SYSTEM GUIDE

MNS Rear

Low voltage switchgear

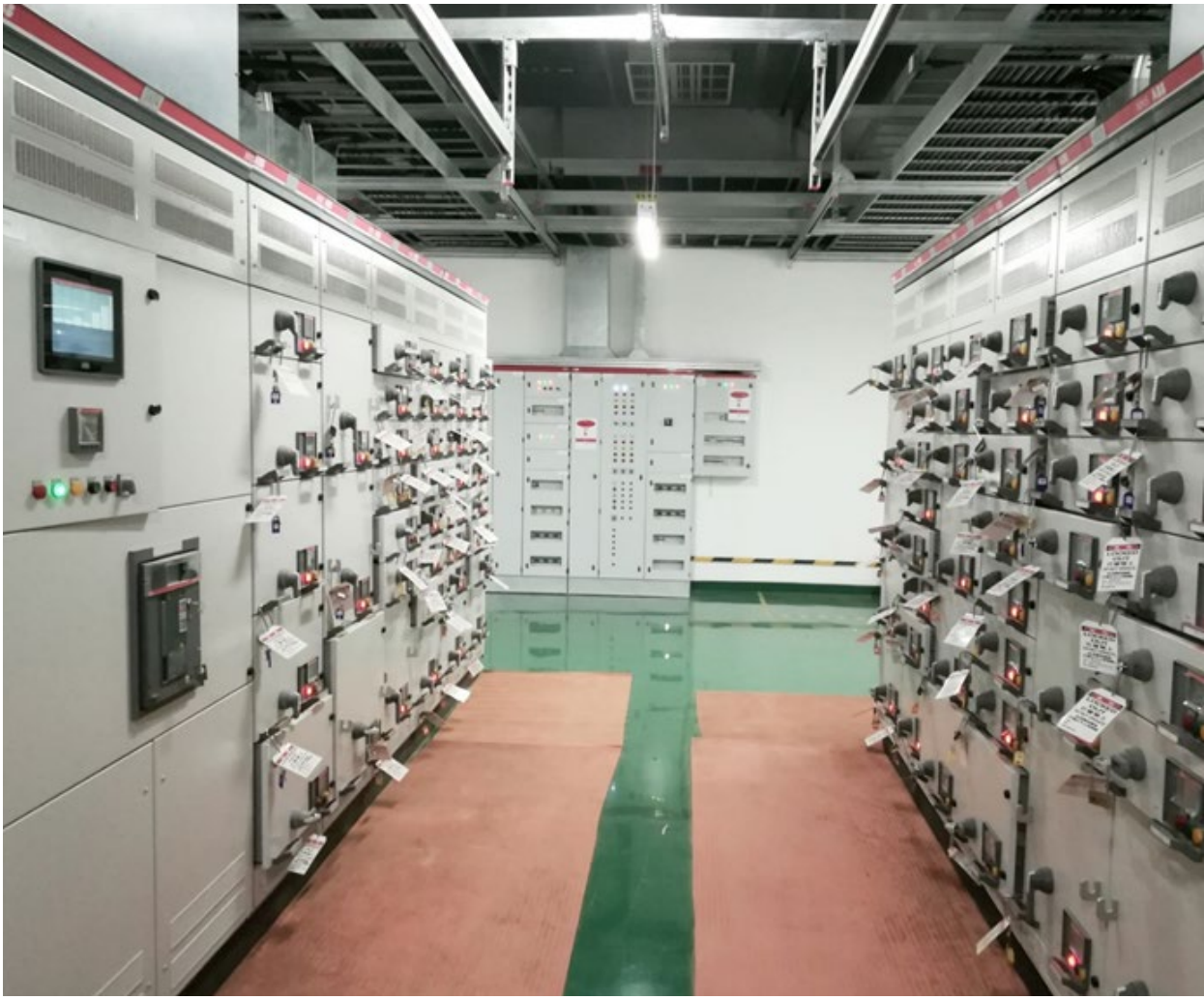
Contents

01. MNS Rear Switchgear Overview

Switchgear Evolution
ABB is the global leader for low voltage switchgear with over 1.5 million MNS cubicles delivered world-wide since the inception of this system in 1973. ABB's history in switchgear can be traced back even further, to the 1890's when we first manufactured switchgear systems in Sweden.

With these credentials it is no surprise that the MNS system is the benchmark for operational safety, reliability and quality.

ABB draws on this wealth of background knowledge in designing and manufacturing low voltage switchgear for its global and local customers. This together with the global service and support network established in over 30 locations worldwide, ensures that the choice of MNS will be the right decision.



Features & Applications
MNS Rear as part of the ABB Low Voltage Switchgear solution uses the well proven ABB MNS standard design aspects. Its design is verified in accordance with IEC 61439-1/-2. The consistent application of the modular principle both in electrical and mechanical design as well as the use of standardized components allows its flexible and compact design. Depending on operating and environmental conditions different design levels are available.

Notable system advantages about design aspects:
- Optimum protection for personnel and plant
- Design verified by testing including arc fault containment
- High operational reliability and availability
- Earthquake-, vibration- and shock-proof designs are available
- Maintenance-free busbar and frame construction
- Simple retrofitting procedures
- Compact, space-saving design
- Simplified project implementation utilizing ABB’s dedicated engineering tool

Thus, MNS Rear proves to have the approved solution for the following industries:
- Oil & Gas, on and off-shore
- Chemical / Petrochemical
- Pharmaceutical
- Power stations
- Paper
- Water treatment
- Mining
- Steel
- Food
- Marine

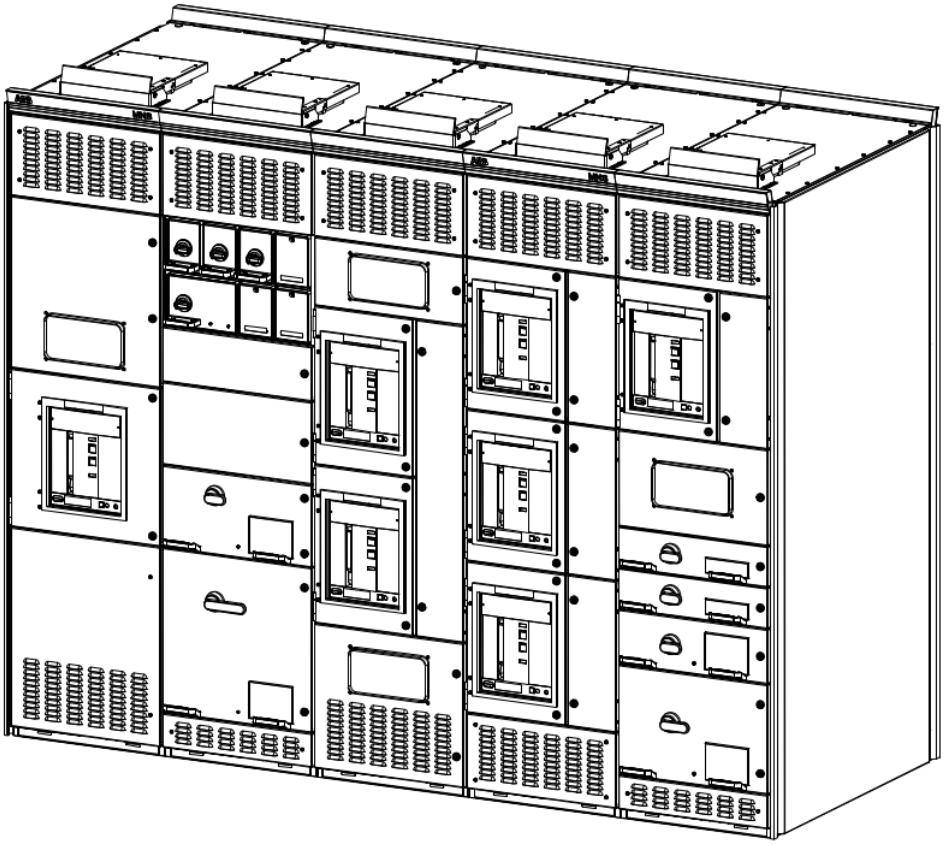
as well as for infrastructure requirements:
- Data centers
- Airports
- Office buildings
- Shopping centers
- Hospitals
- Rail

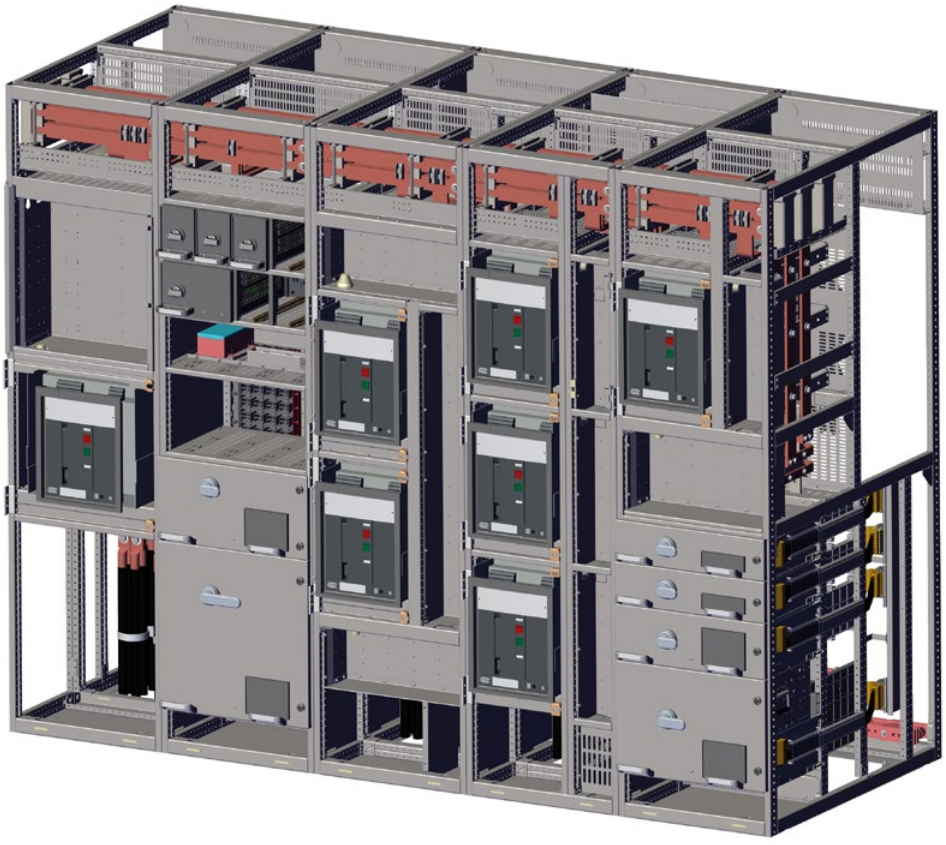
ABB's worldwide competence is second to none, this is possible due to the global MNS switchgear platform, and local ABB manufacturing facilities.

ABB ensures conformance to IEC 61439-1/-2 throughout, these locations with a proprietary switchgear engineering tool. This tool provides a comprehensive database with predefined engineering solutions for MNS Rear. This database is then utilized with minimal engineering effort to provide customer specific solutions, thus meeting local specifications.

Where specific solutions are required on a global basis, these can easily be deployed throughout the ABB manufacturing facilities network, thus significantly reducing project lead times.

Typical Set-up





Technical Data

Standards		**Low-voltage switchgear and controlgear assemblies – verification by testing**	**IEC 61439-1/2**
Test certificates			DEKRA / ASTA
Electrical data	Rated voltages	Rated insulation voltage U_i	up to 1 000 V 3~, 1 500 V-
		Rated operational voltage U_e	up to 690 V 3~
		Rated impulse withstand voltage U_{imp}	6 / 8 / 12 kV *
		Overvoltage category	II / III / IV *
		Degree of pollution	3
		Rated frequency	50/ 60 Hz
	Rated currents	Main busbar	
		Rated current I_n	up to 7300 A
		Rated peak withstand current I_{pk}	up to 220 kA
		Rated short-time withstand current I_{cw}	up to 100 kA
		Distribution busbar	
		Rated current I_n	up to 2000 A
		Rated peak withstand current I_{pk}	up to 220 kA
		Rated short-time withstand current I_{cw}	up to 100 kA
	Arc fault containment	Rated operational voltage	400 V / 690 V
		Prospective short-circuit current	100 kA / 65kA
		Duration	300 ms
		Criteria (IEC TR 61641)	1 to 7
Mechanical characteristics	Dimensions	Cubicles and frames	DIN 41488
		Recommended height	2300 mm
		Recommended width	400, 600, 800, 1000, 1200 mm
		Recommended depth	1000, 1200, 1400 mm
		Basic grid size	1E = 25 mm acc. to DIN 43660
	Degree of protection	According to IEC 60529	External from IP 30 to IP 54 Internal IP XXB
	Form of separation	up to Form 4b	
	Steel components	Frameincl. internal subdivisions	2.0/2.5 mm
		Cladding, internal	1.5/2.0 mm
		Cladding, external	1.5 mm
	Surface protection/ paint	Frame incl. internal subdivisions	Zn or Al-Zn coated
		Cladding, internal	Zn or Al-Zn coated
		Cladding, external	Zn or Al-Zn coated and powder coated RAL 7035 (light grey)
	Plastic components	Halogen-free, self-extinguishing, flame retardant, CFC-free	IEC 60707, DIN VDE 0304 part 3
Extras	Busbar system	Busbars	Bare or insulated copper, silver plating or tin plating
	Paint	Enclosure	Standard RAL 7035, other colors on request

*Depending on the electrical equipment

02. Operational Safety and Availability

The fulfillment of all instructions of the relevant standard for Low Voltage switchgear and control-gear assemblies assures a basic level for personal and system protection. With MNS, ABB exceeds these levels as a standard. ABB goes beyond the standards with the proven Safety "Plus" for Operators and Plants and additionally in cases where a high degree of exposure is anticipated, or specific risks (e.g. earthquake risk) needs to be observed.

To ensure safety of plant and personnel, MNS Rear has been tested in accordance with IEC 61641 standard for conditions of arcing due to an internal fault. There are five criteria observed for the test of personal protection. In line with its 'Safety Plus' statement, ABB ensures that all five criteria are met. In addition to these five criteria, MNS Rear also meets the additional plant protection criteria as detailed in IEC 61641 (criteria 6 and 7).

For more information on arc fault containment the "MNS & MNS iS Low Voltage Switchgear Safety Aspects" brochure delivers essential considerations concerning plant and personal safety assured by MNS, such as:

- Basic safety philosophy
- Switchgear assembly verified by testing
- Arc fault protection
- Degrees of protection (IP code)
- Internal separation
- Earthquake, vibration and shock
- Neutral conductor dimensioning

03. Switchgear Design

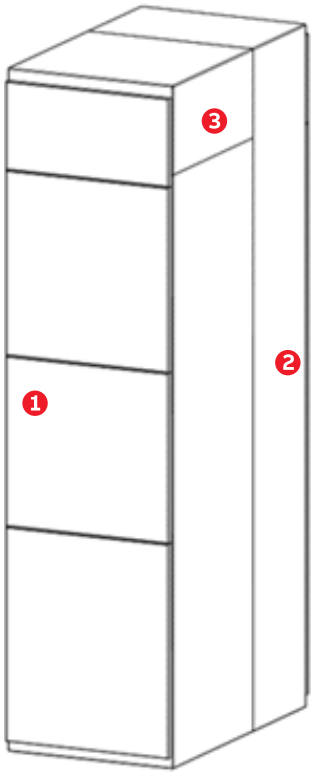
Functional Compartments and Segregation
The assembly is divided into compartments thus separating different functional areas.

Air circuit breaker cubicle

1 Equipment compartment
The equipment compartment is divided into sub-sections & accommodates ACB in withdrawable design. Auxiliary compartment is located on the top/bottom and/or on the right side of equipment compartment.

2 Cable compartment
The cable compartment located at rear and houses the incoming or outgoing cables. Cable entry may be top or bottom.

3 Busbar compartment
Located at the top and contains the MNS Rear main busbar system.



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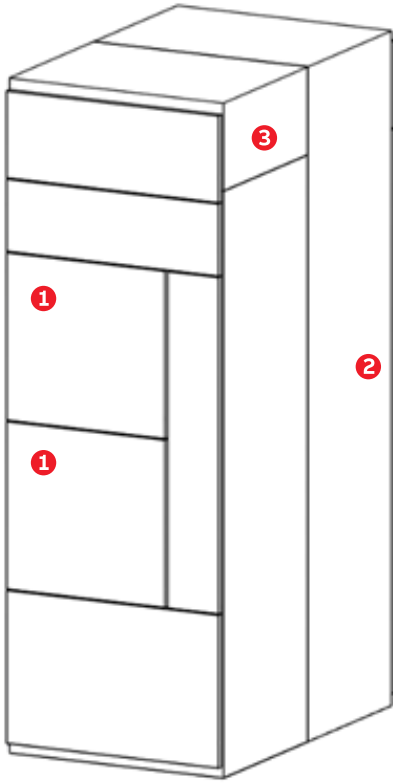
Single ACB Cubicle



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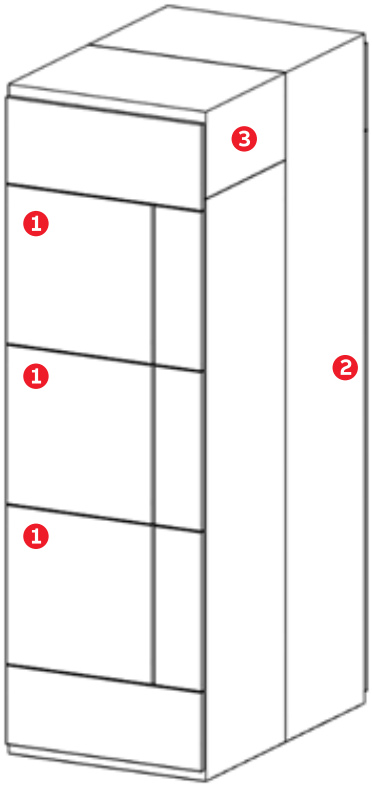
Double stacked ACB Cubicle



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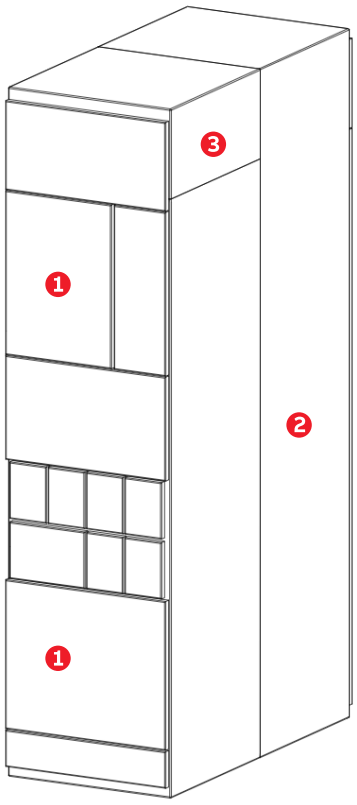
Triple stacked ACB Cubicle

Combined Air circuit breaker & modules cubicle

1 Equipment compartment
The equipment compartment is divided into two subsections. The upper subsection accommodates ACB unit in withdrawable design. The lower subsection is for withdrawable modules.

2 Cable compartment
Contains control cables and terminals, as well as power cables and connection units. Cable entry may be top or bottom.

3 Busbar compartment
Busbar compartment includes main busbar compartment and distribution busbar compartment. Main busbar compartment locates at the top. The distribution busbars are embedded in the multi-function separator (MFS) which is in distribution busbar compartment located between equipment compartment and cable compartment.

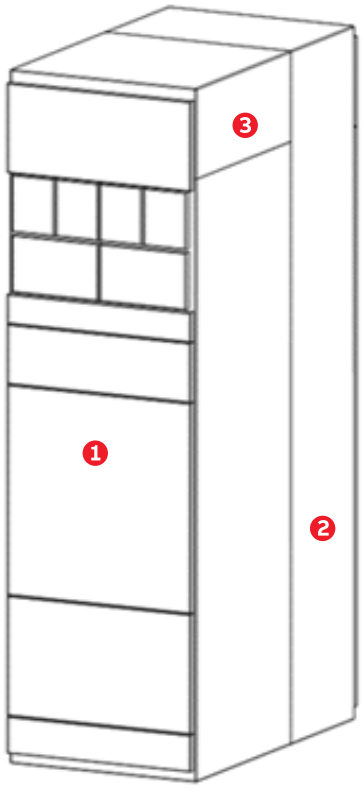


Module cubicle

1 Equipment compartment
All equipment, including motor starter modules in withdrawable design, is situated therein. The compartment can be divided into horizontal and vertical sub compartments.

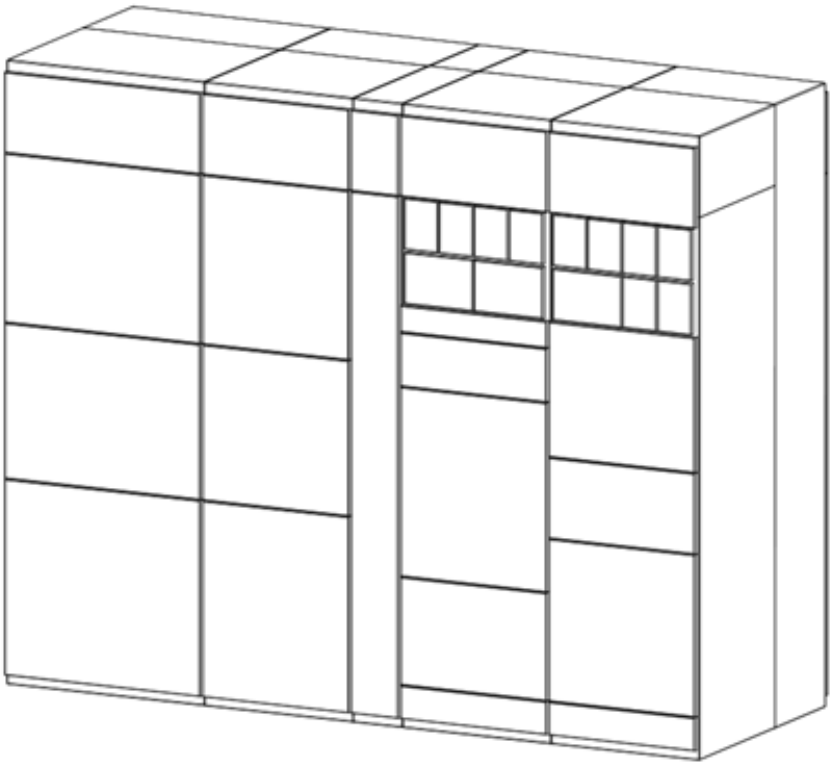
2 Cable compartment
Contains control cables and terminals, as well as power cables and connection units. Cable entry may be top or bottom.

3 Busbar compartment
Busbar compartment includes main busbar compartment and distribution busbar compartment. Main busbar compartment locates at the top. The distribution busbars are embedded in the multifunction separator (MFS) which is in distribution busbar compartment located between equipment compartment and cable compartment.

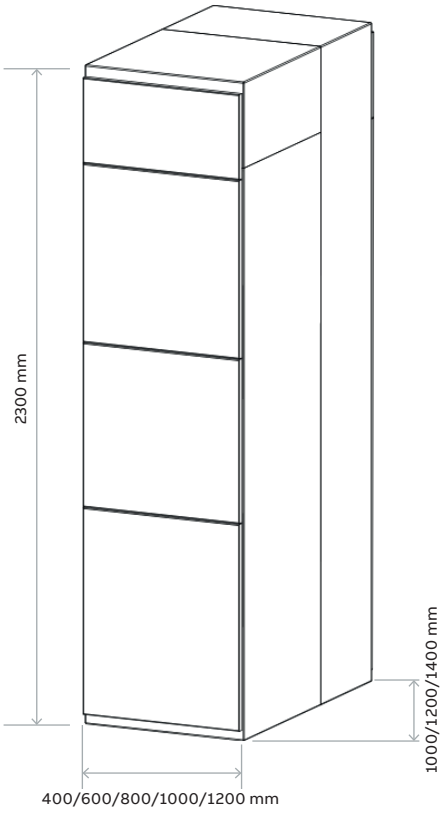


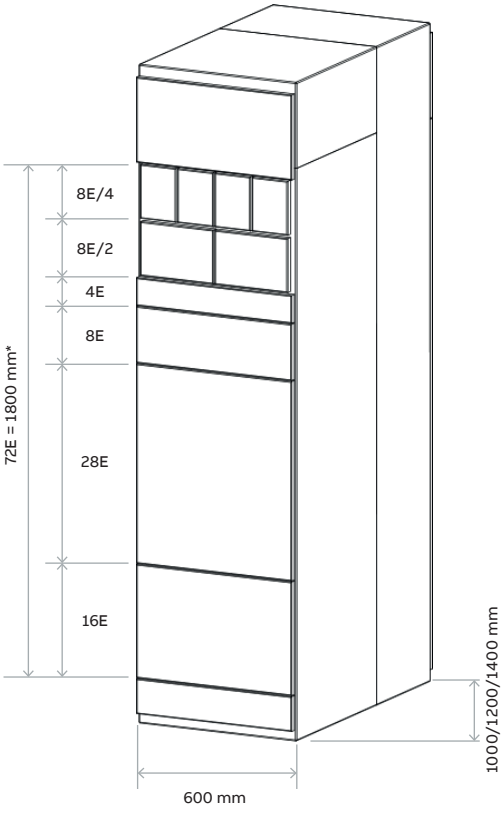
Switchboard arrangements
MNS Rear cubicles are arranged as free standing. They cannot be back to wall as the cable compartment is at the rear.

Operational Access to devices/modules - Front.
Feeder terminal access - Rear.

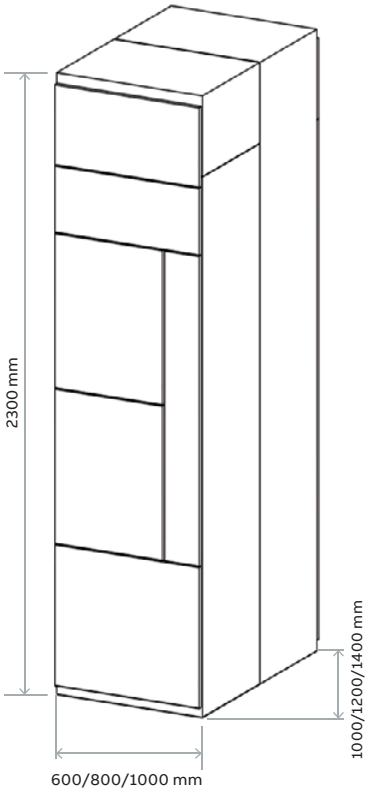


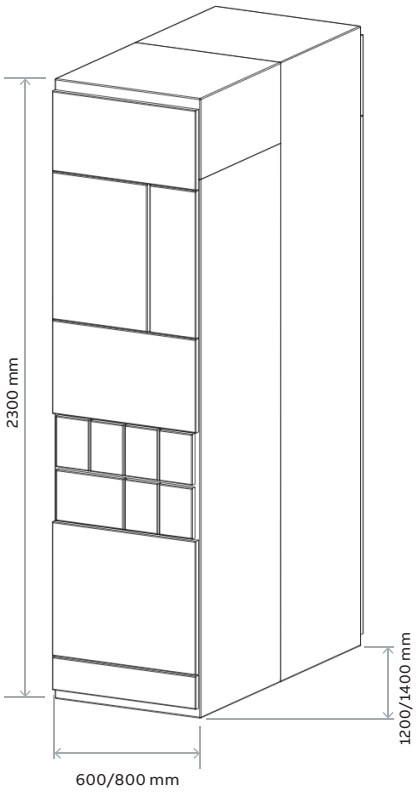
Switchboard dimensions
MNS Rear cubicles have the following representative dimensions:





*64E = 1600 mm for main busbar >= 6300 A





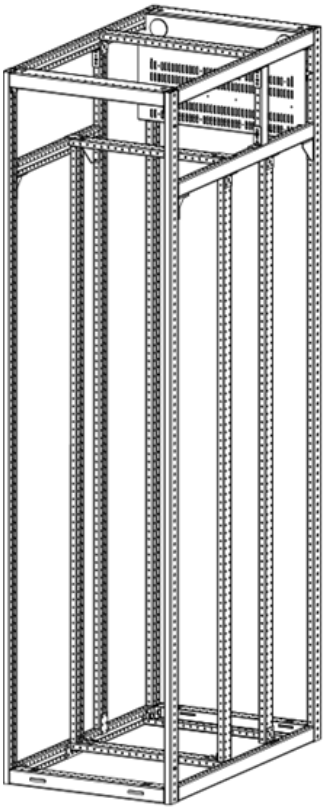
*32E = 800 mm for main busbar >= 6300 A

Mechanical Design

Frame construction
The basic elements of the MNS Rear frame construction are “C” shaped steel profiles with a 25 mm hole pitch according to DIN 43660. This 25 mm equals the dimension of 1E used in MNS Rear to define the area usage within the switchgear.

Each cubicle is precision constructed by bolting horizontal and vertical profiles together, to form a rigid modular structure. The assembly is maintenance free as a result of the construction method utilizing a combination of thread locking ESLOK screws with bolted pressure plates and thread forming screws.

The profiles are galvanic protected (Zn or Al/Zn) against corrosion.



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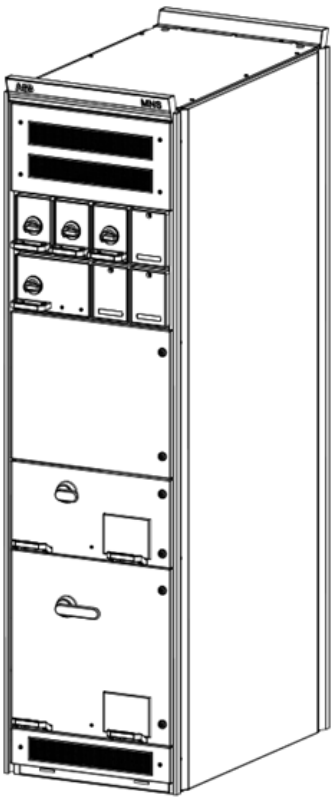
Frame construction

Enclosure

MNS Rear switchboard enclosure is made of sheet steel protected by galvanic coating and powder coating for maximum durability.

The fixing of the enclosure with respect to doors, roof plates and side walls is achieved with thread forming screws. Final construction varies depending upon the required degree of protection.

In accordance with the general safety philosophy followed with MNS, each compartment and sub-compartment which requires access for commissioning, operation or maintenance, has its own door.



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Enclosure

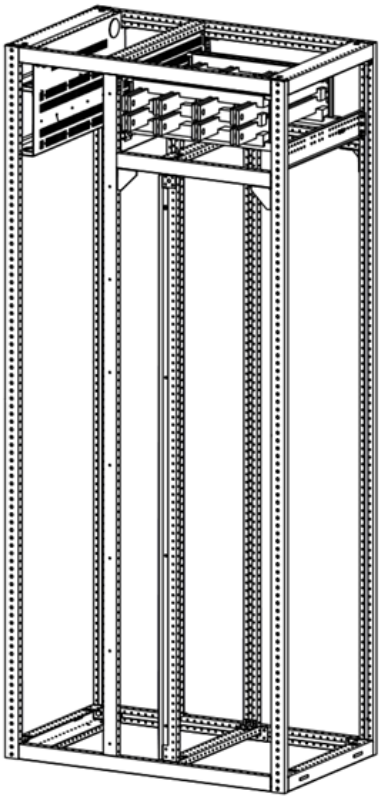
Busbar System

Main Busbars

MNS Rear main busbar system is arranged at the top of the switchgear. The main busbar system is separated from the equipment compartment as well as from the cable compartment.

The busbar system is a maintenance free construction as a result of utilizing thread locking ESLOK screws together with conical spring washers. This technology remains relatively unchanged since the introduction of MNS and has been extensively supplied into the most demanding industries.

The busbar system and all associated parts are manufactured from copper in accordance with DIN 40500. Options are available for silver plating or tin plating.



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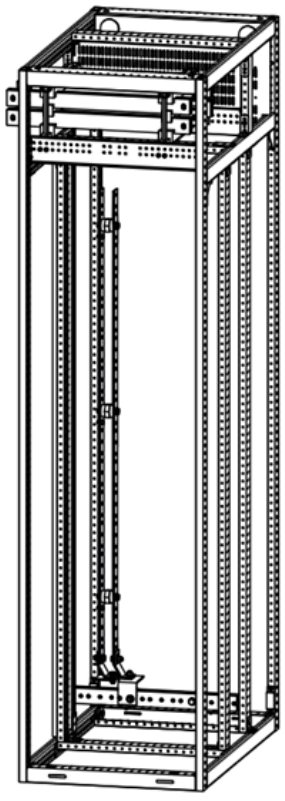
Main Busbars

Protective Earth and Neutral Bars

As a standard, protective earth and neutral bars run horizontally within the rear of the switchboard just above the base. The PE bar is fastened to the frame to assure electrical continuity. Inside the cable compartment they run vertically, located on the rear of the compartment.

For applications where a 100% neutral size is required due to unbalance or harmonic distortion as well as for 4 pole switching, the neutral conductor can be arranged within the busbar compartment running in parallel with the main busbars.



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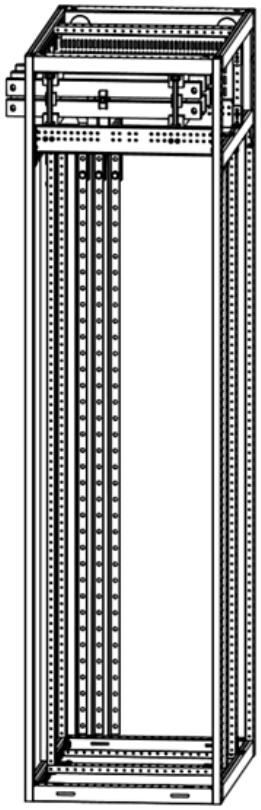
Protective Earth and Neutral Bars

Distribution busbars
A fully phase segregated and encapsulated 3 or 4 pole distribution busbar system runs the full height of the cubicle.

The distribution busbars are silver plated as standard.



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Distribution busbars

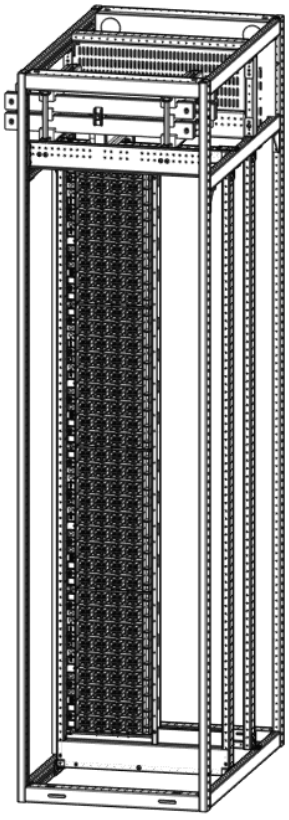
Multifunction separator
The multifunction separator with the embedded distribution busbars is a unique MNS design. It constitutes a complete barrier between equipment compartment and cable compartment.

The distribution busbars are fully phase segregated and insulated. This design makes it virtually impossible for an arc to pass between distribution busbar phases or between equipment compartment and cable compartment. The insulation material is CFC and halogen free. it is also flame-retardant and self-extinguishing.

Contact openings are finger proof (IP 2X) so that personal safety is guaranteed even when modules are removed.

With the use of MNS specific power contact housings full single phase segregation is assured prior to the connection of the power contacts to the distribution busbars.

Highlights
- Maintenance free busbar construction.
- Easy switchgear extension.
- Main busbar arrangement at the TOP thus assuring.
  - maximum safety to personnel.
  - effective withstand against highest stresses in case of short circuit.
  - optimum heat dissipation.
- Gas tight seals for connection from equipment compartment to cable compartment.
- Separation up to Form 4b
- Active and passive arc fault prevention tested according to IEC 61641.
- Isolating materials are free of CFC and halogens.



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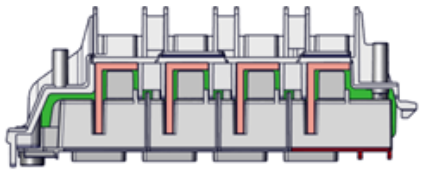
Multifunction separator

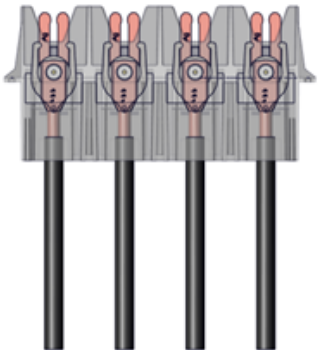
Power Contact
Connection to the distribution busbar is realized using the precision-engineered MNS power contacts. The power contact is characterized by a tunable bearing, thus decoupling cable stress and electrical contact. Consequently, any cable bending forces cannot affect the stability of the power contact.

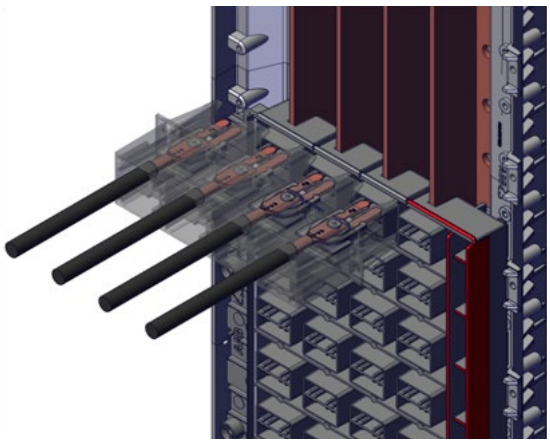
The mechanical stabilization is achieved by the supporting plate and the contact spring where the contact fingers ensure positive electrical contact. Contact fingers are silver plated as standard.

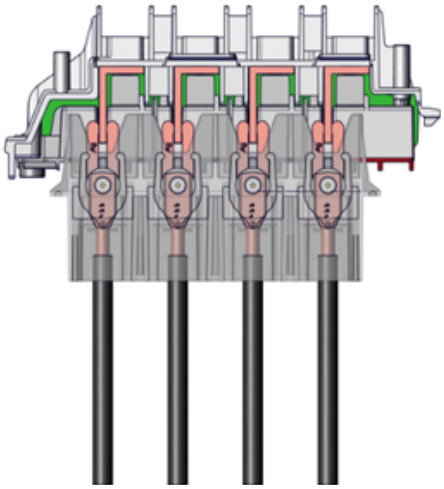
The contact has been subjected to several tests in order to prove the sophisticated design and the high quality, which provides a life cycle up to 1000 insertions.

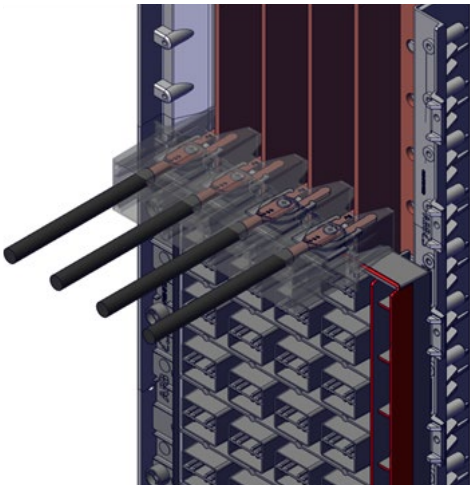
Tests:
- Design verification acc. IEC 61439-1/-2
- Corrosion test acc. DIN 50017 and IEC 60068-2-60
- Crimping quality check acc. IEC 61238-1
- Vibration and shock test acc. IEC 60068-2-6 and IEC 60068-2-27











System Highlights
- Operational life cycle up to 1000 insertions (independently certified)
- Bearing construction eliminating cable stress
- Full single phase segregation assured prior to the connection of the power contacts to the distribution busbars.

04. Withdrawable Modules

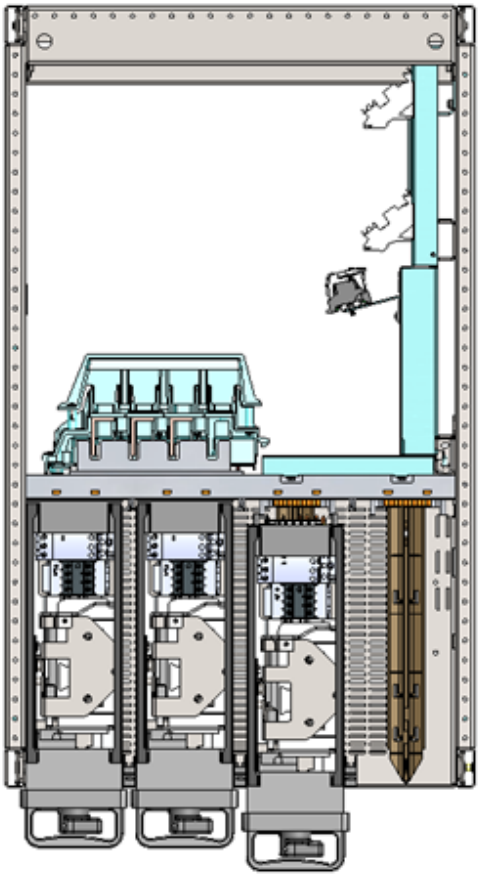
Where high process availability is essential and minimal time is required for module exchange the withdrawable solution has proved to be the definitive choice.

The withdrawable technique has proved to be the appropriate solution for use in industrial applications where requirements for high availability are a must particularly in Motor Control Centers (MCC).

Modules can be easily exchanged under operational conditions thus assuring maximum flexibility.

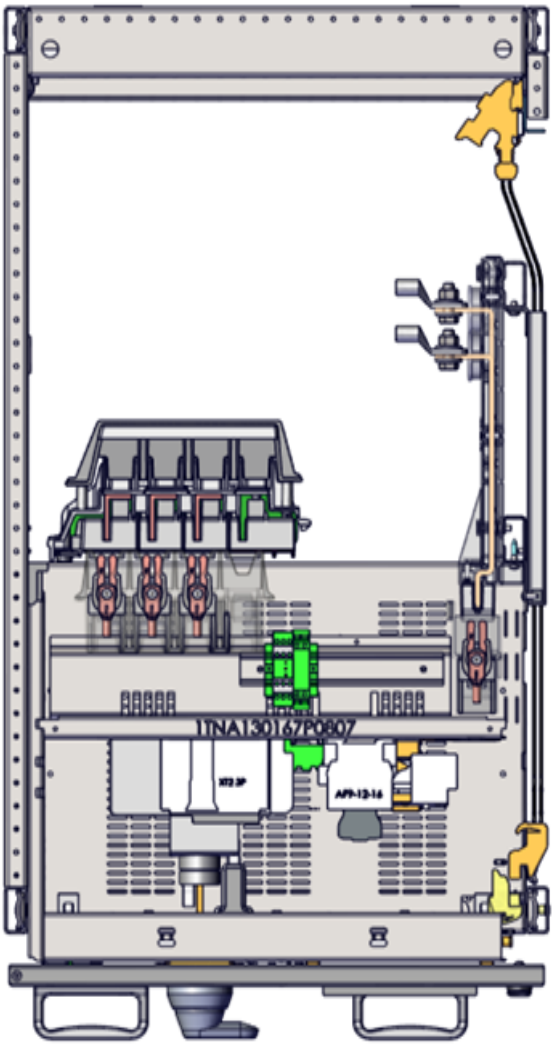
Small modules
Withdrawable technique is distinguished by its compact design where, with the smallest 8E/4 module it is possible to physically define a maximum of 36 modules in the equipment compartment. This modularity enables the assembly to maximize the usage of the available space, which in turn reduces the overall footprint of the switchgear.

The condapter unit enables the horizontal distribution of power from the vertical distribution busbars, this allows 2 modules (8E/2) or 4 modules (8E/4) to be located adjacently within the same horizontal position in the cubicle. Condapter are available in 3 or 4 pole options. Cable connections for main and auxiliary circuits are integrated into the condapter and are accessible from the cable compartment.



Full width modules
These modules are available ranging from 4E to 24E in physical sizes. The construction of the full modules differs slightly from that of the small modules in utilizing a full width hinged door which is mechanically interlocked to the isolator. All operational procedures for the modules are possible without the need to open the door of the module.

Full width modules connect directly to the distribution busbars through the multifunction separator. The design of the module enables auxiliary components to be located on both the vertical and horizontal mounting plates within the module, thus optimizing the available space usage within the module. Cable connections for main and auxiliary circuits are accessible from the cable compartment.



Module operation
Withdrawable modules are operated with the multifunction operating handle. This handle also activates the electrical and mechanical interlocking of the module and the module door. No further tools or unlocking devices are necessary to withdraw a module, thus replacing a module may take less than a minute. Replacement as well as retrofitting of modules can be performed under live conditions, should plant operating procedures allow.

Highlights
- High stacking density, resulting in a reduced footprint
- Complete phase isolation of main power contact prior to connection to the distribution busbars
- Full module functionality with external operation
- Module replacement possible in less than a minute, no tools required

Withdrawable module positions
All main and auxiliary connections are self locating, without the need of additional tools.

ON: Module is inserted, main switch closed, main and control circuit connected

OFF: Module is inserted, main switch open, main and control circuit disconnected, padlocking possible.

TEST: Module is inserted, main switch open, main circuit disconnected, control circuit connected, padlocking possible

ISOLATED: Module is withdrawn 30 mm from the inserted position, main switch open, main and control circuit disconnected, padlocking possible

MOVE: Module can be completely withdrawn from the switchgear

All positions / situations are clearly marked on the fixed section of the operation handle in accordance with IEC 61439-1/-2.

05. MNS Rear Fixed

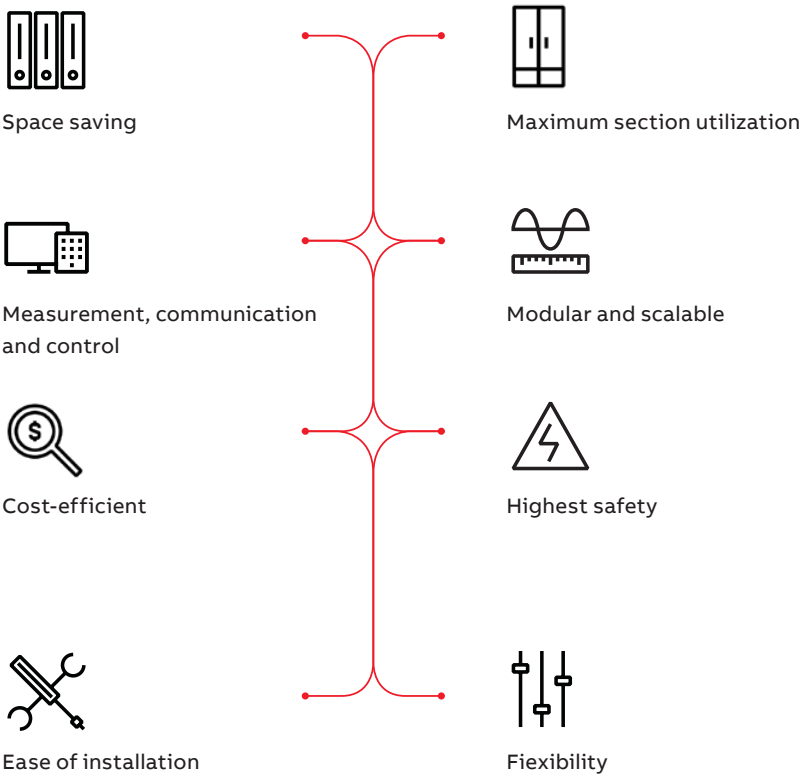
MNS Rear Fixed offers

- Enhanced alignment for light process, infrastructure and food & beverage industries, utilities, and data centers.
- Maximum safety: ensured through design-verified solution according to I EC 61439-2 and IEC TR 61641 Ed.3.
- Footprint reduction: up to 33% space saving compared to alternative Withdrawable Modules.
- Flexible and bespoke: unified integration with the wider MNS portfolio.
- Digital option: application of digital devices that enable condition monitoring and seamlessly integrate into the ABB Ability™ digital portfolio.

MNS Rear Fixed is a cost-efficient solution spanning all industries and applications. The space-saving design enables a footprint reductuin through maximum utilization of each section height.

Safety is a priority. MNS Rear Fixed exceeds the requirements of IEC 61439-2, rigorous testing has been conducted to ensure safety, availability and reliability.

Why choose MNS Rear?



06. Air circuit breaker cubicles

All the air circuit breaker (ACB) cubicles are verified in accordance with IEC 61439-1/-2, in addition to IEC 60947-1 required for the individual apparatus and engineered to meet the requirements of IEC 61641. This ensures ABB's offering of 'Proven Safety Plus' for operators and plant.

Minimum features
All ACBs have the following minimum features:
- Manual charging lever and 'Charged' indication
- Manual Open / Close push buttons
- Mechanical 'Open' / 'Closed' indication
- Mechanical signaling of 'Overcurrent' release
- 4 auxiliary contacts

Project Specific Options
- Separated from the main busbars (separation wall)
- 3 or 4 pole solutions
- Withdrawable configuration
- Top or bottom cable entry / Top bus duct entry
- 50% or 100% neutral
- Shunt opening / closing release
- Undervoltage release
- Electrical signalization of ACB status
- Key locking facilities
- Shutter locking facilities
- Mechanical indication 'Racked In' / 'Racked Out' / 'Test Isolated' position
- Locking in 'Racked In' / 'Racked Out' / 'Test Isolated' position
- Switch disconnector option
- ACB handling truck
- Configuration and test unit

Further options available (but not limited to):
- Zone selectivity
- Dual protection settings
- Directional short circuit protection
- Reverse power
- Under-/overvoltage protection
- Annunciation of measured values, alarms
- Maintenance data
- Integration into a plant wide process control system (refer to page 25)


ABB
SACE Emax 2


In=2500A
SACE Ekip Touch LSIG
Measuring
Protections
Advanced
Measure
Settings
Test
Info
ABB

In addition to the above ABB circuit breakers offer a series of integrated programmable releases (PRs), where combinations of protection functions maybe selected with:
• Overload protection - L
• Selective short circuit protection - S
• Instantaneous short circuit protection – I
• Earth fault protection – G

ACB withdrawable operation
In a withdrawable solution the ACB assembly consists of two components, the fixed part (cassette) and the moving part (ACB). This enables the ACB to be in 3 positions:

CONNECTED: The moving part is fully inserted into the fixed part with the connection of both the power terminals and the auxiliary contacts. The circuit breaker is operational, and the mechanical indicator shows ‘CONNECTED’.

TEST/ISOLATED: The moving part is inserted into the fixed part without the connection of the power terminals, but with connection of the auxiliary terminals. The circuit breaker may be operated for offline tests. The mechanical indicator shows ‘TEST ISOLATED’.

DISCONNECTED: The moving part is inserted into the fixed part without any connection of the power and auxiliary terminals. In this position all electrical operation of the ACB is prevented. The mechanical indicator shows ‘DISCONNECTED’. The switchgear compartment door can remain closed, therefore not compromising the IP degree of the switchgear.

The ACB cassette (fixed part) has shutters which are positively driven closed during the racking out process to prevent the possibility of contact with live parts.

07. Integration into plant-wide Control Systems

System Connectivity Aspects
ABB's structure with respect to offering site wide information is that a field bus connection for process control information and switching commands is utilized. An additional interface, which is typically Ethernet is used to support functions such as parameterization, data distribution to electrical SCADA and / or asset optimization systems. This configuration is also continued through the ABB medium voltage product portfolio.

Configuring the structure as detailed above ensures that the critical process data path is not compromised by also being utilized for parameterization and additional data required for engineering and maintenance.

With the introduction of MNS, ABB has been providing market leading low voltage switchgear systems technology. In 1987 ABB installed the world's first intelligent low voltage motor control center, since then ABB has delivered over 200,000 intelligent motor controllers.

08. After Sales and Service

ABB's goal is to ensure the assets' maximum performance and availability. ABB has supplied over 1.5 million MNS cubicles from its worldwide manufacturing locations. Each of these locations operates with an After Sales and Service department, offering unparalleled global support.

On completion of commissioning, the switchgear is at the peak of its performance. To maintain this condition, it is essential to adopt a service and maintenance plan for this asset. If the switchgear does not receive maintenance, this could result in downtime. In production the availability of the switchgear ensures productivity, and any down time is a lost opportunity for profit. Down time can be attributed to the following maintenance practices.

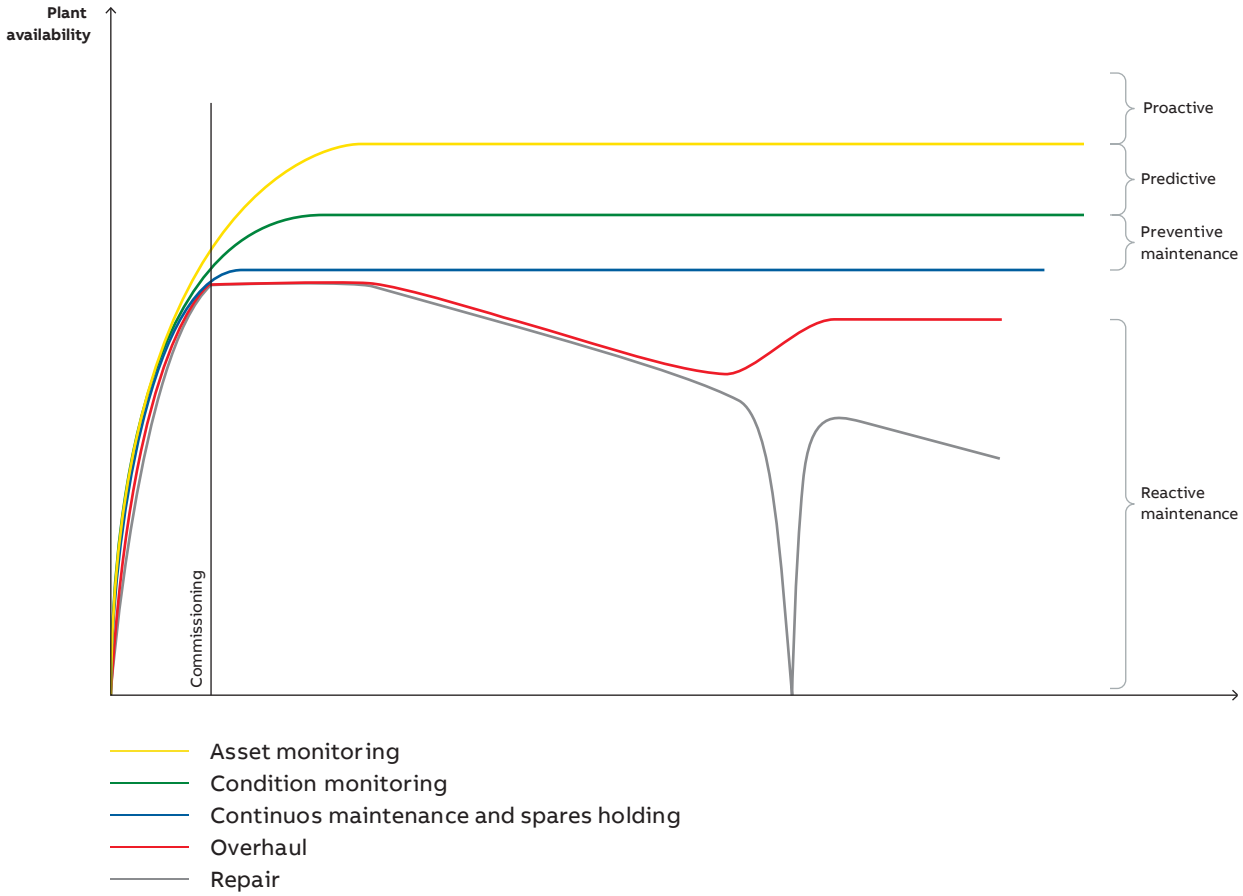
- Reactive maintenance is costly for both production and unplanned downtime.
- Preventive or Continuous maintenance is usually performed on an annual basis, during a scheduled shutdown.
- By evaluating information from the intelligent switchgear, it is possible to adopt a Predictive maintenance schedule.
- Utilizing an ABB expertise can help to increase the life cycle of the switchgear.

Regular Services
ABB offers comprehensive service and support during the whole life time of the switchgear:

- Engineering assistance
- Product training
- Spares holding
- Installation and commissioning
- Service planning
- Hardware and software support
- Upgrades, expansions and modifications

Contract Services
ABB can offer comprehensive maintenance contracts designed specifically for each particular process. Through preventive maintenance programs unscheduled outages can be reduced and maintenance workflows are streamlined.

Utilization of integrated switchgear enables the maintenance to be taken into an even predictive maintenance practice, where information available from the switchgear can further assist with maintenance workflow.


Plant availability
Commissioning
Proactive
Predictive
Preventive maintenance
Reactive maintenance
Asset monitoring
Condition monitoring
Continuos maintenance and spares holding
Overhaul
Repair

09. Annex

Items subject to agreement between manufacturer and user
The following details are intended as a checklist for the specification of low voltage switchgear.

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Extract from IEC 61439-1/-2

User defined functions and characteristics	**Reference clause (for Parts 1 and 2)**
Electrical system	
Earthing system	5.5, 8.4.3.2.3, 8.6.2, 10.5, 11.4
Rated voltage U_n (Volts)	3.8.8.1, 5.2.1, 8.5.3
Overvoltage category	5.2.4, 8.5.3, 9.1, Annex G
Unusual voltage transients, voltage stresses, temporary overvoltages	9.1
Rated frequency f_n (Hz)	3.8.11, 5.4, 8.5.3, 10.10.2.3, 10.11.5.4
Additional on site testing requirements: wiring, operational performance and function	11.10
Short circuit withstand capability	
Prospective short circuit current at supply terminals I_{cp} (kA)	3.8.6
Prospective short circuit current in the neutral	10.11.5.3.5
Prospective short circuit current in the protective circuit	10.11.5.6
SCPD in the incoming functional unit	9.3.2
Co-ordination of short-circuit protective devices including	
external short-circuit protective device details	9.3.4
Data associated with loads likely to contribute to the short circuit current	9.3.2
Protection of persons against electric shock in accordance with IEC 60364-4-41	
Type of protection against electric shock – Basic protection (protection against direct contact) **Note:** This type of protection is intended to protect against electric shock due to direct contact within the ASSEMBLY during normal service conditions.	8.4.2
Type of protection against electric shock – Fault protection (protection against indirect contact) **Note:** These types of protection are intended to protect against the consequences of a fault within the ASSEMBLY	8.4.3
Installation environment	
Location type	3.5, 8.1.4, 8.2
Protection against ingress of solid foreign bodies and ingress of liquid	8.2.2, 8.2.3
External mechanical impact (IK) **Note:** IEC 61439-1 does not nominate specific IK codes.	8.2.1, 10.2.6
Resistance to UV radiation (applies for outdoor assemblies only unless specified otherwise)	10.2.4
Resistance to corrosion	10.2.2
Ambient air temperature – lower limit	7.1.1
Ambient air temperature – upper limit	7.1.1
Ambient air temperature – daily average maximum	7.1.1
Maximum relative humidity	7.1.2
Pollution degree	7.1.3
Altitude	7.1.4
EMC environment	9.4, 10.12, Annex J
Special service conditions (e.g. vibration, exceptional condensation, heavy pollution, corrosive environment, strong electric or magnetic fields, fungus, small creatures, explosion hazards, heavy vibration and shocks, earthquakes)	7.2, 8.5.4, 9.3.3, Table 7

User defined functions and characteristics	Reference clause (for Parts 1 and 2)
Installation method	
Type	3.3, 5.5
Portability	3.5
Maximum overall dimensions and weight	6.2.1
External conductor type(s)	8.8
Direction(s) of external conductors	8.8
External conductor material	8.8
External phase conductor, cross sections, and terminations	8.8
External PE, N, PEN conductors cross sections, and terminations	8.8
Special terminal identification requirements	8.8
Storage and handling	
Maximum dimensions and weight of transport units	6.2.2, 10.2.5
Methods of transport (e.g. forklift, crane)	6.2.2, 8.1.7
Environmental conditions different from the service conditions	7.3
Packing details	6.2.2
Operating arrangements	
Access to manually operated devices	8.4, 8.5.5
Isolation of load installation equipment items	8.4.2, 8.4.3.3, 8.4.5.2
Maintenance and upgrade capabilities	
Requirements related to accessibility in service by ordinary persons; requirement to operate devices or change components while the ASSEMBLY is energized	8.4.5.1
Requirements related to accessibility for inspection and similar operations	8.4.5.2.2
Requirements related to accessibility for maintenance in service by authorized persons	8.4.5.2.3
Requirements related to accessibility for extension in service by authorized persons	8.4.5.2.4
Method of functional units connection	10.2.4
Note: This refers to the capability of removal and reinsertion of functional units.	8.5.1, 8.5.2
Protection against direct contact with hazardous live internal parts during maintenance or upgrade (e.g. functional units, main busbars, distribution busbars)	8.4
Method of functional units connection	7.1.1
Note: This refers to the capability of removal and reinsertion of functional units.	8.5.101
Form of separation	8.101
Capability to test individual operation of the auxiliary circuits relating to specified circuits while the functional unit is isolated	3.1.102, 3.2.102, 3.2.103, 8.5.101, Table 103
Current carrying capability	
Rated current of the ASSEMBLY I_{nA} (Amps)	3.8.9.1, 5.3, 8.4.3.2.3, 8.5.3, 8.8, 10.10.2, 10.10.3, 10.11.5, Annex E
Rated current of circuits I_{nc} (Amps)	5.3.2
Rated diversity factor	5.3.3, 10.10.2.3, Annex E
Ratio of cross section of the neutral conductor to phase conductors: phase conductors up to and including 16 mm^2. **Note:** Current in the neutral may be influenced where there are significant harmonics, unbalanced phase currents, or other conditions in the load that will necessitate a larger conductor.	8.6.1
Ratio of cross section of the neutral conductor to phase conductors: phase conductors above 16 mm^2. **Note:** For the standard value, the neutral current is assumed not to exceed 50% of the phase currents. Current in the neutral may be influenced where there are significant harmonics, unbalanced phase currents, or other conditions in the load that will necessitate a larger conductor.	8.6.1

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