



Application Guide

MNS-SG

Low Voltage, Metal-Enclosed, Drawout Switchgear

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I. Product Description

General

For over 30 years, ABB has been the global leader for low voltage switchgear and motor control centers (MNS). Drawing on a heritage of technology excellence and innovation, the MNS product family in North America has been expanded with the new MNS-SG Low Voltage Metal-Enclosed Arc-Resistant Switchgear.



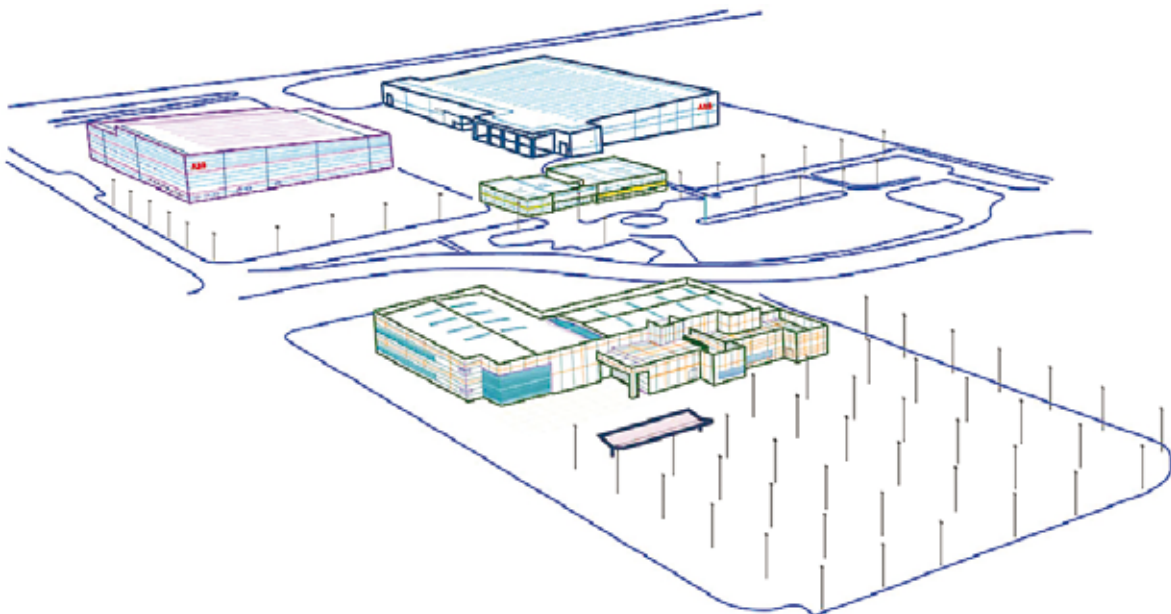
The MNS-SG low voltage arc-resistant switchgear is industrial-duty equipment built to ANSI/UL standards and designed to use 100% rated Emax circuit breakers.

The flexibility of the MNS-SG platform results, in part, from the consistent application of the modular principle both in electrical and mechanical design that enables customization of the structural design, interior arrangement and degree of protection. The switchgear can be outfitted as needed with standardized components to perfectly adapt the MNS-SG to each application.

The MNS-SG was designed, built and tested to meet all applicable requirements for UL1558, ANSI C37.20.1 and ANSI C37.20.7. It represents a further extension of the ABB vision to deliver products that provide customers with advanced solutions meeting their need for equipment able to deliver reliable performance even under the mechanical, electrical and thermal stress of today's manufacturing environment.

The MNS-SG is designed to meet the most stringent industry requirements in a range of markets, including:

- Aerospace
- Critical Power and Data Centers
- Food and Beverage
- Health Care
- Marine
- Mining and Metals
- Oil and Gas
- Pharmaceutical
- Power Generation
- Semiconductor Manufacturing
- Steel Mill
- Utility and Co-generation
- Water and Wastewater



Arc Flash Dangers

NFPA 70E defines an arc flash as “a dangerous condition associated with the release of energy caused by an electric arc.” Independent studies have identified low voltage (LV) metal-enclosed switchgear as a leading contributor to electrical injuries. LV switchgear often presents a unique challenge to factory personnel because of the variety of equipment in use and the relatively frequent maintenance required.

Internal arc faults in LV switchgear may result from improper operation or maintenance, or adverse environmental conditions. While the MNS-SG can provide enhanced protection against arc flash, hazard analyses are essential to determine the appropriate PPE level for technicians working in or near energized equipment.

Electrical equipment has traditionally been designed to withstand bolted faults, incidents when the current spikes to a potentially dangerous level but is quickly and safely interrupted by the protective devices in place, including relays, breakers and fuses. Unfortunately, these protective devices don't detect and, therefore, can't interrupt the internal arc faults that have lower current levels but can still create a dangerous and potentially deadly event.

These internal faults may be the result of the degradation of insulation, insulation contamination, animals or debris contacting the energized bus, or a multitude of other conditions that provide the path for an electrical discharge through the air.

During an arc fault, the voltage at the site of the fault is equivalent to the system voltage. The energy is focused within the switchgear cabinet, generating temperatures as high as 19,500°C (35,000°F), hot enough to damage or destroy equipment and cause serious injury, even at a distance. The blast produced by 480 V AC switchgear rated at 85 kA is equivalent to 9.5 kg (20.7 pounds) of TNT.

Internal arc faults occur within milliseconds but have tremendous destructive potential. The ionized gases generated by the arc create a conductive path between the opposite polarities and/or ground. The arc typically continues until interrupted by the circuit breaker or other protective device. The severity of the blast pressure is dependent on the magnitude and duration of the fault current.

MNS-SG Arc-Resistant Switchgear

In standard switchgear, the metal cabinet provides limited protection from the mechanical forces generated by bolted faults on the load terminals. It should be noted that arc-resistant switchgear does nothing to prevent internal arcs from occurring. Instead, it contains and redirects the arc gasses away from the switchgear and operators.

ABB arc-resistant switchgear protects operating and maintenance personnel from dangerous arc faults by containing and channeling the arc energy out of the top of the switchgear, regardless of where the arc originated inside the equipment.

Arc-resistant switchgear cabinets are reinforced to better withstand the heat and pressure created by the fault, containing them until the current is interrupted by a power circuit breaker or other protective device. Modifications include additional barriers inside the switchgear combined with more-robust locking mechanisms. Heat and pressure are expelled through chimneys mounted on the top of the switchgear and may be vented via an optional plenum to a safe area outside the electrical room.

When a bolted fault occurs, the voltage approaches zero at the fault location, while the energy generated by the fault is dissipated throughout the power system. The circuit breaker chutes cool and extinguish the arc generated within the circuit breaker as it interrupts the fault. There is limited out-gassing created by the arc from the arc chutes, which is contained within the switchgear. This has been verified in interruption tests.

The ability of the cabinet to withstand arc fault energy is verified by testing, including short-circuit and short-time withstand tests on the equipment. Interruption tests are conducted on the power circuit breakers.

The MNS-SG arc-resistant switchgear provides an added degree of protection over standard metal-enclosed switchgear. In addition to bolted faults, ABB MNS-SG low voltage switchgear is designed and performance-tested to ANSI/IEEE C37.20.7 Type 2B accessibility to provide protection from the hazards of internal arc faults. The Type 2 designation indicates “switchgear with arc-resistant designs or features at the freely accessible exterior (front, back, and sides) of the equipment only.” The B suffix is “...designated for equipment where normal operation of the equipment involves opening the door or cover of compartments specifically identified as low voltage control or instrumentation compartments.”



Optional Plenum

Confirmed by Testing

Arc-resistant enclosures are designed to contain the arc forces under specified installation conditions. Testing of the arc-resistant switchgear was conducted using a variety of samples selected to represent worst-case installation scenarios. The selections focused on minimum unit volumes used for maximum-sized components, and the maximum values for unbraced doors and covers. The test circuit was calibrated to deliver 100kA at 480 V for 500 ms, as prescribed by ANSI C37.20.7. A 10 AWG wire was used to conduct the arc ignition in specific locations, simulating events that would typically occur under normal operating conditions. All evaluation criteria were met or exceeded.

The MNS-SG was tested at KEMA-Powertest to IEEE C37.20.7 for Type 2B Accessibility with arcs initiated in the breaker, vertical/horizontal bus and cable compartments. The arc duration was the full duration as recommended by the ANSI standard, with no interdependence on upstream breaker tripping speed.

Arc-Resistant Features

- Reduced PPE requirements due to ANSI C37.20.7 testing as provided for in the NFPA 70E Table 130.7,(C) (9): Arc-resistant equipment reduces the PPE hazard/risk category to zero when inserting or removing (racking) a breaker from the cubicle or opening/closing a breaker within the enclosure with the door closed
- Rear door flaps are open to provide added air flow under normal operating conditions but automatically close during an arc event to prevent pressure and gasses from escaping
- Roof chimney flaps automatically open to safely exhaust pressure and gasses independent of the arc origination point inside the switchgear
- The optional plenum contains exhaust pressure and gas and channels them to a designated safe area outside the electrical room
- Front and optional back doors are strengthened with three-point door latches
- Heavy-duty, two-point breaker door latches prevent door opening during and arc event, even when originating in the breaker cell
- Internal Venting system allows ionized gas to flow into bus compartment from any location within the cabinet and out the top of the switchgear through hinged flaps

- NEMA 1 enclosure
- Up to 480V @ 100kA
- Unobstructed switchgear floor-to-ceiling height is 3 m (10 ft) maximum
- ANSI Type 2B accessibility to protect the operator with the low voltage instrument compartment door open
- Floor plates
- Vertical Barriers between cable compartment sections

Standard Features

These features are found in both arc-resistant and standard switchgear:

- Modular C-channel frame construction and optional arrangements
- Safety shutters prevent accidental contact with live bus on all breaker cradles, with a padlock feature available to lock the shutters in the closed position for added safety
- Vented bus and cable compartment for proper air circulation
- Barriers between breaker and bus compartment, and between bus and cable compartment
- Optional barriers available between cable compartment sections
- Interlocks to prevent racking the breaker while the main contacts are closed
- Ability to rack the breaker from the “CONNECT, TEST and DISCONNECT” positions with the breaker compartment door remaining closed providing maximum convenience and personnel safety
- Breaker doors require no additional ventilating louvers/openings for proper air flow
- Emax 100% rated 1066 circuit breakers, Up to 5000A
- Provisions for padlocking Emax breakers in the “CONNECT, TEST and DISCONNECT” positions for added safety
- Horizontal main bus using “A,B,C” top-to-bottom phasing
- Up to 5000A main horizontal and vertical distribution
- 2500A feeder breakers up to four-high in a section
- Sliding-splice main horizontal bus connectors
- Up to 600V @ 85kA (600V non-Arc-Resistant)
- NEMA 1 enclosure
- UL 1558 compliant
- Seismic compliance to IBC2009, ASCE7-10

II. Industry Standards

The MNS-SG 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 — IEEE Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
- ANSI C37.20.7 ---- IEEE Guide for Testing Metal-Enclosed Switchgear Rated Up to 38kv for Internal Arcing Faults
- 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
- Seismic Qualification to IBC-2009 and ASCE7-10

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

III. System Application

Ground Fault Schemes

1) Ungrounded systems

- a. An ungrounded system is 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 because there always exists a capacitive coupling 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, X_{co} , is considered to be balanced.
- b. One major disadvantage of the ungrounded system is the occurrence of destructive transient over-voltages throughout the system during re-striking ground faults. These over-voltages 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 over-voltages may cause failure of insulation at multiple locations in the system, especially at motors. The solution to the problem of transient over-voltages during re-striking 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 over-voltages 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

Resistance grounding is the most effective method of solving transient over-voltages. The magnitude of the fault current is limited by the installation of resistance in the ground path. 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 the 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, I_r , to a magnitude equal to or slightly greater than the total capacitance charging current, $3 I_{co}$.

Normally, the ground-fault current, I_g , 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 over-voltages 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.

IV. Technical Equipment Ratings

Rated continuous current	1600, 2000, 3200, 4000A, 5000A
Rated tested maximum voltage (Arc-Resistant)	254Vac, 508Vac
Rated voltage (Arc-Resistant)	240Vac, 480Vac
Rated tested maximum voltage (Non Arc-Resistant)	254Vac, 508Vac, 635Vac
Rated voltage (Non Arc-Resistant)	240Vac, 480Vac, 600Vac
Phases	3 phase 3 wire, 3 phase 4 wire
Neutral (when required on 4Wire Systems)	100% rated
Frequency	60 Hz
Short circuit current withstand at 480Vac	up to 100kA
Short circuit current withstand at 600Vac Non Arc-Resistant	up to 85kA
Bus Bracing	up to 100kA @ 480v, up to 85kA @ 600V

Environmental Conditions

Enclosure Rating (Arc-Resistant)	NEMA 1
Enclosure Rating (Non Arc-Resistant)	NEMA 1 (with and without Gasketing)
Seismic Ratings	IBC2009, ASCE7-10
Temperature range during operation	-25 to +40 Degree C (-13 to +104 Degree F)
Temperature range for transport	-40 to +70 Degree C (-40 to 158 Degree F)
Storage	0 to +40 Degree C (32 to 158 Degree F)
Maximum bus temperature	65 over 40 Degree C (149 over 104 Degree F)

Overall System Derating

ANSI Switchgear Altitude Correction Factors

Altitude (m)	Voltage	
6600 ft (2000m) and below	100%	100%
8500 ft (2600m)	95%	99%
13000 ft (3900m)	80%	96%

Notes:

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

Breaker Derating

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

Altitude	(ft) (m)	<6600 2000	9900 3000	13200 4000	16500 5000
Rated service voltage	[V]	600	600	500	400
Continuous current rating	[A]	In	0.98xIn	0.93xIn	0.90xIn

Notes: In = breaker current

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 (F)	Derating Factor
40 C (104 F)	1
45 C (113 F)	0.95
50 C (122 F)	0.89
55 C (131 F)	0.84
60 C (140 F)	0.77
65 C (149 F)	0.71
70 C (158 F)	0.63

Breaker Loss

Circuit Breaker	I _u [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
E6H-A/V-A	3600	1681
	4000	1398
	5000	2388

V. Mechanical Overview



Enclosure

MNS-SG switchgear enclosure is NEMA-1. 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:

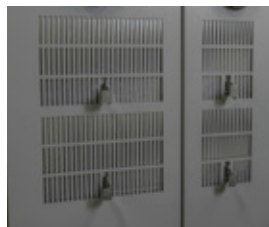
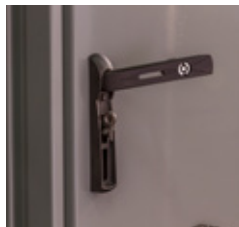
- ANSI 61 paint color
- Barriers between breaker compartment and bus compartment
- Barriers between bus compartment and cable compartment
- Ground bus extensions
- Removable, steel top plates over conduit entrance
- Cable wire trough
- Lifting eyes
- 1800 mm deep enclosure (70.9 in)

Available Options:

- Vertical barriers (in cable compartment)
- Strip heaters and thermostats
- Overhead lift device
- Padlock provisions on breaker compartment doors
- Padlock provisions on rear doors
- Aluminum bottom plates
- Rear hinged doors
- Optional paint colors

Arc-Resistant Enclosure Features:

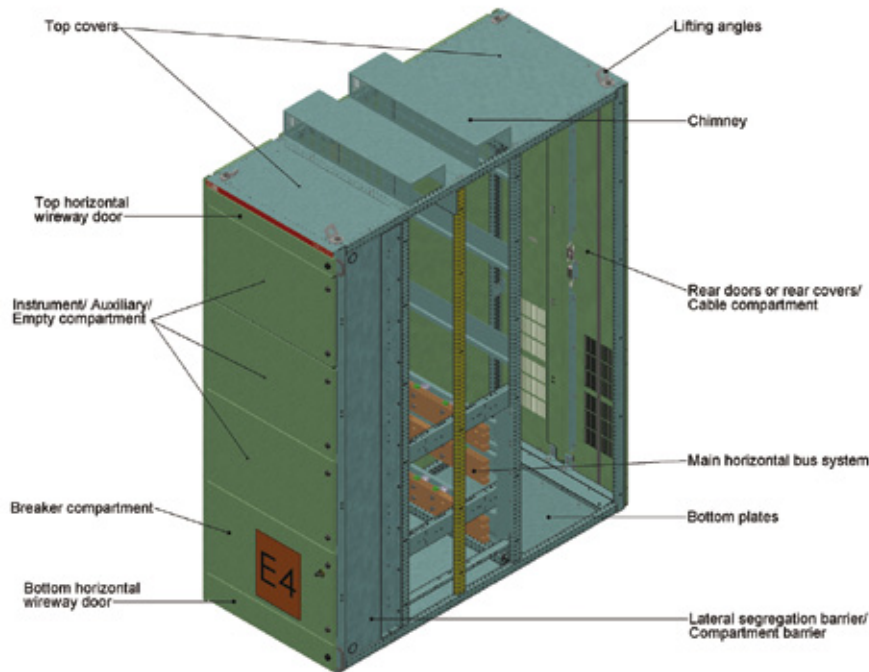
- Plates equipped with pressure relief blow-out flaps
- Optional plenum for direction of exhaust gasses created during arc fault. Direction of plenum discharge customer-specified.
- Cable compartment flaps to block rear ventilation ports during an arc fault
- Bottom plates provided as standard
- Section barriers in cable compartments
- Reinforced door handle mechanism replaces individual door latches
- Reinforced bus bar compartment barriers



Structure

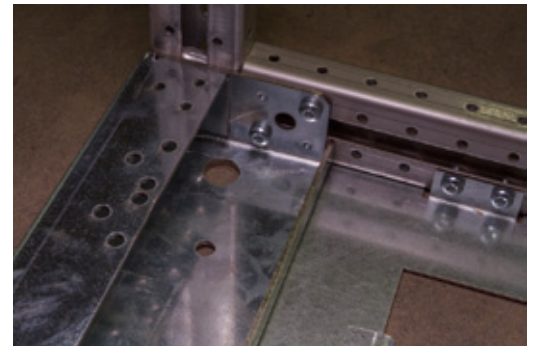
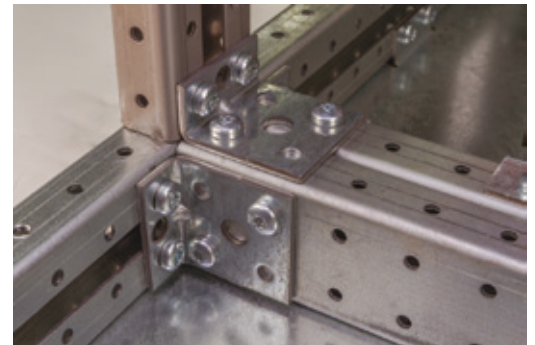
The MNS-SG switchgear assembly consists of one or more enclosed vertical sections. The ends are designed to allow installation of future sections. Each vertical section can contain up to four high individually enclosed Emax power breakers. One or more of these compartments can be utilized as an auxiliary 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 fashion. Each vertical section consists of three compartments: the breaker compartment (front), bus compartment (middle), and cable compartment (rear). 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.



Frame

The switchgear frame members consist of rigid galvanized steel C-channel rails of 12 and 14 gauge thickness with holes at 1" (25 mm) intervals. The frame members are secured with maintenance-free self tapping screws. Corner joints are made using L-shaped steel brackets and are also 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.



Bus Bar System

The bus bar system is installed in the middle compartment of the switchgear vertical sections and includes the main horizontal bus bar system (with neutral bus when required), vertical distribution bus bars, and runback bus to link customer connections with circuit breakers.

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 bus duct connections, ABB offers a standard bus duct riser. Close coupling connections to ABB dry type transformers are also available. For other transformer connections ABB will need to provide a custom designed section. All drawings of transformer connections will need to be provided at the time of quotation request.

Main bus bar

The main horizontal bus bars are arranged in phase A, B, C, order from top to bottom, and are located at the bottom half of the vertical section. When tie sections are installed, the main horizontal bus bars are also provided in the top half of the vertical section. For four-wire systems, a neutral bus is located at the middle of the switchgear section. The bus bars are connected to the adjacent section at each end by means of bus splice links. All bus designs are based on UL and ANSI 37.20.1 standard temperature rise of 65°C maximum, above 40°C maximum ambient air temperature. The bus bar compartment is separated from the breaker compartment and cable compartments by grounded steel barriers. All bus is supported by steel supported polyester fingerplates.

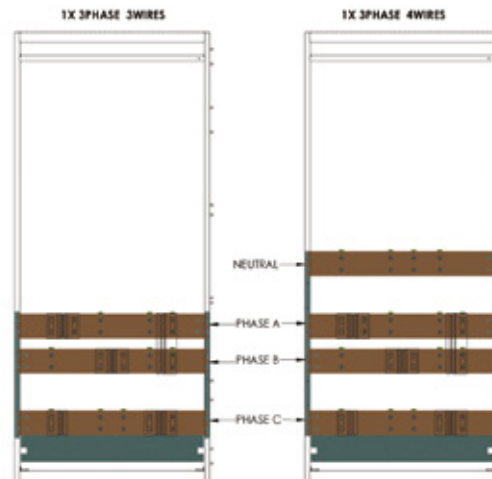
All main bus construction is based on single section shipping splits.

Main bus amperages include: 1600A, 2000A, 3200A, 4000A, and 5000A with bus bracing up to 100kA. Silver plated bus is standard with optional tin plating available.

The size and number of conductors is shown below:

Table x.y: Main bus bar system arrangements

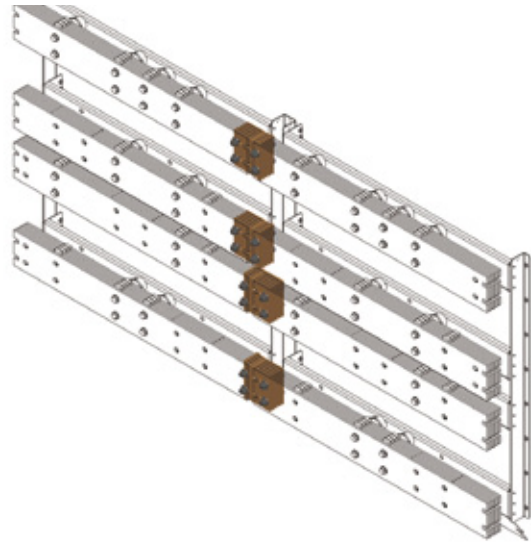
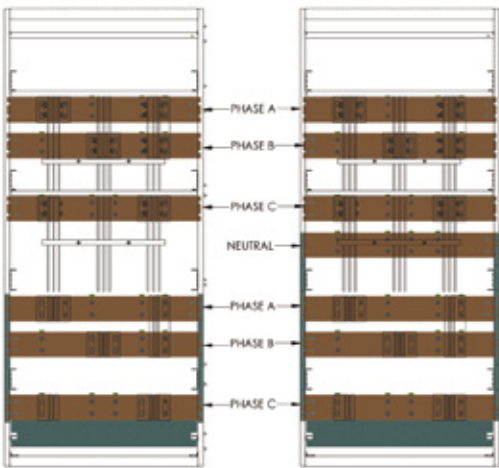
Continuous Current	Number of Conductors	Size of Conductors
1600	1	¼" x 5"
2000	2	¼" x 4"
3200	3	¼" x 5"
4000	4	¼" x 5"
5000	5	¼" x 5"



For tie breaker sections, two horizontal bus bar systems are installed.

Splice Kits

When two or more sections connect to form a lineup, the main horizontal bus bars need to be connected using the factory-provided splice kits. Splice kits are pre-installed in sections that are on the same shipping split. Splice kits are not provided in the end sections of a lineup.



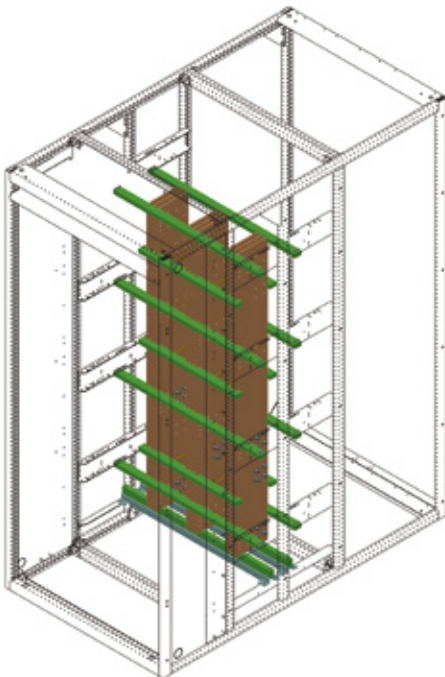
Distribution bus bar systems

The distribution bus bar is a system of vertical bus bars used for distribution of power to the device compartment electrical components (circuit breakers). The vertical distribution busbars are arranged in phase A, B, C order from left to right. The vertical bus busbars are offered as silver-plated standard with an option for tin-plated.

Full distribution bus bar system

This configuration is for at least, one circuit breaker (main or feeder) in position A, B, or AB; cubicle may include circuit breakers in positions C, D or CD.

Continuous Current	Configuration	Section Width (mm)
1600	1" x 3/8" x 5"	600 and 700
2000	1" x 3/8" x 6"	600 and 700
2500	1" x 3/8" x 8"	600 and 700
3200	2" x 3/8" x 6"	600, 700, 800
4000	2" x 3/8" x 8"	600, 700, 800, 1000
5000	3" x 3/8" x 8"	600, 700, 800, 1000



Bottom distribution bus bar system

This configuration is selected for a switchgear section with circuit breakers only in locations C, D or CD. It is not used when breakers are present in locations A, B or AB.

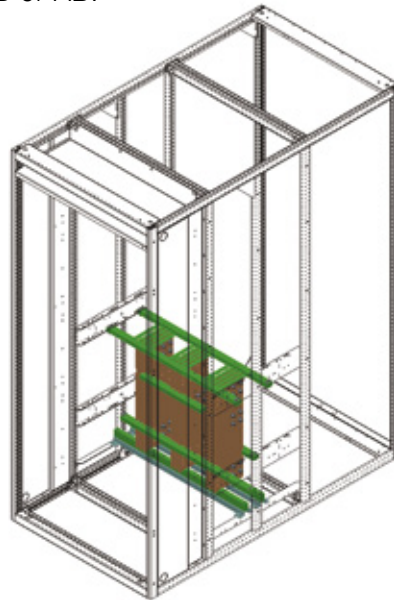


Table x.y: Bottom Distribution Bus Bar

Continuous Current	Configuration	Section Width (mm)
1600	1" x 3/8" x 5"	600 and 700
2000	1" x 3/8" x 6"	600 and 700
2500	1" x 3/8" x 8"	600 and 700
3200	2" x 3/8" x 6"	600, 700, 800
4000	2" x 3/8" x 8"	600, 700, 800, 1000
5000	3" x 3/8" x 8"	600, 700, 800, 1000

Tie distribution bus bar system

In tie breaker sections, the tie distribution bus bar system is used in conjunction with the bottom distribution bus bar system. In addition to the main bus bars in the bottom half of the section, a second set of main horizontal bus bars is installed at the top half of the tie section. When a tie section is installed, the main bus bar location must be returned to the bottom half of the section using an upper-to-lower main bus bar transition section installed adjacent to the tie breaker section.

- Breaker grounding links (bused connection links from breakers to vertical ground bar)
- Lateral ground bar (links vertical ground bar to cable compartment; contains pre-drilled holes on cable compartment end for customer grounding connections)
- Transverse ground bar (located in cable compartment; for section-to section interconnects)

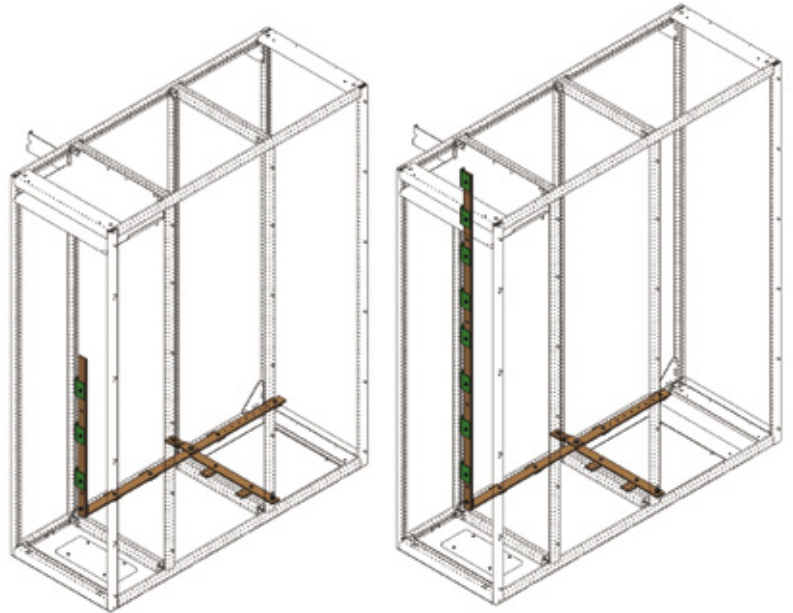
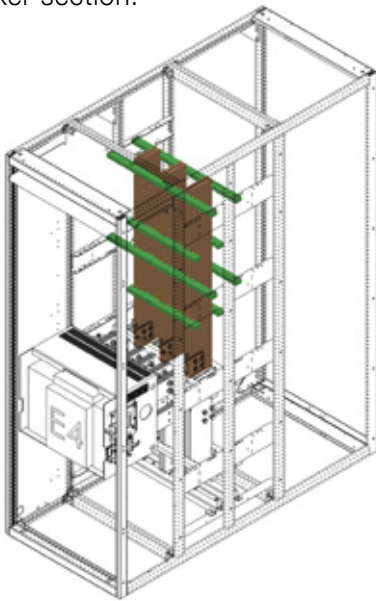


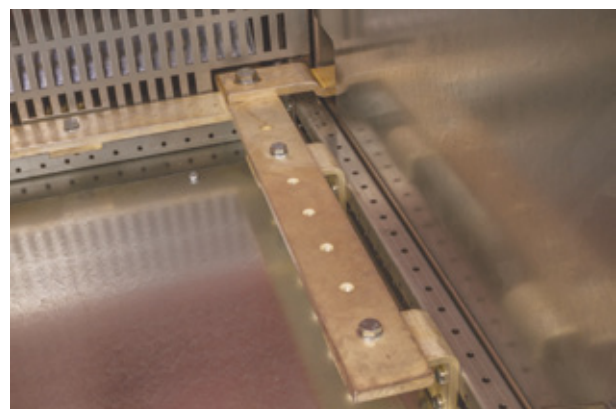
Table x.y: Tie Distribution Bus Bar

Continuous Current	Configuration	Section Width (mm)
1600	1" x 3/8" x 5"	600 and 700
2000	1" x 3/8" x 6"	600 and 700
3200	2" x 3/8" x 6"	800
4000	2" x 3/8" x 6"	1000
5000	3" x 3/8" x 8"	1000

Ground Bus Bar System

The ground bus bar system is comprised of four components:

- Vertical ground bar (located in main bus bar compartment; full and bottom-half lengths available)

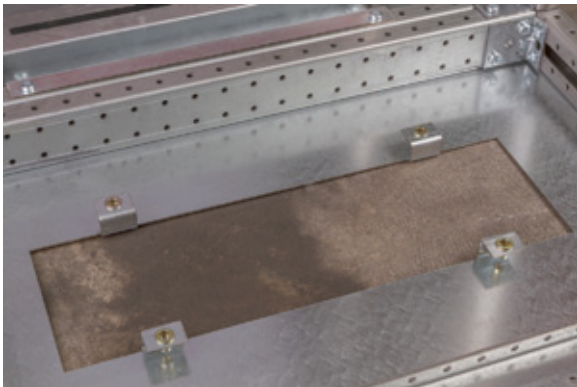
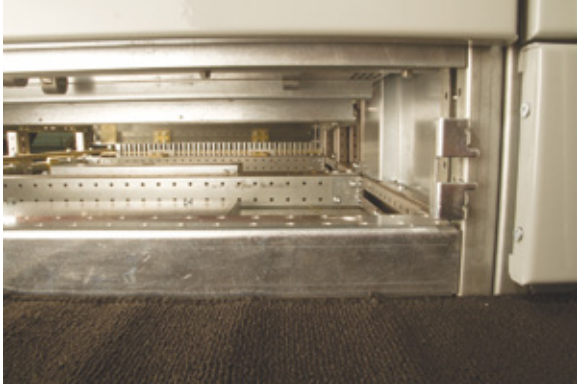
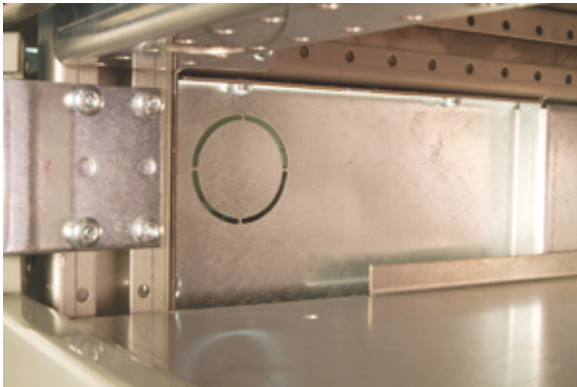


Ground bus bar system is available with silver plating, tin plating, or bare (no plating).

Wireways

Wireways are located at the top and bottom of the MNS-SG sections. These wireways are provided both for internal wiring between sections and shipping splits, as well as customer control wiring.

The top wireway is 100mm high, and the bottom wireway is 150mm high. Wireway doors are secured with quarter-turn latches.



Barriers, Covers and Doors

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

As an option, a hinged door with a three-point latch system is available. Double doors are used for 800mm and 1000mm width sections.

Rear covers and doors on the MNS-SG are provided with ventilation slots which allow for heat rise ventilation.

For the Arc-Resistant switchgear option, self-closing flaps are provided inside the rear cover/door. These flaps block off the ventilation slots and prevent the exit of gases and fire in the event of an arc fault inside the gear.

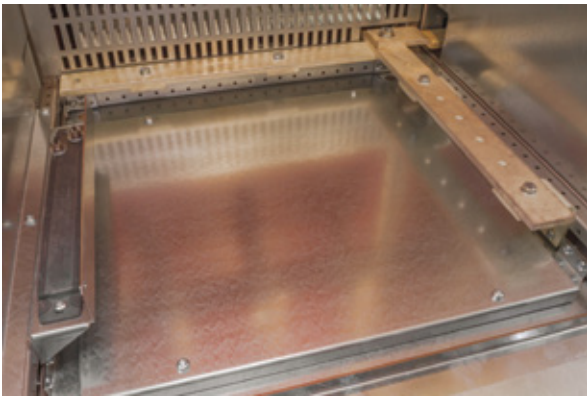
Front doors:

Circuit breaker and equipment compartments doors are provided with 14-gauge individual doors with removable hinges. Breaker compartment doors are provided with cutouts. Cutout gasketing is provided as a standard for non-arc-resistant switchgear lineups, but is removed in the arc-resistant option. Door latches are provided in non-arc-resistant switchgear, and a reinforced three-point latch with locking handle is provided in the arc-resistant option. All compartment doors are provided with a grounding strap.

Top and bottom cover plates:

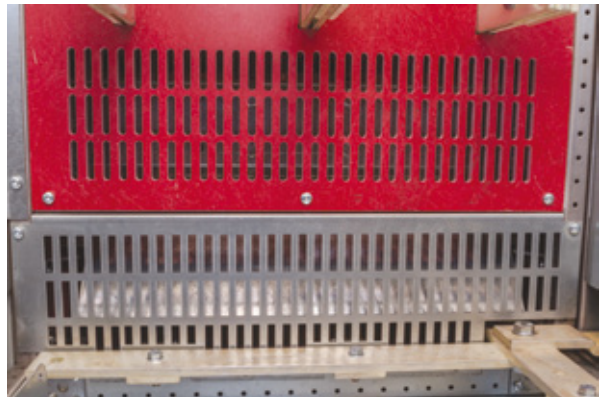
Bottom plates

Bottom plates are manufactured in 14 gauge steel and include removable cutout covers if bottom cable entry is specified. A single bottom plate is provided for the cable and bus bar compartments, and a second bottom plate is provided for the cable compartment. Bottom plates are optional for non-arc-resistant switchgear, standard for arc-resistant switchgear.



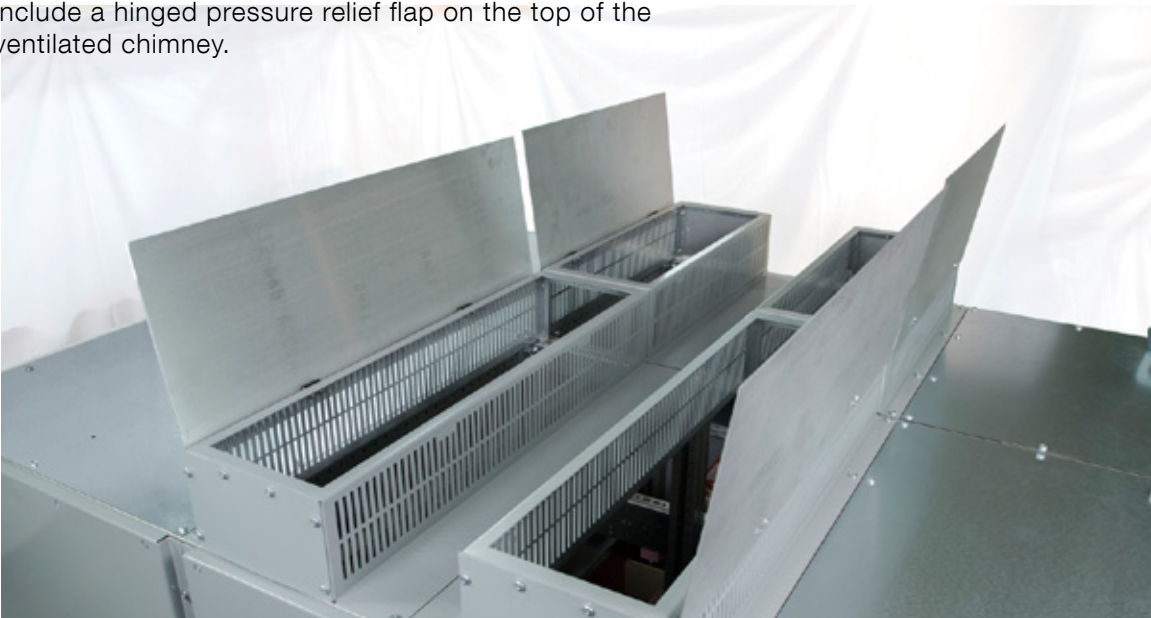
Segregation barriers

The switchgear is provided with a segregation barrier to separate the main bus bar compartment and the cable compartment. These barriers are also included if bus runback assemblies are present. Four-piece cable compartment barriers are also available to provide segregation between sections (standard for arc-resistant).



Roof plate device compartment

Roof plates are manufactured in 14 gauge steel. For the cable and device compartment roof plates, removable cutout covers are provided if top cable entry is specified. The bus bar compartment roof plate is a ventilated chimney. Arc-resistant switchgear lineups include a hinged pressure relief flap on the top of the ventilated chimney.



Paint

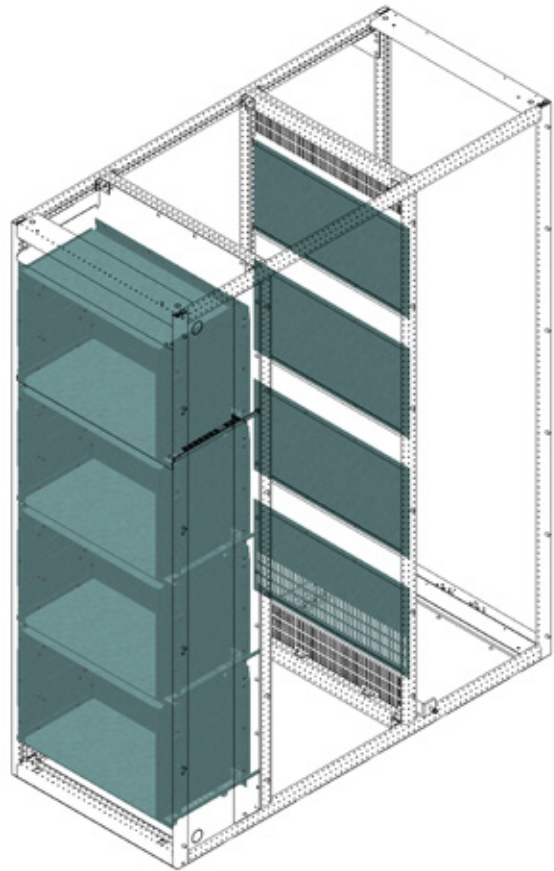
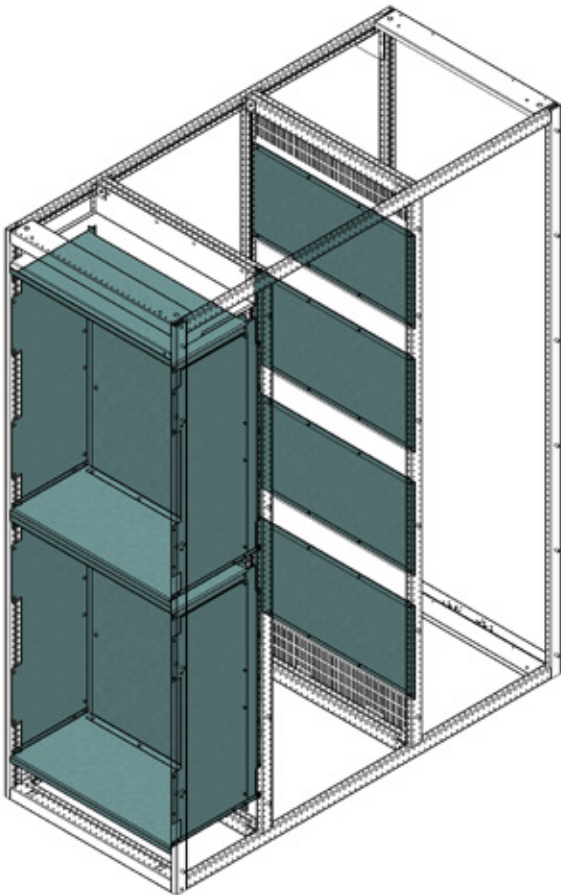
The standard finish color is light gray paint (ANSI 61). The standard painting process is a UL approved electrostatic powder coat paint system utilizing a polyester powder coat paint. The completed finish has a nominal 2.6 mils dry film thickness. The process includes cleaning any grease or deficient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

Auxiliary Compartments

Auxiliary compartments 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 auxiliary compartment may be required.

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



Lug Assemblies

Cabled customer connections may be made using either compression or mechanical lugs, the size and quantity of which are dependent on the connection ampacity. See tables below.

E2 Breaker connection table

Section Width	Contt Current	Vertical Runback Coupling	Number of Lugs	Size of Lug Connector
600	1200	2 x 1/4" x 3"	4	2 x 1/4" x 3"
700				
800				
1000				
600	1600	2 x 1/4" x 4"	5	2 x 1/4" x 4"
700				
800				
1000				

E3 breaker connection table (1600A and 2500A)

Section Width	Breaker	Contt Current	Vertical Runback	Number of Lugs	Size of Lug Connector
700	E3	1800	2 x 1/4" x 4"	5	2 x 1/4" x 4"
800					
1000					
700		2500	4 x 1/4" x 4"	7	4 x 1/4" x 4"
800					
1000					

E3 breaker connection table (2000A)

Section Width	Vertical Runback	Number of Lugs	Size of Lug Connector
600	2 x 3/8" x 4"	6	2 x 3/8" x 4"
700			
800			
1000			

E4 breaker connection table

Vertical Runback	Number of Lugs	Size of Lug Connector
6 x 1/4" x 4"	9	6 x 1/4" x 4"

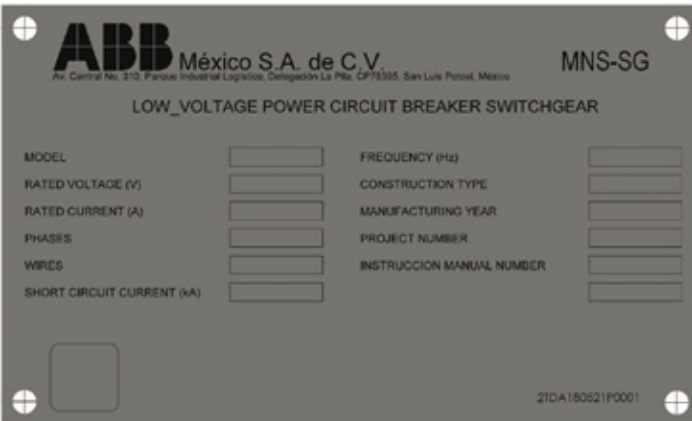
E6 breaker connection table

Section Width	Vertical Runback	Number of Lugs	Size of Lugs
4000	4 x 3/8" x 5"	11	4 x 3/8" x 5"
5000	2 x 1/4" x 5" - 4 x 3/8" x 5"	14	2 x 1/4" x 5" - 4 x 3/8" x 5"

Nameplates

MNS-SG 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 stainless steel and secured with self tapping screws. All lettering is engraved.

The following information is available on switchgear assembly nameplates:



The image shows a nameplate for ABB MNS-SG Low Voltage Power Circuit Breaker Switchgear. The nameplate is dark grey with white text and input fields. It includes the ABB logo and company name, followed by technical specifications and identification fields.

ABB México S.A. de C.V.		MNS-SG	
LOW_VOLTAGE POWER CIRCUIT BREAKER SWITCHGEAR			
MODEL	<input type="text"/>	FREQUENCY (Hz)	<input type="text"/>
RATED VOLTAGE (V)	<input type="text"/>	CONSTRUCTION TYPE	<input type="text"/>
RATED CURRENT (A)	<input type="text"/>	MANUFACTURING YEAR	<input type="text"/>
PHASES	<input type="text"/>	PROJECT NUMBER	<input type="text"/>
WIRES	<input type="text"/>	INSTRUCCION MANUAL NUMBER	<input type="text"/>
SHORT CIRCUIT CURRENT (kA)	<input type="text"/>		<input type="text"/>

21DA190521P0001

Overhead Lifting Device

As an option the ABB MNS-SG can 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 is shipped uninstalled from the gear. Mounting instructions are provided.

Lift Truck

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

Shipping Design

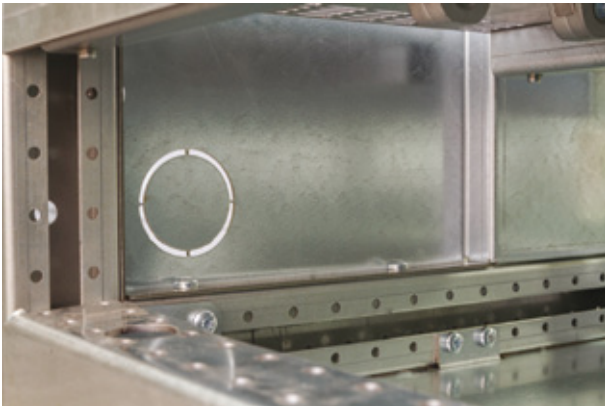
MNS-SG is shipped upright on removable skids in shipping splits that include up to three switchgear sections. The width of the shipping split depends on the customer's specification, the widest being 1800 mm (70.9 inches) total width for a three-section split. The breakers are shipped installed in the section. Equipment top components, such as the overhead lifting device and plenum assemblies are shipped separately and intended for field installation.

VI. Electrical Overview

Wiring

As a standard, all switchgear wiring is #14 AWG SIS with ring tongue terminals. As an option, ABB can provide insulated locking fork terminals instead of ring tongue terminals. Control wire for current transformers is #10 AWG SIS wire. Potential transformers are provided with either #14 AWG SIS wire or #12 AWG SIS wire as an option. Control wire for a control power transformer up to 5kVA is #8 AWG SIS. For larger control power transformers, the appropriately sized wire is used.

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



Voltage Transformers

Voltage transformers utilized in the MNS-SG are mounted in either an instrument compartment or in the rear section on a mounting pan. Primary and secondary fuses are mounted separately in an instrument compartment.

Electrical Characteristics for Standard Potential Transformer:

- Insulation Class: 600 volt dielectric; 10 kV full wave BIL.
- Accuracy Class: 0.6W, 1.2X at 60 Hz.
- Thermal ratings: 150 VA at 30°C ambient and 100 VA at 55°C ambient.

Control Power Transformers

In the absence of externally supplied 125VDC for the required instruments and breakers, a 120VAC control power transformer can be supplied. These transformers are sized according to the load requirement of the breakers and other installed equipment. The control power transformers are mounted in either an available instrument compartment or on a mounting base in the rear of the section. Standard transformer values are 1kVA, 3kVA and 5kVA. Larger transformers (7.5kVA, 10kVA and 15kVA) are available as options that require custom mounting considerations.

The control power transformers are rated for a 600V dielectric insulation class. Primary and secondary fuses are either mounted separately in an instrument compartment or have on-board fuse clips.

Current Transformers

Current transformers are available for mains, ties, and feeders. Standard current transformers are metering class, rated for 600V, 10kV BIL full wave, frequency response 50-400Hz. Available current transformer ratios are: 800:5, 1200:5, 1600:5, 2000:5, 2500:5, 3200:5, 4000:5, and 5000:5.



Relays

Control relays, ANSI protective relays and programmable relays specific to the switchgear application may be installed in MNS-SG breaker and instrumentation compartments. Spacing limitations apply; consult your local ABB sales contact for pricing and availability.

Metering

The MNS-SG switchgear allows for installation of a variety of metering options.

Multifunction meters available as a standard are the Electro Industries Shark 100 or Shark 200 meter, or Nexus 1500 meter. Customer-specified metering options are also available.

Analog switchboard meters such as ammeters, voltmeters, watt-hour meters, power factor indicators etc. are also available. As a standard ABB supplies Crompton Series 77 meters for these applications.

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

Breaker Control Switches

When required, electrically operated breakers can be supplied with breaker control switches. The standard offering is the Electroswitch Series 20. As an option, the Electroswitch Series 24 is available. Optional nameplates with LED's are also available. Please refer to the layout section for restrictions.



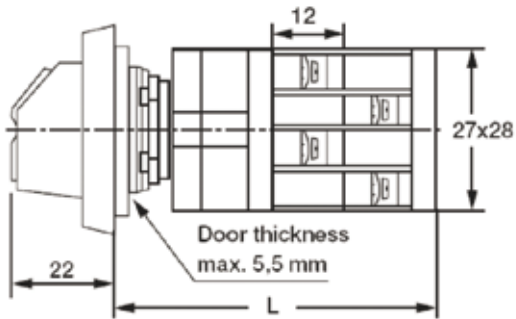
Series 20



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.



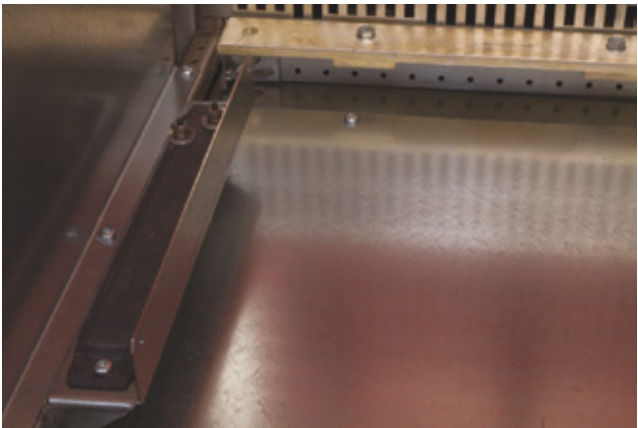
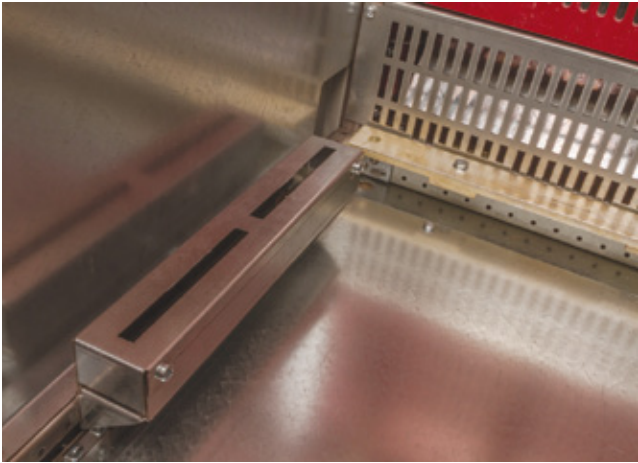
Test Switches and Plugs

As an option, the ABB MNS-SG switchgear allows the installation of ABB Flexitest FT-1 or FT-14 test switches 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 meet or exceed all requirements of ANSI/IEEE Standard C37.90 and are UL, CUL and CSA listed. The standard test switch cover is black, and a clear cover is also available.



Space Heaters, Thermostats, Humidistat

As a standard, one space heater per section is provided and mounted in the main bus compartment. Optional space heaters are available for mounting in the cable compartment. Heaters are rated for a maximum of 250W at 240VAC and operated at 120VAC. The heaters are mounted in a metal protective housing. The thermostat utilized with space heaters has an operating range of -10 to 100 Degrees Fahrenheit. Humidistat controllers are also available.



High Resistance Grounding Systems

High-resistance grounding provides the same fault protection advantages as ungrounded systems, but unlike 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.

High resistance grounding systems are available in MNS-SG. Space requirements include an available instrument compartment and mounting space for the grounding resistor banks. Mounting and layout restrictions are dependent on the system ampacity and incoming mains arrangement.

Transfer Scheme

Transfer schemes can be achieved either manually (with breaker interlocks) or automatically. Automatic transfer systems are often used to minimize the duration of power interruptions by transferring the load from the normal source to an alternate source when the normal source fails or is temporarily unavailable. Typical MNS-SG automatic transfer logics are performed via the use of relay logic.

In automatic transfer schemes, there is a need to provide electrically operated breakers on the incoming sources. Certain loads or plant processes may dictate a different scheme.

VII. Emax Power Circuit Breakers

Refer to [ABB Emax Power Breaker technical guide 1SDC200008D0202 dated 10/13/2011](#) for additional technical details.

Ratings

The MNS-SG 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: E2, E3, E4, and E6

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

Switchgear and Emax Power Circuit Breaker Interrupting Rating

Frame Size	Circuit Breaker Model	Rated Short Time			Rated Time current [kA]	Break Time (<ST current) (max) ms / cycles	Break Time (>ST current) (max) ms / cycles
		240V [kA] (note 1)	480V [kA] (note 1)	600V [kA] (note 2)			
800,1200,1600	E2 S-A	65	65	65	65	70 / 4.2	30 / 1.8
2000,2500	E3 S-A	85	65	65	65	70 / 4.2	30 / 1.8
800,1200, 1600, 2000	E3 V-A	100	100	85	85	70 / 4.2	30 / 1.8
3200	E4 S-A	85	65	65	65	70 / 4.2	30 / 1.8
3200	E4 V-A	100	100	85	85	70 / 4.2	30 / 1.8
4000	E6 H-A	100	85	85	85	70 / 4.2	30 / 1.8
4000	E6 V-A	100	100	85	85	70 / 4.2	30 / 1.8
5000	E6 H-A	100	85	85	85	70 / 4.2	30 / 1.8
5000	E6 V-A	100	100	85	85	70 / 4.2	30 / 1.8

Note 1 applies to Arc-Resistant Rated Equipment

Note 1 and 2 applies to Non Arc-Resistant Rated Equipment

Rating Plugs

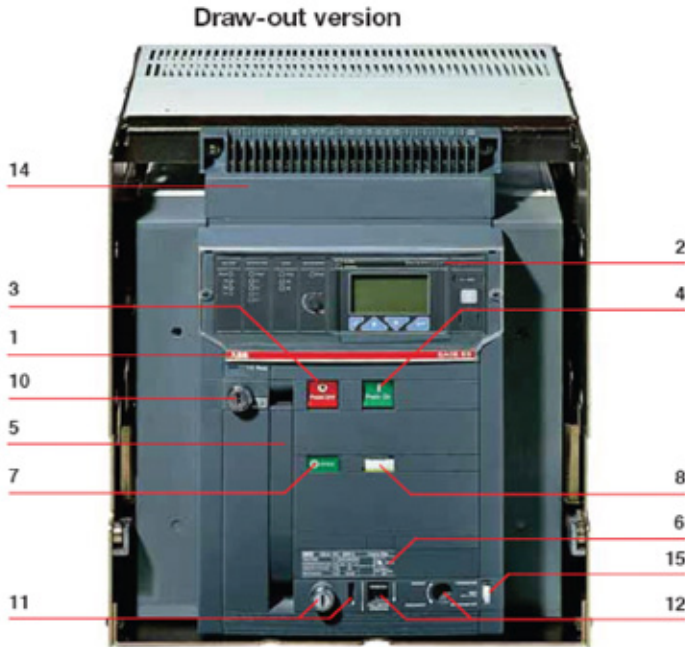
Emax Circuit Breaker Rating Plugs for Electronic Trip Units

Type of circuit breaker	Rated Current I _n	Ln [A] 400	600	800	1000	1200	1600	2000	2500	3000	3200	3600	4000	5000
E2S-A	800	•	•	•										
	1200	•	•	•	•	•	•							
	1600	•	•	•	•	•	•							
	2000	•	•	•	•	•	•	•						
	2500	•	•	•	•	•	•	•	•					
E3V-A	800	•	•	•										
	1200	•	•	•	•	•	•							
	1600	•	•	•	•	•	•							
	2000	•	•	•	•	•	•	•						
E4S-A	3200			•	•	•	•	•	•	•	•			
E4V-A	3200			•	•	•	•	•	•	•	•			
E6H-A	4000			•	•	•	•	•	•	•	•	•	•	
E6V-A	4000			•	•	•	•	•	•	•	•	•	•	
E6H-A	5000			•	•	•	•	•	•	•	•	•	•	•
E6V-A	5000			•	•	•	•	•	•	•	•	•	•	•

Breaker Details

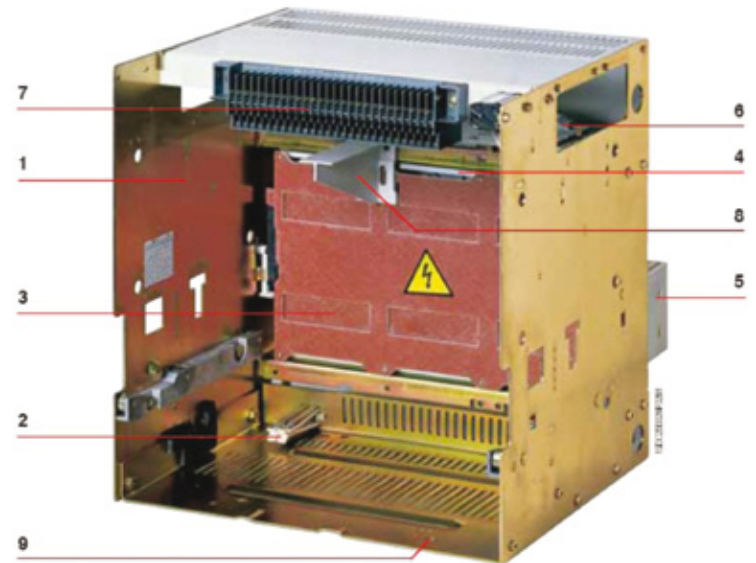
Construction Characteristics

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)

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	Automatic 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



UL Versions available

General characteristics of the electronic trip units:

- operation without the need for an external power supply
- microprocessor technology
- high precision
- true R.M.S. measurements of the current values
- trip cause indication and trip data recording

- interchangeability among all types of trip units
- setting for neutral configurable:
 - OFF-50%-100%-200% of phase setting for circuit breakers, E1, E2, E3 and E4/f, E6/f full-size versions, and E4-E6 with external neutral protection;
 - OFF-50% for standard E4 and E6.

The main performance features of the trip units are listed below.

SACE PR121		
Protection	PR121/P	PR121/P
	L I	L S I
		L S I G
SACE PR122		
Protection	PR122/P	PR122/P
	L I	L S I
		L S I G
	For all versions	U OT M
	New modules available:	
Measuring	opt.	UV OV RV RP UF OF
Communication	opt.	
Signaling	opt.	
Bluetooth (wireless link)	opt.	
SACE PR123		
Protection	PR123/P	PR123/P
	L S I	L S I G
	For all versions	OT D U UV OV RV RP M UF OF
	New modules available:	
Communication	opt.	
Signaling	opt.	
Bluetooth (wireless link)	opt.	

Electronic trip units

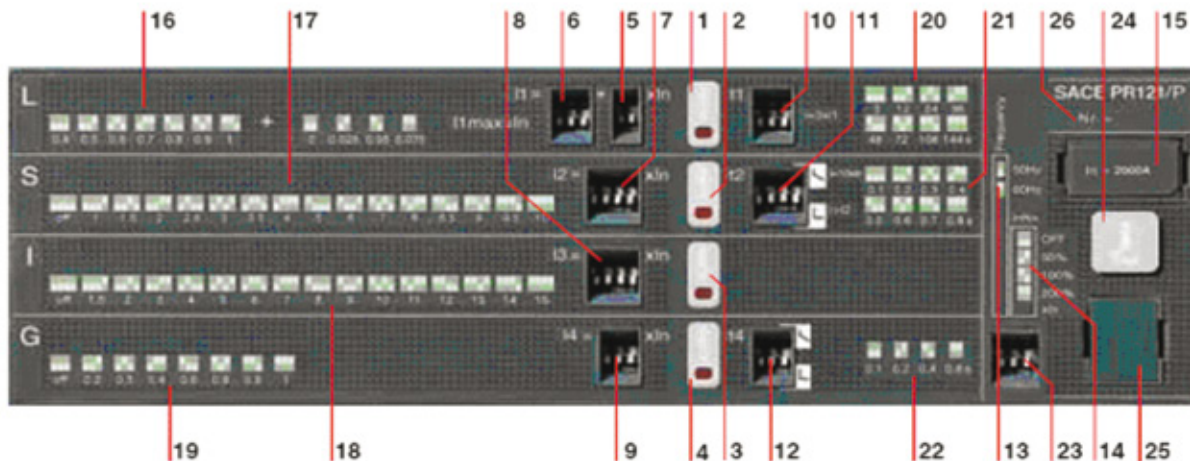
UL Versions available

Features			
Protection functions	PR121	PR122	PR123
L Protection against overload with inverse long time-delay trip	■	■	■
S Selective protection against short circuit inverse or definite short time-delay trip	■	■	■
S Second selective protection against short circuit inverse or definite short time-delay trip			■
I Protection against instantaneous short circuit with adjustable trip current threshold	■	■	■
G Protection against ground fault	residual	■	■
	source ground return	■	■
D Protection against directional short circuit with adjustable time-delay			■
U Protection against phase unbalance		■	■
OT Protection against overtemperature (check)		■	■
UV Undervoltage protection		opt. ⁽¹⁾	■
OV Overvoltage protection		opt. ⁽¹⁾	■
RV Residual voltage protection		opt. ⁽¹⁾	■
RP Reverse active power protection		opt. ⁽¹⁾	■
M Thermal memory for functions L and S		■	■
UF Underfrequency protection		opt. ⁽¹⁾	■
OF Overfrequency protection		opt. ⁽¹⁾	■
Measurements			
Currents (phases, neutral, ground fault)		■	■
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, meter)		opt. ⁽¹⁾	■
Harmonics analysis (display of wave forms and harmonics module)			■
Event marking and maintenance data			
Event marking with the instant it occurred	opt. ⁽²⁾	■	■
Chronological event storage	opt. ⁽²⁾	■	■
Electrical operations counter and contact wear		■	■
Communication with supervision system and centralised control (IEC only)			
Remote setting of the protection functions parameter, unit configuration, communication		opt. ⁽³⁾	opt. ⁽³⁾
Transmission of measurements, states and alarms from circuit breaker to system		opt. ⁽³⁾	opt. ⁽³⁾
Transmission of events and maintenance data from circuit breaker to system		opt. ⁽³⁾	opt. ⁽³⁾
Watchdog			
Alarm and trip for release overtemperature		■	■
Check of trip status	■	■	■
Interface with the user			
Presetting by means of dip switches	■		
Presetting by means of keys and LCD viewer		■	■
Alarm signals for functions L, S, I and G	■	■	■
Alarm signal of one of the following protections: undervoltage, overvoltage, residual voltage, reverse power, phase unbalance, overtemperature		opt. ⁽¹⁾	■
Complete management of pre-alarms and alarms for all the self-control protection functions		■	■
Enabling password for use with consultation in "READ" mode or consultation and setting in "EDIT" mode		■	■
Load control			
Load connection and disconnection according to the current passing through the circuit breaker		■	■
Zone discrimination			
Can be activated for protection functions S, G and (PR123 only) D		■	■

Electronic Trip Units PR121/P

PR121/P is the basic and complete release for the Emax circuit breaker series. The complete range of protection functions together with the wide combination of thresholds and trip times offered make it suitable for protecting a wide range of alternating current

installation. In addition to protection functions the unit is provided with multifunction LED indicators. Furthermore, PR121/P allows connection to external devices enhancing its advanced characteristics like remote signaling and monitoring, or remote supervision display.



Legend

- | | |
|---|--|
| 1 LED signaling Alarm for protection Function L | 16 Indication of the DIP switch positions for the various current threshold values I1 |
| 2 LED signaling Alarm for protection function S | 17 Indication of the DIP switch positions for the various current threshold values I2 |
| 3 LED signaling Alarm for protection function I | 18 Indication of the DIP switch positions for the various current threshold values I3 |
| 4 LED signaling Alarm for protection G function I1 | 19 Indication of the DIP switch positions for the various current threshold values I4 |
| 5 DIP switches for fine setting current threshold I1 | 20 Indication of DIP switch positions for the various time settings t1 |
| 6 DIP switches for main setting current threshold I1 | 21 Indication of DIP switch positions for the various time settings t2 |
| 7 DIP switches for setting current threshold I2 | 22 Indication of DIP switch positions for the various time settings t4 |
| 8 DIP switches for setting current threshold I3 | 23 DIP switch for setting network frequency and neutral protection setting |
| 9 DIP switches for setting current threshold I4 | 24 Trip cause indication and trip test pushbutton |
| 10 DIP switches for setting trip time t1 (type of curve) | 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) |
| 11 DIP switches for setting trip time t2 (type of curve) | 26 Serial number of protection release |
| 12 DIP switches for setting trip time t4 (type of curve) | |
| 13 Indication of the DIP switch position for network frequency | |
| 14 Indication of the DIP switch position for Neutral protection setting | |
| 15 Rating plug | |

Electronic Trip Units PR121/P

Operation and protection functions

The PR121 release offers the following protection functions:

- overload (L)
- selective short-circuit (S)
- instantaneous short-circuit (I)
- Earth fault (G).

Overload (L)

The inverse long time-delay trip overload protection L is type $I^2t = k$; 25 current thresholds and 8 curves are available. Each curve is identified by the trip time in relation to the current $I = 3 \times I_1$ ($I_1 =$ set threshold).

Selective short-circuit (S)

The selective short-circuit protection S can be set with two different types of curves with a trip time independent of the current ($t = k$) or with a constant specific let-through energy ($t = k/I^2$). 15 current

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

- for curves $t = k$ by the trip time for $I > I_2$
- for curves $t = k/I^2$ by the trip time for $I = 10 \times I_n$ ($I_n =$ rated current of the circuit breaker). The function can be excluded by setting the DIP switches to the combination labeled "OFF".

Adjustable instantaneous short-circuit (I)

The protection I offers 15 trip thresholds and can be excluded (dip switches in "OFF" position).

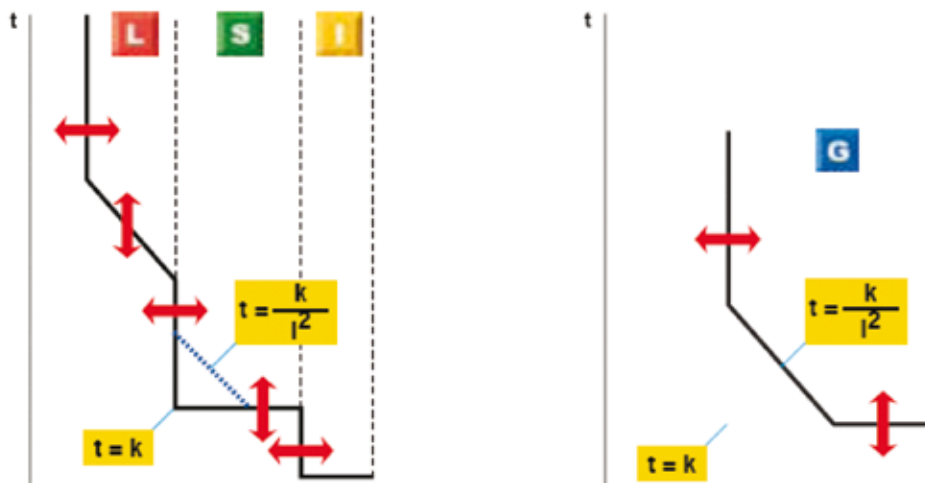
Ground fault (G)

The ground fault protection G (which can be excluded) offers 7 current thresholds and 3 curves. Each curve is identified by the time t_4 in relation to current I_4 . As per S protection the trip time can be chosen independent of the current ($t = k$) or with a constant specific let-through energy ($t = k/I^2$).

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

I4 threshold	Repression threshold
$I_4 < 0.5 I_n$	$4 I_n$
$0.5 I_n \leq I_4 < 0.8 I_n$	$6 I_n$
$I_4 \geq 0.8 I_n$	$8 I_n$

$I_n =$ 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 signaling.

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

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

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

Communication

By means of the BT030 wireless communication unit, PR121/P can be connected to a pocket PC (PDA) or to a personal computer, extending the range of information available for the user. In fact, by means of ABB SACE's SD-Pocket communication software,

It is possible to read the values of the currents flowing through the circuit-breaker, the value of the last 20 interrupted currents, and the protection settings. PR121 can also be connected to the optional external PR021/K signaling unit, for the remote signaling 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 $0.5I_n$ 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.

Electronic Trip Units PR122/P

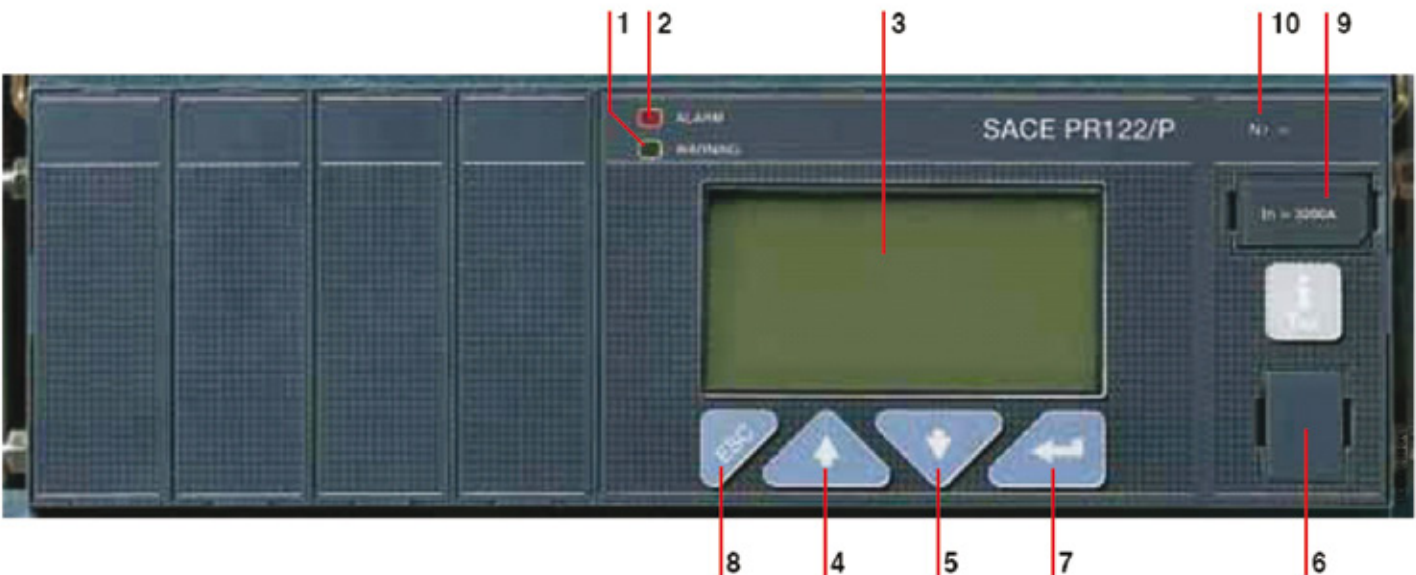
The SACE PR122 release is a sophisticated and flexible protection system based on a state-of-the-art microprocessor and DSP technology. Fitted with the optional internal PR120/D-M dialogue unit, PR122/P turns into an intelligent protection, measurement and communication device, based on the Modbus protocol.

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, signaling, measurement, and wireless communication units.

Functions S and G can operate with a time delay independent of the current ($t = k$) or with an inverse time delay (constant specific let-through energy: $I^2 t = k$), as required. Protection against earth 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 earth (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

Electronic Trip Units PR122/P

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)
- earth 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

I4 threshold	Repression threshold
$I_4 < 0.5 I_n$	4 I _n
$0.5 I_n \leq I_4 < 0.8 I_n$	6 I _n
$I_4 \geq 0.8 I_n$	8 I _n

I_n=rated current of the rating plug

E6/f. In installations where very high harmonics occur, the resulting current at the neutral can be higher than that of the phases. Therefore it is possible to set the neutral protection at 150% or 200% of the value set for the phases. In this case it is necessary to reduce the setting of protection L accordingly.(1) The table below lists the neutral settings for the various possible combinations between type of circuit-breaker and the threshold I1 setting.

Start-up function

The start-up function allows protections S, I and G to operate with higher trip thresholds during the start-up phase. This avoids untimely tripping caused by the high inrush currents of certain loads (motors, transformers, lamps). The start-up phase lasts from 100ms 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 $0.1 \times I_n$. A new start-up becomes possible after the current has fallen below the threshold of $0.1 \times I_n$, if the release is supplied from an external source.

Adjustable neutral protection setting

Circuit-breaker model	Threshold I1 settings (overload protection)		
	$0.4 \leq I_1 \leq 0.5$	$0.5 \leq I_1 \leq 0.66$	$0.66 \leq I_1 \leq 1$ (*)
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 I_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.

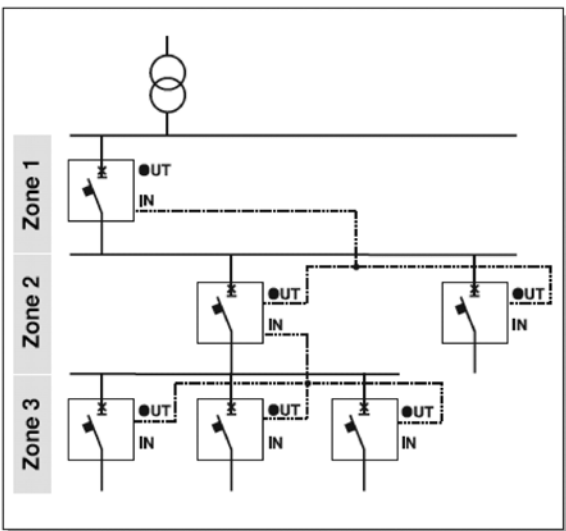
Protection against over temperature

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 can no longer guarantee correct operation) 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, signaling 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 $1.05 \times I_n < I < 1.3 \times I_n$, 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 (guaranteed 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 is 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. Earth 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 I_n .

- Currents: three phases (L1, L2, L3), neutral (Ne) and earth 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

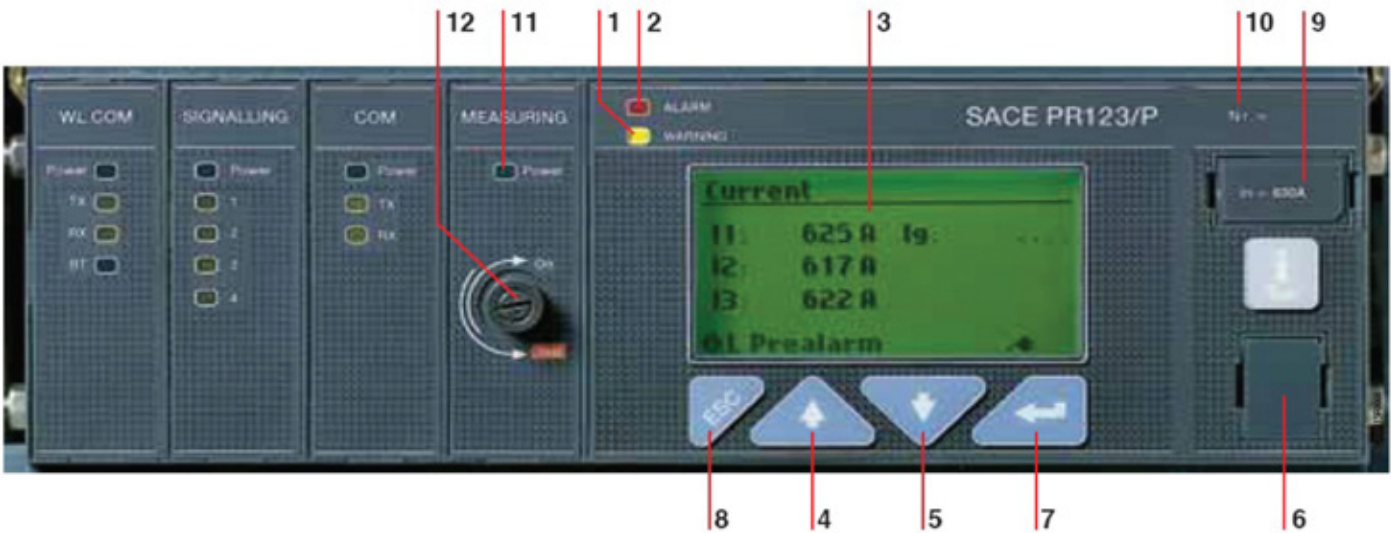
Electronic Trip Units PR123/P

Characteristics

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

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

PR123 integrates all the features offered by PR122/P plus a series of 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)

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

11 PowerLED

12 Voltage-uptake switch-disconnector

Electronic Trip Units PR123/P

Protection functions

The PR123 release offers the following protection functions:

- Overload (L) (1),
- Selective short-circuit (S),
- Instantaneous short-circuit (I),
- Earth fault with adjustable delay (G),
- Directional short-circuit with adjustable delay (D),
- Phase unbalance (U),
- Protection against over temperature (OT),
- Load control (K),
- Under voltage (UV),
- Overvoltage (OV),
- Residual voltage (RV),
- Reverse power (RP),
- Under frequency (UF),
- Over frequency (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 earth 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 earth fault current measuring), PR123/P offers the exclusive feature of the contemporaneous management of both

the configuration, by means of two independent earth fault protection curves. The main application of this characteristic is simultaneous activation of restricted and unrestricted earth 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 phase’s 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 (Maintenance Switch)

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.

Electronic Trip Units PR123/P

Protection functions

The PR123 release offers the following protection functions:

- Overload (L) (1),
- Selective short-circuit (S),
- Instantaneous short-circuit (I),
- Earth fault with adjustable delay (G),
- Directional short-circuit with adjustable delay (D),
- Phase unbalance (U),
- Protection against over temperature (OT),
- Load control (K),
- Under voltage (UV),
- Overvoltage (OV),
- Residual voltage (RV),
- Reverse power (RP),
- Under frequency (UF),
- Over frequency (OF),
- Phase sequence (alarm only).

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

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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 interval 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 earth fault
- Voltage: phase-phase, phase-neutral and residual voltage
- Power: active, reactive and apparent
- Power factor
- Frequency and peak factor,
- Energy: active, reactive, apparent, counter
- Harmonics calculation: up to the 40th harmonic (waveform and module of the harmonics displayed); up to the 35th for frequency $f = 60\text{Hz}$
- 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.

Metering

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:

- Under Voltage (UV) protection
- Overvoltage (OV) protection
- Residual voltage (RV) protection
- Reverse power (RP) protection
- Under frequency (UF) protection
- Over frequency (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 under voltage 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 earthed neutral) and faults that shift the star center in systems with insulated neutral (e.g. large earth 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.



Communications

Industrial networking and Emax Circuit Breakers

In addition to providing flexible and safe protection of power installations, ABB Emax electronic releases have an extended range of communication features, 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:

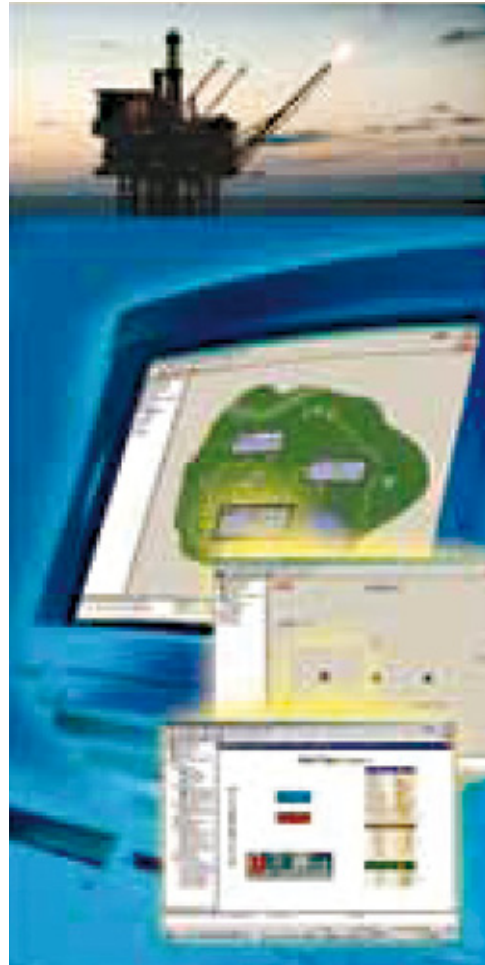
- Circuit breaker status: closed, open, opened by protection release trip
- All values measured by the protection release: RMS currents, voltages, power, power factor and so on
- Alarms and pre-alarms from protection release, e.g. overload protection alarm (timing to trip or pre-alarm warning)
- Fault 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.

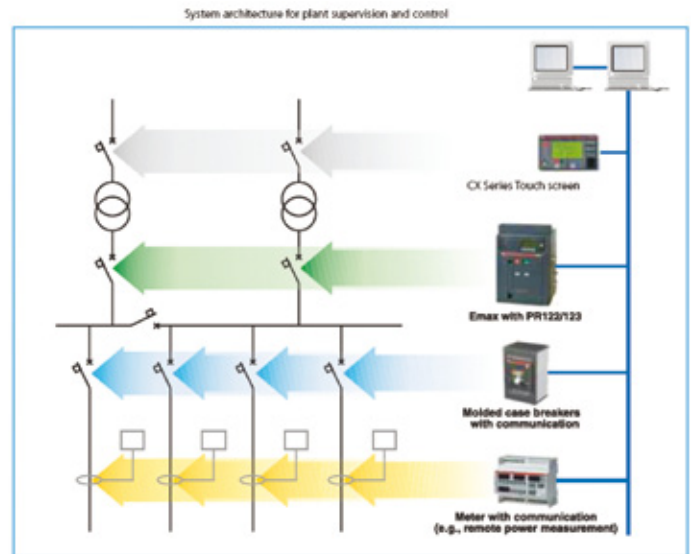


Circuit breakers with communication can easily be integrated with automation and supervision systems. Typical applications include:

- Supervision of the installation with continuous data logging (values of currents, voltage, and 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-Pocket

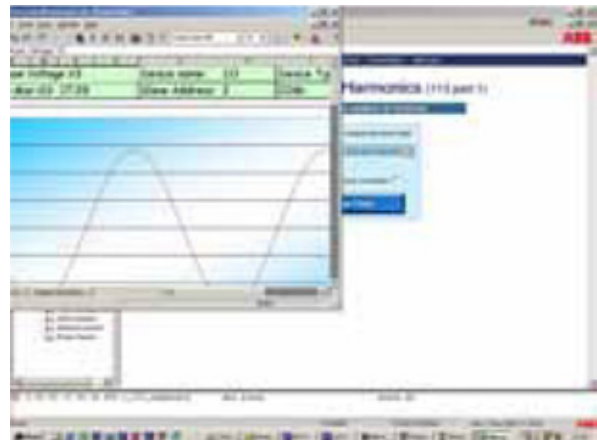
SD-Pocket is an application designed to connect the new protection releases to a PDA or to a personal computer. This means it is now possible to use wireless communication to:

- 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.

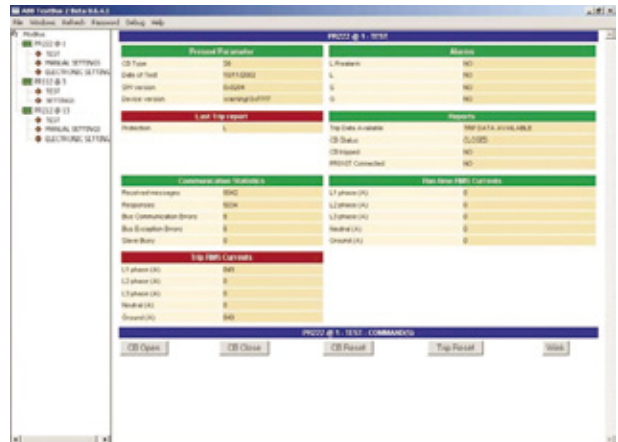


TestBus 2

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, mis-configured 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>)



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 pre-cabled auxiliary switches and cables for signaling the circuit breaker status (springs, position inserted).

It is provided with three LEDs on the front side:

- Power LED
- Rx/TX LEDs



Measurement, signaling and available data functions

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 analysis up to the 40 th 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 PR120V

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 over temperature threshold exceeded ($T > 185\text{ °F} / 85\text{ °C}$)
- 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.

Specifications of the signaling relays

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

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

Breaker 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

A breaker test cabinet is an optional feature 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

VIII. Arc Flash Mitigation

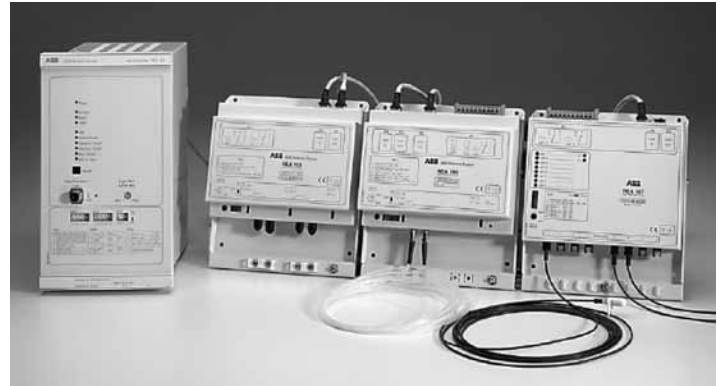
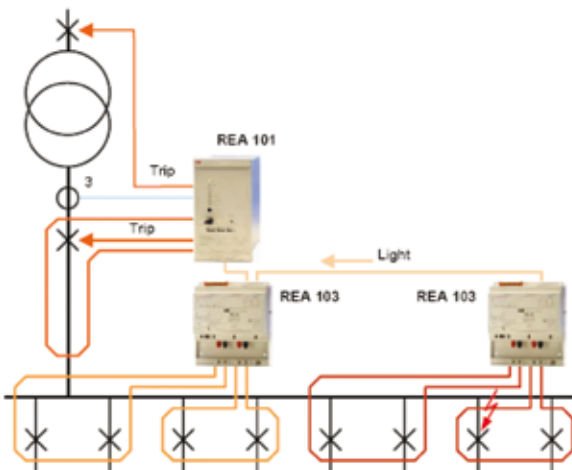
REA Relay System

The REA arc protection relays minimize material damage to switchgear, enable quick restoration of the power distribution and guarantee improved personnel safety. The REA detects an arc anywhere in the bus compartment and cable compartment utilizing long-fiber sensor system.

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 run through the bus compartment and cable compartment in order to detect an arc flash. It then feeds a 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.

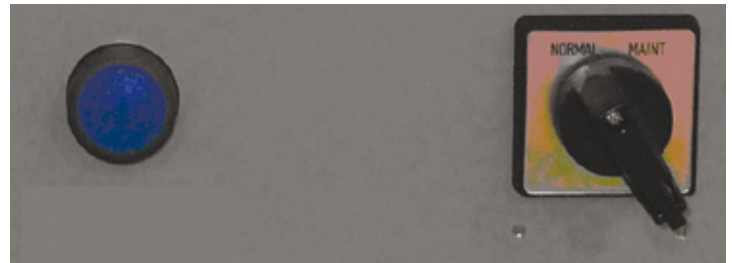
Typical Diagram

Devices



Maintenance Switch

The maintenance switch is used to manually change the circuit breaker 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 operation of the maintenance switch (normal to Maintenance) can be easily controlled from the front door by means of a switch.

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 pad lockable handle in both positions. Part number: ON8PZBS18138.
- 24v DC Timer

Infrared Windows

Infrared windows shall be available 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 shall minimize the exposure to live conductors while performing this type of preventative maintenance inspection. Quantity and location of the IR windows shall be dependent on the breaker stacking arrangement.

- Structural Integrity: Unique design bolts through the panel in eight positions, through patent pending oversized stainless steel reinforcing plate to ensure seal to flat surface, even in the event of panel distortion.
- Impact Resistant: Proprietary design compatible with IEEE/ANSI and UL standards for impact resistance of inspection optics on electrical applications.
- Larger Viewing Area: Square aperture results 28% to 55% more viewing area compared to similar sized round inspection windows.
- Ease of Use: Patent pending hinged cover with spring-loaded captive bolts for one-handed access.
- Stable Transmission: Optic material unaffected by moisture, humidity, vibration, and high-frequency noise. Warranted against transmission loss.
- Standards Compliant: Complies with NFPA 70E/Z463 mandates to maintain equipment in an enclosed state while energized (unlike an open port design).

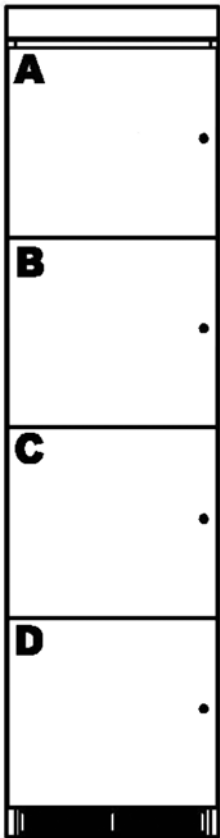


IX. Layout Details

1600A - 2500A Dimensions and Breaker Arrangement

Minimum Width by Ampacity

Ampacity	Width	Depth	Height
1600A - 2500A	27.6" (700mm)	Depth 70.87 (1800mm)	Arc-Resistant (top of chimney) 96.1" (2439.7mm)
			Arc-Resistant w/overhead lifting device 99.4" (2524mm)
			Arc-Resistant (top of plenum) 122.1" (3100.5mm)
			Non Arc-Resistant (top of chimney) 95.92" (2436.4mm)
			Non Arc-Resistant w/overhead lifting device 99.4" (2524mm)



Section Type: Feeder

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder
Location B	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder
Location C	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder
Location D	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder	Above 1600A to 2500A Feeder

Section Type: Main

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	Not Applicable	1600A/2000A Feeder	Not Applicable	Not Applicable
Location B	Not Applicable	1600A/2000A Main (Note 1)	Not Applicable	Not Applicable
Location C	Not Applicable	1600A/2000A Main (Note 2)	Not Applicable	1600A/2000A Main
Location D	Not Applicable	1600A/2000A Feeder	Not Applicable	Not Applicable

note 1: when main is in Location B, Location C can have a 1600A/2000A Feeder and when main is in Location C, Location B can have a 1600A/2000A Feeder

note 2: when main is in Location B, Location C can have a 1600A/2000A Feeder and when main is in Location C, Location B can have a 1600A/2000A Feeder

Section Type: Tie

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	Not Applicable	1600A/2000A Feeder	Not Applicable	1600A/2000A Feeder
Location B	Not Applicable	1600A/2000A Feeder	Not Applicable	1600A/2000A Feeder
Location C	Not Applicable	1600A/2000A Tie	Not Applicable	1600A/2000A Tie
Location D	Not Applicable	1600A/2000A Feeder	Not Applicable	1600A/2000A Feeder

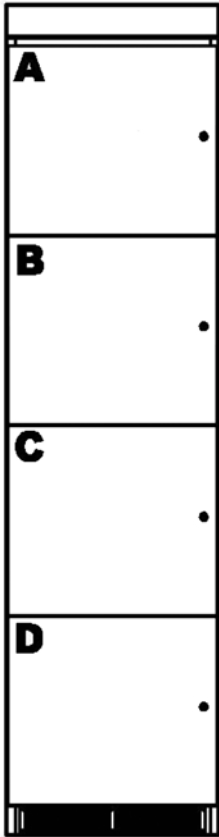
Section Type: Main/Tie Same Section

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	Not Applicable	1600A/2000A Feeder	Not Applicable	1600A/2000A Feeder
Location B	Not Applicable	1600A/2000A Main	Not Applicable	1600A/2000A Main
Location C	Not Applicable	1600a/2000A Tie	Not Applicable	1600A/2000A Tie
Location D	Not Applicable	1600A/2000A Feeder	Not Applicable	1600A/2000A Feeder

2000A Dimensions and Breaker Arrangement

Minimum Width by Ampacity

Ampacity	Width	Depth	Height
2000A	23.6" (600mm)	Depth 70.87 (1800mm)	Arc-Resistant (top of chimney) 96.1" (2439.7mm)
			Arc-Resistant w/overhead lifting device 99.4" (2524mm)
			Arc-Resistant (top of plenum) 122.1" (3100.5mm)
			Non Arc-Resistant (top of chimney) 95.92" (2436.4mm)
			Non Arc-Resistant w/overhead lifting device 99.4" (2524mm)



Section Type: Feeder

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	1600A Feeder	Up 2000A Feeder	Up 2000A Feeder	Not Available
Location B	1600A Feeder	Up 2000A Feeder	Up 2000A Feeder	1600A/2000A Main
Location C	1600A Feeder	Up 2000A Feeder	Up 2000A Feeder	Not Available
Location D	1600A Feeder	Up 2000A Feeder	Up 2000A Feeder	Not Available

Section Type: Main

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	1600A Feeder	1600A Feeder	Not Available	Not Available
Location B	1600A Main	1600A/2000A Main	Not Available	Not Available
Location C	1600A Main	1600A/2000A Main	1600A Main	1600A/2000A Main
Location D	1600A Feeder	1600A Feeder	Not Available	Not Available

Section Type: Tie

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	1600A/2000A Feeder	1600A Feeder	1600A/2000A Feeder	1600A Feeder
Location B	1600A/2000A Feeder	1600A Feeder	1600A/2000A Feeder	1600A Feeder
Location C	1600A/2000A Tie	1600A Tie	1600A/2000A Tie	1600A Tie
Location D	1600A/2000A Feeder	1600A Feeder	1600A/2000A Feeder	1600A Feeder

Section Type: Main/Tie Same Section

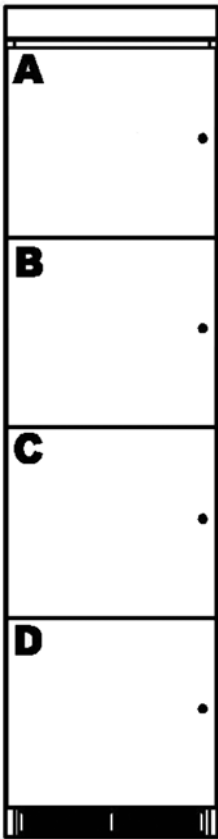
	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	1600A/2000A Feeder	1600A Feeder	1600A/2000A Feeder	1600A Feeder
Location B	1600A/2000A Main	1600A Main	1600A/2000A Main	1600A Main
Location C	1600A/2000A Tie	1600A Tie	1600A/2000A Tie	1600A Tie
Location D	1600A/2000A Feeder	1600A Feeder	1600A/2000A Feeder	1600A Feeder

Note: All Section types above are Bus Braced for 100KA

2500A - 3200A Dimensions and Breaker Arrangement

Minimum Width by Ampacity

Ampacity	Width	Depth	Height
2500A-3200A	31.5" (800mm)	Depth 70.87 (1800mm)	Arc-Resistant (top of chimney) 96.1" (2439.7mm)
			Arc-Resistant w/overhead lifting device 99.4" (2524mm)
			Arc-Resistant (top of plenum) 122.1" (3100.5mm)
			Non Arc-Resistant (top of chimney) 95.92" (2436.4mm)
			Non Arc-Resistant w/overhead lifting device 99.4" (2524mm)



Section Type: Main

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A Feeder	3200A A/B main, 2500A Feeder in Location C and C	Not Applicable	Not Applicable
Location B	3200A Main when in Location B 2500A Feeder is Location C		Not Applicable	Not Applicable
Location C	3200A Main when in Location C 2500A Feeder is Location B	3200A A/B Main, 2500A Feeder in Location A and B	3200A Main	3200A Main
Location D	2500A Feeder		Not Applicable	

Section Type: Tie

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A Feeder	2500A Feeder	2500A Feeder	2500A Feeder
Location B	2500A Feeder	2500A Feeder	2500A Feeder	2500A Feeder
Location C	3200A Main	3200A Tie	3200A Main	3200A Tie
Location D	2500A Feeder		2500A Feeder	

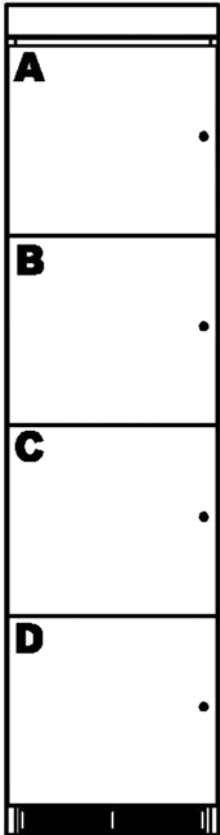
Section Type: Main/Tie Same Section

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A Feeder	3200A Main	N/A	N/A
Location B	3200A Main		N/A	N/A
Location C	3200A Tie	3200A Tie	N/A	N/A
Location D	2500A Feeder		N/A	N/A

4000A Dimensions and Breaker Arrangement

Width by Ampacity

Ampacity	Width	Depth	Height
4000A	39.4" (1000mm)	Depth 70.87 (1800mm)	Arc-Resistant (top of chimney) 96.1" (2439.7mm)
			Arc-Resistant w/overhead lifting device 99.4" (2524mm)
			Arc-Resistant (top of plenum) 122.1" (3100.5mm)
			Non Arc-Resistant (top of chimney) 95.92" (2436.4mm)
			Non Arc-Resistant w/overhead lifting device 99.4" (2524mm)



Section Type: Main

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A unless 4000A in Location D and then not allowed	4000A Main, 2500A Feeder in Location C and D	Not Applicable	Not Applicable
Location B	4000A Main, 2500A Feeders in Location A, C, D		Not Applicable	Not Applicable
Location C	4000A Main, 2500A Feeders in Location A, B, C	4000A Main, 2500A Feeder in Location A and B, with CT's no feeders	4000A Main	4000A Main
Location D	4000A Main, with CT's no feeders		Not Applicable	

Section Type: Tie

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A unless CT's in Tie	2500A unless CT's in Tie	2500A unless CT's in Tie	2500A unless CT's in Tie
Location B	2500A unless CT's in Tie	2500A unless CT's in Tie	2500A unless CT's in Tie	2500A unless CT's in Tie
Location C	4000A Tie, no ct's 2500A Feeders in Locations A, B, D	4000A Tie	4000A Tie, no ct's 2500A Feeders in Locations A, B, D	4000A Tie
Location D	4000A Tie, with ct's no feeder		4000A Tie, with ct's no feeder	

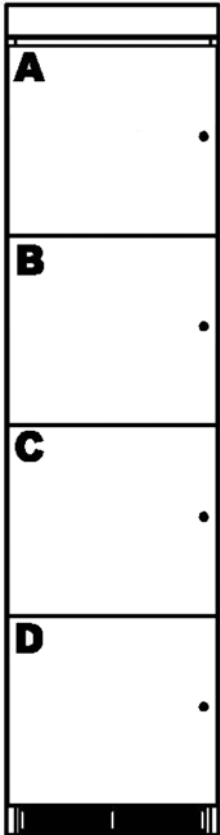
Section Type: Main/Tie Same Section

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A Feeder	4000A Main	N/A	N/A
Location B	4000A Main	4000A Main	N/A	N/A
Location C	4000A Tie	4000A Tie	N/A	N/A
Location D	2500A Feeder	4000A Tie	N/A	N/A

5000A Dimensions and Breaker Arrangement

Width by Ampacity

Ampacity	Width		Height
5000A	39.4" (1000mm)	Depth 70.87 (1800mm)	Arc-Resistant (top of chimney) 96.1" (2439.7mm)
			Arc-Resistant w/overhead lifting device 99.4" (2524mm)
			Arc-Resistant (top of plenum) 122.1" (3100.5mm)
			Non Arc-Resistant (top of chimney) 95.9" (2436.4mm)
			Non Arc-Resistant w/overhead lifting device 99.4" (2524mm)



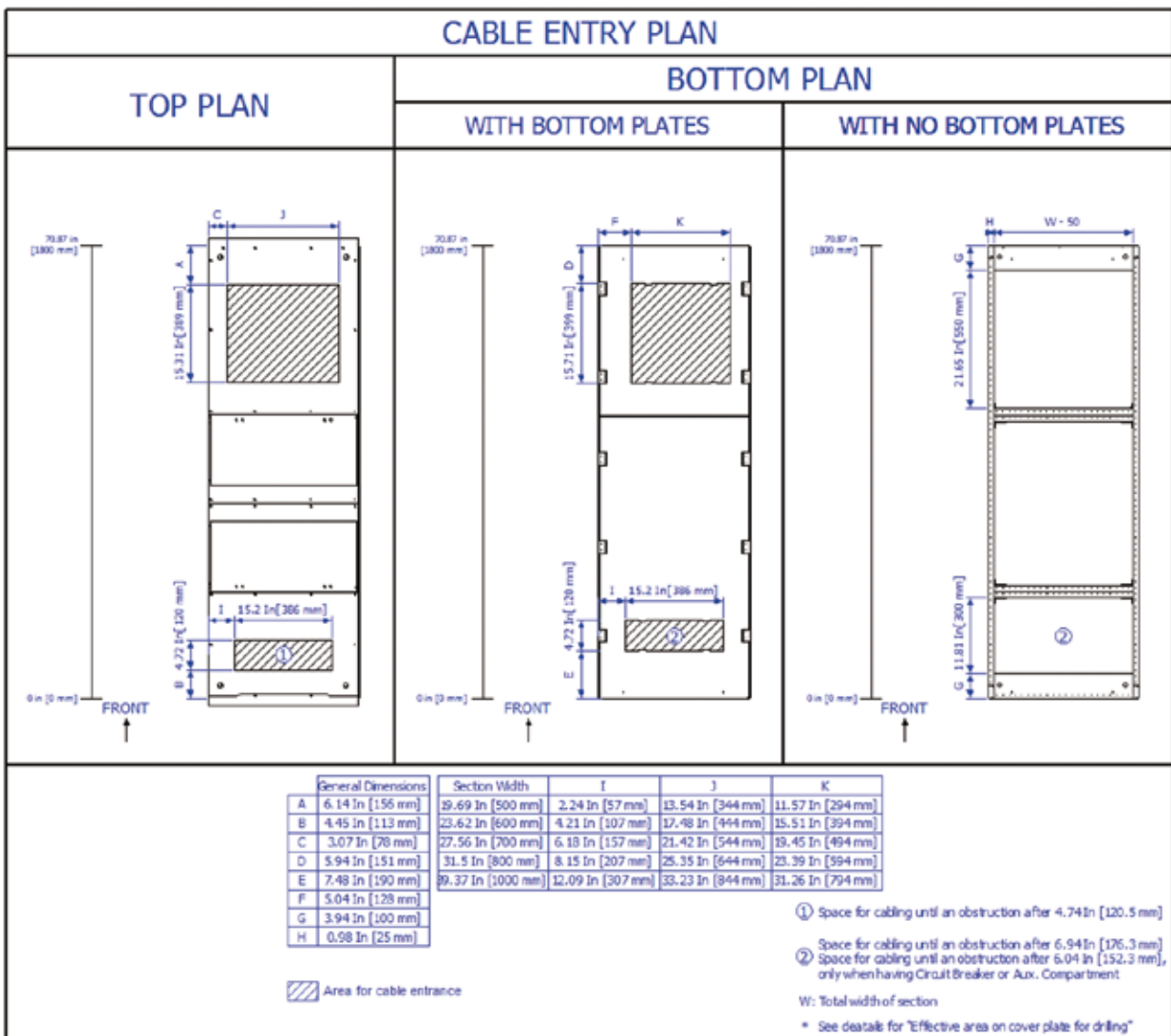
Section Type: Main

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	2500A unless 5000A in Cell D with CT's and then not allowed	2500A unless 5000A in Cell D with CT's and then not allowed	n/a	n/a
Location B	2500A unless 5000A in Cell D with CT's and then not allowed	2500A unless 5000A in Cell D with CT's and then not allowed	n/a	n/a
Location C	2500A unless 5000A in Cell D with CT's and then not allowed	5000A main 2500A Feeder in Location A and B, with CT's no feeders	5000A Main	5000A Main
Location D	5000A Main, no CT's			

Section Type: Tie

	65KA, 3Wire	100KA, 3Wire	65KA, 4Wire	100KA, 4Wire
Location A	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker
Location B	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker	E3 - 2500A Feeder (Bus A) if no CT's are required in Tie Breaker
Location C	5000A Tie	5000A Tie	5000A Tie	5000A Tie
Location D	N/A		N/A	

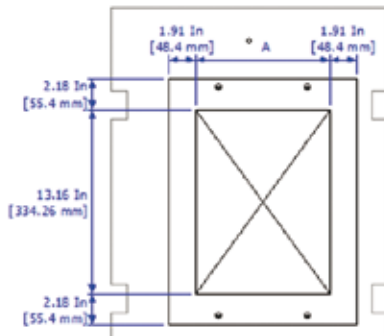
MNS-SG Switchgear Floor Plans 70.87" (1800 mm) Depth



MNS-SG Switchgear Floor Plans 70.87" (1800 mm) Depth

COVER PLATES DRILLING DETAILS

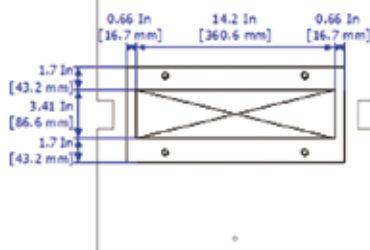
BOTTOM PLATES



CABLE COMPARTMENT

Section Width	A
19.69 in [500 mm]	9.57 in [243.2 mm]
23.62 in [600 mm]	13.51 in [343.2 mm]
27.56 in [700 mm]	17.45 in [443.2 mm]
31.5 in [800 mm]	21.39 in [543.2 mm]
39.37 in [1000 mm]	29.26 in [743.2 mm]

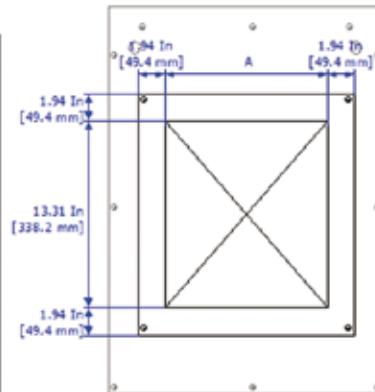
☒ Effective area on cover plate for drilling



BREAKER COMPARTMENT

☒ Effective area on cover plate for drilling

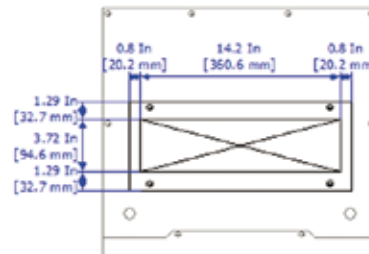
TOP PLATES



CABLE COMPARTMENT

Section Width	A
19.69 in [500 mm]	11.54 in [293.2 mm]
23.62 in [600 mm]	15.48 in [393.2 mm]
27.56 in [700 mm]	19.42 in [493.2 mm]
31.5 in [800 mm]	23.35 in [593.2 mm]
39.37 in [1000 mm]	31.23 in [793.2 mm]

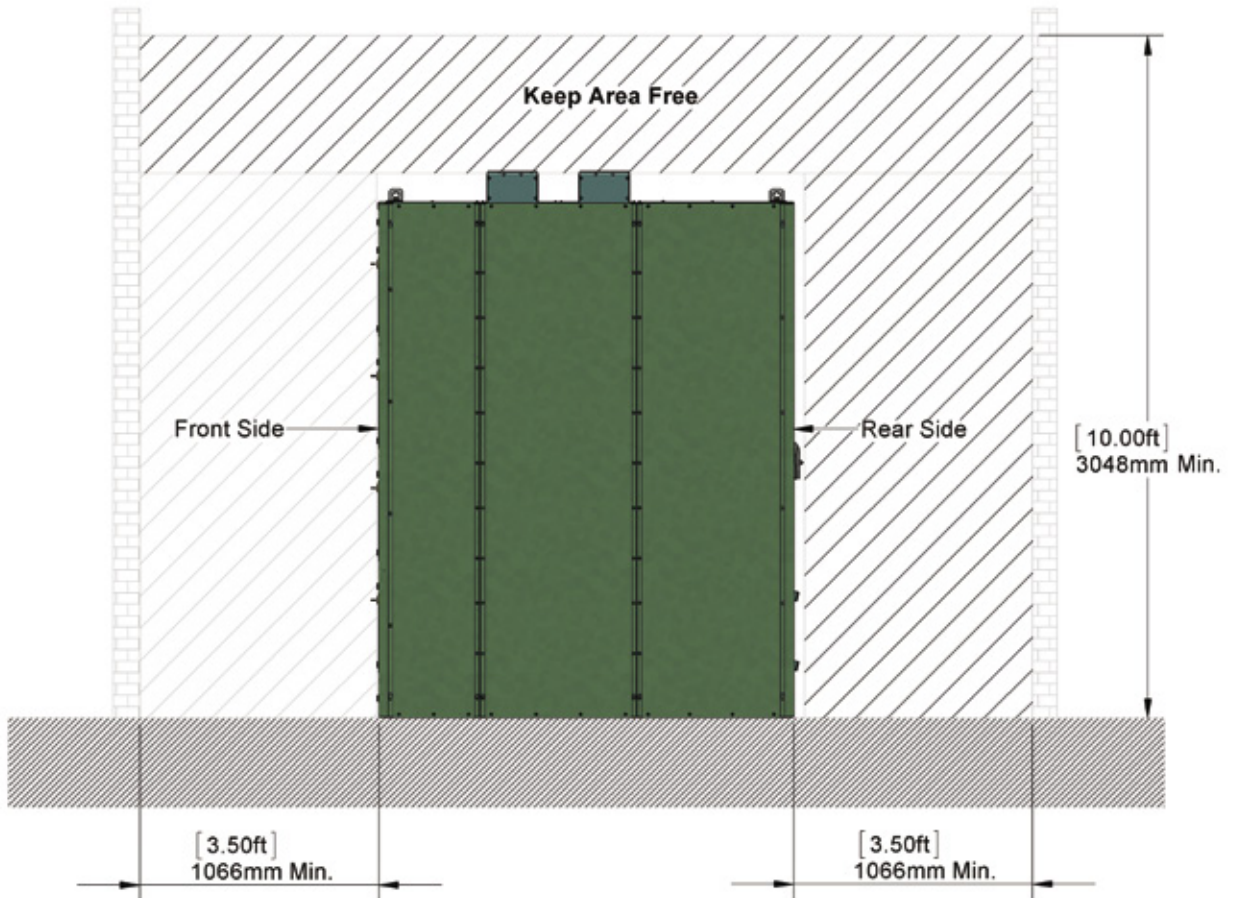
☒ Effective area on cover plate for drilling



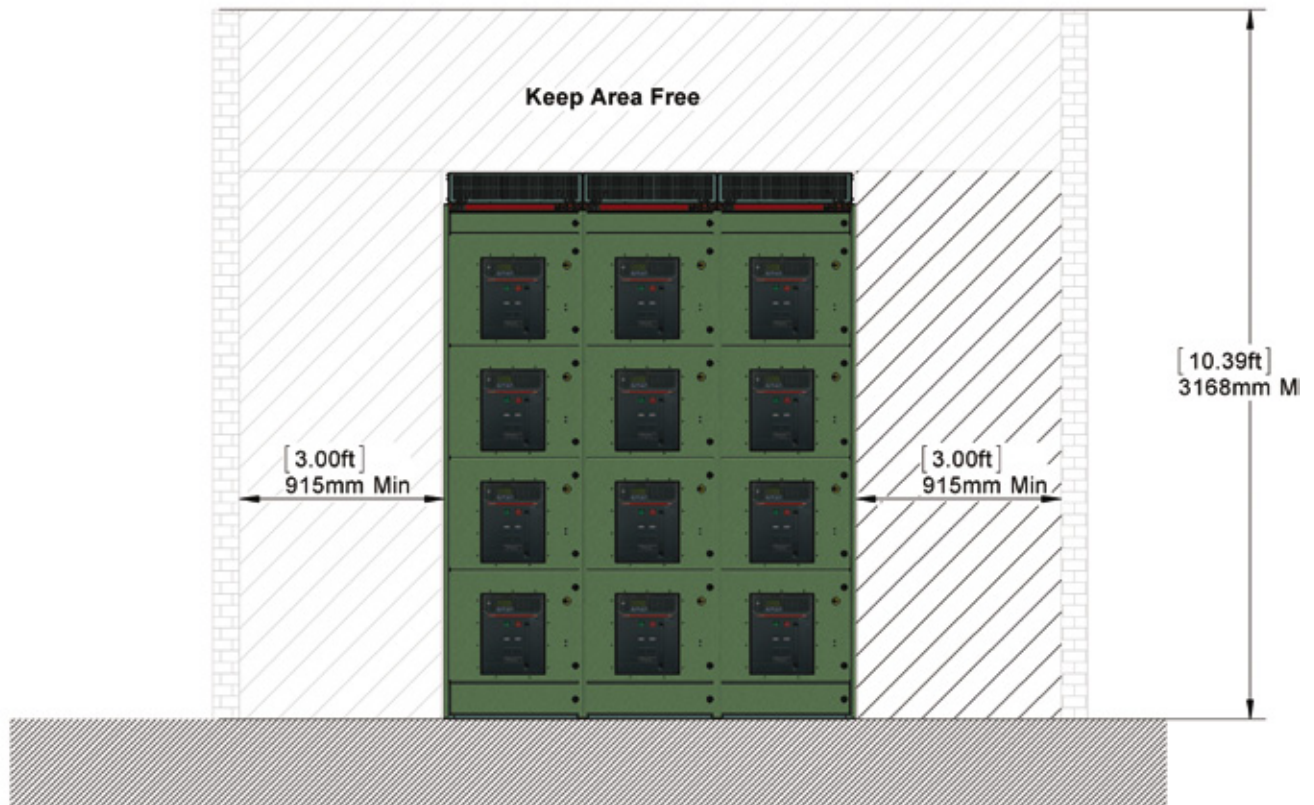
BREAKER COMPARTMENT

☒ Effective area on cover plate for drilling

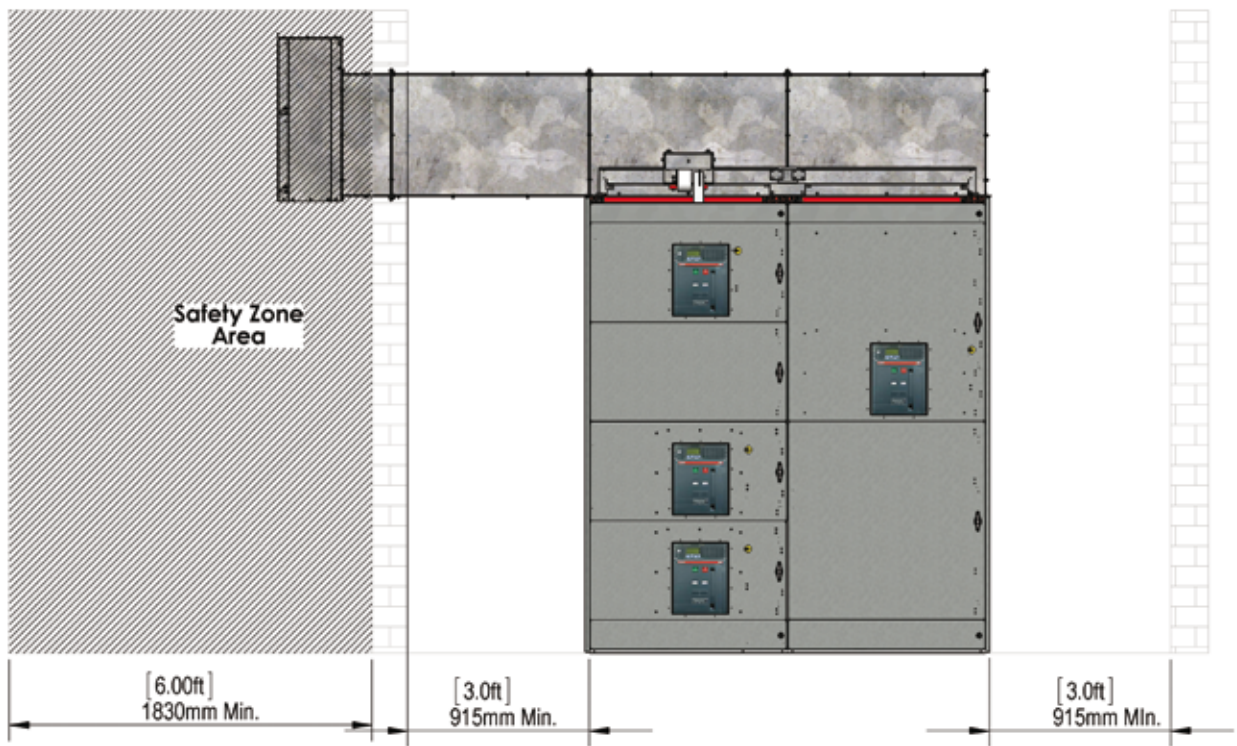
MNS-SG Arc-Resistant Layout Restrictions Side View with Chimney Design



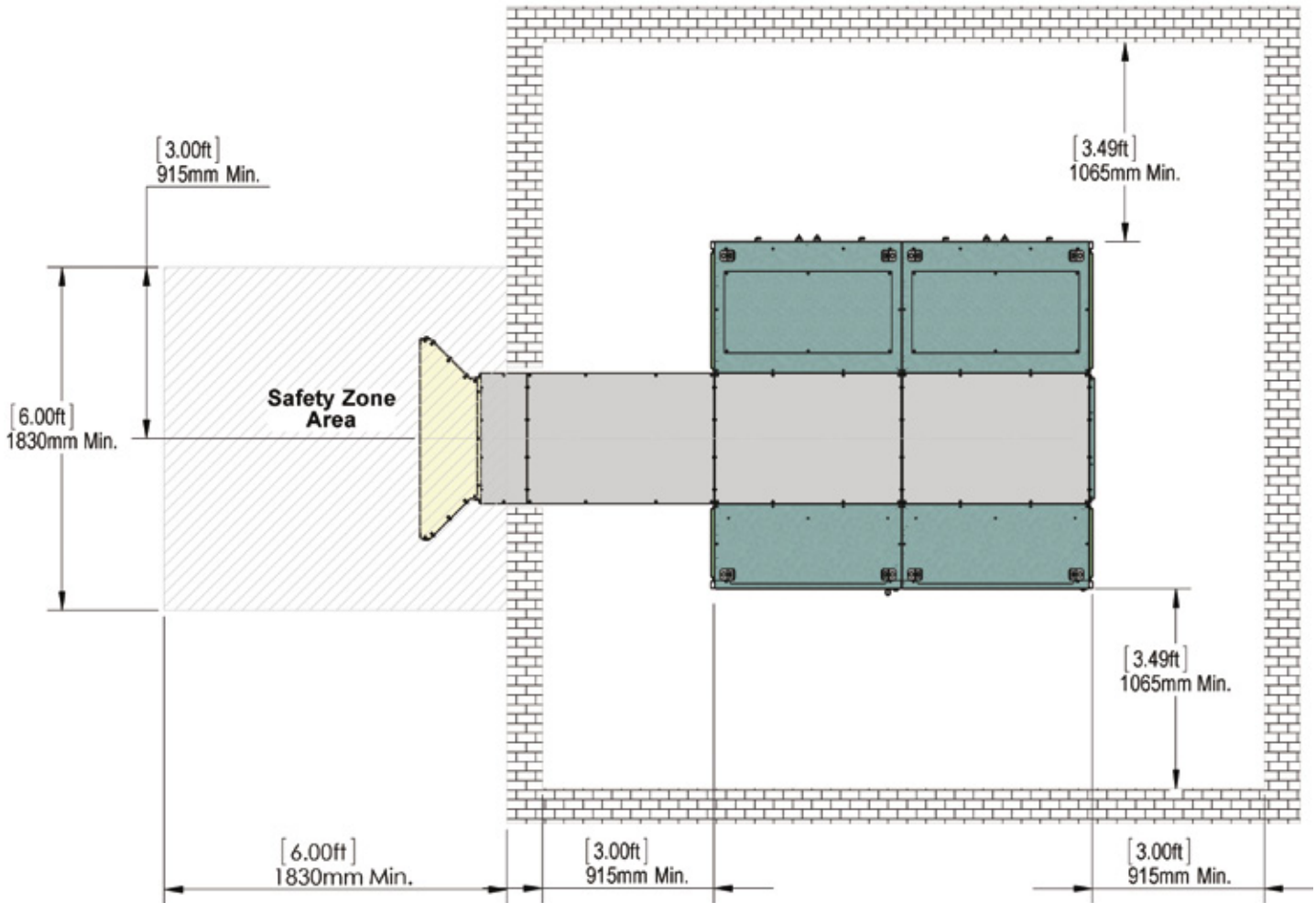
MNS-SG Arc-Resistant Layout Restrictions Front View with Chimney Design



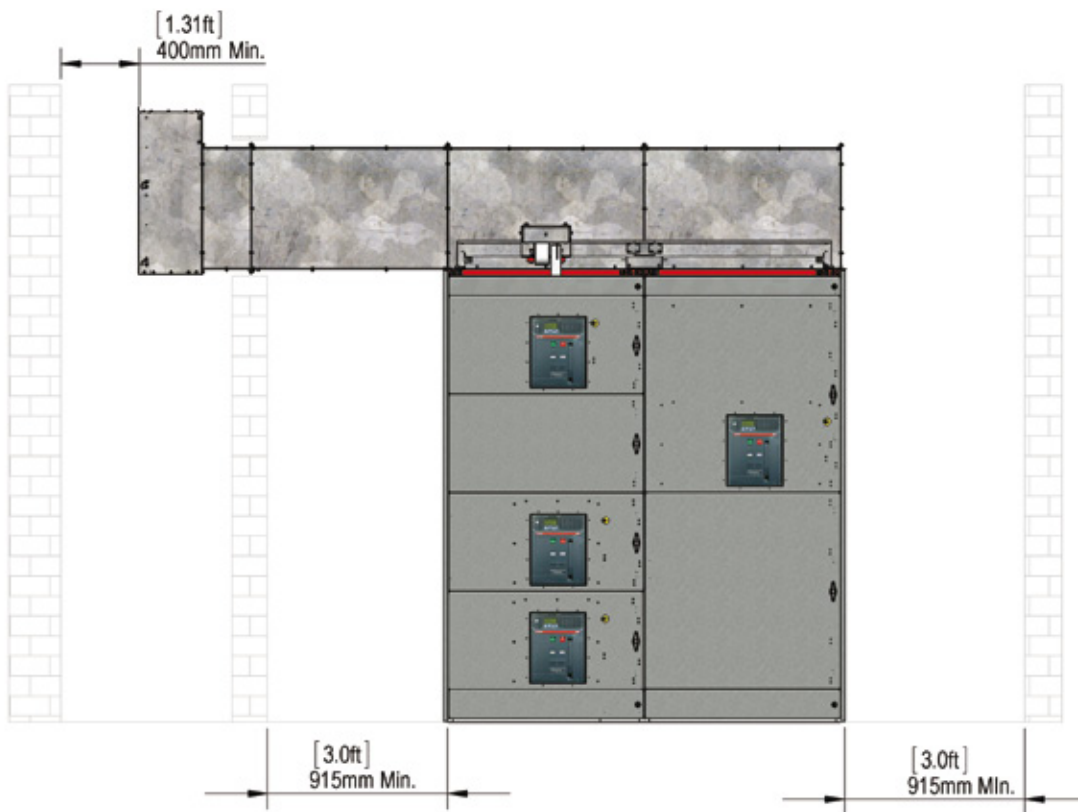
MNS-SG Arc-Resistant Layout Restrictions Front View with Plenum Design



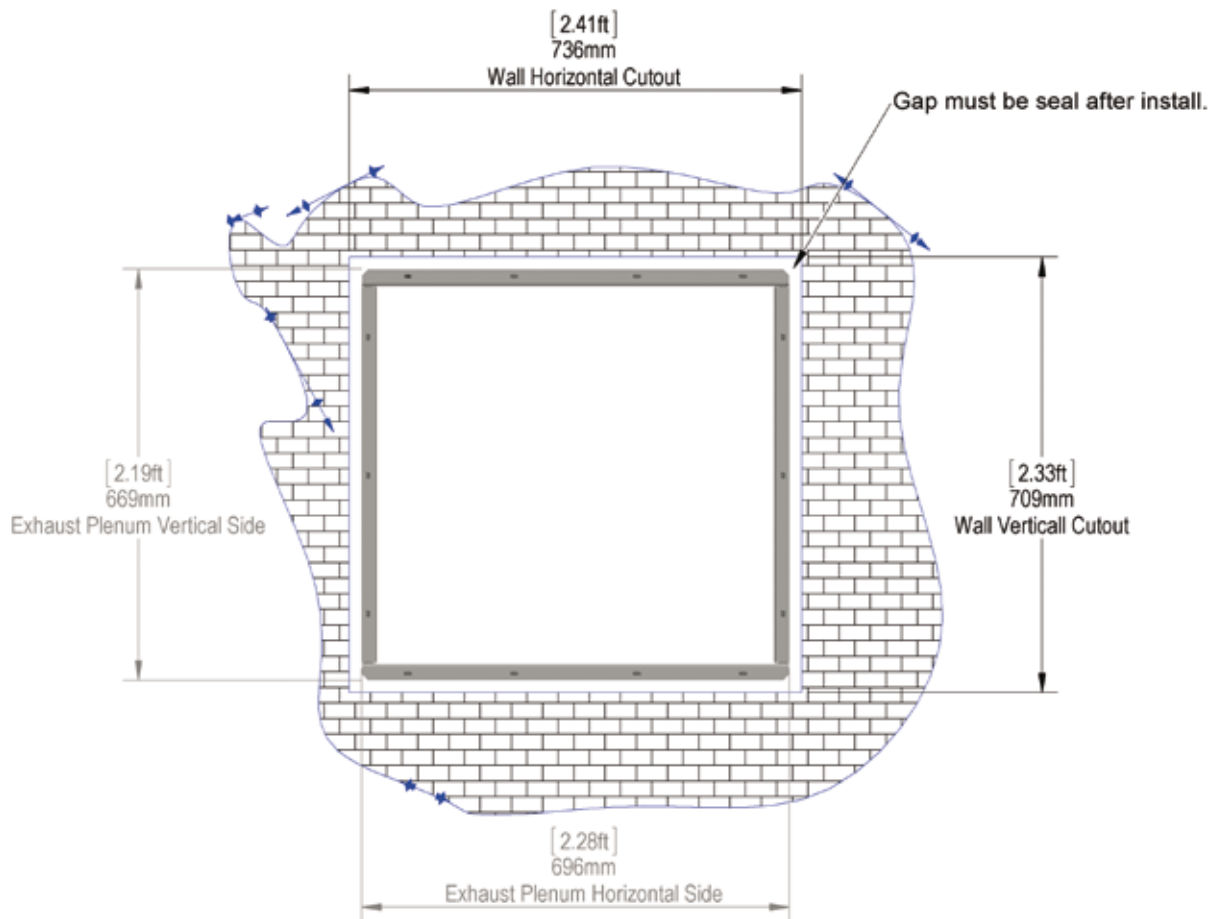
MNS-SG Arc-Resistant Layout Restrictions Top View with Plenum Design



MNS-SG Arc-Resistant Layout Restrictions Front View with Plenum Design (to wall)



MNS-SG Arc-Resistant Layout Restrictions Exhaust Opening for Plenum Design



Weights by Breaker/Section

Weights listed in the following table are approximate.
Consult equipment shipping documents for actual weights and dimensions.

Structure/Breaker Ampacity	23.6" (600mm) Wide 70.9" (1800mm) Deep	27.6" (700mm) Wide 70.9" (1800mm) Deep	31.5" (800mm) Wide 70.9" (1800mm) Deep	39.4" (1000mm) Wide 70.9" (1800mm) Deep	Breaker Weight (per Breaker)	Units
up to 1600A	749				661	lbs
	340				300	kg
above 1600 to 3200A		793	848		771	lbs
		360	385		350	kg
Above 3200A to 5000A				980	1,322	lbs
				445	600	kg
Overhead lifting device					118	lbs
					54	kg
CT's (set of three up to 3200A)					33	lbs
					15	kg
CT's (set of three, 4000 and 5000A)					77	lbs
					35	kg
HRG					132	lbs
					60	kg
PT's (each)					11	lbs
					5	kg
Overhead lifting device					1,322	lbs
					600	kg
Close coupling or bus duct raisers (3200A)					441	lbs
					200	kg
Close coupling or bus duct raisers (5000A)					661	lbs
					300	kg

Contact us

USA

ABB, Inc.

Low Voltage Products & Systems

3700 W Sam Houston Pkwy S
Houston, TX 77042
Toll Free: 1 888 385-1221

ABB, Inc.

Low Voltage Products & Systems

400 Crown Colony Drive, Suite 303
Quincy, MA 02169

www.abb.us/lowvoltage

Canada

ABB, Inc.

Low Voltage Products & Systems

2117 - 32e Avenue
Lachine, QC H8T 3J1
Tel.: 1 514 420-3100
Toll Free: 1 800 567-0283
Fax: 1 514 420-3137
lvs.rfq@ca.abb.com

ABB, Inc.

Low Voltage Products & Systems

201 Westcreek Blvd.
Brampton, ON L6T 5S6
Tel.: 1 905 460-3000
Fax: 1 905 460-3395

ABB, Inc.

Low Voltage Products & Systems

110, 4411-6th Avenue S.E.
Calgary, AB T2G 4E8
Tel.: 1 403 278-7111
Fax: 1 403 278-8232

www.abb.ca/lowvoltage

Mexico

ABB Mexico, S.A. de CV.

Low Voltage Systems

Av. Central No. 405, Parque Logistico
C.P. 78395, San Luis Potosi, SLP
Tel.: +52 444 8708 000

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