APPLICATION GUIDE

MNS-SG

Low Voltage, Metal-Enclosed, Drawout Arc Resistant Switchgear

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The MNS-SG Low Voltage Arc-Resistant, metal-enclosed, drawout Switchgear is industrial-duty equipment built to ANSI/NEMA/UL standards and designed to provide superior power distribution and protection with Emax 2® circuit breakers.

The MNS-SG Arc-Resistant offers excellent flexibility due to the modularity of both the electrical and mechanical design. MNS-SG is designed, constructed, and tested to meet all applicable requirements for UL1558, ANSI C37.20.1, ANSI C37.20.7 and CSA C22.2 No. 31.

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.

The MNS-SG supports the ABB vision of providing equipment that delivers world class performance under the intense mechanical, electrical and thermal stress of today’s rigorous manufacturing environments.

Table of contents

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 2® 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 me tals
- 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.

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01 MNS-SG.
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02 Optional plenum installed.
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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

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— 02

- 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 2 100% rated UL 1066 circuit breakers, up to 4000A
- Provisions for padlocking Emax 2 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

Industry standards

The MNS-SG with Emax 2 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 2 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

ABB

SPECIAL SEISMIC CERTIFICATE OF COMPLIANCE

Product Line: ABB, Inc. 1600A-5000A MNS Switchgear
Floor Mount – Bolted & Welded

Qualified to CBC-2010 Section 1708A.4 and IBC 2009 Section 1708.4
S_{DS} = 1.39g for z/h = 1 and S_{DS} = 2.22g for z/h = 0, I_p = 1.5

Qualified to National Building Code of Canada 2010 Volume 2, Section 4.1.8.18
F_aS_a = 1.85g for h_x/h_n = 1 and F_aS_a = 2.95g for h_x/h_n = 0, I_e = 1.5

Qualified to IEEE 693-2005 Inherently Acceptable

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

(WEGAI Seismic Report No. 1089-151-SG) (Clark Lab Report No. 1826)

WEGAI report No. 1089-151-SG for details on the product line and seismic installation requirements.

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.

REGISTERED PROFESSIONAL ENGINEER TRAVIS E. SOPPE C 71864 EXP: CIVIL STATE OF CALIFORNIA

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

WEGAI

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 the connection, without any intentional impedance, from the neutral of a generator, power transformer or grounding transformer, directly to ground.
Solid grounding is generally recommended for low voltage systems when the automatic isolation of a faulted circuit can be tolerated or where it is not feasible to isolate a ground fault in a high-resistance grounded system.

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

The systems are:
- 120/240V, 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 systems 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, Ir, to a magnitude equal to or slightly greater than the total capacitance charging current, 3 Ico.

Normally, the ground-fault current, Ig, is limited to 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.

Technical equipment ratings

Technical equipment ratings	
Rated continuous current	1600A, 2000A, 3200A, 4000A
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

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

Notes:

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

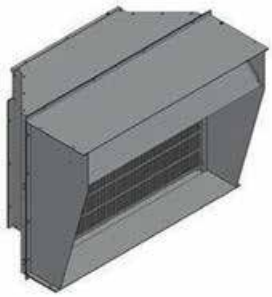
Mechanical overview

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

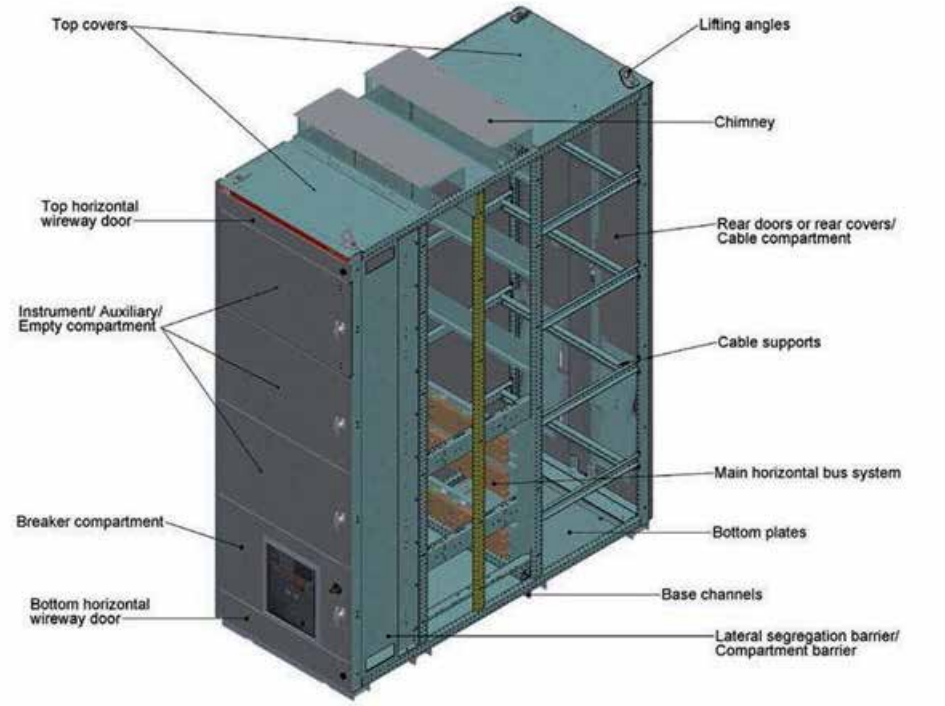
Available options:
- Vertical barriers between cable compartment sections
- Barriers between bus compartment and cable compartment
- Strip heaters and thermostats
- Overhead lift device
- Padlock provisions on breaker compartment doors
- Padlock provisions on rear doors
- Aluminum bottom plates
- Rear 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)



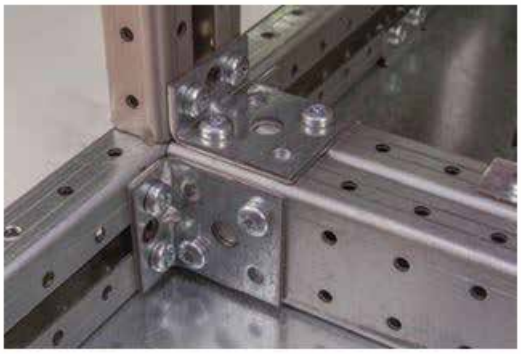


Structure
The MNS-SG switchgear assembly consists of one or more enclosed vertical sections. The ends are designed to allow installation of future sections. Each vertical section can contain up to four high individually enclosed Emax 2 power breakers. One or more of these compartments can be used as 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.

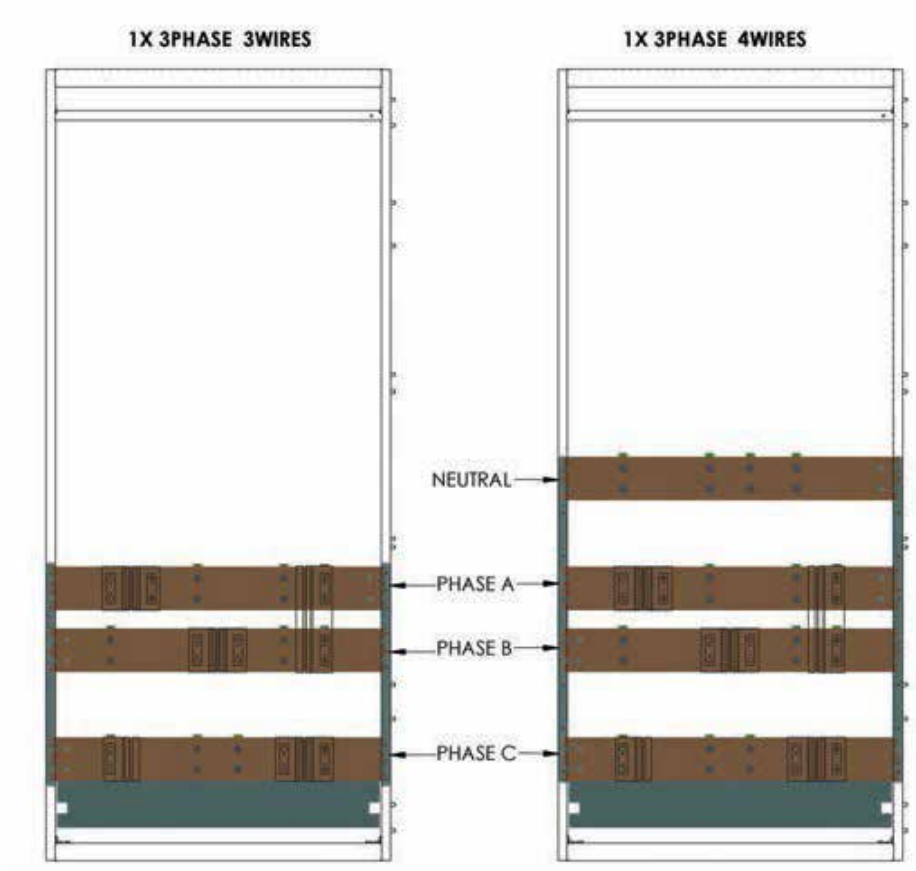
All bus designs are based on UL and ANSI 37.20.1 standard temperature rise of 65°C maximum, above 40°C maximum ambient air temperature. The busbar compartment is separated from the breaker compartment and cable compartments by grounded steel barriers.

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.

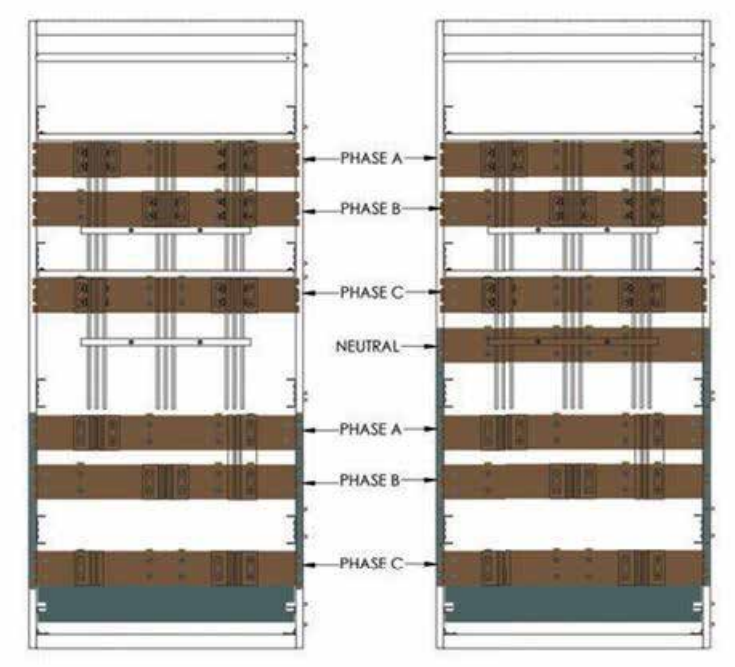
The size and number of conductors is shown below:

Main busbar system arrangements

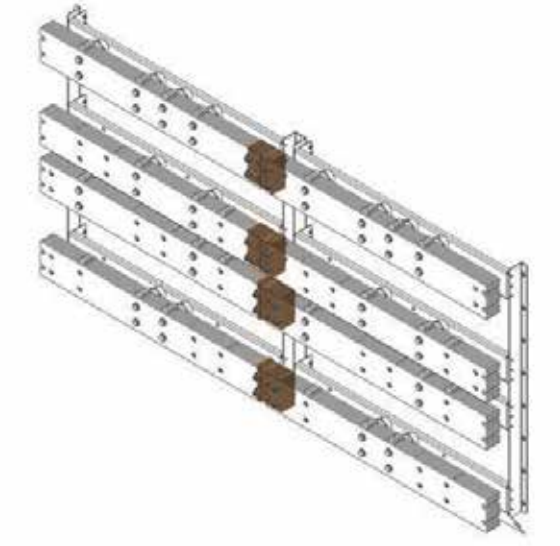
Continuous current	Number of conductor	Size of conductors
1600	1	1/4" x 5"
2000	2	1/4" x 4"
3000	3	1/4" x 5"
4000	4	1/4" x 5"



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

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

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.

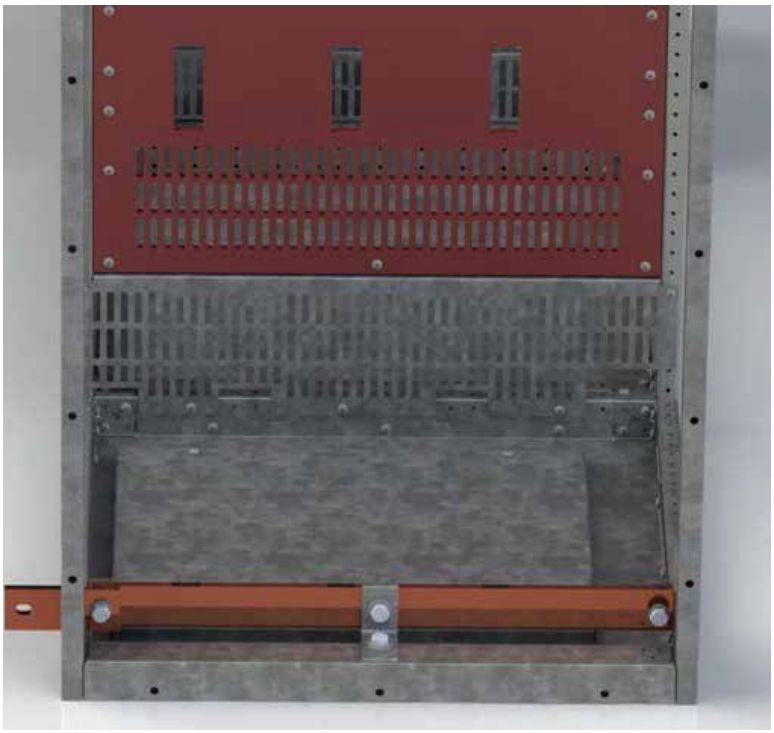
Front doors
Circuit breaker and equipment doors have 14-gauge individual doors with removable hinges. Breaker compartment doors have cutouts. Cutout gasketing is standard for non arc-resistant switchgear lineups, but is removed in the arc-resistant option. Door latches are provided in non arc-resistant 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

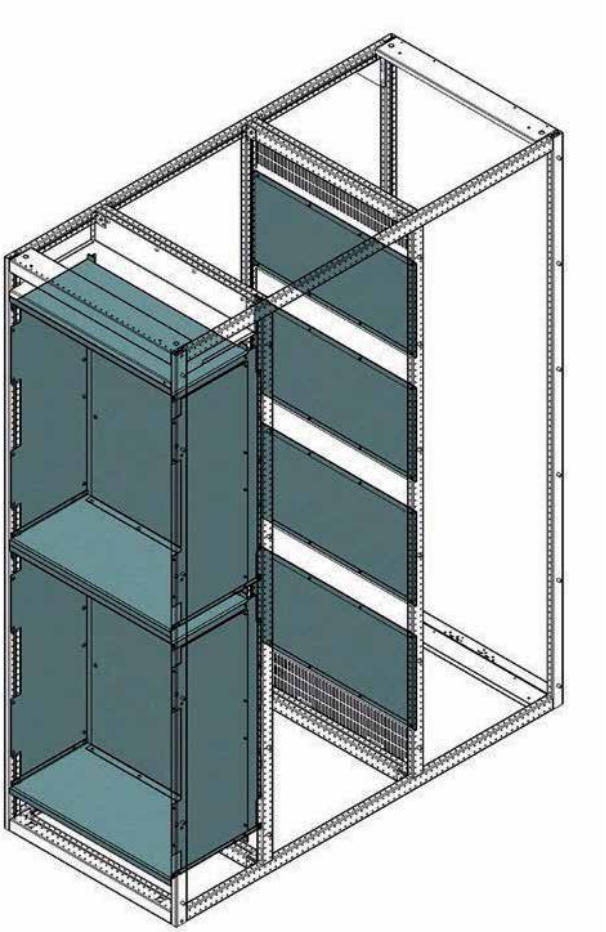
Bottom plates
Bottom plates are manufactured in 14 gauge steel and include removable cutout covers if bottom cable entry is specified. A single bottom plate is provided for the cable and busbar compartments, and a second bottom plate is provided for the cable compartment. Bottom plates are optional for 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).



Auxiliary compartments
Auxiliary compartments are available to mount additional devices, including but not limited to: voltage transformers, control power transformers, metering, and supervisory devices.



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.

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.

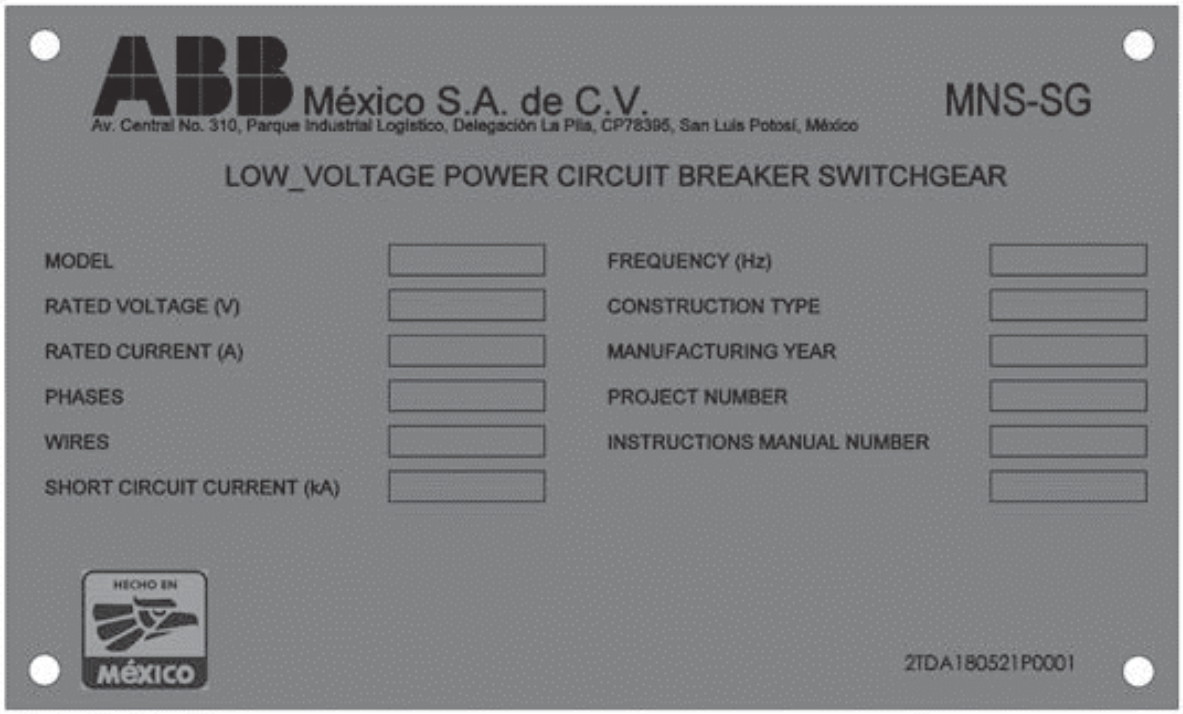
Auxiliary compartments are provided with an unpainted galvanized steel back panel for component mounting. A white painted instrument compartment back panel is also available as an option.

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:

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.



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, and 4000:5.

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 2 electronic trip units have an extended range of communication features which may be accessed using the communication modules. 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 communications network requires the addition of Ekip communication modules, which are only applicable to the Ekip Touch and Ekip Hi-Touch trip units. All circuit breakers can be equipped with communication units available for direct use with Modbus RTU, Profibus, and DeviceNet protocols as well as the modern Modbus TCP, Profinet, IEC61850 and EtherNet IP protocols. A single connection point is provided for connection to network segments outside the switchgear.

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.

Selector switches
When selector switches are required such as for auto/manual transfer schemes or local/remote selection an ABB type cam switch is used as a standard.
Optional switches can be provided upon request.

Test switches and plugs
As an option, the ABB MNS-SG switchgear allows the installation of ABB Flexitest FT-1 or FT-14 test switches or test plugs. The test switch may be utilized for current transformer and potential transformer testing. ABB provides shorting blocks for current transformers as a standard. All Flexitest switches meet or exceed all requirements of ANSI/IEEE Standard C37.90 and are UL, CUL and CSA listed.

The standard test switch cover is black, and a clear cover is also available. Standard switch colors are black for potential transformer connections and red for current transformer connections. Custom color schemes are available by request.

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.

Emax 2
Power circuit breakers

Refer to ABB Emax 2 Power Breaker Technical Guide 1SDC200039D0202 for additional technical details

Ratings

The MNS-SG is designed to accommodate up to four high drawout type Emax 2 power circuit breakers. Each circuit breaker is located in a completely enclosed ventilated compartment with top, bottom, and rear grounded steel barriers.

There are three available frame sizes that may be used: E2.2, E4.2, and E6.2.

The Emax 2 power circuit breaker is available in various levels of interrupting ratings (AIR) as listed below:

Switchgear and Emax 2 power circuit breaker interrupting rating

		Rated short time					
Frame Size	**Circuit breaker model**	**240V [kA] (note 1)**	**480V [kA] (note 1)**	**600V [kA] (note 2)**	**Rated time current [kA]**	**Break time (I<ST current) (max) ms/ cycles**	**Break time (I>ST current) (max) ms /cycles**
800, 1200, 1600, 2000	E2.2 S-A	65	65	65	65	40 / 2.4	25 / 1.5
2500	E4.2 S-A	65	65	65	65	40 / 2.4	25 / 1.5
800, 1600, 2000, 2500	E4.2 V-A	100	100	100	100	40 / 2.4	25 / 1.5
3200	E4.2 S-A	65	65	65	65	40 / 2.4	25 / 1.5
3200	E4.2 V-A	100	100	100	100	40 / 2.4	25 / 1.5
4000	E6.2 H-A	85	85	85	85	40 / 2.4	25 / 1.5
4000	E6.2 V-A	100	100	100	100	40 / 2.4	25 / 1.5

Note 1 applies to arc-resistant rated equipment
Note 1 and 2 apply to non arc-resistant rated equipment.

Rating plugs

Emax 2 circuit breaker rating plugs for electronic trip units

Type of circuit breaker	**Rated Current Iu**	**Ln [A] 400**	**600**	**800**	**1000**	**1200**	**1600**	**2000**	**2500**	**3000**	**3200**	**3600**	**4000**	**5000**
E22V-A	400	●												
	800	●	●	●										
	1200	●	●	●	●	●								
	1600	●	●	●	●	●	●							
	2000	●	●	●	●	●	●	●						
E42V-A	800	●	●	●										
	1600	●	●	●	●	●	●							
	2000	●	●	●	●	●	●	●						
	2500	●	●	●	●	●	●	●	●					
E4.2S-A	3200			●	●	●	●	●	●	●	●			
E4.2V-A	3200			●	●	●	●	●	●	●	●			
E6.2H-A	4000			●	●	●	●	●	●	●	●	●	●	
E6.2V-A	4000			●	●	●	●	●	●	●	●	●	●	
E6.2H-A	5000			●	●	●	●	●	●	●	●	●	●	●
E6.2V-A	5000			●	●	●	●	●	●	●	●	●	●	●

Breaker details

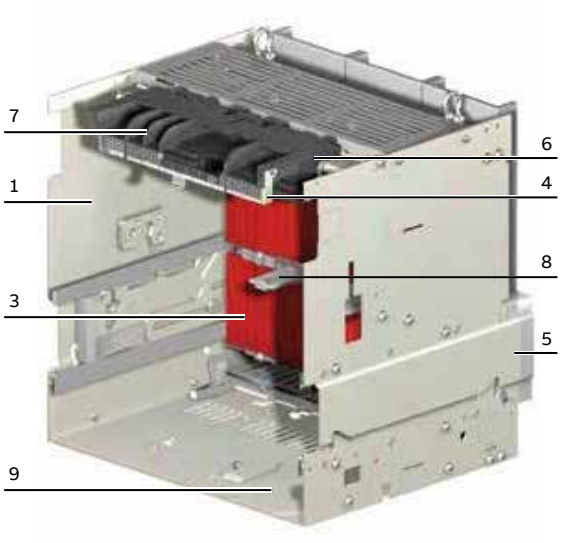
Construction characteristics

The Emax 2 power circuit breaker offers a series of operating and signaling parts to minimize the risk of operational errors:

Caption	
1	Trademark and size of circuit
2	Ekip protection trip unit
3	Pushbutton for manual opening
4	Pushbutton for manual closing
5	Lever to manually charge closing springs
6	Label with electrical characteristics
7	Mechanical device to signal circuit breaker open "O" and closed "I"
8	Signal for springs charged or discharged
9	Mechanical indication of trip
10	Size and serial number

Non arc-resistant cradles

Construction characteristics

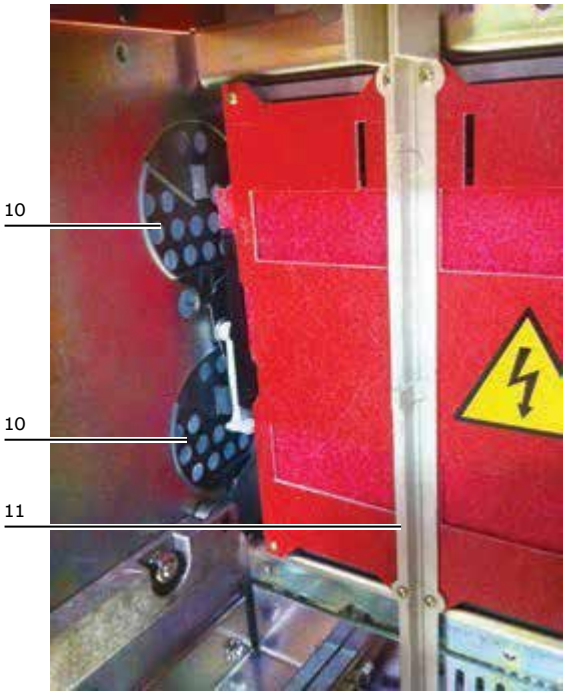


Caption	
1	Sheet steel supporting structure
2	Single grounding pilers mounted on the left for E1.2, and E2.2 double grounding pilers for E4.2 and E6.2
3	Automatic safety shutters
4	Terminal support base
5	Terminals
6	Contacts signaling that the circuit breaker is connected, isolated for test, racked-out
7	Sliding contacts
8	Padlock device for safety shutters (Standard)
9	Fixing points (4 for E1.2, E2.2, and 6 for E4.2, E6.2)
10	Ventilation covers
11	Insulating barriers between phases

Arc-resistant cradles

Construction characteristics

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



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

The protection units are divided into two families: Ekip for distribution protection and Ekip G for generator protection. The trip unit range is available with three levels of performance: Dip, Touch and Hi-Touch, to satisfy simple to advanced applications. Exclusive functions such as the Ekip Power Controller and Network Analyzer complete the range, enabling power management and analysis of energy quality.

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

Version	**Application**		
	Distribution	**Power control**	**Generators**
Ekip Dip	Protection	-	-
Ekip Touch	Protection and Measurement	Protection, Measurement and Load control	-
Ekip Hi-Touch	Protection, Measurement and Network Analyzer	Protection, Measurement, Network Analyzer and Load control	-
Ekip G Touch	-	Protection, Measurement and Load control	Protection and Measurement
Ekip G Hi-Touch	-	Protection, Measurement, Network Analyzer and Load control	Protection, Measurement and Network Analyzer

Electronic trip units

ABB Code	ANSI Code	Function	Ekip Dip	Ekip Touch	Ekip Hi-Touch	Ekip G Touch	Ekip G Hi-Touch
L	49	Overload Protection	●	●	●	●	●
		Thermal Memory	●	●	●	●	●
		Tolerance					
S	50TD	Time-delayed overcurrent protection	●	●	●	●	●
	68	Zone selectivity		●	●	●	●
		Star up		●	●	●	●
		Tolerance					
	51	Time-delayed overcurrent protection	●	●	●	●	●
		Thermal Memory		●	●	●	●
		Tolerance					
I	50	Instantaneous overcurrent protection	●	●	●	●	●
		Star up		●	●	●	●
		Tolerance					
G	50N TD	Earth fault protection	●	●	●	●	●
	68	Zone selectivity		●	●	●	●
		Start up		●	●	●	●
		Tolerance					
	51N	Earth fault protection	●	●	●	●	●
		Tolerance					
IU	46	Current unbalance protection		●	●	●	●
		Tolerance					
2I	50	Programmable instantaneous overcurrent protection		●	●	●	●
		Tolerance					
MRC		Closing on short-circuit protection		●	●	●	●
		Tolerance					
Gext	50G TD	Earth fault protection		●	●	●	●
	68	Zone Selectivity					
		Start up		●	●	●	●
		Tolerance					
	51G	Earth fault protection		●	●	●	●
		Tolerance					





ABB Code	ANSI Code	Function	Ekip Dip	Ekip Touch	Ekip Hi-Touch	Ekip G Touch	Ekip G Hi-Touch
Rc	64 50N TD 87N	residual current protection Diferential ground fault protection		●	●	●	●
		Tolerance					
LC½ Iw½		Current threshold LC		●	●	●	●
		Current threshold Iw		●	●	●	●
		Tolerance					
UV	27	Undervoltage Protection		o	●	●	●
		Tolerance					
OV	59	Overvoltage protection		o	●	●	●
		Tolerance					
VU	47	Voltage unbalance protection		o	●	●	●
		Tolerance					
UF	81L	Underfrequency protection		o	●	●	●
		Tolerance					
OF	81H	Overfrequency protection		o	●	●	●
		Tolerance					
RP	32R	Reverse active power protection		o	●	●	●
		Tolerance					
Cyclical direction	47	Cyclical direction of the phases		o	●	●	●
Power factor	78	3phase Power factor		o	●	●	●
S2	50TD	Time delayed overcurrent protection			●		●
	68	Zone selectivity			●		●
		Start up			●		●
		Tolerance					
D	67	Directional overcurrent protection (forward & backward)			●		●
	68	Zone selectivity			●		●
		Start up (forward & backward)			●		●
		Trip direction			●		●
		Minimun angle direction			●		●
		Tolerance					

ABB Code	ANSI Code	Function	Ekip Dip	Ekip Touch	Ekip Hi-Touch	Ekip G Touch	Ekip G Hi-Touch
UV2	27	Undervoltage Protection			●		●
		Tolerance					
OV2	59	Overvoltage protection			●		●
		Tolerance					
UF2	81L	Underfrequency protection			●		●
		Tolerance					
OF2	81H	Overfrequency protection			●		●
		Tolerance					
S(V)	51V	Voltage controlled overcurrent protection				●	●
		Step Mode				●	●
		Linear Mode				●	●
		Tolerance					
RV	59N	Residual overvoltage protection				●	●
		Tolerance					
OP	32OF	Active overpower protection				●	●
		Tolerance					
OQ	32OF	Reactive overpower protection				●	●
		Tolerance					
UP	32LF	Active underpower protection				●	●
		Start up					
		Tolerance					

- \- not available
- ● available
- O available with Ekip Measuring and Ekip Measuring Pro
- OO available with Ekip Synchrocheck

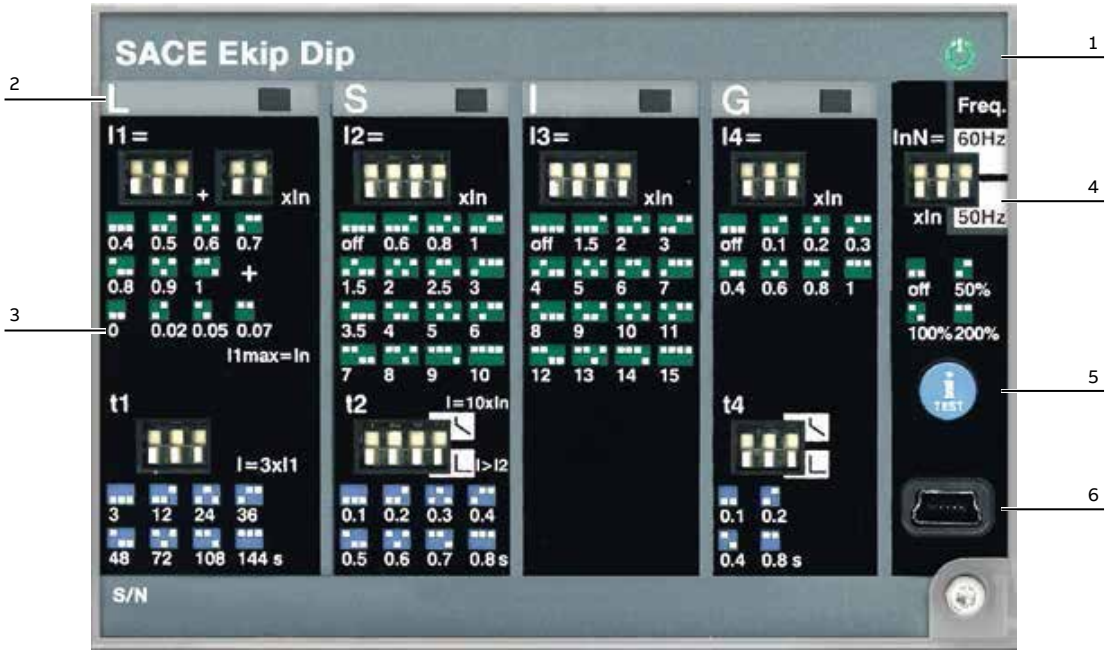
Electronic trip units Ekip Dip

Ekip Dip is the new protection trip unit of the Emax 2 family for all applications in which high accuracy and reliable protection against overcurrent are required.

Ekip Dip offers a complete set of standard protection functions. Dedicated LEDs allow the fault that caused tripping to be determined.

The unit is available in the following versions:

- Ekip Dip LI
- Ekip Dip LSI
- Ekip Dip LSIG



Legend

1. Power-on LED for signaling correct operation (watchdog).
2. LEDs for alarm signaling of L, S, I and G protection functions and diagnostics.
3. Dip switches for setting the protection functions.
4. Dip switches for setting the network frequency and neutral protection device.
5. Pushbutton for test and for indicating the cause of tripping.
6. Test and programming connector.

Electronic trip units Ekip Dip

Protection functions
Ekip Dip offers overcurrent protection functions and, in the event of tripping, controls the opening of the circuit breaker, preventing it from closing again unless it has been reset by the operator (lock-out device – code ANSI 86).)

Overload (L - ANSI 49)
With inverse long-time delay trip of the type t = k/I2 available with 25 current thresholds and 8 curves, it provides effective protection of all systems. A pre-alarm warning is also available on reaching 90% of the threshold set.

Time-delayed overcurrent (S - ANSI 51 & 50TD)
With constant tripping time (t = k), or with constant specific let-through energy (t = k/I2), it provides 15 current thresholds and 8 curves, for fine adjustment. The function can be excluded by setting the dip switch combination to “OFF”.

Thermal memory
For L and S protection functions, this is used to protect components, such as transformers, from overheating following an overload. The function, which can be enabled by the Ekip Connect software, adjusts the protection tripping time according to the length of time that has elapsed since the first overload, taking into account the amount of heat generated.

Instantaneous overcurrent (I - ANSI 50)
With tripping curve without intentional delay, it offers 15 tripping thresholds and can be excluded by setting the dip switch combination to “OFF”.

Ground fault (G - ANSI 51N & 50NTD)
With tripping time independent of current (t = k) or constant specific let-through energy (t = k/I2). The function can be excluded by set-ting the dip switch combination to “OFF”.

Neutral protection
Available at 50%, 100% or 200% of the phase currents, or disabled, it is applied to the overcurrent protections L, S and I.

Measurements
The Ekip Dip unit measures phase and neutral current with great accuracy: 1% including the current transformers in the 0.2 ...1.2 In range (class 1 in accordance with IEC 61557-12). Using the current sensors in the circuit breaker and without the need to install an external measuring system, it is possible to view the measurements from the display on the front of the Ekip Multimeter and Ekip Control Panel. Ekip Dip also records the characteristics of the circuit breaker, to enable a rapid analysis during troubleshooting or maintenance:

- Maximum and average current values per phase;
- Date, time, fault current per phase and type of protection tripped over the last 30 trips;
- Date, time and type of operation of the last 200 events (for example: opening/closing of the circuit breaker, pre-alarms, editing settings);
- Number of mechanical and electric operations of the circuit breaker;
- Total operating time;
- Contact wear (endurance);
- Date and time of the last maintenance carried out, in addition to the estimate of the next maintenance required;
- Circuit-breaker identifying data: type, serial number, firmware version, name of the device as assigned by the user.

The values can be displayed on the front of the Ekip Multimeter or Ekip Control Panel or by Ekip Connect software on a Smartphone, Tablet or PC by using the communication units Ekip T&P or Ekip Bluetooth.

Watchdog
All the protection trip units of the Emax 2 family ensure high reliability owing to an electronic circuit that periodically controls the continuity of the internal connections, such as trip coil, rating plug and each current sensor (Ansi 74). In the event of a malfunction, the LEDs indicate the corresponding alarm to enable the fault to be identify rapidly. Furthermore, Ekip Dip detects and indicates that the circuit breaker has been opened because one of the protection functions has been tripped (Ansi BF code).

In order to preserve the correct operation of the unit, Ekip Dip is also provided with self-protection against abnormal temperature (OT) inside the protection trip unit. The user can set it to open the circuit breaker or to merely indicate an alarm.

User interface
Ekip offers a great variety of thresholds and trip times, the protections can be set by dip-switches. Up to 5 LEDs are also available (depending on the version) to indicate correct operation or alarms. The interface always enables the status of the installation to be identified clearly and quickly:
- Correct operation (green LED)
- Overcurrent pre-alarms or alarms
- Presence of self-control functions alarms
- Maintenance interval expired
- Indication of tripped protection after a fault

The protection tripped indication is activated by pressing the iTest key, and operates without the need of an external power supply because a battery is installed inside the unit.

Communication
The Ekip Bluetooth wireless communication unit enables the operator to interact with the protection trip unit by computer, Smartphone or Tablet. In fact, the free Ekip Connect software for Smartphones, Tablets and PC, enables measurements and fault data to be read along with alarm status and information from the circuit breaker to be displayed. It is also possible to set parameters such as date, time and thermal memory and for records to be reset.

Test function
The test port on the front of the protection trip unit can be used to run circuit breaker tests by connecting one of the following devices:
- Ekip TT to run the trip test, the LEDs test and check absence of alarms detected by the watchdog function;
- Ekip T&P to permit not only the trip test and LEDs test but also to run the test of the individual protection functions and save the relative report;
- ITest key that is pressed to run the battery test when the circuit breaker is disconnected.

Supply
The Ekip Dip protection trip unit does not require an external supply for the protection functions or for the alarm indication functions because it is self-supplied by the current sensors installed on the circuit breaker. A three-phase 100A current suffices to activate the LED indications.

The Ekip Supply module enables an auxiliary supply to be easily connected and is able to receive both a direct current supply (24-48VDC or 110-240VDC) and an alternating current (110-240VAC) to activate additional functions such as:
- G protection at values below 100A or below 0.2 In;
- connecting to external devices such as Ekip Multimeter and Ekip Control Panel;
- Recording the number of operations.

The Ekip Dip protection trip unit also has a battery that enables the indication of the cause of the fault to be viewed for an unlimited time after tripping. In addition to that, the battery enables date and time to be maintained and updated, thus ensuring the chronology of the events. On the other hand, when the unit is switched off, the battery test can be run by simply pressing the iTest key.

Whenever cartridge modules are not used in the terminal box area, the trip unit can be supplied by means of a galvanically isolated 24V DC auxiliary voltage.

Electronic trip units Ekip Touch

Ekip Touch is the new protection trip unit for Emax 2 that provides a complete series of protections and high accuracy measurements of all electric parameters and can be integrated perfectly with the most common automation and supervision systems.

The simple and intuitive touch screen interface enables the operator to access all the information and settings rapidly and easily by minimizing installation and commissioning time.

The unit is available in the versions:

- Ekip Touch LI
- Ekip Touch LSI
- Ekip Touch LSIG

Legend

1. Wide high-resolution color touch screen display.
2. Power-on LED to indicate correct operation (watchdog).
3. Pre-alarm LED.
4. Alarm LED.
5. Home pushbutton to return to home page.
6. Pushbutton for test and indicating cause of trip.
7. Test and programming connector.

Electronic trip units Ekip Touch

Protection functions
Ekip Touch enables all the protection functions to be set with a few simple steps directly from the wide touch-screen display. If the circuit breaker is tripped it must be reset manually or electrically by the operator (lockout relay – code ANSI 86).

Overload (L - ANSI 49)
Available with three different types of trip curve:
- t = k/I2 with inverse long time.
- IDMT in accordance with IEC 60255-3 for coordination with medium voltage protections, that are available according to the Standard Inverse (SI), Very Inverse (VI) and Extremely Inverse (EI) curves.
- with t = k/I4 curve for better coordination with upstream circuit breakers or with fuses.

The thresholds can be fine-tuned (for example 1A for circuit breaker E1.2 1000A) and the timings to the second can be set directly from the display. The settable pre-alarm indicates the set threshold is reached before the protection is tripped. The protection can be disabled by rating plug L=off.

Time-delayed overcurrent (S - ANSI 51 & 50TD)
With constant trip time (t = k), or constant specific let- through energy (t = k/I2).

Thermal memory
For protections L and S it is used to protect the components, such as transformers, against overheating following overloads. The protection adjusts the trip time of the protection according to how much time has elapsed after the first overload, taking account of the overheating caused.

Instantaneous overcurrent (I - ANSI 50)
With trip curve without intentional delay.
Closing on short-circuit (MCR): the protection uses the same algorithm of the protection I, limiting operation to a settable time window from the closing of the circuit breaker. The protection can be disabled, also alternatively to protection I. The function is active with an auxiliary supply.

Ground fault (G - ANSI 51N & 50NTD)
With trip time independent of the current (t = k) or with constant specific let-through energy (t = k/I2). A pre-alarm indication is also available when 90% of the threshold is reached to activate corrective measures before the protection is tripped. The function also enables the trip to be excluded so that only the alarm is indicated, for use in installations where continuity of service is an essential requirement.

Instantaneous ground fault (G - ANSI 50N)
With trip curve without intentional delay.

Ground fault on toroid (G ext - ANSI 51G & 50GTD)
With trip time independent of the current (t = k) or with constant specific let-through energy (t = k/I2). Pre-alarm that 90% threshold has been reached permit the fault to be reported to supervision systems without interruption of continuity. The protection uses the external toroid installed, for example, on the star center of the transformer, and is an alternative to the G and Rc functions. The function is active with an auxiliary supply.

Neutral protection
Available at 50%, 100%, 150% or 200% of the phase currents, or disabled, it is applied to the overcurrent protections L, S and I.

Start-up function
Enables protections S, I and G to operate with higher trip thresholds during the starting phase, avoiding untimely trips due to high inrush currents of certain loads (motors, transformers, lamps). The

starting phase lasts 100 ms to 30 s and is recognized automatically by the trip unit:
- at the closing of the circuit breaker with a self-supplied trip unit;
- when the peak value of the maximum current exceeds the set threshold (0.1…10 x In) with an externally supplied trip unit; a new start-up is possible after the current falls below the threshold.

Current imbalance (IU – ANSI 46)
With constant trip time (t = k), protects from an imbalance between the currents of the single phases protected by the circuit breaker.

Zone selectivity for S and G protection (ANSI 68)
Can be used to minimize circuit breaker trip times closest to the fault. The protection is provided by connecting all the zone selectivity outputs of the trip units belonging to the same zone and feeding this signal to the trip unit input that is immediately upstream. Each circuit breaker that detects a fault reports it to the circuit breaker upstream; the circuit breaker that detects the fault but does not receive any communication from those downstream opens without waiting for the set delay to elapse. It is possible to enable zone selectivity if the fixed-time curve has been selected and the auxiliary supply is present.

Current thresholds
This function enables the realization of four independent thresholds to be indicated in order to enable corrective action implementation before the overload L protection trips the circuit breaker. For example, by disconnecting loads located downstream of the circuit breaker that are controlled by Ekip Signaling.

Power Controller
Power controller function (optional) with Ekip Measuring module.

Second protection against instantaneous overcurrent (2I)
The function is supplied as standard on all Ekip Touch and Hi-Touch versions. It is an instantaneous protection that permits opening of the circuit breaker faster than the standard I protection. It is independent from ANSI 50, with predetermined thresholds and is a temporarily activation. It can be activated for different uses in three ways:
- locally, directly on the input on the Ekip display unit
- remotely, via any Ekip Com module connected to the circuit breaker
- remotely, via a switch wired through an Ekip Signaling module.

When active, the Ekip display unit will show a confirmation of the activation and a red LED alarm will flash on the diagnosis bar.

Protection functions with Ekip Measuring Pro

The Ekip Touch protection functions can be further increased by using the Ekip Measuring Pro measuring and protection module. With this module, all the protection functions linked to voltage, frequency and power can be enabled, thus making Ekip Touch a multifunction unit that can measure, control and protect even the most complex installation.
A different operating mode can be chosen for each protection function:
- Active: protection enabled by opening of the circuit breaker when the threshold is reached;
- Only alarm: protection active, with only alarm indication when the threshold is reached;
- Deactivated: protection disabled.

Furthermore, when the voltage and frequency protections are activated, they indicate an alarm status even when the circuit breaker is open so that a fault can be identified before the circuit breaker closes.

Undervoltage (UV - ANSI 27)
With constant trip time (t = k), function is tripped when phase voltage falls below set threshold.

Overvoltage (OV - ANSI 59)
With constant trip time (t = k), function is tripped when phase voltage exceeds the set threshold.

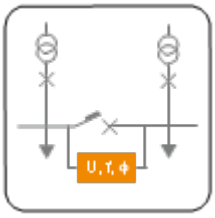
Underfrequency (UF - ANSI 81L)
With constant trip time (t = k), function is tripped when network frequency falls below set threshold.

Overfrequency (OF - ANSI 81H)
With constant trip time (t = k), function is tripped when network frequency exceeds the set threshold.

Voltage imbalance (VU – ANSI 47)
With constant trip time (t = k), protects against an imbalance between the voltages of the individual phases that are protected by the circuit breaker.

Residual current (Rc – ANSI 64 & 50NDT)
With constant temperature (t=k) protects against indirect contacts and is integrated into Ekip Touch LSIG with Ekip Measuring Pro by a dedicated residual current rating plug and external toroid. The protection is an alternative to the functions G and Gext.

Reverse active power (RP - ANSI 32R)
With constant trip time (t = k), function is tripped when total active power – in the opposite direction of the current - exceeds the set threshold.



In addition to the protection functions, the following indication and control functions are available to warn the user that a given condition has been reached. The active indications are always shown on the display and are also available by communication on the system bus (with Ekip Com modules) or electrical indication (with Ekip Signalling modules).

Synchrocheck (SC - ANSI 25)
The synchronism control function compares the voltages in the module, the frequency and phase of the two circuits to which the circuit breaker is connected. Ekip Touch indicates that conditions have been reached that enable the two lines to be made parallel. The function is available with two work modes:

- In systems with both busbars supplied, where synchronism is determined by:
  1. voltage of the two half-busbars above the Ulive threshold for the set time
  2. difference of the module of the two voltages below the threshold ΔU
  3. difference of the frequency of the two voltages below the threshold Δf
  4. difference of the phase of the two voltages below the threshold Δ
  5. desirable time for synchronism condition tsyn
  6. circuit breaker open
- In systems with an out-of-service line (dead busbar), where the synchronism condition is determined by the concurrence of the following conditions for the tref set time:
  1. voltage of the active half-busbar above threshold Ulive
  2. voltage of the dead half-busbar below threshold Udead
  3. circuit breaker open

In both cases, synchronism consent is withdrawn when one of the above conditions is missing and it has not been less than 200ms from the change of the circuit breaker condition (when the relationship has been set).
The indication of reached synchronism is available directly as an electrical indication via a contact that is always supplied with the module. The function can be activated simply by connecting the Ekip Synchrocheck module to any Ekip Touch provided with an Ekip Measuring Pro module.

Cyclical direction of the phases (ANSI 47)
Indicates an alarm through inversion of the phases sequence.

Power factor (ANSI 78)
Available with a three-phase threshold, warns when the system operates with a power factor that is less than the set power factor.

Measurements and meters

All versions of the Ekip Touch unit measure the RMS value of the currents of the three phases (L1, L2, L3) and of neutral (Ne) with 1% accuracy in the 0.2 to 1.2 In range (class 1 in accordance with IEC 61557-12). The complete range of measurement is from 0.03 to 16x In, where In is the value of the rating plug.
The display shows the current of the most loaded phase both in numeric and analogue format on an ammeter with a 0-125% In scale for rapid identification of the load of the circuit breaker.

Alternatively, bar graphs that show the currents of the three phases and of neutral on a 0-125% In scale in addition to the numeric value of the most loaded phase can be selected as the default page. The bar graphs are yellow in the event of a pre-alarm and red in the event of an overload to enable an irregular condition to be identified immediately. Where applicable, the measurement of the ground fault current is shown on a dedicated page. The ammeter can operate both in self-supplied mode and with auxiliary voltage. In the latter case, the display always has back lighting and the ammeter is also active at currents below 100A.

Adding the Ekip Measuring or Ekip Measuring Pro module to Ekip Touch enables Ekip Touch to be used as a multimeter to measure the values of:
- Voltage: phase-phase, phase-neutral (accuracy 0.5%);
- Power: active, reactive, apparent (accuracy 2%);
- Energy: active, reactive, apparent (accuracy 2%);
- Frequency (accuracy 0.2%);
- Power factor by phase and total;
- Peak factor.

Maximum values and values register
The Ekip Touch unit is able to supply the measurement trend of certain parameters over a settable period of time such as: average power, maximum power, maximum and minimum current, maximum and minimum voltage. The values of the last 24 time intervals are recorded in the unit with a relative timestamp and can be consulted directly from the display or remotely using one of the available communication protocols. The communication can also be used to synchronize the recording time interval.

Data logger
Ekip Touch is always supplied with the exclusive Data Logger (register) function that stores with high sampling frequency the instantaneous values of all the measurements in two memory buffer registers. The data can be easily downloaded by the Ekip Connect unit and transferred to any personal computer. This enables the current and voltage waveforms to be analyzed for rapid fault analysis. The function continuously stores and stops recording, with a selectable delay, whenever the event set by the user occurs (e.g. trip or alarm). In this manner, it is possible to analyze the complete evolution of the fault: from the start to its complete elimination.

Information on trip and opening data
If a trip occurs, Ekip Touch stores all the information that is required for rapid identification and elimination of the causes:
- Protection tripped
- Opening data (current, voltage or frequency)
- Time-stamping (data, time and consecutive opening number)

If the iTest key is pressed, the trip unit displays all these data directly on the display. No auxiliary supply is required. The information is also available to the user with the circuit breaker open or without current flow, due to the battery installed inside the unit.

Maintenance indicators

A complete set of information about the circuit breaker and its operation is available for effective fault analysis and preventive scheduling of maintenance. All the information can be seen from the display or from a PC using a communication unit. In particular:

- Date, time, fault current by phase and type of protection tripped over the last 30 trips;
- Date, time and type of operation of the last 200 events (example: opening/closing of the circuit breaker, pre-alarms, editing of settings, ect.);
- Number of operations of the circuit breaker: divided into mechanical operations (no current), electrical operations (with current) and protection function (trip);
- Contact wear (endurance) estimated in function of the number and type of openings;
- Total operating time of the circuit breaker with circulating current;
- Date and time of the last maintenance session, scheduling of the next maintenance session;
- Circuit-breaker identifying data: type, serial number, firmware version, device name assigned by the user.

All the information can be viewed directly from the display and from a Smartphone, Tablet (with Ekip Bluetooth) or PC using the front port of the trip unit or the system communication

Watchdog

All of the trip units in the Emax 2 family ensure high reliability because of an electronic circuit that periodically controls continuity of the internal connections, such as trip coil, rating plug and each current sensor (Ansi 74). In the event of an alarm, a message is shown on the display, and if it is set during the installation phase, the trip unit can command the opening of the circuit breaker. If a protection function intervenes, Ekip Touch always checks that the circuit breaker has been opened by auxiliary contacts that indicate the position of the main contacts. Otherwise, Ekip Touch indicates an alarm (ANSI BF code - Breaker Failure) to be used to command the opening of the circuit breaker located upstream.

Ekip also contains self-protection that preserves the correct operation of the unit against abnormal tempera-tures (OT) inside the protection trip unit. The user disposes of the following indications or controls:

- “Warning” LED for temperature below -4°F/-20°C or above 158°F/70°C, at which the trip unit operates correctly with the display switched off
- “Alarm” LED for temperature outside the operating range, at which the trip unit commands the opening of the circuit breaker (if set during the configuration phase).

User interface

All Ekip Touch operations are simple and intuitive due to the wide graphic color touchscreen display. For example, all the main information is listed on one page (settable by default), thus enabling the state of the installation to be identified rapidly: maximum current, maximum voltage, active, reactive, apparent power and energy.
In addition, the use of Ekip Touch is further simplified by the possibility of scrolling through the menu and reading the alarms in one of the languages that can be set directly from the display: Italian, English, German, French, Spanish, Portuguese, Chinese, Russian, Turkish and Thai.
The home pushbutton enables you to return, at any moment, to the main page and the iTest key enables the information to be viewed after a circuit breaker trip or test.
As in the previous generation of trip units, a password system is used to manage “Read” or “Edit” modes. The default password, 00001, can be edited by the user. The protection parameters (curve and trip thresholds) are settable in “Edit” mode whereas it is always possible to consult the information in “Read” mode.

On the front of the trip unit there are also two LEDs: a pre-alarm LED (square yellow LED) and an alarm LED (red triangular LED); a message on the display always accompanies the flashing of the LEDs for clear identification of the type of event. The list of all the alarms active at that moment can be viewed by simply touching the display on the white strip in the bottom left of the alarms zone. Ekip Touch is also supplied with a front port that permits a temporary connection to devices for test, supply or communication (for example Ekip T&P).

Communication
Communication modules that can be installed inside the circuit breaker enable Ekip Touch to be integrated into the most modern supervision systems with protocols:
- IEC 61850
- Modbus TCP
- Modbus RS-485
- Profibus
- ProfiNet
- DeviceNet
- EtherNet/IP

The integration into communication systems enables measurements, statuses and alarms to be programmed and viewed by remote functions. If the circuit breaker has to be opened and closed remotely, the Ekip Com Actuator module can be installed in the circuit breaker front, in the right-hand accessories chamber.

For each circuit breaker, several communication modules with different protocols can be used simultaneously; for example, this enables the circuit breaker to be connected to the Ekip link system to obtain local supervision from the front of the switchgear and to simultaneously integrate it into a communication network. In addition, for applications requiring very high reliability, up to two modules of the same protocol can be inserted by use of the redundant version that enables two different addresses to communicate on the same bus.

Test function
For testing the circuit breaker, it is possible to use the test port and the iTest key positioned on the front of the protection trip unit. The available functions are:
- trip test, test of the display and of the LEDs and check of absence of alarms detected by the watchdog function using Ekip TT (always supplied with Ekip Touch);
- test of the single protection functions and saving of the report, in addition to the trip test and test of the display, using Ekip T&P;
- test of the battery with the circuit breaker switched off by pressing the iTest kit.

Supply
The Ekip Touch protection trip unit is self-supplied by the current sensors and does not require an external supply for the basic protection functions or for the alarm indication functions. All protection settings are stored in a non-volatile memory that maintains the information, even without a power supply. To activate the indication functions the ammeter and the display, a 100A three-phase current suffices.
An auxiliary supply can easily be connected. The Ekip Supply module can be connected to supplies of both direct current and alternating current to activate additional functions such as:
- using the unit with circuit breaker open;
- using additional modules such as Ekip Signaling and Ekip C om;
- connection to external devices such as Ekip Multimeter and Ekip Control Panel;
- recording the number of operations;
- G protection with values below 100A or below 0.2 In;
- zone selectivity;
- Gext and MCR protection functions.

The Ekip Supply module allows the cartridge modules to be used in the terminal box area. Otherwise, the trip unit can be supplied by means of a galvanically isolated 24 VDC auxiliary voltage.

The Ekip Measuring Pro module can supply the Ekip Touch trip unit with line voltage above 85V.

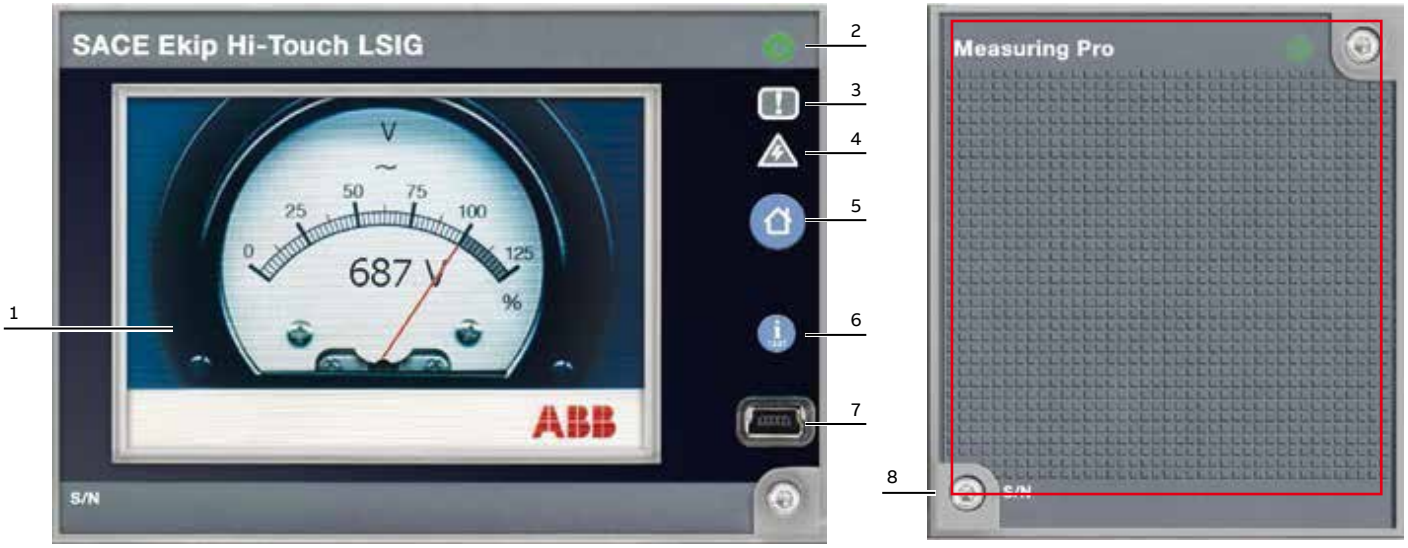
Electronic trip units Ekip Hi-Touch

The Ekip Hi-Touch of Emax 2 is a high-performance multifunction unit that is extraordinarily versatile and can be used in even the most complex installations. Ekip Hi-Touch, in fact, features exclusive functions such as: directional protection, restricted ground fault and dual setting of the protections. In addition, Ekip Hi-Touch is supplied with the exclusive Network Analyzer function that can monitor the quality of the power absorbed by the installation in accordance with IEEE 1159 and IEEE 1250.

Ekip Hi-Touch boasts all the features of Ekip Touch; as standard, it features the measuring and protection module Ekip Measuring Pro and can also be fitted, like Ekip Touch, with the additional features provided by the internal modules and by the external accessories.

The front interface of the unit, which is common to Ekip Touch, is extremely simple to use because of the touchscreen color display; it is able to show measurements, bar graphs and sine curves of the different electrical values.

The unit is available in the versions:
- Ekip Hi-Touch LSI
- Ekip Hi-Touch LSIG



Legend

1. Wide high-resolution color touch screen display
2. Power-on LED indicating correct operation
3. Pre-alarm LED
4. Alarm LED
5. Home pushbutton to return to home page
6. Pushbutton for test and for indicating cause of the trip
7. Test and programming connector
8. Ekip Measuring Pro module, with relative LED power on

Electronic trip units Ekip Hi-Touch

Protection functions
The Ekip Hi-Touch trip unit shares the following protection functions with Ekip Touch:
- Overload (L – ANSI 49);
- Time-delayed overcurrent (S – ANSI 51 & 50TD);
- Thermal memory;
- Instantaneous overcurrent (I – ANSI 50);
- Closing on short-circuit (MCR);
- Ground fault (G – ANSI 51N & 50NTD);
- Instantaneous ground fault (G - ANSI 50N);
- Ground fault on toroid (G ext – ANSI 51G & 50GTD)
- Neutral protection;
- Start-up function;
- Zone selectivity for functions S and G (ANSI 68);
- Current imbalance (IU – ANSI 46);
- Undervoltage (UV – ANSI 27);
- Overvoltage (OV – ANSI 59);
- Underfrequency (UF – ANSI 81L);
- Overfrequency (OF – ANSI 81H);
- Voltage imbalance (VU – ANSI 47);
- Residual current (Rc – ANSI 64 & 50NTD);
- Reverse active power (RP – ANSI 32R);
- Synchrocheck (SC – ANSI 25, optional);
- Cyclical direction of the phases (ANSI 47);
- Power factor (ANSI 78);
- Current thresholds;
- Power Controller function (optional);
- Second protection against instantaneous overcurrent (2I).

In addition to Ekip Touch features, the following protections are also available:

Second time-delayed overcurrent protection (S2 – ANSI 50TD)
In addition to the standard protection S, a second (excludible) time-constant protection is available that enables two independent thresholds to be set in order to ensure precise selectivity, especially in highly critical conditions.

Second protection against ground fault (ANSI 50GTD/51G & 64REF)
Whereas with Ekip Touch the user has to choose between implementation of the protection G by internal current sensors (calculating the vector sum of the currents) or Gext external toroids (direct measurement of the ground fault current), Ekip Hi-Touch offers the exclusive feature of simultaneous management of both configurations by two independent ground fault protection curves.

Owing to this characteristic, the trip unit is able to distinguish a non-restricted ground fault and then activate the opening of Emax 2, from a restricted ground fault, and to thus command the opening of the medium voltage circuit breaker.
Another possible configuration is with the residual current protection replacing the Gext protection, while the G protection remains active. The residual current protection is activated in the presence of the residual current rating-plug and of the toroid.

Directional overcurrent (D – ANSI 67)
The protection is able to recognize the direction of the current during the fault period and thus detect if the fault is upstream or downstream of the circuit breaker. The protection, with fixed time trip curve (t=k), intervenes with two different time delays (t7bw and t7fw), according to the current direction. In ring distribution systems, this enables the distribution portion to be identified in which the fault occurred and to disconnect it while maintaining the operation of the rest of the installation.

Zone selectivity for protection D (ANSI 68)
Enables the possibility to connect circuit breakers among them that in case of fault rapidly isolate the fault area, disconnecting the installation only at the level nearest to the fault, maintaining the operation of the rest of the installation. The function is particularly useful in ring and grid installations where, in addition to the zone, it is also essential to define the flow direction of the power that supplies the fault. It is possible to enable directional zone selectivity alternatively to the zone selectivity of the protections S and G, and in the presence of an auxiliary supply.

Start-up function for protection D
Enables higher trip thresholds to be set at the outgoing point, as available for protections S, I and G.

Second protection against undervoltage and overvoltage (UV2 and OV2 – ANSI 27 and 59)
Enables two minimum and maximum voltage thresholds to be set with different delays in order to be able to discriminate, for example, between voltage dip transients due to the start-up of a motor and an actual fault.

Second protection against underfrequency and overfrequency (UF2 and OF2 – ANSI 81L and 87H)

Enables two minimum and maximum frequency thresholds to be set simultaneously. For example, only an alarm can be set to be tripped when the first threshold is reached, and the circuit breaker can be set to be opened when the second threshold is reached.

Dual setting of protections
Ekip Hi-Touch can store a set of alternative parameters for all protections. This second series (set B) can replace, if necessary, the default series (set A) by an external control.
The control can be given when the network configuration is edited, for example when an emergency source is activated in the system, changing the load capacity and the short-circuit levels. Another typical application is protecting the operator opposite the switchgear against the electric arc. In this case, protection delays are minimized to safeguard the operator (Set A), whereas in the absence of an operator the protections are set to ensure selectivity with the circuit breakers downstream (Set B). It is possible to activate series B by:
- Digital input available with an Ekip Signalling module;
- Communication network, by means of one of the Ekip Com communication modules;
- Directly from the Ekip Hi-Touch display;
- By a settable internal time, after the circuit breaker has closed.

Measurements
The Ekip Hi-Touch trip unit offers a complete series of measurements, common to Ekip Touch:
- Measurements and counters: currents, voltage, power, energy;
- Maximum values and value log;
- Data logger;
- Information on the trip and opening data;
- Maintenance indicators.

Ekip Hi-Touch integrates the exclusive Network Analyzer function, which analyzes the quality of energy consumed by the installation, in accordance with the provisions of international standards EN50160, IEC 61000-4-30, IEEE 1159 and IEEE 1250, in terms of harmonic content, average value and long or short term changes in voltage. Changes in the quality of energy can cause malfunctions in the switchgear and a reduction in their lifespan, as well as increasing losses and reducing the energy efficiency of the installation.

It is therefore increasingly important to assess the quality of the energy and the economic impact it has on the productive process, so that the appropriate preventive and corrective actions can be taken. With Ekip Hi-Touch, the causes of an increase in power lost in transformers or motors, or a reduction in the lifespan of cables and capacitors, can be identified without the need to install any external instrumentation.

The Network Analyzer function performs continuous monitoring of the quality of energy, and shows all results through a display or communication module. In particular:
- **Hourly average voltage value**: in accordance with international standards, this must remain within 10% of the rated value, but different limits can be defined according to the needs of the installation. The positive sequence voltage is obtained from the three line voltages and compared with the limits. If the limits are exceeded, Ekip Hi-Touch generates a signaling event. The quantity of these events is stored in a counter. The counter values are available for each of last 7 days, as well as the total. The measures available are the positive and negative sequence voltages and positive and negative sequence currents of the last interval monitored. The interval calculation time of the

average values can be set between 5 minutes and 2 hours.

- **Interruptions / short dips in voltage (voltage interruptions / voltage dip):** if the voltage remains below the threshold for more than 40ms, Ekip Hi-Touch generates an event that is counted in a dedicated log. The voltage is monitored on all lines.
- **Short voltage spikes (voltage transients, spikes):** if the voltage exceeds the threshold for 40ms, set for a pre-determined time, Ekip Hi-Touch generates an event that is counted.
- **Slow voltage sags and swells (voltage sag / voltage swell):** when the voltage goes outside the range of acceptable limit values for a time greater than the one set, Ekip Hi-Touch generates an event that is counted. Three values can be configured for voltage sags and two for voltage swells, each of which associated to a time limit: this enables us to verify whether the voltage remains within a curve of values that are acceptable by equipment such as computers. The voltage is monitored on all lines.
- **Voltage imbalances:** if the voltages are not equal or the phase displacements between them are not exactly 120°, an imbalance occurs, which is manifested with a negative sequence voltage value. If this limit exceeds the threshold value set, an event is stored which is counted.
- **Harmonic analysis:** the harmonic content of voltages and currents, measured to the 50th harmonic, as well as the value of total harmonic distortion (THD), is available in real time on the display or through the communication modules. Ekip Hi-Touch also generates an alarm if the THD value or the magnitude of at least one of the harmonics exceeds the values set. The voltage is monitored on all lines and currents on all phases.

Measurement and protection

Ekip Measuring module

The Ekip Measuring module enables the trip unit to measure the phase and neutral voltages, powers and energy.

The Ekip Measuring module is installed on the front, right housing of the distribution protection versions of the Ekip Touch trip units, without having to remove the trip unit itself. The voltage connections are installed by default on the lower terminals, but can be altered to the upper terminals on request.

The measuring module requires no external connection since it is connected internally to the lower or upper terminals of Emax 2. If necessary, the voltage outlet connection can be moved outside the circuit breaker by using voltage transformers and the alternative connection positioned in the terminal box. The use of external connections is obligatory for rated voltages that are higher than 690V. The module must be disconnected for dielectric strength tests on the main busbars.

Ekip Measuring Pro module

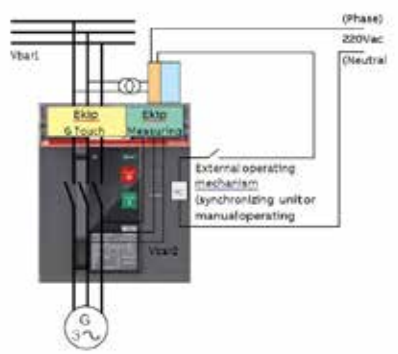
The module has the same connection and installation characteristics as the Ekip Measuring module. In addition, the Ekip Measuring Pro version offers:

- Protection features for voltage and power values.
- Ekip trip unit power supply from busbar voltage (for line voltages greater than 85V).
- LED signaling when voltage is detected on the main busbars.

The Ekip Measurement Pro module comes standard with the Ekip Hi-Touch, Ekip G Touch and Ekip G-Hi Touch trip units.

Ekip Synchrocheck
This module enables the control of the synchronism condition when placing two lines in parallel. The module can be used with distribution and generator protection versions of the Ekip Touch and Hi-Touch trip units equipped with the Ekip Measuring Pro module.

Ekip Synchrocheck measures the voltages from two phases of one line through an external transformer and compares them to the measured voltages at the breaker utilizing the Ekip Measuring Pro Module. An output contact is available, which is activated upon reaching synchronism, and enables the circuit breaker to be closed by means of wiring with the closing coil.



Connectivity

Industrial networking and Emax 2 circuit breakers
The Ekip Com modules enable all Emax 2 circuit breakers to be integrated in an industrial communication network for remote supervision and control of the circuit breaker. They are suitable for all distribution and generator protection versions of the Ekip Touch and Hi-Touch trip units.

Since they are mounted in the terminal box, communication can be maintained with withdrawable circuit breakers, even while in the racked out position.
Several Ekip Com modules can be installed at the same time, thereby enabling connection to communication systems that use different protocols.

The Ekip Com modules are supplied complete with auxiliary position contacts Ekip AUP and ready to close circuit breaker contacts Ekip RTC.

The Ekip Com modules for Modbus RTU, Profibus-DP and DeviceNet contain a terminating resistor and dip switch for optional activation to terminate the serial network or bus. The Profibus-DP module also contains a polarization resistor and dip switch for its activation.

For industrial applications where superior reliability of the communication network is required, the Ekip Com R communication modules, installed together with the corresponding Ekip Com modules, guarantee redundant connection to the network.

The Ekip Com modules enable Ekip trip units to be connected to networks that use the following protocols:

Protocol	Ekip Com Module	Ekip Com Redundant Module
Modbus RTU	Ekip Com Modbus RS-485	Ekip Com R Modbus RS-485
Modbus TCP	Ekip Com Modbus TCP	Ekip com R Modbus TCP
Profibus-DP	Ekip Com Profibus	Ekip Com R Profibus
Profinet	Ekip Com Profinet	Ekip Com R Profinet
EtherNet / IP	Ekip Com EtherNet / IP	Ekip Com R EtherNet / IP
DeviceNet	Ekip Com DeviceNet	Ekip Com R DeviceNet
IEC61850	Ekip Com IEC61850	Ekip Com R IEC61850

Ekip Link module
The Ekip Link module enables an Emax 2 circuit breaker to be connected to the ABB communication system for locally supervising switchgear by means of the Ekip Control Panel and to act as Power Controller. It is suitable for all Ekip trip units and can be factory or field installed in the circuit breaker terminal box, even when Ekip Com communication modules are present. In this way, it is possible to have both local supervision of the switchgear by means of the Ekip Control Panel and supervision of the electrical system by means of the Ekip Com modules connected to the communication network.

The Ekip Link modules are supplied complete with auxiliary position contacts Ekip AUP and ready to close circuit breaker contacts Ekip RTC.

Ekip Com Actuator module
The Ekip Com Actuator module enables the Emax 2 circuit breakers to be opened and closed remotely.

The Ekip com Actuator is optional and can be ordered for all Ekip trip units equipped with Ekip Com or Ekip Link modules; it is installed on the front of the circuit breaker in the right-hand accessories area.

Ekip Bluetooth wireless communication unit
Ekip Bluetooth permits remote connection with the trip unit by portable PC, tablet or smart phone on which Ekip Connect software has been installed. The device is connected to the front test port found on all Ekip trip units of Emax 2 and Tmax XT circuit breakers and supplies power by means of a rechargeable Li-ion battery.

Communication products
Thanks to the wide range of communication protocols supported, Emax 2 circuit breakers equipped with Ekip Touch electronic trip units can be directly integrated into communication networks without the need for external interface devices.

The distinctive characteristics of the Emax 2 circuit breaker offering for industrial communication are:
- Wide range of protocols supported; the Ekip Com communication modules enable integration with the most common communication protocols

based on RS485 serial lines and the most modern communication systems based on EtherNet infrastructures, which guarantee an exchange of data in the order of 100 Mbit/s.
- Reduced installation times; the plug & play technology of the communication modules enable them to be snapped directly into the terminal box, without needing to remove the electronic trip unit.
- Repetition of communication for greater reliability of the system; the circuit breaker can be equipped with two communication modules at the same time, allowing the information on two buses to be exchanged simultaneously.
- Ready to smart grid; the Ekip Com 61850 module is the solution for integrating Emax 2 into the automated systems of electrical substations without the need for complex external devices.
- Complete supervision of Modbus RTU or Modbus TCP/IP networks via the Ekip View software for PCs.)

ABB offers software applications that allow the Ekip electronic trip units to be utilized to their fullest potential in terms of power management, acquisition and analysis of the electrical values, and testing of the protection, maintenance and diagnostic functions.

Software	Functions	Distinctive characteristics
Ekip Connect	commissioning of circuit breakers analysis of faults testing of communication bus	simple and intuitive use
		integrated with DOC electrical design software (IEC)
		useable via EtherNet
		automatic updating from the Internet
		off-line mode
		multi-media (smart phone, tablet or PC)
Ekip View	supervision and control of communication networks analysis of electrical value trends condition monitoring	engineering free
		analysis of past trends
		customizable reports
		access to the installation via the Internet
		possibility of integrating third party devices
Ekip T&P interface	testing of protection functions ordinary maintenance of trip units	test signals can be pre-set or configured as desired
		advanced graphical interface
		generation of test reports

Ekip Connect

Ekip Connect enables data to be exchanged with one or more protection trip units, which:

- Assists with system commissioning; all system parameters and the protection thresholds can be set rapidly in the Ekip trip units because of to the easy and intuitive navigation pages of the software.
- Permits rapid access to diagnostics; it is possible to consult and download the records of events, alarms and trip history, thereby facilitating the identification and understanding of the anomalies.
- Enables testing of the communication network; Ekip Connect performs an automatic scan of the Modbus RS-485 or Modbus TCP network and determines whether the circuit breakers have been correctly connected and, when necessary, signals incorrect configurations of the communication parameters (addresses, baud rate, parity).

The distinctive characteristics of the software are:

- Integration with DOC electrical design software (IEC only); the adjustments and settings calculated by the DOC software can be downloaded directly into the protection trip units, thereby reducing commissioning times and the potential for errors.
- Ease of connection: Ekip trip units equipped with Modbus TCP Ekip Com modules can be controlled directly by the EtherNet network.
- Multi-media; Ekip Connect is designed tooperate on a PC or on the more modern tablet PCs and smart phones.
- Automatic updating from the Internet; if connected to the Internet, the software is able to constantly control the availability of any updates.

Ekip View

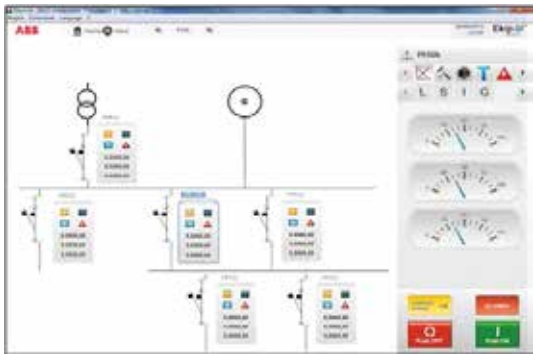
Ekip View is the software for supervising devices connected to a communication network that uses a Modbus RTU or Modbus TCP protocol.

It is the ideal tool for all applications that require:

- remote control of the system,
- monitoring of power consumption,
- fault detection of the system,
- allocation of energy consumption to the different processes and departments,
- preventative planning of maintenance.

The main characteristics of Ekip View are:

- Engineering free and ready to use software which guides the user in the recognition and configuration of the protection units without the need for any supervision system engineering activities.
- Dynamic mimic panel; after automatic scanning of the network, for each of the devices found, Ekip View proposes a dynamic symbol that summarizes the most important information (status, electrical measurements, alarms). The extensive library of electrical symbols enables the entire electrical system to be depicted in detail.
- Analysis of trends; the instantaneous and past trends of currents, powers and power factors are represented graphically and can be exported into Microsoft Excel for detailed analysis.
- Reports; advanced reports can be created regarding system and communication network diagnostics. Using the Alarm Dispatcher option, the user can receive the most important indications via SMS or e-mail.
- Access via web to the installation, due to the Web Server function of Ekip View.



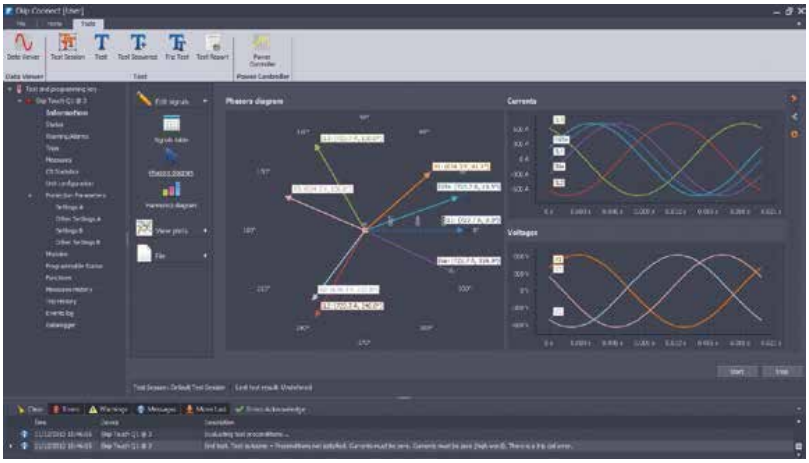
Media	Ekip Connect Software				
	Personal PC			**Smartphone/Tablet**	**iPhone/iPad**
Operating System	Windows XP, Windows 7, Windows Vista			Android	iOS
Method of connection to the trip units	Communication network	Test connector	Wireless communication	Wireless communication	Wireless communication
SACE Emax 2 trip units	Ekip Com Modbus RS485 or TCP	Ekip T&P	Ekip Bluetooth	Ekip Bluetooth	Ekip Bluetooth
SACE Tmax XT trip units	Ekip Com	Ekip T&P	Ekip Bluetooth	-	-
SACE Emax,T7,X1,T8 trip units	PR120/D-M, PR330/D-M	Ekip T&P or BT030	BT030	-	-
SACE Tmax T trip units	PR222DS/PD, PR223DS; PR223/EF	Ekip T&P or BT030	BT030	-	-

Communication characteristics	**Ekip View Software**	
Protocol Supported	**Modbus RTU**	**Modbus TCP**
Physical layer	RS 485	EtherNet
Maximum data exchange rate	19200 bps	100 Mbps
Operating system	Windows XP, Windows 7, Windows Vista	
Devices supported		
Emax 2 trip units	Ekip com Modbus RS485	Ekip com Modbus TCP
Emax,T7,X1,T8 trip units	PR120/D-M, PR330/D-M	-
Tmax T trip units	PR222DS/PD, PR223DS	-
Tmax XT trip units	Ekip com	-
Third party devices	optional [1]	optional [1]
Licenses available	up to 30 [2] controllable devices	
	up to 60 [2] controllable devices	
	unlimited number [3] of controllable devices	
Supervision and control functions		
Circuit breaker opening and closing [4]	•	•
Electrical value trends	•	•
Log of electrical value trends	•	•
Dynamic installation mimic panel	•	•
Automatic scanning	•	•
Centralized synchronizing of time	•	•
Web server function	• [5]	• [5]
Redundancy	optional	optional
OPC server-client	optional	optional

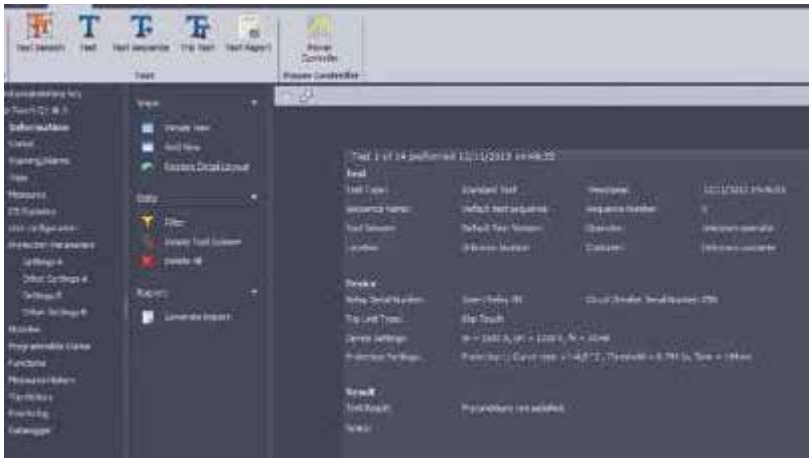
Measurement functions [6]		
Currents	•	•
Voltages	•	•
Powers	•	•
Energies	•	•
Harmonics	•	•
Network Analyzer	•	•
Data logger	•	•
Adjusments functions		
Setting of thresholds	•	•
Resetting of alarms	•	•
Diagnostics		
Protection function alarms	•	•
Device alarms	•	•
Communication system alarms	•	•
Protection unit tripping details	•	•
Events log	•	•
Protection unit tripping log	•	•
Report generation	•	•
Transmission of alarms via SMS	optional	optional
Transmission of alarms via e-mail	optional	optional
Maintenance		
Number of operations	•	•
Number of trips	•	•
Contact wear (endurance)	•	•
Other data		
Circuit breaker status	•	•
Circuit breaker position [7]	•	•
Local/remote mode	•	•

1) Contact ABB to integrate other devices in the Ekip View software
2) can be increased
3) within the physical limit of the protocol used
4) circuit breakers equipped with Ekip com Actuator module and electrical accessories
5) two client web accesses included in the license, optional accesses for up to 5
6) according to the values supported by the trip units
7) circuit breakers equipped with auxiliary contacts for position indication

Ekip T&P Interface
The Ekip T&P Interface software, used together with the Ekip T&P device, enables the electronic protection trip units to be tested for correct operation during the stages of commissioning and system maintenance.
As a result of advanced graphical interfaces, the user can simply select the test to perform: from simple current and voltage signals to more complex wave forms with the presence of harmonic distortion.



The software creates and stores all reports, keeping a record of the tests carried out and essential information such as the operator name, date, serial number of the circuit breaker, type of test and the result.



Testing and programming

Ekip TT testing and power supply unit (battery pack)
Ekip TT is a device that allows you to verify that the circuit breaker trip mechanism is functioning correctly (trip test).

It also allows a trip unit not provided with auxiliary power supply to be supplied with power so that the last protection device tripped can be displayed directly on the screen or by the lighting up of corresponding LEDs.

The device can be connected to the front test port of any Ekip trip unit of Emax 2; it is supplied as standard with the versions for distribution and generator protection of the Ekip Touch, Hi-Touch trip units to set protection functions.

Ekip T&P testing kit
Ekip T&P is a kit that includes different components for programming and testing the electronic protection trip units.
The kit includes:
- Ekip T&P unit;
- Ekip TT unit;
- adaptors for Emax and Tmax trip units;
- USB cable to connect the T&P unit to the Ekip trip units;
- - installation CD for Ekip Connect and Ekip T&P interface software.

The Ekip T&P unit easily connects from your PC (via USB) to the trip unit (via mini USB) with the cable provided.

The Ekip T&P unit can perform simple manual or automatic tests on the trip unit functions. The Ekip T&P will also provide the ability to conduct more advanced function testing that allows the addition of harmonics and the shifting of phases to more accurately represent the real conditions of an application. Thus, leading to more concise protection function parameters that may be required for critical applications. It can also generate a test report as well as help you to monitor maintenance schedules.

Ekip Programming Module
The Ekip Programming module is used for programming Ekip trip units via USB to a PC using the Ekip Connect software that can be downloaded online. This can be useful for uploading/ downloading entire sets of parameters for multiple breakers both for set-up as well as for maintenance (for periodic cataloging breaker parameters in case of a catastrophic situation).

Breaker test cabinet
A breaker test cabinet is an optional feature that can be used to test the ABB Emax 2 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.

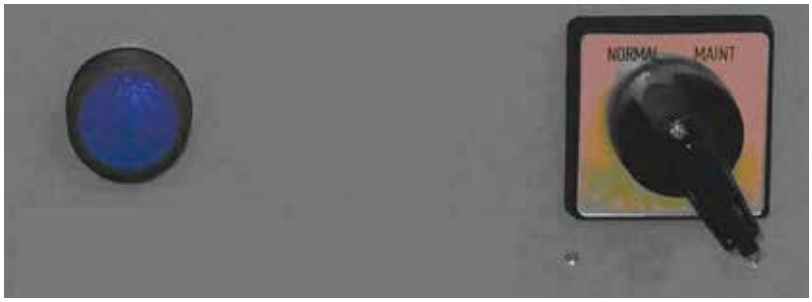
Arc flash mitigation

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
- Ekip Hi-Touch trip unit for the Emax 2 circuit breaker
- Ekip 2K or 4K signaling module
- Blue indicating light (to be blinking when in maintenance mode)
- 24VDC power supply (this is standard with Ekip Hi-Touch)
- ABB 2 position changeover switch, 4 pole, with padlocking handle in both positions
- 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.

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 2 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 2 circuit breakers
- 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

Depth	Height
Rated service voltage	110VAC (-20%/+15%)
Frequency	110VDC (-20%/+15%)
Rated power	50-60 Hz
Inrush power	120 W, 120 VA
Inrush time	consumption 600 W, 600 VA
Working and storage temperature range	0,5 s
Duty cycle	-10 °C ... +40 °C
Minimum time out between operations	20 operations / hour 1 minute
Maximum operating distance	9 m / 30 ft
Weight	9 kg / 20 lb

The device is always equipped with a dedicated adapter kit to allow the complete mounting of the RRD device on up to 5 Emax 2 circuit breakers. The kit can be ordered even as a loose accessory to allow the installation on another 5 additional Emax 2. 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.

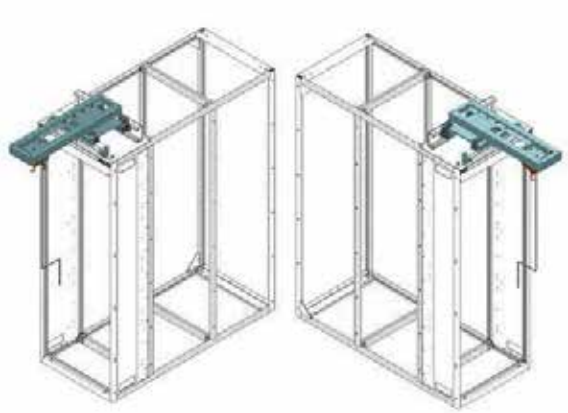
Mimic bus
Mimic bus, when requested, is provided as an engraved 11” x 17” phenolic nameplate. Mimic bus may also be provided on individual breaker doors using phenolic plates depicting symbols and single line connections.

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.

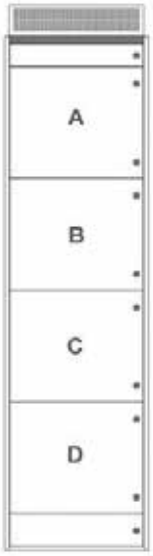
Transition sections from MNS-SG to ABB MaxSG lineups are also available.

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 2 circuit breaker in front of the switchgear. The device may be used in place of an overhead lift device.

Layout Details



Depth	Height
Depth 72.9" (1852mm, standard) or 80.8" (2052mm, optional)	Arc-resistant (top of chimney) 96.1" (2439.7mm)
	Arc-resistant with overhead lifting device 99.4" (2524mm)
	Arc-resistant (top of plenum) 122.1" (3100.5mm)
	Non arc-resistant (top of chimney) 95.92" (2436.4mm)
	Non arc-resistant with overhead lifting device 99.4" (2524mm)
	Non arc-resistant with overhead lifting device 99.4"

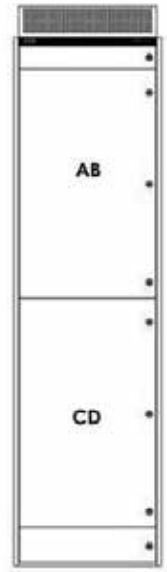
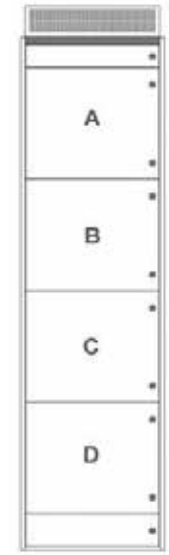
Note: With base channel, add 1.5" to each height above

Configurations for feeder section

Global parameters				Feeder	
Current (A)	**Sccr* (kA)**	**Section width**	**CTs load side**	**Feeder breaker**	**Location**
800-1600	65	600mm-1000mm (23.6 in-39.4 in)	Optional up 2 CTs per phase RELAYING METERING/ METERING	E2.2	A, B, C, D
2000					
800 - 2000	100/85			E4.2	
2500	65	700mm-1000mm(27.6 in-39.4 in)			B, C, D
	100/85				

***** 100kA is up to 480VAC, 85kA is for 600VAC
Not for construction

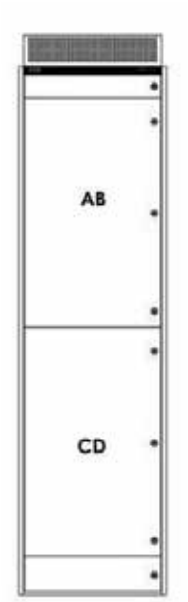
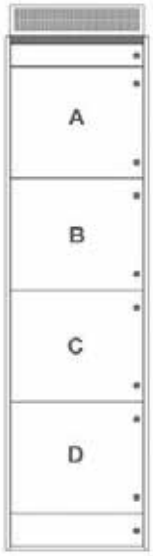
Configurations for main section with close couple connection and feeders

Global parameters					Main with close couple connection				Feeder	
	Current (A)	Sccr* (kA)	Section width (mm)	System	Main breaker	Location	CTs line side	CTs load side	Feeder optional location	Maximum feeder breaker
	1600	65	600	3P 3W	E2.2	B	Optional	Optional	C, D	E2.2-1600A
						C			D	
		100 / 85			E4.2	B			C, D	E4.2-1600A
						C			D	
			700			B			C, D	
						C			D	
	2000	65	600		E2.2	B			C, D	E2.2-2000A
						C			D	
		100 / 85			E4.2	B			C, D	E4.2-2000A
						C			D	
			700			B			C, D	
						C			D	
	3200	65	800		E4.2	B			C, D	E4.2-2500A
						C			D	
		100 / 85				AB			C, D	
						CD			None	-
	4000	65	1000		E6.2	B		No	C, D	E4.2-2500A
						C			D	
		100 / 85				AB			C, D	
						D		Yes	None	-
						CD		D		
	1600	65	600	3P 4W	E2.2	B			D	E2.2-1600A
						C				
		100 / 85			E4.2	B				E4.2-1600A
						C				
			700			B				
						C				
	2000	65	600		E2.2	B				E2.2-2000A
						C				
		100 / 85			E4.2	B				E4.2-2000A
						C				
			700			B				
						C				
	3200	65	800		E4.2	B				E4.2-2500A
						C				
		100 / 85				AB				
						CD			None	-
	4000	65	1000		E6.2	B		No	D	E4.2-2500A
						C				
		100 / 85				AB				
						D		Yes	None	-
						CD		Optional		

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

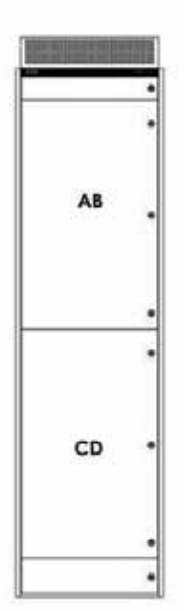
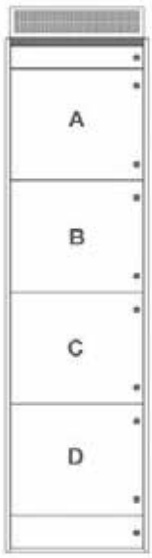
Not for construction

Configurations for main section with close couple connection and feeders

Global parameters					Main with close couple connection					Feeder		
	Current (A)	Sccr* (kA)	Section width (mm)	System	Incoming	Main breaker	Location	CTs line side	CTs load side	Outgoing	Feeder optional location	Maximum feeder breaker
	1600	65	600	3P 3W	Bottom	E2.2	B	Optional	Optional	Top	A	E2.2-1600A
							C				A, B	
		100 / 85				E4.2	B				A	E4.2-1600A
							C				A, B	
			700				B				A	
							C				A, B	
	2000	**65**	**600**			E2.2	B				A	E2.2-2000A
							C				A, B	
		100 / 85				E4.2	B				A	E4.2-2000A
							C				A, B	
			700				B				A	
							C				A, B	
	3200	65	800			E4.2	B				A	E4.2-2500A
							C				A, B	
		100 / 85					AB				None	-
							CD				A, B	E4.2-2500A
	4000	65	1000			E6.2	B		No		A	
							C				A, B	
		100 / 85					AB				None	-
							D		Yes			
							CD		Optional			
	1600	65	600	3P 4W		E2.2	C				A	E2.2-1600A
		100 / 85	700			E4.2						E4.2-1600A
	2000	65	600			E2.2						E2.2-2000A
		100 / 85	700			E4.2						E4.2-2000A
	3200	65	800			E4.2					None	-
		100 / 85					CD				B	E4.2-2500A
	4000	65	1000			E6.2	C		No		None	-
		100 / 85					D		Yes			
							CD		Optional			

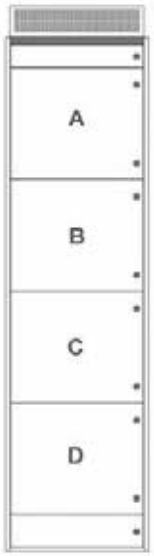
***** 100kA is up to 480VAC, 85kA is for 600VAC
Not for construction

Configurations for main section with bus duct and feeders

Global parameters					Main with close couple connection					Feeder		
	Current (A)	Sccr* (kA)	Section width (mm)	System	Incoming	Main breaker	Location	CTs line side	CTs load side	Outgoing	Feeder optional location	Maximum feeder breaker
	1600	65	600	3P 3W	Top	E2.2	B	Optional	Optional	Bottom	C, D	E2.2-1600A
							C				D	
		100 / 85				E4.2	B				C, D	E4.2-1600A
							C				D	
			700				B				C, D	
							C				D	
	2000	65	600			E2.2	B				C, D	E2.2-2000A
							C				D	
		100 / 85				E4.2	B				C, D	E4.2-2000A
							C				D	
			700				B				C, D	
							C				D	
	3200	65	800			E4.2	B				C, D	E4.2-2500A
							C				D	
		100 / 85					AB				C, D	
							CD				None	-
	4000	65	1000			E6.2	B		No		C, D	E4.2-2500A
							C				D	
		100 / 85					AB				C, D	
							D		Yes		None	-
							CD		Optional			
	1600	65	600	3P 4W		E2.2	B				D	E2.2-1600A
							C					
		100 / 85				E4.2	B					E4.2-1600A
							C					
			700				B					
							C					
	2000	65	600			E2.2	B					E2.2-2000A
							C					
		100 / 85				E4.2	B					E4.2-2000A
							C					
			700				B					
							C					
	3200	65	800			E4.2	B					E4.2-2500A
							C					
		100 / 85					AB					
							CD				None	-
	4000	65	1000			E4.2	B		No		D	E4.2-2500A
							C					
		100 / 85					AB					
							D		Yes		None	-
							CD		Optional			

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

Not for construction



Depth	Height
Depth 72.9" (1852mm, standard) or 80.8" (2052mm, optional)	Arc-resistant (top of chimney) 96.1" (2439.7mm)
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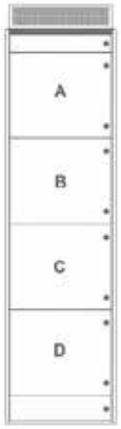
	Arc-resistant (top of plenum) 122.1" (3100.5mm)
	Non arc-resistant (top of chimney) 95.92" (2436.4mm)
	Non arc-resistant with overhead lifting device 99.4" (2524mm)

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

Configurations for main section with feeders**

Global parameters				Main				Feeder	
Current (A)	**Sccr* (kA)**	**Section width (mm)**	**System**	**Main breaker**	**Location**	**CTs line side**	**CTs load side**	**Feeder optional location**	**Maximum feeder breaker**
1600	65	600	3P 3W	E2.2	B	Optional up to 2 CT per phase for RELAYING METERING / METERING	Optional 1 CT per phase for RELAYING METERING	A, C, D	E2.2-1600A
					C			A, B, D	
	100 / 85			E4.2	B			A, C, D	E4.2-1600A
					C			A,B, D	
		700			B			A, C, D	
					C			A, B, D	
2000	65	600		E2.2	B			A, C, D	E2.2-2000A
					C			A, B, D	
	100 / 85			E4.2	B			A, C, D	E4.2-2000A
					C			A, B, D	
		700			B			A, C, D	
					C			A, B, D	
3200	65	800		E4.2	B			A, C, D	E2.2-2000A / E4.2-2500A
					C			A, B, D	
	100 / 85				AB			C, D	E4.2-2500A
					CD			B	
4000	65	1000		E6.2	B	No	No	A, C, D	E2.2-2000A / E4.2-2500A
					C			A, B, D	
	100 / 85				AB			C, D	E4.2-2500A
					CD			B	
400	65				D	Optional up to 2 CT per phase for RELAYING METERING / METERING	Optional 1CT per phase for RELAYING METERING	None	-
	100 / 85				CD				
1600	65	600	3P 4W	E2.2	C				
	100 / 85	700		E4.2					
2000	65	600		E2.2					
	100 / 85	700		E4.2					
3200	65	800		E4.2					
	100 / 85				CD				
4000	65	1000		E6.2	C	No	No		
	100 / 85				CD				

* 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



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	Non arc-resistant with overhead lifting device 99.4" (2524mm)

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

Configurations for main-tie section with

Global parameters				Main				Tie breaker				Feeder	
Current (A)	Sccr* (kA)	Section width (mm)	System	Main breaker	Location	CTs line side	CTs load side	Tie breaker	Location	CTs bus A	CTs bus B	Feeder optional location	Maximum feeder breaker
1600	65	600	3P 3W	E2.2	B	Optional up to 2 CT per phase for RELAYING METERING / METERING	Optional 1 CT per phase for RELAYING METERING	E2.2	C	Optional 1 CT per phase for RELAYING METERING	Optional 1CT per phase for RELAYING METERING	A (Bus A)	E2.2-1600A
	100 / 85	700		E4.2				E4.2					E4.2-1600A
2000	65	600		E2.2								D (Bus B)	E4.2-2000A
	100 / 85	700		E4.2									
3200	65	800		E4.2				E4.2				D (Bus B)	E4.2-2500A
	100 / 85				AB				CD			None	-
4000	65	1000		E6.2	B	No	No	E6.2	C	No	No	D (Bus B)	E4.2-2500A
	100 / 85				AB				CD			None	-

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

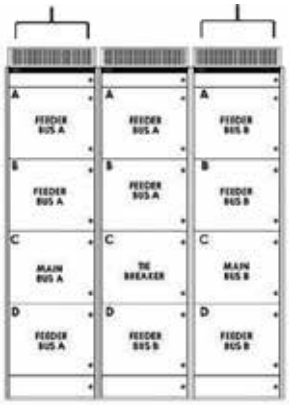
A. M-T-M in two sections
A main-tie-main configuration can fit into two sections and still have room for feeders. This is possible only for the 3-wire, 3-phase system. Some restrictions on the use of CTs (or room for feeders) may apply for systems at 4000A, and for systems 3200A, 85kA or above.

Top/bottom Incoming Cable connection

Top/bottom Incoming Cable connection

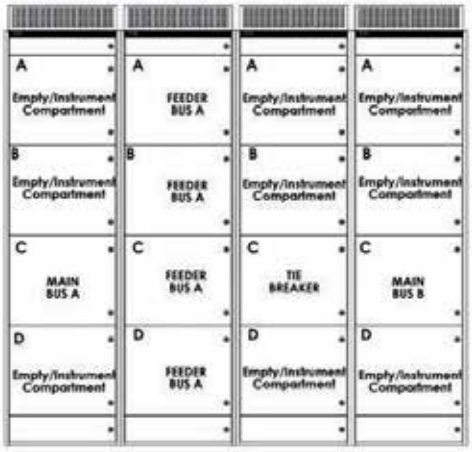
B. M-T-M in three sections
When CTs are required in 3-phase, 3-wire systems, a main-tie-main configuration will typically be implemented in three sections.

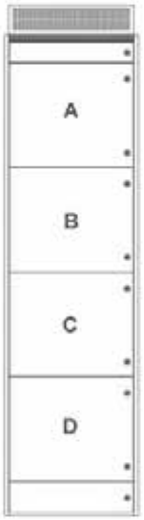
Top/bottom Incoming Cable connection



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.





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	Non arc-resistant with overhead lifting device 99.4" (2524mm)

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

Configurations for tie section with feeders

Global parameters			Tie				Feeder	
Current (A)	**Sccr* (kA)**	**Section width (mm)**	**Tie breaker**	**Location**	**CTs line side**	**CTs load side**	**Feeder optional location**	**Maximum feeder breaker**
1600	65	600		C	Optional 1 CT per phase for RELAYING METERING	Optional 1 CT per phase for RELAYING METERING	A, B (bus A) D (bus B)	E2.2-1600A
	100 / 85	700	E4.2					E4.2-1600A
2000	65	600						E4.2-2000A
	100 / 85	700						
3200	65	800	E4.2				B (bus A) D (bus B)	E4.2-2500A
	100 / 85			CD			B (bus A)	
4000	65	1000	E6.2	C	No	No	B (bus A) D (bus B)	
	100 / 85			CD			B (bus A)	
4000	65			D	Yes	Yes	None	-
	100 / 85			CD				

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

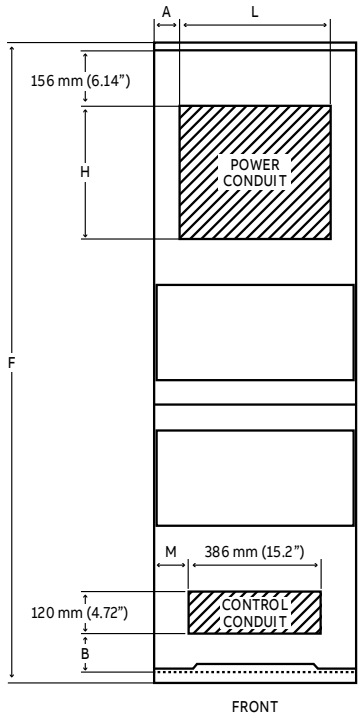
Not for construction

MNS-SG switchgear floor plans

72.9” (1852mm, standard) or 80.8” (2052mm, optional) depth

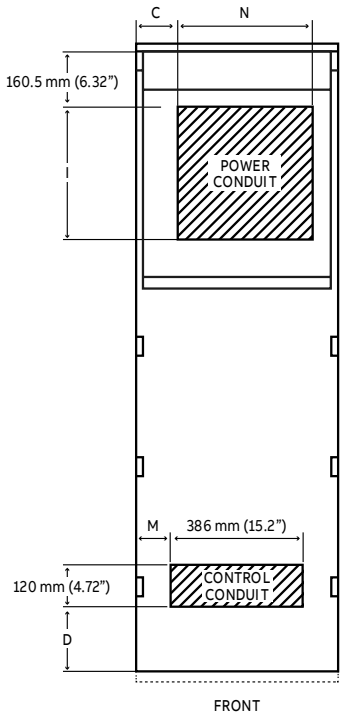
Conduit Entry Plan

Top Plan

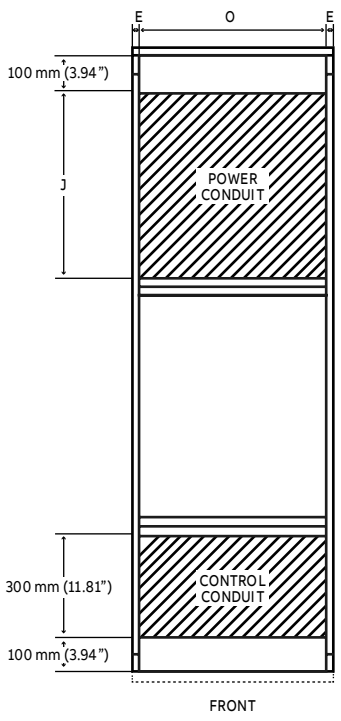


Bottom Plan

With bottom plates

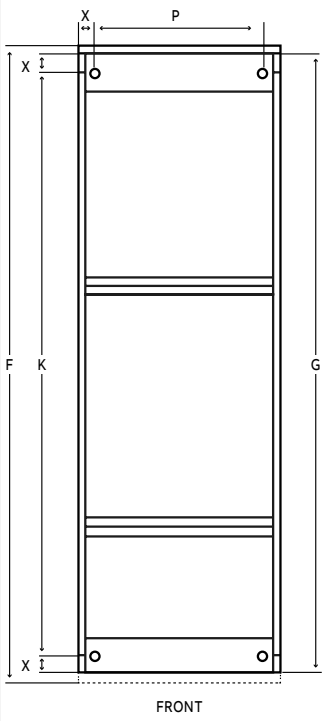


Without bottom plates



Anchoring Plan

With or without bottom plates



General Dimensions	
A	78mm (3.07")
B	113 mm (4.45")
C	131 mm (7.48")
D	190 mm (7.48")
E	25 mm (0.98")

F (Total depth)	G (Frame depth)	H	I	J	K
1852 mm (72.91")	1800 mm (70.87")	389 mm (15.31")	399 mm (15.71")	550 mm (21.65")	1715 mm (67.52")
2052 mm (80.79")	2000 mm (78.74")	619 mm (24.37")	599 mm (23.58")	750 mm (29.53")	1915 mm (75.39")

Section width	L	M	N	O	P
500 mm (19.69") *	344 mm (13.54")	57 mm (2.24")	294 mm (11.57")	450 mm (17.72")	400 mm (15.75")
600 mm (23.62")	444 mm (17.48")	107 mm (4.21")	394 mm (15.51")	550 mm (21.65")	500 mm (19.69")
700 mm (27.56")	544 mm (21.42")	157 mm (6.18")	494 mm (19.45")	650 mm (25.59")	600 mm (23.62")
800 mm (31.5")	644 mm (25.35")	207 mm (8.15")	594 mm (23.39")	750 mm (29.53")	700 mm (27.56")
1000 mm (39.37")	844 mm (33.23")	307 mm (12.09")	794 mm (31.26")	950 mm (37.4")	900 mm (35.43")

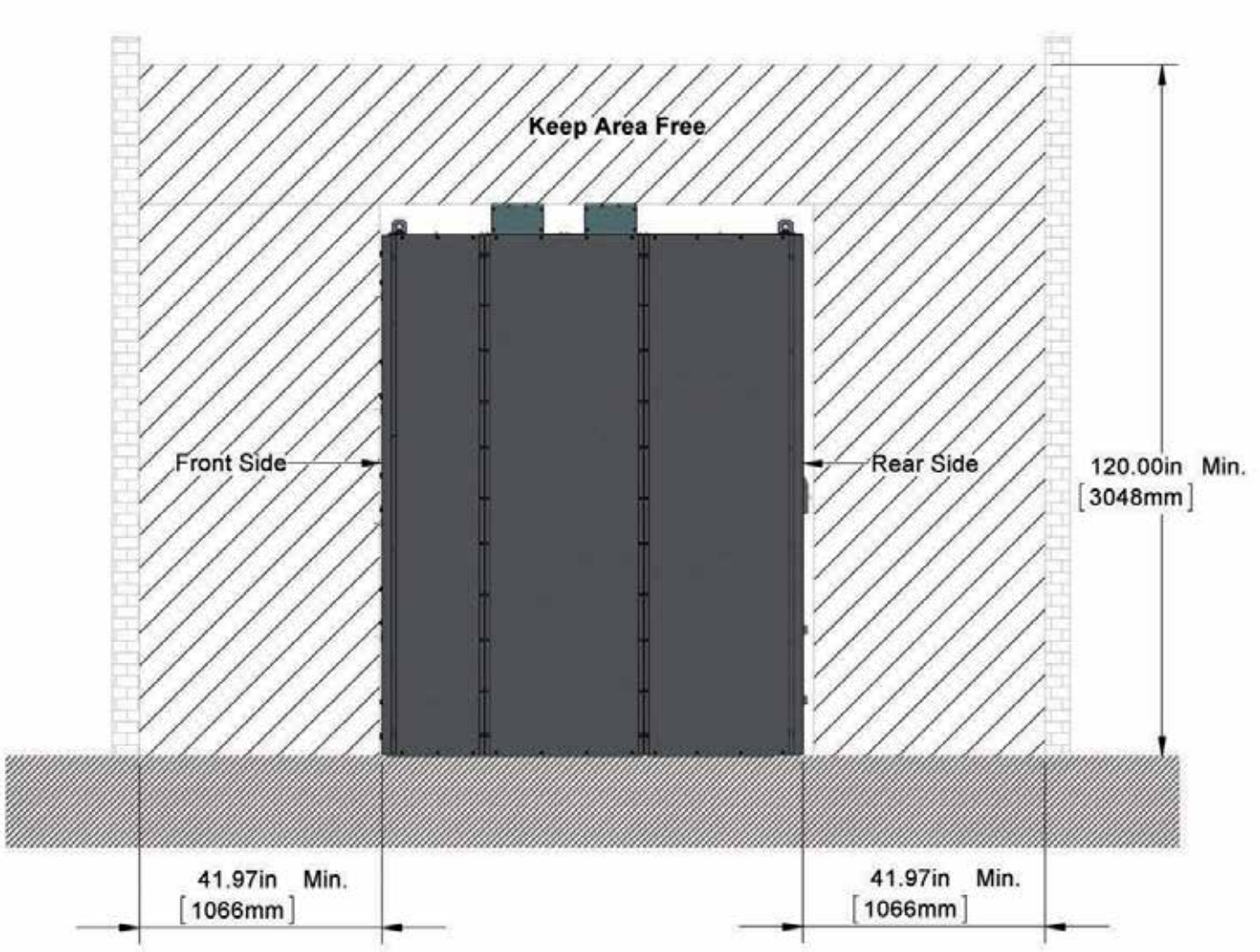
General Dimensions	
X	50 mm (1.97")

* For transition section only.

Not for construction.

MNS-SG arc-resistant layout restrictions

Side view with chimney design

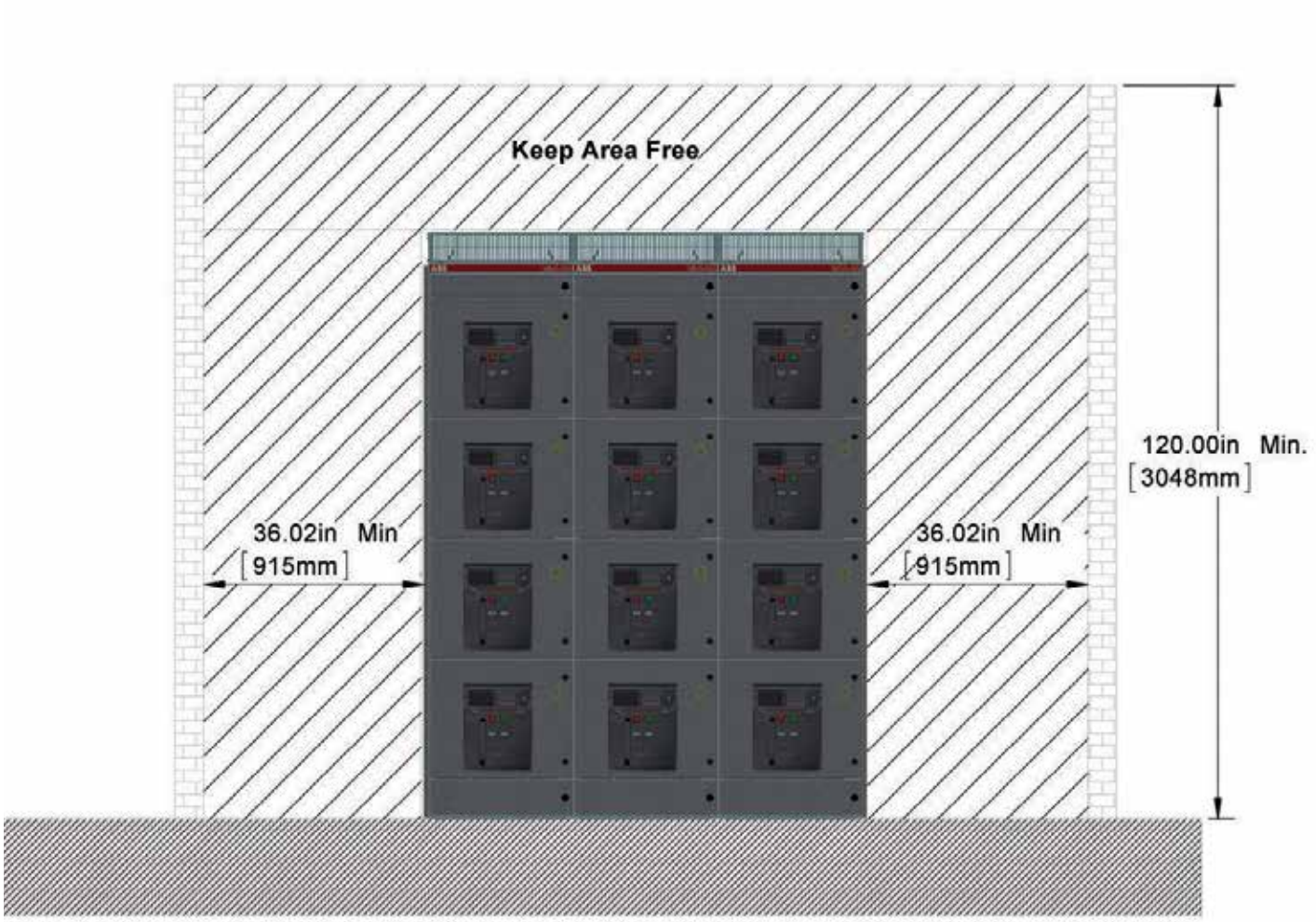


Note: dimensions shown are not for power distribution center (PDC) / E-house installations

Not for construction

MNS-SG arc-resistant layout restrictions

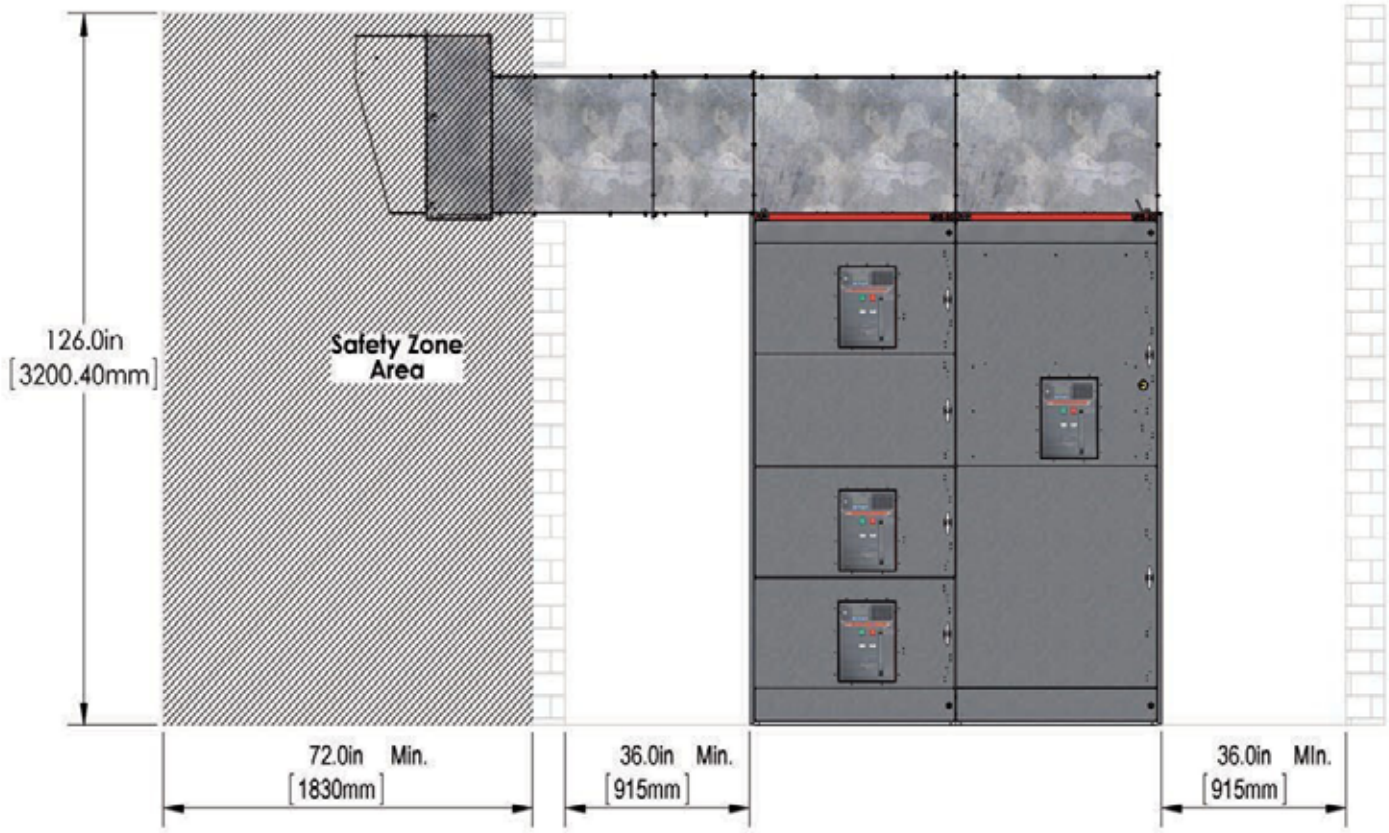
Front view with chimney design



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

MNS-SG arc-resistant layout restrictions

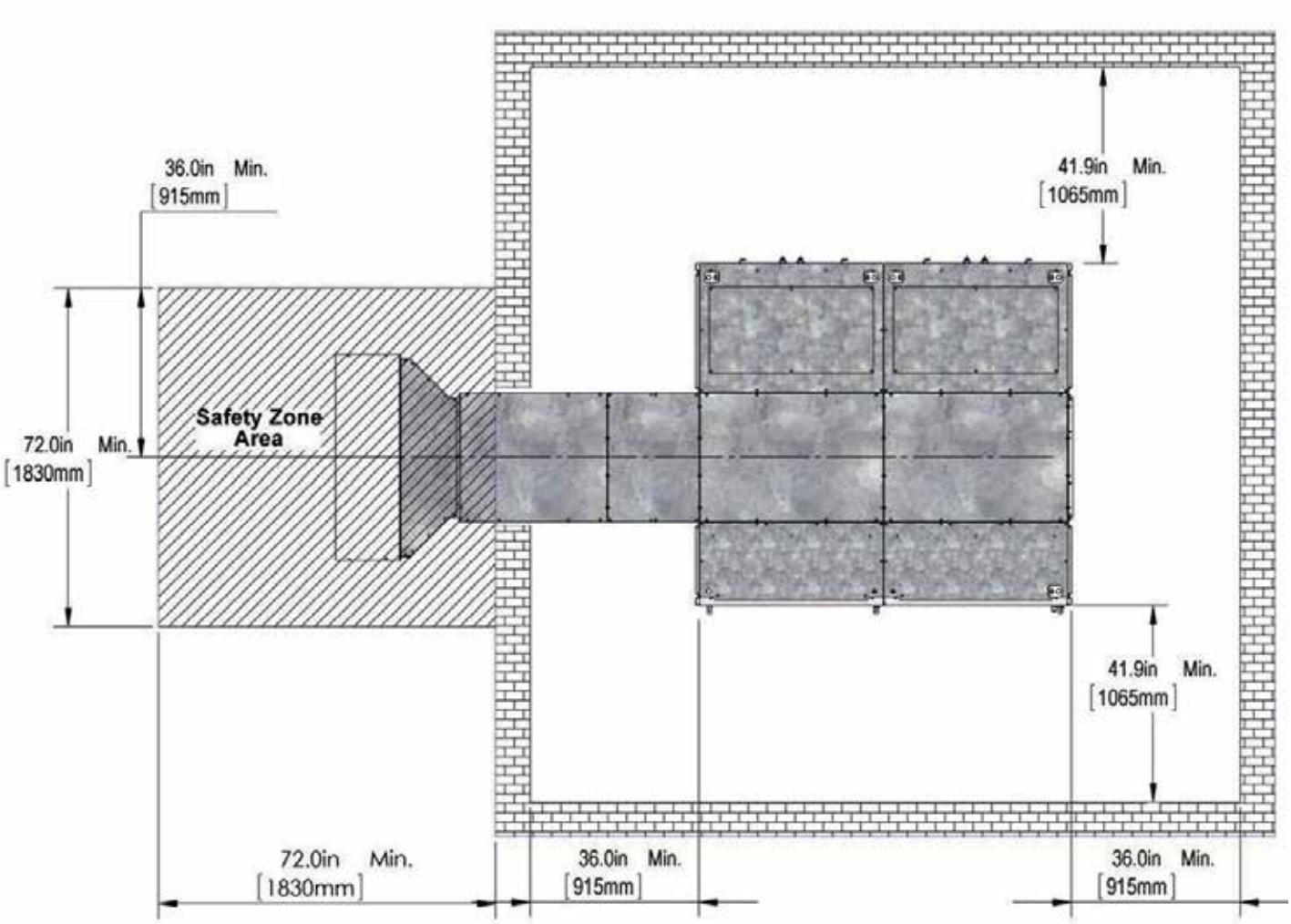
Front view with plenum design



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

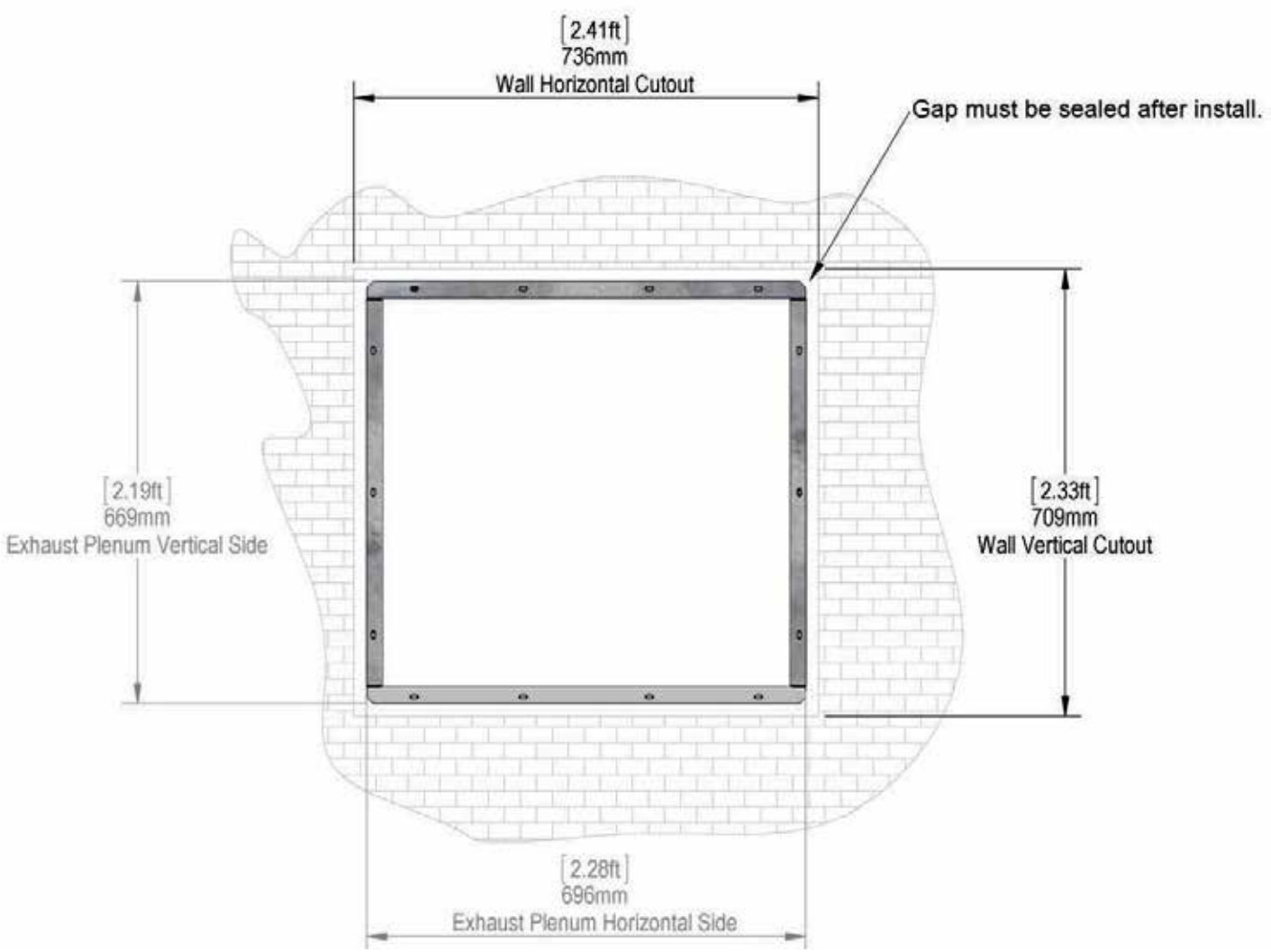
MNS-SG arc-resistant layout restrictions

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

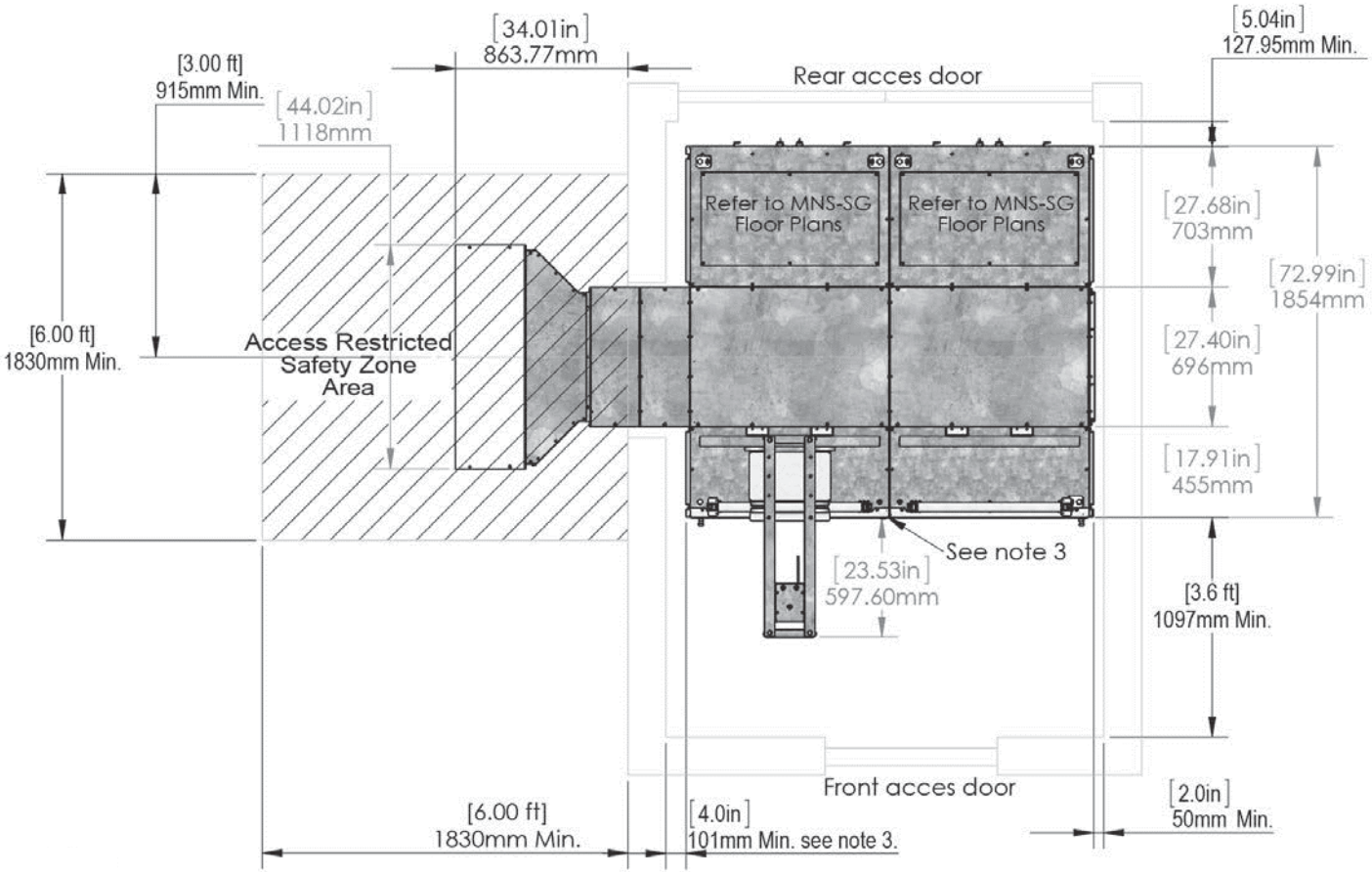
Exhaust opening for plenum design



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

Power distribution/e

House

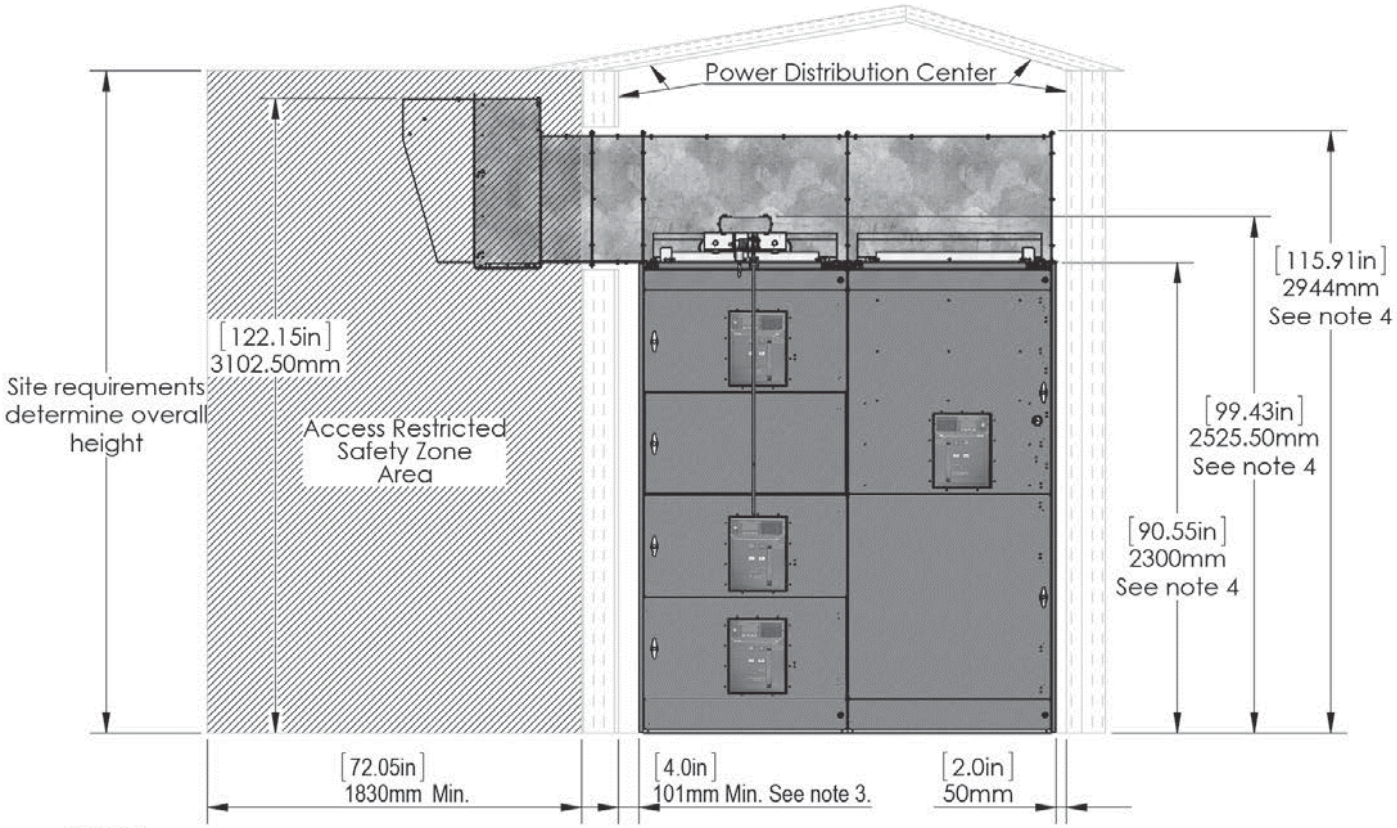


Notes:

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 posible for single door.
   (4000A and greater require two doors wich 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 wich 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.

Width	Units	Enclosure and Structure		Copper busbars									
		Depth		1600		2000		3200		4000		5000	
		1852 mm (72.9")	2000 mm (80.7")	3P-3W	3P-4W	3P-3W	3P-4W	3P-3W	3P-4W	3P-3W	3P-4W	3P-3W	3P-4W
500 mm* (19.6")	kg	269.9	283..3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	lbs	595.0	624.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
600 (23.6")	kg	326.0	339.9	174.1	183.0	222.8	233.9	N/A	N/A	N/A	N/A	N/A	N/A
	lbs	718.6	749.4	383.8	403.4	491.2	515.7	N/A	N/A	N/A	N/A	N/A	N/A
700 (27.5")	kg	345.5	360.2	182.0	191.9	230.8	243.4	N/A	N/A	N/A	N/A	N/A	N/A
	lbs	761.7	794.0	401.1	423.1	508.8	536.6	N/A	N/A	N/A	N/A	N/A	N/A
800 (31.5")	kg	374.8	390.1	N/A	N/A	N/A	N/A	412.6	424.2	N/A	N/A	N/A	N/A
	lbs	826.3	860.0	N/A	N/A	N/A	N/A	909.6	957.2	N/A	N/A	N/A	N/A
1000 (39.4")	kg	413.1	429.7	N/A	N/A	N/A	N/A	N/A	N/A	615.8	649.2	810.6	850.6
	lbs	910.7	947.2	N/A	N/A	N/A	N/A	N/A	N/A	1357.6	1431.2	1787.1	1875.3

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

Breaker w/cradle			
E2.2	E4.2 up to 2500A	E4.2 3200 A	E6.2
58 kg 12 lbs	118 kg 261 lbs	136 kg 300 lbs	220 kg 486 lbs

Note: Hardware and control factor adds 4% to total

Breaker/instrument/empty compartment
28.6 kg 63.1 lbs
33.25 kg 73.3 lbs
38 kg 83.8 lbs
42.7 kg 94.1 lbs
52 kg 114.6 lbs

Accesories	
Overhead lifting device	118 lbs
	54 kgs
CTs (set of three up to 3200A)	33 lbs
	15 kg
CTs (set of three, 4000A)	77 lbs
	35 kg
HRG	132 lbs
	60 kg
PTs (each)	11 lbs
	5 kg
Close coupling or bus duct raisers (3200A)	441 lbs
	200 kg
Close coupling or bus duct raisers (5000A)	661 lbs
	300 kg

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