MNS-SG
Low Voltage, Metal-Enclosed, Drawout Switchgear
# Table of contents

I. Product Description .......................................................... 4
   - General ............................................................................ 4
   - Arc flash dangers ......................................................... 5
   - MNS-SG arc-resistant switchgear .................................... 6
   - Standard features .......................................................... 7
   - Arc-resistant features .................................................... 7
   - Available options ......................................................... 7

II. Industry Standards ............................................................ 8

III. System Grounding Schemes .............................................. 9
    - Ungrounded systems .................................................... 9
    - Grounded systems ....................................................... 9

IV. Technical Equipment Ratings .......................................... 11

V. Mechanical Overview ..................................................... 12
    - Enclosure ...................................................................... 12
      - Arc-resistant
      - Non arc-resistant
    - Structure ...................................................................... 13
    - Frame .......................................................................... 13
    - Busbar system ............................................................ 14
    - Horizontal and vertical wireways .................................. 17
    - Barriers and cover ....................................................... 17
    - Paint ............................................................................ 19
    - Auxiliary compartments .............................................. 19
    - Nameplates ................................................................... 20
    - Shipping design .......................................................... 20

VI. Electrical Overview ........................................................ 21
    - Wiring .......................................................................... 21
    - Voltage transformer .................................................... 21
    - Control power transformer .......................................... 21
    - Current transformer .................................................... 22
    - Surge protective devices ............................................. 22
    - Relays .......................................................................... 22
    - Metering ...................................................................... 22
    - Integrated communications network ................................ 22
    - Breaker control switches ............................................ 23
    - Selector switches ....................................................... 23
    - Test switches and plugs .............................................. 23
    - Space heaters, thermostats, humidistat ......................... 24
    - High-resistance grounding systems ................................ 24
    - Bus differential relay .................................................. 24
    - Manual and automatic transfer schemes ....................... 24

VII. Emax Power Circuit Breakers .......................................... 25
    - Ratings ........................................................................ 25
    - Rating plugs ................................................................ 26
    - Breaker details ........................................................... 27
    - Cradle details .............................................................. 28
    - Electronic trip unit comparison .................................... 29
    - Electronic trip unit PR121/P ......................................... 31
    - Electronic trip unit PR122/P ......................................... 34
    - Electronic trip unit PR123/P ......................................... 39
    - Metering ...................................................................... 42
    - Communications ......................................................... 43
    - Breaker test unit .......................................................... 47
    - Breaker test cabinet .................................................... 48

VIII. Arc Flash Mitigation ...................................................... 49
    - Arc flash relays ........................................................... 49
    - Maintenance switch .................................................... 49
    - Infrared windows ........................................................ 49

IX. Accessories ..................................................................... 50
    - Remote racking device ................................................ 50
    - Mimic bus .................................................................... 50
    - Remote control panel .................................................. 51
    - Transition sections to Max-SG and MNS-MCC ............... 51
    - Overhead lifting device ............................................... 51
    - Lift truck ..................................................................... 51

X. Layout Detail Dimensions and Breaker Arrangement ........... 52
    - Floor plan/conduit area .............................................. 60
    - Arc-resistant layout restrictions .................................... 61
    - Power distribution/e house ......................................... 67
    - Weights by breaker/section ......................................... 69
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, ANSI C37.20.7 and CSA C22.2 No. 31. It represents a further extension of the ABB vision to deliver products that provide customers with advanced solutions meeting their need for equipment that delivers 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
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 do not detect and, therefore, cannot interrupt 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 insulation degradation, 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 fault site 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.

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 gases 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 in the arc from the arc chutes, which is contained within the switchgear. This has been verified by 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.”
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 480V and 85kA at 600V 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. The testing was witnessed and certified by UL representatives.

Standard features

- 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
- 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 UL 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
- NEMA 1 enclosure

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 gases from escaping
- Roof chimney flaps automatically open to safely exhaust pressure and gases independent of the arc origination point inside the switchgear. Flaps are self-closing.
- 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 an 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
- Up to 480V at 100kA and 85kA at 600V
- 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

Available options

- Barriers between cable compartment sections
- Barriers between bus compartments and cable compartments
- Bus insulation
- Overhead lift device
- Lift truck
II. Industry standards

The MNS-SG with Emax power breakers is designed, tested, and built in accordance with the following industry standards:

- UL 1558 — Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
- CSA C22.2 No. 31 – Switchgear Assemblies
- 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: see attached certificate

The Emax power breakers are designed, tested, and built 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
- UL 1066 – Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

---

**SPECIAL SEISMIC CERTIFICATE OF COMPLIANCE**

Product Line: ABB, Inc. 1600A-5000A MNS Switchgear

Floor Mount – Bolted & Welded

Qualified to CBC-2019 Section 1708A.4 and IBC-2009 Section 1708.4

\[ S_{0.5} = 1.39g \text{ for } f_{y} = 1 \text{ and } S_{0.5} = 2.22g \text{ for } f_{y} = 0, f_{p} = 1.5 \]

Qualified to National Building Code of Canada 2010 Volume 2, Section 4.1.8.18

\[ F_{p}S_{0.5} = 1.85g \text{ for } \frac{V_{1}}{V_{0}} = 1 \text{ and } F_{p}S_{0.5} = 2.95g \text{ for } \frac{V_{1}}{V_{0}} = 0, f_{p} = 1.5 \]

Qualified to IEEE 693-2006 Inherently Acceptable

Qualified by Shake-Table Testing at Clark Testing Labs, Jefferson Hills, PA, May/June 2013

(WEGAI Seismic Report No. 1089-151-SG)

Certification:

This document certifies the above mentioned Switchgear product line manufactured by ABB, Inc. meets the requirements for special seismic certificate with the seismic parameters listed above.

Seismic certification and analytical work performed by W.E. Gundy & Associates, Inc.
(www.wegai.com); Travis E. Soppe, Registered Professional Engineer, California
III. System grounding schemes

Ungrounded systems

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, 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 can be neglected. For practical purposes, the distributed capacitive reactance to ground, Xco, is considered to be balanced.

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 result from a resonant condition between the inductive reactance of the system and the distributed capacitance to ground.

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.

Grounded systems

The methods of grounding the system neutral can be divided into two general categories: solid grounding and impedance grounding.

Solid grounding

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:

- 120/240V, single-phase, 3-wire
- 208Y/120V, 3-phase, 4-wire
- 480Y/277V, 3-phase, 4-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.

Impedance grounding

Impedance grounding may be further divided into several subcategories: reactance grounding and high or low-resistance grounding.

Reactance grounding

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 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 kA.

Reactance-grounded systems are not commonly employed in industrial power systems.
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.

**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 10A or less, although some medium voltage specialized systems may require higher ground-fault levels. The potential damage caused by an arcing current larger than 10A in confined spaces makes the use of high-resistance grounding on systems where the line-to-ground fault exceeds 10A inadvisable.

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

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

In a low-resistance grounding application, 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 1600A, 2000A, 3200A, 4000A, 5000A
Rated tested maximum voltage 254VAC, 508VAC & 635V
Rated voltage 240VAC, 480VAC & 600V
Phases 3-phase 3-wire, 3-phase 4-wire
Neutral (when required on 4-wire systems) 100% rated
Frequency 50Hz/60Hz
Short circuit current withstand at 480VAC up to 100kA
Short circuit current withstand at 600VAC up to 85kA
Bus bracing up to 100kA @ 480VAC, up to 85kA @ 600VAC

Environmental conditions

Enclosure rating (arc-resistant) NEMA 1
Enclosure rating (non arc-resistant) NEMA 1 (with and without gasketing)
Temperature range during operation -25 to +40°C (-13 to +104°F)
Temperature range for transport -40 to +70°C (-40 to 158°F)
Temperature range for storage 0 to +40°C (32 to 104°F)
Maximum bus temperature 65 over 40°C (149 over 104°F)

Overall system derating

ANSI switchgear altitude correction factors

<table>
<thead>
<tr>
<th>Altitude (m)</th>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>6600 ft (2000 m) and below</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>8500 ft (2600 m)</td>
<td>95%</td>
<td>99%</td>
</tr>
<tr>
<td>13000 ft (3900 m)</td>
<td>80%</td>
<td>96%</td>
</tr>
</tbody>
</table>

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.
V. Mechanical overview

Enclosure

MNS-SG switchgear enclosure is NEMA 1 compliant. 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
- Ground bus extensions
- Removable, steel top plates over conduit entrance
- Lifting eyes
- 1852mm deep enclosure (72.9 in)

Arc-resistant enclosure features:

- Plates equipped with pressure relief blow-out flaps
- Optional plenum for direction of exhaust gases 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
- Vertical barriers between cable compartment sections
- Reinforced door handle mechanism replaces individual door latches

Available options:

- Vertical barriers between cable compartment sections
- Barriers between bus compartment and 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
- Cable tie-down supports in cable compartment
- Mimic bus
- 1.5" base channels
- Rodent barriers
- 2052mm deep enclosure (80.8 in)
**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 used 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 compartmentalized, with each vertical section consisting of three compartments: the breaker compartment (front), bus compartment (middle), and cable compartment (rear). The structure can be 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 on the roof of the enclosure are standard to allow lifting by a crane.
**Busbar system**

The busbar system is installed in the middle compartment of the switchgear vertical sections and includes the main horizontal busbar system (with neutral bus when required), vertical distribution busbars, 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. Custom designed bussed incoming sections may also be provided upon request.

**Main busbar**

The main horizontal busbars 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 busbars 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 busbars 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 busbar compartment is separated from the breaker compartment and cable compartments by grounded steel barriers.

Main busbar splices are located between every section. Main bus amperages include: 1600A, 2000A, 3200A, 4000A, and 5000A with bus bracing up to 100kA at 480V or 85kA at 600V. Silver plated bus is standard with optional tin plating available.

The size and number of conductors is shown below:

<table>
<thead>
<tr>
<th>Continuous current</th>
<th>Number of conductors</th>
<th>Size of conductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>1</td>
<td>⅛&quot; x 5&quot;</td>
</tr>
<tr>
<td>2000</td>
<td>2</td>
<td>⅛&quot; x 4&quot;</td>
</tr>
<tr>
<td>3200</td>
<td>3</td>
<td>⅛&quot; x 5&quot;</td>
</tr>
<tr>
<td>4000</td>
<td>4</td>
<td>⅛&quot; x 5&quot;</td>
</tr>
</tbody>
</table>

Main busbar system arrangements
For tie breaker sections, two horizontal busbar systems are installed.

**Splice kits**

When two or more sections connect to form a lineup, the main horizontal busbars must be connected using 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.

When required, a 100% rated neutral horizontal busbar is provided in the busbar compartment above the lower A-phase horizontal busbar. For four-wire systems that have no line-to-neutral load requirements, an incoming neutral connection point can be provided to facilitate the power system grounding connection, but without neutral horizontal or distribution busbars are provided.

**Insulated bus**

MNS-SG is available with optional bus insulation on all busbars. The bus insulation system uses a combination of insulating sleeves and molded insulating boots. Connection lug insulating boots are optional.
Bused incoming connections

Bused incoming connections are available for close coupling to dry-type transformers on the left or right ends of MNS-SG lineups, or for top or bottom incoming bus duct connections. These incoming configurations are available for both 3-wire and 4-wire systems. Current transformers are also available for all types of bused incoming connections.

Dry type transformer connections

Close coupling to an ABB dry type transformer does not require a transition section. The transformer will be flush to the side of the switchgear. When using another brand of dry type transformer or a liquid filled transformer from any manufacturer, a transition section will be required. The width of the transition section will depend upon the bus rating of the switchgear. Consult with ABB if needed, since empty compartments may not have distribution busbars installed behind them.

Distribution busbar systems

The distribution busbar is a system of vertical busbars 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, and are offered as silver-plated standard, with an option for tin-plated.

Ground busbar

The ground busbar is rated for 1000A and is located in the cable compartment. Section-to-section ground bus connections are made with removable splice plate kits.

### Standard distribution busbar configurations

<table>
<thead>
<tr>
<th>Continuous current</th>
<th>Configuration</th>
<th>Section width (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>1* x 3/8” x 5”</td>
<td>600, 700</td>
</tr>
<tr>
<td>2000</td>
<td>1* x 3/8” x 6”</td>
<td>600, 700</td>
</tr>
<tr>
<td>2500</td>
<td>1* x 3/8” x 8”</td>
<td>600, 700</td>
</tr>
<tr>
<td>3200</td>
<td>2* x 3/8” x 6”</td>
<td>600, 700, 800</td>
</tr>
<tr>
<td>4000</td>
<td>2* x 3/8” x 8”</td>
<td>600, 700, 800, 1000</td>
</tr>
<tr>
<td>5000</td>
<td>3* x 3/8” x 8”</td>
<td>600, 700, 800, 1000</td>
</tr>
</tbody>
</table>
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. Vertical wireways are also provided for wiring between cubicles.

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 doors have 14-gauge individual doors with removable hinges. Breaker compartment doors have cutouts. Cutout gasketing is 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 enclosures. All compartment doors are equipped 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 busbar 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.

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 busbar compartment roof plate is a ventilated chimney. Arc-resistant switchgear lineups include a self-resetting hinged pressure relief flap on the top of the ventilated chimney.

Segregation barriers

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

The standard finish color is light gray paint ANSI 61). The standard painting process is a UL-approved electrostatic powder coat paint system using a polyester powder coat paint. The completed finish has a nominal 2.6mm 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, including 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.

Auxiliary compartments are provided with an unpainted galvanized steel back panel for component mounting. A white painted instrument compartment back panel is also available as an option.
**Nameplates**

MNS-SG nameplates meet all standards listed in ANSI C37.20.1 and CSA C22.2 No. 31. Precautionary labels meet ANSI Z535.4. 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:

![Nameplate Diagram]

**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 1852 mm (72.9 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 gray #14 AWG SIS with insulated locking fork terminals. As an option, ABB can provide ring tongue terminals instead of locking fork terminals. Standard control wire for current transformers is gray #10 AWG SIS wire (#12 AWG optional). Control wire for control power transformers up to 5kVA is #12 AWG SIS. For larger control power transformers, 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 used 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: 600V dielectric; 10kV 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.

**Surge protective devices**

Surge protective devices (SPD) are available in MNS-SG and are installed in instrument compartments. Available ratings range from 80kA-300kA/mode or 160kA-600kA/phase. These may be installed for all power system types at all standard nominal voltages. Standard SPD installations in MNS-SG use the UL 1449-listed Current Technology SL3 SPD and comes equipped with a door mounted display with options for auxiliary alarm contacts and a surge counter.

**Relays**

Control relays, ANSI protective relays and programmable relays specific to the switchgear application may be installed in MNS-SG breaker and instrumentation compartments. Commonly installed devices include undervoltage, synch-check, or lockout relays. Other relays may be installed to implement customized control, protection or transfer schemes. Spacing limitations apply; consult local ABB sales personnel for pricing and availability.

**Metering**

The MNS-SG switchgear allows for installation of a variety of metering options. A wide variety of factory-installed multifunction meters may be provided in MNS-SG. Analog switchboard meters such as ammeters, voltmeters, watthour meters, power factor indicators etc., are also available. ABB supplies standard Crompton Series 77 meters for these applications.

**Integrated communications network**

Emax electronic trip units have an extended range of communication features which may be accessed using a Modbus RTU connection. These features are:
- Circuit breaker status
- All values measured by the protection trip unit
- Alarms and pre-alarms from protection trip unit, e.g., overload protection alarm (time to trip or pre-alarm warning)
- Fault currents in case of circuit breaker opening on a protection event
- 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 trip unit
- Estimate of the residual life of circuit breaker contacts, calculated on the basis of interrupted currents

The optional integrated Modbus RTU network requires the addition of PR120D/M communication modules, which are only applicable to the PR122 and PR123 trip units. A single connection point is provided for connection to network segments outside the switchgear. Modbus TCP/IP Ethernet gateways are also available in MNS-SG to provide an Ethernet communications link.
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 LEDs are also available. Please refer to the layout section for restrictions.

![Series 20](image)

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. Standard switch colors are black for potential transformer connections and red for current transformer connections. Custom color schemes are available by request.

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.

![Selector Switch](image)
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 used with space heaters has an operating range of -10° to 100°F. 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.

Bus differential relay

Internal bus faults occur less often than line faults. Though less often, the bus fault tends to be more severe. When an internal fault occurs, the magnitude of the fault current may be so large that the line CTs saturate, causing the output e.m.f. to drop to zero. When an external fault (just outside the line CTs of a feeder) occurs, the current may be as large as 500 times the rating of the feeder, and the CTs will saturate at a higher speed.

Manual and automatic transfer schemes

Transfer schemes can be achieved either manually with breaker interlocks or automatically using programmable relays or PLC controllers.

Manual transfer schemes use key interlocks installed in breaker compartments and are operable without opening a breaker door. Key lock transfer schemes are typically used to prevent switchgear lineups from paralleling sources. These are commonly used from feeding a load bus with more than one source. Keys are held captive in the key interlock until the breaker is opened, thereby preventing the key from being withdrawn and used to enable another source's breaker.

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. In automatic transfer schemes, there is a need to provide electrically operated breakers on the incoming sources. Specifics of a plant process or load grouping strategy may dictate the scheme’s operating sequence.

Automatic transfer schemes may use either a factory programmed PLC with touchscreen control and monitoring display, or use interconnected programmable breaker protection relays such as the ABB REF615, SEL351, SEL751, or Multilin SR750/760 series.
VII. Emax power circuit breakers


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

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Circuit breaker model</th>
<th>240V [kA] (note 1)</th>
<th>480V [kA] (note 1)</th>
<th>600V [kA] (note 2)</th>
<th>Rated time current [kA]</th>
<th>Break time (I&lt;ST current) (max) ms/ cycles</th>
<th>Break time (I&gt;ST current) (max) ms /cycles</th>
</tr>
</thead>
<tbody>
<tr>
<td>800, 1200, 1600</td>
<td>E2 S-A</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>2000, 2500</td>
<td>E3 S-A</td>
<td>85</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>800, 1200, 1600, 2000</td>
<td>E3 V-A</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>3200</td>
<td>E4 S-A</td>
<td>85</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>3200</td>
<td>E4 V-A</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>4000</td>
<td>E6 H-A</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>4000</td>
<td>E6 V-A</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>5000</td>
<td>E6 H-A</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
<tr>
<td>5000</td>
<td>E6 V-A</td>
<td>100</td>
<td>100</td>
<td>85</td>
<td>85</td>
<td>70 /4.2</td>
<td>30/1.8</td>
</tr>
</tbody>
</table>

Note 1 applies to arc-resistant rated equipment
Note 1 and 2 apply to non arc-resistant rated equipment
# Rating plugs

**Emax circuit breaker rating plugs for electronic trip units**

<table>
<thead>
<tr>
<th>Type of circuit breaker</th>
<th>Rated current lu [A]</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>1200</th>
<th>1600</th>
<th>2000</th>
<th>2500</th>
<th>3000</th>
<th>3200</th>
<th>3600</th>
<th>4000</th>
<th>5000</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2S-A</td>
<td>800</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2500</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E3V-A</td>
<td>800</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1200</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1600</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E4S-A</td>
<td>3200</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E4V-A</td>
<td>3200</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E6H-A</td>
<td>4000</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E6V-A</td>
<td>4000</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E6H-A</td>
<td>5000</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E6V-A</td>
<td>5000</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Breaker details

Construction characteristics

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

<table>
<thead>
<tr>
<th>Caption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Trademark and size of circuit breaker</td>
</tr>
<tr>
<td>2</td>
<td>PR121, PR122 or PR123 trip units</td>
</tr>
<tr>
<td>3</td>
<td>Pushbutton for manual opening</td>
</tr>
<tr>
<td>4</td>
<td>Pushbutton for manual closing</td>
</tr>
<tr>
<td>5</td>
<td>Lever to manually charge closing springs</td>
</tr>
<tr>
<td>6</td>
<td>Label with electrical characteristics</td>
</tr>
<tr>
<td>7</td>
<td>Mechanical device to signal circuit breaker open &quot;O&quot; and closed &quot;I&quot;</td>
</tr>
<tr>
<td>8</td>
<td>Signal for springs charged or discharged</td>
</tr>
<tr>
<td>9</td>
<td>Mechanical indication of trip</td>
</tr>
<tr>
<td>10</td>
<td>Key lock in open position</td>
</tr>
<tr>
<td>11</td>
<td>Key lock and padlock in racked-in/racked-out position (for drawout version only)</td>
</tr>
<tr>
<td>12</td>
<td>Racking-in/racking out device (for drawout version only)</td>
</tr>
<tr>
<td>13</td>
<td>Terminal box (for fixed version only)</td>
</tr>
<tr>
<td>14</td>
<td>Sliding contacts (for drawout version only)</td>
</tr>
<tr>
<td>15</td>
<td>Circuit breaker position indicator: connected/isolated for test/racked-out (for drawout version only)</td>
</tr>
</tbody>
</table>
Non arc-resistant cradles

Construction characteristics

Arc-resistant cradles

Construction characteristics

In addition to all of the listed characteristics for the non arc-resistant cradle, these features are included:

<table>
<thead>
<tr>
<th>Caption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sheet steel supporting structure</td>
</tr>
<tr>
<td>2</td>
<td>Single grounding pilers mounted on the left for E1, E2, and E3 double grounding pilers for E4 and E6</td>
</tr>
<tr>
<td>3</td>
<td>Automatic safety shutters</td>
</tr>
<tr>
<td>4</td>
<td>Terminal support base</td>
</tr>
<tr>
<td>5</td>
<td>Terminals</td>
</tr>
<tr>
<td>6</td>
<td>Contacts signaling that the circuit breaker is connected, isolated for test, racked-out</td>
</tr>
<tr>
<td>7</td>
<td>Sliding contacts</td>
</tr>
<tr>
<td>8</td>
<td>Padlock device for safety shutters (on request)</td>
</tr>
<tr>
<td>9</td>
<td>Fixing points (4 for E1, E2, E3, and 6 for E4, E6)</td>
</tr>
<tr>
<td>10</td>
<td>Ventilation covers</td>
</tr>
<tr>
<td>11</td>
<td>Insulating barriers between phases</td>
</tr>
</tbody>
</table>
**Electronic trip units**

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.
## Electronic trip units

<table>
<thead>
<tr>
<th>Features</th>
<th>PR121</th>
<th>PR122</th>
<th>PR123</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection functions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Protection against overload with inverse long time-delay trip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Selective protection against short circuit inverse or definite short time-delay trip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Second selective protection against short circuit inverse or definite short time-delay trip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Protection against instantaneous short circuit with adjustable trip current threshold</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Protection against ground fault residual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Protection against directional short circuit with adjustable time-delay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Protection against phase unbalance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Protection against overtemperature (check)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Undervoltage protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Overvoltage protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Residual voltage protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Reverse active power protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Thermal memory for functions L and S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Underfrequency protection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Overfrequency protection</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measurements</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Currents (phases, neutral, ground fault)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage (phase-phase, phase-neutral, residual)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power (active, reactive, apparent)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power factor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency and peak factor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (active, reactive, apparent, meter)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harmonics (measurement)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Event marking and maintenance data</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Event marking with the instant it occurred</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronological event storage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical operations counter and contact wear</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication with supervision system and centralised control (IEC only)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote setting of the protection functions parameter, unit configuration, communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission of measurements, states and alarms from circuit breaker to system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmission of events and maintenance data from circuit breaker to system</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Watchdog</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarm and trip for release overtemperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check of trip status</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interface with the user</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Presetting by means of dip switches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presetting by means of keys and LCD viewer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm signals for functions L, S, I and G</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm signal of one of the following protections: undervoltage, overvoltage, residual voltage, reverse power, phase unbalance, overtemperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete management of pre-alerts and alerts for all the self-control protection functions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enabling password for use with consultation in &quot;READ&quot; mode or consultation and setting in &quot;EDIT&quot; mode</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load control</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Load connection and disconnection according to the current passing through the circuit breaker</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Zone discrimination</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be activated for protection functions S, G and (PR123 only) D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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, making it suitable for protecting a wide range of alternating current installation. In addition to protection functions, the unit is provided with multifunction LED indicators. PR121/P also allows connection to external devices, enhancing advanced characteristics like remote signaling and monitoring, or remote supervision display.

Legend

1. LED signaling Alarm for protection function L
2. LED signaling Alarm for protection function S
3. LED signaling Alarm for protection function I
4. LED signaling Alarm for protection G function l1
5. DIP switches for fine setting current threshold I1
6. DIP switches for main setting current threshold I1
7. DIP switches for setting current threshold I2
8. DIP switches for setting current threshold I3
9. DIP switches for setting current threshold I4
10. DIP switches for setting trip time t1 (type of curve)
11. DIP switches for setting trip time t2 (type of curve)
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
16. Indication of the DIP switch positions for the various current thresholds values l1
17. Indication of the DIP switch positions for the various current threshold values l2
18. Indication of the DIP switch positions for the various current threshold values l3
19. Indication of the DIP switch positions for the various current threshold values l4
20. Indication of DIP switch positions for the various time settings t1
21. Indication of DIP switch positions for the various time settings t2
22. Indication of DIP switch positions for the various time settings t4
23. DIP switch for setting network frequency and neutral protection setting
24. Trip cause indication and trip test pushbutton
25. Test connector for connecting or testing the release through an external device (PR030/B battery unit, BT030 wireless communication unit and SACE PR010/T unit)
26. Serial number of protection release
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 \( I^2 t = k \); 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.
User interface

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

Setting the neutral

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

Test function

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

All thresholds and trip curve delays of 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, the neutral protection is 50% of the value set for phase protection in the standard version. The neutral protection can be excluded or set to 100% for E1, E2, E3, E4/f and E6/f. In installations where very high harmonics occur, the resulting current at the neutral can be higher than that of the phases. Therefore, it is possible to set the neutral protection at 150% or 200% of the value set for the phases. In this case it is necessary to reduce the setting of protection L accordingly. The table below lists the neutral settings for the various possible combinations between type of circuit breaker and the threshold I1 setting.

<table>
<thead>
<tr>
<th>I4 threshold</th>
<th>Repression threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>I4 &lt; 0.5 in</td>
<td>4 in</td>
</tr>
<tr>
<td>0.5in ≤ I4 &lt; 0.8 in</td>
<td>6 in</td>
</tr>
<tr>
<td>I4 ≥ 0.8 in</td>
<td>8 in</td>
</tr>
</tbody>
</table>

In = rated current of the rating plug

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 x In. A new start-up becomes possible after the current has fallen below the threshold of 0.1 x In, if the release is supplied from an external source.

Adjustable neutral protection setting

<table>
<thead>
<tr>
<th>Circuit breaker model</th>
<th>Threshold I1 settings (overload protection)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.4 ≤ I1 ≤ 0.5</td>
</tr>
<tr>
<td>E1B-N</td>
<td>0-50-100-150-200%</td>
</tr>
<tr>
<td>E2B-N-S-L</td>
<td>0-50-100-150-200%</td>
</tr>
<tr>
<td>E3N-S-H-V-L</td>
<td>0-50-100-150-200%</td>
</tr>
<tr>
<td>E4S-H-V</td>
<td>0-50-100%</td>
</tr>
<tr>
<td>E4S/f-H/f</td>
<td>0-50-100-150-200%</td>
</tr>
<tr>
<td>E6H-V</td>
<td>0-50-100%</td>
</tr>
<tr>
<td>E6H/f</td>
<td>50-100-150-200%</td>
</tr>
</tbody>
</table>

(*) 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 section)

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

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

Protection against over temperature

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

- Lighting up of the WARNING LED when the temperature is higher than 70°C (temperature at which the microprocessor is still able to operate correctly)
- Lighting up of the ALARM LED when the temperature is higher than 85°C (temperature above which the microprocessor 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 coordinating 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. “Zone” refers to the part of an installation between two circuit breakers in series (see figure to the left). Protection is provided by connecting all zone selectivity outputs of releases belonging to the same zone and sending 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 also highlighted by the Alarm LED.

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 in addition to residual current protection. 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 for easy use in five languages: Italian, English, German, French, and Spanish. As in the previous generation of releases, a password system is used to manage the Read and Edit modes. The default password, 0001, can be modified by the user. The protection parameters (curves and trip thresholds) can be set directly via the HMI of the device. The parameters can only be changed when the release is operating in Edit mode, but the information available and the parameter settings can be checked at any time in Read mode. When a communication device (internal PR120/D-M and PR120/D-BT modules or external BT030 device) is connected, it is possible to set parameters simply by downloading them into the unit (over the network for PR120/D-M, by using the SD-Pocket software and a PDA or a notebook for PR120/D-BT and BT030). Parameterization can then be carried out quickly and automatically in an error-free way by transferring data directly from DocWin.

Indicator LEDs

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

Example of events indicated by the WARNING LED:

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

Example of events indicated by the ALARM LED:

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

Data logger

By default, PR122/P and PR123/P are equipped with the Data Logger function, which automatically records instantaneous values of all current and voltages in a wide memory buffer. 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 analysis. 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 sec (@ sampling rate 600 Hz)
- 64 events tracking
Trip information and opening data

If 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)

Pushing the info/Test pushbutton displays all data directly onscreen, with no auxiliary power supply needed. The information remains available for 48 hours with the circuit breaker open or without current flow. Up to 20 trips are stored in memory. If information is needed after 48 hours have passed, it can be retrieved by connecting a PR020/B battery unit or 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 upon 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 auxiliary power supply voltage. In the latter case, the display is rear-lit and the ammeter is active even at current levels lower than 160A. Accuracy of the ammeter measurement chain (current sensor plus ammeter), is no more than 1.5% in the 30% - 120% current interval of In.

- Currents: three phases (L1, L2, L3), neutral (Ne) and 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 its 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. Like PR122, it can be integrated with 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)
- 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 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, i.e., when a parallel of incoming lines is closed or when an emergency source is present in the system, changing load capability and short-circuit levels.

The set B can be activated by:

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

The zone selectivity function allows the fault area to be insulated by segregating the system very rapidly only at the level closest to the fault, while leaving the rest of the installation running. This is done by connecting the releases: 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 = 60Hz
- Maintenance: number of operations, percentage of contact wear, opening data storage

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

Other functions

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

Notes:

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

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 residual voltage protection (RV). 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 (eg, 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, ie, 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 that open the way for connection of circuit breakers to the world of industrial communication. PR122 and PR123 electronic releases can be fitted with communication modules, making 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 in industrial automation and power distribution equipment. A Modbus RTU communication interface can be connected immediately and exchange data with a 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 (eg, 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
- 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 (ie, 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 Windows 2000 OS and new PR120/D-BT or BT030 Bluetooth interface devices. SD-Pocket is freeware and 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.
TestBus2

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 simple. 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 with 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 equipped 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:

<table>
<thead>
<tr>
<th>Communication functions</th>
<th>PR122/P + PR120/D-M</th>
<th>PR123/P + PR120/D-M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>Modbus RTU</td>
<td>Modbus RTU</td>
</tr>
<tr>
<td>Physical layer</td>
<td>RS-485</td>
<td>RS-485</td>
</tr>
<tr>
<td>Maximum baudrate</td>
<td>19200 bps</td>
<td>19200 bps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measuring functions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase currents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage (phase-phase, phase-neutral, residual)</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Power (active, reactive, apparent)</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Power factor</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Frequency and peak factor</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Energy (active, reactive, apparent)</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Harmonic analysis up to the 40th harmonic</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signaling functions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LED: auxiliary power supply, warning, alarm</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Temperature</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Indication for L, S, I, G and other protection</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Available data</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breaker status (open, closed)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Circuit breaker position (racked-in, racked-out)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Mode (local, remote)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Protection parameters set</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Load control parameters</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alarms</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection L</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Protection S</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Protection I</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Protection G</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Trip unit command for fault failure</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Undervoltage, overvoltage and residual voltage (timing and trip) protection</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Reverse power protection (timing and trip)</td>
<td>opt. (1)</td>
<td>■</td>
</tr>
<tr>
<td>Directional protection (timing and trip)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Underfrequency/overfrequency protection (timing and trip)</td>
<td>opt. (6)</td>
<td>■</td>
</tr>
<tr>
<td>Phases rotation</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maintenance</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total number of operations</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Total number of trips</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Number of trip tests</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Number of manual operations</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Number of separate trips for each protection function</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Contact wear (%)</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Record data of last trip</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Operating mechanisms</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breaker open/close</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Reset alarms</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Setting of curves and protection thresholds</td>
<td>■</td>
<td>■</td>
</tr>
<tr>
<td>Synchronize system time</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Events</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Status changes in circuit breaker, protections and all alarms</td>
<td>■</td>
<td>■</td>
</tr>
</tbody>
</table>
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 three consecutive hours for the sole purpose of reading and configuring data. Battery life decreases if the PR030/B accessory is also used to perform the trip test and 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°F/85°C)
- Two load control contacts (connection and disconnection of a load, or disconnection of two loads)
- Trip unit tripped
- Dialogue fault on a serial line (connecting the protection and signaling units)
- Phase unbalance

Setting a dip-switch allows up to seven signal contacts to be freely configured in PR122-PR123 including: direction protection D tripped, under- and overvoltage UV, OV tripped, reverse power RP tripped, and others. Two contacts available on the PR021/K unit (load control) can pilot a circuit breaker shunt trip and closing coil. These contacts allow various applications, including load control, alarms, signals and electrical locks.

Pressing the Reset pushbutton resets the status of all signals.

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

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

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

### Specifications of the signaling relays

<table>
<thead>
<tr>
<th>Auxiliary power supply</th>
<th>24VDC ± 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum ripple</td>
<td>5%</td>
</tr>
<tr>
<td>Rated power @ 24V</td>
<td>4.4W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Monostable STDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum switching power (resistive load)</td>
<td>100 W/1250VAC</td>
</tr>
<tr>
<td>Maximum switching voltage</td>
<td>130VDC/250VAC</td>
</tr>
<tr>
<td>Maximum switching current</td>
<td>5A</td>
</tr>
<tr>
<td>Breaking (resistive load) @ 30VDC</td>
<td>3.3A</td>
</tr>
<tr>
<td></td>
<td>250VAC</td>
</tr>
<tr>
<td>Contact/coil insulation</td>
<td>2000 Veff</td>
</tr>
<tr>
<td></td>
<td>(1 min @ 50 Hz)</td>
</tr>
</tbody>
</table>

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.
The test function involves all versions of the PRS121/P, PR122/P and PR123/P. The parameter programming and reading functions involve 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
- Rstimated trip time
- Measured trip time
- Test results

At least five 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 center
- 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 used to test the ABB Emax air low voltage circuit breaker. The standard test unit has indicating lights and a control switch that can be used to test the different functions of the breaker.
VIII. Arc flash mitigation

Arc flash relays

Arc flash relays are used for protection against arc flash events and are an effective way of minimizing damage to switchgear. These relays detect an arc flash event using fiber optic sensors that can be installed using a single sensor loop passing through the switchgear bus and cable compartments, or with an array of point sensors installed in multiple locations throughout the switchgear. Detection of an arc flash event by the protective relay triggers the main circuit breaker of the switchgear to open. For multiple-ended systems, coordination of arc flash relays may be implemented into the design.

Standard arc flash relays installed in MNS-SG are the ABB REA 101 and the ABB Arc Guard System TVOC-2.

Installations for arc flash detection relays by standard employ an array of point-lens light sensors placed in locations throughout the bus, breaker and cable compartments. Along with current monitoring at the main breakers, this network of sensors serves as the detection mechanism for a high current electrical arc.

Maintenance switch

The maintenance switch is used to manually change the circuit breakers 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 regard 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 padlocking handle in both positions
  Part number: ON8PZBS18138.
- 24VDC timer

Infrared windows

Infrared windows are available for installation in the switchgear rear covers to facilitate the use of IR cameras for thermally scanning cable terminations. The use of the IR windows minimizes the exposure to live conductors while performing this type of preventative maintenance inspection. Quantity and location of the IR windows are dependent on the breaker stacking arrangement. Standard infrared window viewing diameter is 75mm, with an option for a 100mm viewing window. Square infrared viewing windows are also available in four-inch square dimensions. When possible, one window may be used to measure connections for two breakers. One window per breaker may also be installed if required.
IX. Accessories

Remote racking device – RRD:

During the racking-in and racking-out operations of the circuit breaker, the RRD increases the safety of the personnel and prevents from any risk of injuries due to any possible electric arc.

It allows operating the Emax circuit breakers without being in front of the gear. This device works with the circuit breaker open and with the spring discharged.

The RRD is supplied by the main grid. The remote control is connected to the main device with a 9 meter (30 feet) cable which allows the racking in or out command from remote location. The cable length guarantees a far distance from the arc flash boundary for traditional LV switchgear.

Advantages

- Increased personnel safety, thanks to the long distance between the circuit breaker and the operator
- One single device for all the Emax circuit breakers (Emax and New Emax – from the smallest E1 3 poles up to the biggest E6 full size)
- Ergonomic handle allows easy mounting and removal of the device from the circuit breaker
- All the positions can be reached: Connected/Disconnected/Test position
- Immediate visual checking of position reached due to the 3 LEDs available both on the device and on the remote control
- Emergency pushbutton on the remote control allows option to interrupt operation at any moment
- Dedicated case allows easy storage

Electrical and technical data

<table>
<thead>
<tr>
<th>Depth</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated service voltage</td>
<td>110VAC (-20%/+15%)</td>
</tr>
<tr>
<td></td>
<td>110VDC (-20%/+15%)</td>
</tr>
<tr>
<td>Frequency</td>
<td>50-60 Hz</td>
</tr>
<tr>
<td>Rated power</td>
<td>120 W, 120 VA</td>
</tr>
<tr>
<td>Inrush power</td>
<td>consumption 600 W, 600 VA</td>
</tr>
<tr>
<td>Inrush time</td>
<td>0.5 s</td>
</tr>
<tr>
<td>Working and storage temperature range</td>
<td>-10 °C ... +40 °C</td>
</tr>
<tr>
<td>Duty cycle</td>
<td>20 operations / hour</td>
</tr>
<tr>
<td>Minimum time out between operations</td>
<td>1 minute</td>
</tr>
<tr>
<td>Maximum operating distance</td>
<td>9 m / 30 ft</td>
</tr>
<tr>
<td>Weight</td>
<td>9 kg / 20 lb</td>
</tr>
</tbody>
</table>

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

1.5" base channels

Painted steel 1.5" base channels are available for mounting to the switchgear bottom frame. These channels contain prybar notches to facilitate moving a switchgear section into place and are suitable for welding to a floor.

Rodent barriers

When 1.5" base channels are installed, 14 gauge painted steel rodent barriers may also be provided on the switchgear ends to seal off the gap created by raising the switchgear off of the ground.

Mimic bus

Mimic bus, when requested, is provided as an engraved 11" x 17" phenolic nameplate. Mimic bus may also be provided on individual breaker doors using phenolic plates depicting symbols and single line connections.
Remote control panels

Additional personnel protection may be obtained by using optional remote open/close breaker control panels. These control panels connect to MNS-SG using a 9m Ethernet cable. These factory programmed touch screen panels may be panel/wall mounted or provided in a portable enclosure.

Transition sections to MaxSG and MNS-MCC

Transition sections to MNS-MCC motor control center lineups are available for left and right side switchgear connections, and can connect to either a single row lineup of MNS-MCC, or a back-to-back arrangement of MNS-MCC. These transition sections directly link the horizontal bus systems of MNS-SG rated up to 4000A to MNS-MCC lineups with horizontal bus ratings of 800A, 1200A, 1600A and 2000A. Application of these transition sections requires that MCC bus ratings must be less than or equal to the switchgear bus ratings.

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.

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.
X. Layout details

<table>
<thead>
<tr>
<th>Depth</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.9&quot; (1852mm, standard) or 80.9&quot; (2052mm, optional)</td>
<td>Arc-resistant (top of chimney) 96.1&quot; (2439.7mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-resistant with overhead lifting device 99.4&quot; (2524mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-resistant (top of plenum) 122.1&quot; (3100.5mm)</td>
</tr>
<tr>
<td></td>
<td>Non arc-resistant (top of chimney) 95.92&quot; (2436.4mm)</td>
</tr>
<tr>
<td></td>
<td>Non arc-resistant with overhead lifting device 99.4&quot; (2524mm)</td>
</tr>
</tbody>
</table>

**Note:** With base channel, add 1.5" to each height above

**Configurations for feeder section**

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Sccr* (kA)</th>
<th>Section width</th>
<th>CTs load side</th>
<th>Feeder breaker</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 - 1600</td>
<td>65</td>
<td>600mm-1000mm (23.6 in-39.4 in)</td>
<td>Optional up 2 CTs per phase RELAYING METERING/METERING</td>
<td>E2</td>
<td>A, B, C, D</td>
</tr>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 - 2000</td>
<td>100/85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2500</td>
<td>65</td>
<td>700mm-1000mm (27.6 in-39.4 in)</td>
<td></td>
<td>E3</td>
<td>B, C, D</td>
</tr>
<tr>
<td></td>
<td>100/85</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 100kA is up to 480VAC, 85kA is for 600VAC

**Not for construction**
## Configurations for main section with close couple connection and feeders

<table>
<thead>
<tr>
<th>Global parameters</th>
<th>Main with close couple connection</th>
<th>Feeder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current (A)</td>
<td>Sccr* (KA)</td>
<td>Section width (mm)</td>
</tr>
<tr>
<td>1600</td>
<td>65</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>1000</td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>1000</td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>1000</td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>1000</td>
</tr>
</tbody>
</table>

* 100kA is up to 480VAC, 85kA is for 600VAC

**Not for construction**
## Configurations for main section with bus duct and feeders

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Scrr* (KA)</th>
<th>Section width (mm)</th>
<th>System</th>
<th>incoming</th>
<th>Main breaker Location</th>
<th>CTs line side</th>
<th>CTs load side</th>
<th>outgoing</th>
<th>Feeder optional location</th>
<th>Maximum feeder breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>65</td>
<td>600</td>
<td></td>
<td>E2</td>
<td>B</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>A</td>
<td>E2- 1600A</td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600</td>
<td>3P 3W</td>
<td>E3</td>
<td>B</td>
<td></td>
<td>100 / 85</td>
<td>Optional</td>
<td>A</td>
<td>E2- 1600A/</td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800</td>
<td></td>
<td>E4</td>
<td>B</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>A</td>
<td>E3- 2500A</td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000</td>
<td>Bottom</td>
<td>E6</td>
<td>B</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>A</td>
<td>E3- 2500A/</td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000</td>
<td></td>
<td>E2</td>
<td>B</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>A</td>
<td>E2- 1600A</td>
</tr>
<tr>
<td>1600</td>
<td>65</td>
<td>600</td>
<td></td>
<td>E3</td>
<td>C</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>A</td>
<td>E2- 1600A/</td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600</td>
<td></td>
<td>E4</td>
<td>C</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>B</td>
<td>E3- 2000A</td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800</td>
<td>3P 4W</td>
<td>E6</td>
<td>C</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>B</td>
<td>E3- 2500A</td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000</td>
<td></td>
<td>E6</td>
<td>C</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000</td>
<td></td>
<td>E6</td>
<td>C</td>
<td></td>
<td>100 / 85</td>
<td></td>
<td>None</td>
<td>-</td>
</tr>
</tbody>
</table>

*Not for construction*
### Configurations for main section with bus duct and feeders

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Sccr* (KA)</th>
<th>Section width (mm)</th>
<th>System</th>
<th>Incoming</th>
<th>Main breaker</th>
<th>Location</th>
<th>CTs line side</th>
<th>CTs load side</th>
<th>Outgoing</th>
<th>Feeder optional location</th>
<th>Maximum feeder breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>65</td>
<td>600</td>
<td>E2</td>
<td>B</td>
<td>Optional</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E2 - 1600A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600</td>
<td>E3</td>
<td>B</td>
<td>Optional</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E2 - 1600A/ E3-2000A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800</td>
<td>E4</td>
<td>C</td>
<td>Optional</td>
<td>AB</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E3-2500A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>1000</td>
<td></td>
<td></td>
<td>CD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000</td>
<td>E6</td>
<td>AB</td>
<td>No</td>
<td>D</td>
<td>CD</td>
<td>D</td>
<td>None</td>
<td>E3-2500A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
<td></td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>65</td>
<td>600</td>
<td>E2</td>
<td>B</td>
<td>Optional</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E2 - 1600A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600</td>
<td>E3</td>
<td>B</td>
<td>Optional</td>
<td>C</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E2 - 1600A/ E3-2000A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td>700</td>
<td></td>
<td></td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800</td>
<td>E4</td>
<td>C</td>
<td>Optional</td>
<td>AB</td>
<td>C</td>
<td>B</td>
<td>D</td>
<td>E3-2500A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
<td></td>
<td>CD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000</td>
<td>E6</td>
<td>D</td>
<td>Yes</td>
<td>C</td>
<td>CD</td>
<td>D</td>
<td>None</td>
<td>E3-2500A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
<td></td>
<td>AB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000</td>
<td>E6</td>
<td>D</td>
<td>Yes</td>
<td>C</td>
<td>CD</td>
<td>D</td>
<td>None</td>
<td>E3-2500A</td>
<td></td>
</tr>
</tbody>
</table>

---

**Not for construction**
### Depth Measurements

<table>
<thead>
<tr>
<th>Depth</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.9” (1852mm, standard) or 80.8” (2052mm, optional)</td>
<td>Arc-resistant (top of chimney) 96.1” (2439.7mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-resistant with overhead lifting device 99.4” (2524mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-resistant (top of plenum) 122.1” (3100.5mm)</td>
</tr>
<tr>
<td></td>
<td>Non arc-resistant (top of chimney) 95.92” (2436.4mm)</td>
</tr>
<tr>
<td></td>
<td>Non arc-resistant with overhead lifting device 99.4” (2524mm)</td>
</tr>
</tbody>
</table>

**Note:** With base channel, add 1.5” to each height above

### Configurations for main section with feeders**

#### Global parameters

| Current (A) | Scct* (kA) | Section width | System \(\text{Main breaker Location CTs line side CTs load side Feeder optional location Maximum feeder breaker)}
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>65</td>
<td>600mm (23.6 in)</td>
<td>E2 B C Optional</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600mm (23.6 in)</td>
<td>E3 B C Optional up 2 CTs per phase</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800mm (31.5 in)</td>
<td>E4 B C Optional 1 CT per phase for RELAYING METERING</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000mm (39.4 in)</td>
<td>E6 D C No</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000mm (39.4 in)</td>
<td>E6 D C No</td>
</tr>
<tr>
<td></td>
<td>100 / 85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1600</td>
<td>65</td>
<td>600mm (23.6 in)</td>
<td>E2 C Optional up 2 CTs per phase RELAYING METERING</td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600mm (23.6 in)</td>
<td>E3 C Optional 1 CT per phase for RELAYING METERING</td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800mm (31.5 in)</td>
<td>E4 CD</td>
</tr>
<tr>
<td>4000</td>
<td>65</td>
<td>1000mm (39.4 in)</td>
<td>E6 CD</td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000mm (39.4 in)</td>
<td>E6 CD</td>
</tr>
</tbody>
</table>

* 100kA is up to 480VAC, 85kA is for 600VAC
** 3P-4W in main section feeders are not possible
*** 2500A feeder is not available for position “A”

**Not for construction**
### Configurations for main-tie section with

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>ScCCR (kA)</th>
<th>Section width</th>
<th>Main breaker</th>
<th>Location</th>
<th>CTs line side</th>
<th>CTs load side</th>
<th>Tie breaker</th>
<th>Location</th>
<th>CTs bus A</th>
<th>CTs bus B</th>
<th>Feeder optional location</th>
<th>Maximum feeder breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>100 / 85</td>
<td>600mm (23.6 in)</td>
<td>E2</td>
<td>B</td>
<td>Optional up 2 CTs per phase</td>
<td>Optional 1 CT per phase for RELAYING METERING</td>
<td>E2</td>
<td></td>
<td></td>
<td></td>
<td>A (Bus A)</td>
<td>E2- 1600A</td>
</tr>
<tr>
<td>2000</td>
<td>100 / 85</td>
<td>600mm (23.6 in)</td>
<td>E3</td>
<td>B</td>
<td>Optional 1 CT per phase for RELAYING METERING</td>
<td>Optional 1 CT per phase for RELAYING METERING</td>
<td>E3</td>
<td>C</td>
<td></td>
<td></td>
<td>D (Bus B)</td>
<td>E3- 2000A</td>
</tr>
<tr>
<td>3200</td>
<td>100 / 85</td>
<td>800mm (31.5 in)</td>
<td>E4</td>
<td>AB</td>
<td></td>
<td></td>
<td>E4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>E3- 2500A</td>
</tr>
<tr>
<td>4000</td>
<td>100 / 85</td>
<td>1000mm (39.4 in)</td>
<td>E6</td>
<td>B</td>
<td></td>
<td></td>
<td>E6</td>
<td>C</td>
<td></td>
<td></td>
<td>D (Bus B)</td>
<td>E3- 2500A</td>
</tr>
</tbody>
</table>

* 100kA is up to 480VAC, 85kA is for 600VAC
** Not valid for 3P-4W

**Not for construction**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth 72.9&quot; (1852mm, standard) or 80.8&quot; (2052mm, optional)</td>
<td>Arc-resistant (top of chimney) 96.1&quot; (2439.7mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-resistant with overhead lifting device 99.4&quot; (2524mm)</td>
</tr>
<tr>
<td></td>
<td>Arc-resistant (top of plenum) 122.1&quot; (3100.5mm)</td>
</tr>
<tr>
<td></td>
<td>Non arc-resistant (top of chimney) 95.92&quot; (2436.4mm)</td>
</tr>
<tr>
<td></td>
<td>Non arc-resistant with overhead lifting device 99.4&quot; (2524mm)</td>
</tr>
</tbody>
</table>

**Note:** With base channel, add 1.5" to each height above
A. **M-T-M in two sections**

A main-tie-main configuration can fit into two sections and still have room for feeders. This is possible only for the 3-wire, 3-phase system. Some restrictions on the use of CTs (or room for feeders) may apply for systems at 4000A, and for systems 3200A, 85kA or above.

B. **M-T-M in three sections**

When CTs are required in 3-phase, 3-wire systems, a main-tie-main configuration will typically be implemented in three sections.

C. **M-T-M where an intermediate section is required**

An intermediate section is required on main-tie-main configurations with certain limiting design criteria such as 4-wire systems or close coupled/bus duct incoming systems.

**Note:** Please refer to layout details for specific configuration information pertaining to main-feeder and tie-feeder switchgear sections.
<table>
<thead>
<tr>
<th>Current</th>
<th>Sccr*</th>
<th>Section</th>
<th>Tie</th>
<th>Location</th>
<th>CTs</th>
<th>CTs</th>
<th>Feeder</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>100 / 85</td>
<td>600mm</td>
<td>C</td>
<td>Optional</td>
<td>1 CT per phase for</td>
<td>Optional</td>
<td>1 CT per phase for</td>
<td>A, B (Bus A)</td>
</tr>
<tr>
<td>2000</td>
<td>65</td>
<td>600mm</td>
<td>C</td>
<td>700mm</td>
<td>(23.6 in)</td>
<td>RELAYING</td>
<td>METERING</td>
<td>D (Bus B)</td>
</tr>
<tr>
<td>3200</td>
<td>65</td>
<td>800mm</td>
<td>E4</td>
<td>1000 mm</td>
<td>(31.5 in)</td>
<td>CD</td>
<td>CD</td>
<td>B (Bus A)</td>
</tr>
<tr>
<td>5000</td>
<td>65</td>
<td>1000 mm</td>
<td>E6</td>
<td>1000 mm</td>
<td>(39.4 in)</td>
<td>CD</td>
<td>CD</td>
<td>B (Bus A)</td>
</tr>
</tbody>
</table>

* 100kA is up to 480VAC, 85kA is for 600VAC

**Not for construction**
MNS-SG switchgear floor plans
72.9" (1852mm, standard) or 80.8" (2052mm, optional) depth

Not for construction
MNS-SG arc-resistant layout restrictions
side view with chimney design

Note: dimensions shown are not for power distribution center (PDC) / E-house installations
Not for construction
MNS-SG arc-resistant layout restrictions
front view with chimney design

Note: dimensions shown are not for power distribution center (PDC) / E-house installations

Not for construction
MNS-SG arc-resistant layout restrictions
front view with plenum design

Note: dimensions shown are not for power distribution center (PDC) / E-house installations

Not for construction
MNS-SG arc-resistant layout restrictions
top view with plenum design

Note: dimensions shown are not for power distribution center (PDC) / E-house installations

Not for construction
MNS-SG arc-resistant layout restrictions
front view with plenum design (to wall)

Note: dimensions shown are not for power distribution center (PDC) / E-house installations
Not for construction
MNS-SG arc-resistant layout restrictions
exhaust opening for plenum design

Note: dimensions shown are not for power distribution center (PDC) / E-house installations

Not for construction
Power distribution/e house

Notes:
1. Not for construction.
2. Minimum dimensions indicated, refer to local codes, guides and NEC for specific site requirements.
3. 4” minimum space is available with door hinged opposite side of wall and possible for single door (4000A and greater require two doors which would require minimum 12’ wall to switchgear clearance)
Power distribution/e house

Notes:
1. Not for construction.
2. Minimum dimensions indicated, refer to local codes, guides and NEC for specific site requirements.
3. 4" minimum space is available with door hinged opposite side of wall and posible for single door (4000A and greater require two doors which would require minimum 12 wall to switchgear clearance)
4. Add 1.5" to overall height if base channels provided.
# Weights by breaker/section

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

<table>
<thead>
<tr>
<th>Width</th>
<th>Units</th>
<th>Enclosure and structure</th>
<th>Copper busbars</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Depth 1600</td>
<td>2000</td>
</tr>
<tr>
<td>500mm* (19.6 in)</td>
<td>kg</td>
<td>269.9</td>
<td>283.3</td>
</tr>
<tr>
<td></td>
<td>lbs</td>
<td>595.0</td>
<td>624.6</td>
</tr>
<tr>
<td>600 (23.6 in)</td>
<td>kg</td>
<td>326.0</td>
<td>339.9</td>
</tr>
<tr>
<td></td>
<td>lbs</td>
<td>718.6</td>
<td>749.4</td>
</tr>
<tr>
<td>700 (27.5 in)</td>
<td>kg</td>
<td>345.5</td>
<td>360.2</td>
</tr>
<tr>
<td></td>
<td>lbs</td>
<td>781.7</td>
<td>794.0</td>
</tr>
<tr>
<td>800 (31.5 in)</td>
<td>kg</td>
<td>374.8</td>
<td>390.1</td>
</tr>
<tr>
<td></td>
<td>lbs</td>
<td>826.3</td>
<td>860.0</td>
</tr>
<tr>
<td>1000 (39.4 in)</td>
<td>kg</td>
<td>413.1</td>
<td>429.7</td>
</tr>
<tr>
<td></td>
<td>lbs</td>
<td>910.7</td>
<td>947.2</td>
</tr>
</tbody>
</table>

**Note:** Breaker compartment and breakers weight shall be multiplied times the quantity in each section

* For transition section only

## Breaker/cradle

<table>
<thead>
<tr>
<th>E2</th>
<th>E3</th>
<th>E4</th>
<th>E6</th>
</tr>
</thead>
<tbody>
<tr>
<td>78 kg</td>
<td>104 kg</td>
<td>47 kg</td>
<td>210 kg</td>
</tr>
<tr>
<td>171.9 lbs</td>
<td>229.3 lbs</td>
<td>324.1 lbs</td>
<td>462.9 lbs</td>
</tr>
</tbody>
</table>

**Note:** Hardware and control factor adds 4% to total

## Accessories

<table>
<thead>
<tr>
<th>Accessory</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead lifting device</td>
<td>118 lbs</td>
</tr>
<tr>
<td>CTs (set of three up to 3200A)</td>
<td>33 lbs</td>
</tr>
<tr>
<td>CTs (set of three, 4000 and 5000A)</td>
<td>77 lbs</td>
</tr>
<tr>
<td>HRG</td>
<td>132 lbs</td>
</tr>
<tr>
<td>PTs (each)</td>
<td>11 lbs</td>
</tr>
<tr>
<td>Close coupling or bus duct raisers (3200A)</td>
<td>441 lbs</td>
</tr>
<tr>
<td>Close coupling or bus duct raisers (5000A)</td>
<td>661 lbs</td>
</tr>
</tbody>
</table>

Manual | MNS-SG Drawout Switchgear 69
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

While all care has been taken to ensure that the information contained in this publication is correct, no responsibility can be accepted for any inaccuracy. The Company reserves the right to alter or modify the information contained herein at any time in the light of technical or other developments. Technical specifications are valid under normal operating conditions only. The Company does not accept any responsibility for any misuse of the product and cannot be held liable for indirect or consequential damages.

© Copyright 2013 ABB Inc. All rights reserved.