABB SACE commissioning and diagnostic software for all Modbus RTU devices. It can be used during system startup, or to troubleshoot an installed network.

Ekip automatically scans the RS-485 bus, detects all connected devices and checks their communication settings. All possible combination of device address, parity and baud rate are checked.

A click on “scan” is enough to spot devices which are not responding, have wrong addresses, misconfigured parity bits, and so on. This function is not limited to ABB SACE devices. All standard Modbus RTU devices are detected and their configuration is displayed. After the scan, the software displays warning messages about potential problems and configuration errors, allowing complete diagnosis of a field bus network. When ABB SACE circuit breakers are detected, additional functions can be used to check wirings, send open/ close/reset commands, and retrieve diagnostic information. This user-friendly tool makes commissioning of Modbus networks a breeze. Ekip is freeware and can be downloaded from the BOL website (http://bol.it.abb.com)

Other communication protocols

EP 010 - FBP is the Fieldbus plug interface between the Emax protection trip units and the ABB Fieldbus Plug system, allowing connection of Emax circuit breakers to a Profibus, DeviceNet or AS-I field bus network. EP 010 - FBP can be connected to the new Emax PR122 and PR123 protection trip units (the PR120/D dialogue module is required).

The ABB Fieldbus Plug concept is the latest development in industrial communication systems. All devices feature a standard connection socket to which a set of interchangeable “smart” connectors can be plugged. Each connector is fitted with advanced electronics implementing the communication interface towards the selected field bus. Selecting a communication system is made as easy as selecting and connecting a plug. Communication systems currently available are Profibus-DP, DeviceNet and AS-i. More are being developed.

Applications

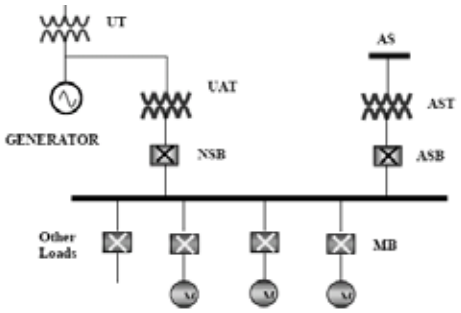
Automatic transfer schemes

Automatic transfer systems are often used to minimize power interruption by transferring the load from the normal source to an alternate source when the normal source fails or is temporarily unavailable. Transfer schemes can be achieved either automatically or manually. In automatic transfer schemes there is a need to provide electrically operated breakers on the incoming sources.

Below are some ABB suggested transfer logics with their descriptions and features. Typical automatic transfer logics are performed via the use of a PLC or relay logic. Certain loads or plant processes may dictate a different scheme.

Case 1: Two sources, no tie, open transition, automatic mode

1. Upon failure of the normal or preferred utility source, the system shall automatically transfer the load from this normal or preferred source to the alternate or emergency source.
2. When the normal source has returned, the system will apply a user-adjustable time delay, and then the load will be retransferred to the normal or preferred utility source.
3. Should the alternate or emergency source fail while feeding the load, the system will instantaneously transfer the load to the normal power supply provided that it has been restored within acceptable limits.

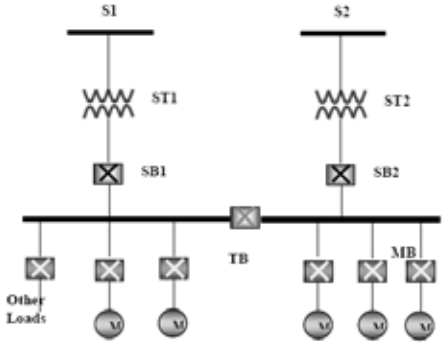


Case 2: Two sources, no tie, open transition, manual mode

1. When operated manually, both main breakers will be opened and closed by means of pushbuttons or control switches. Both breakers will be mechanically or electrically interlocked to avoid the closing of both mains at the same time.

Case 3: Two sources, one tie, open transition, automatic mode

1. Normal condition: both main breakers 1 and 2 are closed and the tie breaker is open.
2. Upon failure of either utility source, and after a user-adjustable time delay, the system shall open the main breaker corresponding to the lost utility source and close the tie breaker.
3. After the normal or preferred utility source voltage has been restored, the system will apply the pre-set user-adjustable time delay, and then shall open the tie breaker. The transfer system shall apply a second user adjustable time-delay (allowing voltage to decay) before the main normal utility source breaker is closed allowing an open transition re-transfer of the load.
4. Should utility source 2 fail while feeding the load, re-transfer to source 1 shall be instantaneous provided that source 1 is within acceptable parameters.
5. Should both sources 1 and 2 fail at the same time, the system will not react upon restoration of any of the two (or both) sources to acceptable limits.



Case 4: Two sources, one tie, open transition, manual mode

If manually operated, the three breakers Main 1, Main 2 and Tie shall be opened and closed by means of push buttons or control switches. The three breakers will be mechanically or electrically interlocked to prevent the simultaneous closing of both mains and the tie.

Case 5: Two sources, one tie, closed transition, automatic mode

1. Normal condition: both main breakers 1 and 2 are closed and the tie breaker is open.
2. Upon loss of either utility source 1 or 2, the system will apply the pre-set user-adjustable time delay (to override momentary failures of source voltage), and then open the affected main breaker and close the tie breaker.
3. Upon return of the preferred utility voltage and after the pre-set user-adjustable time delay expires, the transfer system shall check for synchronism of the two utility sources 1 and 2 via a sync check relay (Device 25), and then close the affected main breaker before opening the tie breaker allowing momentary paralleling of the two sources (closed transition re-transfer to Normal). The time for momentary paralleling shall be user-adjustable with a maximum number of predefined seconds.
4. Should the alternate source 2 fail while feeding the load, and provided that the normal or preferred source 1 is back and within acceptable limits the system will instantaneously (over-riding any time-delay) re-transfer the load to Source 1.
5. Should both sources 1 and 2 fail at the same time, the system will not react until restoration of any of the two (or both) sources to acceptable limits had taken place.

Case 6: Two sources, one tie, closed transition transfer, manual mode

1. If operated manually, all three breakers shall be opened and closed using pushbuttons or control switches. If open transition mode is chosen, breakers should be mechanically or electrically interlocked to prevent the inadvertent and simultaneous closing of both mains and the tie. If closed transition mode is selected, all three breakers might be simultaneously closed for a user-adjustable and pre-set time delay of 5 seconds. ANSI 25 shall avoid momentary paralleling of both sources if they are out of synchronism. Breakers shall be opened via pushbuttons or control switches or the system shall open the tie breaker after the time delay has expired.

Ground fault schemes

1) Ungrounded systems

a. An ungrounded system is the one that has no intentional connection between the system conductors and ground. However, the ungrounded system is in fact a capacitance grounded system. This is so because there always exists a capacitive coupling between conductors and also between system conductors and ground. The capacitance between phases has minimal influence on the grounding characteristics of the system; and therefore, it can be neglected. For practical purposes, the distributed capacitive reactance to ground, Xco, is considered to be balanced.

b. One major disadvantage of the ungrounded system is the occurrence of destructive transient overvoltages throughout the system during restriking ground faults. These overvoltages are the result from a resonant condition between the inductive reactance of the system and the distributed capacitance to ground.

c. It has been proven that these overvoltages may cause failure of insulation at multiple locations in the system, especially at motors. The solution to the problem of transient overvoltages during restriking ground faults is to ground the system either solidly or by means of impedance.

2) Grounded systems

The methods of grounding the system neutral can be divided into two general categories:

a. Solid grounding
b. Impedance grounding

Impedance grounding may be further divided into several subcategories:

a. Reactance grounding
b. Resistance grounding

Resistance grounding may be either of two classes:

a. High resistance grounding
b. Low resistance grounding

3) Solid grounding

Solid grounding is the connection of a conductor, without any intentional impedance, from the neutral of a generator, power transformer, or grounding transformer directly to ground.

Solid grounding is generally recommended for low-voltage systems when the automatic isolation of a faulted circuit can be tolerated or where it is not feasible to isolate a ground fault in a high-resistance grounded system.

Systems used to supply phase-to-neutral loads must be solidly grounded as required by the National Electrical Code (NEC).
The systems are :

- 120/240 V, single-phase, three-wire
- 208Y/120 V, three-phase, four-wire
- 480Y/277 V, three-phase, four-wire
- 600Y/347 V, three-phase, four wire

Solidly grounded systems have the greatest control of overvoltages but also have the highest magnitudes of ground-fault current. These high-magnitude fault currents must be taken into consideration when designing the system.

4) **Reactance grounding**

The term reactance grounding applies to the case in which a reactor is connected between the system neutral and ground.
Reactance grounding is usually employed in applications where there is a need to limit the magnitude of the ground-fault current to a level that is relatively close to that of a three-phase fault. The use of reactors to provide this fault limitation is often less expensive than the use of grounding resistors if the desired current magnitude is of several kilo amperes.
Reactance-grounded systems are not commonly employed in industrial power systems.

5) **Resistance grounding**

In this type of system, the neutral of the generator or transformer is connected to ground through a resistor.
The line-to ground fault current is primarily limited by the high ohmic magnitude of the resistor as compared to that of the system reactance.
Based on the magnitude of ground-fault current permitted to flow, resistance grounding may be either of two classes, high resistance or low resistance.

6) **High-resistance grounding**

As the term implies, high-resistance grounding employs a neutral resistor of high ohmic value. The value of the resistor is selected to limit the current, Ir, to a magnitude equal to or slightly greater than the total capacitance charging current.

Normally, the ground-fault current, Ig, is limited to 10 Amps or less. The potential damage caused by an arcing current larger than 10 Amps in confined spaces makes the use of high-resistance grounding on systems where the line-to-ground fault exceeds 10 Amps not advisable.

High-resistance grounding provides the same advantages as ungrounded systems, but unlike the ungrounded systems, it limits the steady state and severe transient overvoltages associated with ungrounded systems.

The protective scheme associated with high-resistance grounding is usually detection and alarming rather than immediate trip out. High-resistance grounding usually does not require immediate clearing of a ground fault since the fault current is limited to a very low level.

Layouts

The following layouts are available:

Main/tie section width:

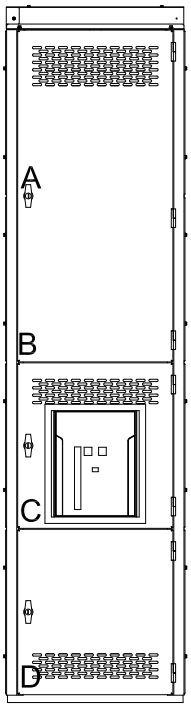
24” (610 mm)
30” (762 mm)
40” (1016 mm)

Feeder sections width:

24” (610 mm)
30” (762 mm)

Auxiliary sections width:

24” (610 mm)
30” (762 mm)
40” (1016 mm)



E3 up to 2500A

Main/tie section
24” (610 mm)

Application rules

1) Main/tie circuit breaker: up to 2500 A
2) Frame size: E3
3) Bus bracing: up to 100 kA
4) Main/tie circuit breaker in C compartment only
5) Compartment A: Height may vary based on interrupting rating and voltage selected

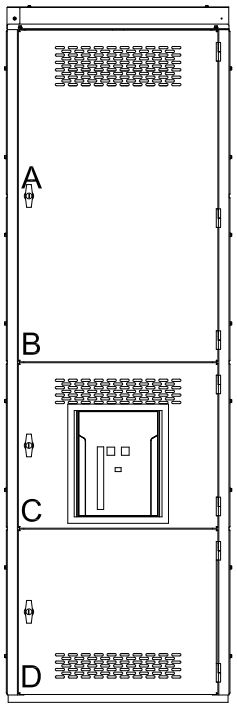
Connection to main/tie circuit breaker

a) Cable to main/tie circuit breaker

Current transformer rules

a) A set of current transformers can be placed around the bus runbacks in the cable compartment of the main breaker section, no dis-assembly of the bus is required.

Layouts



E4 up to 3200A

Main/tie section
30” (762 mm)

Application rules

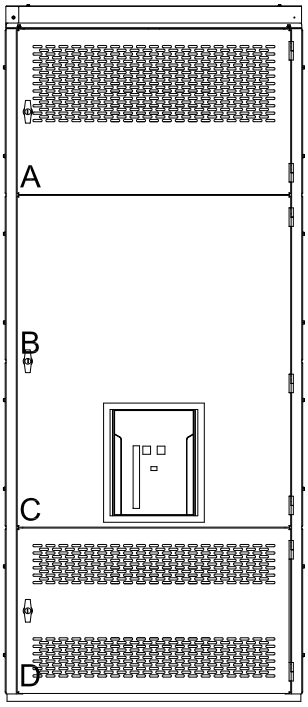
1) Main/tie circuit breaker: up to 3200 A
2) Frame size: E4
3) Bus bracing: up to 100 kA
4) Main/tie circuit breaker in C compartment only
5) Compartment A: Height may vary based on interrupting rating and voltage selected

Connection to main/tie circuit breaker

a) Cable to main/tie circuit breaker

Current transformer rules

a) A set of current transformers can be placed around the bus runbacks in the cable compartment of the main breaker section, no dis-assembly of the bus is required.



E6 up to 5000A

Main/tie section
40” (1016 mm)

Application rules

1) Main/tie circuit breaker: up to 5000 A

2) Frame size: E6

3) Bus bracing: up to 100 kA

4) Main/tie circuit breaker in C compartment only

5) Compartment A: Height may vary based on interrupting rating and voltage selected

Connection to main/tie circuit breaker

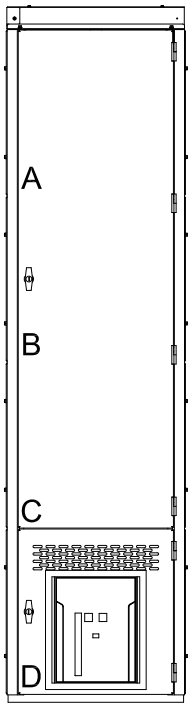
a) Cable to main/tie circuit breaker

Current transformer rules

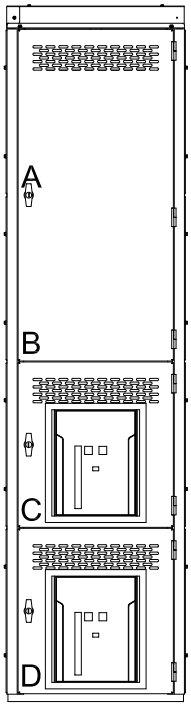
a) A set of current transformers can be placed around the bus run-backs in the cable compartment of the main breaker section, no dis-assembly of the bus is required.

Layouts

Feeder section
24” (610mm)

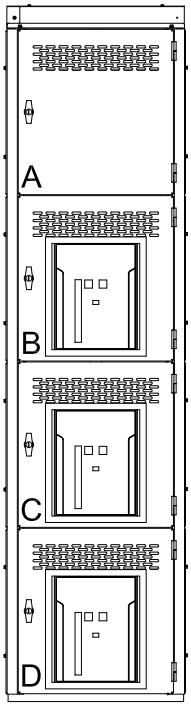


E3 up to 2000A



E3 up to 2000A

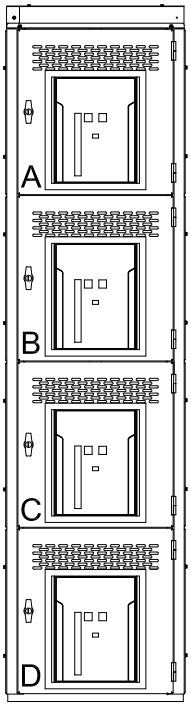
E3 up to 2000A



E3 up to 2000A

E3 up to 2000A

E3 up to 2000A



E3 up to 2000A

E3 up to 2000A

E3 up to 2000A

E3 up to 2000A

Application rules

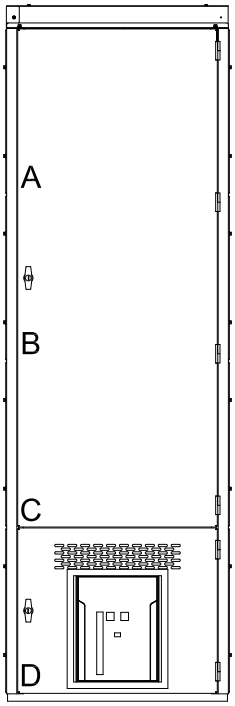
1) Feeder circuit breaker: up to 2000 A
2) Frame size: E3
3) Bus bracing: 100 kA
4) Feeder order preference: D, C, B, A
5) If more than one instrument compartment is selected then the door and mounting pan of the instrument compartment will be combined into a single door rather than individual doors

Notes:

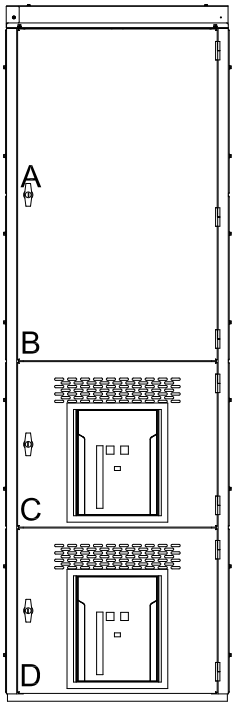
a) Cumulative loading limits of the vertical bus applies.

Feeder section

30” (762mm)

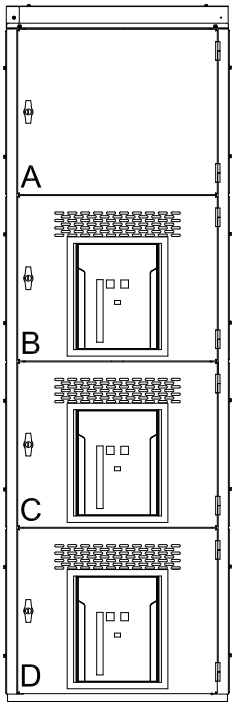


E3 up to 2000A



E3 up to 2000A

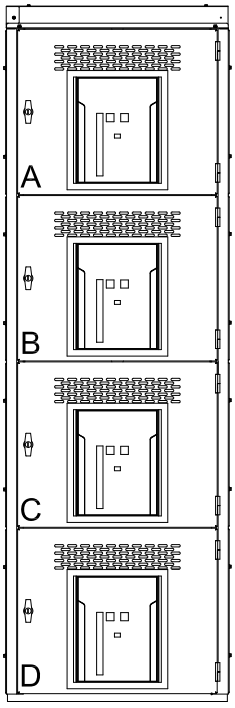
E3 up to 2000A



E3 up to 2000A

E3 up to 2000A

E3 up to 2000A



E3 up to 2000A

E3 up to 2000A

E3 up to 2000A

E3 up to 2000A

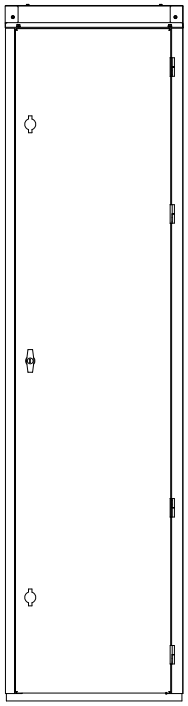
Feeder section
30” (762mm)

Application rules

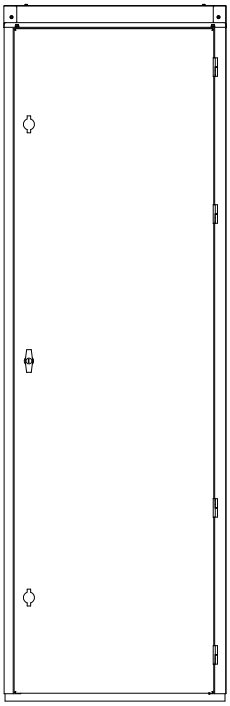
1. Feeder circuit breaker: up to 2000A
2. Frame size: E3
3. Bus bracing: 100kA
4. Feeder order preference: D, C, B, A
5. If more than one instrument compartment is selected then the door and mounting pan of the instrument compartment will be combined into a single door rather than individual doors

Notes:
a) Cumulative loading limits of the vertical bus applies.

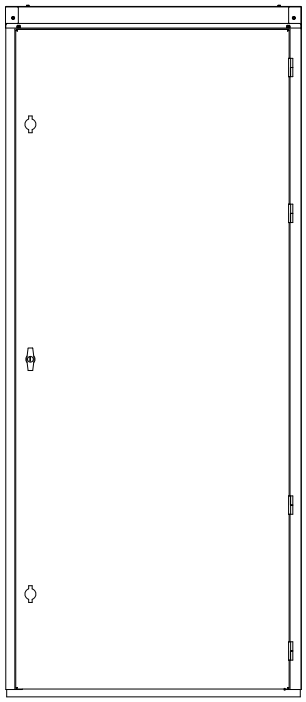
Auxiliary sections



24” (610 mm)



30” (762 mm)

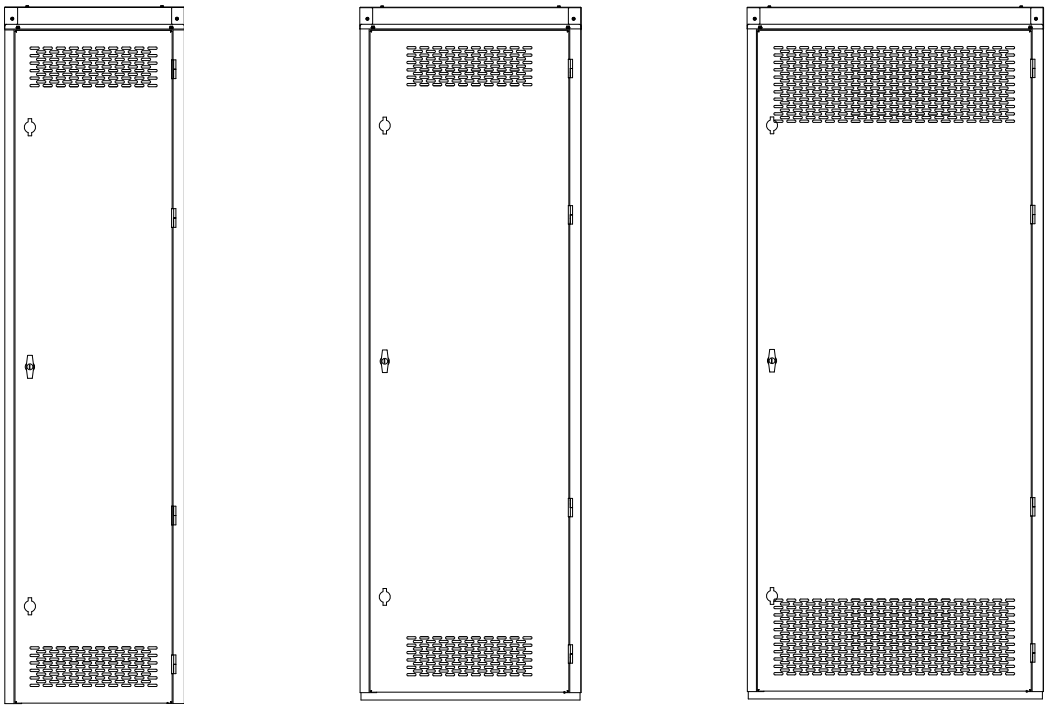


40” (1016 mm)

Application rules

1) Auxiliary sections can be used for instrument and control compartments and can be supplied with or without horizontal bus.

View of rear door for all sections



Application rules

1) All sections can be equipped with a full height hinged rear door or 2 pc. rear screw covers, full height door is shown.

Approximate weights

	Main Bus Amps	24” Wide 84” Deep	30” Wide 84” Deep	40” Wide 84” Deep	
Main Sections	2000	1485	–	–	lbs.
	2500	1720	–	–	lbs.
	3200	1768	1779	–	lbs.
	4000	–	1897	–	lbs.
	5000	–	1957	2835	lbs.
	6000	–	2077	3022	lbs.
	8000	–	2197	3155	lbs.
	10000	–	2317	3315	lbs.

	Main Bus Amps	24” Wide 2000A	30” Wide 3200A	40” Wide 4000A	
Feeder Sections	2000	1803	–	–	lbs.
	2500	1835	–	–	lbs.
	3200	1991	2134	–	lbs.
	4000	–	2134	2243	lbs.
	5000	–	2194	2303	lbs.
	6000	–	2314	2423	lbs.
	8000	–	2434	2543	lbs.
	10000	–	2554	2663	lbs.

	Main Bus Amps	24” Wide 84” Deep	30” Wide 84” Deep	40” Wide 84” Deep	
Tie Sections	2500	1867	–	–	lbs.
	3200	–	1997	–	lbs.
	4000	–	–	2344	lbs.
	5000	–	–	2915	lbs.

	Main Bus Amps	24” Wide 84” Deep	30” Wide 84” Deep	40” Wide 84” Deep	
Auxiliary Sections	NO BUS	1265	1353	1500	lbs.
	2000	1361	1473	1660	lbs.
	2500	1361	1473	1660	lbs.
	3200	1409	1533	1740	lbs.
	4000	1409	1533	1740	lbs.
	5000	1457	1593	1820	lbs.
	6000	1553	1713	1980	lbs.
	8000	1649	1833	2140	lbs.
	10000	1745	1953	2300	lbs.

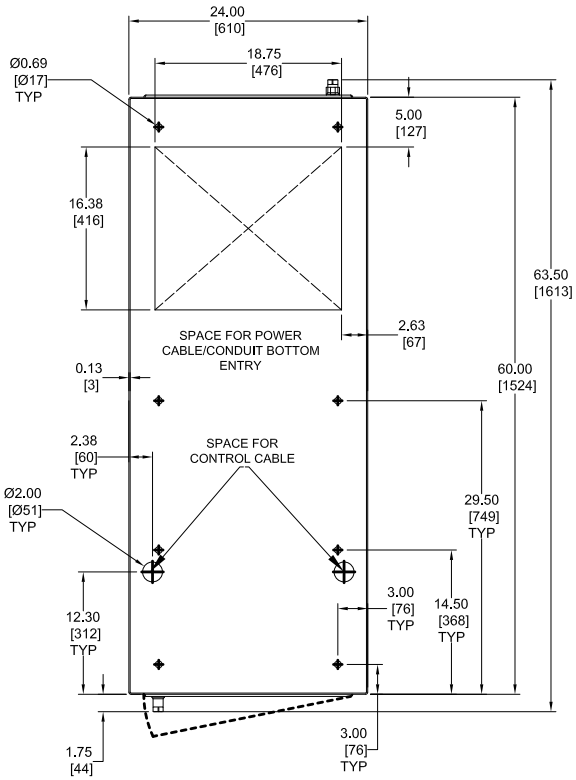
Notes:

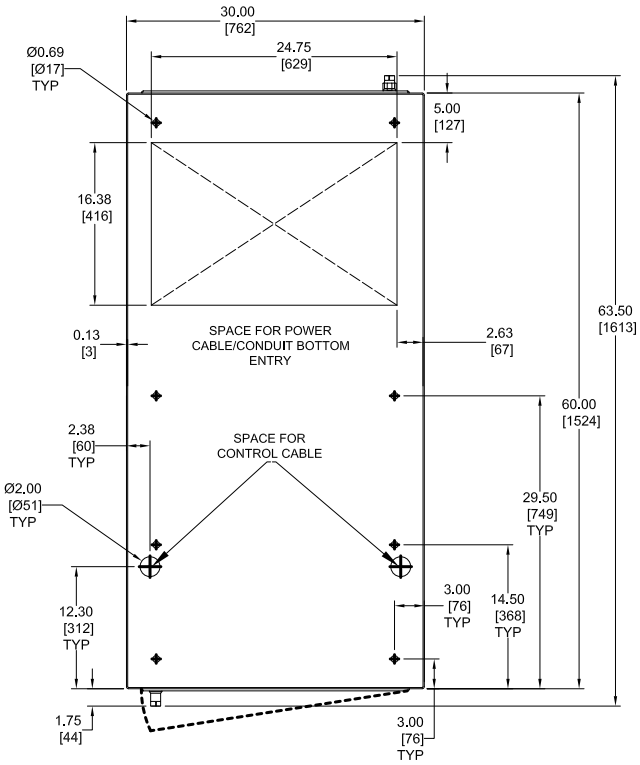
1. Weight of each section does not include moving part of each breaker.
2. Overhead lift device weight is approximately: 118 lbs, 54 kg
3. Weight for feeder sections is with 4-high 2000A breakers.

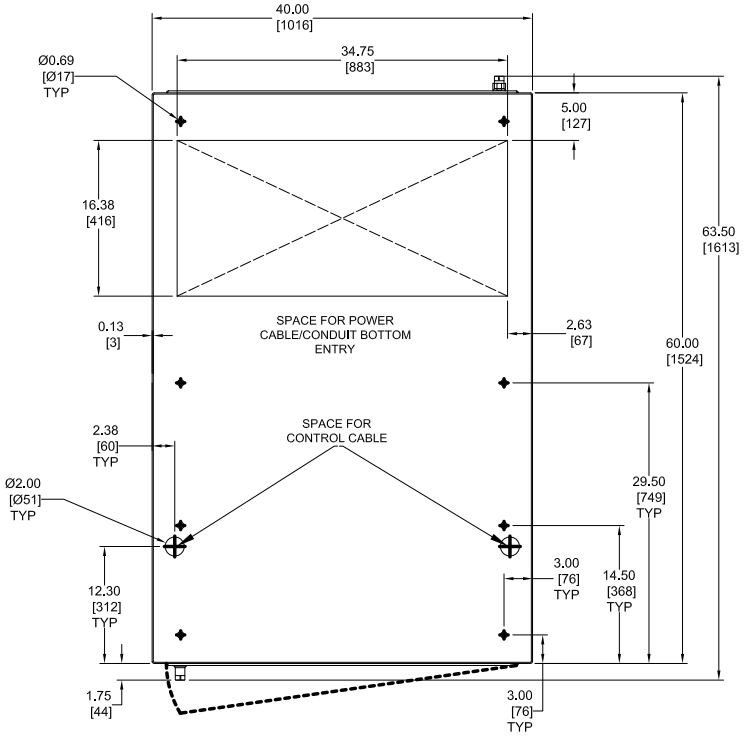
Breaker weights

Breaker Frame Size	Weight (lbs)	Weight (kg)
E3	145	66
E4	214	97
E6	270	122

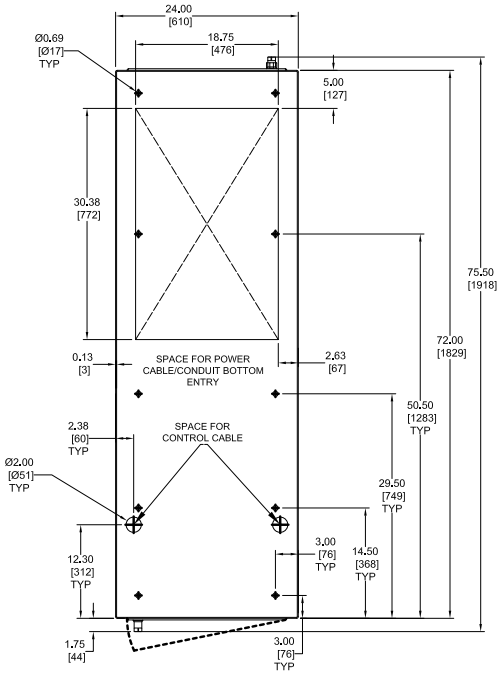
Switchgear floor plans
60” (1524 mm) depth

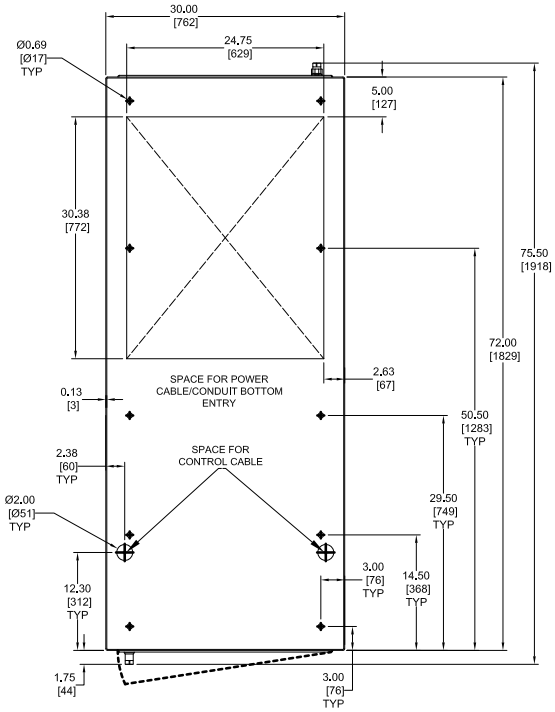


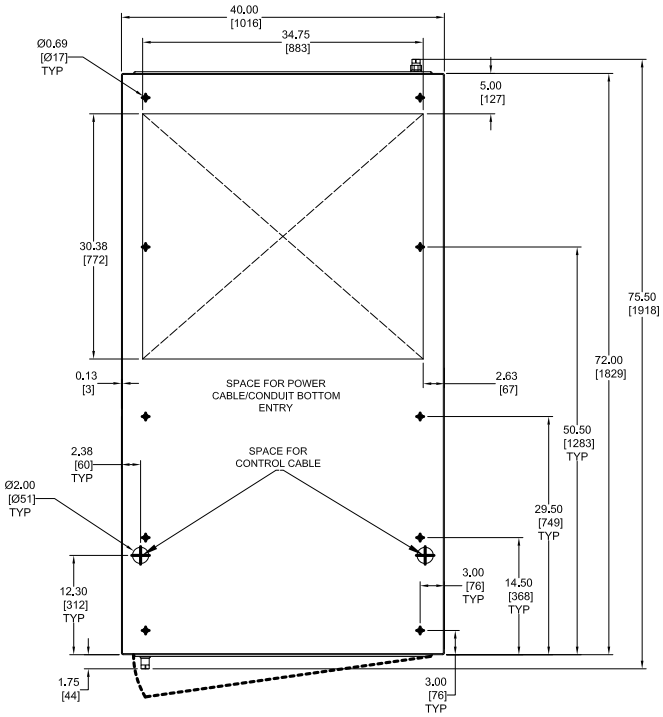




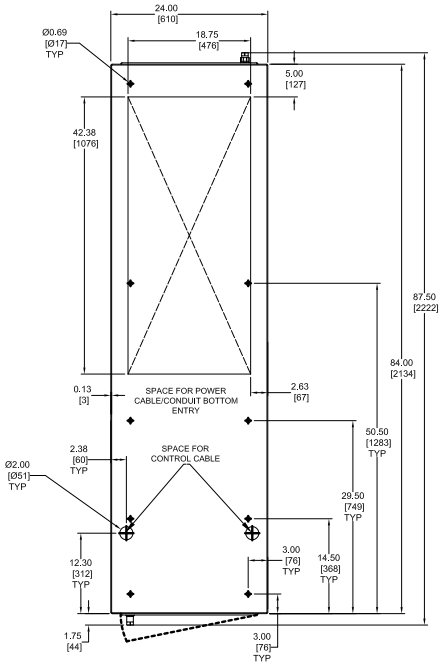
Switchgear floor plans
72” (1829 mm) depth

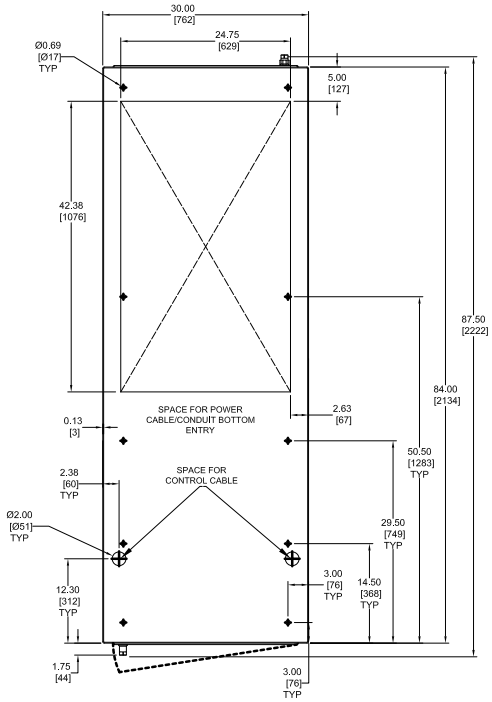


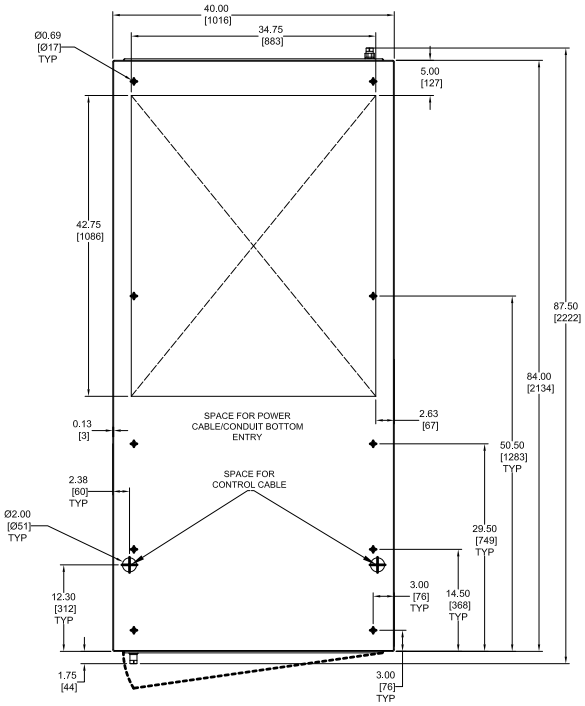




Switchgear floor plans
84” (2134 mm) depth







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