MaxSG Switchgear
Application guide

Power and productivity
for a better world™

MaxSG Application Guide
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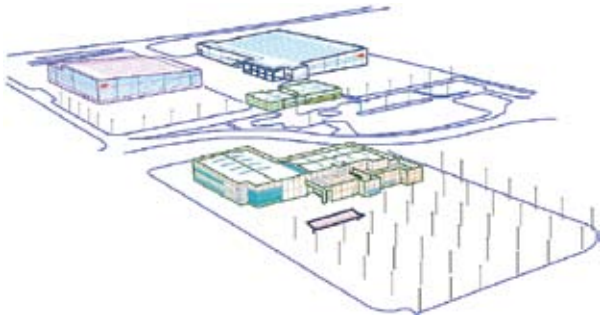
The MaxSG has been utilized in the following markets:

- 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 MaxSG low voltage switchgear is designed, constructed, and tested to provide superior power distribution, protection, and power monitoring and control. MaxSG 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 MaxSG Metal-Enclosed Low Voltage Switchgear offers many advantages that include:

- Modular frame design arrangements for flexibility
- No front door breaker ventilation
- Optional barriers for increased personnel protection
- Maintenance Switch Option
- Insulated bus through 4000A
- Standard connections to a full range of ABB products
- Modbus Communication
- REA Relay Arc Flash System

System Overview

The basic design:

- Standard UL1558 and ANSI C37.20.1
- Modular frame arrangements
- Efficient and flexible designs
- Operational reliability
- Enclosure Types: NEMA-1 (with gasketed doors) and NEMA 3R Walk In

MaxSG is available with the following nominal ratings:

- 600Vac max
- 4000A max
- 50/60 Hz
- 2200Vac RMS Dielectric
- 65kA and 100kA Symmetrical Short Circuit withstand rating

Standard Line-Up of MaxSG Metal Enclosed Low Voltage Switchgear with Instrumentation and Emax Power Circuit Breakers.

Standards

The MaxSG with Emax power breakers 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 C37.50 — Test Procedure for Low Voltage AC Power Circuit Breakers Used in Enclosures
- ANSI C37.51 — Conformance Testing of Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies
- CSA C22.2 No. 31– Switchgear Assemblies
- Seismic Qualification to IBC-2006 and CBC-2007, AC156, “Shake-Table Testing for Nonstructural Components and Systems,” and ASCE/SEI 7-05, “Minimum Design Loads for Buildings and Other Structures”.

The Emax power 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
- UL1066 – Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

Ratings

Description	Value
Rated continuous current	2000, 3200, 4000A
Rated tested maximum voltage	3 phase 3 wire, 3 phase 4 wire
Rated voltage	254Vac, 508Vac, 635Vac
240Vac, 480Vac, 600Vac	50/60 Hz
Phases	3 phase 3 wire, 3 phase 4 wire
Neutral	100% rated
Frequency	50/60 Hz
Short circuit current withstand at 600Vac	
Max peak short circuit current	65 kA, 100 kA
149.5 kA, 230 kA	

Ambient Conditions

Requirements	Unit	Value
Temperature range during operation	°C	-25 to +40
For ambient temperature of 50°C ABB self certification letter to be provided.		
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.
- All values are under review by an IEEE Switchgear Committee Working Group, PC37.100.1 on Common Requirements for Power Switchgear and are provided here for reference until revised values are available.

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)**	**<6600**	**9900**	**13200**	**16500**
	(m)	**2000**	**3000**	**4000**	**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 [btu/hr]
E2B-A/N-A/S-A/H-A	800	170
	1200	377
	1600	675
E3N- A/S-A/H-A/V-A	800	116
	1200	261
	1600	471
	2000	707
E4S-A/H-A/V-A	2500	817
	3000	1175
	3200	1326
	3600	1681
E6H-A/V-A	4000	1398

Breaker Temperature Derating

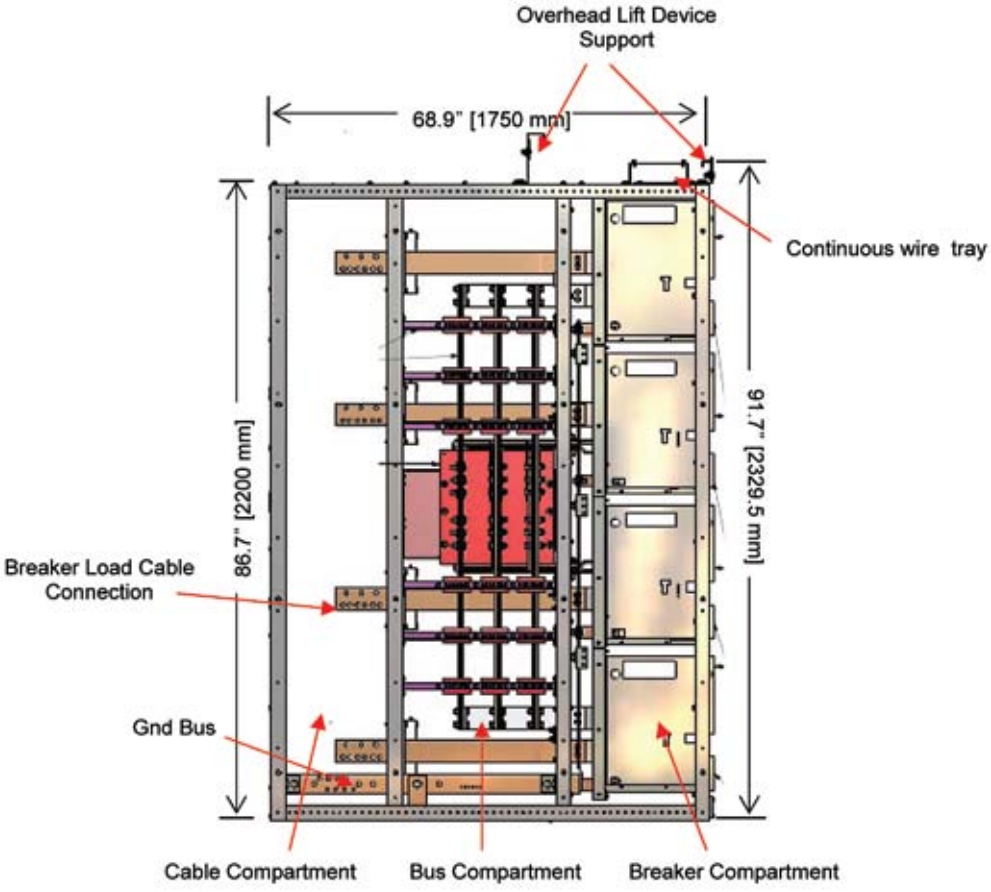
The continuous current rating of Emax circuit breakers is based on their use in an enclosure at 40°C ambient temperature and 105°C maximum breaker temperature for Class A insulation. Continuous current ratings of Emax circuit breakers must be derated for ambient temperatures above 40°C (Trip unit ambient is limited to 70°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

Structure

The MaxSG switchgear assembly consists of one or more enclosed vertical sections. The ends are designed to allow installation of future sections. Each vertical section can consists of four high individually enclosed Emax power breakers with uniformed height. One or more of these compartments can be utilized as an auxiliary compartment for mounting of instrument devices such as potential transformers, control power transformers, relays, meters and other control devices.

The section is constructed in a compartmentalized way. Each vertical section consist of three compartments: the front compartment (including breakers), middle compartment (bus compartment), and a rear cable compartment. A continuous wire tray is placed on top of the roof above the breaker compartment. The structure has the capability of being bolted together to form a single assembly.

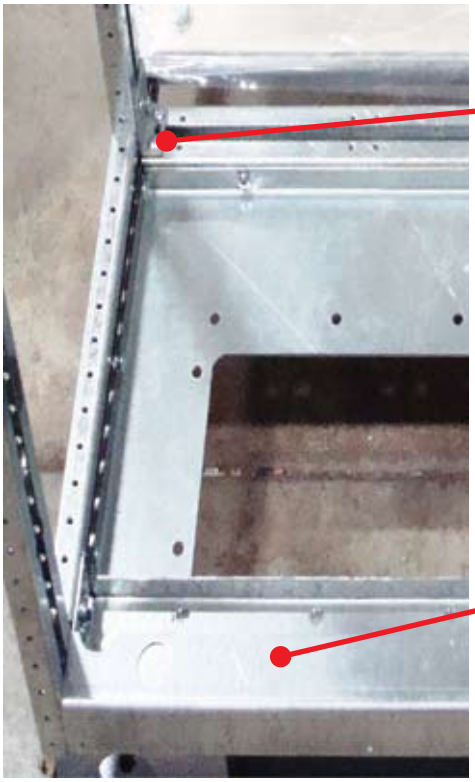


Standard finish

The standard finish color is light gray paint (ANSI 61). The standard painting process is a UL approved electrostatic powder coat paint system utilizing polyester powder coat paint. The completed finish has a nominal 2.6 mils dry film thickness. The process includes cleaning any grease or deficient phosphate, rinsing, spray coating, oven drying, electrostatic powder spray paint coating, and oven baking.

Frame

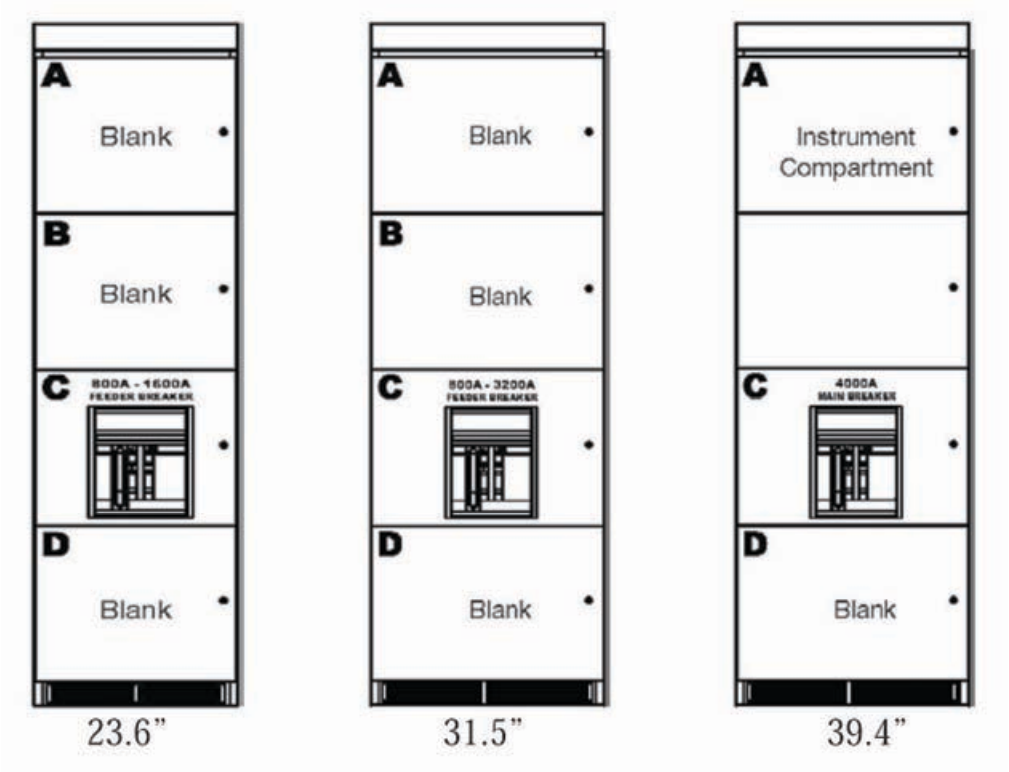
The basic elements of the frames are: rigid C-channel rails of 12 and 14 gauge thickness galvanized steel with holes at 1" (25 mm) intervals. The parts of the frame are secured with self-tapping screws and require no maintenance. The corner joints are carried out by means of an L shape steel bracket and secured with self-tapping screws. Lifting eyes are provided as a standard on the roof of the enclosure to allow lifting by the use of a crane.



Available Dimensions

The available widths are: 23.6" (600 mm) [standard], 31.5" (800mm) [standard], 39.4" (1000mm) [standard], and 19.7" (500 mm) [optional]. The standard height is: 86.6" (2200 mm) without wire trough. With wire trough the height is 91.7" (2329.5 mm). The MaxSG height with an overhead lift device is 104.2" (2648mm).

The standard depth is 68.9" (1750 mm); optional 59.1" (1500 mm) – restriction to apply.



Shipping design

Removable wood shipping base is heat-treated and fumigated; the wood base is provided per shipping split and anchored at four points. The switchgear maximum shipping split is 71” (1800 mm).

All breakers will be shipped separately, uninstalled in the switchgear to be installed in the field by others.

Barriers and covers

Side Panels and rear panels consist of a 3-piece design 14 gauge thickness galvanized steel secured by self-tapping torque-head screws. Rear panels are provided with lifting handles and standard finish paint.

Option: Rear hinged door with 3-point closing latch system.

The MaxSG is provided with a two piece slotted top cover. The slotted holes are there to allow for heat rise ventilation per each section. The top panel is made of 14 gauge thickness galvanized steel. A continuous wire tray is placed on top of the roof above the breaker compartment in order to allow for wiring between sections and shipping splits. The dimensions of the cable tray are 5” (125 mm) high by 7.8” (198 mm) wide, allowing space for control wiring connections for internal use as well as for customer control wiring to be run through it.

Barriers provided between bus compartments and cable compartments consist of a two or four piece design of 11 gauge galvanized steel. Barriers provided between breaker compartments and bus compartments consist of multiple pieces of sheet metal. The dimensions for the barriers are approximately 21.5” (546 mm) or 42” (1066 mm) high and are made up of 11 gauge thickness galvanized steel (As seen on left). As an option 11 gauge galvanized barriers can be provided between sections in the cable compartment in order for complete isolate each rear section (As seen on right).

Optional corrosion resistant aluminum bottom plates are available for the cable and bus compartments. The cable bottom plates are removable to allow conduit holes to be punched out by others for outgoing or incoming cables.

Circuit breaker and equipment compartments doors are provided with 14-gauge individual doors with removable hinges. All doors are secured by quarter turn latches and provided with a grounding strap.

Nameplates

MaxSG nameplates meet all standards listed in ANSI C37.20.1. Precautionary labels meet ANSI Z53.4. Standard nameplates for devices are white background with black lettering phenolic screwed on type. Other optional nameplates are available upon request. The main system nameplate is a stainless steel screwed on type with self tapping screws. All lettering is engraved. 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 (gasketed doors only)

MaxSG switchgear enclosure is NEMA-1 with gasketed front doors. The enclosures are deadfront, metal-enclosed structures. All front doors, side panels, and rear panels or doors are painted using electrostatic powder type paint.

Standard Features:

- ANSI 61 paint color
- Barriers between breaker compartment and bus compartment
- Barriers between bus compartment and cable compartment
- Ground bus extensions
- Removable, steel top plates over conduit entrance
- Cable wire trough
- Gasketing around front doors
- Lifting eyes

Available Options:

- Vertical barriers (in cable compartment)
- Strip heaters and thermostats
- Overhead lift device
- Padlock provisions on breaker compartment doors
- Padlock provisions on rear covers and doors
- Aluminum bottom plates
- Rear hinged doors
- Optional paint colors
- 59.1” deep enclosure (restrictions may apply)

Bus Bar System

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

The horizontal busbar is arranged in phases A, B, C and neutral from front to back in each vertical section about half ways through each vertical section. The bus bars are connected to the adjacent section at each end by means of shipping splices secured by grade 5 hardware. All bus designs are based on UL and ANSI 37.20.1 standard temperature rise of 65°C above maximum ambient air temperature of maximum of 40°C. The bus bar compartment is separated from the breaker compartment by grounded steel barriers. The bus bar compartment is also separated from the cable compartment by means of two galvanized steel barriers with handles for ease of installation and removal. All bus is supported by steel supported polyester fingerplates.

Main bus amperages include: 2000A, 3200A, and 4000A with bus bracing at 65kA or 100kA. Non-insulated silver plating bussing is standard; optional tin-plating is available.

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

Optional insulated bussing consist of: thermal-contractile flame resistant non-hydroscopic tubing and boots on main horizontal and cable compartment runback bussing.

ABB offers several options for incoming connections including: cable, bus duct, and close couple connections to transformers. For cable incoming requirements ABB can accommodate top or bottom lugs for amperages 2000A, 3200A, and 4000A applications. For bus duct connections, ABB offers a standard bus duct riser. Designs are available for top and bottom incoming for 2000A, 3200A, and 4000A main bus. In close coupling applications ABB offers a standard connection to ABB dry type transformers for all available bus amperages. In connection to oil filled ABB transformers, a transition section of a minimum width of 19.7" (500mm) is required. For all non ABB transformer connections ABB will need to provide a custom design section and all drawings of existing transformer will need to be provided at time of quotation request.

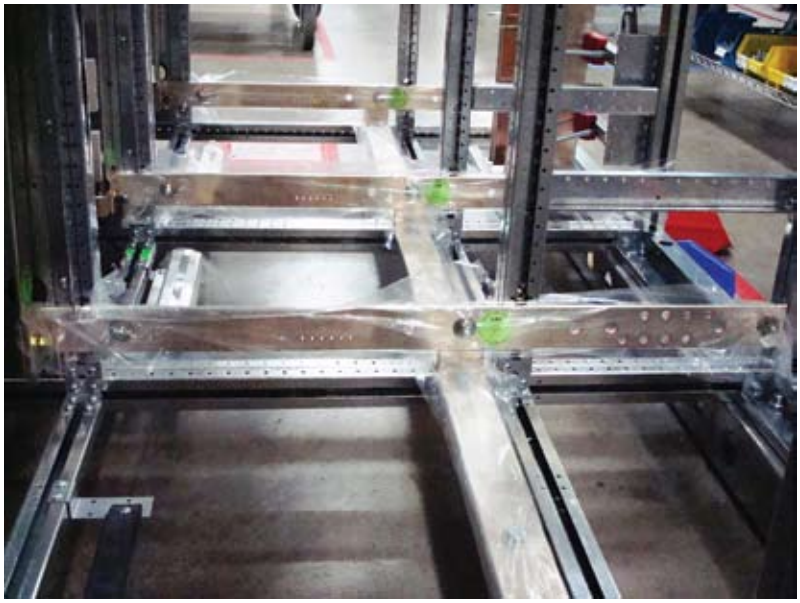
The **vertical busbars** run A, B, and C phase from front to back along the right side of the vertical section. The vertical bus riser is rated up 2000A for feeder sections and 4000A for Tie sections. The bus bracing is rated for 65kA and 100kA. The vertical bus busbars are offered as silver-plated standard with an option for tin-plated.

The vertical bus is utilized for breakers only in compartments A and D. There are three vertical busbar offerings: A, D, or A and D. For compartments B and C runbacks from the breaker are directly connected to the main bus. Run backs in B allow breakers up to 4000A for certain applications and sections. For positions A and D, the maximum breaker amperage is 2000A. Optional insulated bussing consist of: thermal-contractile flame resistant non-hydroscopic tubing and boots on main horizontal and cable compartment runback bussing.

For Main-Tie-Main applications there is a need to provide a vertical bus riser in the Tie section in order to be able to tie buses from multiple sources.

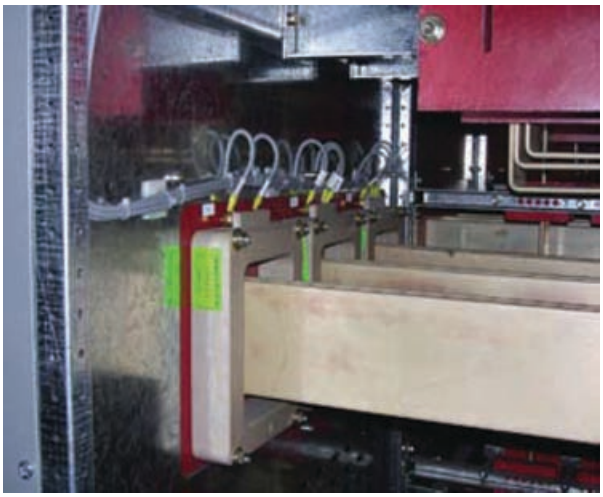
The **ground bus** is rated as follows: 1 bar of 1/4” x 2 ½”, rated 600A at 100 kA. As a standard ground bus, ABB offers a bare copper bus with an option for silver or tin platting. A 4/0 AWG mechanical ground lug with NEMA 2 hole mounting pattern is installed at the end of each line up on either side for grounding. As an option ABB may accommodate other mechanical lug sizes. Some limitations may apply.

As a standard ABB provides ground bus extensions that extend to the rear of the section on the far end sections of either side of a line up for ease of connection to transformers or other equipment. As an option ABB may provide ground bus extensions on all sections.



Wiring

Intercubicle wiring is done on terminal strips located in a wire way on top of the equipment. The top terminal blocks are used only for shipping split wiring to allow for quick and easy access when installing or expanding the MaxSG switchgear.



As a standard all wiring is #14 ga SIS with ring tongue type connectors. As an option ABB can provide insulated locking forks instead of ring tongue type. Control wire for current transformer is #10 ga SIS wire. Potential transformers are provided with either #14 ga SIS wire or #12 ga SIS wire as an option. Control wire for a control power transformer up to 5kVA is #8 ga SIS. For higher control power transformers the appropriate wire size is used.

Control wires are run through gasketed openings between each compartment within each section and in between sections.

Instrument compartments (21”(546mm) or 42”(1066mm) are available to mount additional devices such as but not limited to: voltage transformers, control power transformers, metering, and supervisory devices. Internal compartments are also available for mounting of terminal blocks for customer use and internal use. Breaker devices such as indicating lights, control switches, and specified meters are mounted in the breaker compartment door as a standard. Due to space limitations the use of an instrument compartment may be required.

Spare customer terminal points can be located in the front of the gear in an instrument compartment or in the breaker compartment. Number of spare terminal points may impact overall equipment layout dimensions.

Voltage Transformer – External Metering and Relaying

Voltage transformers utilized in the MaxSG are mounted in either an instrument compartment or in the rear section on a mounting plate. The electrical characteristics of ABB's standard potential transformer consists of the following:

Insulation Class is 600 volt dielectric, 10 kV full wave BIL. Accuracy Class is 0.6W and 1.2 X burdens at 60 Hz. Thermal ratings are 150 VA at 30°C ambient and 100 VA at 55°C ambient. Primary and secondary fuses are mounted separately in an instrument compartment. Terminals are brass studs No. 10-32 with one lockwasher, flatwasher, and regular nut. Approximate weight is 7.75 lbs.

Voltage Ratio	Turns Ratio	Rec. Primary Fuse Rating
120:120	1:1	4.0
240:120	2:1	2.0
277:120	2.3.1:1	2.0
288:120	2.4:1	1.5
480:120	4:1	1.0
600:120	5:1	0.75

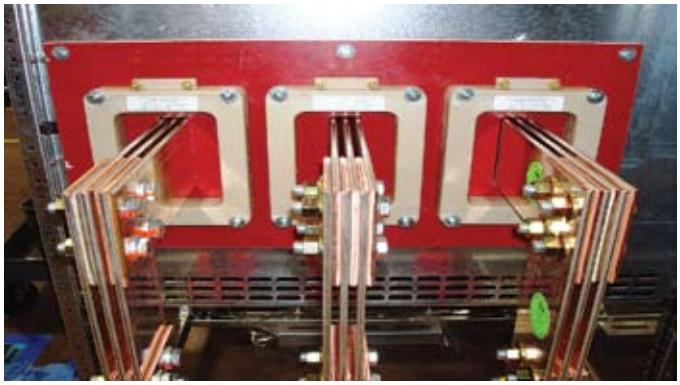
Control Power Transformer

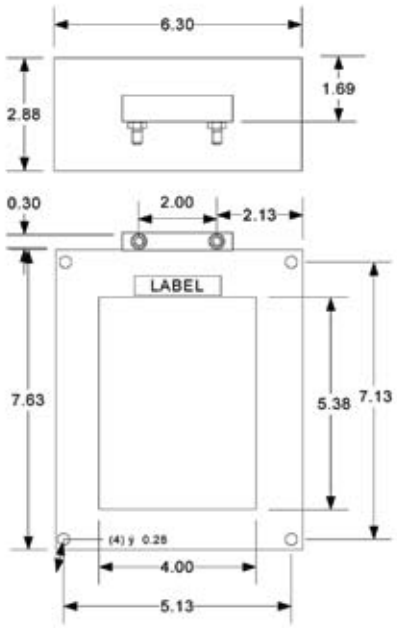
The ABB MaxSG can be supplied with a control power transformer as an option in order to provide 120VAC control power. In the absence of 125VDC available for the required instruments and breakers, a 120VAC control power transformer shall be sized accordingly to the load requirement of the breakers and other equipment. The control power transformer shall be mounted in either an available instrument compartment or on a mounting base in the rear of the section. The available control power transformers are:

Insulation Class is 600 volt dielectric. Primary and secondary fuses are either mounted separately in an instrument compartment or have on board fuse clips. An ABB control power transformer is available with the following ratings: 1 kVA, 3 kVA and 5kVA. For ratings higher than 5kVA an option for 7.5kVA, 10kVA, and 15kVA is available. For mounting of control power transformers above 7.5kVA, the factory would need to be contacted.

Current Transformers - Single Phase Mains Metering/Relay Line Side Current Transformers 600Volts, 10 kV BIL Frequency 50-400Hz

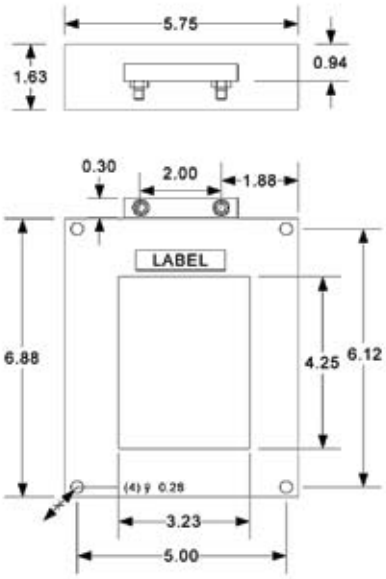
Current Ratio	Relay Class	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE (OHMS @ 75 °C)
		BO.1	BO.2	BO.5	BO.9	B1.8	
2000:5	C50	0.3	0.3	0.3	0.3	0.3	0.095
2500:5	C50	0.3	0.3	0.3	0.3	0.3	1.244
3000:5	C20	0.3	0.3	0.3	0.3	0.3	1.382
3200:5	C20	0.3	0.3	0.3	0.3	0.3	1.474
4000:5	C20	0.3	0.3	0.3	0.3	0.3	1.842





Current Transformers – Feeder Breakers Metering 600Volts, 10 kV BIL Frequency 50-400Hz

Current Ratio	ANSI METERING CLASS AT 60HZ					SECONDARY WINDING RESISTANCE (OHMS @ 75 °C)
	BO.1	BO.2	BO.5	BO.9	B1.8	
100:5	2.4	.	.	.	.	0.012
150:5	1.2	2.4	.	.	.	0.017
200:5	1.2	1.2	.	.	.	0.023
250:5	0.6	1.2	2.4	.	.	0.038
300:5	0.6	0.6	1.2	2.4	.	0.045
400:5	0.6	0.6	1.2	1.2	.	0.095
500:5	0.3	0.3	0.6	1.2	2.4	0.178
600:5	0.3	0.3	0.6	0.6	1.2	0.190
750:5	0.3	0.3	0.3	0.6	1.2	0.211
800:5	0.3	0.3	0.3	0.6	0.6	0.256
1000:5	0.3	0.3	0.3	0.3	0.6	0.368
1200:5	0.3	0.3	0.3	0.3	0.6	0.262
1500:5	0.3	0.3	0.3	0.6	0.6	0.328
1600:5	0.3	0.3	0.3	0.6	0.6	0.410
2000:5	0.3	0.3	0.3	0.3	0.6	0.347



Zero Sequence Current Transformers and Ground Fault Relays

Zero Sequence Current Transformers can be offered as option for all feeder breakers. The accuracy of the standard zero sequence CT's shall be C50 or higher. ABB is the preferred supplier. Along with the zero sequence CT an optional ABB Ground Fault Relay is available to select. If another ground fault relay is customer specified, factory will need to be contacted. The minimum depth of the switchgear shall be 68.9" (1750mm) when this option is selected.

Metering

The MaxSG switchgear allows for mounting of a variety of metering options.

Standard Multifunction Meter: Electro Industries Shark 200

Basic Features Summary

- Meets ANSI C12.20
- 0.2% Class Revenue Certifiable Energy and Demand Metering
- Multifunction Measurement
- 3 Line .56 inch LED display
- % of Load Bar for Analog Perception
- Standard RS485 (Modbus and DNP 3.0)
- IrDA Port for PDA Read
- Ultra-Compact
- Fits both ANSI and DIN Cutouts

The detail specification and wiring details can be found in Attachment 1 - Shark 200 Spec at the end of this document.

Other Multifunction Meters available are Electro Industries Shark 100, Nexus 1250, or customer specified.

Analog switchboard meters such as ammeters, voltmeters, watthour, power factor etc. are also available. As a standard ABB will supply Crompton Series 77 for these types of devices.

As a standard all metering devices are provided with their individual voltage protection by means of an ABB miniature breaker.

Breaker Control Switch

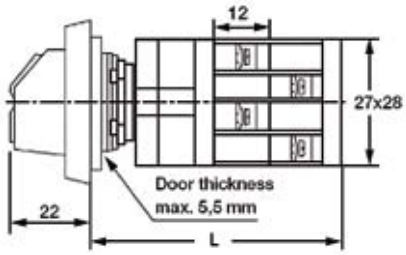
Electrically operated breakers can be provided with breaker control switches when a control device for the breakers is required. The standard offering is the Series 20 Electroswitch breaker control switch. As an option the Series 24 is available. Optional nameplates with LED's are available. Please see Layout section below for restrictions.

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 is used as a standard. Optional switches can be provided upon request.



Test Switches and Plugs

As an option the ABB MaxSG switchgear will allow the installation of the ABB FT-1 or FT-14 test switch or test plugs. The test switch may be utilized for current transformer and potential transformer testing. ABB provides shorting blocks for current transformers as a standard. All Flexitest Switches shall meet or exceed all requirements of ANSI/ IEEE Standard C37.90 and are UL, CUL and CSA listed. As a standard ABB will offer the black cover test switch while the clear cover shall be an option.

Space Heaters, Thermostats, and Humidistat

One space heater per section mounted in the bottom C channel frame piece of the main bus compartment is provided as a standard. Optional space heaters are available to be mounted in the bottom C channel frame piece in the cable compartment cable compartment. Heaters are rated for 240VAC; 250W operated at 120VAC and are enclosed in a metal protective housing mounted. The thermostat utilized with space heaters has an operating range of -10/100 Degrees Fahrenheit type SPST rated at 22A operating at 120/240VAC. A humidistat controller is also available.

Emax Power Breakers
Interrupting Ratings

Ratings

The MaxSG is designed to accommodate up to four high drawout type Emax power circuit breakers. Each circuit breaker is located in a completely enclosed ventilated compartment with top, bottom, and rear grounded steel barriers.

There are four available frame sizes that may be used in the MaxSG: E2, 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

		Rated Short Time						
Frame Size	Circuit Breaker Model	240V [kA]	480V [kA]	600V [kA]	Rated Time current [kA]	**Make time (max)**	**Break Time (I<ST current) (max) ms**	**Break Time (I>ST current) (max) ms**
1600	E2 B-A	42	42	42	42	80	70	30
800,1200, 1600	E2 N-A	65	50	50	50	80	70	30
800,1200, 1600	E2 S-A	65	65	65	65	80	70	30
2000, 2500	E3 N-A	65	50	50	50	80	70	30
800,1200, 1600, 2000,	E3 S-A	85	65	65	65	80	70	30
800,1200, 1600, 2000,	E3 H-A	85	85	85	65	80	70	30
800,1200, 1600, 2000,	E3 V-A	125	125	100	85	80	70	30
2500, 3200	E4 S-A	85	65	65	65	80	70	30
2500, 3200	E4 H-A	100	85	85	85	80	70	30
2500, 3200	E4 V-A	100	100	100	100	80	70	30
2500, 3200	E4 L-A	150	150	100	100	80	70	30
4000	E6 H-A	125	85	85	100	80	70	30
4000	E6 V-A	125	125	100	100	80	70	30
4000	E6 L-A	150	150	100	100	80	70	30

ABB offers UL switches; electrical characteristics shown below.

Table 2: Emax Switches Interrupting Rating

Frame Size	Circuit Breaker Model	Rated Short Time Current 600V [kA]
1600	E2B-A/MS	42
800,1200, 1600	E2N-A/MS	50
800,1200, 1600	E2S-A/MS	65
2000, 2500	E3N-A/MS	50
800,1200, 1600, 2000	E3S-A/MS	65
800,1200, 1600, 2000	E3V-A/MS	85
2500, 3200	E4S-A/MS	65
2500, 3200	E4H-A/MS	85
3200	E4V-A/MS	100
4000	E6H-A/MS	100

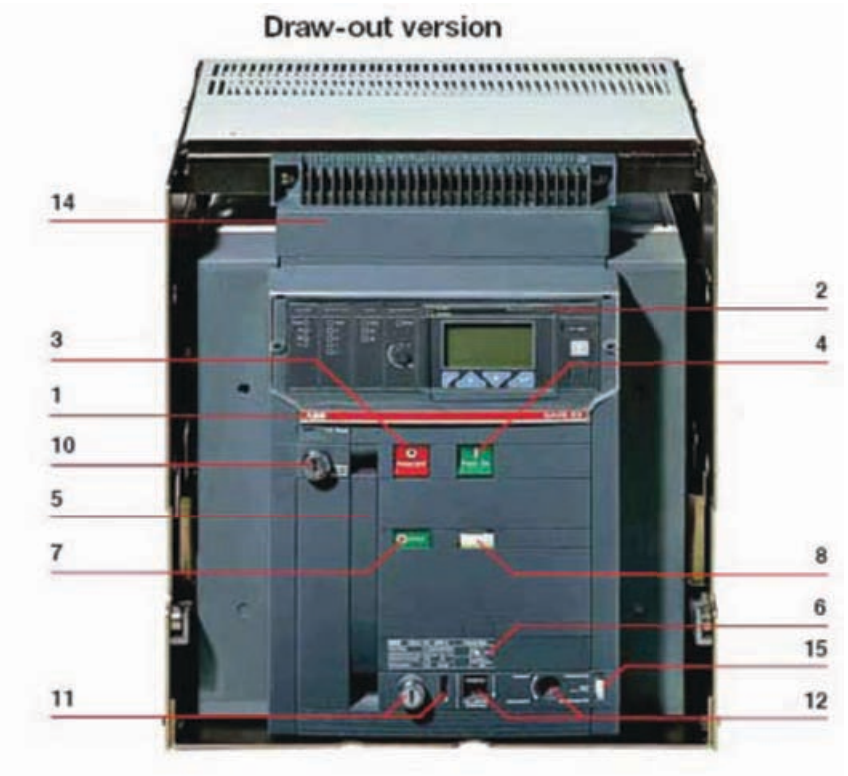
Table 3: Emax Circuit Breaker Rating Plugs for Electronic Trip Units

Type of circuit breaker	Rated Current Iu	Ln [A] 400	600	800	1000	1200	1600	2000	2500	3000	3200	3600	4000
E2 B-A	1600	•	•	•	•	•	•						
E2S-A	800	•	•	•									
	1200	•	•	•	•	•							
	1600	•	•	•	•	•	•						
E3N-A	2000	•	•	•	•	•	•	•					
	2500	•	•	•	•	•	•	•	•				
E3S-A	800	•	•	•									
	1200	•	•	•	•	•							
	1600	•	•	•	•	•	•						
	2000	•	•	•	•	•	•	•					
E3H-A	800	•	•	•									
	1200	•	•	•	•	•							
	1600	•	•	•	•	•	•						
	2000	•	•	•	•	•	•	•					
E3V-A	800	•	•	•									
	1200	•	•	•	•	•							
	1600	•	•	•	•	•	•						
	2000	•	•	•	•	•	•	•					
E4S-A	3200			•	•	•	•	•	•	•	•		
E4H-A	3200			•	•	•	•	•	•	•	•		
E4V-A	3200			•	•	•	•	•	•	•	•		
E4L-A	3200			•	•	•	•	•	•	•	•		
E6H-A	4000			•	•	•	•	•	•	•	•	•	•
E6V-A	4000			•	•	•	•	•	•	•	•	•	•

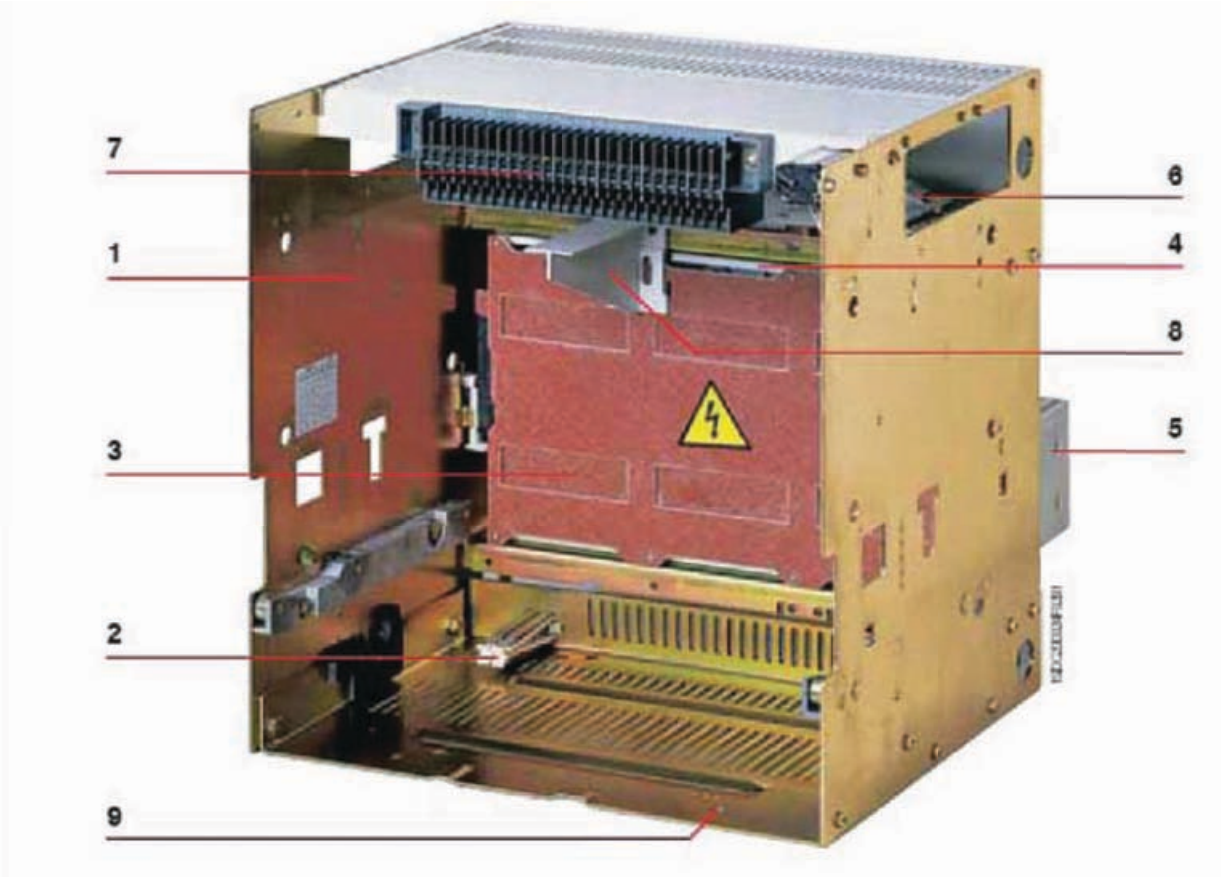
Construction Characteristics

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

Caption	
1	Trademark and size of circuit
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 drawout version only)
12	Racking-in/racking out device (for draw out version only)
13	Terminal box (for fixed version only)
14	Sliding contacts (fro draw out version only)
15	Circuit breaker position indicator: connected/ isolated for test/racked-out (for draw out version only)



Emax Power Breakers
Cradle Details

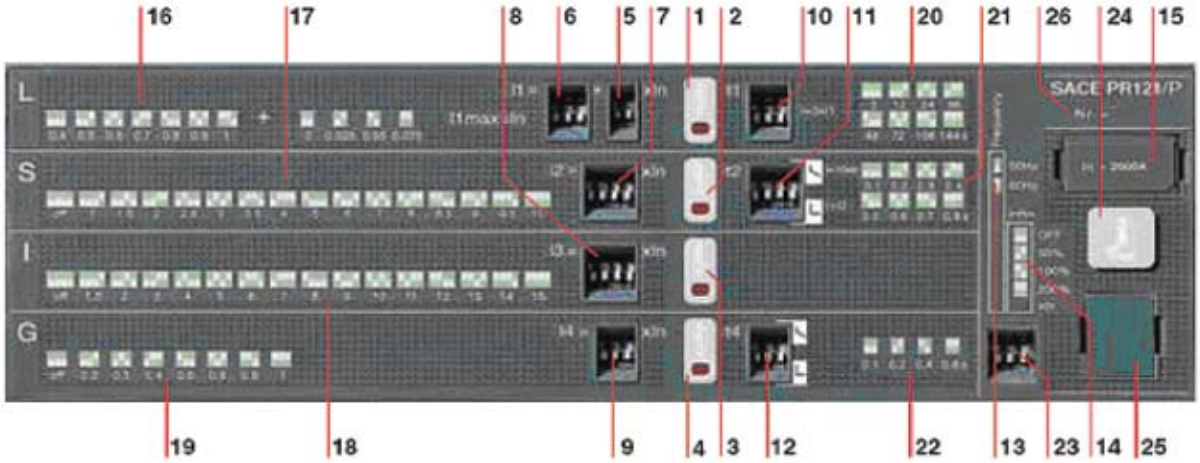


Caption

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)

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 signalling and monitoring, or remote supervision display.



Legend

1 LED signaling Alarm for protection Function L

2 LED signaling Alarm for protection function S

3 LED signaling Alarm for protection function I

4 ED signalling Alarm for protection function I1

5 IP switches for fine setting current threshold I1

6 IP switches for main setting current threshold I1

7 P switches for setting current threshold I2

8 IP switches for setting current threshold I3

9 DIP switches for setting current threshold I4

10 DIP switches for setting trip timet1 (type of curve)

11 DIP switches for setting trip timet2 (type of curve)

12 DIP switches for setting trip timet4 (type of curve)

13 Indication of the DIP switch position for network frequency

14 Indication of the DIP switch position for Neutral protection setting

1 5 Rating plug

16 Indication of the DIP switch positions for the various current thresholds values I1

17 Indication of the DIP switch positions for the various current threshold values I2

18 Indication of the DIP switch positions for the various current threshold values I3

19 Indication of the DIP switch positions for the various current threshold values I4

20 Indication of DIP switch positions for the various time settings t1

21 Indication of DIP switch positions for the various time settings t2

22 Indication of DIP switch positions for the various time settings t4

23 DIP switch for setting network frequency and neutral protection setting

24 Trip cause indication and trip test pushbutton

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)

26 Serial number of protection release

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 I2t = 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/I2).

15 current thresholds and 8 curves are available, allowing a _ne 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).

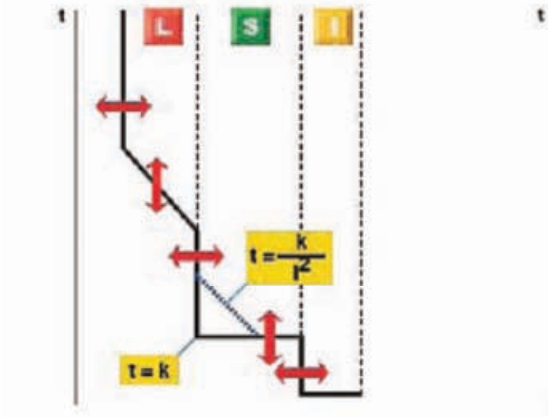
Ground fault (G)

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

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



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 BT030wireless 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 _owing 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.

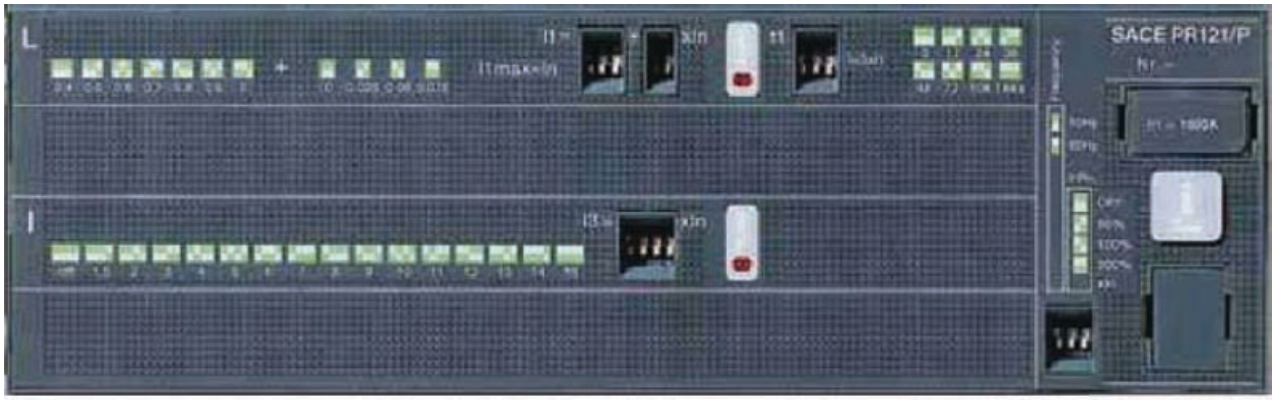
Test Function

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.

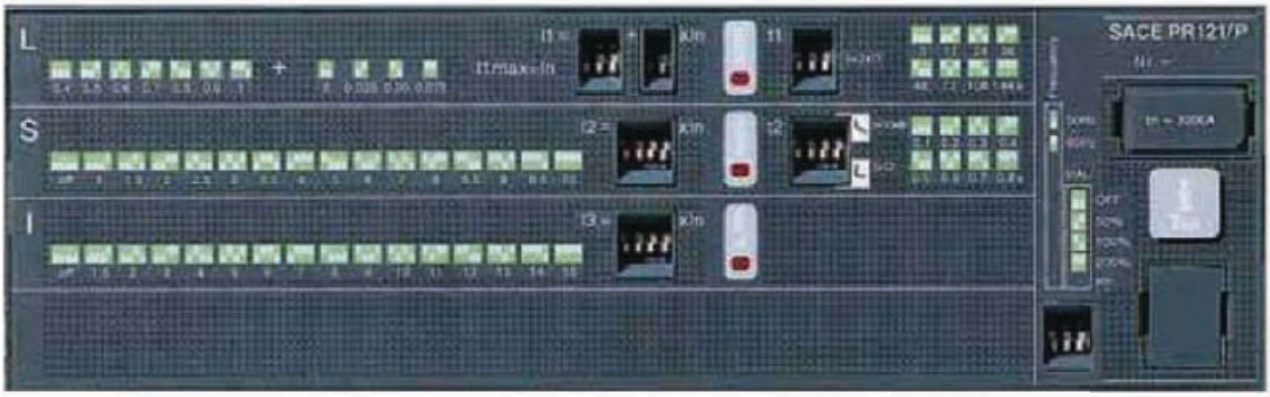
Emax Power Breakers
Trip Units PR121/P

Versions available

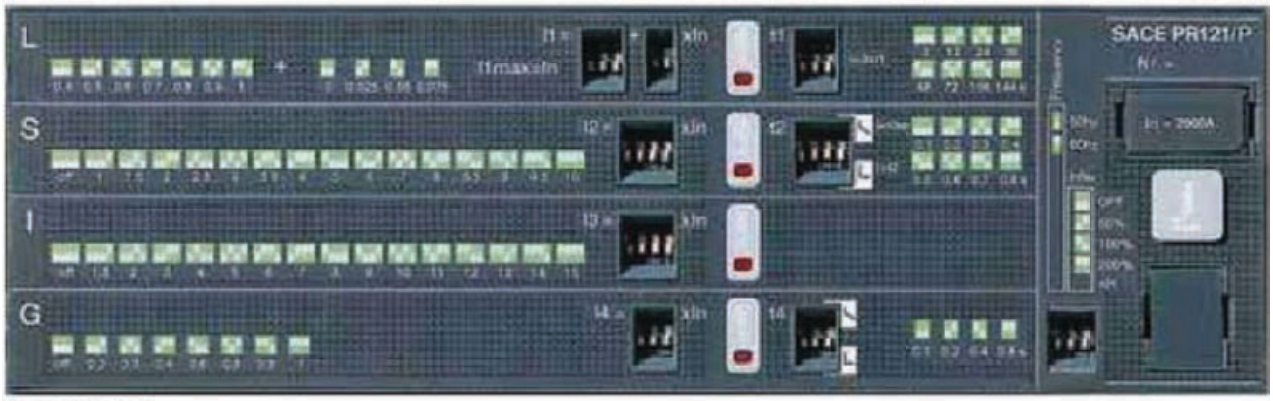
The following versions are available.



PR121/P LI



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		
		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 - 0.8 s	■	$t=k/I^2$
	Tolerance (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%		
		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
	Tolerance (2)	± 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

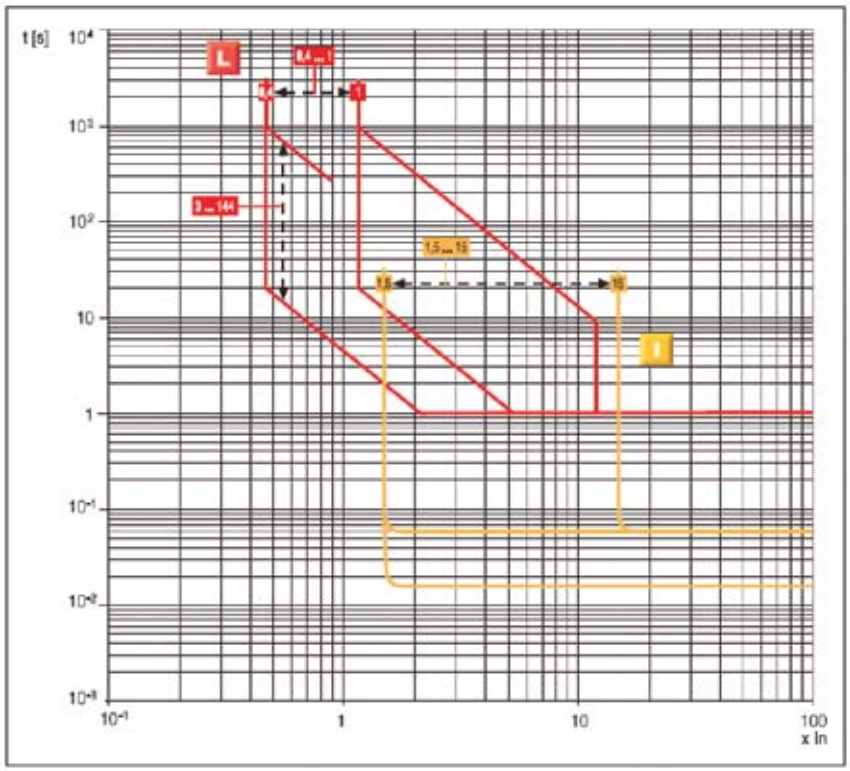
The unit does not require an external power supply either for protection functions or for alarm signaling functions. It is self-supplied by means of the current sensors installed on the circuit breaker.

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.

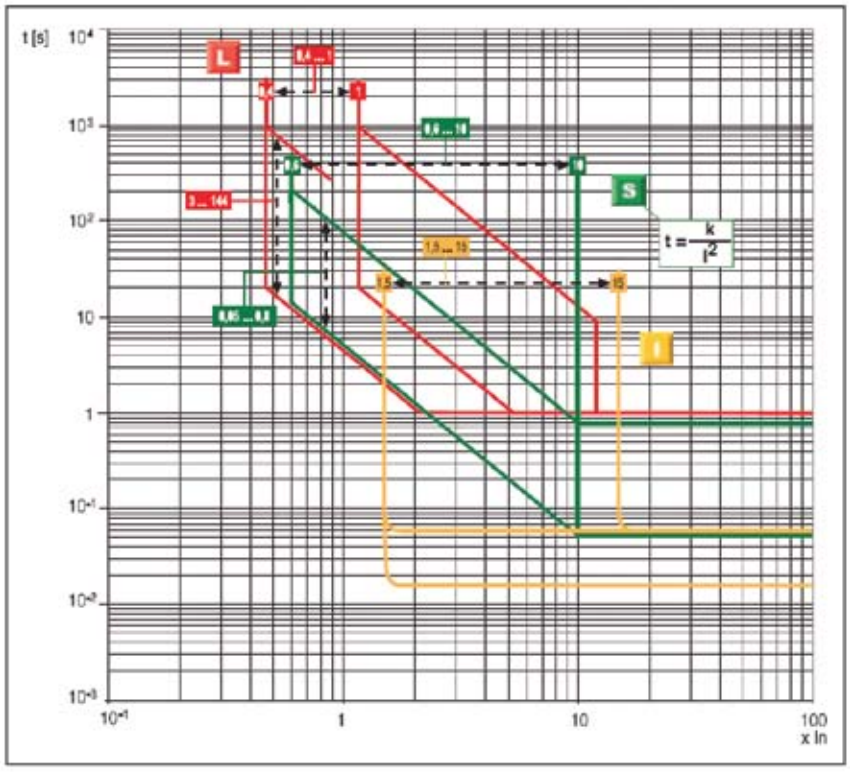
	PR121/P
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%
Maximum ripple	5%
Inrush current @ 24V	~10 A for 5 ms
Rated power @ 24V	~2 W

Emax Power Breakers
Trip Units PR121/P

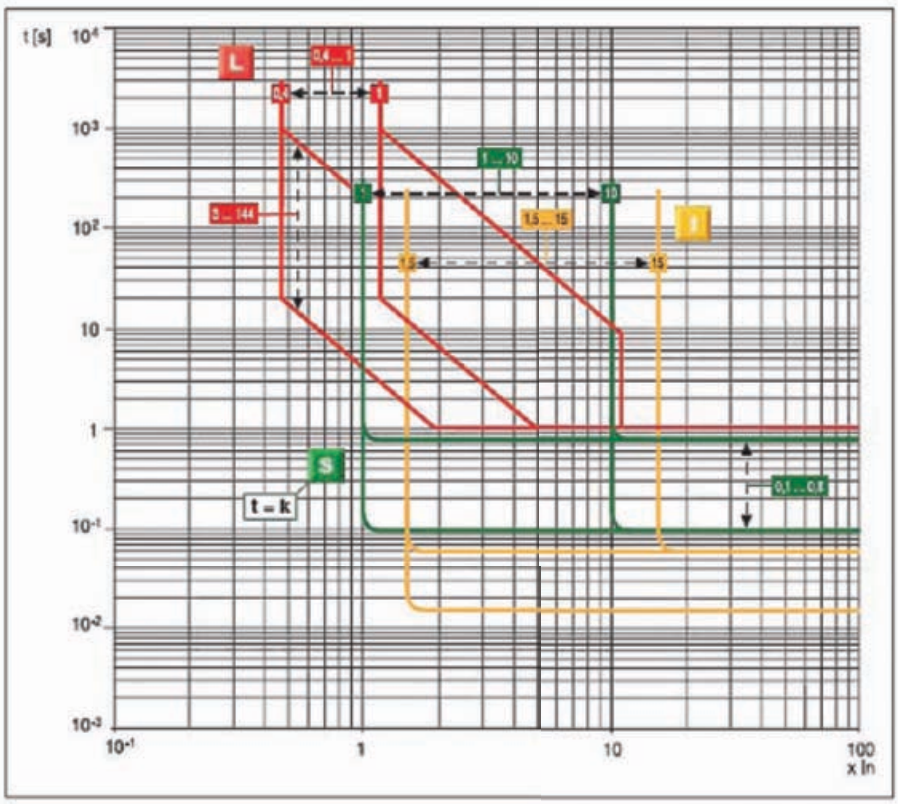
Functions L-I



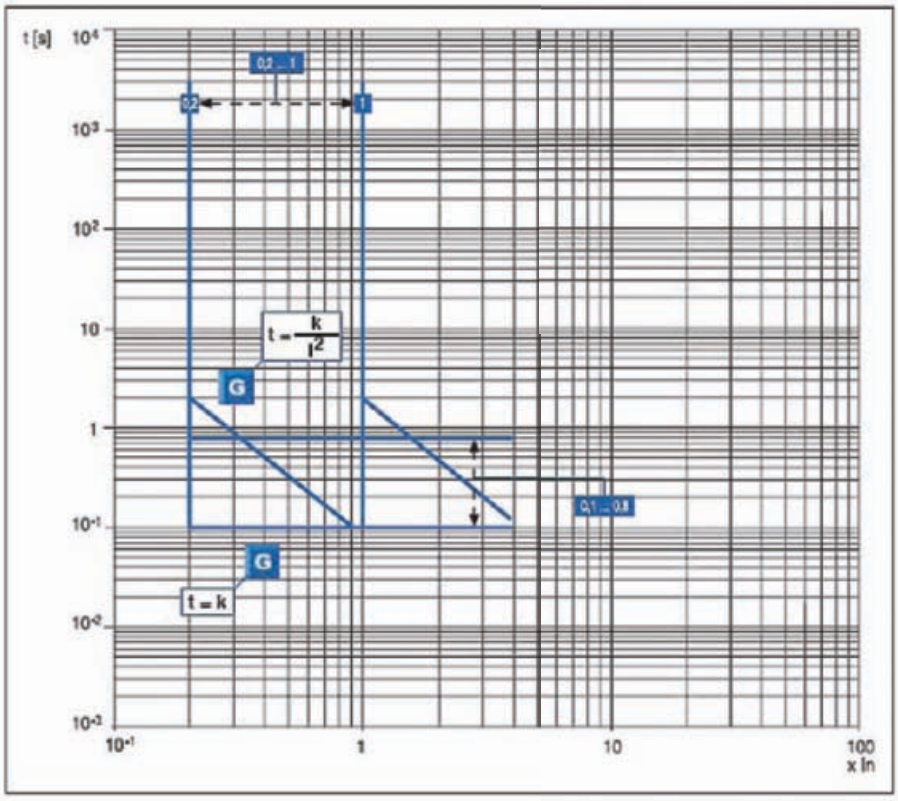
Functions L-S-I



Functions L-S-I



Function G



Emax Power Breakers
Trip Units PR122/P

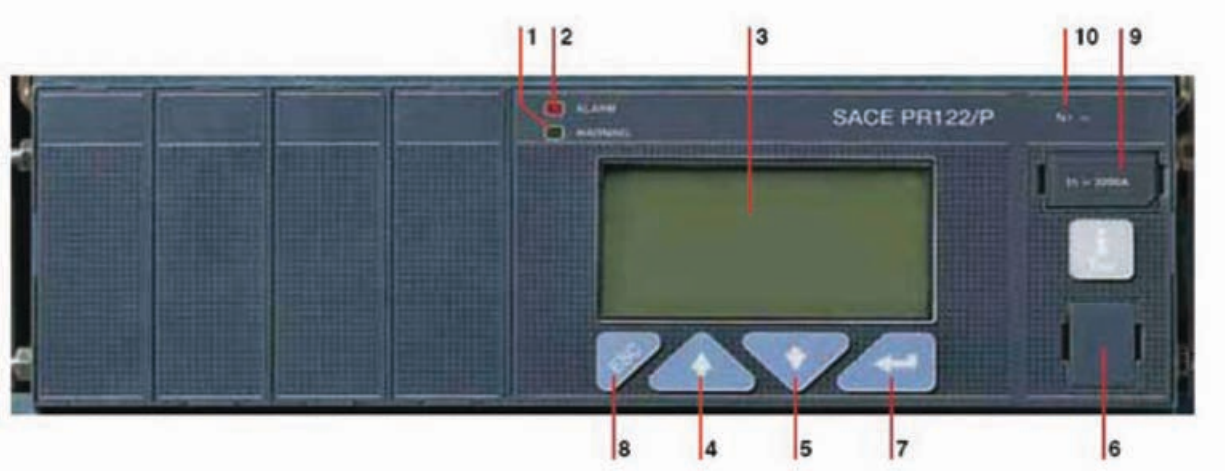
The SACE PR122 release is a sophisticated and flexible protection system based on a state-of the art microprocessor and DSP technology. Fitted with the optional internal PR120/D-M dialogue unit, PR122/P turns into an intelligent protection, measurement and communication device, based on the Modbus protocol.

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: I2 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

2 Alarm LED

3 Rear-lit graphic display

4 Cursor UP button

5 Cursor DOWN button

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)

7 ENTER button to confirm data or change pages

8 Button to exit submenus or cancel operations (ESC)

9 Rating plug

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).

Thestart-upphaselasts-from100 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 (see the "Installations" chapter)

(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:

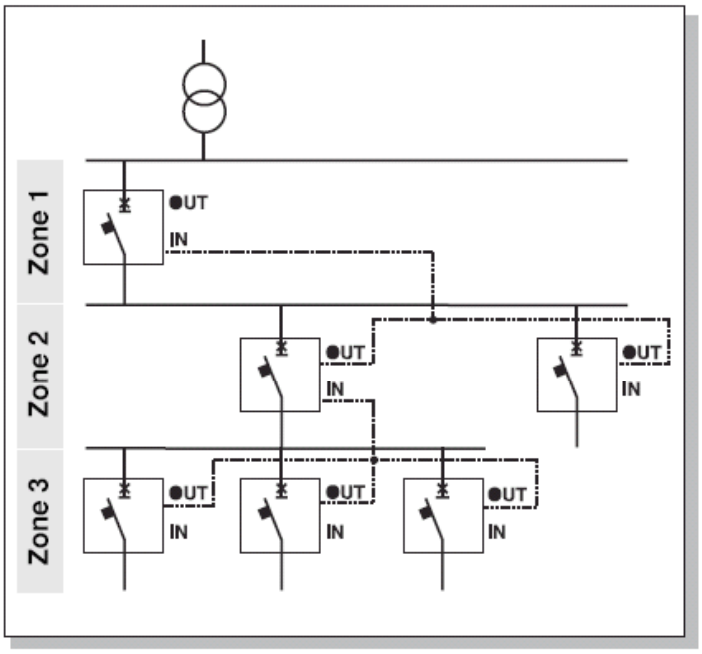
– lighting up of the “Warning” LED when the temperature is higher than 70 °C (temperature at which the microprocessor is still able to operate correctly)

– 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 co-ordination 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 left). 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-Mand PR120/D-BTmodules 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 TestBus2 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 TestBus2 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 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

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/I²	■	–
	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 (3)	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					
		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/I²	■	–
	Tolerance (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					
		I4= 0.2....1 x In	0.02 x In	t4= 0.1 s.....1 s (with I=4xIn)	0.05 s	■	t=k/I²	–	■
	Tolerance (2)	± 7%		± 15%					
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%

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

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 100 A.

For the display to come on, at least one phase must have a current load higher than 160 A. The 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.

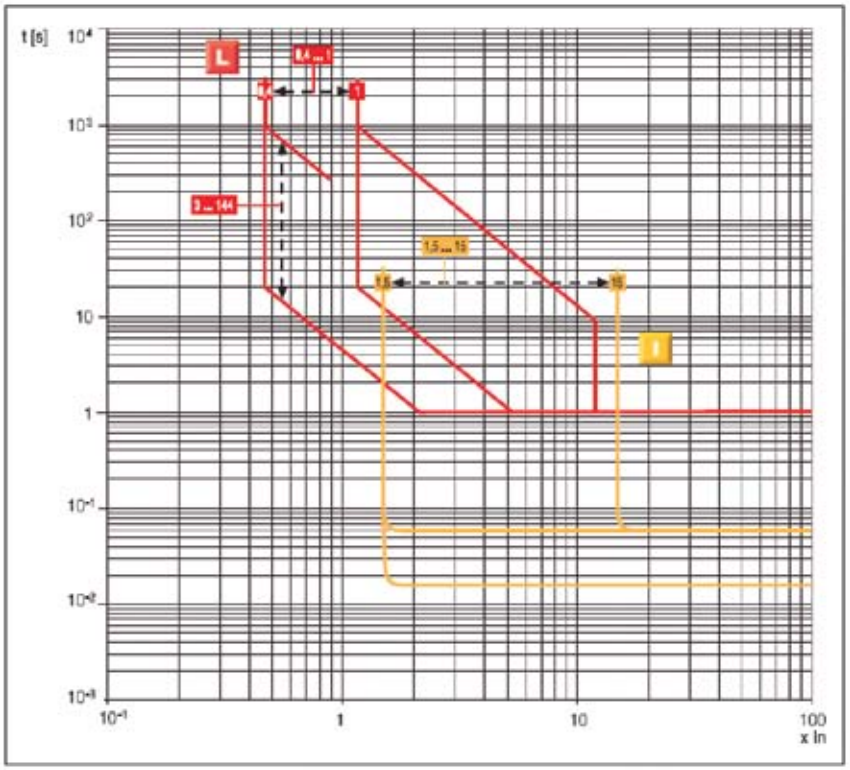
It is also possible to use an auxiliary power supply provided by the PR030/B portable battery unit (always supplied), which allows the protection functions to be set when the release is not self-supplied.

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.

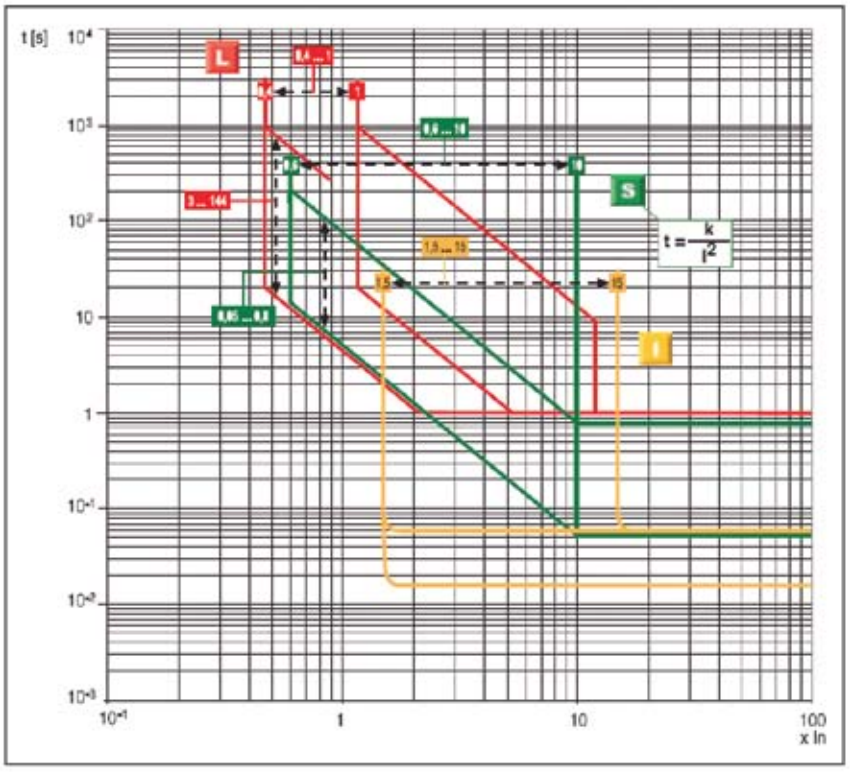
	PR122/P	PR120/D-M	PR120/K	PR120/D-BT
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	from PR122/PR123	from PR122/PR123	from PR122/PR123
Maximum ripple	5%			
Inrush current @ 24V	~10 A for 5 ms			
Rated power @ 24V	~3 W	+1 W	+1 W	+1 W

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

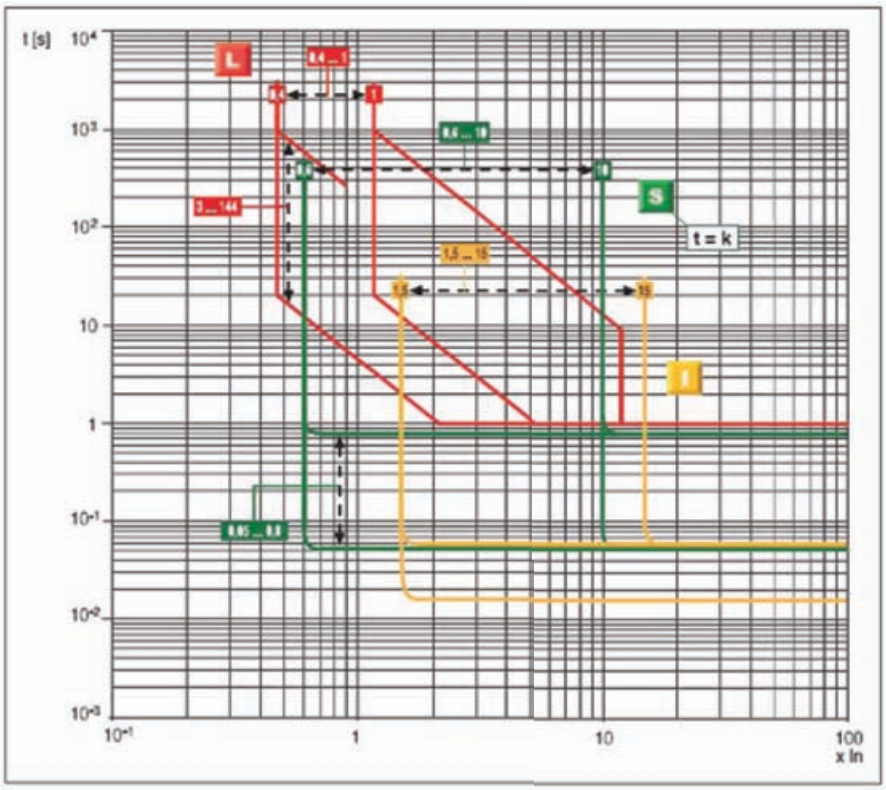
Functions L-I



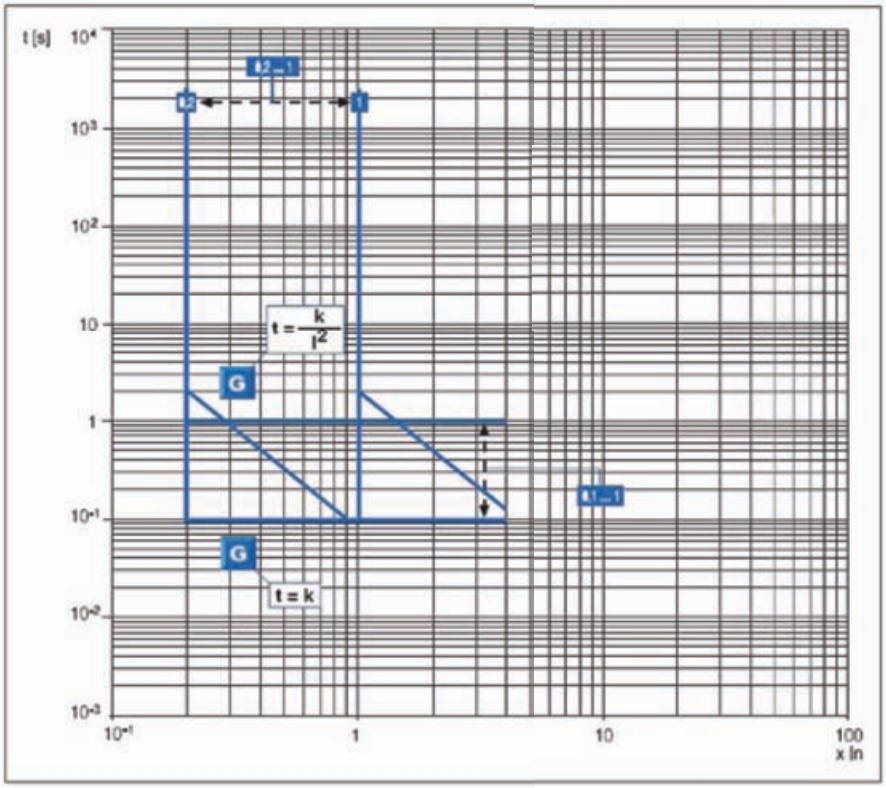
Functions L-S-I



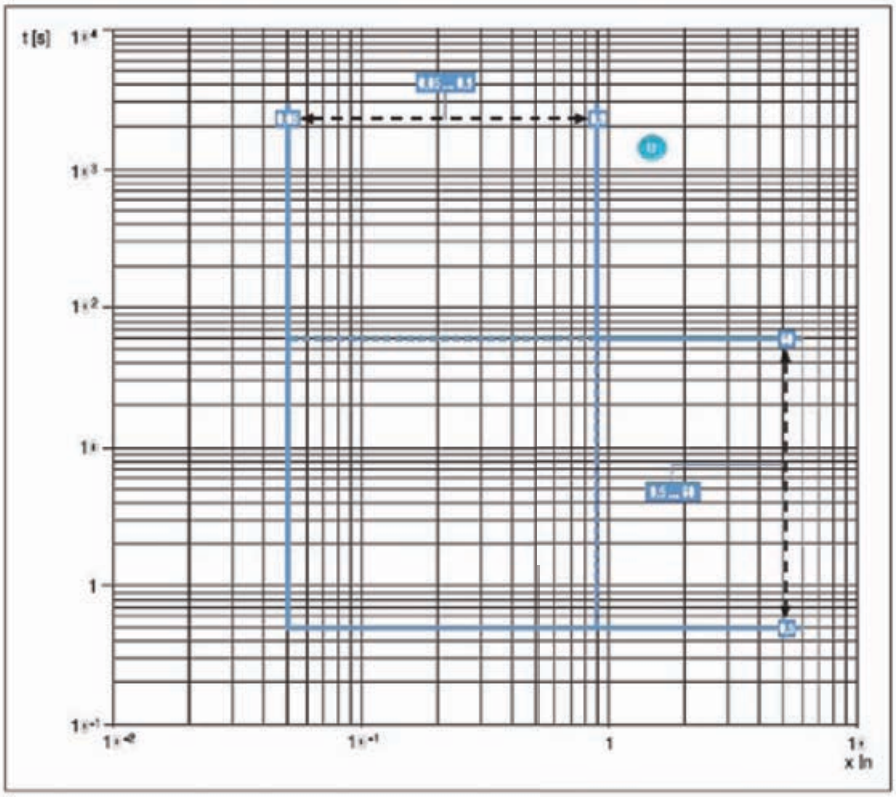
Functions L-I



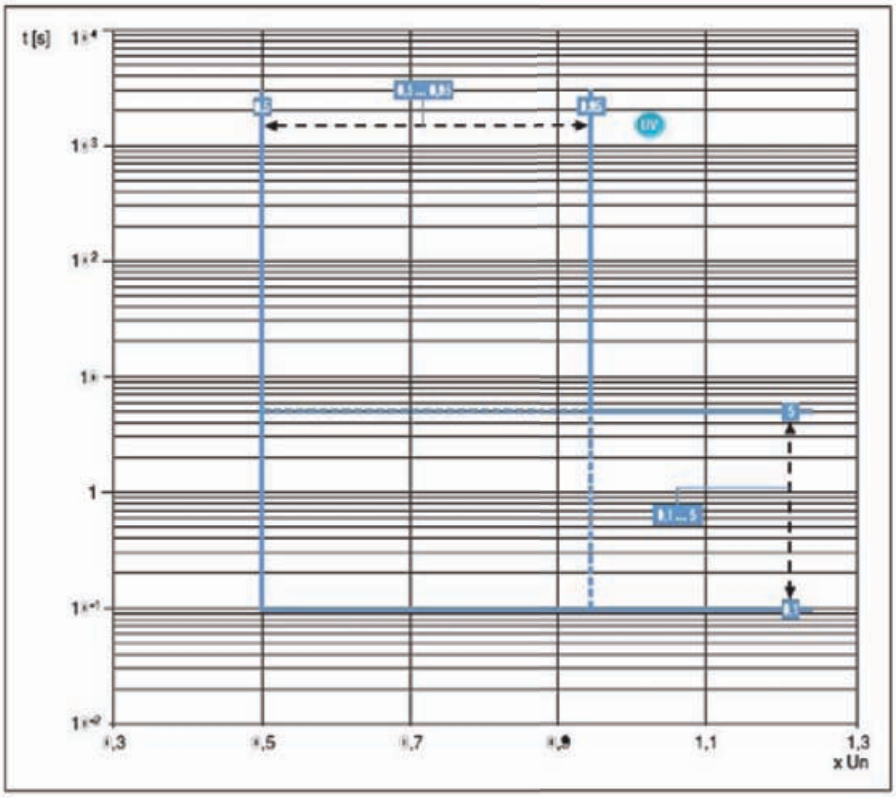
Function G



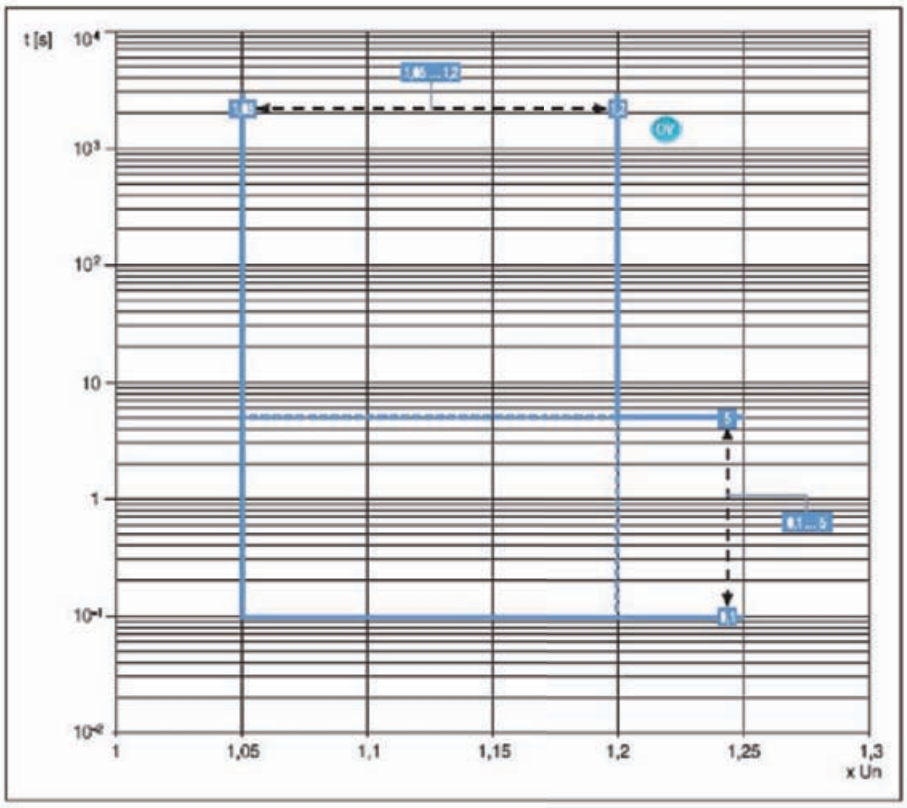
Function U



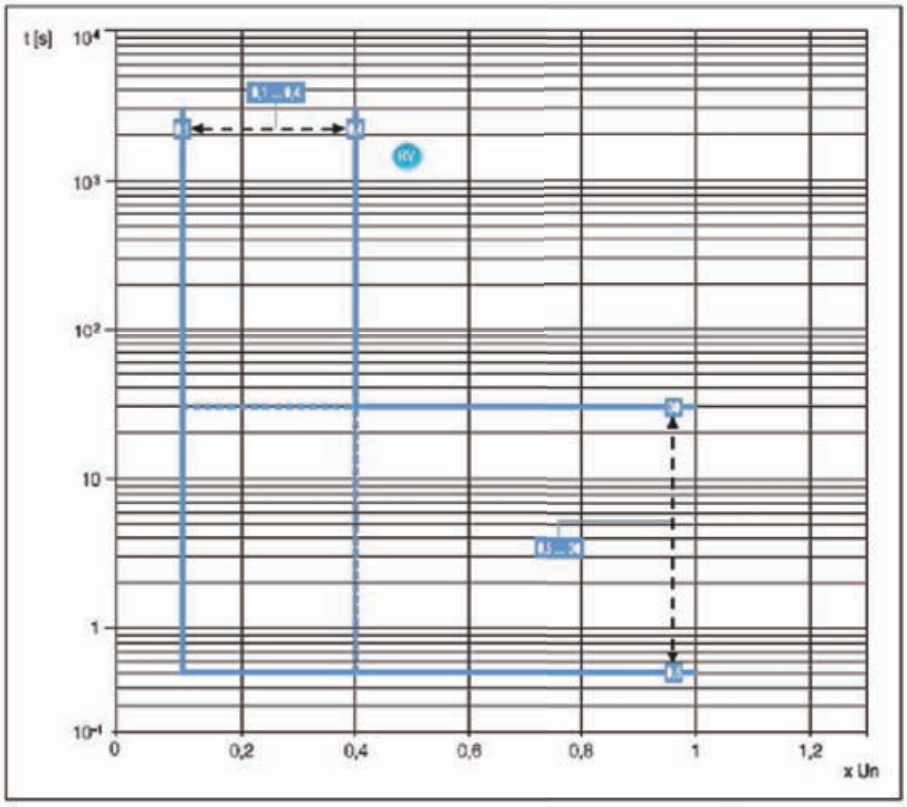
Function UV



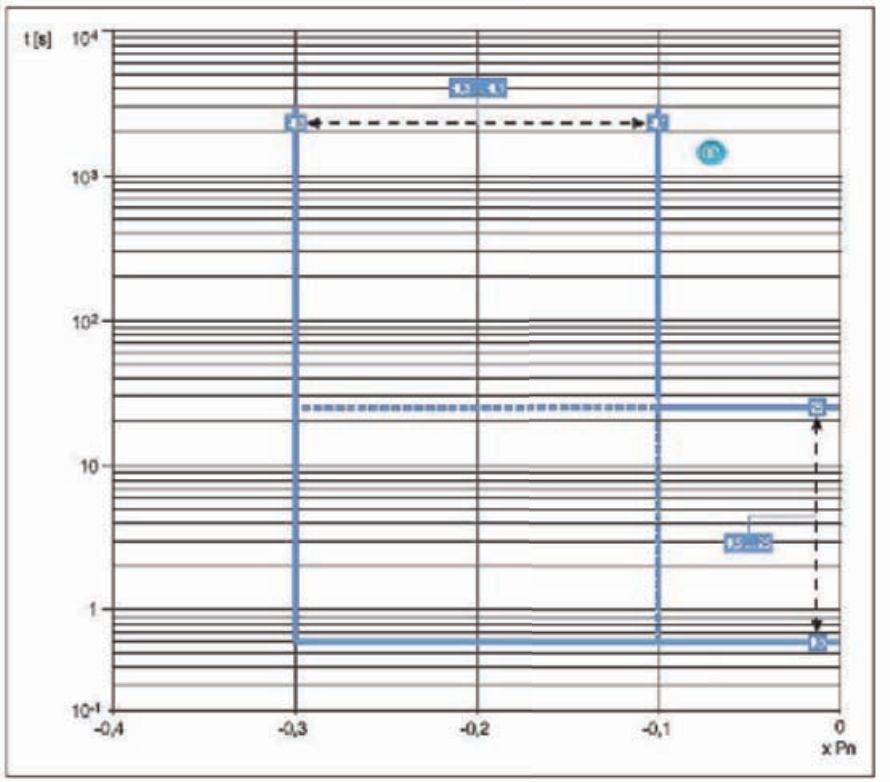
Function OV



Function RV



Function RP



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 evolute 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

2 Alarm LED

3 Rear-lit graphic display

4 Cursor UP button

5 Cursor DOWN button

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)

8 Button to exit submenus or cancel operations (ESC)

9 Rating plug

10 Serial number of protection release

11 PowerLED

12 Voltage-uptake switch-disconnector

Protection functions

- The PR123 release offers the following protection functions:
- Overload (L) (1),
- 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 40thharmonic (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.

Notes:

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.

Protection functions and setting values - PR123

	Function	Trip threshold	Threshold steps	Trip Time	Time Step	Can be excluded	Relation t=f(I)	Thermal memory	Zone selectivity
L	Overload protection	I1= 0.4....1 x In	0.01 x In	With current I = 3xI1 t1= 3 s....144 s	3 s (1)	–	t=k/I²	■	–
	Tolerance (2)	Release between 1.05 and 1.2 x I1		± 10% Ig ≤ 4 x In ± 20% Ig > 4 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=3xIn(4); t1=3 s....144 s ± 20% Ig > 5 x I1 ± 30% 2xI1≤ Ig ≤ 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	0.01s	■	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 ± 7% Ig ≤ 4 x In ± 10% Ig > 4 x In	0.1 x In	With current I=10xIn; t2=0,05 s...0,8 s ± 15% Ig ≤ 4 x In ± 20% Ig > 4 x In	0.01s	■	t=k/I²	■	–
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 s	0.01s	■	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 ± 7% Ig ≤ 4 x In ± 10% Ig > 4 x In	0.1 x In	With I=10xIn; t2=0,05 s...0,8 s ± 15% Ig ≤ 4 x In ± 20% Ig > 4 x In	0.01s	■	t=k/I²	■	–
I	Instantaneous short-circuit protection	I3= 1.5....15 x In	0.1 x In	Instantaneous ≤ 30 ms	–	■	t=k	–	–
	Tolerance (2)	± 10%							
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=4xIn) ± 15%	0.05 s	■	t=k/I²	–	–
Rc	Residual Current protection	Id= 0.3-0.5-0.6-1-3-5-7-10-20-30 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%							
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					
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 hold in the following conditions:
- self-powered relay 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%

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 100 A. For the display to come on, at least one phase must have a current load higher than 160 A. The 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.

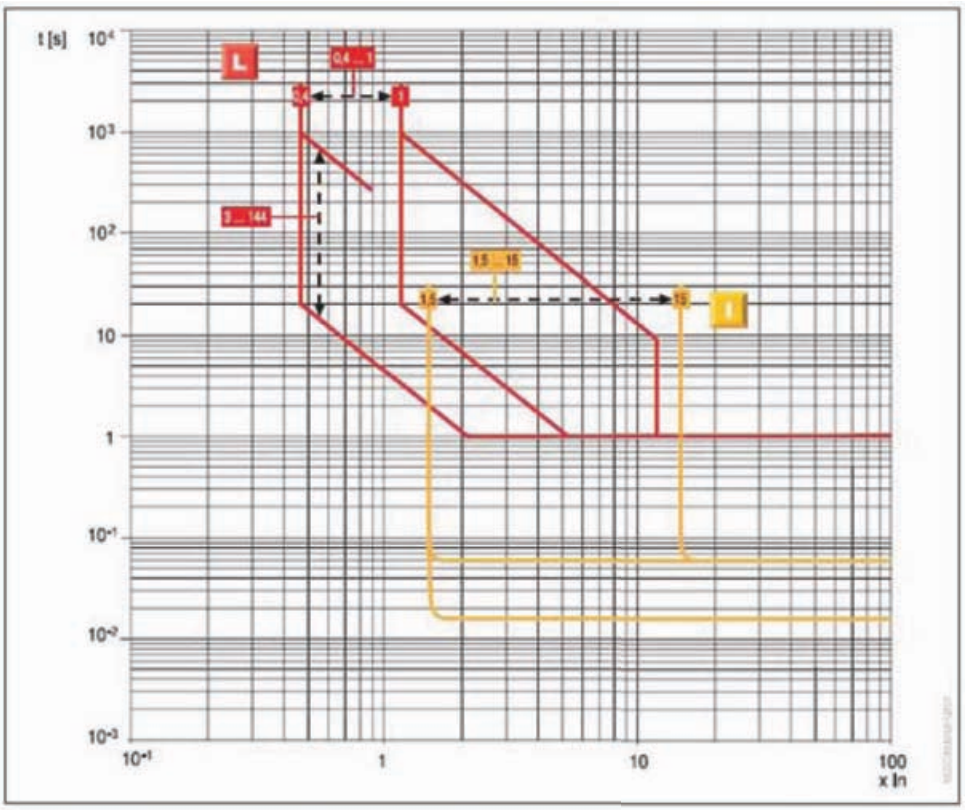
It is also possible to use an auxiliary power supply provided by the PR030/B portable battery unit (always supplied), which allows the protection functions to be set when the release is not self supplied.

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.

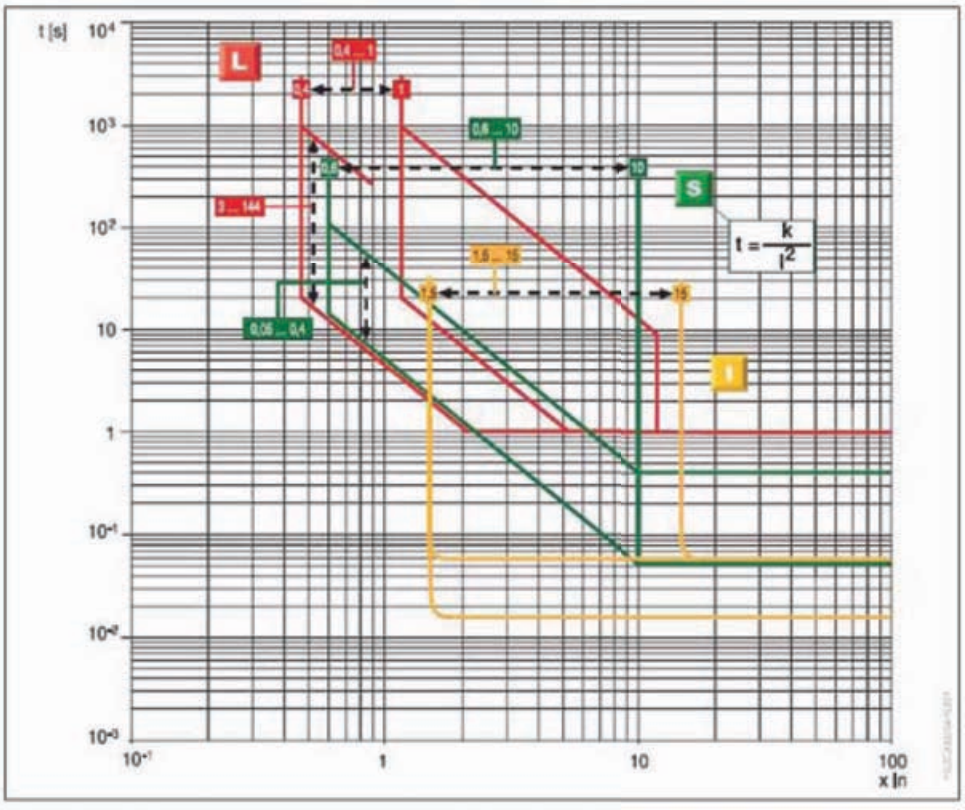
	PR123/P	PR120/D-M	PR120/K	PR120/D-BT
Auxiliary power supply (galvanically insulated)	24 V DC ± 20%	from PR122/PR123	from PR122/PR123	from PR122/PR123
Maximum ripple	5%			
Inrush current @ 24V	~10 A for 5 ms			
Rated power @ 24V	~3 W	+1 W	+1 W	+1 W

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

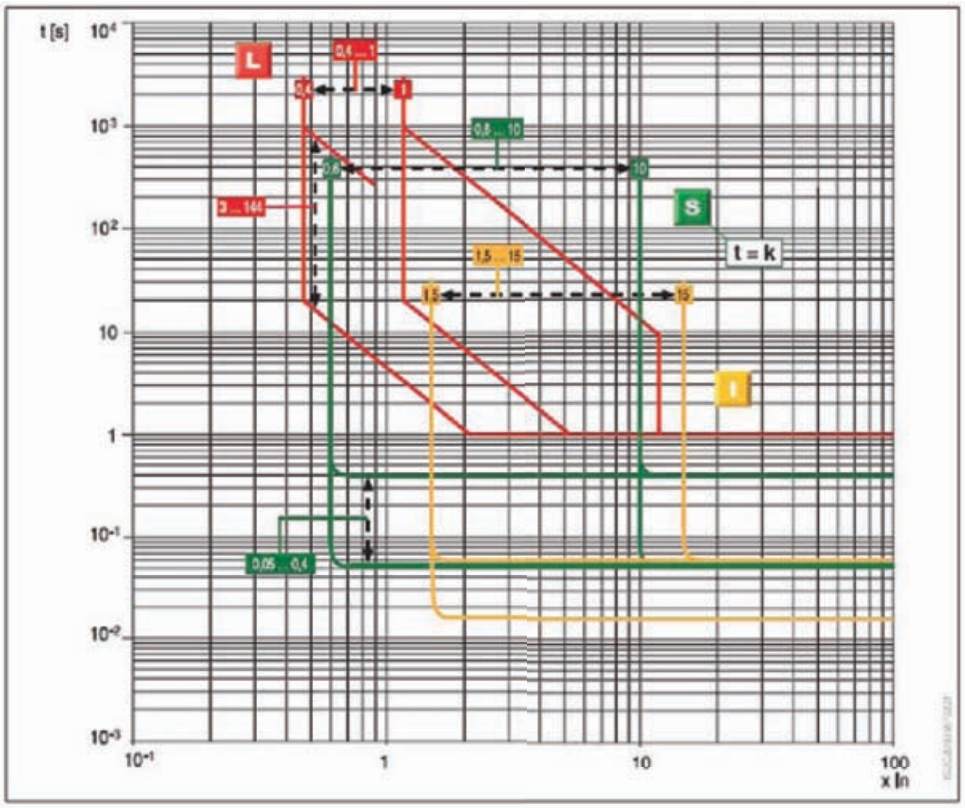
Functions L-I



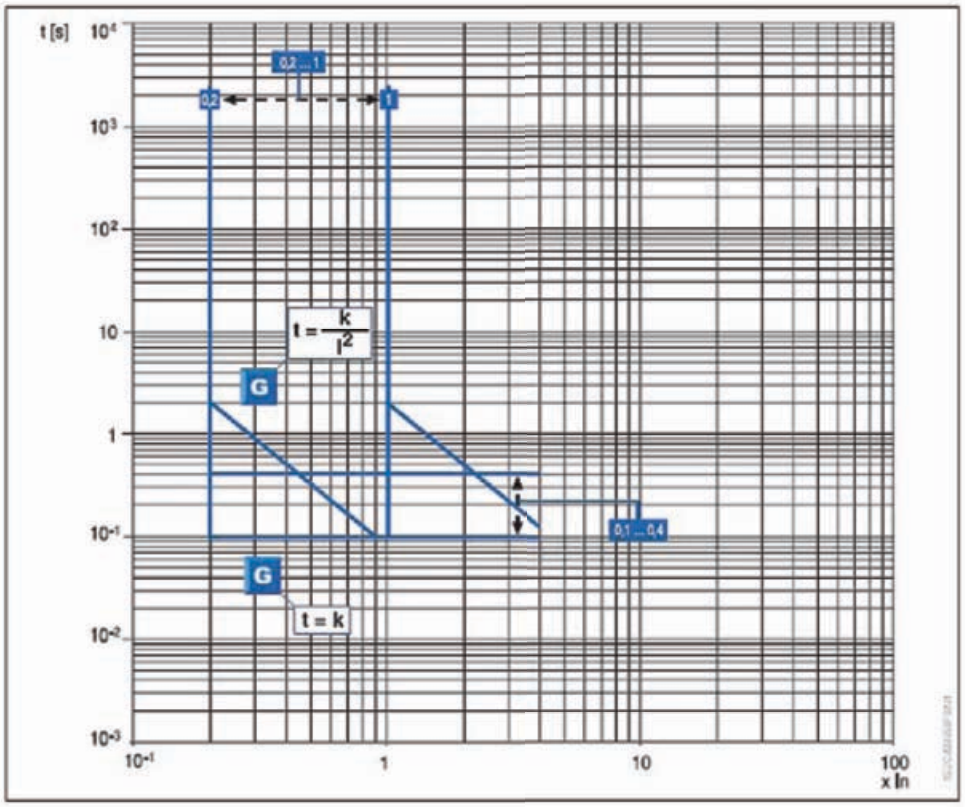
Functions L-S-I



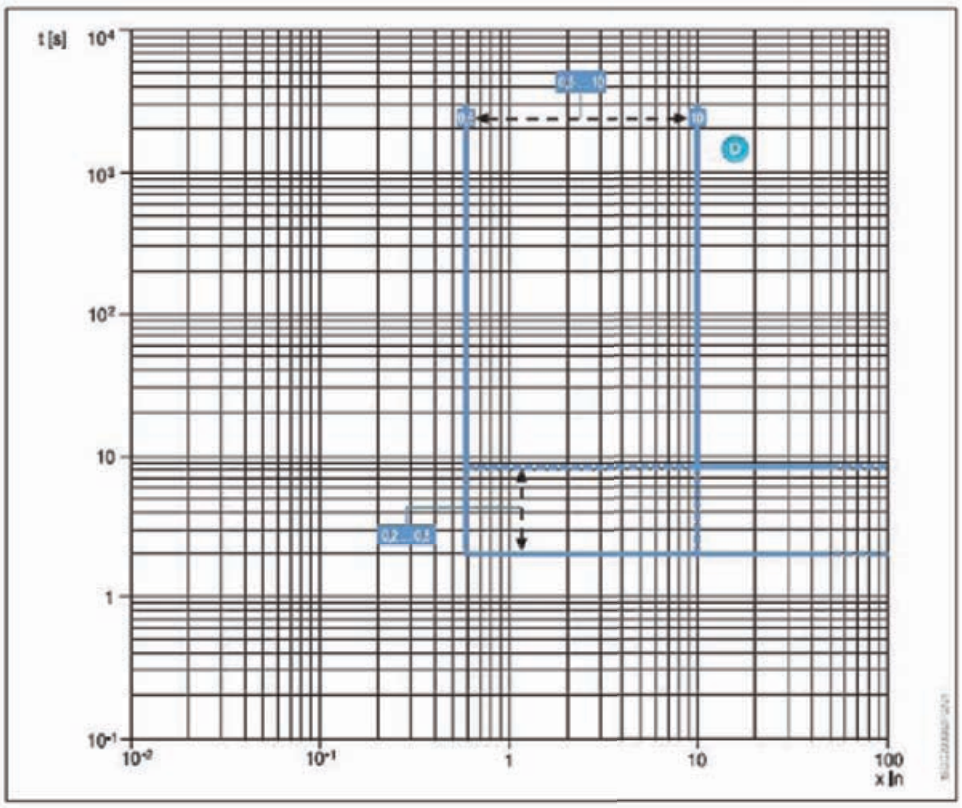
Functions L-S-I



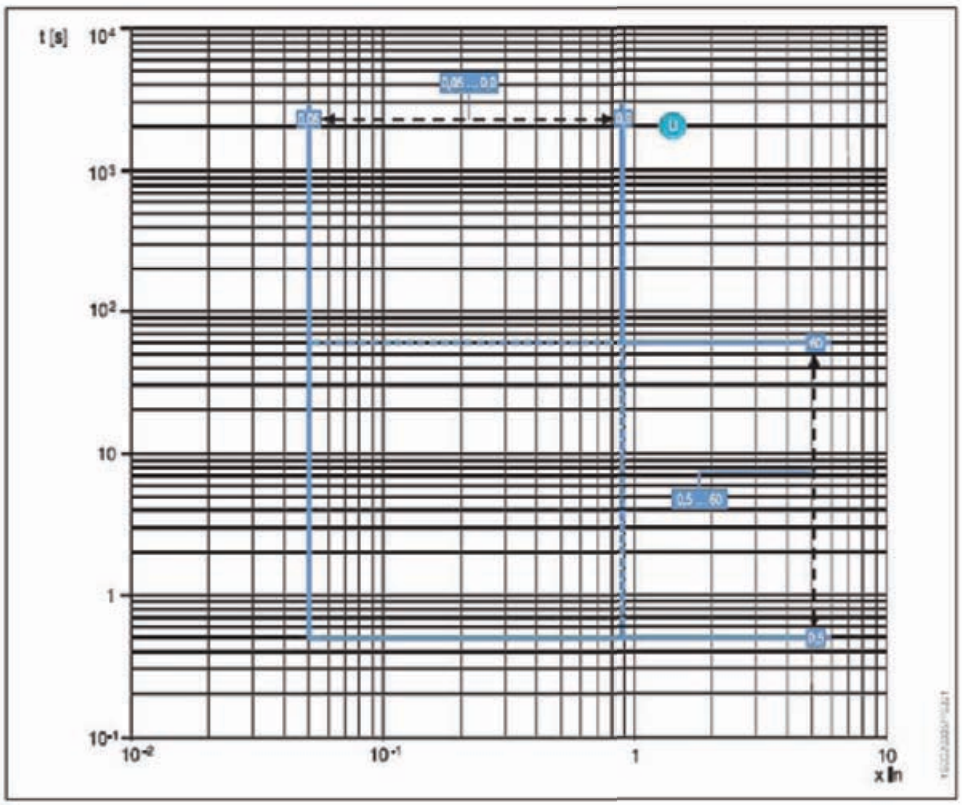
Functions G



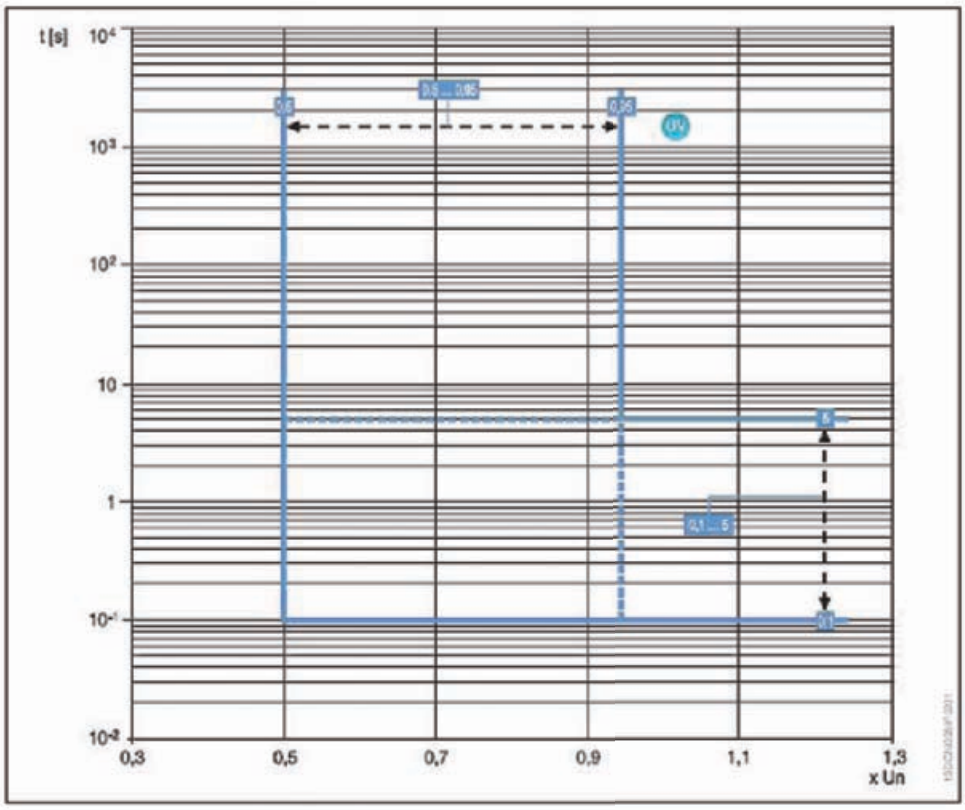
Functions D



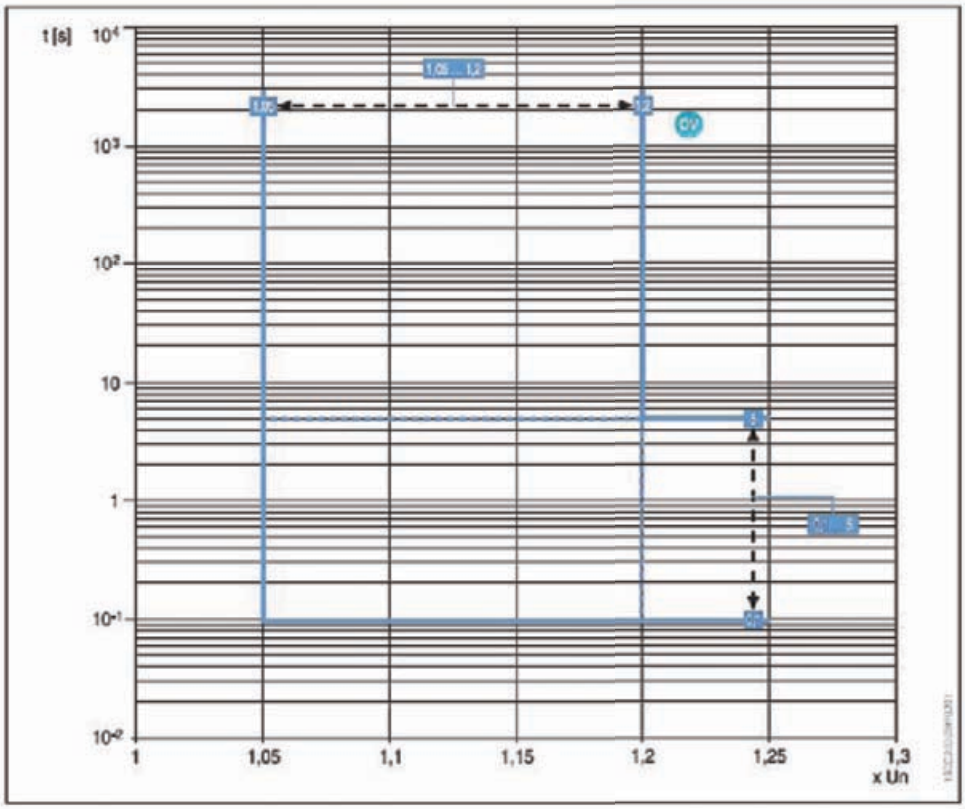
Functions U



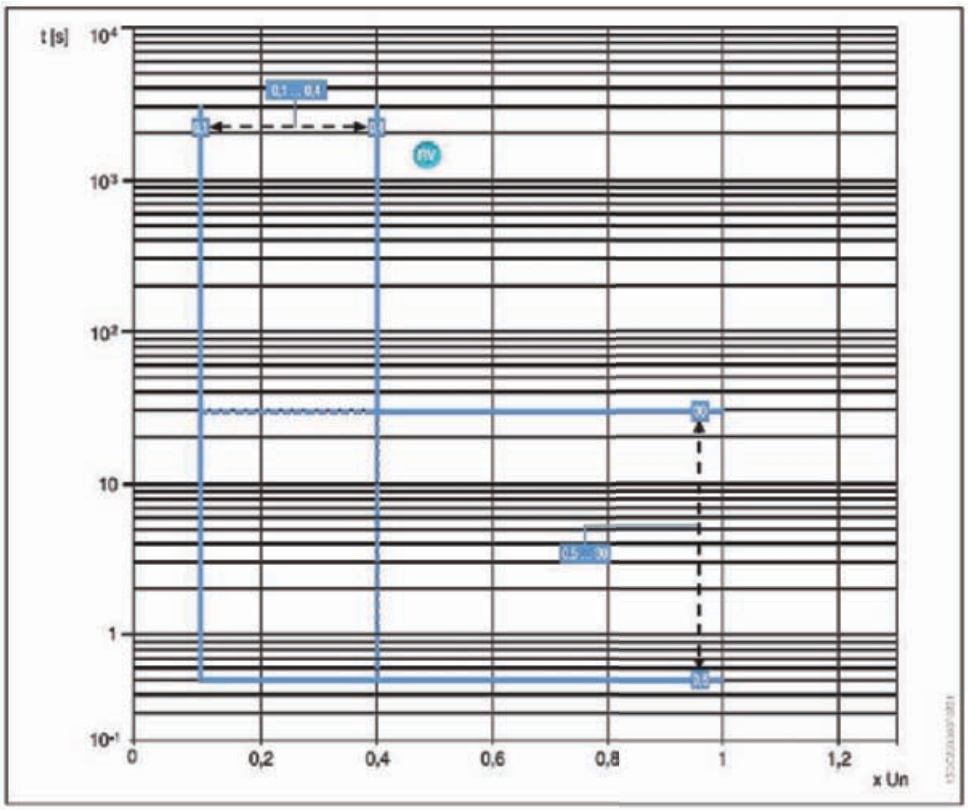
Functions UV



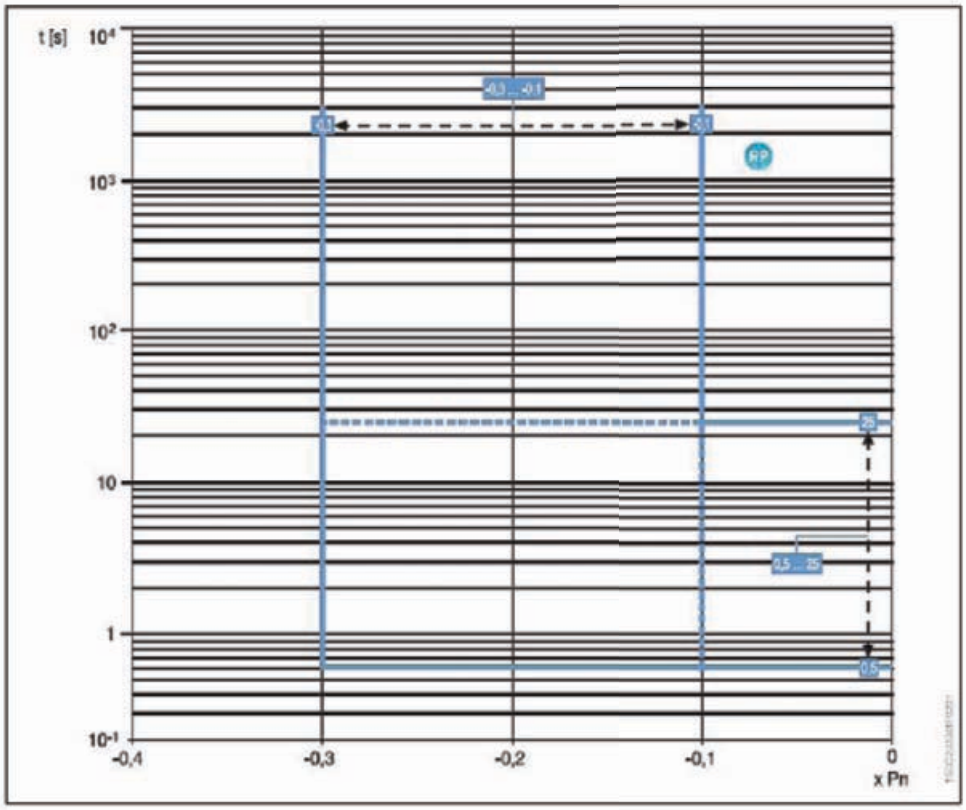
Functions OV



Functions RV



Functions RP



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 (see circuit diagrams Chapter 6).

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)		
	@ 30V DC	3.3 A
	@ 250V AC	5 A
Contact/coil insulation		2000 V eff (1 min@ 50 Hz)

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 PR122 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 PR122 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 genset.

PR120/D-M Communication Module

PR 120/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 precabled 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

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 VA
Maximum switching voltage		130 V DC/250 V AC
Maximum switching current		5 A
Breaking capacity (resistive load)		
	@ 30V DC	3.3 A
	@ 250V AC	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 are listed in the table below:

	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	19200 bps	19200 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 analisys 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	opt. (1)	■
Reverse power protection (timing and trip)	opt. (1)	■
Directional protection (timing and trip)	■	■
Underfrequency/overfrequency protection (timing and trip)	opt. (1)	■
Phases rotation		■
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 PR120/V

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

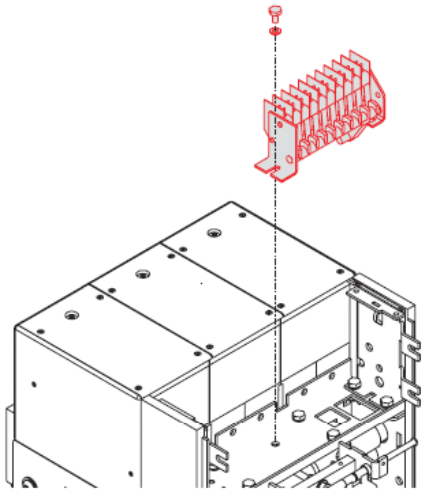
The versions available are as follows:

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 fasten connector on the microswitch.

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

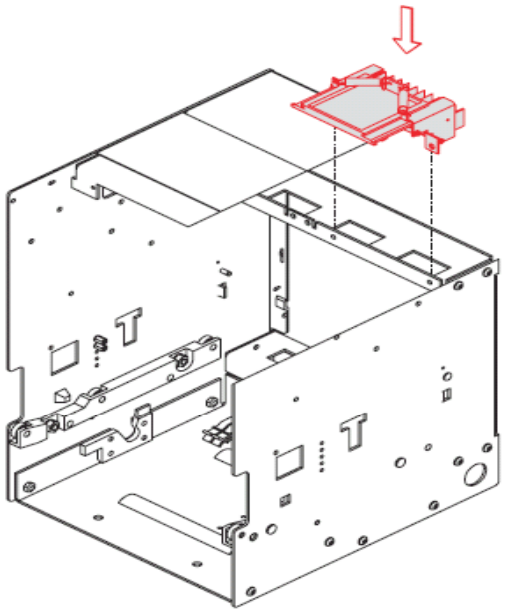


Electrical signaling of circuit breaker racked-in/test isolated/racked-out

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

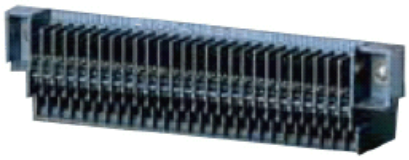
The auxiliary contacts take on the following configurations:

- 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, 2 contacts to signal the test position (main power isolated, but sliding contacts connected)



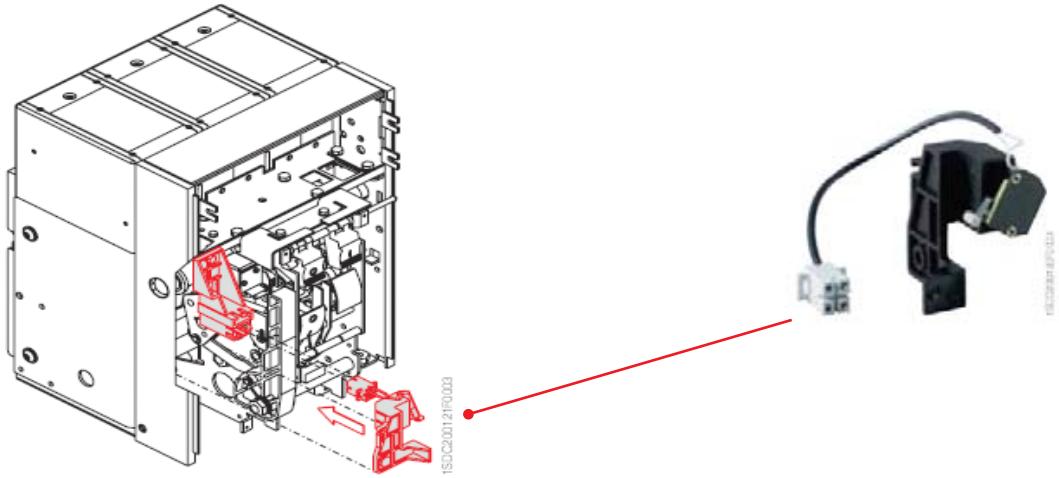
Sliding contacts

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 CONNECT position. Up to 54 points are available so that all circuit breaker accessories can be wired to dedicated disconnect points.



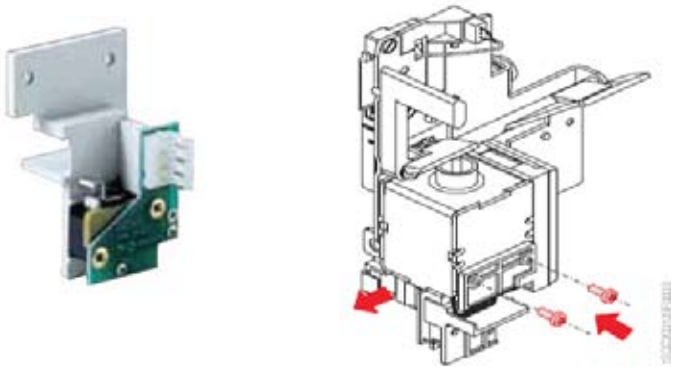
Contact signaling closing springs charged

A microswitch allows remote signaling of the status of the closing springs (always supplied with the spring charging geared motor).



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

The undervoltage releases can be fitted with a contact for signaling remotely the status of the undervoltage release.

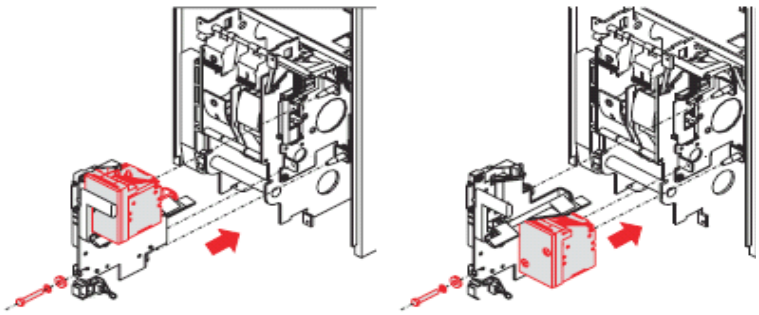


Shunt Trip/Closing Coil (YO/YC) and Second Shunt Trip (YO2)

This is used for remote control of the circuit breaker. The accessory is the same and the function depends on the installation position on the circuit breaker. 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,(1) or with a permanent signal.(2)

For safety reasons, Emax circuit breakers can be equipped with a second shunt trip, mounted on a special support as an alternative to the UVR. 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.



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	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)	

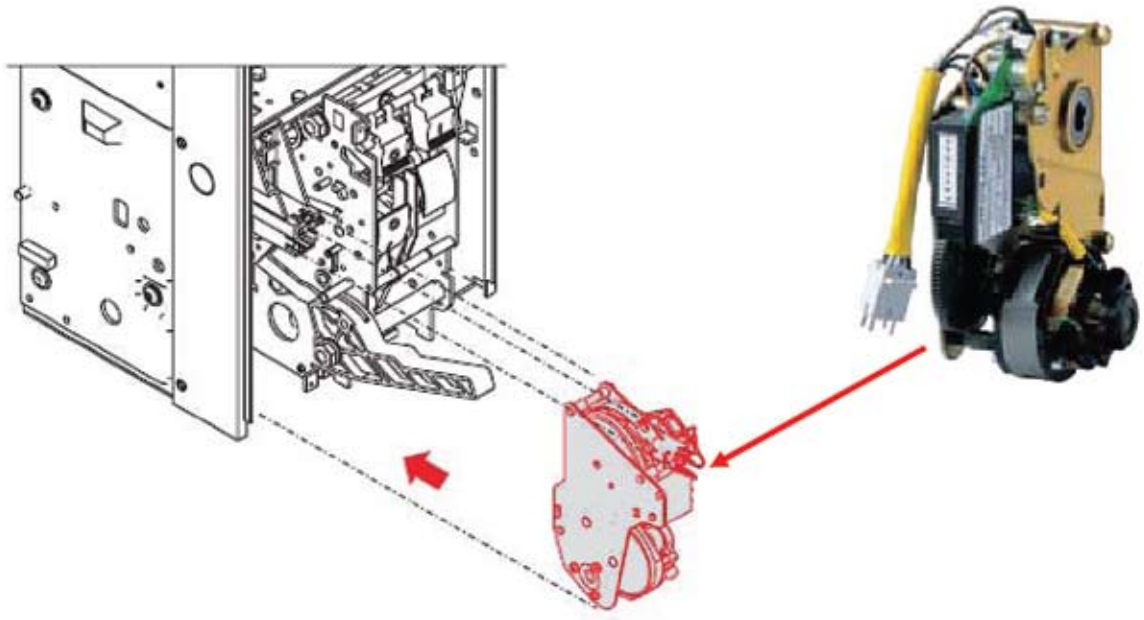
Gear Motor for the Automatic Charging of Closing Springs (M)

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 relative operating 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.

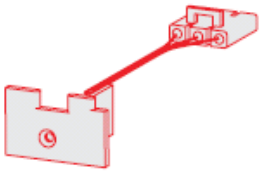
Characteristics	
Power supply	24-30 V AC/DC
	48-60 V AC/DC
	100-130 V AC/DC
	220-250 V AC/DC
Operating limits:	85%...110% Un
Inrush power (Ps):	DC = 500 W
	AC = 500 VA
Rated power (Pn):	DC = 200 W
	AC = 200 VA
Inrush time	0.2 s
Charging time:	4-5 s
Insulation voltage:	2500 V 50 Hz (for 1 min)



Bell alarm

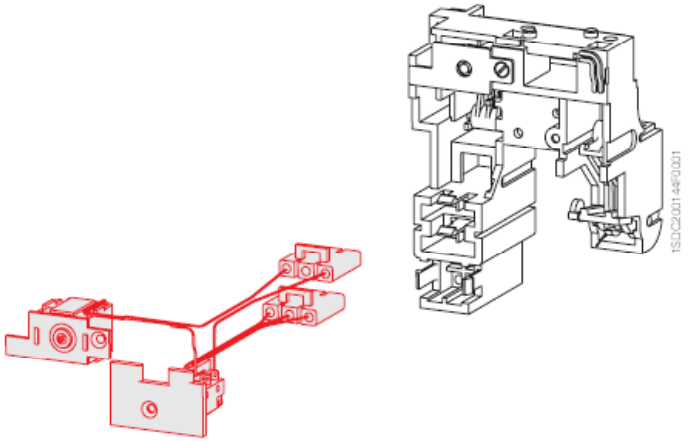
The following signals are available after the trip unit trips.

Allows the local (mechanical accessory supplied as standard) and remote signaling (electrical by means of changeover switch) that the circuit breaker is open following operation of the trip units. The mechanical signaling pushbutton must be rearmed to reclose the circuit breaker.



Bell alarm with remote reset command

Allows the local (mechanical accessory supplied as standard) and remote signaling (electrical by means of changeover switch) that the circuit breaker is open following operation of the trip units. With this accessory, it is possible to reset the mechanical signaling pushbutton via an electrical coil from remote command, which allows the circuit breaker to be reset.



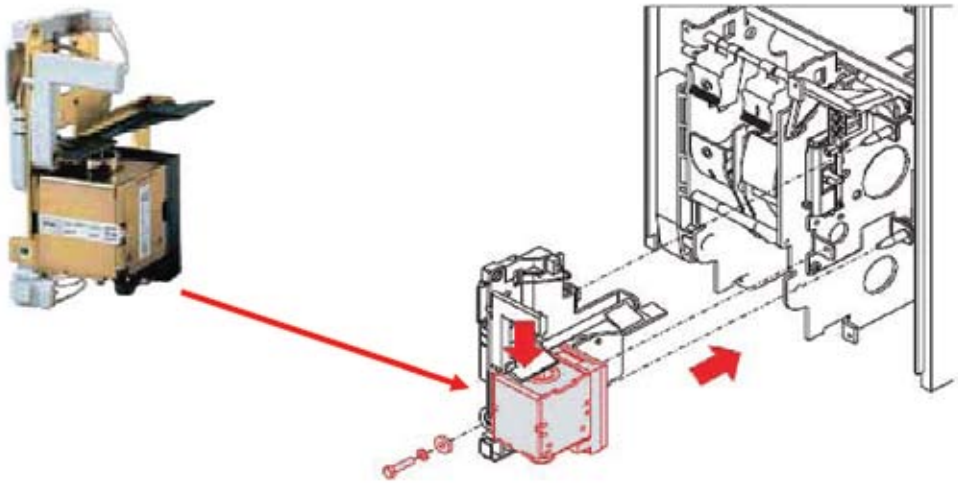
Undervoltage Release (YU)

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	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)	

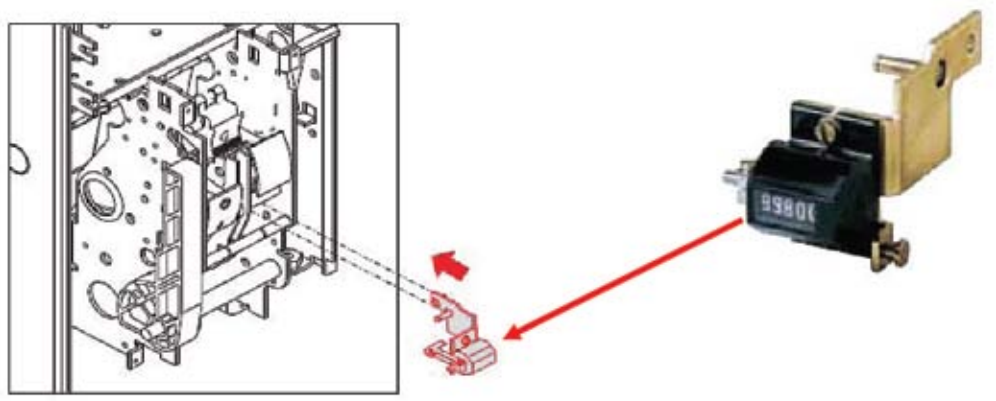
It can be used also to open the circuit breaker (using normally closed pushbuttons), as a lock in closing position. The power supply is therefore obtained on the supply side of the circuit breaker or from an independent source. The circuit breaker can be closed only when the release is energized. The release can operate with either direct current or alternating current. When the voltage drops below 10% 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 under voltage release, the use of the anti-racking-out device is not allowed.



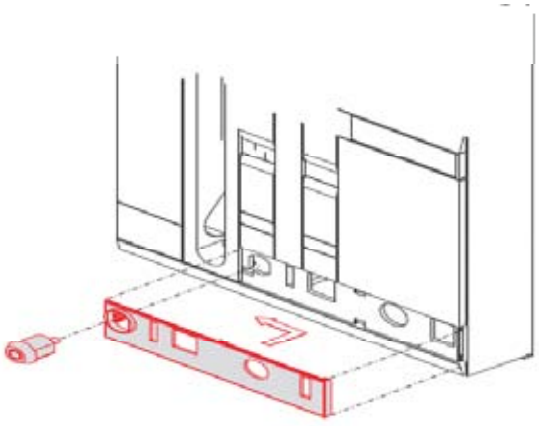
Mechanical Operation Counter

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.



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

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



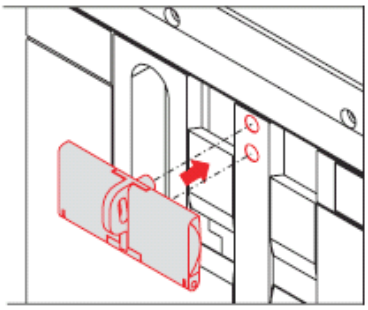
Locking provisions

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

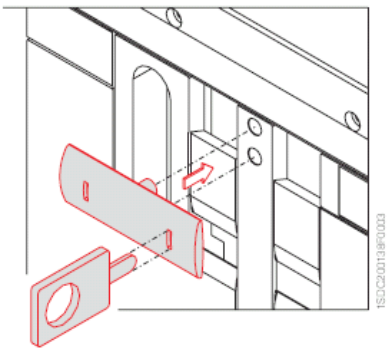
These devices can be controlled by:

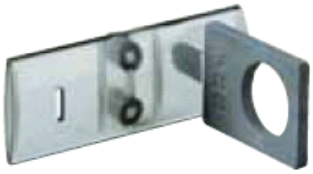
- Key: a special circular lock with different keys (for a single circuit breaker) or the same keys (for several circuit breakers).

- As a standard feature for the MaxSG, the low-voltage circuit breaker is provided with padlock provisions in order so that it can be padlocked in the open position with up to three ¼”-3/8” shank padlocks to prevent unauthorized closing.



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





Closed-Door, Draw-out Capability (standard)

MaxSG offers the ability to rack the circuit breaker from the “CONNECT” position through the “TEST” position and to the “DISCONNECT” position while the circuit breaker compartment door remains stationary and closed providing maximum convenience and personnel safety.

Complete closed door breaker operation

Circuit Breaker Rejection Feature (standard)

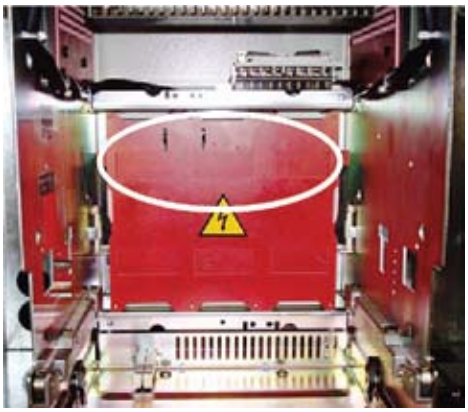
Prevents circuit breakers with lower short circuit/continuous current ratings from being inserted into the circuit breaker compartment.

Safety Shutters (standard)

Safety shutters to prevent accidental contact with live bus are a standard on all circuit breakers. 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.

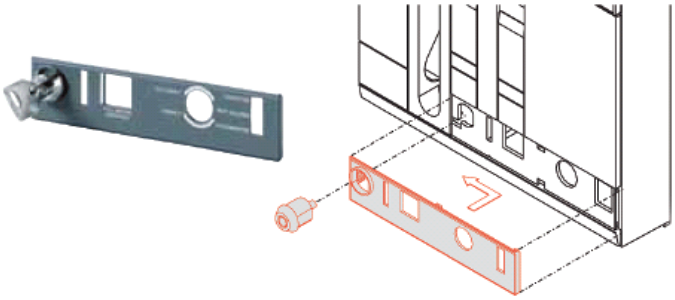


Padlockable door (optional)

Emax and MaxSG offer an array of standard, safety locking features that provide extra measures of security when breaker, equipment, or load maintenance is performed. Padlocks may be placed on the compartment doors for lock out tag out procedures.

Circuit breaker lock-in racked-in/test isolated/racked-out position (standard)

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.

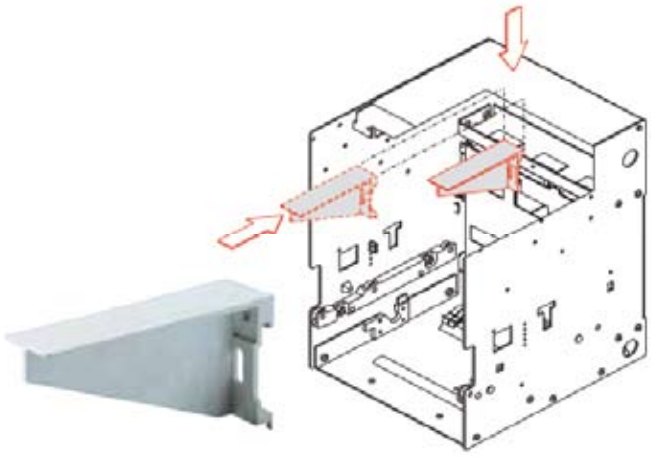


Accessories for lock-in test isolated/racked-out position (standard)

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)

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

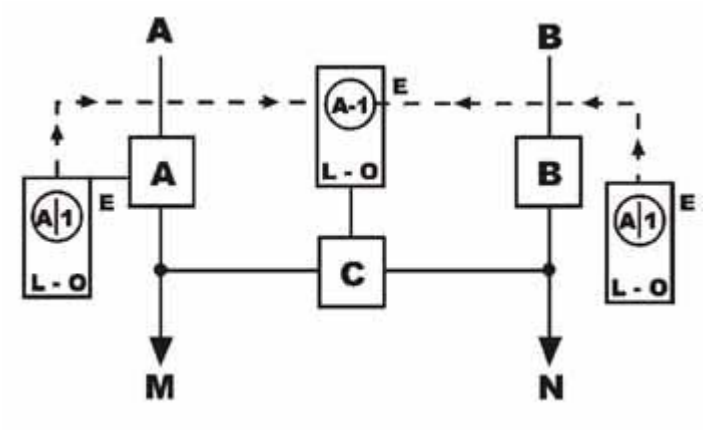


Mechanical lock for compartment door (optional)

This feature locks the compartment door from being opened when the circuit breaker is closed (and circuit breaker racked-in for draw-out circuit breakers) and 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 key locks are available. Key locking does not prevent operation when the breaker is in the test or disconnect position.

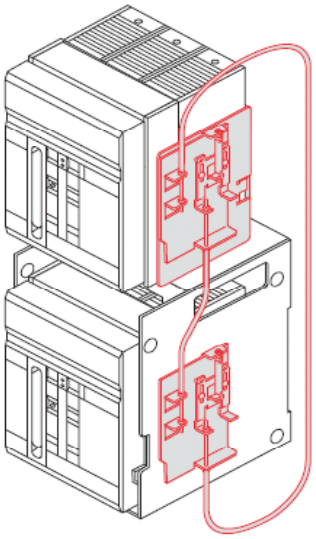


Mechanical interlock (interlock between circuit breakers) Optional

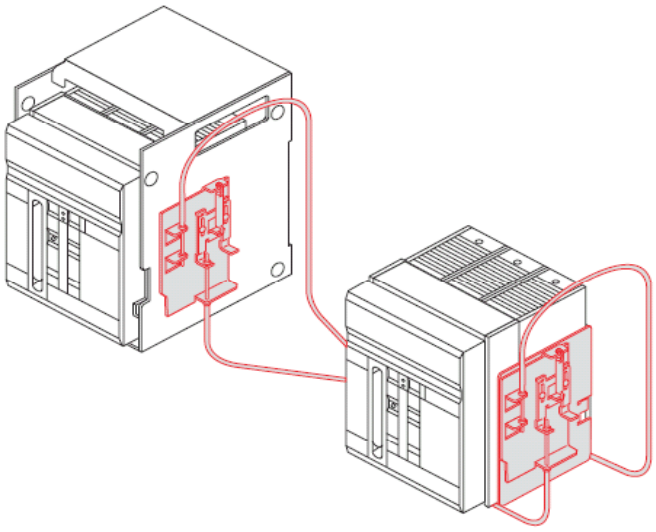
This mechanism creates a mechanical interlock between two or three circuit breakers (even different models and in any fixed/draw out version) using flexible cables. The electrical diagram for electrical switching by means of a relay (to be provided by the customer) is supplied with the mechanical interlock. The circuit breakers can be installed 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

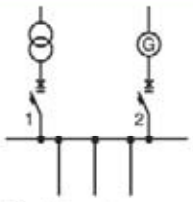
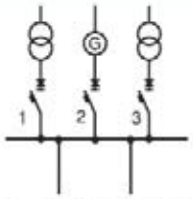
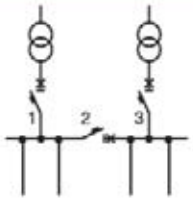
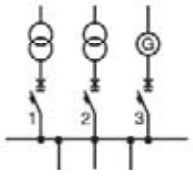


Vertical interlock



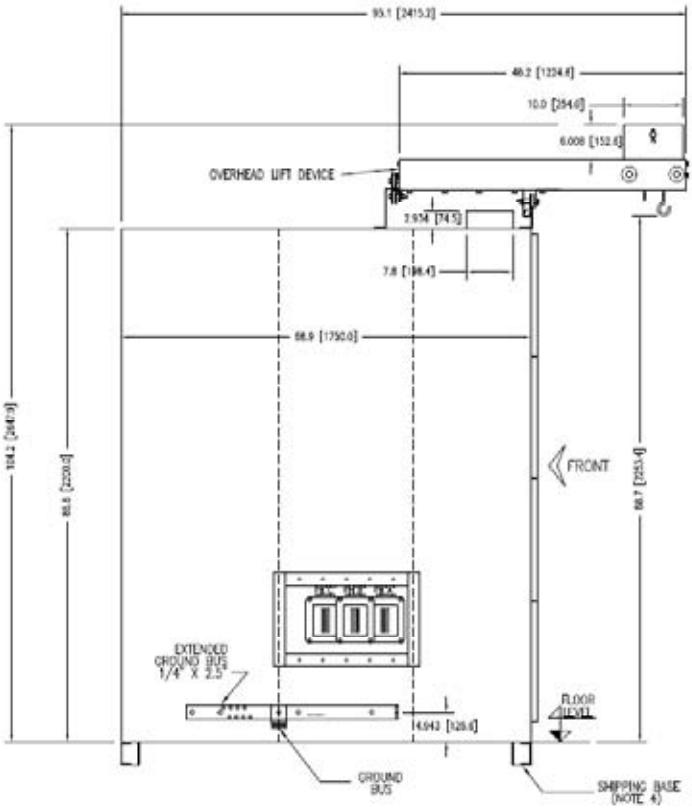
Horizontal interlock

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. 1 2 O O I O O I
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. 1 2 3 O O O I O O O O I I O I O I O
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. 1 2 3 O O O I O O O I O O O I O I I I I O I O I
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. 1 2 3 O O O I O O O I O O O I

Overhead Lift Device

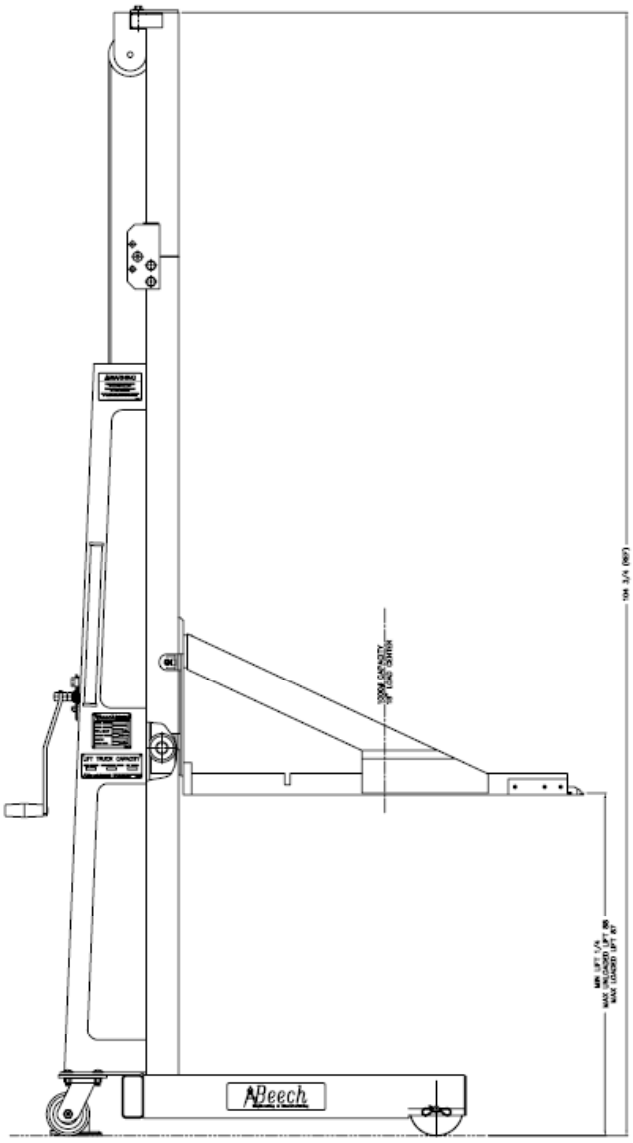
As an option the ABB MaxSG is able to be provided with a rail mounted hoist installed on top of the switchgear for lifting the breakers into and out of the circuit breaker compartments. The overhead lift device shall be shipped uninstalled from the gear. Mounting instructions shall be provided with the switchgear. The overhead lift device is available for indoor and outdoor walk-in enclosures.



RIGHT VIEW

Lift Truck

Another available option would be a circuit breaker lift truck which can be used to lift and/or lower the Emax circuit breaker in front of the switchgear for ease of the removal or installation of the circuit breakers. The device may be used in place of an overhead lift device.



Configuration Test Unit

As an option ABB can provide a portable test unit for the Emax circuit breaker trip units. The PR010/T unit is an instrument capable of performing the functions of secondary injection testing, programming, and reading parameters for the trip units equipping Emax low voltage air circuit breakers. In particular, the test function involves the following units:

- PR121P (all versions)
- PR122P (all versions)
- PR123P (all versions)

whereas the parameter programming and reading functions regard the range of PR122 and PR123 trip units.

All of the functions mentioned can be carried out “on board” by connecting the SACE PR010/T unit to the front multi-pin connector on the various protection units. Special interfacing cables supplied with the unit must be used for this connection.

The human-machine interface takes the form of a touchpad and multi-line alphanumeric display.

The unit also has two LEDs to indicate, respectively:

- POWER-ON and STAND BY
- battery charge state

Two different types of test are available: automatic (for PR121, PR122, and PR123) and manual.

By connection to a PC (using the floppy-disc supplied by ABB), it is also possible to upgrade the software of the PR010/T unit and adapt the test unit to the development of new products.

It is also possible to store the most important results in the unit itself, and to send a report to the personal computer with following information:

- type of protection tested
- threshold selected
- curve selected
- phase tested
- test current
- estimated trip time
- measured trip time
- test results

At least 5 complete tests can be stored in memory. The report downloaded onto a PC allows creation of an archive of tests carried out on the installation.

In automatic mode, the PR010/T unit is capable of testing the following with the PR122 range:

protection functions L, S, I

- G protection function with internal transformer,
- G protection function with toroid on the transformer star centre
- Monitoring of correct microprocessor operation

The unit can also test the following protections of the PR122 equipped with the PR120/V:

- Over voltage protection function OV
- Under voltage protection function UV
- Residual voltage protection function RV
- Phase unbalance protection function U

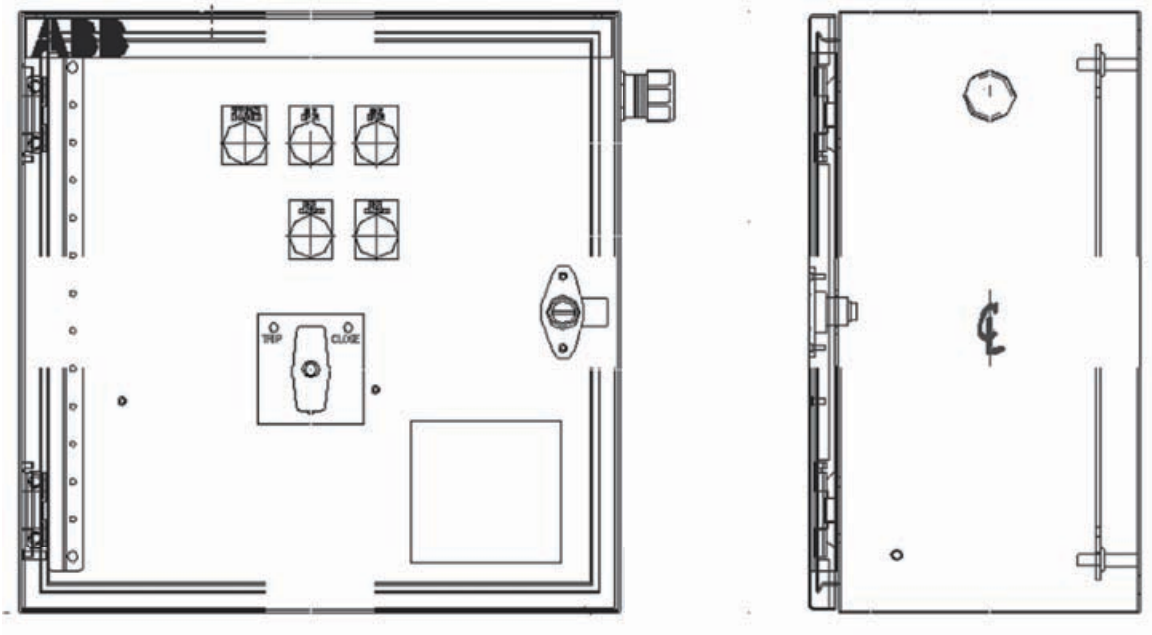
The PR010/T unit is portable and runs on rechargeable batteries and/or with an external power supply (always supplied) with a rated voltage of 100-240VAC/12VDC.

The standard version of the PR010/T unit includes:

- PR010/T test unit complete with rechargeable batteries
- TT1 test unit
- 100-240VAC/12VDC external power supply with cord
- Cables to connect the unit and a PC (RS232 serial)
- User manual and compact disc containing application software

Breaker Test Cabinet

An available feature of the MaxSG is an option of a breaker test cabinet that can be utilized to test the ABB Emax air low voltage circuit breaker. The standard test unit shall have indicating lights and a control switch that can be used to test the different functions of the breaker



Infrared Windows

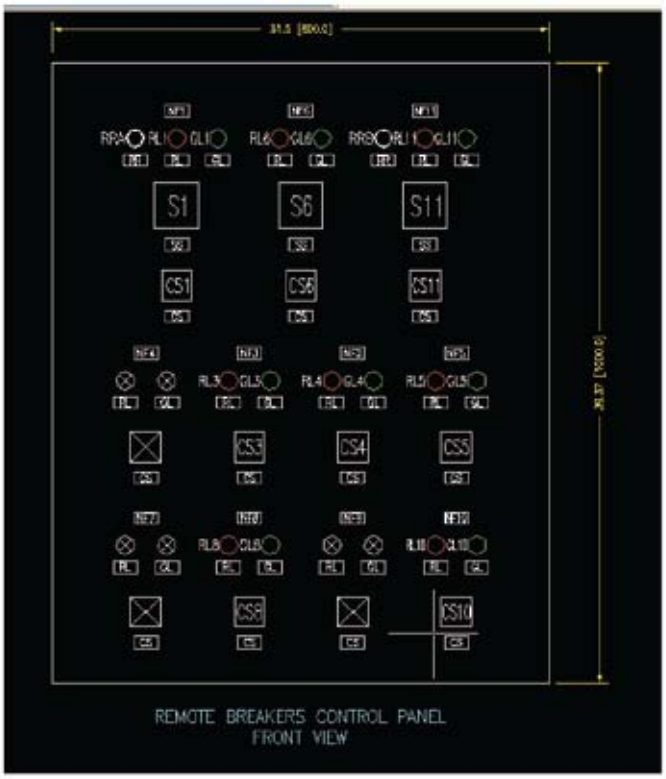
Optional infrared windows are available as an option to be installed in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations. The use of the IR windows minimize the exposure to live conductors while performing this type of preventative maintenance operation. The standard window is type Global Maintenance Technologies (GMTech). For indoor applications a grill type without crystal shall be the standard offering. The two available sizes are 3" (75 mm) and 4" (100 mm) in diameter. Both sizes shall have a gasketted cover plate secured with tamper-resistant hardware. Quantity and location of the IR windows shall be dependent on the breaker stacking arrangement.

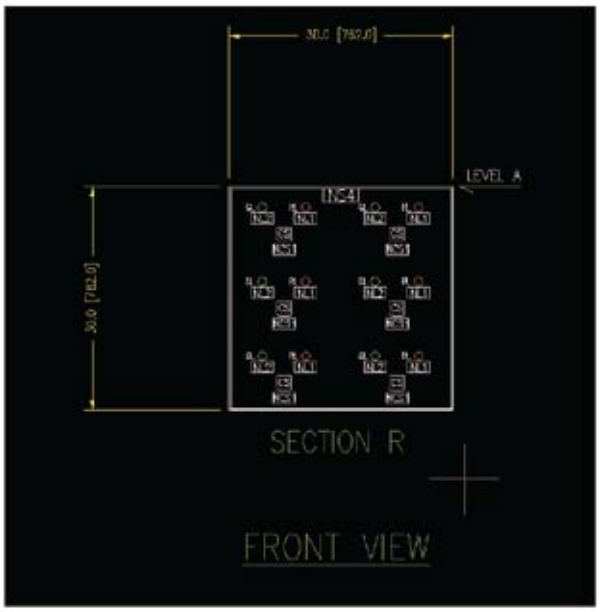
High Resistance Ground System

Where continuity of service is a high priority, the MaxSG can be supplied with a high resistance grounding which 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. Please see Attachment 2 for detail information on High Resistance Ground System.

Custom Remote Breaker Control Panels

In need of controlling the breakers opening and closing from a remote location for increased personnel safety, ABB is able to provide custom remote breaker control panels. Within the panel ABB indicating lights, pushbuttons, control switches or selector switches are provided for control.





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.

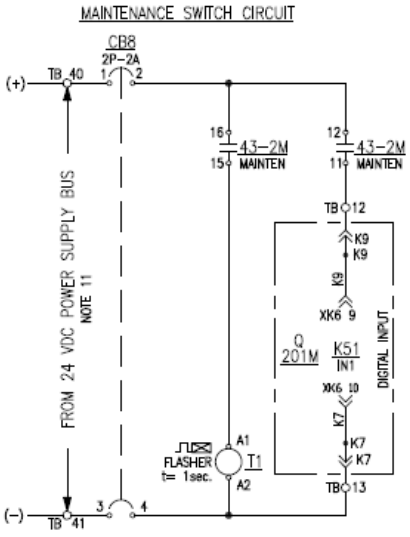
Application

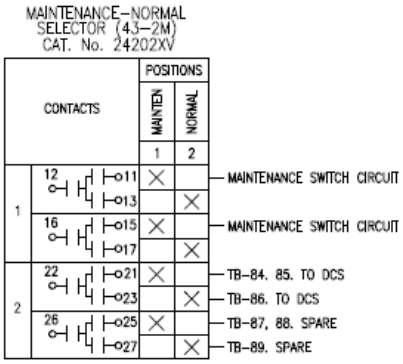
The maintenance switch concept is used when the customer requires a faster tripping time when personnel are working in and around the switchgear. The circuit breaker stores preset values (Value A = "Normal" and Value B = "Maintenance") with regards to the instantaneous settings. These values are determined 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 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 (this is standard with PR123)
- ABB 2 position changeover switch, 4 pole, with padlockable handle in both positions.

Example Schematics





REA Relay System

Description

The REA arc protection relays minimizes material damage to switchgear, enables quick restoration of the power distribution and improves personnel safety. The REA detects an arc anywhere in the bus compartment and cable compartment utilizing long-fiber sensor system. Total reaction time is less than 2.5ms plus Emax breaker opening time.

Application

The REA relay system concept is used when the customer requires protection on the equipment against an arc. The REA system uses a fiber optic cable wired through the bus compartment and cable compartment in order to detect an arc flash. It then feeds signal to an REA relay which verifies current change on the incoming main bus by the use of CT's. If a change is detected by the relay along with a signal from the fiber optic cable 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 which is 2.5ms plus the Emax breaker opening time.

Required Parts

- REA 101 relay – One per each main breaker
- REA 103 – For multiple shipping splits. Consult AE for quantity required.
- Fiber optic cable (maximum length of 60 m)
- (3) C10 Accuracy Relay Type Current Transformer per each main breaker
- Splitting jacks

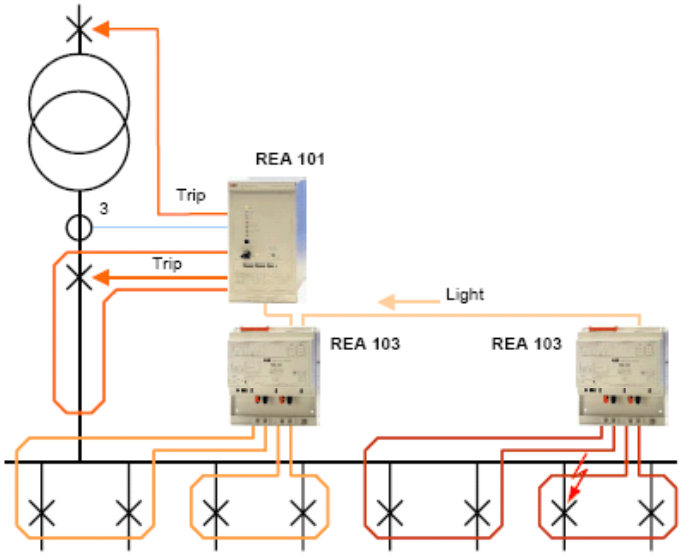
Installation

The REA relay shall be installed in an instrument compartment of its corresponding main for each bus. The fiber 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 fiber. Fiber shall be well supported along the process through some means of tie wraps or other means.

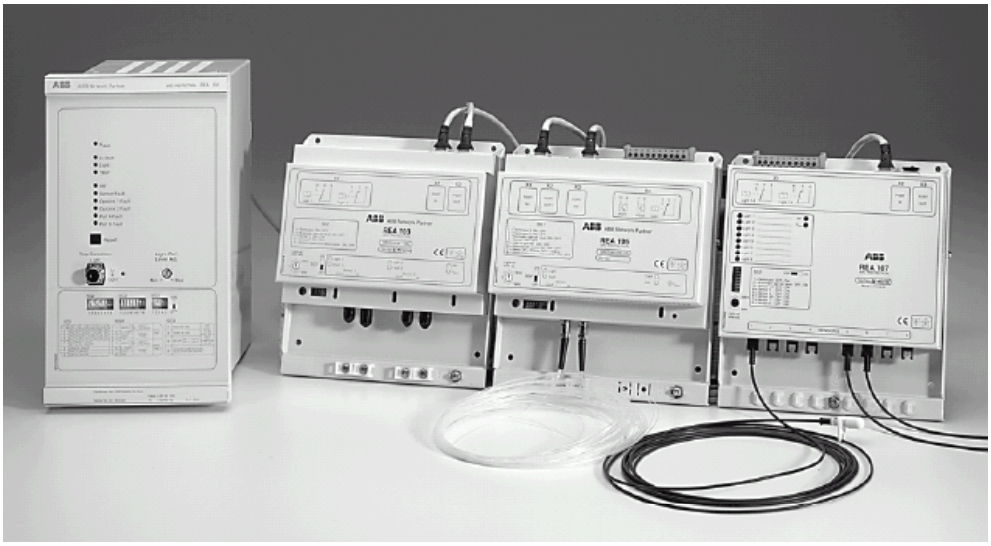
After the fiber is passed through the instrument compartment barrier it shall be wired through a large loop in the main bus compartment covering of its corresponding bus looping around tie breaker (for MTM applications). For shipping splits splicing jacks or REA 103 devices shall be utilized. There shall be a maximize use of four splicing jacks per REA relay and fiber. If more than one, then the use of the REA 103 device shall be required. Fiber shall be well supported along the process through some means of tie wraps or other means.

Following the loop in the main bus the fiber shall be passed to the cable compartment through an opening on the main bus barrier and shall be looped around all four breaker load connections and supported with supports or other means.

Typical Diagram



Devices



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, which opens the way for connection of circuit breakers to the world of industrial communication. 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 immediately and 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.

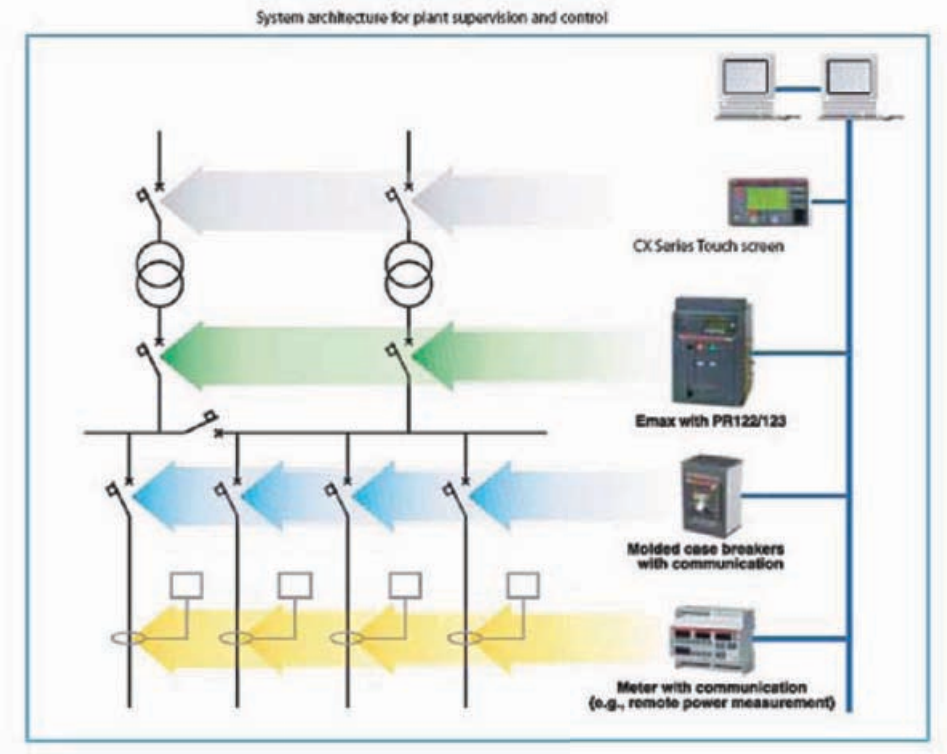
Communication Products

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). Supervision can be limited to low voltage devices or include medium voltage and possibly other kinds of industrial apparatus
- 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

Communication products for ABB SACE Emax 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
- TestBus2



SD-View 2000

SD-View 2000 is a “ready-to-use” system, consisting of software for personal computers, in standard configuration, which allows complete control of the low voltage electrical installation.

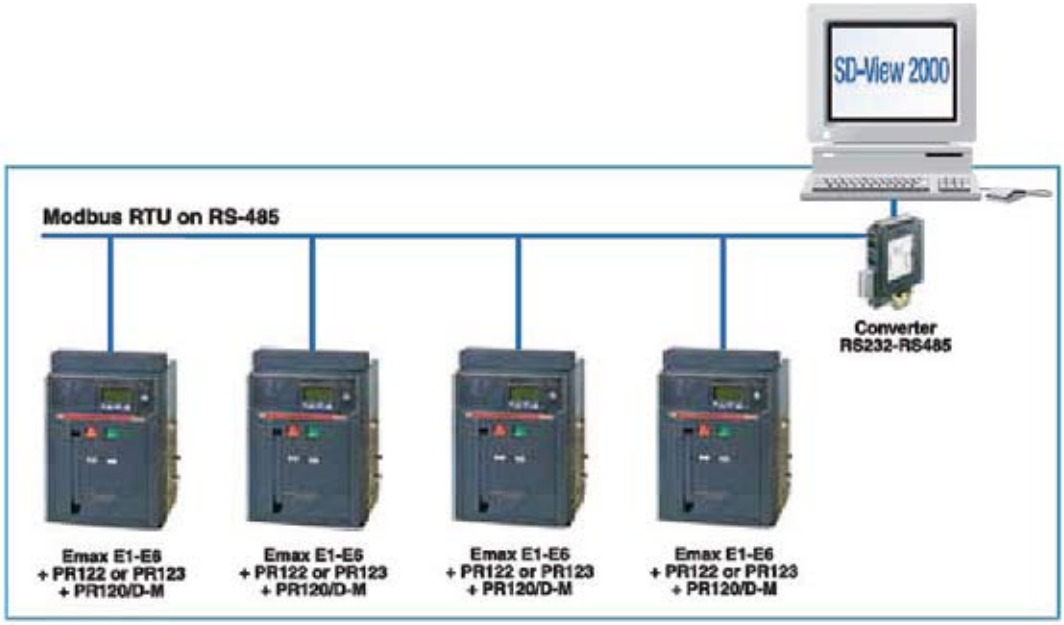
Putting the SD-View 2000 system into operation is quick and easy. In fact, the software itself guides the user in recognizing and configuring the protection units. The user only needs knowledge of the installation (such as how many circuit breakers are installed and how they are connected to each other). No engineering work on the supervision system is required, since all the pages displayed are already configured in the system, ready to be used.

Usage of the software is intuitive and easy to learn for the operator: SD-View 2000 has graphic pages based on Internet Explorer, which makes the system as simple to manage as surfing on the Internet.

System architecture is based on the latest developments in personal computer and industrial communication network technology.

The ABB SACE devices are connected to the serial bus RS485 Modbus. A maximum of 31 devices can be connected to a bus. A maximum of 4 serial bus lines can be connected to a personal computer which works as data server, reading and storing the data received from the devices. The server is also used as the operator station, from where the data can be displayed and printed, commands can be sent to the devices and all the operations needed to manage the installation can be carried out.

The server can be connected to a local network together with other personal computers which work as additional operator stations (clients). This way, installation supervision and control can be carried out with total reliability from any station connected to the network on which SD-View 2000 is installed.



SD-View 2000 is the ideal tool available to managers, in order to have the situation of the installations under control at all times and to be able to control all the functions easily and in real time.

The SD-View 2000 operator station (personal computer) allows information from the installation to be received and control the circuit breakers and relative releases. In particular, it is possible to:

- Send opening and closing commands to the circuit breakers
- Read the electrical installation values (current, voltage, power factor, etc.)
- Read and modify the trip characteristics of the protection units
- Determine the status of the apparatus (open, closed, number of operations, trip for fault, etc.)
- Determine abnormal operating situations (e.g. Overload) and, in the case of the releases tripping, the type of fault (short-circuit, ground fault, value of the uninterrupted currents, etc.)
- Log the history of the installation (energy consumption, most highly loaded phase, any warnings of anomalies or faults, etc.)
- Show the temporal evolution of the installation by means of graphs.

Access to the various system functions can be enabled by means of secret codes or passwords with different levels of authorization.

Usage of the system is really simple thanks to the user interface based on Internet explorer. The graphic pages relative to each circuit breaker are particularly intuitive and easy to use.

The circuit breakers with electronic releases which can be interfaced with

SD-View 2000 are:

- Emax LV air circuit breakers from E1 to E6 fitted with PR122/P or PR123/P releases with Modbus RTU PR120/D-M communication unit
- Emax LV air circuit breakers from E1 to E6 fitted with PR112/PD or PR113/PD Modbus releases
- Tmax LV molded case circuit breakers T4 and T5 fitted with PR222/PD release
- Isomax LV circuit breakers from S4 to S7 fitted with PR212/P release with Modbus RTU PR212/D-M communication unit.

In addition, SD-View 2000 can acquire current, voltage and power measurements in real time from the MTME-485 multimeters with Modbus communication.

Furthermore, it is possible to interface any air or molded-case circuit breaker or switch-disconnector, not fitted with electronics, with SD-View 2000 by using a PLC AC31 unit as the communication module. For the circuit breakers or switch-disconnectors connected in this way, SD-View 2000 shows the conditions of the apparatus (open, closed, tripped, racked-in or racked-out) in real time and allows it to be operated remotely.

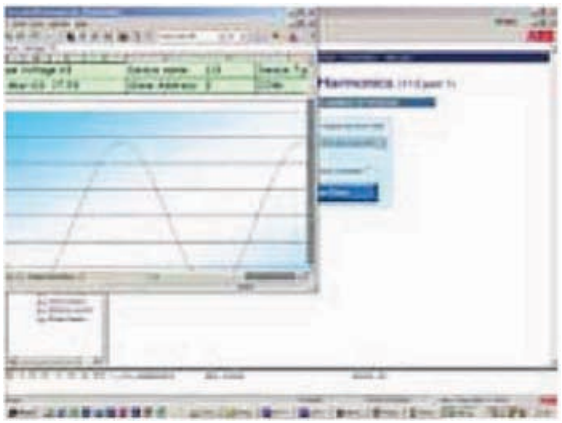
All the characteristics of the devices listed are pre-configured in the SD-View 2000 system. Therefore, the user does not have to carry out any detailed configuration (i.e. insert tables with data to be displayed for each release, or draft ad hoc graphic pages): simply enter the list of devices connected into the system.

Technical characteristics
Up to 4 serial ports
Up to 31 ABB SACE devices for each serial port
9600 or 19200 baud
Modbus® RTU Protocol

Personal computer requirements

Pentium 1 GHz, 256 MB RAM (512 MB recommended), 20 GB hard disk, Windows 2000, Internet Explorer 6, Ethernet card, Printer (optional).

SD-Pocket



SD-Pocket is an application designed to connect the new protection releases to a PDA or to a personal computer. This means it is now possible to use wireless communication to:

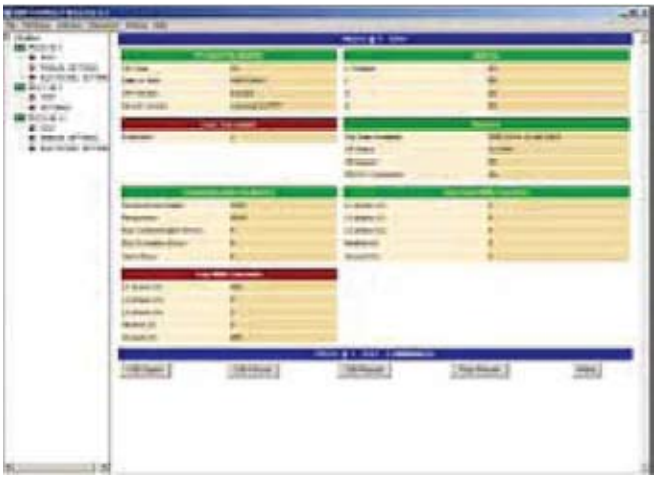
- Configure the protection threshold function
- Monitor measurement functions, including reading of data recorded in data logger (PR122/PR123)
- Verify the status of the circuit breaker (i.e. number of operations, trip data, according to the release connected)

SD-Pocket application scenarios include:

- During start-up of switchgear, with rapid and error-free transfer of the protection parameters to the releases (also using the dedicated exchange file directly from Docwin);
- During normal installation service, gathering information on the circuit breaker and load conditions (last trip information, runtime currents, and other information)

To use all these functions, it is sufficient to have a PDA with MS Windows Mobile 2003 and BT interface or a personal computer with MS Windows2000 OS and new PR120/D-BT or BT030 Bluetooth interface devices. SD-Pocket is freeware and it can be downloaded from the BOL website (http://bol.it.abb.com). Its use does not require the presence of dialogue units for the releases.

TestBus 2



TestBus2 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.

TestBus2 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. TestBus2 is freeware and can be downloaded from the BOL website (http://bol.it.abb.com)

Other Communication Protocols

The MaxSG low voltage switchgear shall be able to offer other types of communication protocols such as: Ethernet, Profibus, DeviceNet, or IEC-61850 through the use converters.

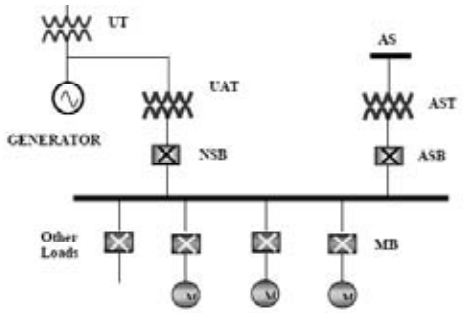
Automatic Transfer Schemes

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. Bus configurations vary from plant to plant. 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 MaxSG automatic transfer logics are performed via the use of a PLC or relay logic. ABB standard transfer schemes shall include ABB type relays and ABB PLC's. 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.

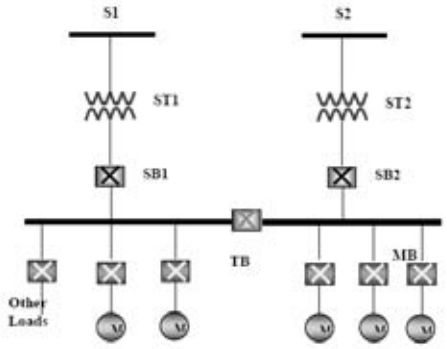


Case 2: Two sources, No Tie, Open Transition, Manual Mode

1. When operated manually, both main breakers will be opened and closed by means of pushbuttons or control switches. Both breakers will be 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 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 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 open 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 proved 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:

i. Solid grounding
ii. Impedance grounding

Impedance grounding may be further divided into several subcategories:

i. Reactance grounding
ii. Resistance grounding

Resistance grounding may be either of two classes:

i. High resistance grounding
ii. 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

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, 3 Ico.

Normally, the ground-fault current, Ig, is limited to 10 Amps or less, although some medium voltage specialized systems may require higher ground-fault levels. 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.

7) Low-resistance grounding

Low-resistance grounding is mostly employed in medium-voltage systems of 15 kV and below, especially where large rotating machinery is used. For large generators neutral resistor is usually selected to limit a minimum of 100 Amps up to a maximum of 1.5 times the normal rated generator current.

The resistor ohmic value is selected to allow a ground-fault current acceptable for relaying. The grounding resistor can be rated for intermittent duty. In normal practice it is rated for 10 sec or 30 sec.

The following layouts are available:

Main/Tie Section:

23.6” (600 mm)
31.5” (800 mm)
39.4” (1000 mm)

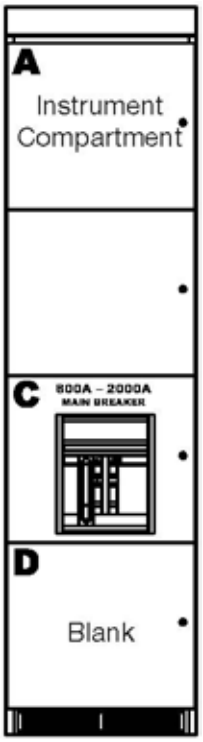
Feeder Sections Width:

23.6” (600 mm)
31.5” (800 mm)
19.7” (500 mm) Optional

Auxiliary Sections Width:

19.7” (500 mm)
23.6” (600 mm)
31.5” (800 mm)

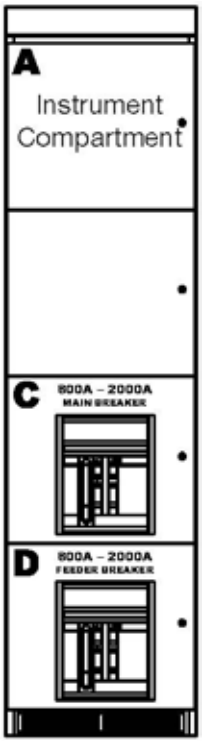
Main/Tie Section
23.6” (600 mm)



E3 up to 2000A

Application Rules

1) Main/Tie Circuit Breaker: up to 2000 A
2) Frame Size: E2, E3
3) Bus Bracing: up to 100 kA
4) Main/Tie Circuit Breaker in C Compartment Only
5) Compartment A: 21.5“ or 42”
6) For HRG: Compartment A is Needed
7) Feeder Circuit Breaker: up to 1600 A
8) Frame Size: E2, E3
9) Feeder Circuit Breaker Location: Compartment D



E3 up to 2000A

E2 up to 1600A

Connection to Main/Tie Circuit Breaker

a) Cable to Main/Tie Circuit Breaker

b) Dry Type Transformer Coupling

c) Busduct Top to Main Circuit Breaker

Current Transformer Rules

a) Two sets of metering CT’s per phase can be provided on the line side of a bus duct and cable incoming connection.

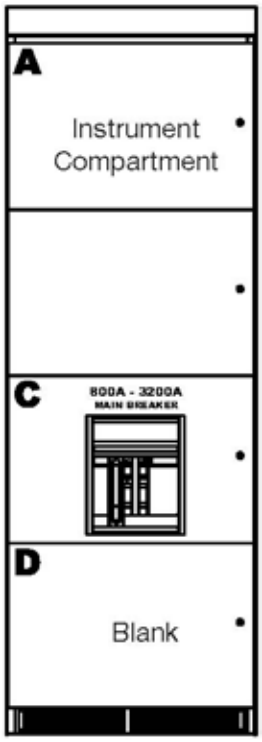
b) One set of metering CT’s can be provided on the line side aof a dry type transformer coupling connection.

c) For relay accuracy CT’s up to C50 they can be mounted on line side for all incoming types. For higher accuracy CT’s please consult with factory.

d) For CT’s on load side of each main/tie section please consult with factory.

Main/Tie Section

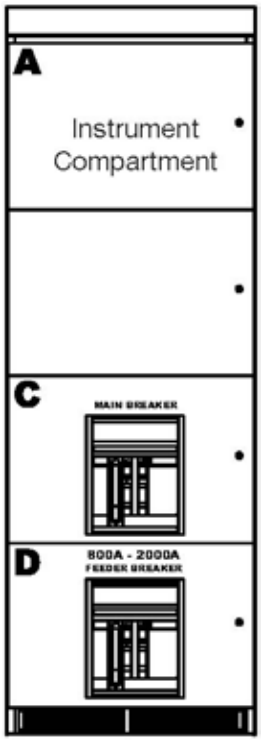
31.5” (800 mm)



E3 up to 2000A
E4 3200A

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: 21.5“ or 42”
6) For HRG: Compartment A is Needed
7) Feeder Circuit Breaker: up to 2000 A
8) Frame Size: E2, E3
9) Feeder Circuit Breaker Location: Compartment D



E3 up to 2000A
E4 3200A

E2 up to 1600A
E3 up to 2000A

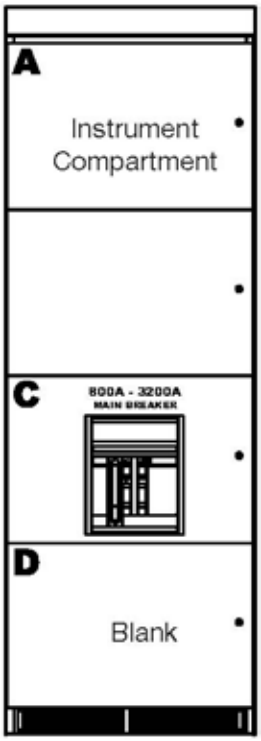
Connection to Main/Tie Circuit Breaker

a) Cable to Main/Tie Circuit Breaker
b) Dry Type Transformer Coupling
c) Busduct Top to Main Circuit Breaker

Current Transformer Rules

a) Two sets of metering CT’s per phase can be provided on the line side of a bus duct and cable incoming connection.
b) One set of metering CT’s can be provided on the line side of a dry type transformer coupling connection.
c) For relay accuracy CT’s up to C50 they can be mounted on line side for all incoming types. For higher accuracy CT’s please consult with factory.
d) For CT’s on load side of each main/tie section please consult with factory.

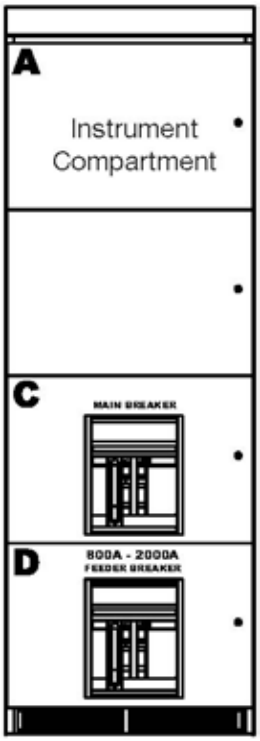
Main/Tie Section
39.4” (1000 mm)



E6 4000A

Application Rules

1) Main/Tie Circuit Breaker: up to 4000 A
2) Frame Size: E6
3) Bus Bracing: up to 100 kA
4) Main/Tie Circuit Breaker in C Compartment Only
5) Compartment A: 21.5“ or 42”
6) For HRG: Compartment A is Needed
7) Feeder Circuit Breaker: up to 2000 A
8) Frame Size: E2, E3
9) Feeder Circuit Breaker Location: Compartment D
10) An option for a Main and Generator application is available. An E6 4000A breaker can be placed in Compartment B with a second one in Compartment C



E6 4000A

E2 up to 1600A
E3 up to 2000A

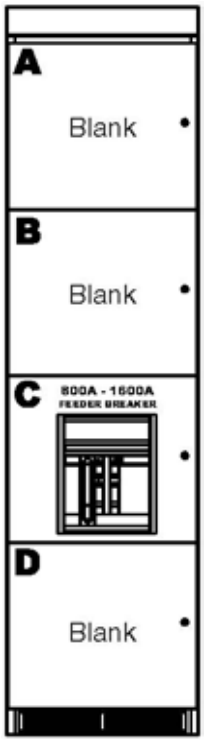
Connection to Main/Tie Circuit Breaker

a) Cable to Main/Tie Circuit Breaker
b) Dry Type Transformer Coupling
c) Busduct Top to Main Circuit Breaker

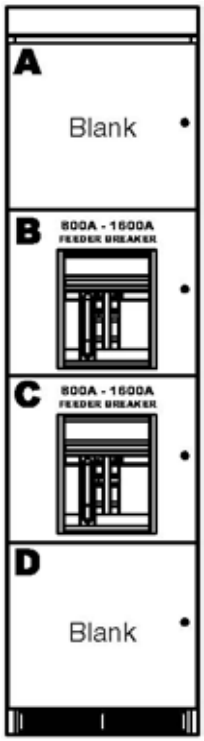
Current Transformer Rules

a) Two sets of metering CT’s per phase can be provided on the line side of a bus duct and cable incoming connection.
b) One set of metering CT’s can be provided on the line side of a dry type transformer coupling connection.
c) For relay accuracy CT’s up to C50 they can be mounted on line side for all incoming types. For higher accuracy CT’s please consult with factory.
d) For CT’s on load side of each main/tie section please consult with factory.

Feeder Section
23.6” (600mm)

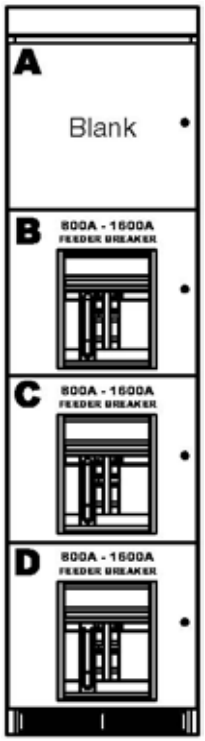


E2 up to 1600A
E3 up to 2000A



E2 up to 1600A
E3 up to 2000A
See note 6

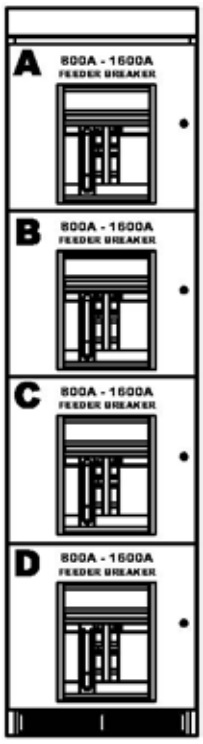
E2 up to 1600A
E3 up to 2000A
See note 6



E2 up to 1600A
E3 up to 2000A
See note 6

E2 up to 1600A
E3 up to 2000A
See note 6

E2 up to 1600A
E3 up to 2000A



E2 up to 1600A
E3 up to 2000A

E2 up to 1600A
E3 up to 2000A
See note 6

E2 up to 1600A
E3 up to 2000A
See note 6

E2 up to 1600A
E3 up to 2000A

Application Rules

1) Feeder Circuit Breaker: up to 2000 A
2) Frame Size: E2, E3
3) Bus Bracing: E2 up to 65kA, E3 up to 100 kA
4) Feeder Order Preference: C, B, D, A
5) Compartment A or D: 21.5” or 42”
6) B and C position breakers must be same cradle size

With E2 Frame Size

Maximum 5 devices are allowed:

a) 2 ABB LED pilot lights, 2 ABB pushbuttons, or one additional light and a Series 20 breaker control switch (2 deck max)

With E3 Frame Size

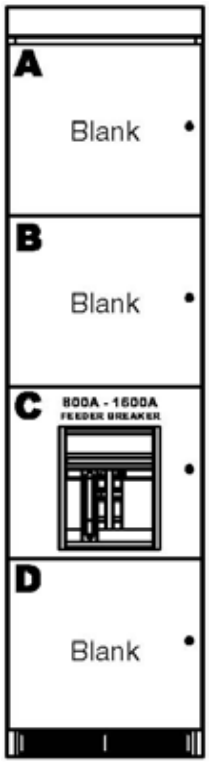
Maximum 4 devices are allowed:

a) 2 ABB LED pilot lights, 2 ABB pushbuttons

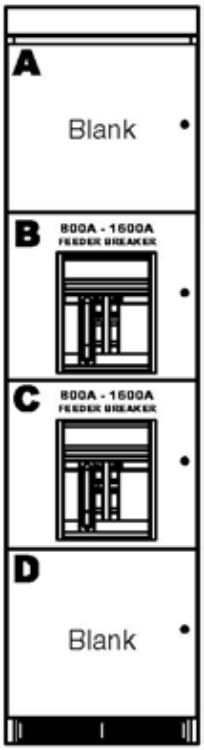
Notes:

a) No wired spare terminals can be provided.
b) 15 Auxiliary Contacts are not available with E3 cradles
c) If breakers require individual circuit protection then limitation is to three high constructions only.
d) One set of metering class CT’s can be provided on the load side of each feeder breaker as standard. For than one set please consult with factory.

Feeder Section
31.5” (800mm)

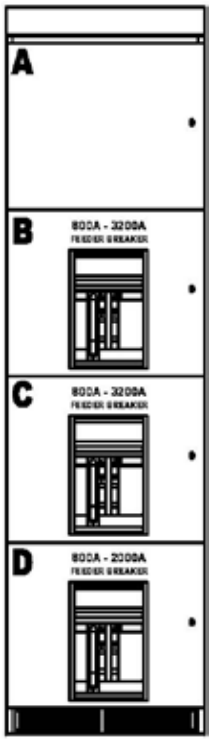


E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7



E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7

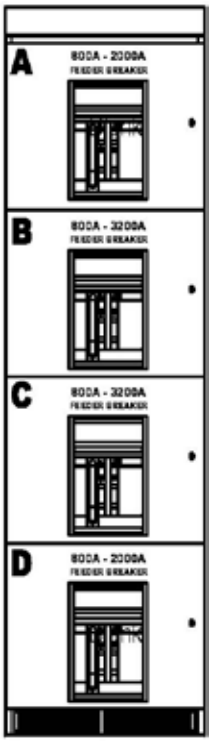
E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7



E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7

E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7

E2 up to 1600A
E3 up to 2000A



E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7

E2 up to 1600A
E3 up to 2000A
E4 3200A
See note 6 & 7

E2 up to 1600A
E3 up to 2000A

Feeder Section
31.5” (800mm)

Application rules

1. Feeder Circuit Breaker: up to 3200A
2. Frame Size: E2, E3, E4
3. Bus Bracing: E2 up to 65kA, E3 and E4 up to 100kA
4. Feeder Order Preference: C, B, D, A
5. Compartment A or D: 21.5” or 42”
6. B and C position breakers must be same cradle size
7. 3200A in B and C position only available together in main/generator (back up applications. One breaker must be open and the other close while in operation.

With E2 Frame Size

Maximum 5 devices are allowed:

a) 2 ABB LED pilot lights, 2 ABB pushbuttons, or one additional light and a Series 20 breaker control switch (2 deck max)

b) 2 ABB LED pilot lights, 2 ABB pushbuttons, or one additional light and a Series 24 breaker control switch (2 deck max)

c) 2 ABB LED pilot lights, one Series 20 breaker control switch (2 Deck), and one ABB 2-3 position selector switch

d) 2 ABB LED pilot lights, one Series 24 breaker control switch (2 Deck), and one ABB 2-3 position selector switch

With E3 Frame Size

Maximum 5 devices are allowed:

a) 2 ABB LED pilot lights, 2 ABB pushbuttons, or one additional light and a Series 20 breaker control switch (2 deck max)

b) 2 ABB LED pilot lights, 2 ABB pushbuttons, or one additional light and a Series 24 breaker control switch (2 deck max)

c) 2 ABB LED pilot lights, one Series 20 breaker control switch, and one ABB 2-3 position selector switch

d) 2 ABB LED pilot lights, one Series 24 breaker control switch, and one ABB 2-3 position selector switch

With E4 Frame Size

Maximum 5 devices are allowed:

a) 2 ABB LED pilot lights, 2 ABB pushbuttons, or one additional light and a Series 20 breaker control switch (1 deck max)

Notes:

a) No wired spare terminals can be provided.

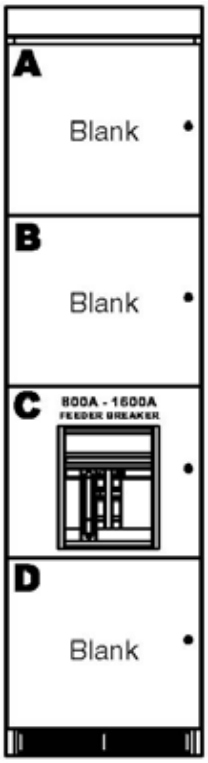
b) If breakers require individual circuit protection then limitation is to three high constructions only.

c) Devices shall be mounted uniformly to match each of the other breaker compartments

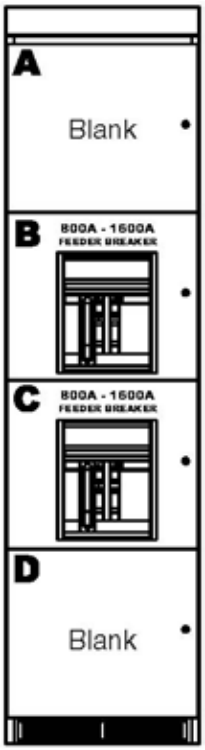
d) For mounting of metering devices for these sections, consult with factory.

e) One set of metering class CT’s can be provided on the load side of each feeder breaker as standard. For than one set please consult factory.

Optional Feeder Section
19.7” (500mm)

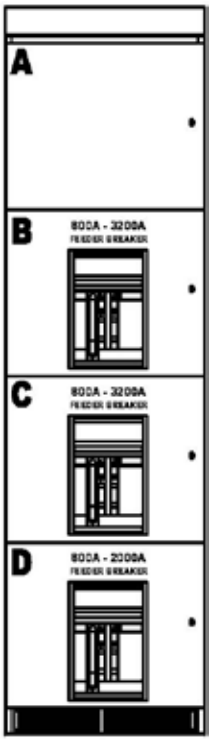


E2 up to 1600A



E2 up to 1600A

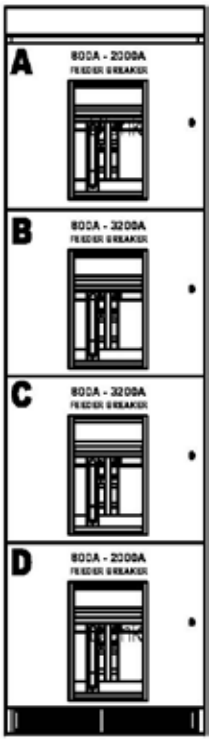
E2 up to 1600A



E2 up to 1600A

E2 up to 1600A

E2 up to 1600A



E2 up to 1600A

E2 up to 1600A

E2 up to 1600A

Application Rules

1) Feeder Circuit Breaker: up to 1600 A
2) Frame Size: E2
3) Bus Bracing: up to 65 kA
4) Feeder Order Preference: C, B, D, A
5) Compartment A or D: 21.5” or 42”

With E2 Frame Size

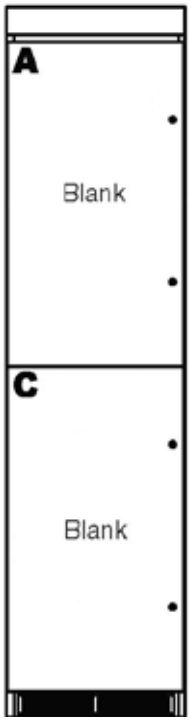
Maximum 3 devices are allowed:
3 ABB LED pilot lights

Notes:

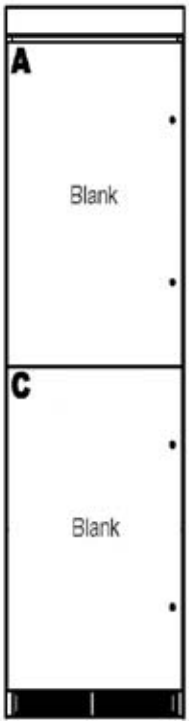
a) Only manually operated breakers may be installed in this frame size

b) One set of metering class CT’s can be provided on the load side of each feeder breaker as standard. For than one set please consult with factory.

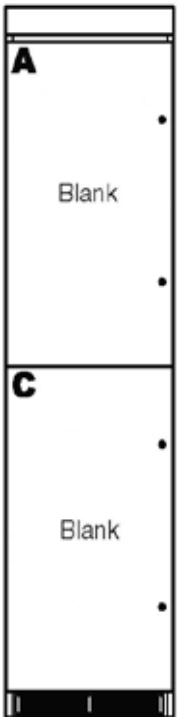
Auxiliary Sections



19.7” (500 mm)



23.6” (600 mm)



31.5” (800 mm)

Application Rules

1) Auxiliary Sections are used for transition sections for close coupling to liquid filled transformers, empty auxiliary sections, or incoming pull sections

Approximate Weights

Section Type	19.7" Wide 68.9" Deep	19.7" Wide 59.1" Deep	23.6" Wide 68.9" Deep	23.6" Wide 59.1" Deep	31.5" Wide 68.9" Deep see note 4	31.5" Wide 59.1" Deep see note 4	31.5" Wide 68.9" Deeps see note 5	31.5" Wide 59.1" Deep see note 5	39.4" Wide 68.9" Deep	39.4" Wide 59.1" Deep	Units
Feeder	1325	1170	1397	1232	1627	1407	1946	1726	N/A		lbs
	601	531	634	559	738	638	883	783			kg
Main	N/A		953	778	1351	1001	N/A		1885	1710	lbs
			432	353	613	454			855	776	kg
Tie			956	766	1612	1132			2249	1504	lbs
			434	347	731	513			1020	682	kg

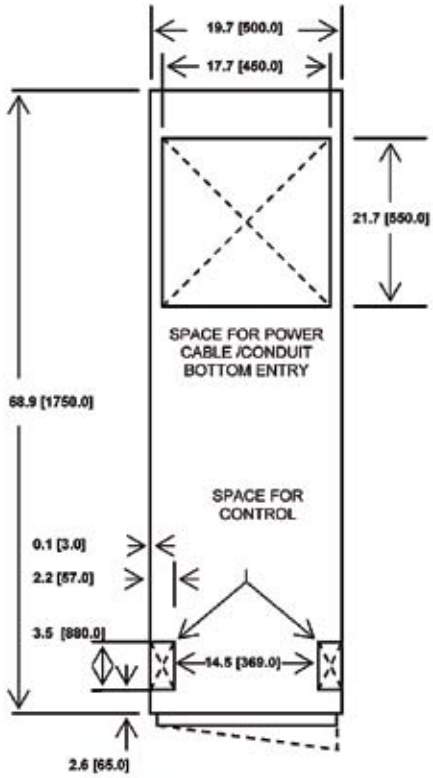
Notes:

1. Weight of each section does not include moving part of each breaker.
2. Weight of each section does not consider additional electrical components such as HRG, relays, meters, etc.
3. Overhead lift device weight is approximately: 118 lbs, 54 kg
4. Weight for feeder sections is with 4-high 2000A breakers.
5. Weight feeder section is with 2-2000A breakers and 2-3200A breakers.

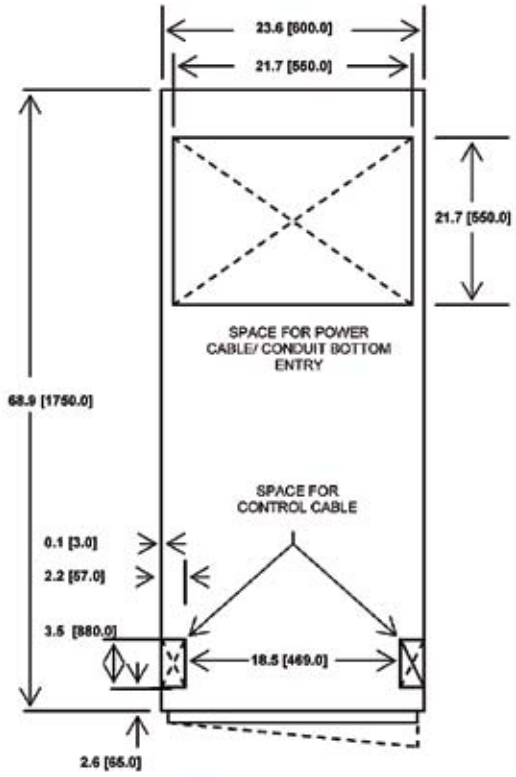
Breaker Weights

Breaker Frame Size	Weight (lbs)	Weight (kg)
E2	111	50
E3	145	66
E4	214	97
E6	270	122

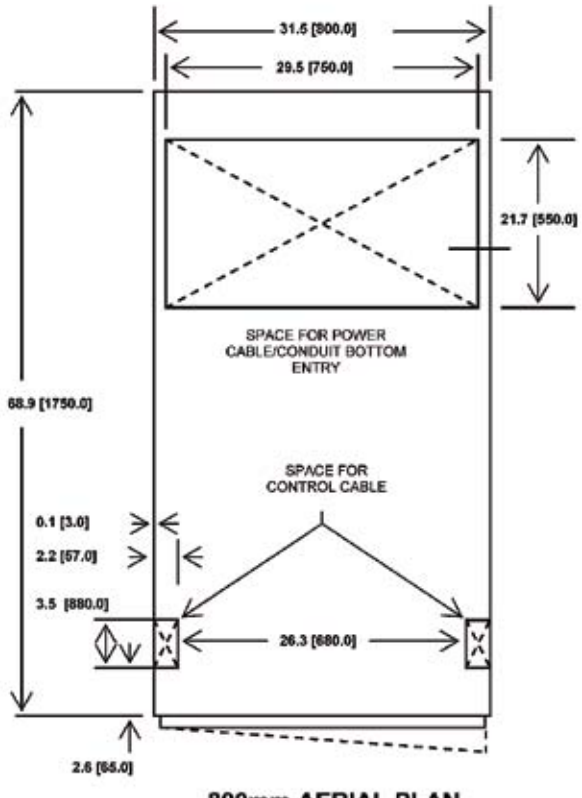
Switchgear Floor Plans
68.9” (1750 mm) Depth



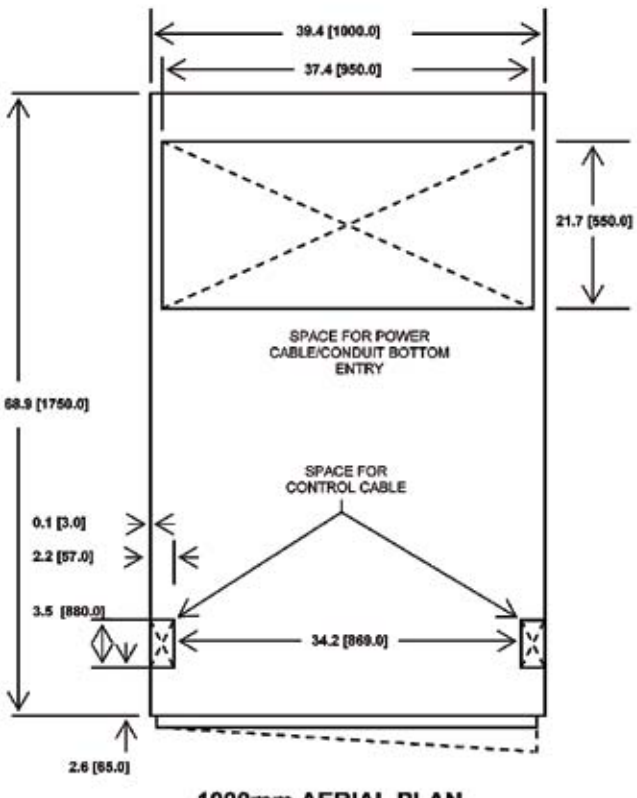
500mm AERIAL PLAN



600mm AERIAL PLAN

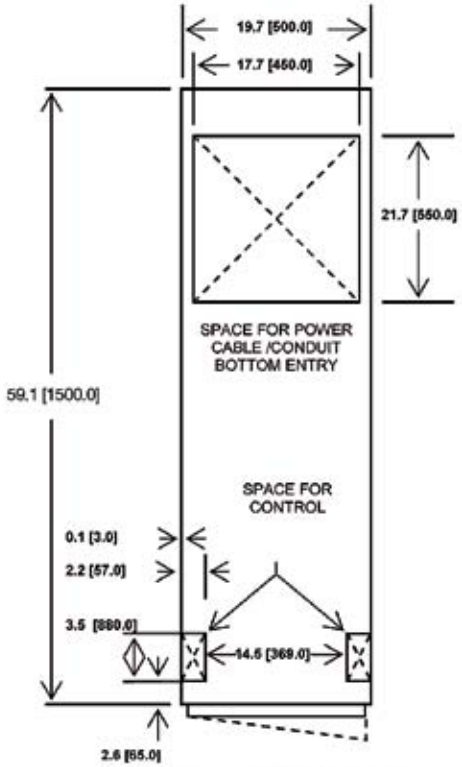


800mm AERIAL PLAN

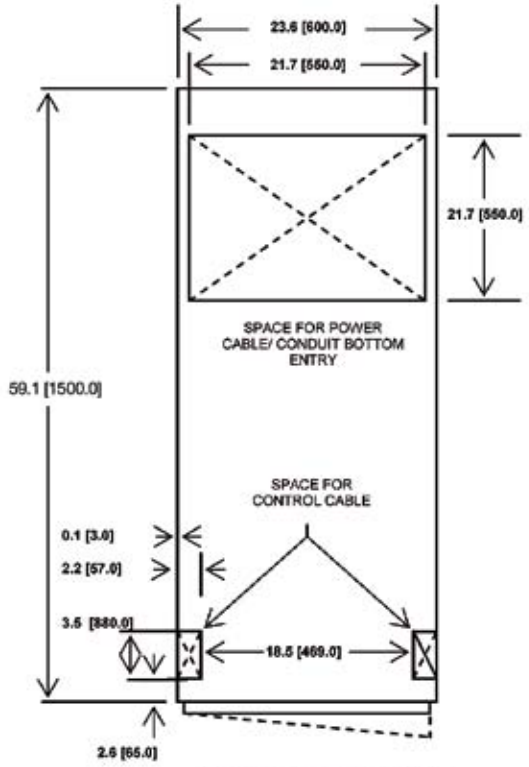


1000mm AERIAL PLAN

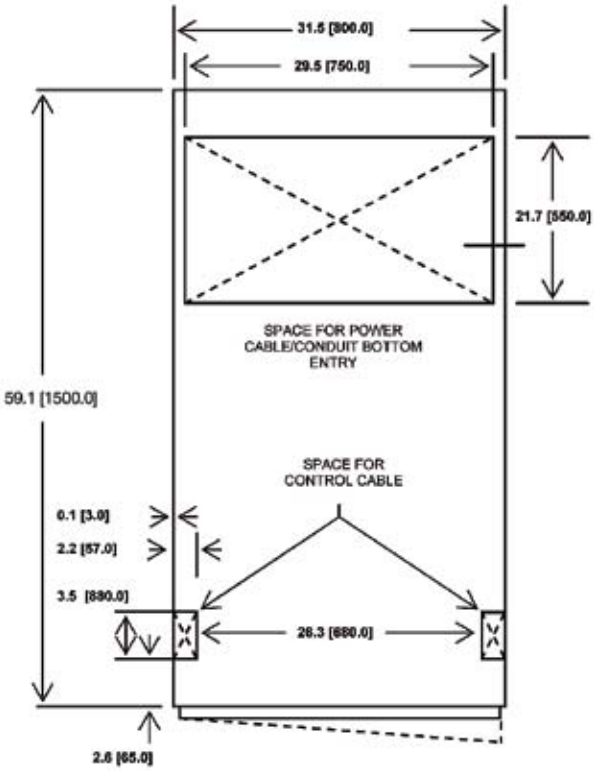
Switchgear Floor Plans
59.1” (1500 mm) Depth



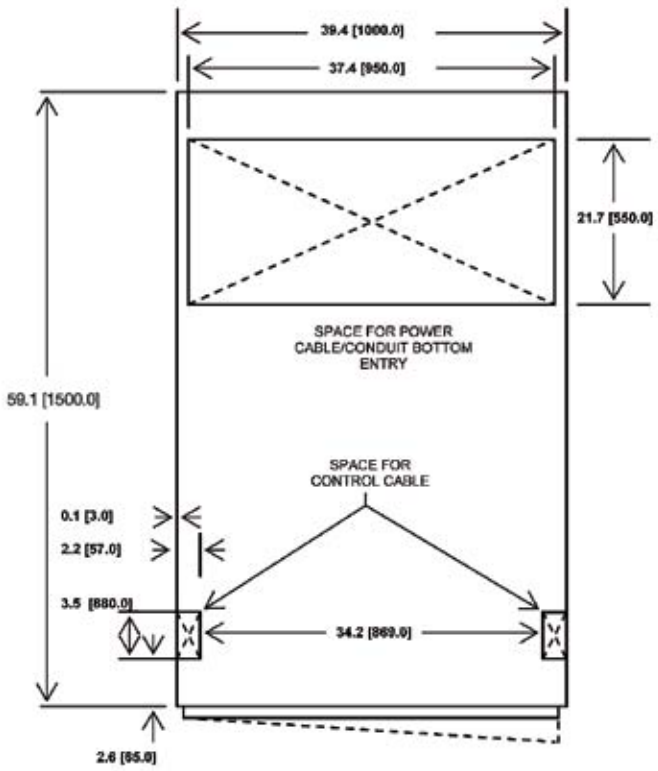
500mm AERIAL PLAN



600mm AERIAL PLAN



800mm AERIAL PLAN



1000mm AERIAL PLAN

Attachment 1 – Shark 200 Spec

Product Specifications

A. Voltage inputs
- 20-576 volts line to neutral, 0-721 volts line to line
- Input withstand capability – meets IEEE C37.90.1 (Surge withstand Capability)
- Programmable voltage range to any PT ratio
- Supports: 3 Phase 4 wire Wye, 3 Phase 3 wire Delta
- Burden: Input Impedance 1 Mega Ohm. Burden 0.014W at 120 volts
- Input wire gauge max (12 AWG/2.5mm squared)
- Current Inputs
- Class 10: (0.005 to 11) A, 5 amp nominal
- Class 2: (0.001 to 2) A, 1 amp nominal secondary
- Fault current withstand: 100 amps for 10 secs, 300 amps for 3 secs, 500 amps for 1 sec
- Continuous current withstand: 20 amps for screw terminated or pass through connections
- Programmable current to any CT ratio
- Burden 0.005VA per phase max at 11 amps
- Pickup current: 0.1% of nominal, class 10: 5mA, class 2: 1mA
- Pass through wire diameter: 0.177”/4.5mm

Isolation

A. All inputs and outputs are galvanically isolated to 2500 volts

Environmental Ratings

A. Storage temperature: -20 to +70 degrees C
B. Operating temperature: -20 to +70 degrees C
C. Humidity: to 95% RH Non-condensing
D. Faceplate rating: NEMA 12 (water resistant), mounting gasket included

Sensing Method

A. True RMS
B. Sampling at over 400 samples per cycle on all channels measured readings simultaneously
C. Harmonics resolution to 40th order
D. Waveform up to 512 samples per cycle

Power Supply

A. 90 to 265 volts AC and 100 to 370 volts DC. Universal AC/DC supply (Option D2)
B. 18-60 volts DC (Option D)

Standard Communication Format

A. 2 com ports (back and faceplate)
B. RS485 port (through backplate)
C. IrDA (through faceplate)
D. Com port baud rate: 9,600-57,600
E. Com port address: 1-247
F. 8 Bit, no parity
G. Modbus RTU, ASCII or DNP 3.0 protocols

Attachments

Attachment 1

KYZ Pulse

A. Type form C contact
B. On resistance: 35 ohms max
C. Peak voltage: 350VDC
D. Continuous load current: 120mA
E. Peak load current: 350mA (10ms)
F. Off state leakage current @ 350VDC: 1 micro amp

Accuracy

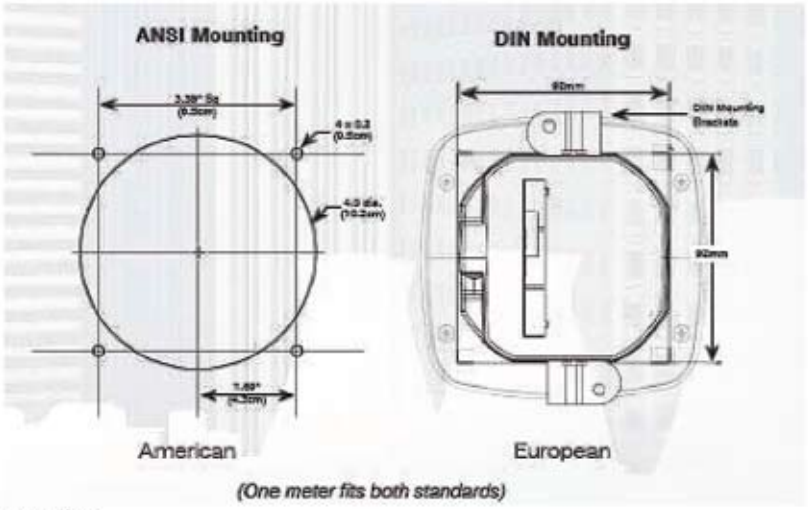
Measured Parameters	Accuracy %	Display Range
Voltage L-N	0.1%	0-9999 Scalable V or kV
Voltage L-L	0.2%	0-9999 Scalable V or kV
Current	0.1%	0-9999 Amps or kA
+/- Watts	0.2%	0-9999 Watts, kW, MW
+/- Wh	0.2%	5 to 8 Digits Programmable
+/- VARs	0.2%	0-9999 VARs, kVARs, MVARs
+/- VARh	0.2%	5 to 8 Digits Programmable
VA	0.2%	0-9999 VA, kVA, MVA
Vah	0.2%	5 to 8 Digits Programmable
PF	0.2%	+/- 0.5 to 1.0
Frequency	+/- 0.03 Hz	45 to 65Hz
%THD	+/- 2.0%	1 to 99.99%
% Load Bar	+/- 1 Segment	0.005 to 6 amps

Compliance

A. ANSI C12.20
B. ANSI (IEEE) C37.90.1 surge withstand
C. ANSI C62.41 (Burst)

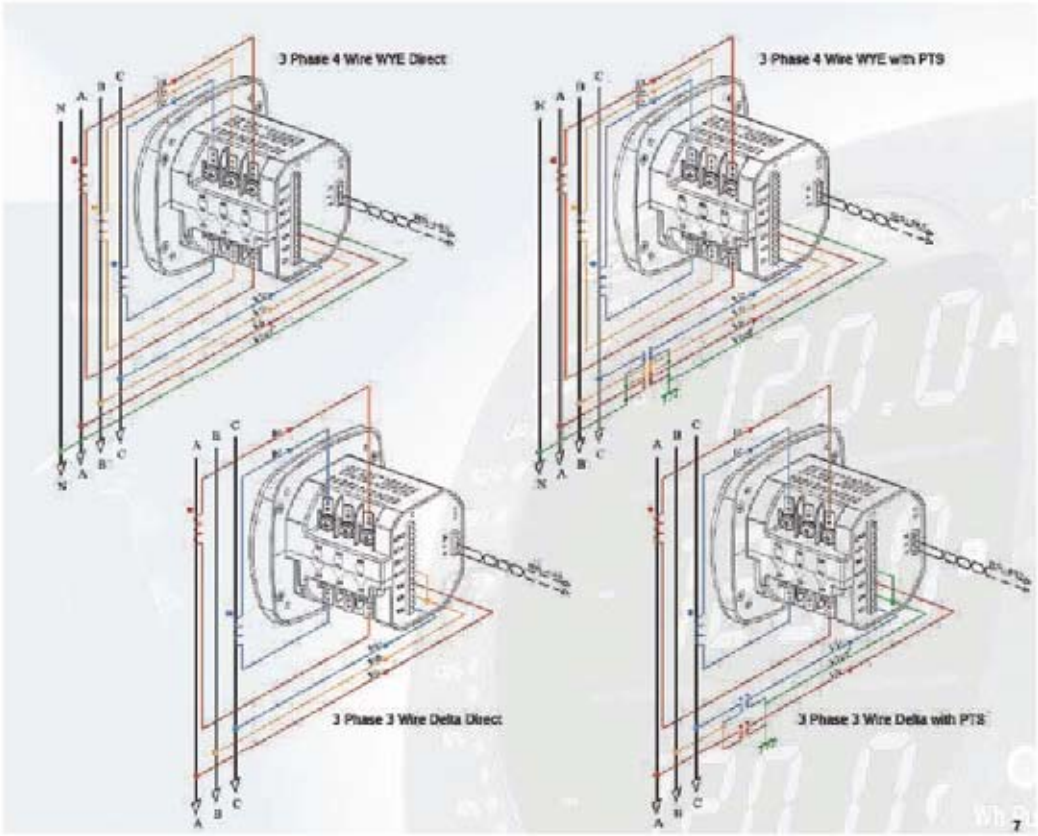
Dimensions and shipping

A. Weight: 2lbs
B. Basic unit: H4.85 x W4.85 x L4.65
C. Mounts in 92mm DIN & ANSI C39.1 round cut-outs
D. 2-inch din rail included
E. Shipping container dimensions: 6” cube



(One meter fits both standards)

Wiring Schematics



Attachment 2: Post Glover High Resistance Ground System

The standard High Resistance Ground System utilized in the MaxSG has these features:

1) Overvoltage Reduction
   - Reduces the transient over voltages that can occur during arcing-type faults.
   - Fault Detection
   - Provides an indication when the first ground fault occurs. An adjustable time delay is included to eliminate nuisance faults.
   - Fault Tracking
   - Helps to locate the fault by producing a tracer signal of current pulses easily distinguishable from background noise.
2) Operation Protection
   - Enables the system to continue operation with a single line-to-ground fault present.
3) Harmonic Detection
   - Provides an indication when third harmonics exceed a preset value. An adjustable time delay is included to eliminate nuisance faults.
4) Arc Flash/Blast Reduction
   - Eliminates hazardous energy during ground faults that are present in 90% of all electrical faults.

I. Normal Operation

1) During normal operation, only an insignificant capacitive-charging current, unbalanced harmonic current, and/or leakage current flows through the resistor. The display will show this current and/or voltage. The green NORMAL indicating light on the operator's panel will be illuminated.
2) The PulserPlus Pro™ controller detects Fundamental Current and/or Voltage and 3rd Harmonic Current and/or Voltage for both over- and under-conditions. Each of the four can be independently disabled by turning the feature OFF, and the underconditions can be disabled by entering a "0" value. A common time delay setting is used for all Fundamental alarming and a separate common time delay setting is used for all 3rd Harmonic alarming.

II. Loss of Ground

1) When the current mentioned above goes to zero, typically this indicates a Loss of Ground condition (i.e. grounding wire failure). If this occurs, the system will be Ungrounded. The PulserPlus Pro™ controller has an Under-Current/Under-Voltage feature that detects this condition for both Fundamental and 3rd Harmonics. Upon detection, the green NORMAL indicating light will turn off and its auxiliary form-C contacts change state. This feature can be disabled by setting its value to zero.

III. Ground Fault

1) When a ground fault occurs, the resistor acts to limit the ground current to a predetermined low value. Fault current magnitude can be set by adjusting the taps provided on the resistor. Fault current shall be set so that the fault current is slightly greater than the system's natural capacitive-charging current (see Figure 1).

2) The fundamental voltage appearing across the resistor or the fundamental amperage through the resistor is sensed by the PulserPlus Pro™ controller. To prevent nuisance indications, a variable time delay is entered via the operator's panel. When the time delay expires, the red GROUND FAULT indicator light will start to blink, the NORMAL indicator light will turn off, and an alarm horn will sound. Upon detection, SYSTEM NORMAL and GROUND FAULT auxiliary form-C contacts change state.
3) The alarm horn can be silenced by pressing the ALARM SILENCE button while searching for the cause of the ground fault. The red GROUND FAULT indicator light will continue blinking until the ground fault is removed and the system is manually reset by pressing the RESET and ALARM SILENCE buttons. Optionally, the PulserPlus Pro™ can be configured for auto-reset.
4) The Under-Voltage / Under-Current feature for 3rd Harmonics can also be used for detecting Ground faults near the neutral of a wye connected generator. During a Ground Fault near the neutral, the voltage may not be sufficient to drive enough current for Ground Fault detection. However, the typical 3rd harmonic caused by fractional pitched generators will be shorted and the value will go to 0.
5) High 3rd Harmonics To prevent nuisance indications, the adjustable time delay setting can be manipulated via the operator's panel. The PulserPlus Pro™ controller does know the difference between this condition and a Loss of Ground condition, so only the green NORMAL indicating light will turn off and the SYSTEM NORMAL auxiliary form-C contacts change state.
6) High 3rd harmonics are also sensed by the PulserPlus Pro™ controller. An upper limit is set by the user for detection of current or voltage across the resistor. After a time delay expires; the amber THIRD HARMONIC indicator light will illuminate, the NORMAL indicator light will turn off, and an alarm horn will sound. Upon detection, the SYSTEM NORMAL and THIRD HARMONIC auxiliary form-C contacts change state.
7) The alarm horn can be silenced by pressing the ALARM SILENCE button while searching for the cause of the third harmonic fault. The amber THIRD HARMONIC light will remain illuminated until the condition is removed and the system is manually reset by pressing the RESET and ALARM SILENCE buttons. Optionally, the PulserPlus Pro™ can be configured for auto-reset.
    a. A Summary of Events is shown on the following page.

Operation Description

		Field Condition					
		Over-Voltage	**Under-Voltage**	**Over-Current**	**Under-Current**		
Fundamental Voltage	**On**	1) Display changes to Fnd Vlt Hi Limit 2) Fundamental timer begins and expires 3) Normal light turns off 4) System Normal relay changes state 5) Ground Fault light blinks 6) Grd Fault Alarm relay changes state 7) Internal horn sounds 8) External Horn relay changes state	*IF ENABLED, SET TO 0 TO DISABLE.* 1) Display changes to Fnd Vlt Lo Limit 2) Fundamental timer begins and expires 3) Normal light turns off 4) System Normal relay changes state	1) Display changes to Fnd Amp Hi Limit 2) Fundamental timer begins and expires 3) Normal light turns off 4) System Normal relay changes state 5) Ground Fault light blinks 6) Gnd Fault Alarm relay changes state 7) Internal horn sounds 8) External horn relay changes state	*IF ENABLED, SET TO 0 TO DISABLE.* 1) Display changes to Fnd Amp Lo Limit 2) Fundamental timer begins and expires 3) Normal light turns off 4) System normal relay changes state	**On**	**Fundamental Current**
Fundamental Voltage	**Off**	No display or monitoring	No display or monitoring	No display or monitoring	No display or monitoring	**Off**	**Fundamental Current**
Harmonic Voltage	**On**	1) Display changes to Hrm Vlt Hi Limit 2) Harmonic timer begins and expires 3) Normal light turns off 4) System Normal relay changes state 5) Third Harmonic light blinks 6) Third Harmonic relay changes state 7) Internal horn sounds 8) External Horn relay changes state	*IF ENABLED, SET TO 0 TO DISABLE.* 1) Display changes to Hrm Vlt Lo Limit 2) Harmonic timer begins and expires 3) Normal light turns off 4) System normal relay changes state	1) Display changes to Hrm Amp Hi Limit 2) Harmonic timer begins and expires 3) Normal light turns off 4) System Normal relay changes state 5) Third Harmonic light blinks 6) Third Harmonic relay changes state 7) Internal horn sounds 8) External Horn relay changes state	*IF ENABLED, SET TO 0 TO DISABLE.* 1) Display changes to Hrm Amp Lo Limit 2) Harmonic timer begins and expires 3) Normal light turns off 4) System Normal relay changes state	**On**	**Harmonic Current**
Harmonic Voltage	**Off**	No display or monitoring	No display or monitoring	No display or monitoring	No display or monitoring	**Off**	**Harmonic Current**

Presing Alarm Silence Button:
1) Turns off Internal horn
2) Resets External horn relay

Pressing Pulse Button:
1) Amber light blinks
2) Pulsing relay begins

Pressing Reset Button:
1) Resets Display
2) Resets all latching relays
3) Only does above if Auto Reset is turned off

Pressing Reset and Down Arrow Buttons:
1) Enters Setup mode

IV. ABB's High Resistance Grounding Systems are packaged in a variety of different configurations depending on the ratings and site requirements. The resistor maybe provided mounted internally in the rear cable compartment or may be provided in its own NEMA 3R rated enclosure. The controller is mounted in a 42" (1066 mm) instrument compartment. The location of the resistor may be impacted due to the mounting of other devices. There might need to be need to mount the whole unit in its own enclosure 23.6" (600 mm) wide.

1) Line and Control Connections
    a. Refer to application specific drawings that accompany the ABB's system. Generally, the line connections are made from either the top or bottom of the enclosure. Space is provided for line cables to run down the side without any cable bends. The control power and auxiliary device connections are made to the terminal blocks rated 30 amperes, 600 volts.
        a. Refer to the specific diagrams furnished with the equipment for location detail.
        b. As a final check, inspect all wiring to verify that connections are made properly and that they are clean and tight. Make sure there is adequate clearance between the external connections and all devices.
2) Setting Resistor Tap Connections
    a. Adjust the resistor at installation so that ground current with one ground fault is equal to or greater than the system capacitive-charging current. As long as this minimum criteria is met, the exact magnitude of the setting is not critical. In fact, a value slightly higher than the system capacitive-charging current may be selected to allow for future system growth. Refer to the elementary schematics for grounding resistor connections.
3) General
    a. When the installation is complete and all incoming wiring has been terminated, clean the inside of the unit with a soft cloth or vacuum cleaner. Make sure any dirt or debris, such as packing material, is removed so it does not interfere with the operation of the unit. Before connecting power to the control panel, check all components to make sure all shipping devices, such as blocking or tying of relays, have been removed.
4) Energize Circuit
    a. Close the disconnect switch (SW1). This will connect the equipment to the power system.
    b. Enter the setup information through the operator's panel per the instructions given below. The system NORMAL green light should be illuminated on the operator panel, indicating the presence of power and that no fault or under-condition is present.
5) Ground Fault Alarm Test With Test Resistor:
    a. This test actually places a controlled ground fault on the system within the enclosure through a test resistor. The test resistor is connected between a phase conductor and ground, so the test circuit begins at a phase, goes through the test resistor to ground, from ground through the neutral grounding resistor, and finally to the PulserPlus ProTM module.
    b. The readings on the PulserPlus ProTM module will be lower than normal readings due to the test resistor connected in series with the neutral grounding resistor.

c. The purpose of the test resistor is to avoid a phase-ground-phase fault if an actual ground fault were to occur during testing. The resistor would be connected between the two phases.

d. Enter a test value in the Fundamental Voltage Hi Limit Setpoint. This test voltage needs to be calculated depending on the actual resistor values. Although 100 volts is typically used for a test value, the schematic drawings provided with the PulserPlus ProTM unit should be consulted.

e. The equation below can be used to determine a non-typical test value.

$$Vtest = (VL\text{-}N / (RGF + RT\text{-}G)) RGF - 10V$$

i. Where: Vtest is the test voltage to be entered in the Fnd Vlt Hi Limit

ii. VL-N is the line-to-neutral system voltage

iii. RGF is the resistance of the neutral grounding resistor at the chosen tap

iv. RT-G is the test-to-ground resistance – see schematic drawing

v. Press and hold the SYSTEM TEST pushbutton on the operator's panel to activate the ground-fault circuitry. After a delay, the green NORMAL light should turn off, and the red GROUND FAULT light should start to blink. In addition, the audible alarm will sound.

vi. Release the SYSTEM TEST pushbutton. Press and hold the ALARM SILENCE pushbutton and the audible alarm should cease. Press the RESET pushbutton and the red and green lights and auxiliary contacts should revert to their normal states.

6) Without Test Resistor:

a. This test will verify operation of the PulserPlus ProTM module only. The test bypasses the neutral grounding resistor and most of the circuitry by opening the neutral grounding circuit and applying control voltage (~120Vac) to the PulserPlus ProTM controller module.

b. Enter a value lower than 100 volts in the Fundamental Voltage Hi Limit Setpoint.

c. The same procedure that is used with a test resistor can now be followed.

7) General

a. The magnitude of zero-sequence charging current is determined by the line-to-ground capacitance associated with system components. The value of the current must be known to properly coordinate the ABB High-Resistance Grounding System. In an industrial power system where the design and components are known, the charging current can be estimated with reasonable accuracy. With a complex array of machines and cables this may be tedious and yield less-than-accurate results. The discussion that follows outlines a suitable test for determining the value of current in a system. A transformer's capacitance-to-ground is usually negligible because of the large spacing between the transformer's core and winding, and the shielding effect of the winding layer adjacent to the core. Shielding prevents other winding layers from significantly increasing the winding-to-ground capacitance. Cable and overhead line capacitance, on the other hand, can be significant if the circuit is large.

b. Major contributions to the overall system capacitance-to-ground are made by rotating machines. Attributes such as the type of insulation and the number and depth of slots can produce wide variations. A typical value for a 200 hp, 2300 volt, 1800 rpm induction motor might be 0.002 micro-farads phase-to-ground capacitance.

8) The most accurate way to determine the maximum value of the charging current is by test, since extreme variations can exist. The charging current per phase is represented by ICA, ICB or ICC while IC corresponds to the total line-to-ground charging current. To obtain the zero-sequence charging current, one phase conductor is intentionally grounded as shown in Figure 1, next page.

9) Test Procedure (refer to Figure 1 below)

   a. Temporarily install a disconnect switch, a current limiting fuse and a portable ammeter in the path between the phase to be tested and earth ground, as shown in Figure 1 on the next page. DO NOT CLOSE TEMPORARY DISCONNECT UNTIL SW1 IS CLOSED.

   b. Close the disconnect switch in the PulserPlus Pro cabinet (SW1) to provide a return path to measure current returning through the neutral grounding resistor.

   c. Close the temporary disconnect switch installed on the phase to be grounded (as shown in Figure 1) in the system.

   d. With both disconnect switches closed, current through the grounded phase (IG) can be read by the portable ammeter and current through the neutral grounding resistor (IR) can be read by the PulserPlus Pro™ Display unit.

   e. After the test is completed and all data is collected, open the temporary disconnect switch associated with the grounded phase before opening the disconnect switch (SW1) in the PulserPlus Pro cabinet.

   f. Use the charging current calculations below to find the total line-to-ground charging current (IC).

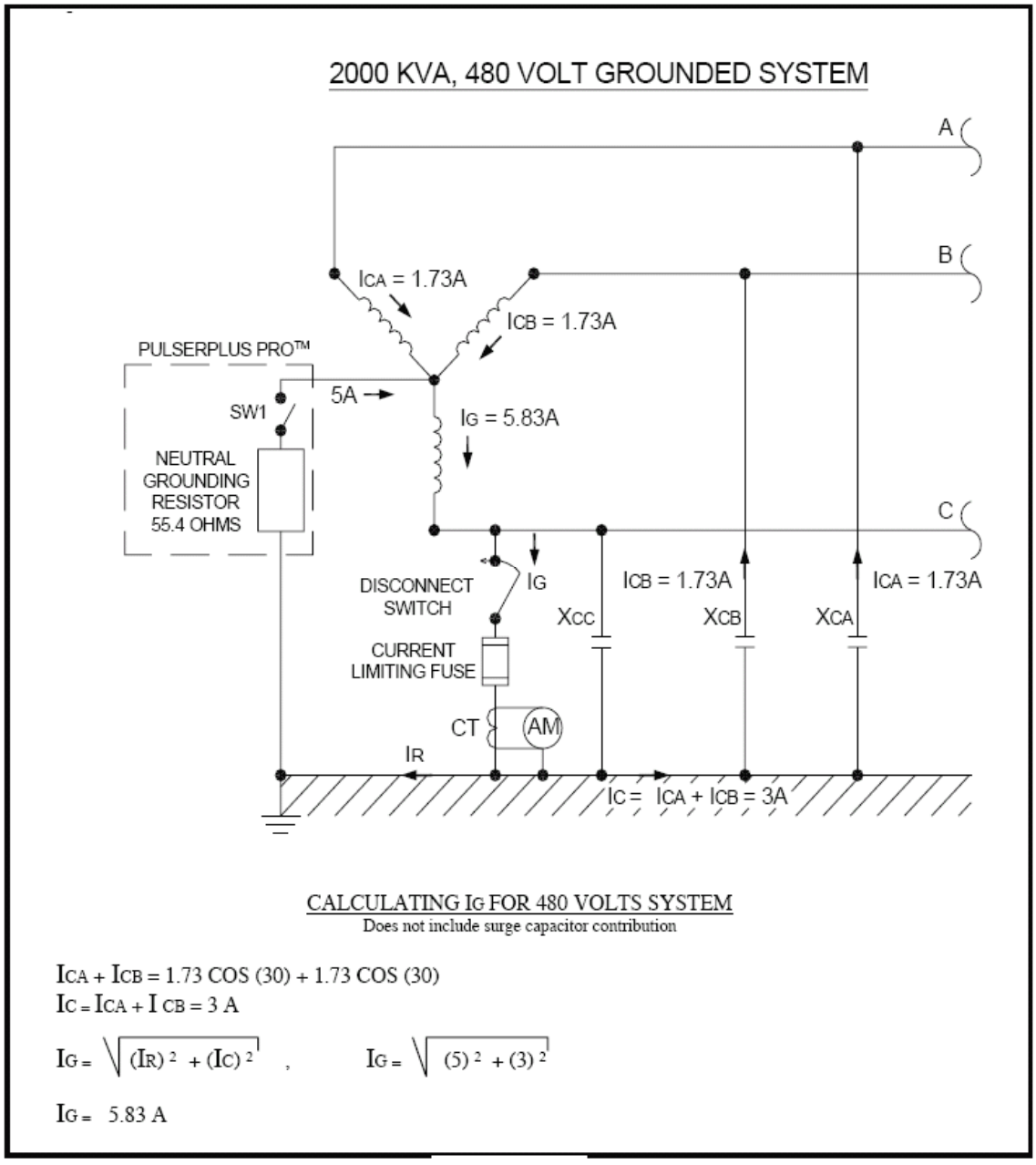

2000 KVA, 480 VOLT GROUNDED SYSTEM
A
B
C
ICA = 1.73A
ICB = 1.73A
PULSERPLUS PRO™
SW1
5A
IG = 5.83A
NEUTRAL
GROUNDING
RESISTOR
55.4 OHMS
DISCONNECT
SWITCH
IG
ICB = 1.73A
ICA = 1.73A
XCC
XCB
XCA
CURRENT
LIMITING FUSE
CT
AM
IR
IC = ICA + ICB = 3A
CALCULATING IG FOR 480 VOLTS SYSTEM
Does not include surge capacitor contribution
ICA + ICB = 1.73 COS (30) + 1.73 COS (30)
IC = ICA + I CB = 3 A
IG = √(IR)² + (IC)² , IG = √(5)² + (3)²
IG = 5.83 A

Figure 1

Charging Current Calculation:

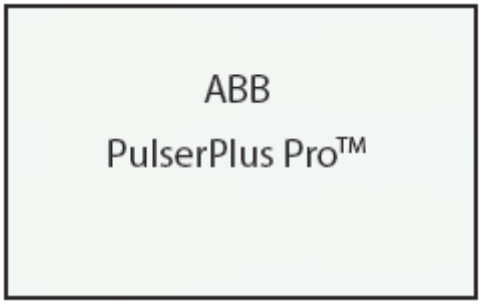
From Figure 1:

$$| Ig | = \sqrt{(I_R)^2 + (Ic)^2}$$

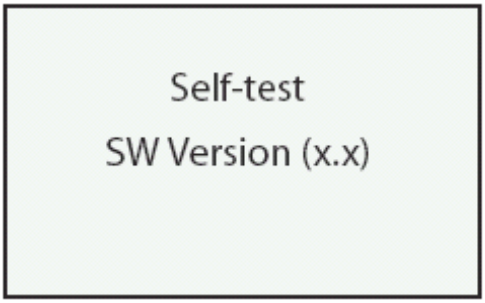
$$| Ic | = \sqrt{(I_G)^2 - (I_R)^2}$$

3) Test Results
   a. All components that are operating during testing contribute to the test results. This includes the contribution of the surge-protective capacitor which, as mentioned previously, can be quite significant. As such, the test results should be modified to include all surge-protective capacitors not in operation during testing.
   b. The resulting value should be used to determine a minimum current for ground fault alarming. Set the resistor taps in Section 6 so that the fault current is slightly greater than IC.NOTE: The temporary disconnect switch and current limiting fuse associated with the phase to be grounded are not included with the PulserPlus Pro™. A portable ammeter can be included as an option with the PulserPlus Pro™.

4) Controller Setup
   a. Power Up Supply
   b. Apply AC power to the unit. After a 1/2 second beep, the following message will be displayed for 5 seconds:



   c. The unit then goes through a short self check. During the self check, the following message will be displayed:



d. Once the self check is complete, the display unit will display the fundamental and/or 3rd harmonic voltage and/or the amperage of the grounded system by automatically toggling between the screens. The unit may be programmed to display any or all of these measurements.

5) Adjustable Parameters

a. The following features of the PulserPlus ProTM can be set from the front panel.

Fundamental Voltage Measurement On/Off
Harmonic Voltage Measurement On/Off
Fundamental Amperage Measurement On/Off
Harmonic Amperage Measurement On/Off
CT Ratio On/Off
Fundamental Voltage Hi Limit nnn V
Fundamental Voltage Lo Limit nnn V
Harmonic Voltage Hi Limit nnn V
Harmonic Voltage Lo Limit nnn V
Fundamental Amp Hi Limit nn.n A
Fundamental Amp Lo Limit nn.n A
Harmonic Amp Hi Limit nn.n A
Harmonic Amp Lo Limit nn.n A
Pulse Time Sec n.n S
Fundamental Alarm Delay nn.n S
Harmonic Alarm Delay nn.n S
Auto Reset On/Off

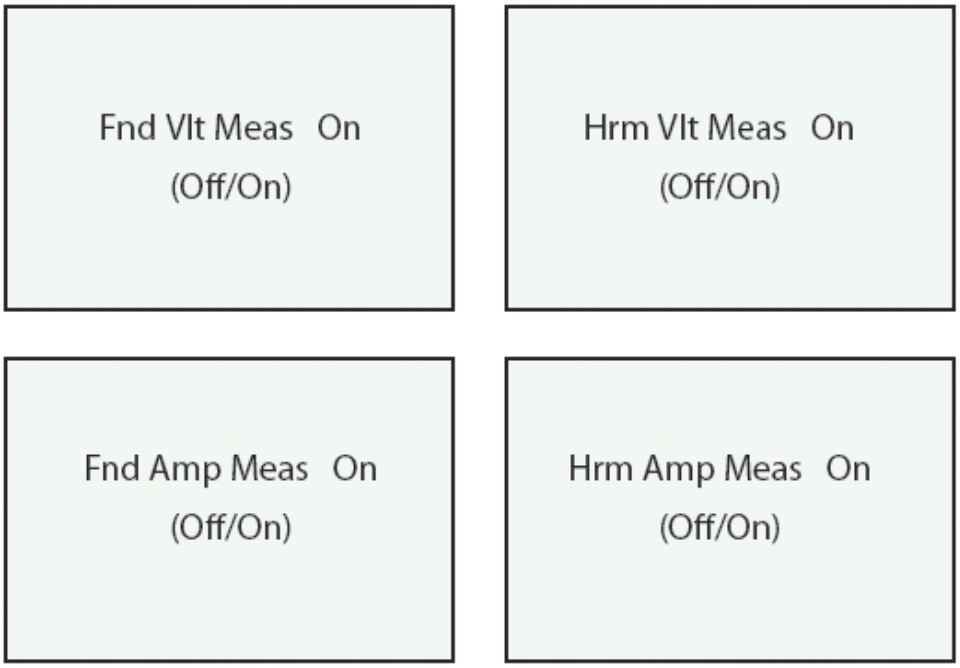
b. Configuration mode

i. To Enter Configuration Mode

Press BOTH the RESET and DOWN ARROW buttons until the unit BEEPS, then release.

ii. Adjust Values in Configuration Mode:
Numeric values can be adjusted by using the UP ARROW and DOWN ARROW buttons. The buttons have two speeds. If either button is held in, the display will increment/decrement by single units for 5 counts, then it will increment/decrement by ten units. Releasing the button will restore the single units counting.
Pressing the ENTER button will store the NEW value and go to the next setting.
Pressing the MODE button will go to the next setting WITHOUT changing the stored setting.
Pressing the PULSE button will go back to the previous screen WITHOUT changing the stored setting.

iii. Exit Configuration Mode
Pressing the RESET button will EXIT configuration mode.
After 60 seconds of inactivity, the unit will exit configuration mode and return to displaying fundamental and/or harmonic measurements.



c. Measurement Enable

Using the UP ARROW and DOWN ARROW buttons, the Fundamental Voltage and Amperage, and the 3rd Harmonic Voltage and Amperage measurement displays can be enabled or disabled. Measurement displays default to the ENABLED condition.

d. Current Transformer Ratio

Set CT Ratio	Off	ON	ON	ON
Selection:	1X	0.57x	2x	6x

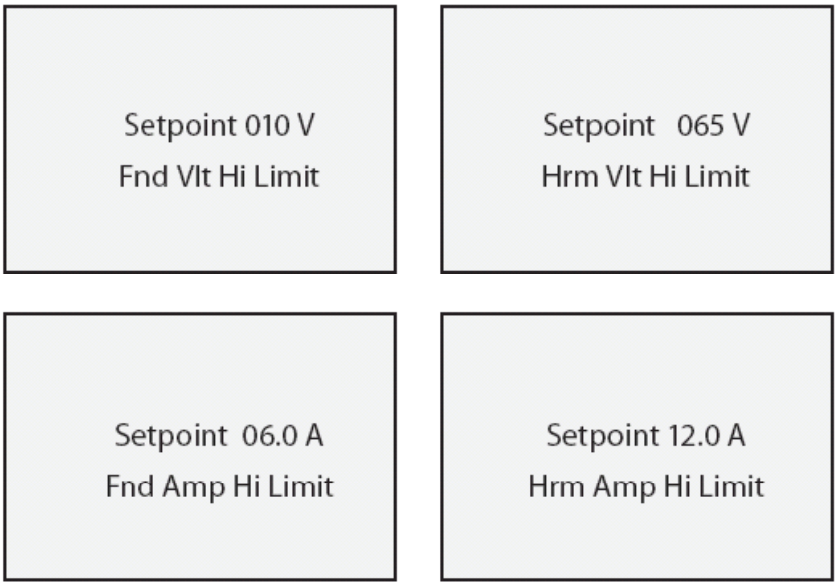
Press the UP ARROW or DOWN ARROW buttons to select the desired ratio, then press ENTER to store the parameter.

This feature multiplies the measured current by the selected CT ratio. For example, the physical limitation of the PulserPlus Pro™ module is 16A. If 20A is desired, a 30:5 CT is used to send a 0-5A signal the module. The CT ratio is set for 6x, so the measured current (0 to 5A) is multiplied by 6x. The display and alarming uses this multiplied current (0 to 30A).

Default setting for the CT ratio is Off, 1X. The CT ratio is factory set to the proper rating for the installed components.

e. Hi Limit Setpoints

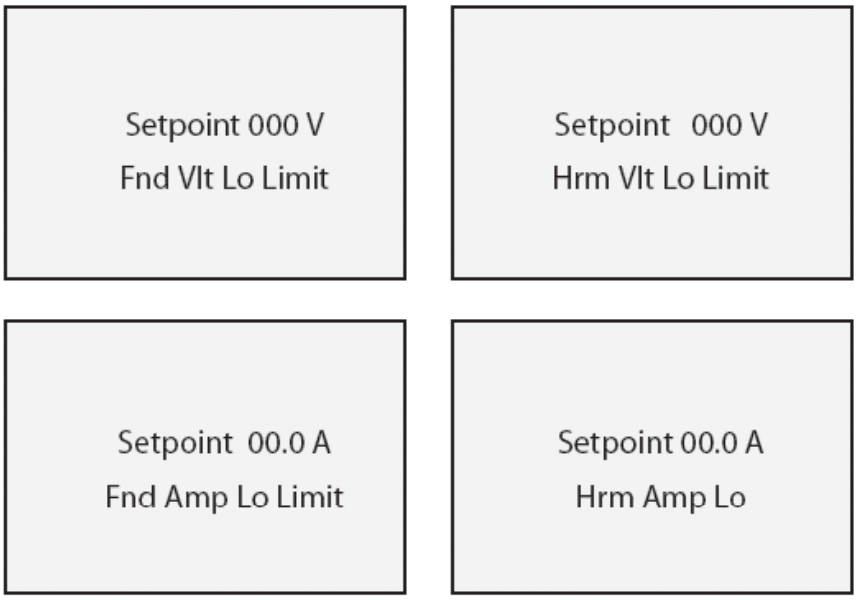
The Hi Limits are only accessible if the associated measurement display is enabled.



The Hi Limit setpoint indicates the level at which the Ground Fault or Third Harmonic alarm will activate.
Using the UP ARROW and DOWN ARROW buttons, the voltage hi limits may be set to any voltage between 0 and 400 volts. For Medium Voltage applications, see the schematic prints provided with the unit for information on setting this value. The amperage hi limits may be adjusted between 00.0 and 16.0 amps.

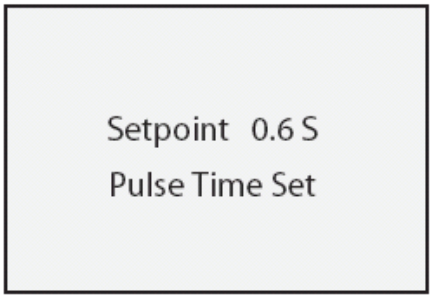
f. Lo Limit Setpoints

The Lo Limits are only accessible if the associated measurement display is enabled.



The Lo Limit setpoint indicates the level at which the Loss of Ground condition will activate. For a Harmonic Lo Limit, it may also indicate a Ground Fault.
Using the UP ARROW and DOWN ARROW buttons, the voltage Lo limits may be set to any voltage between 0 and 400 volts.

g. Pulsing Timer

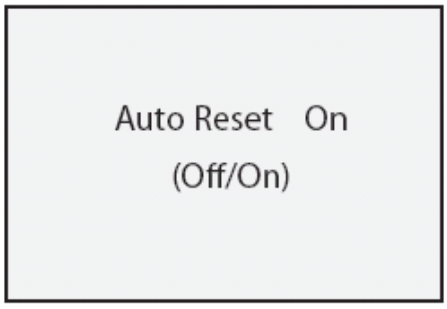


The Pulse Rate used to locate ground faults can be adjusted from 0.5 to 3.0 seconds in increments of 0.1 seconds. The setpoint indicates time on and time off, so a setting of 1.0 S results in the pulse on for 1 second and off for 1 second (pulse rate of 30 per minute).
Calculation: 60 / [2 * setpoint (seconds)] = pulse rate per minute
Sample Settings 0.5 s 1.0 s 2.0 s 3.0 s
Resulting Pulse Rate 60/min 30/min 15/min 10/min

h. Alarm Delay

The Alarm Delay setpoints indicate the amount of time between a fault indication and the alarm activation in seconds. During the alarm delay time, the system will monitor the fundamental and/or harmonic voltage and/or amperage measurement. If the faulted parameter returns to a value within the set limits prior to the expiration of the delay, the alarm will be canceled. Thus, a transient high measurement will not activate the alarm. The default setting for this setpoint is 4.5 seconds.
Using the UP ARROW and DOWN ARROW buttons, the alarm delay may be set for any time between 0 and 20.4 seconds.

i. Auto Reset



When turned On (enabled), auto-reset will reset the unit when a fault is cleared. When turned Off (disabled), a user must press the ALARM SILENCE and RESET buttons to place the system in NORMAL state after clearing a fault.

j. Locating a Ground Fault

To locate a ground fault, activate the pulsing circuit by pressing and holding the PULSE pushbutton on the operator's panel. Once the words "Pulser On" are indicated on the alphanumeric display, the button may be released. This activates a control circuit which causes a cyclic switching sequence. The switching sequence consists of the cycle timing of an integral pulsing relay (P). The pulsing relay (P) output contact on the controller alternately energizes and de-energizes a pulsing contactor (PX) mounted on the Pulser-Plus Pro™ control panel backplate. The pulsing contactor (PX) shorts out a portion of the grounding resistor (NGR) each time the contactor is energized, producing a tracer signal.

below). The feeder with the fault will show rhythmic fluctuations on the detector's readout. The fault can be traced to the sub-feeder and eventually to the faulted device. Once this location is determined, the pulser should be turned off by pressing and holding the PULSE pushbutton on the operator's panel. Once the words "Pulser Off" are indicated on the alphanumeric display, the button may be released.

After clearing the fault, place the system in its normal operation mode by pressing the RESET pushbutton. See Figure 2, next page.

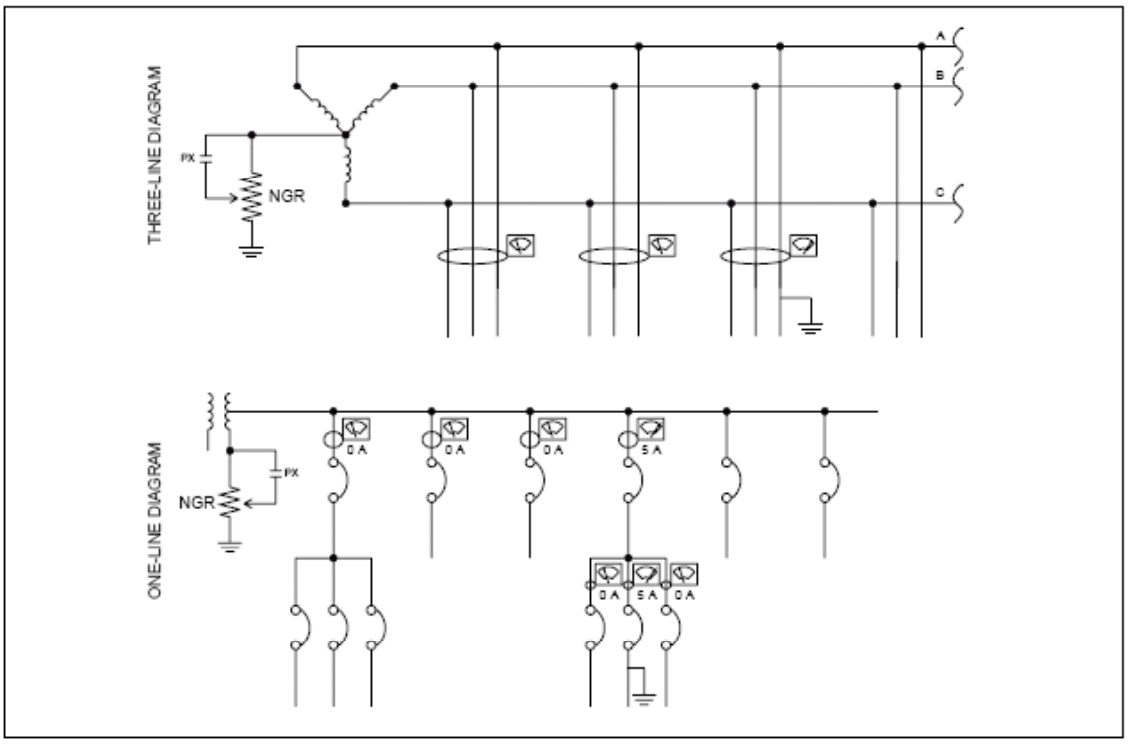


Figure 2
How to Locate a Ground Fault

k. Maintenance

Normally, no maintenance is necessary for the PulserPlus Pro™ high resistance grounding system. However, periodic inspections are needed to ensure that the controller is functioning correctly and the resistor is still capable of protecting the system. ABB recommends that the periodic inspections coincide with your normal system Preventative Maintenance schedule.

The following procedure is recommended for periodic field inspections:

a. De-energize the system being grounded and break the connection between the system, the neutral, and the grounding resistor using the disconnect switch. Always use proper lock-out/tag-out procedures when working on electrical equipment.

b. Open the front door on the control enclosure. For systems with a separately mounted resistor, remove the front and rear covers. This will allow for a visual inspection of all internal components.

c. Carefully check for cracked insulators and resistor cores. A MEGGAR or Hi-Pot test is the most reliable method of ensuring that the insulation is still providing the necessary electrical isolation.

d. Check the resistive element for continuity. Ohmmeter readings made between each neutral tap and the ground side of the resistor should be within 10% of the values on the resistor drawing. If the resistances of the elements are more than 15% different from the drawing values, the resistors should be replaced. Any open resistors should be replaced.

e. Check all internal connections for tightness. Check wiring for signs of damage from heat or overloads.

f. Check the enclosure for signs of damage from weather or rodents. Remove any dirt or debris from the inside of the enclosure using a vacuum cleaner. Replace all side covers removed during inspection and check the mounting bolts for tightness. Close the front door of the control enclosure.

g. After re-energizing the system, perform the Test procedure in section 4.3 to verify system operation.

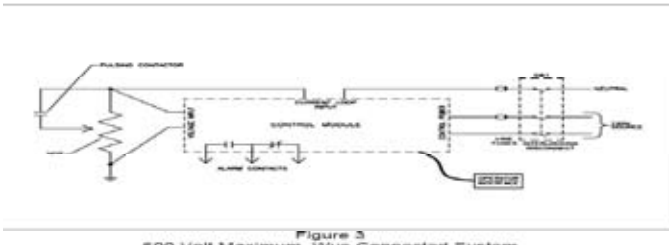


Figure 3
600 Volt Maximum, Wye Connected System

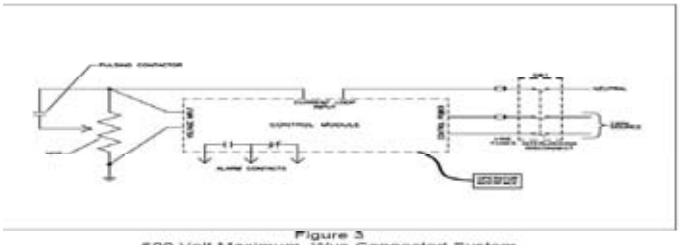


Figure 3
600 Volt Maximum, Wye Connected System

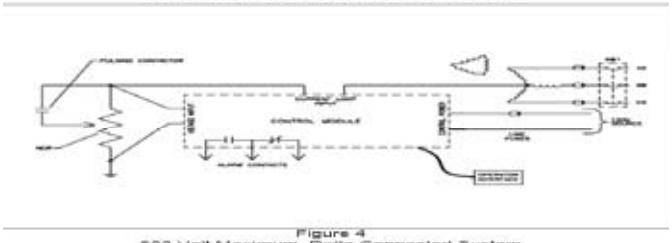


Figure 4
600 Volt Maximum, Delta Connected System

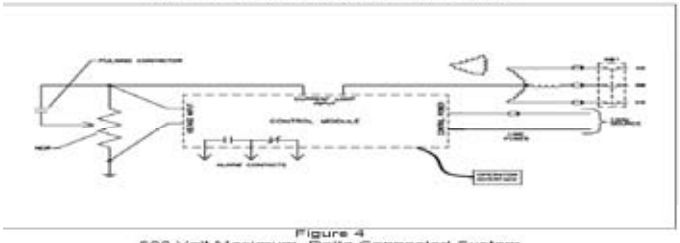
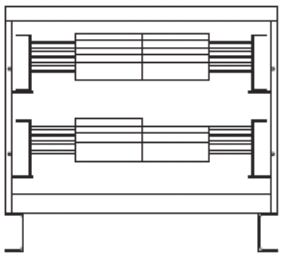


Figure 4
600 Volt Maximum, Delta Connected System

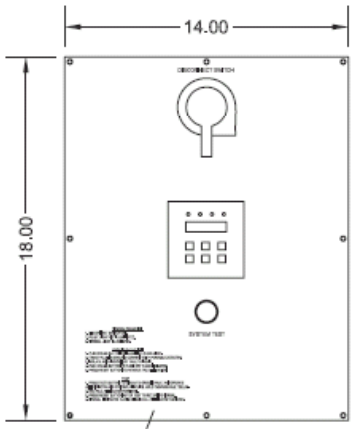
600 VOLT WYE AND DELTA SYSTEMS

SEPARATELY MOUNTED RESISTOR ASSEMBLY

FRONT VIEW



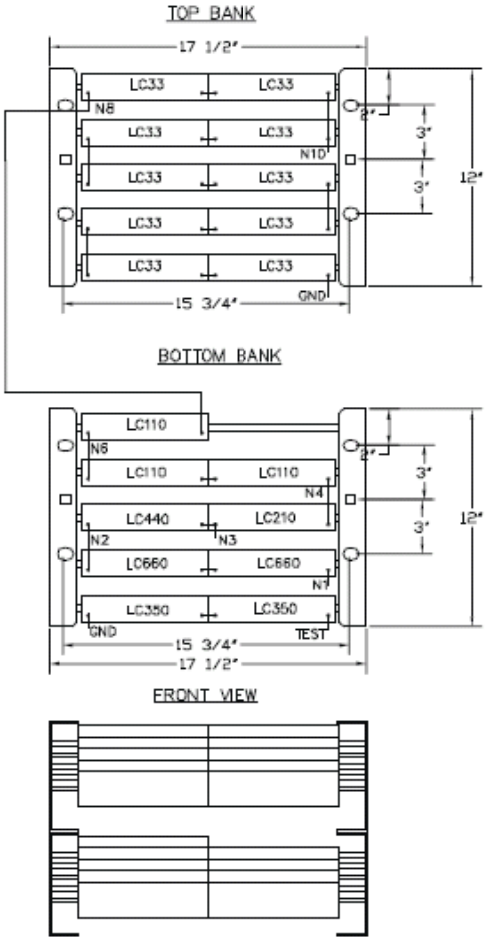
FRONT CONTROL PANEL



NORMAL OPERATION
1. DISCONNECT SWITCH "ON".
2. PULSE LIGHT NOT ILLUMINATED.
3. NORMAL LIGHT ILLUMINATED.

GROUND DETECTION
1. PUSH PULSE BUTTON TO ILLUMINATE PULSE LIGHT.
2. TRACE PULSING GROUND CURRENT WITH PORTABLE DETECTOR.
3. ISOLATE AND DISCONNECT FAULTY CIRCUIT.
4. PUSH PULSE BUTTON TO TURN OFF PULSE INDICATOR.
5. PRESS RESET BUTTON TO REMOVE FAULT INDICATION.

TEST
1. PRESS TEST BUTTON TO SIMULATE GROUND FAULT AND OPERATE ANNUNCIATOR AND CONTROL CIRCUITS, HOLD THROUGH FAULT DELAY.
2. RED FAULT INDICATOR TURNS ON.
3. PRESS RESET BUTTON AFTER TEST TO RETURN TO NORMAL.
4. NORMAL INDICATOR TURNS ON AND FAULT INDICATOR TURNS OFF.



CONNECT TO "N10" FOR 10 AMP FAULT CURRENT
CONNECT TO "N8" FOR 8 AMP FAULT CURRENT
CONNECT TO "N6" FOR 6 AMP FAULT CURRENT
CONNECT TO "N4" FOR 4 AMP FAULT CURRENT
CONNECT TO "N3" FOR 3 AMP FAULT CURRENT
CONNECT TO "N2" FOR 2 AMP FAULT CURRENT
CONNECT TO "N1" FOR 1 AMP FAULT CURRENT

CONNECT THE PULSING TAP (WIRE #24) TO THE TAP THAT IS 2 TAPS HIGHER THAN THE SELECTED NEUTRAL TAP. (EX. CONNECT WIRE #12 TO THE "N8" TERMINAL AND WIRE #24 TO THE "N10" TERMINAL.)

FACTORY SET PULSING TAP (WIRE #24) ON "N10" AND NEUTRAL TAP (WIRE #12) TO "N8".

STEPS	OHMS	C.C.
N10–GND	26.4	10
N8–GND	33.0	8
N6–GND	44.0	6
N4–GND	66.0	4
N3–GND	87.0	3
N2–GND	131.0	2
N1–GND	263.0	1
TEST–GND	70.0	3

VOLTS LINE TO NEUTRAL 277
AMPS 1–10
TIME (SECONDS) CONTINUOUS
TEMPERATURE RISE 385°C
OHMS @ 25°C 263± 10%

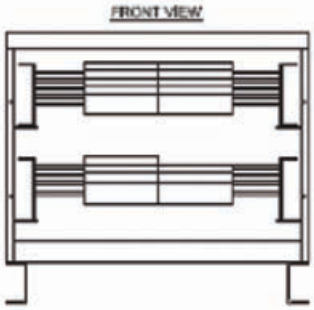
ADD OR REPLACE –MM WITH
–61 TO DRAWING FOR ANSI 61 FINISH
–49 TO DRAWING FOR ANSI 49 FINISH
–70 TO DRAWING FOR ANSI 70 FINISH
–MG TO DRAWING FOR MILL GALVANIZED STEEL
–SS TO DRAWING FOR 304 STAINLESS
–AL TO DRAWING FOR ALUMINUM

(1) 10 COILS/BANK, (1) 9 COILS/BANK. 17.5"L x 12"W x 6"H EACH.
2727–5P ENDFRAMES. TURN FLANGES IN. TERMINALS UP. FURNISH JUMPERS.

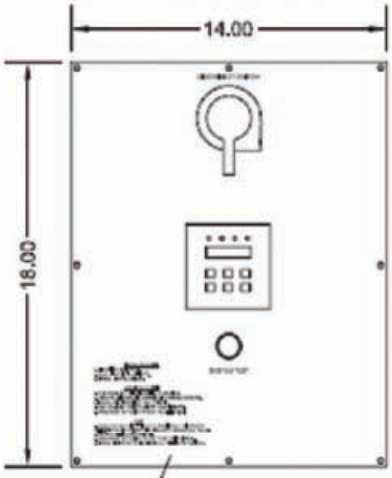
UL LISTED

600 VOLT WYE AND DELTA SYSTEMS

SEPARATELY MOUNTED RESISTOR ASSEMBLY



FRONT CONTROL PANEL



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Notes

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